A Biological Model of Union Politics[*]

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Abstract

This paper applies principles from evolutionary biology to the study of unions. We show that unions which maximize the present discounted wages of current members will be displaced in evolutionary competition by unions with more moderate wage policies that allow their firms to live longer. This suggests that unions with constitutional incumbency advantages that allow leaders to moderate members' wage demands may have a selective advantage. When incumbency advantages are exogenously reduced, the model predicts unions should increase their wage demands. These predictions seem broadly consistent with the evidence.

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Biological models suggest that selection pressure often works against organisms that are too harmful to their hosts. For example, a disease such as the Ebola virus, which kills its hosts in days, has little opportunity to spread from one host to another. In contrast, the viruses that cause the common cold are widespread. Mitochondria, which were probably originally parasites, evolved to become essential to their hosts and are now universal.

This paper applies this basic biological concept from evolutionary biology to the interaction between unions and firms and compares the results to a model in which unions maximize the present discounted rents of members. We argue that unions that demand the level of wages optimal for their members will be displaced in competition with more moderate unions. In our model, the dynamics of union coverage depend on both the rate at which unions spread to non-union firms and the rate at which unionized firms die. Greater rent extraction by a union can increase the spread rate of the union by making the union more attractive to workers in non-unionized firms. On the other hand, greater rent extraction by unions can also lead to increases in the death rates of unionized firms. The evolutionarily stable level of rent extraction therefore involves a tradeoff between attractiveness to workers and the effect on firm death rates.

The model suggests that reducing the level of rent extraction slightly from the level that maximizes the present discounted value of rents to union members causes a second-order reduction in members' welfare, and hence in the spread of unions, but a first-order reduction in the death rate of unionized firms. Selection pressure therefore favors unions with lower levels of rent extraction than would be optimal for workers.

In biology, evolutionary pressures may be the ultimate cause of an organism's attributes, but the proximate cause of those attributes are specific genes and the resulting chemical processes. Similarly, while evolutionary pressures may select for a union that tends to moderate worker's wage demands, there must be specific persistent organizational mechanisms that make unions more moderate. For example, if a union is controlled by its rank and file, its members will vote for the policies that maximize their welfare rather than the policies that would survive evolutionary competition. In the presence of incumbency advantages, however, union leaders may choose to moderate wage demands, which would benefit workers, in return for contract provisions that benefit the union leadership. Selection pressure may therefore also favor unions with constitutional incumbency advantages that allow leaders to pursue more moderate wage demands than those preferred by the rank and file.

There is evidence for these implications. Most existing unions do, in fact, have constitutions that create strong advantages for incumbents. Furthermore, rank and file dissident movements almost always demand more rent extraction than union leadership, suggesting that the policies of unions tend to be more moderate than would be optimal for workers. In several cases in which incumbency advantages have been weakened due to plausibly exogenous factors, dissident movements have become powerful, wage demands have escalated, and industries have declined. The model also suggests that if multiple unions compete for the same workers within firms, as in several European countries, incumbency advantages will be weaker and unions will have to adopt more militant policies.

This paper builds on earlier work. Dickens and Leonard [1985] and Freeman [1983] show that unions must continually organize new enterprises in order to offset the natural decline in membership due to turnover among firms. Freeman [1998] documents sudden spurts in unionization followed by gradual declines. He accounts for this in a model in which as unionization levels increase, it becomes first easier and then more difficult to unionize new firms. This means that there will be one steady-state level of unionization at zero, and one positive steady state. Hannan and Freeman [1987, 1988] use a sociological model of organizational ecology to examine how birth and death rates of unions depend on the existing number of unions. This paper differs in explicitly examining the predator-prey population dynamics involving unions and firms and in deriving the implications for union politics.

This paper is also related to several papers that apply biological techniques to other economic situations. Dutta and Radner [1999] argue that firms that retain more earnings than would be optimal for their shareholders will survive longer and eventually outnumber firms that retain the optimal amount. This paper differs in methodology from Dutta and Radner, however, by explicitly modelling the spread of unions within a population of firms and by considering competition among unions in determining which unions will survive.

The focus of this paper is on deriving endogenously the evolutionarily stable level of rent extraction and its implications for union politics. In a related paper (Kremer and Olken [2001]), we explore extensions to the model that take the level of rent extraction by unions as given. We show that if negative shocks to firms reduce productivity but are not fatal to firms, then there can be multiple equilibria–one equilibrium with low productivity and high unionization and one with high productivity and low unionization. We also present empirical evidence documenting the model's implication that increases in the death rate of firms should lead to lower unionization levels.

The remainder of the paper is organized as follows. Section 1 provides background on relevant U.S. collective bargaining institutions. Section 2 presents the model and solves for the steady-state level of unionization with a single union and an exogenously given level of rent extraction. Section 3 contrasts economic and evolutionary models of the determination of levels of rent extraction, and finds that the evolutionarily stable level of rent extraction is less than that which maximizes the welfare of the workers. Section 4 discusses the model's implications for union institutions, and shows that incumbency advantages for union leaders will be present in the evolutionarily stable union. Section 5 presents evidence from the history of unions that suggests the model's predictions seem consistent with union behavior. Section 6 concludes by arguing that the welfare effects of unions, and of union moderation, are ambiguous under the model, and by discussing the applicability of this biological approach to other institutions.

1 Background on U.S. Collective Bargaining Institutions

Before introducing the model, it is useful to review a few features of U.S. collective bargaining institutions relevant to the model. Outside of construction, music, and a few other industries, most new firms begin life without unions. Under the Federal law covering most industries, if thirty percent of workers sign a petition calling for an election, a certification election supervised by the National Labor Relations Board (NLRB) is held. A union is recognized if more than half the workers vote for it in such an election.

Support from existing unions plays an important role in unionizing new firms. Not only are workers more likely to support unions if they have friends or relatives who are union members, but hired union organizers, paid for through dues of existing union members, also play an important role. These paid organizers are often critical in obtaining the signatures required to have an election and in campaigning for union certification, because unlike activists within firms, paid organizers are not susceptible to threats from management. Workers at a plant are theoretically protected from retaliation for supporting a union, but penalties for dismissing union supporters are weak, and union activists are often dismissed. In fact, one in twenty workers who vote for a union in an organizing election are later found to have a valid claim for unfair dismissal by the NLRB [Weiler, 1984]. The percentage among union activists is likely to be even higher, making it dangerous for workers in a firm to openly campaign for a union in an NLRB election. In addition to making organizing activities hazardous for employees, firms also use legal tactics to delay unionization votes, such as challenging definitions of the bargaining unit and thus the set of workers who are eligible to vote in the NLRB election. Responding to these challenges requires lawyers and money, which existing unions can help provide.

Once a firm unionizes, workers can theoretically deunionize through a decertification election, or vote to change their affiliation from one union to another. In practice, however, decertifications are infrequent, and switching union affiliations rarely happens, given the organizing costs involved and the reluctance of unions to poach each others' territory. In fact, the AFL-CIO constitution explicitly prohibits member unions from attempting to organize a firm currently organized by a different AFL-CIO member union. When unions decline, it is therefore not primarily because of decertification elections, but rather because the firms covered by the union reduce employment or close down a unionized location altogether.

The model in this paper is designed to apply to those U.S. industries covered by the standard NLRB rules: new firms start as non-union; paid union organizers play an important role in unionizing new firms; and once employees at a firm vote in a particular union, the firm stays unionized for the remainder of its life.[1] The resulting dynamics of unionization levels bear a similarity to those under the Susceptible-Infected (SI) model of epidemiological dynamics (see Anderson and

[1] As discussed above, in a few industries, such as construction, textiles, and music, institutions differ, and new firms often start out unionized. The model is not intended to apply to these industries.

May [1991]). In that model, new potential hosts are born uninfected; the chance that they become infected increases with the number of hosts already infected; and once hosts are infected, they stay infected until they die. (As discussed in the conclusion, this comparison is purely positive, not normative.)

2 The Model with a Single Union and Exogenous Rent Extraction

This section describes the basic model for the spread of a single union with an exogenously given level of rent extraction. Section 2.1 begins by outlining the entry, investment, and exit behavior of firms taking union behavior as given. Section 2.2 then describes how unions spread and characterizes the steady-state level of unionization.

2.1 Firms

We assume that firms produce one of a continuum of measure F possible products, and that there is a downward-sloping demand curve for each product. Entry into a sector requires start-up costs, described below, but once these costs have been paid, output is linear in labor and requires no other inputs, i.e. $q(L) = \beta L$. Once there is a firm in a market, if a second firm were to enter, the two firms would engage in Bertrand competition and earn zero profits. Knowing this, only one firm enters each market, and the measure of the number of firms is equal to F. For simplicity, we will assume that all firms face identical production functions, and so behave identically.

In addition, there is a competitive, constant returns to scale home-production sector in which workers can earn some fixed effective wage, $\underline{w}$. We assume that there is a sufficient quantity of workers such that some are always employed in the home-production sector, i.e. $N > L^*F$, where N is the quantity of workers and L^* is the optimum quantity of workers each firm employs at wage $\underline{w}$.

Given that each firm is a monopoly, each firm charges the profit maximizing price, pays workers the wages $\underline{w}$, and earns pre-union profits denoted by π. By "pre-union profits," we mean the surplus of revenues over the wages paid in the absence of a union. (We assume that there is some demand for each product at a price above $\frac{w}{\rho}$, so that each firm produces a positive amount, and that the profits are maximized at some finite price.[2]) If the firm is unionized, the union extracts a fixed proportion α of these profits. Later, we will endogenize α, but from the perspective of the firm, α is an exogenous parameter.

Suppose that firms are subject to large negative productivity shocks that cause them to exit with hazard rate δ, where δ depends in part on unobservable investment, I, such as avoiding negligence that could lead to lawsuits.[3] We also assume that $\delta_I < 0$ and $\delta_{II} > 0$.

The optimal investment for a unionized firm depends on the share of profits it can keep if it stays alive. Given the discount rate, r, the firm chooses I to maximize its present discounted value given α:[4]

$$I(\alpha) = \arg\max_{I} \frac{(1-\alpha)\pi - I}{r + \delta(I)}: \qquad (1)$$

Investment is decreasing in rent extraction by unions, α, since

$$\frac{dI}{d\alpha} = \frac{\pi\delta_I}{\delta_{II}\left[(1-\alpha)\pi - I\right]} < 0: \qquad (2)$$

It is therefore possible to write $\delta = \delta(I(\alpha))$, or more concisely, $\delta = \delta(\alpha)$, where $\delta_\alpha > 0$.

So far, we have said that there will be only one firm in each industry, but have not yet specified how a given capitalist gets to own that firm. We model the process by which a given capitalist obtains the monopoly on a particular product as an auction or, equivalently, as a lottery. This can be thought of either literally, such as a government auction for a cell-phone license, or as a metaphor for advertising, research and development, or other up-front expenditures that result in some probability of being successful in an industry, as is widespread among Internet firms today. Assuming that there is competition among a large number of risk-neutral capitalists, the cost of

[2] For example, suppose that all consumers had an identical CES utility function equal to $U = \left(\int_0^F x_i^\rho di\right)^{\frac{1}{\rho}}$, where x_i represents demand for good i. As long as $\rho > 0$; so that the elasticity of substitution is greater than 1, all firms will charge a finite price.

[3] The hazard rate could also depend on observable investment, but since unions and firms can contract on the efficient level of observable investment, it would not vary with rent extraction, and hence we abstract from observable investment in this paper.

[4] Note that equation (1) assumes that the owner of the firm receives a continuation payoff of 0 in the event the firm dies. This is because if the firm dies, the owner will need to start a new firm, and as will be shown below, the ex-ante profits of starting a new firm will be 0.

entering an industry will be equal to the expected value of owning a firm. The ex ante profits from opening a firm will therefore always be zero. Whenever a firm dies, an auction is held and a new firm enters. The number of firms therefore remains equal to F.

2.2 Steady-State Unionization Levels

Under the model, new firms are established without unions. Firms differ in how easy they are to unionize, depending on factors ranging from the layout of the factory floor to the personalities of managers. (In order to keep the model tractable, we consider a simple model in which firms, plants, and union bargaining units are coterminous.) Each firm is born with a certain difficulty of being organized, which we denote by c (for cost), and retains that same level of difficulty until it dies. For simplicity, we will assume that for newborn firms c is distributed uniformly on the interval [0,1].[5]

In each unit of time, the union has an organizing budget that it uses to organize new firms. We assume that unions are credit constrained, so that the amount they can spend on organizing efforts depends on their current level of dues collection. The union's budget is therefore equal to BU, where B represents the amount that unionized workers in each firm contribute toward the overall union's organizing budget and U is the number of unionized firms. (We abstract from size differences among firms.)

The attractiveness of a particular union to workers depends on α, the proportion of the firm's total profits it extracts for the workers. The union's effective organizing budget is $A(\alpha)BU$, where $A(\alpha)$ indicates the union's attractiveness as a function of α. Workers recognize that firms will die off quickly if unions extract high levels of rents, so $A(\alpha)$ will not be monotonic in α.

The analysis in this section will focus on identifying steady states. The transition dynamics outside of the steady state are somewhat more complex, and are discussed in Appendix A.2. There are two criteria that must be satisfied in the steady state. First, in the steady state, the total number of unionized firms, denoted U, must remain constant. Next, note that when a firm dies,

[5] In standard epidemiological models, the efficiency with which infected hosts pass on the disease also declines as disease prevalence increases, but for a different reason. In epidemiology, efficiency declines because of random matching between hosts in the population–when the disease becomes very prevalent, many of these matches occur between two infected hosts, so those matches do not contribute to the spread of the disease. In this model, efficiency declines because firms are heterogeneous in the ease in which they can be unionized, and unions focus first on the easiest firms to organize.

the …rm that replaces it has a new di¢culty of unionization c, distributed according to the initial Uniform[0,1] distribution. This leads to the second criteria for the steady state, that the distribution of organizing di¢culties of union and non-union …rms must also remain constant.

To identify the steady state, in this section we …rst consider the case in which there is only one union, with an exogenously given level of ®. (Section 3 endogenizes ®.) We assume that the union can observe the di¢culty of organizing a …rm before it starts an organizing e¤ort. Therefore, the union will target those …rms that are the easiest to organize …rst. Suppose that at a given moment all …rms with organizing di¢culty below some cuto¤ point p are unionized and all …rms with di¢culty above p are non-unionized. This will be the case in steady state or if the size of the union is increasing, since unions always target the easiest to organize …rms …rst.[6] In a given instant, there will be two segments of non-unionized …rms, a "thin" segment of …rms that have just been created with di¢cultly distributed according to the initial distribution and a "thick" segment of pre-existing …rms with di¢culties greater than p. Unions will optimally spend their organizing budget …rst to organize newly emerged …rms in the thin segment with organizing di¢culty below p. Once the union has organized those …rms, it will spend what remains of its budget on the remaining previously existing …rms in the thick segment with marginal di¢culty of organizing p.[7]

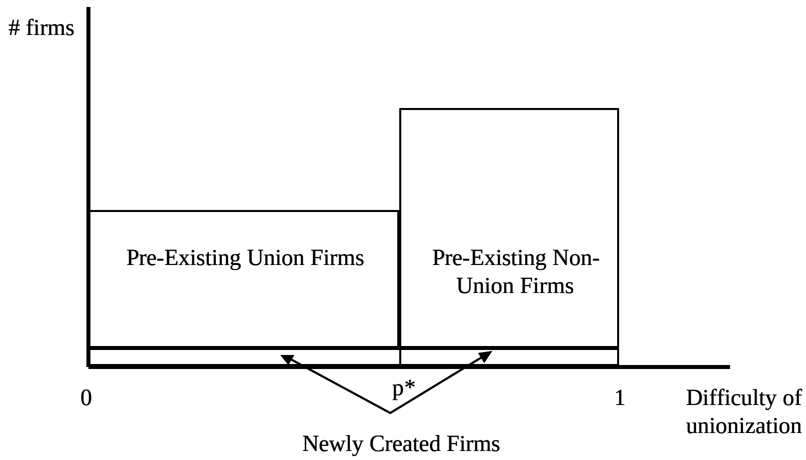
A graphical depiction of the steady-state is given in Figure 1. Note that the density of unionized …rms is lower than the density of non-unionized …rms in steady-state, because although the cost distribution for newborn …rms is uniform, unionized …rms have a higher death rate, and therefore do not live as long as non-union …rms.

Normalize the number of …rms, F, to 1, so that U becomes the fraction of …rms that are unionized. At an instant of time dt, [± (®) U + ± (0) (1 ¡ U)] dt …rms will have just exited due to a negative productivity shock. As those …rms die, new …rms will be born with di¢culties of being

[6] During transitions that involve the decline of a union–for example, in response to some kind of shock that reduces the union's e¤ective organizing budget–there will actually be a range of costs where there will be both unionized and non-unionized …rms. This is discussed in more detail in Appendix A.2. In the steady state, however, there will be some p below which all …rms are organized and above which no …rms are organized.

[7] Strictly speaking, this suggests that in the steady state, the percentage of unionized …rms will be higher among newly-created …rms than among older …rms. However, this is an artifact of our assumption of identical …rms with Poisson death rates. In practice, if …rms di¤er in intrinsic pro…tability, more pro…table …rms will be more attractive to unions and longer-lived. To take another example, if …rms take time to grow and initially face a high death rate, unions may not organize early in the …rm's life.

Figure 1: Steady-State Unionization



unionized distributed according to the initial distribution. For a union to organize all newborn firms with difficulty level below p, the union will have to spend

$$[\delta(\alpha)U + \delta(0)(1 - U)]\,dt \int_0^p c\, dG(c)\,; \tag{3}$$

which, since $G(c)$ is Uniform[0,1], is just

$$[\delta(\alpha)U + \delta(0)(1 - U)]\,dt\frac{p^2}{2}. \tag{4}$$

In order for p; the threshold below which all firms are organized, to remain constant, the union's effective organizing budget must exactly correspond to the total cost of organizing all newly created firms with cost less than or equal to p, i.e.:

$$A(\alpha)BU = [\delta(\alpha)U + \delta(0)(1 - U)]\frac{p^2}{2}. \tag{5}$$

This condition, that p must not change, is one of the two conditions that must be satisfied in the steady-state. If the union had a surplus, i.e. if $A(\alpha)BU > [\delta(\alpha)U + \delta(0)(1 - U)]\frac{p^2}{2}$, then it would spend that surplus organizing non-union firms in the "thick" segment with difficulty greater than

p, and p would increase. Conversely, if the union's budget was not sufficient to organize all of the newly born firms with difficulty below p, then p would decrease.

The other condition that must be satisfied in the steady-state is that the number of unionized firms, U, must also not change. This means that the number of newly born firms the union organizes must exactly equal the number of firms the union loses to attrition. This yields the condition

$$[\delta(\alpha)U + \delta(0)(1 - U)]\,p = \delta(\alpha)U. \qquad (6)$$

These two conditions, that the difficulty distribution of unionized and non-unionized firms does not change and that the number of unionized firms does not change, lead us to the following characterization of the steady-state:

Proposition 1 With a single union, there can be two steady-states, the trivial steady-state with no unionization ($U = p = 0$) and the steady-state with

$$U^{*} = \begin{cases} \dfrac{2\delta(0)A(\alpha)B}{\delta(\alpha)^{2} - 2A(\alpha)B[\delta(\alpha) - \delta(0)]} & \text{if } 2A(\alpha)B \le \delta(\alpha) \\ 1 & \text{otherwise} \end{cases}; \qquad (7)$$

$$p^{*} = \begin{cases} \dfrac{2A(\alpha)B}{\delta(\alpha)} & \text{if } 2A(\alpha)B \le \delta(\alpha) \\ 1 & \text{otherwise} \end{cases}. \qquad (8)$$

Moreover, the trivial steady state with no unionization is locally unstable, and the steady state with partial unionization is locally stable.

Proof. See Appendix A.1. ■

Note that when $2A(\alpha)B > \delta(\alpha)$, the union's organizing budget is substantial enough to overcome the attrition of member unions, so the model would be at a corner solution with steady state unionization levels of either 0 or 1. For the remainder of the paper we will assume that

$$2A(\alpha)B \le \delta(\alpha); \qquad (9)$$

unless otherwise stated, so that we are in the more interesting interior case with only partial unionization in the non-trivial steady-state.

The intuition behind the stability results is that the total resources available for union organizing rise linearly with the number of unionized …rms, while the cost of replacing …rms lost to attrition rises faster than linearly given that the easiest …rms to unionize are unionized …rst. Given our assumption of a uniform distribution of di¢culty of unionization, the cost of replacing …rms lost to attrition is quadratic in the level of unionization. The cost of replacing unionized …rms lost to attrition is less than the resources available for unionization at all unionization levels between 0 and the non-trivial steady-state, and greater than the available resources curve at higher levels of unionization. With a non-uniform cost distribution, there could be multiple stable non-trivial equilibria, but we focus on a simple case here.

Since the distribution of unionization di¢culties is uniform on [0, 1], $p^{¤}$, the di¢culty level below which all newborn …rms are unionized, is also the percentage of newborn …rms that are unionized. In steady state, $U^{¤}$, the proportion of unionized …rms, is less than $p^{¤}$, because unionized …rms die at a faster rate than non-union …rms.[8]

Exogenous increases in the death rate of …rms reduce steady-state unionization. The intuition is that with higher attrition rates, at every level of membership the union must devote a greater share of its resources to replacing …rms lost to attrition and less to expanding the size of the union. The following proposition states these results formally.

Proposition 2 *Increasing the death rate of all union and non-union …rms by the same proportion reduces the steady-state level of unionization $U^{¤}$.*

Proof. See Appendix A.1. ■

Empirical results supporting this conclusion are presented in Kremer and Olken [2001]. We test whether industries with a high turnover of …rms have low unionization rates. We …nd that a 1 percentage point increase in the annual exit rate of …rms in an industry is associated with a

[8] Of course, in the real world, factors outside the model may obscure this relationship. In particular, …rms may di¤er in intrinsic pro…tability, and more pro…table …rms are more likely to attract attention from unions and less likely to exit.

3.4 percentage point decrease in the unionization rate, controlling for average plant size, capital intensity, and industry concentration. These results are of similar magnitude to those predicted by the model when equation (28) is evaluated using mean values for union membership and exit values and a range of parameter values.[9]

3 Rent Extraction Under Optimizing and Evolutionary Models

This section contrasts economic and evolutionary analyses of the determination of the level of rent extraction, α. Under a standard economic approach, unions choose α to maximize the present discounted value of rents to union members, taking into account the dependence of firm investment on α. Under the evolutionary approach, unions are endowed with different values of α. Unions with different levels of α compete, and only those unions with evolutionarily stable values of α survive. In many circumstances, the economic and evolutionary approaches yield the same steady-state predictions, albeit with different dynamics (as in Nelson and Winter, 1982). In this model, however, the evolutionarily stable value of α will be less than the value of α that maximizes the present discounted value of rents to current union members.

The remainder of this section is organized as follows. Subsection 3.1 derives the conditions for the optimal level of α for the workers. Subsection 3.2 then shows that the evolutionarily stable level of rent extraction is less than this welfare maximizing level.

3.1 Welfare-Maximizing Level of Rent Extraction

We first consider a fairly conventional setting in which unions choose α to maximize the present discounted value of rents accruing to current union members.

We assume that unions cannot commit to a path of rent extraction over time. Otherwise, the optimal contract would involve a one-time payment from the firm in exchange for an agreement to never again extract any rents. This would avoid distorting the firms's investments in staying

[9] Assuming $U^* = 0.26$, $\lambda = 1.5$, $\delta(0) = .076$, and $2A(\alpha)B = \frac{\delta(0)}{2}$ yields a predicted value (from equation (28) of the coefficient on exit rates of 3.8. Changing any of these assumptions by 25% yields predicted coefficients between 2.8 and 5.2.

alive. In fact, it is difficult to contract on rent extraction, since firms may not be able to specify in advance the exact tasks needed later and unions may have difficulty committing never to extract rents.

Given this, the union chooses how much it will extract each year. Since firms' pre-union profits are constant, there is no difference between extracting a lump sum each year and a share of profits each year. We will consider for the moment the case in which unions have all the bargaining power in negotiations with firms, in the sense that they can present firms with take-it-or-leave-it offers. (Section 4 presents a somewhat more complex bargaining game between unions and firms.) This assumption may be reasonable if a single union bargains with many firms and has incentives to acquire a reputation for toughness. Although unions cannot commit to a time-path of future rent extraction, bargaining is statically efficient, so that all firms employ the efficient number of workers.

The present discounted value of rents accruing to current union members is

$$\frac{\alpha\pi}{r + \delta(\alpha)}. \qquad (10)$$

[10]

Since $\delta(\alpha)$ increases with α, the optimal level of rent extraction for the worker involves a trade-off between the flow of rents and the hazard rate that the firm will chose, which would cause workers to cease to obtain any rents.[11]

The first order condition for the level of α that maximizes the present discounted value of rents for workers, denoted α_W, is

$$r + \delta(\alpha_W) - \alpha_W \delta'(\alpha_W) = 0. \qquad (11)$$

For the remainder of the paper, we assume that the parameter values are such that we have an interior solution for α_W.

We assume that the function $A(\alpha)$, which indexes how attractive a union is to potential new

[10] Note that the results would not be substantially different if workers had a higher discount rate than firms. For example, workers might have a higher discount rate to incorporate the chance of death of workers or separation from the firm.

[11] Note that this expression assumes implicitly that workers receive no union rents if they leave the firm. This will be true if the labor supply, N, is large enough, so that the probability the worker obtains a second job in the potentially unionizable sector, and therefore has a chance of getting a unionized job, approaches 0.

members, is continuously increasing in the present discounted value of rents obtained by workers (i.e., equation (10)). The assumption that A(®) is increasing in the present discounted value of rents extracted by workers implies that a union that maximizes the welfare of its members, i.e. a union that extracts ®$_W$, has the easiest time organizing unorganized …rms.[12]

3.2 Evolutionarily Stable Rent Extraction

An alternative approach to understanding how ® is determined is to assume that ®, the level of rents a union extracts, is …xed for a given union, but that there are many unions with di¤ering levels of ®. One can then ask which union will survive in evolutionary competition.

If there are multiple unions, each would like to spend its organizing budget trying to organize the easiest …rms. Rather than assume that unions waste resources on battles to organize the same unorganized …rms, we will assume that they divide them so that at every level of di¢culty, c, unions organize …rms in proportion to their e¤ective organizing budgets.[13] Since the e¤ective organizing budget is the actual organizing budget (BU) multiplied by how attractive the union is to workers (indexed by the function A (®)), unions that are more attractive to workers can organize disproportionately more …rms. For example, suppose that there are two unions, a moderate union with M member …rms and extraction rate ®$_M$ and a radical union with R member …rms and extraction rate ®$_R$. The moderate union targets $\frac{A(\circledR_M)BM}{A(\circledR_M)BM+A(\circledR_R)BR}$ of the non-unionized …rms with di¢culty less than p and the radical union targets the remainder.

We can now identify the evolutionarily stable level of rent extraction and show that it will be

[12] In fact, while we assume that A (®) is maximized at ®$_W$, it is plausible that it is maximized at some value less than ®$_W$. Firms can employ a wide variety of anti-unionization tactics, including requiring workers to attend anti-union meetings on company time, challenging the proposed de…nition of the bargaining unit, and illegally …ring union activists, and the more they expect unions to extract, the more vociferously they will oppose unions. Given the response of …rms' unobservable investment to ®, as ® approaches ®$_W$, increases in ® hurt …rms much more than they help workers. Firms' opposition to unionization might therefore increase more rapidly with ® than workers' support for unionization. Firms may even ease the entry of more moderate unions to forestall more radical alternatives. Such e¤ects, however, would only make showing that ®$_S$ < ®$_W$ easier, so we ignore any e¤ects of this sort in the model.

[13] We thus allow for unions that extract more for their members to be more successful in attracting members, but rather than have a completely general function for union recruiting as a function of the union's level of rent extraction and that of each of its competitors, we consider the case in which each union's recruiting is proportional to its attractiveness to workers and its organizing budget. We conjecture that the main results of the paper (in particular, Proposition 5) would hold for any division of …rms that is continuously increasing in the e¤ective organizing budget at each di¢culty level. We model unions dividing …rms in proportion to their e¤ective organizing budgets for analytical tractability.

smaller than the welfare-maximizing level of rent extraction. First, we specify how the de…nition of evolutionary stability applies in our context.

De…nition 1 A union that extracts a rent level ® is **evolutionarily stable** if and only if, starting from the steady state containing only the ® union, there exists an ° > 0 such that if any other union with size " < ° invades, the invading union will disappear.

Proposition 3 The union that extracts the level of rent ® that maximizes the ratio $\frac{2A(®)B}{±(®)}$ will be evolutionarily stable.[14]

Proof. See Appendix A.1. ■

The key idea of the proof is that $\frac{2A(®)B}{±(®)}$ is the steady-state level of $p^{¤}$, the proportion of newborn …rms that are unionized in steady-state. This determines the average cost level the union can sustain in steady-state. A union that can bear a higher average cost level than the incumbent will be able to unionize disproportionately more …rms, and will be able to invade; a union unable to bear as much will experience negative growth and disappear. Therefore, no union can successfully invade a steady-state containing the union with the highest possible steady-state average cost level. The union with the maximum value of $\frac{2A(®)B}{±(®)}$ is therefore evolutionarily stable.

Proposition 3 guarantees that, starting from a steady state occupied by only the $®_S$ union, no other union can invade. We now show that facing a steady state containing any other union or combination of unions, the $®_S$ union can successfully invade. Furthermore, if the system then converges to a steady state, that steady state will contain only the $®_S$ union. To show this, it will be useful to …rst state the following lemma.

Lemma 1 If multiple unions coexist in the steady-state, then they must have the same ratio of e¤ective organizing budget to …rm death rate, i.e. $\frac{2A(®_M)B}{±(®_M)} = \frac{2A(®_R)B}{±(®_R)}$. Furthermore, this ratio

[14] It is worth noting that while the level of ® that maximizes $\frac{2A(®)B}{±(®)}$ will be unique under most normal parameterizations of $A(®)$ and $±(®)$, this need not hold in general. It is possible to construct functions $A(®)$ and $±(®)$ satisfying all of the conditions above such that $\frac{2A(®)B}{±(®)}$ has multiple global maxima. In this case, there will be several possible levels of rent extraction $®_S$ that, together or independently, would be evolutionarily stable. However, …nding examples of functions $A(®)$ and $±(®)$ satisfying all of the conditions above and where $\frac{2A(®)B}{±(®)}$ has multiple global maxima requires careful construction, so it seems likely that this will not occur empirically.

will be equal to the organizing cost of the most di¢cult to organize …rm that is unionized in the steady-state, i.e. $p^{¤}_M = \frac{2A(®_M)B}{±(®_M)}$.

Proof. See Appendix A.1. ■

The intuition behind the Lemma is that for two unions to exist in the steady-state, one must be a more moderate union that is less attractive to workers but loses fewer of its member …rms due to attrition, while the other must be a more militant union that is better able to unionize new …rms but also loses more of its member …rms to attrition. Lemma 1 speci…es how precisely to balance this trade-o¤.[15]

With this lemma characterizing the steady-state in mind, we can show that an evolutionarily stable union will be able to invade a steady-state containing any other union.

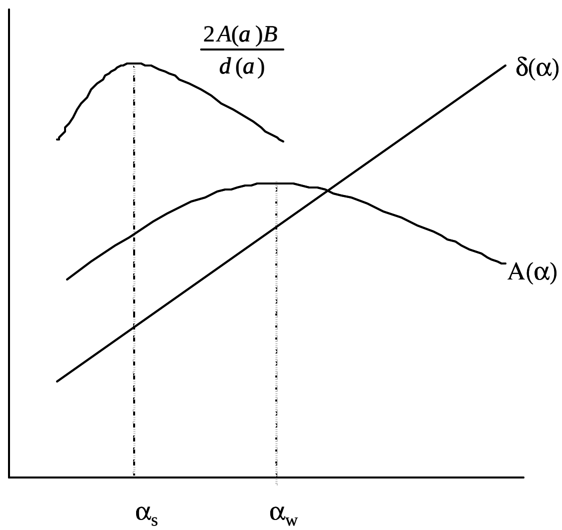
Proposition 4 The $®_S$ union can successfully invade any steady-state other than the one containing another $®_S$ union.

Proof. The proof is essentially similar to the proof of Proposition 3, and is given in Appendix A.1. ■

We have so far shown that, starting from a steady-state containing the $®_S$ union, no union can invade, and starting from a steady-state with any other union, the $®_S$ union can invade and grow. We have not ruled out a limit cycle, but we do know that if there is a steady-state, it must be the steady-state containing only the evolutionarily stable union. To see this, suppose that there are two unions, the stable union S and an incumbent union I. By Lemma 1, the eventual steady state cannot contain both the S union and the I union, since they have di¤erent ratios $\frac{2A(®)B}{±(®)}$. We have already shown that as the world approaches the steady-state with the I union, whatever tiny amount " of the S union that remains will grow, so the " union can not be eliminated entirely. Therefore, we have shown that the $®_S$ union cannot be displaced by any other union and that, assuming that there is no cycling, the $®_S$ union can invade and displace any other union.

[15] Note that when the function $\frac{2A(®)B}{±(®)}$ is strictly concave, which it will be for many (but not all) concave functions $A(®)$ and increasing functions $±(®)$, there can be at most two unions in equilibrium. When $\frac{2A(®)B}{±(®)}$ is not strictly concave, on the other hand, there can be three or more unions in equilibrium. Even in this case, however, the same argument in Lemma 1 goes through.

Figure 2: Evolutionarily stable and welfare-maximizing levels of rent extraction.



Now that we know which union will be evolutionarily stable, we can show our key result: that the evolutionarily stable union it is more moderate than the welfare-maximizing union.

Proposition 5 The evolutionarily stable level of rent extraction, ®_S, is smaller than the level of rent extraction that maximizes the present discounted value of wages of current members, ®_W.

Proof. As shown above, the evolutionarily stable level of rent extraction, ®_S, maximizes the ratio $\frac{2A(\text{®})B}{\pm(\text{®})}$. Since ®_W, the level of rent extraction that maximizes the present discounted value of wages of current union members, maximizes $A(\text{®})$, and since ± monotonically increases in ®, $\frac{2A(\text{®})B}{\pm(\text{®})}$ is decreasing in ® at ®_W and at all greater values of ®. Since ®_S maximizes $\frac{2A(\text{®})B}{\pm(\text{®})}$, it must be less than ®_W. ■

Figure 2 presents the proof graphically, showing $A(\text{®})$, $\pm(\text{®})$, and $\frac{2A(\text{®})B}{\pm(\text{®})}$ as functions of ®. ± increases monotonically with ®, and $A(\text{®})$ increases with ® up to ®_W, the level of output that maximizes the welfare of current workers, and then declines. This implies that ®_S, the evolutionarily stable level of rent extraction, is less than ®_W. If one starts at the level of rent extraction that is optimal for members, a small reduction in ® causes a second-order reduction in attractiveness of the union to potential members, and thus a second-order reduction in the spread rate of the union. However, it causes a ...rst-order decrease in the exit rate of unionized ...rms. Therefore, the evolutionarily stable level of ® must be less than the welfare-maximizing level of ®. This result holds as long as the spread rate of unions is continuous in the present discounted value of wages extracted.

Note that the relative shapes of the A (®) and ± (®) functions determines how far ®$_S$ will be from ®$_W$. If ±(®) is steep, so that ...rm survival is sensitive to rent extraction, then ®$_S$ will be far below ®$_W$, whereas if ±(®) is fairly ‡at, then ®$_S$ will be close to ®$_W$. Similarly, if A (®) declines gradually as one moves away from ®$_W$, then ®$_S$ is likely to be considerably less than ®$_W$. On the other hand, if A (®) declines steeply as one moves away from the welfare maximizing level of output, then ®$_S$ will be very close to ®$_W$. In particular, if there were Bertrand competition among unions for potential members at unorganized ...rms, in which workers joined whichever union delivered greater discounted rents, then the slope of A (®) would be in...nite at ®$_W$ and the evolutionarily stable level of rent extraction would equal the optimal amount of rent extraction for current workers. However, if workers decide which union to join based not only on the present discounted value of rent extraction but also on other idiosyncratic factors, such as the match between the personality of union organizers and the workers at the ...rm, then workers may join a union other than the one that maximizes the present discounted value of rents. Union recruitment will therefore increase continuously rather than discretely in the present discounted value of rents delivered to members.

As discussed above, we assume that the attractiveness function A (®) is continuously increasing in ®. The assumption that A is continuous is important for the result that the evolutionarily stable level of rent extraction is less than the welfare-maximizing level of rent extraction. If there were simple Bertrand competition among unions for potential members at unorganized ...rms, in which workers joined whichever union delivered greater discounted rents, then the evolutionarily stable level of rent extraction would equal the optimal amount of rent extraction for current workers. However, if workers decide which union to join based not only on the present discounted value of rent extraction but also on other idiosyncratic factors, such as the match between the personality of union organizers and the workers at the ...rm, then workers may join a union other than the one that maximizes the present discounted value of rents. Union recruitment will therefore increase continuously rather than discretely in the present discounted value of rents delivered to members.

The steady-state number of unionized firms in society is higher if unions extract α_S than if they extract α_W. Furthermore, the level of rent extraction that maximizes the number of unionized firms will be less than or equal to the evolutionarily stable level α_S, and therefore, by Proposition 5, less than α_W. The intuition for this result is that, under any union extracting more rent than the α_S union, a smaller percentage of newly created firms are unionized (since α_S maximizes p^*) and the death rate of those firms is higher (since $\delta(\alpha)$ increases monotonically with α). The following proposition shows these results formally.

Proposition 6 For any level of rent extraction α greater than the evolutionarily stable level of rent extraction α_S, the steady-state level of unionization, $U^*(\alpha)$, will be lower than the steady-state level of unionization under the evolutionarily stable union, $U^*(\alpha_S)$. This implies that the level of α that maximizes the steady-state level of unionization will be less than or equal to the level that maximizes α_S.[16]

Proof. See Appendix A.1. ■

Corollary 6.1 The steady-state level of unionization under the evolutionarily stable level of rent extraction, $U^*(\alpha_S)$, will be greater than that under the welfare-maximizing level of rent-extraction, $U^*(\alpha_W)$.

Proof. This follows directly from Proposition 6 and from the fact that $\alpha_S < \alpha_W$, which was shown in Proposition 5. ■

It is worth noting, however, that it is ambiguous whether the total flow of rent extracted by the union in steady-state, $U^*\alpha\pi$, would be higher or lower with the evolutionarily stable union than with the welfare-maximizing union.[17] The reason is that decreasing α from α_W to α_S increases the number of unionized firms, but decreases the amount extracted from each firm. It is theoretically ambiguous which of these two effects dominates.

[16] Note that technically, if the function $\frac{2A(\alpha)B}{\delta(\alpha)}$ has multiple global maxima, so that the evolutionarily stable level $\{\alpha_S\}$ is not unique, then this result holds for the highest α_S belonging to that set.

[17] See Kremer and Olken [2001] for an example demonstrating this point.

In this paper we take B, the amount unions spend per unionized firm on organizing, as exogenous, but unions may also differ in the amount they spend on organizing efforts. The traditional maximizing approach assumes that increased union density increases the union's bargaining power, and asks what level of B would be optimal for members (see Wallerstein [1989]). However, there are certain phenomena that this approach has difficulty explaining. In particular, many unions devote substantial resources to organizing outside their core industries. For example, the Steelworkers organize employees at Chock Full O'Nuts, the Teamsters represent casino workers in Las Vegas, and as discussed above, the UAW organizes graduate students at NYU. While it is possible to see how a steel worker or auto worker might benefit from organizing other workers in their industry, it is harder to see why they would prefer to spend their union dues organizing outside their core industries.

By contrast, our approach takes a worker's preferences over the determination of B as given, and ask what level of B is evolutionarily stable. As in the determination of rent extraction, we argue that there may be a selective advantage to unions that encourage leaders to spend more on organizing efforts than would be optimal for members. As a result, unions controlled by leaders may not only have lower δ but also higher B than would be preferred by members. Kremer and Olken [2001] presents a simple extension to the model which shows that, if worker preferences over A and B are separable, then the evolutionarily stable union has both a lower level of α and a higher level of B than the welfare-maximizing union.

4 Implications for Union Institutions

Evolutionary pressure selects for a certain type of attribute–in this case, for unions that moderate workers' wage demands. However, both in biology and in economics, there must be a mechanism by which that attribute is expressed. In this section, we discuss one possible mechanism–incumbency advantages for leaders–by which a union's institutions might serve to reduce the level of rents received by workers. We show under reasonable assumptions that the greater incumbency advantages for union leaders, the lower the present discounted value of rents received by workers. We then show that the evolutionarily stable union provides incumbency advantages for union leaders, whereas the union that maximizes the welfare of its workers does not.

We consider a stylized model of union decision making. The key feature of this model is that increases in incumbency advantages lead to both a lower total level of rent extracted from firms and a lower amount of rent received by workers. This occurs because union leaders offer to extract less rent in total from firms in return for channeling some of that rent to leaders in the form of private benefits, and the greater incumbency advantages for unions, the more they can extract in terms of private benefits without being voted out of office. This will be true so long as firms have at least some bargaining power in the negotiations with union leaders over private benefits. The model we present is one stylized form of such a bargaining game; there many be many other similar ways of modelling the bargaining situation that would produce similar results.

In all negotiations, union leaders represent the rank-and-file in negotiations with firms. Union leaders and firms bargain over a level of rent extraction, α, which represents the proportion of the firms' profits π which are extracted by the union for the rank and file, and over β, the proportion of the firms' profits paid directly by the firm as private benefits to union leaders. These private benefits β can be literal monetary offers or, as frequently happens, contract provisions that benefit union leaders, such as preferential seniority for union officials or a role in grievance procedures. While workers may obtain some benefit from these provisions, we consider any benefit obtained by workers to be part of α, so that β captures the benefit received only by the union leaders.

Workers receive benefits only from the first part of the contract–the level of rent extraction α. As before, workers seek a level of α that maximizes the present discounted value of rents accruing to current union members, i.e.

$$\frac{\alpha\pi}{r+\delta(\alpha+\beta)}. \qquad (12)$$

This expression is identical to equation (10), except that the death rate now depends on the total amount extracted from the firm, $\alpha+\beta$, rather than just the amount extracted for workers, α.

The approval of contracts and selection of union leaders works as follows. Each union without a leader begins by electing one. As will be discussed below, all potential candidates look ex-ante identical, so electing a candidate can be thought of as drawing one at random from the population of potential union leaders. The elected leader negotiates a contract with the firm, and presents it for ratification by the workers.

Presented with a contract, the workers have three choices–approve the contract, reject the contract but retain the current union leader, or reject the contract and elect a new union leader. If the workers reject the contract but retain the union leader, the union leader renegotiates the contract, the contract is put up for another vote, and the process repeats. Each worker incurs a cost s (for strike) due to the renegotiation.

If the workers choose to reject the contract and elect a new union leader, a new union leader is elected, a new contract is negotiated, and each worker incur a cost v (for voting). The cost v represents the advantages possessed by incumbents in union elections–a union with no incumbency advantages would have $v = 0$, and increases in v represent increases in the power of incumbents. We assume that a given union's level of v is determined by its constitutional provisions. Unions vary in the degree of incumbency advantages–i.e. the level of v created by their constitutional provisions. As long as a leader is not voted out of office, he can anoint a successor who will continue his contract policy.[18]

There are two types of union leaders–idealists and opportunists. Idealist union leaders care only about the interests of the rank-and-file, and therefore in negotiating contracts will demand the welfare-maximizing level of rent extraction and set private benefits equal to 0, i.e. $(\alpha_W; \beta_W) = (\alpha_W; 0)$. By contrast, opportunists seek to maximize only their private gains while in office, i.e. β. Therefore, in negotiating contracts with firms, opportunistic union leaders they will trade off as much rent-extraction as possible in return for private transfers from firms. In the population of potential union leaders, a fraction i are idealistic. However, idealism is not directly observable, so all potential union candidates claim to be idealistic. The union leader's true colors are revealed only when when he is elected and proposes a contract.

[18] An opportunist has incentives to pass anoint another opportunist, who (as an opportunist) would offer bribes to the incumbent in return for the job. An idealist, by contrast, might not be able to discern idealists from opportunists. Therefore, while there is chance that unions headed by idealist leaders might revert back to being headed by opportunists, it is less likely for a union headed by an opportunistic leader to revert back to being idealistic. Assuming this pattern of transitions only increases the evolutionary convergence to unions with opportunistic leaders.

We model the negotiations between unions and firms as follows. In the first stage, union leaders and firms Nash bargain over $(\alpha; \beta)$, where the relative bargaining power is such that the union leader obtains x percent of the surplus. If these initial private negotiations fail, the negotiations enter the "strike" phase. Once the strike has begun, the union can make take it or leave it offers to the firm in terms of α, as once in the public eye it has an incentive to maintain a reputation for toughness, since it will bargain publicly with many other firms. On the other hand, because of the public scrutiny caused by the strike, it becomes impossible for the firm to offer side payments to the union officials, so any contracts emerging from the strike phase must have $\beta = 0$.

To find the Sub-Game Perfect Nash equilibrium of this game, we solve backwards for the case of an opportunistic union leader. (For the case of an idealistic union leader, it is clear that the union will extract the welfare maximizing rent α_W and set private payments to union leaders $\beta_W = 0$). First, note that the rank and file will never choose the second option, i.e. rejecting the contract while retaining the current union leadership. To see this, note that if workers reject a contract $(\alpha\beta)$ but retain the union leadership, they expect to receive

$$\frac{\alpha^E \pi}{r + \delta(\alpha^E + \beta^E)} - s; \qquad (13)$$

where $(\alpha^E; \beta^E)$ represents the contract the rank-and-file expect to receive in the next period. The rank-and-file expect that, since future subgames are identical to this game, the union leader will propose the same level of rent extraction α and private payments β, i.e. $(\alpha^E; \beta^E) = (\alpha; \beta)$.[19] Therefore the expected amount received by rejecting the contract but keeping the union leader, expression (13), is strictly less than the amount received by accepting the contract, $\frac{\alpha^E \pi}{r+\delta(\alpha^E+\beta^E)}$, so the workers will never choose to reject the contract while retaining the union leadership.[20]

The other option open to workers besides accepting the contract is to reject the contract and

[19] In practice, this seems to be precisely what happens–when contracts are rejected by the rank-and-file, the union leadership often simply repackages the contract in new language rather than fundamentally altering the contract offer.

[20] We thank Keith Chen for this argument.

change the leadership. Workers will chose to do this if and only if

$$\frac{\alpha\pi}{r+\delta(\alpha+\beta)} < (1-i)\frac{\alpha^E\pi}{r+\delta(\alpha^E+\beta^E)} + i\frac{\alpha_W\pi}{r+\delta(\alpha_W)} - v; \qquad (14)$$

where $\left(\alpha^E;\beta^E\right)$ represents the contract the rank-and-file expect to receive if an opportunist is elected in the subsequent period. Once again, rank-and-file expect that, since future subgames are identical to this game, if an opportunist is elected again he will propose the same level of rent extraction α and private payments β, i.e. $\left(\alpha^E;\beta^E\right) = (\alpha;\beta)$: Since the union leader earns 0 if he is voted out of office, he will chose a contract such that workers are just indifferent between voting him out of office and retaining him, i.e.

$$\frac{\alpha\pi}{r+\delta(\alpha+\beta)} = \frac{\alpha_W\pi}{r+\delta(\alpha_W)} - \frac{v}{i}: \qquad (15)$$

Note also that in equilibrium, opportunists are never voted out of office.

The intuition for the amount obtained by rank-and-file in equilibrium is straightforward. Opportunists can reduce the present discounted value of rents by the expected discounted cost of continuing to reject opportunists until an idealist is found and the level of rent α_W is extracted.

Note that while equation (15) determines the present discounted value of rents obtained by the workers, it does not uniquely determine α and β. To determine α and β, note that Nash bargaining in the first stage implies that the union leaders obtain x percent of the total surplus over not reaching an agreement and having a level of rent extraction α_W. This implies that

$$x\left[\frac{1-\alpha}{r+\delta(\alpha+\beta)} - \frac{1-\alpha_W}{r+\delta(\alpha_W)}\right] = \frac{\beta}{r+\delta(\alpha+\beta)}: \qquad (16)$$

Together, equations (15) and (16) uniquely determine a level of α and β extracted by a union with a given level of v and an opportunistic union leader.

Given this relationship between incumbency advantages and rent extraction, we can use the analysis of Section 3 to determine the level of incumbency advantages in the evolutionary equilibrium. To do this, we define the functions $\delta(v) = \delta(\alpha(v)+\beta(v))$, and $A(v) = A(\alpha(v))$, and then repeat the same analysis above. In particular, we know from Proposition 3 that the evolutionarily stable union will be the union maximizing $\frac{2A(v)B}{\pm(v)}$. The following Proposition shows that such a union will have a constitution that provides incumbency advantages for leaders.

Proposition 7 The evolutionarily stable union will have incumbency advantages for union leaders, i.e. $v > 0$, whereas the union that maximizes the present-discounted value of rents accruing to workers would have no incumbency advantages, i.e. $v = 0$.

Proof. See Appendix A.1 ■

It is also worth noting that the level of incumbency advantages present in the evolutionarily stable union depends on the percentage of the surplus from negotiations extracted by union leaders, x. Increases in x, the percentage of the surplus from negotiations extracted by union leaders as opposed to …rms, decrease the evolutionarily stable level of incumbency advantages, v. The reason is that as x increases, a given increase in v reduces the attractiveness of the union by the same amount as before (since, as shown by equation (15), the presented discounted value of rents from workers does not depend on x). On the other hand, a given increase in v results in a smaller evolutionary gain for the union in terms of reduced death rates of …rms, because the total amount of rent extracted by the union decreases by less than before. Put another way, increasing x leaves the $A(v)$ curve untouched while making the $\pm(v)$ curve ‡atter. As demonstrated by Figure 2, a ‡atter $\pm(v)$ curve will tend to make the evolutionarily stable level of v closer to the welfare-maximizing level.

The premise of the analysis in this section is that union leaders will take advantages of incumbency advantages to moderate wage demands. In fact, Ross [1950] argues that this is precisely what often occurs–unions are often prepared to sacri…ce worker-oriented provisions, such as wages, for union-oriented provisions, such as union security, automatic checko¤ of union dues, the right of the union to participate in all grievance negotiations, and preferential seniority for union o¢cials.

Though we focus on incumbency advantages and the possibility of idealistic union leaders as the mechanism moderating wage demands, there are other possible mechanisms as well. First, just as …rm managers are often assumed to be empire builders, with a preference for increasing …rm size, union leaders may prefer to be in charge of larger unions, as leaders of larger unions have more prestige and political power. As was shown in Proposition 6, increasing the steady-state size of the union requires extracting less than the welfare-maximizing level of rent. Therefore, union leaders that care about the size of their union beyond the impact on members will extract less rent than would be preferred by their members. Also, workers may be heterogeneous in their desired level of wage demands, and union institutions may evolve to favor the subset of workers with less aggressive wage demands. Alternatively, union institutions may require a supermajority to call an strike, shifting the critical union member from the median to someone desiring more moderate wage policies.

Of course, in an evolutionary model, there need be no presumption that all union constitutions that create incumbency advantages also create incentives for moderation. If some union constitutions create incumbency advantages but have provisions that encourage leaders to be extract more rent than members would prefer, these unions will die out. Meanwhile, if other union constitutions create incumbency advantages and also encourage leaders to moderate members' wage demands, these unions will grow.

5 Evidence From the History of Unions

The implication of the previous section is that unions should exhibit substantial incumbency advantages. Moreover, exogenous reductions in those incumbency advantages should be associated with increases in union wage demands. This section presents evidence from the history of unions that seems to support these conclusions.

5.1 Presence of Incumbency Advantages

Overall, incumbents have a substantial advantage over their potential challengers in union elections. Table 1 shows the turnover of union presidents for the ten largest U.S. unions since each union's founding. We focus on the chance an incumbent was defeated each year as a measure of incumbency advantages, since this captures both the advantages incumbents have through infrequent elections

Table 1: Turnover of union presidents for 10 largest American unions.

Union		Year Founded	Total Number of Presidents	Average Tenure of Presidents	Number of Defeated Incumbents	Chance Incumbent Defeated Per Year
1. National Education Association (NEA)		1934	12	5.5	3	4.5%
2. Teamsters (IBT)		1903	6	16	2*	2.1%
3. Food & Commercial Workers (UFCW)		1912	14	6	0	0.0%
4. State, County & Municipal Employees (AFSCME)		1932	3	22	0	0.0%
5. Teachers (AFT)		1916	15	6.5	2	2.4%
6. Auto Workers (UAW)		1947	8	6.5	1	1.9%
7. Electrical Workers (IBEW)		1890	16	7	2	1.8%
8. Communication Workers (CWA)		1938	3	21	1	1.6%
9. Machinists (IAM)		1888	13	9	N/A	N/A
10. Steelworkers (USW)		1894	6	18	0	0.0%
Average:	All Unions		9.6	11.8	1.2	1.5%
	Private Sector Unions**		8.6	13.2	0.9	1.2%
	Public Sector Unions**		10.0	11.3	1.7	2.3%
Comparison:						
Presidents of the United States (1900-2000)			18	5.6	5***	5.0%

Source: National union offices.

* Both of the defeated Teamsters presidents were defeated after the Federal government takeover of the union and the imposition of direct elections for the union president.
** The NEA, AFT, and AFSCME are classified as public sector unions; the remainder are classified as private sector unions.
*** General election defeats.

and the electoral advantages gained once an election is held. Over the history of the nine unions for which data is available, an incumbent union president had only a 1.5% chance of being defeated in an election each year. This ...gure would be even lower–only 1.2%–if one does not include the period under which the Federal government took over the Teamsters union and imposed changes in election procedures that decreased incumbency advantages and led to the defeat of 2 incumbents. To put these numbers in perspective, during roughly the same period, an incumbent President of the United States had a 5% annualized chance of being defeated in a general election.

This data seems generally consistent with the model. In general, the relatively low chance of an incumbent being defeated is consistent with the high levels of incumbency advantages necessary to sustain more moderate wage policies.

Furthermore, note that the two unions with the greatest chance of an incumbent being defeated each year were the National Education Association and the American Federation of Teachers, both public sector unions. More broadly, incumbents in public sector unions had a 2.3% chance of defeat, while those in the private sector had a 1.2% chance of defeat (0.8% excluding the two Teamster defeats.) This is consistent with the model's predictions. To see this, note that there is a very small chance that a public employer will be forced out of business. The function $\delta(\alpha)$ is therefore much flatter for the public sector than for private sector firms.[21] As discussed in Sections 3 and 4, as a result, α_S will be very close to α_W, and incumbency advantages v will be close to 0. Therefore, competition will select for unions with weak incumbency advantages. The fact that the chance of a union president being defeated in public sector unions is almost twice that of private sector unions is consistent with this prediction, though there are other possible explanations as well.

5.2 Sources of Incumbency Advantages

One reason why incumbents are so often reelected is that most existing unions have constitutional features creating substantial incumbency advantages for leaders. This section presents several examples of the sources of incumbency advantages typically found in U.S. labor unions.

First, most unions have indirect leadership elections, in which the president of the union is elected by delegates to a national convention, rather than by the membership at large. At these conventions, the delegates, often local union leaders, face strong pressure to support incumbents in national office if they think that the incumbents will win, because local union leaders need several types of services from national unions. For example, the union leadership often controls access to national strike funds and has the power to put local branches in trusteeship. [Geoghegan, 1992; Benson, 1986]. Furthermore, since incumbency advantages are much weaker in some union locals than at the national level, local leaders face the threat of not being re-elected and having to return to the shop floor. Local leaders' insurance against this threat is the possibility of obtaining a job with the national union staff, which will be much more likely to occur if they have reliably supported

[21] The function $\delta(\alpha)$ is probably not completely flat, as militant actions on the part of unions can provoke a government to de-unionize. One classic example of this is President Reagan's confrontation with the air traffic controllers. Such situations are, however, relatively rare.

the national leadership. All of these factors encourage the delegates to the national conventions to support the incumbents.

Union incumbents have other direct advantages over challengers as well. Union staff are often not restricted from donating money to support campaigns of current leadership, and laws restricting union staff from campaigning on union time are extremely weak. To take another example, union officers are not often required to give membership lists or even lists of local chapters to opposition candidates. Since unions often represent diverse sets of workers (for example, the United Auto Workers represents graduate students at NYU), this makes it difficult for challengers to campaign against incumbent leaders. On the other hand, incumbents can use official union communications, such as union newsletters, to promote their own candidacies.

Even if there is a viable challenger, local union officers, rather than neutral third parties, are typically in charge of vote counting in union elections [Geoghegan, 1992], so there are few safeguards against fraud. In fact, there is anecdotal evidence of a significant amount of outright vote-stealing in union elections. Moreover, prior to mandated periodic elections under federal law, unions could go for decades without even holding elections. For example, the Laborers' union had no conventions between 1920 and 1941 [Benson, 1986].

5.3 Comparative Statistics of Wage Demands and Incumbency Advantages

In addition to predicting the existence of incumbency advantages for union leaders, the model also predicts that union leaders should use their incumbency advantages to moderate wages. Increases in incumbency advantages should be associated with declines in wage demands, and vice-versa.

Perhaps the most important evidence that union leaders typically favor more moderate policies than would be preferred by members comes from the asymmetry of challenges to established leaders. Union dissidents typically accuse union leaders of being too moderate in their negotiations with the firms, not of threatening members' jobs by extracting too much from firms. If union leaders sought to represent the typical worker, one would expect challenges to come as often from either direction.

There is also evidence that weaker incumbency advantages are associated with more aggressive policy. For example, Lipset, Trow, and Coleman [1950] single out the International Typographer's Union as the only major U.S. union to have a functioning two-party system, the result of a split by Progressives during the 1911 union convention. Power in the union subsequently alternated between the Progressive and more the conservative Wahneta party throughout the first half of the century. Consistent with the model, Lipset, Trow, and Coleman note that the union was distinguished by its militance and willingness to strike. For example, during WWII, ITU was one of the few unions that repudiated the no-strike pledge, since it felt that the War Labor Board's policies were drastically hurting the real wages of ITU members. When the Taft-Hartley act was passed in 1947, the union still insisted on the closed shop practice, even though it was made illegal by the law. It is also worth noting that the ITU has substantially declined in membership. While part of this decline was due to technological change in the typesetting industry, unions in other industries have managed to adapt and survive despite similar technological shifts.

While incumbency advantages are strong at the national or international level, union locals vary in the degree of control of incumbency advantages, and in some union locals, there is regular turnover of leadership. We would therefore expect that the weaker the incumbency advantages in the local, the more militant that local will be. Kleiner and Pilarski [2001] find exactly such an effect in a comparison of two similarly-sized locals of the UAW with plausibly exogenous differences in incumbency advantages. One local was organized with indirect elections because it was comprised of many plants spread out over the Los Angeles areas, making frequent large meetings difficult. The second local, by contrast, was organized with direct elections of union officials because it was comprised primarily of a single large plant which made direct elections more feasible. Kleiner and Pilarski found that the geographically concentrated local with direct elections had a much more vigorous union democracy and much more aggressive wage demands.

To the extent that locals have weaker incumbency advantages than national unions, we should also expect that local unions should advocate stronger wage demands than national unions. In fact, this is generally the case, and there are a number of examples of local unions conducting strikes against the wishes of the national union. For example, the P9 Hormel strike of the mid-1980s strike was conducted by the local union without the support of the national union, as was the 1994-1995

Caterpillar strike.[22]

The model also suggests that if incumbency advantages decline exogenously, wages will rise and …rms will be more likely to fail. It is instructive to examine a case study of two unions that for plausibly exogenous reasons were subject to shocks that reduced incumbency advantages. In the late 1930's, John L. Lewis, the president of the United Mine Workers (UMW) and founder of the CIO, feuded with Roosevelt, going so far as to endorse Wendell Willkie, Roosevelt's Republican opponent. As part of an e¤ort to enhance his national political stature, Lewis, who faced no serious opposition within the UMW, instituted direct leadership elections. The Steelworkers, which were created by the UMW, adopted a similar constitutional provision.

By the 1970's, leadership of the UMW had passed to the corrupt Tony Boyle. Just after the 1969 leadership election, Boyle arranged for the murder of his opponent, "Jock" Yablonski, and of Yablonski's family. This over-reaching led to intense federal scrutiny of the 1972 UMW election and the victory of the challenger, Arnold Miller. Miller's victory was followed by much increased militancy on the part of the union, the decline of the Eastern coal industry, and a dramatic decline in union membership.

Following the election defeat of the incumbent UMW leadership, in 1977 a major challenge was also launched to the Steelworkers' leadership, which was similarly vulnerable due to its constitutional provision for direct leadership elections. Before the election, the heir apparent, Lloyd McBride, had promised to make a number of concessions to management in the hopes of saving jobs in the ailing steel industry. Ed Sadlowski, McBride's opponent, challenged McBride as being too close to management, and was explicit about his willingness to sacri…ce union membership for higher wages. Sadlowski said that he did not mind if the Steelworkers' membership dropped from 400,000 to 100,000 or even 60,000, and that it should be a goal of labor to have the steel industry pay high wages that would allow its workers to …nance education so that they or their children could obtain better jobs. It is hard to imagine typical incumbent union leadership adopting policies that would cut membership to a quarter of its initial level. Though Sadlowski lost the election, as a

[22] It is not clear what other models would predict about the relative militancy of the national union and locals. On the one hand, the national has to provide resources to support the local union in strikes, for example through the strike fund. On the other hand, a national union might wish to demonstrate its willingness to strike against other employers by striking against one employer.

result of his challenge McBride was forced to drop his concessions to management and adopt much more aggressive wage demands. With several years, the steel industry had begun a precipitous decline, shedding 56 percent of its workforce in the period from 1979 to 1986, a decline from which it has yet to recover [Tornell, 1997]. Of course, the decline of the Eastern coal industry and the U.S. steel industry was probably the result of a number of other factors as well, but the model is at least consistent with the data.

5.4 Individual vs. Group-Level Competition

Though the model presented here focuses on competition of unions across a group of firms, biological models also consider the effects of competition within a single individual. A natural extension of the model would therefore be to consider what would happen if unions continued to compete with one another within a firm, rather than having all within-firm competition end once a union is elected. The prediction of such a model would be that the higher the level of competition within firms, the higher the level of rent-extraction. This may be a partial explanation for why unions in the U.S., where labor laws greatly favor incumbent unions, seem to be more moderate than many of their European counterparts, where the threat of entry by competing unions may prevent incumbent leaders from departing too far from the workers' preferred policies. (Of course, this does not apply to the same extent in countries with encompassing unions on the Scandinavian model, where unions may have other incentives to moderate wages.)

Relative to labor law in most of Europe, U.S. labor law enhances incumbency advantages for existing unions. In the US, once a particular union has won a union certification election, it is officially recognized as the sole collective bargaining partner representing the covered workers, and it can only be replaced if the majority of workers vote to decertify it and then certify another union. Decertification, however, is relatively rare. In some European countries, such as France, Italy, and the Netherlands, several different unions may compete for workers within the same firm on an ongoing basis. The threat of entry makes it more difficult for incumbents to depart from members' preferred policies.[23] Reducing rent extraction from the level that maximizes the present

[23] Ongoing within-firm competition for members among unions will produce higher long-run rent extraction than

discounted value of rents for current union members may increase the lifespan of firms, but it will lead to the loss of workers within the firm to rival unions.

As a result, individual-level selection is likely to be a much more potent force in European countries with multiple unions inside a single firm than in a U.S.-style system in which a single union is certified to collectively bargain on behalf of a defined set of workers. Even in countries such as Britain, where a single union typically represents a given set of workers, the weakness of barriers to entry for competing unions relative to the U.S. means that the implicit threat of competition is likely to constrain unions to represent their members relatively well.

Evolutionary and standard maximizing models differ most sharply in their predictions of relative militancy of unions under the U.S. system of multiple craft unions representing different types of workers within the firm and European systems in which different unions can potentially compete for the same potential members. In the U.S. craft union system, for example, airline pilots, machinists, and flight attendants are all represented by separate unions, and hence under standard maximizing models, if there are many unions each union has no incentive to internalize the effect of its own rent extraction on the firm's investment. Standard maximizing models therefore imply that rent extraction should therefore be greater in this craft union environment than under a European environment in which multiple unions compete within a single firm but wage concessions to one union apply to all employees. In an evolutionary model, however, the ongoing competition for members among unions in the European system could lead to more rent extraction than under a system of U.S.-style craft unions. The model is consistent with the widespread view that European unions are more militant than their U.S. counterparts.[24]

A similar comparison can also be made within the U.S. Prior to the merger of the AFL and

restricting competition to the initial choice of union. This is because if unions only compete at some initial stage, unions that initially extract the level of rents which maximizes the present discounted welfare of members, and then gradually lower rent extraction, will be able to attract members with a policy which approaches the evolutionarily stable policy in the long run. Note that this policy does not require a commitment technology for unions, because it does not involve promises to undertake time-inconsistent policies. Extra benefits to workers joining a union are provided in the short run, not the long run. For example, unions could make an up-front payment in the form of support for organizers and support for an initial strike if necessary. In contrast, unions must maintain a high level of rent extraction in the long run to retain members in the face of ongoing competition.

[24] More systematic evidence on relative rent extraction is hard to come by. Wage premia for union members as conventionally measured are higher in the U.S. However, the lower union coverage in the U.S. means that wage premia may not be a good measure of rent extraction. In the U.S., unions may only be present in industries and firms with large amounts of rents to extract, whereas in Europe, unions are widespread.

the CIO, unions affiliated with each of the two umbrella organizations often continually competed to organize a given set of workers. This higher level of competition seems to have coincided with more militant behavior on the part of unions, as the model would predict.

The analysis of how rent extraction differs depending on whether or not unions compete within firms is analogous to the analysis of the evolution of virulence in biology. The strength of selective pressures for organisms to become more benign or even symbiotic depends on the mode of transmission of the organism [Ewald, 1994] . For example, if several different HIV strains are competing within the human body, one that reproduces more rapidly within the human body may be more likely to kill its host, but will also be more likely to be transmitted to another host. Thus individual-level selection within the host favors rapid reproduction while group-level selection favors more benign forms of the disease that are less likely to kill the host. In contrast, mitochondria reproduce only through cell division, so selection among mitochondria favors those that help their cells survive. Similarly, the system of incumbency advantages built into U.S. labor law produces an advantage for unions that help their firms survive. The greater ongoing competition for members among several different unions, the more this effect is counterbalanced by the need to extract more rent to attract members.

6 Conclusion

This paper has applied techniques from biology to model unions. A key implication of the model is that the unions we observe today are likely to extract less rent than would be optimal for current members, because unions that do so will have a selective advantage over unions that better represent their members' interests. For union leaders to moderate workers' wage demands, however, they must be insulated from workers by incumbency advantages. In fact, these incumbency advantages are widespread among today's unions.

In the conclusion, we discuss the relationship between our model and other theories of incumbency advantages in unions, the normative implications of the analysis, and the applicability of the evolutionary analysis here to other institutions, such as firms.

6.1 Relationship to Other Theories of Incumbency Advantages

The model outlined in this paper is complementary with other, more traditional explanations of incumbency advantages in unions. Sociological explanations, such as Michel's [1949 (1915)] "Iron Law of Oligarchy," suggest that leaders will inevitably seize control of their organizations and work to preserve the organization itself rather than to advance the original goals of the organization. In contrast, the argument here is not that all union leaders will wrest control away from their members due to internal sociological factors and then work to maximize the membership of the union, but rather that those unions that create structures in which this occurs will grow at the expense of unions that narrowly serve their current members' interests. If Michel's process occurs even in a few unions, we will empirically observe these unions much more frequently than unions that are more responsive to their membership.

Another way to explain the typically more moderate position of union leadership is through models in which union leaders are agents whose interests differ from those of their principals, the rank and file. An example of such an agency model was presented in Section 4, and as we points out, these considerations may well be the proximate cause of moderation of wage demands by union leaders. However, standard agency theory implies that principals should design optimal mechanisms for agents. It thus begs the question of why so many unions have constitutional institutions that exacerbate agency problems in controlling leaders, such as indirect elections, secret lists of locals and members, and no prohibitions on campaign donations from union staff. In contrast, this biological model suggests that unions with constitutional procedures that exacerbate agency problems will outcompete others that do not.

6.2 Normative Implications

The normative implications of the analysis are ambiguous. As shown above, the evolutionarily stable level of rent extraction will lead to more unionization in the steady-state than the welfare-maximizing level of rent extraction, but which union will extract more rent overall is ambiguous.

The difference in startup-cost expenditure is also ambiguous. On the one hand, since the steady-state chance of a new firm being unionized, p^*, is maximized by the evolutionarily stable union, the chance of a new …rm being unionized is higher, reducing the expenditure on start-up costs. Furthermore, the death rate of …rms will be lower, so startup costs will be paid less frequently. However, the cost of being unionized, ®¼, is lower, increasing the ex ante value of the …rm and thus increasing start-up costs, so the overall e¤ect could go in either direction. In any case, the welfare implications of these changes depend on the interpretation of investment and start-up costs. Investment and start-up costs may be productive, such as investment in research and development of improved products, or unproductive, such as advertising designed to establish market leadership for a dot.com seeking …rst-mover advantage.

Regardless of these general equilibrium e¤ects, however, the model implies that unions are not extracting the optimal level of rent for their workers. Changing union constitutions to reduce incumbency advantages will likely lead to increased welfare for the union's current members, though it will also reduce long-term unionization.

6.3 Applicability to Other Organizations

Similar evolutionary arguments could be made about organizations other than unions. For example, those religions that grow may be those that are most successful at retaining members, rather than those that maximize members' welfare. Universities whose boards accumulate large endowments may be more likely to survive than universities that pay out from the endowment less conservatively, whether or not this contributes to the universities' educational and research mission. As Dutta and Radner (1999) suggest, …rms that maximize their stockholders' interests by paying out dividends may eventually be outnumbered by …rms that retain earnings as a safety net, because paying out dividends makes …rms more vulnerable to negative shocks.

Reality is likely to lie between the predictions of models in which institutions maximize their owners' welfare and biological models in which organizational characteristics are …xed. The more that members have opportunities to control their organizations, the closer reality is likely to lie to the welfare-maximizing model. For example, the model presented in this paper suggests that if unions are controlled by opportunistic leaders, these leaders will pass on the leadership to similar opportunistic leaders, and these unions will displace unions with idealistic leaders. One could consider a more complicated model in which there is some chance that an opportunistic leader is replaced by an idealistic successor, and vice-versa. In this case, there will be a mixture of opportunistic and idealistic union leaders in steady-state. The longer it takes unions with incumbency advantages to displace those that serve their members perfectly, the longer these idealistic unions will survive and the better the economic model of welfare-maximizing unions will describe union behavior.

This suggests that firms may be closer to the welfare-maximizing end of the spectrum than unions, since control of unions by members is likely to be weaker than control of firms by shareholders. There is a substantial free-rider problem for workers in controlling union management, just as there is an important free-rider problem for shareholders in controlling firm management. However, in many cases, firms will have one large shareholder with a substantial stake in firm governance. In contrast, no single union member has a substantial stake in reforming the union leadership. Moreover, whereas there is a large financial incentive for outsiders to take over firms managed against shareholders' interests, there is much less incentive for outsiders to challenge existing unions for the right to represent workers.

A Appendix

The first part of the appendix gives some of the proofs omitted from the main text. The second part discusses the behavior of the model outside of the steady-state.

A.1 Proofs

Proof of Proposition 1. Equations (7) and (8) can be obtained by combining equation (5) and equation (6). The derivation for the condition that guarantees an interior solution, $2A(\alpha)B \leq \delta(\alpha)$, can be seen by setting the algebraic expressions for U^* and p^* equal to 1, the maximum value they can take, given that the maximum proportion of firms that can be unionized is 1 and that the difficulties of unionization are distributed on the interval [0,1].

To see that the steady-state with $U = 0$ is locally unstable, consider starting out from the steady-state of $U = 0$ and introducing a union of size $\varepsilon > 0$. Assume that this union consists of the least-costly ε firms, so that the remaining non-unionized firms have costs uniformly distributed on the interval $[\varepsilon; 1]$. This assumption makes it the hardest to show instability, because the cost distribution facing the union is the highest possible. Recall from equation (50) that the budget surplus or deficit will be given by

$$A(\alpha)B\varepsilon - [\delta(\alpha)\varepsilon + \delta(0)(1-\varepsilon)]\,dt\frac{\varepsilon^2}{2} \tag{17}$$

since p will be equal to ε. Note that the average organizing costs faced by the union will be less than ε since it will be organizing some newly created firms in the thin segment $[0; \varepsilon]$ and some in the thick segment at ε. The growth rate of the union will therefore be greater than it would be if it spent its entire budget organizing firms with cost ε, i.e.

$$\dot{U} > \frac{A(\alpha)B\varepsilon}{\varepsilon} - \delta(\alpha)\varepsilon \tag{18}$$

which will be clearly positive for ε small enough.

To see that the steady state with positive unionization is locally stable, consider first a union in the steady state where ε of the firms in the union revert back to non-union status. The union's organizing budget will therefore be $A(\alpha)B(U - \varepsilon)$. Denote by f the highest cost level firm in the thin segment the union could organize with such a budget, and by p' the lowest cost value of firms in the thick segment. We know that $p' \leq p$, but the precise value will depend on the cost level of the ε firms that switched from being unionized to being non-unionized. If $f > p'$, the union will spend the remaining budget surplus organizing the thick segment of firms with cost p'; otherwise it will organize as many firms in the thin segment as it can. The growth of the union will therefore be greater than or equal to the growth if it spend its entire organizing budget on firms with costs less than or equal to f, i.e.

$$\dot{U} \geq \sqrt{2A(\alpha)BU^*[\delta(\alpha)U^* + \delta(0)(1-U^*)]} - \delta(\alpha)U^* \tag{19}$$

Substituting in $U^* - \varepsilon$ for U and rearranging terms, we can see that, for $\varepsilon > 0$, the growth will be positive (and therefore the steady-state will be stable) if

$$2A(\alpha)B\left[\delta(\alpha)(U^* - \varepsilon) + \delta(0)(1 - U^* + \varepsilon)\right] > \delta^2(\alpha)(U^* - \varepsilon) \tag{20}$$

Since $\dot{U} = 0$ at U^*, the U^* terms in this expression cancel, and we are left with the condition

$$2A(\alpha)B\left[\delta(\alpha)\varepsilon - \delta(0)\varepsilon\right] < \delta^2(\alpha)\varepsilon \tag{21}$$

Since condition (9) guarantees that $2A(\alpha)B \leq \delta(\alpha)$, this condition will be satisfied and the union will return to the steady-state.

Next, consider a union in the steady state where ε of the non-union firms spontaneously unionize. To make it hardest to show stability, assume that these firms are the costliest to unionize, i.e. the firms with costs from the interval $\left[1 - \frac{\varepsilon(1-p)}{(1-U)}; 1\right]$. This is the most difficult assumption for showing stability since we have removed the firms that are costliest to organize. The first thing to check is whether the union will have sufficient organizing funds left over to begin organizing the thick segment, i.e. whether or not equation (50) is positive. The budget surplus will be

$$A(\alpha)B(U^* + \varepsilon) - \left[\delta(\alpha)(U^* + \varepsilon) + \delta(0)(1 - U^* - \varepsilon)\right]\frac{p^2}{2} \tag{22}$$

Since $\dot{U}^* = 0$ at the steady state, the terms from equation (5) cancel, so the surplus will be greater than or equal to 0 if

$$A(\alpha)B\varepsilon - \left[\delta(\alpha)\varepsilon - \delta(0)\varepsilon\right]\frac{p^2}{2} \geq 0 \tag{23}$$

Since p is equal to $\frac{2A(\alpha)B}{\delta(\alpha)}$ in the steady-state, we know that this condition will hold if

$$\delta(\alpha)^2 \geq 2A(\alpha)B\varepsilon\left[\delta(\alpha)\varepsilon - \delta(0)\varepsilon\right] \tag{24}$$

which is exactly the same as inequality (??), and holds by the same logic.

Given that there is a budget surplus, the change in U will be given by

$$U = [\delta(\alpha)(U^* + \varepsilon) + \delta(0)(1 - U^* - \varepsilon)]p + \frac{A(\alpha)B(U^* + \varepsilon) - [\delta(\alpha)(U^* + \varepsilon) + \delta(0)(1 - U^* - \varepsilon)]\frac{p^2}{2}}{p} - \delta(\alpha)(U^* + \varepsilon) \quad (25)$$

Once again, since $U^* = 0$ at the steady state, canceling out the terms from equation (5) and (6) yields

$$U = [\delta(\alpha)\varepsilon - \delta(0)\varepsilon]p + \frac{A(\alpha)B\varepsilon - [\delta(\alpha)\varepsilon - \delta(0)\varepsilon]\frac{p^2}{2}}{p} - \delta(\alpha)\varepsilon \quad (26)$$

Substituting in for p and rearranging terms yields inequality (??) as the condition for $U < 0$. Since we have already shown that this inequality holds, the growth rate of the union will be negative and it will return to the steady-state. ∎

Proof of Proposition 2. Suppose that the ratio $\frac{\delta(\alpha)}{\delta(0)}$ is fixed at $\lambda(\alpha)$. Then equation 7 can be rewritten as

$$U^* = \frac{2A(\alpha)B}{\lambda(\alpha)^2\delta(0) - 2A(\alpha)B[\lambda(\alpha) - 1]}. \quad (27)$$

Taking the derivative with respect to $\delta(0)$ yields

$$\frac{dU^*}{d\delta(0)} = -\frac{U^*\lambda(\alpha)^2}{\lambda(\alpha)^2\delta(0) - 2A(\alpha)B[\lambda(\alpha) - 1]}. \quad (28)$$

Condition (9) guarantees that $2A(\alpha)B \leq \lambda(\alpha)\delta(0)$, which in turn guarantees that $\frac{dU^*}{d\delta(0)}$ will be less than zero. ∎

Proof of Proposition 3. Denote by α_S the level of α that maximizes $\frac{2A(\alpha)B}{\delta(\alpha)}$. Let S represent the number of unionized firms in the union that extracts α_S. Consider a steady-state containing only the α_S union, and introduce into this steady-state a small union of size $\varepsilon > 0$ that extracts $\alpha_\varepsilon \neq \alpha_S$. In order to show that α_S is evolutionarily stable, we need to show that for each α_ε, there exists a minimum size γ such that if the size of the invading union ε is less than γ, then the invader will have negative growth and die off. To see that this will be the case, consider how the ε union spends its effective organizing budget of $A(\alpha_\varepsilon)B\varepsilon$. With such a budget, it can afford to organize the newborn firms up to some level p_ε, determined by setting the effective organizing budget equal to the number of newborn firms times the proportion organized by the invading union times the average cost of unionization for firms with cost less than p_ε:

$$A(\alpha_\varepsilon)B\varepsilon = [\delta(\alpha_S)S + \delta(\alpha_\varepsilon)\varepsilon + \delta(0)(1 - S - \varepsilon)]\frac{A(\alpha_\varepsilon)B\varepsilon}{A(\alpha_S)BS + A(\alpha_\varepsilon)B\varepsilon}\int_0^{p_\varepsilon} c\,dc; \tag{29}$$

which yields

$$p_\varepsilon = \sqrt{\frac{2[A(\alpha_S)BS + A(\alpha_\varepsilon)B\varepsilon]}{\delta(\alpha_S)S + \delta(\alpha_\varepsilon)\varepsilon + \delta(0)(1 - S - \varepsilon)}}. \tag{30}$$

Recall from the single-union case (equations (5) and (8)) that in the steady state,

$$p_S^* = \frac{2A(\alpha_S)B}{\delta(\alpha_S)} = \sqrt{\frac{2A(\alpha_S)BS}{\delta(\alpha_S)S + \delta(0)(1 - S)}}. \tag{31}$$

Note that when ε is close to 0, p_ε is approximately equal to p_S^*. Since in the steady state before the invasion all firms with difficulty level less than p_S^* are unionized, when ε is close to 0 the invading union will exhaust its budget organizing firms up to p_ε. The growth rate of the invading union will be

$$\dot{\varepsilon} = [\delta(\alpha_S)S + \delta(\alpha_\varepsilon)\varepsilon + \delta(0)(1 - S - \varepsilon)]\frac{A(\alpha_\varepsilon)B\varepsilon}{A(\alpha_S)BS + A(\alpha_\varepsilon)B\varepsilon}p_\varepsilon - \delta(\alpha_\varepsilon)\varepsilon. \tag{32}$$

Rearranging terms, we find that the growth rate of the invading union $\dot{\varepsilon}$ will be less than 0 if

$$\frac{2A(\alpha_\varepsilon)B}{\delta(\alpha_\varepsilon)} < \sqrt{\frac{2[A(\alpha_S)BS + A(\alpha_\varepsilon)B\varepsilon]}{\delta(\alpha_S)S + \delta(\alpha_\varepsilon)\varepsilon + \delta(0)(1 - S - \varepsilon)}}. \tag{33}$$

Since the RHS equals p_ε and p_ε can be made arbitrarily close to p_S^* by setting ε small enough, we can re-write this inequality as

$$\frac{2A(\alpha_\varepsilon)B}{\delta(\alpha_\varepsilon)} < \frac{2A(\alpha_S)B}{\delta(\alpha_S)}. \tag{34}$$

Since the ratio $\frac{2A(\alpha)B}{\delta(\alpha)}$ is precisely what α_S maximizes, we know that this inequality will hold and that the α_S union will be evolutionarily stable. ■

Proof of Lemma 1. For clarity of exposition, this proof will consider the case of a steady-state with two unions. However, the same arguments go through in the cases when there are more than two unions in the steady-state. As will be shown, however, there can be more than two unions in the steady state only if there is some value q such that there are more than two distinct levels α such that $\frac{2A(\alpha)B}{\delta(\alpha)} = q$, which will only occur under parameterizations of $A(\alpha)$ and $\delta(\alpha)$ such that $\frac{2A(\alpha)B}{\delta(\alpha)}$ has more than 1 critical point.

Recall that in the steady-state in which a single union has organized all firms with difficulty levels less than or equal to p, equation (5) stated that a union must spend its entire organizing budget organizing new firms with difficulty levels less than or equal to p. Adapting this condition to the case of two unions yields

$$A(\alpha_M)BM = [\delta(\alpha_M)M + \delta(\alpha_R)R + \delta(0)(1-U)]\frac{A(\alpha_M)BM}{A(\alpha_M)BM + A(\alpha_R)BR}\frac{p_M^2}{2}. \qquad (35)$$

If p_M and p_R were different, then this equation would apply only to the union with the smaller p. Supposing for the moment that M had the lower p (though in practice it could be either M or R), then the union R would be able to organize all unions in the interval $[p_M, p_R]$ instead of just the fraction $\frac{A(\alpha_R)BR}{A(\alpha_M)BM + A(\alpha_R)BR}$ of them. However, rewriting equation (35) shows that

$$p_M = \sqrt{\frac{2[A(\alpha_M)B + A(\alpha_R)B]}{\delta(\alpha_M)M + \delta(\alpha_R)R + \delta(0)(1-M-R)}}. \qquad (36)$$

Inspection of equation (36) shows that p_M and p_R must be the same for both unions in the steady-state since the equation for p_R would be exactly the same. Therefore we know that in the steady state the set of firms being organized each period by both unions have the same difficulty profile. This, in turn, is a consequence of allocating firms in proportion to the unions' effective organizing budget.

The second condition for the steady state is that $\dot{U} = 0$, so that the size of the union remains the same. Since the union's entire budget is exhausted in organizing newly created firms, in the steady state we know that, for $U = 0$,

$$\delta(\alpha_M)M = [\delta(\alpha_M)M + \delta(\alpha_R)R + \delta(0)(1 - M - R)]\frac{A(\alpha_M)BM}{A(\alpha_M)BM + A(\alpha_R)BR}p_M \qquad (37)$$

and the equivalent equation for R. This equation states that the number of member firms lost due to negative shocks must be exactly replaced by the number of firms organized during the same period. There are $[\delta(\alpha_M)M + \delta(\alpha_R)R + \delta(0)(1 - M - R)]$ firms created each period, of which the M union targets the fraction $\frac{A(\alpha_M)BM}{A(\alpha_M)BM + A(\alpha_R)BR}$ and from which it organizes all firms with difficulty levels below p_M. Substituting equation (36) for p_M yields the steady-state condition

$$\frac{A(\alpha_M)B}{\delta(\alpha)} = \sqrt{\frac{A(\alpha_M)BM + A(\alpha_R)BR}{2[\delta(\alpha_M)M + \delta(\alpha_R)R + \delta(0)(1 - M - R)]}}. \qquad (38)$$

By substituting equation (38) into equation (36), we can see that

$$\frac{2A(\alpha_M)B}{\delta(\alpha_M)} = p_M = p_R = \frac{2A(\alpha_R)B}{\delta(\alpha_R)}. \qquad (39)$$

The algebra would have been essentially similar if there had been more than two types of union. ∎

Proof of Proposition 4. Suppose that the steady state contains an incumbent union, α_I. Lemma 1 guarantees that if there are additional unions in the steady state with different α, those unions will have the same value of $p^* = p_I^*$. Therefore, in the steady-state, all firms with difficulty level less than p_I^* will be unionized and all firms with higher difficulty levels will not be unionized. For simplicity, the remainder of the proof focuses on the case where there is only one union in the steady state, but because the ratio $\frac{2A(\alpha)B}{\delta(\alpha)}$ is the same for all incumbent unions in a steady state, the same arguments go through when there are multiple incumbent unions.

Consider an invasion by a union that extracts α_S with size $S < \varepsilon$, where ε is very close to 0. Using a similar argument to the one in Proposition 3, we can see that $p_S \approx p_I^*$. Therefore, the initial growth of the union will be approximately

$$\dot{S} \approx [\delta(\alpha_I)I + \delta(\alpha_S)S + \delta(0)(1 - I - S)]\frac{A(\alpha_S)BS}{A(\alpha_I)BI + A(\alpha_S)BS}p_I^* - \delta(\alpha_S)S. \qquad (40)$$

To see that this growth is positive, observe that S is approximately equal to 0 and recall that in the steady state, $p_I^* = \frac{2A(\alpha_I)B}{\delta(\alpha_I)} = \sqrt{\frac{2A(\alpha_I)BI}{\delta(\alpha_I)I+\delta(0)(1-I)}}$. This allows us to simplify this expression and write

$$\frac{\dot{S}}{S} \approx \frac{2A(\alpha_S)B}{p_I^*} - \delta(\alpha_S) \tag{41}$$

which is greater than 0 since $\frac{2A(\alpha_S)B}{\delta(\alpha_S)} > \frac{2A(\alpha_I)B}{\delta(\alpha_I)}$. This means that the invading union will grow. ∎

Proof of Proposition 6. Recall from equation (6) that in the steady state, the number of unionized firms that die each instant must exactly match the number of newly created forms unionized in that instant. Rearranging equation (6) yields the condition

$$\frac{2A(\alpha)B\delta(0)}{\delta(\alpha)} = U^* \left(\delta(\alpha) - \frac{2A(\alpha)B}{\delta(\alpha)}[\delta(\alpha) - \delta(0)] \right): \tag{42}$$

Consider a change from α to α_S. Denote by ΔP the difference in the fraction of firms unionized each period, i.e. $\Delta P = \frac{2A(\alpha_S)B}{\delta(\alpha_S)} - \frac{2A(\alpha)B}{\delta(\alpha)}$, and denote by $\Delta\delta$ the same change in $\delta(\alpha)$, i.e. $\Delta\delta = \delta(\alpha_S) - \delta(\alpha)$. Since α_S maximizes the ratio $\frac{2A(\alpha)B}{\delta(\alpha)}$, ΔP will be greater than 0, and since $\alpha_S < \alpha$ by assumption, $\Delta\delta$ will be less than 0.

Since the left hand side of equation (42) is higher under α_S than under α, U^* will be higher under α_S than under α if the right hand side is lower. The change in the right hand side between α and α_S will be

$$\Delta\delta \left[1 - \frac{2A(\alpha)B}{\delta(\alpha)} \right] - [\delta(\alpha_S) - \delta(0)]\,\Delta P: \tag{43}$$

From condition (9), we know that $\frac{2A(\alpha)B}{\delta(\alpha)} < 1$ for all α, and since $\delta(\alpha) \geq \delta(0)$ for all α, we know that $\delta(\alpha_S) - \delta(0) \geq 0$. Therefore the expression for the change in the right hand side, equation (43), will be less than 0. We can therefore conclude that $U^*(\alpha_S) > U^*(\alpha)$. ∎

Proof of Proposition 7. All that is required to show the result is to show that $\frac{2A(v)B}{\delta(v)}$ is maximized at a point $v > 0$. Since $v = 0$ implies $\alpha = \alpha_W$, $\beta = 0$, we know that $A(v)$ is maximized at $v = 0$, and therefore in an ε-neighborhood around $v = 0$ changes in $A(v)$ will be second-order. What remains to be shown is that in an ε-neighborhood around $v = 0$, $\frac{d\delta(v)}{dv} < 0$. Note that it is sufficient to consider only $v \geq 0$ because any $v < 0$ yields the same α and β as $v = 0$, i.e.

$\alpha = \alpha_W; \beta = 0$.

To show this, it is convenient to define $\gamma = \alpha + \beta$. Rewriting equations (15) and (16) in terms of α and γ, we have:

$$x\left[\frac{1-\alpha}{r+\delta(\gamma)} - \frac{1-\alpha_W}{r+\delta(\alpha_W)}\right] = \frac{\gamma-\alpha}{r+\delta(\gamma)} \tag{44}$$

$$\frac{\alpha}{r+\delta(\gamma)} = \left[\frac{\alpha_W}{r+\delta(\alpha_W)} - \frac{v}{-\pi}\right]. \tag{45}$$

We can therefore eliminate α:

$$\frac{\gamma}{r+\delta(\gamma)} - x\left[\frac{1}{r+\delta(\gamma)} - \frac{1-\alpha_W}{r+\delta(\alpha_W)}\right] = (1-x)\left[\frac{\alpha_W}{r+\delta(\alpha_W)} - \frac{v}{-\pi}\right]. \tag{46}$$

The implicit function theorem implies that

$$\frac{d\gamma}{dv} = \frac{-\left(\frac{(1-x)}{\pi -}\right)}{\frac{d\left(\frac{\gamma}{r+\delta(\gamma)}\right)}{d\gamma} + \frac{x\frac{d\delta(\gamma)}{d\gamma}}{(r+\delta(\gamma))^2}}. \tag{47}$$

Since $\gamma = \alpha_W$ when $v = 0$, and since α_W maximizes $\frac{\gamma}{r+\delta(\gamma)}$, $\frac{d\left(\frac{\gamma}{r+\delta(\gamma)}\right)}{d\gamma} \approx 0$ in a neighborhood of $v = 0$. Therefore,

$$\frac{d\gamma}{dv} \approx -\frac{(1-x)(r+\delta(\gamma))^2}{\pi - x\frac{d\delta(\gamma)}{d\gamma}} < 0.$$

Since $\frac{d\gamma}{dv} < 0$ and $\frac{d\delta(\gamma)}{d\gamma} > 0$, we have shown that $\frac{d\delta(v)}{dv} < 0$ in a neighborhood of $v = 0$. Therefore, since in a small neighborhood of $v = 0$; $\frac{dA(v)}{dv} \approx 0$ but $\frac{d\delta(v)}{dv} < 0$, the value of v that maximizes $\frac{2A(v)B}{\delta(v)}$ is strictly greater than 0. ■

A.2 Dynamics

Outside of the steady-state, the state-space can be characterized by the number of union firms, U, and the difficulty distribution of all unorganized firms. As discussed above, in the steady-state the distribution of non-unionized firms' difficulties is simply uniform from the threshold p to 1, but in certain kinds of transitions–for example, those in which the difficulty level below which all firms are unionized, p, is shrinking–the distribution can be non-uniform. To track the dynamics, then, one needs keep track not only of the transition equations for U and p, but also the transition equation for the entire difficulty distribution. These transition equations are used in Section 3 to characterize the evolutionarily stable steady-state.

At any instant, assuming that there is no discontinuous increase in the number of firms, there are two different sets of firms that the union may chose to organize: the "thick" set of firms that are non-unionized and the "thin" set of firms that were created that instant to replace firms that exited due to a negative shock. The number of non-unionized firms is in the thick set is $1 - U$ and the number of firms in the thin segment is

$$[\delta(\alpha)U + \delta(0)(1 - U)]\,dt \tag{48}$$

Facing this profile of non-unionized firms, the union will organize the easiest firms it can. These will be all of the firms in the thin segment with cost less than p and then as many firms in the thick segment as it can with whatever remains of its organizing budget at that moment. Note that p represents the lower bound of the "thick" set of non-unionized firms–it will be possible in certain transitions that there are unionized firms whose difficulties are greater than p. Since the distribution of firms in the thin segment is uniform, the cost of organizing all firms in the thin segment with cost less than p will be

$$[\delta(\alpha)U + \delta(0)(1 - U)]\,dt\frac{p^2}{2} \tag{49}$$

so that the budget surplus or effective deficit becomes

$$A(\alpha)BU - [\delta(\alpha)U + \delta(0)(1 - U)]\,dt\frac{p^2}{2} \tag{50}$$

If the budget has a surplus, then the growth of the union will be the number of firms in the thin segment with difficulty levels less than or equal to p plus however many older firms the union can afford to organize at marginal cost p with whatever remains of its budget, minus the number of its member firms it lost due to negative shocks:

$$\dot U = [\delta(\alpha)U + \delta(0)(1-U)]\,p + \frac{A(\alpha)BU - [\delta(\alpha)U + \delta(0)(1-U)]\frac{p^2}{2}}{p} - \delta(\alpha)U \tag{51}$$

On the other hand, if the union's budget is not sufficient to organize all firms in the thin segment with costs less than or equal to p, the union will organize as many of those firms as it can. This will be all newly created firms with difficulty levels less than or equal to some cutoff level l such that the total budget exactly equals the cost of organizing the firms, i.e.

$$[A(\alpha)BU]\,dt = [\delta(\alpha)U + \delta(0)(1-U)]\,dt\frac{l^2}{2} \tag{52}$$

This implies that

$$l = \sqrt{\frac{2A(\alpha)BU}{[\delta(\alpha)U + \delta(0)(1-U)]}} \tag{53}$$

The change in the number of unionized firms in this case will therefore be the fraction l of thin firms unionized, multiplied by the total number of thin firms, less the number of unionized firms that exit:

$$\dot U = \sqrt{2A(\alpha)BU[\delta(\alpha)U + \delta(0)(1-U)]} - \delta(\alpha)U \tag{54}$$

Keeping track of changes in the distribution of the non-unionized firms is somewhat trickier. Suppose that the density of non-union firms in the thick segment at some difficulty level c is f(c). To find $\dot f(c)$ for those levels c that remain non-unionized (which will be all $c \geq p$) it will be instructive to consider the discrete case and take limits, so suppose that the density is the same over some small segment dz and small amount of time dt. Denote by $f_0(c)$ the density of firms in the segment dz before the time starts and $f_1(c)$ the density after the unit of time has passed. Define the density so that the total number of firms in the segment dz before the change will be $(1-U)\,f_0(c)\,dz$ and after the change will be $\left(1 - U - \dot U dt\right) f_1(c)\,dz$. The number of firms after the change will be equal to the number of firms in the segment before the change plus the number of firms that are born with costs in the segment minus the number of firms in the segment that exit due to the shock:

$$\left(1 - U - \dot{U}dt\right) f_1(c)\,dz = f_0(c)(1-U)\,dz + [\delta(\alpha)U + \delta(0)(1-U)]\,dtdz - \delta(0)(1-U) f_0(c)\,dtdz \quad (55)$$

The change in f will therefore be

$$\begin{aligned} \dot{f}dt &= [f_1(c)\,dz - f_0(c)\,dz]\,dt \\ &= \frac{f_0(c)(1-U)\,dz + [\delta(\alpha)U + \delta(0)(1-U)]\,dtdz - \delta(0) f_0(c)(1-U)\,dtdz}{1 - U - \dot{U}dt} - f_0(c)\,dz \end{aligned} \quad (56)$$

Simplifying and taking limits yields the equation for $\dot{f}$:

$$\dot{f}(c) = \frac{[\delta(\alpha)U + \delta(0)(1-U)] - \left[\delta(0)(1-U) - \dot{U}\right] f_0(c)}{(1-U)} \quad (57)$$

Note that substituting in the steady-state value of U and setting $\dot{f}(c)$ and $\dot{U}$ equal to 0 yields a steady-state value for $f_0(c)$ of $\frac{1}{1-p^*}$, which means that the distribution of costs of non-unionized firms in the steady-state is uniform over the range $[p, 1]$, as expected.

We also need to keep track of changes to p, the lower bound of the support set of the thick segment. If the union has a budget surplus (i.e. equation (50) is positive), the union has organizing funds remaining after unionizing all firms in the thin segment with costs less than or equal to p. The change in p will therefore be equal to the number of new firms unionized at cost p divided by the density of firms at that cost level, i.e.

$$\dot{p} = \frac{A(\alpha)BU - [\delta(\alpha)U + \delta(0)(1-U)]\frac{p^2}{2}}{p} \frac{1}{(1-U)f(c)}. \quad (58)$$

On the other hand, when the union's organizing budget is not sufficient to unionize all newly created firms with costs less than or equal to p, the new value of p will be the highest-cost firm that the union is able to unionize, i.e.

$$p = \sqrt{\frac{2A(\alpha)BU}{[\delta(\alpha)U + \delta(0)(1 - U)]}}. \qquad (59)$$

Together, the transition equations U; $\underline{f}(c)$, and $\underline{p}$ completely characterize the dynamics of the system.

References

[1] Anderson, Roy M., and May, Robert M., Infectious Diseases of Humans: Dynamics and Control. Oxford University Press [1991].

[2] Benson, Herman, [1986]. "The Fight for Union Democracy," in Unions in Transition: Entering the Second Century, Seymour Martin Lipset, ed. San Francisco: Institute for Contemporary Studies, pp. 323-373.

[3] Caballero, Ricardo J. and Hammour, Mohamad L, "The Macroeconomics of Speci…city," Journal of Political Economy 106(4), [August, 724-767, 1998].

[4] Dickens, William T. and Jonathan S. Leonard, "Accounting for the Decline in Union Membership, [1950-1980]," Industrial and Labor Relations Review 38(3), [April, 323-334, 1985].

[5] Dunne, Timothy; Roberts, Mark J; Samuelson, Larry, "Patterns of Firm Entry and Exit in U.S. Manufacturing Industries," Rand Journal of Economics 19 (4), [Winter, 495-515, 1988].

[6] Dutta, Prajit and Radner, Roy, "Pro…t Maximization and the Market Selection Hypothesis," Review of Economic Studies 66, [October, 769-798, 1999].

[7] Ewald, Paul W. Evolution of Infectious Disease. Oxford and New York: Oxford University Press, 1994.

[8] Moene, Karl Ove, Wallerstein, Michael, and Michael Hoel. "Bargaining Structure and Economic Performance. In eds. Flanagan, R. J., Moene, K. O., and M. Wallerstein, Trade Union Behavior, Pay-Bargaining, and Economic Performance. FIEF Studies in Labour Markets and Economic Policy. Oxford; New York; Toronto and Melbourne: Oxford University Press, Clarendon Press, 1993.

[9] Freeman, Richard B., "Spurts In Union Growth: De…ning Moments And Social Processes." In eds. Bordo, Michael D; Goldin, Claudia; and Eugene N. White, The De…ning Moment: The Great Depression and the American Economy in the Twentieth Century. NBER Project Report Series. Chicago and London: University of Chicago Press, 1998.

[10] Clark, Kim and Richard B. Freeman, "How Elastic is the Demand for Labor? A Reply." Review of Economics and Statistics 65(4) [November, 694, 1983].

[11] Freeman, Richard B. and Morris M. Kleiner, "Do Unions Make Enterprises Insolvent?" Industrial and Labor Relations Review 52 (4) [July, 510-27, 1999].

[12] Geoghegan, Thomas, [1992]. Which side are you on? Trying To be For Labor When It's Flat On Its Back. New York: Farrar, Straus, & Giroux.

[13] Hannan, M.T., and J. Freeman. "The Ecology of Organizational Founding: American Labor Unions, [1836-1985]." American Journal of Sociology 92: 910-43 [1987].

[14] Hannan, M. T., and J. Freeman, The Ecology of Organizational Mortality: American Labor Unions, 1836-1985. American Journal of Sociology 94: 22-52 [1988].

[15] Hirsch, Barry T; MacPherson, David A. "Union Membership and Coverage Files from the Current Population Surveys: Note." Industrial & Labor Relations Review 46 (3), [April, 574-78, 1993].

[16] Kleiner, Morris M., and Pilarski, Adam M. "Does Internal Union Political Competition Enhance Its E¤ectiveness?" In Samuel Estreicher, Harry Katz, and Bruce Kaufman, eds., Internal Governance and Organizational E¤ectiveness of Labor Unions, New York: Kluwer Publishing, forthcoming.

[17] Kremer, Michael and Benjamin A. Olken, "A Biological Model of Unions." NBER Working Paper Series #8257. [2001].

[18] Lipset, Seymour Martin, Martin Trow, and James S. Coleman, Unions Democracy. NY: Free Press [1956].

[19] Michels, Robert. 1949. Political Parties. Translated by Edward Cedar Paul. Glencoe, IL: Free Press [1915].

[20] Nelson, R.P., and S.G. Winter, An Evolutionary Theory of Economic Change. Cambridge, MA: Harvard University Press [1982].

[21] Ross, Arthur M., Trade Union Wage Policy. University of California Press. Berkeley and LA [1950].

[22] Tornell, Aaron, "Rational Atrophy: the U.S. Steel Industry." NBER Working Paper Series #6804 [1997].

[23] Wallerstein, Michael, "Union Organization in Advanced Industrial Democracies." American Political Science Review 83 (2), [June, 481-501, 1989].

[24] Weiler, Paul. "Striking a New Balance: Freedom of Contract and the Prospects for Union Organization." Harvard Law Review 98(351), [December, 1984].