

Unionization Patterns and Firm Reallocation

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Abstract

The unionization rate in the US varies widely both across sectors and states. Furthermore, unions have been in a steady decline over past 55 years. This paper constructs a dynamic macro model of unionization that is tractable yet capturing important stylized facts of US unionism. The focus of the model is on the dynamic interaction between firm entry and costly union organizing. It is shown how industry characteristics such as entry costs, and exit rates, as well as differences in costs of union organizing imply cross-sectional and time-series patterns of unionization rates that are in line with the data. Sectors with high entry costs, low firm death rates, or low organizing costs experience higher unionization rates. Firm reallocation plays an important amplifying role: Firm entry is higher in sectors that have a lower unionization rate. This in turn lowers the returns to organizing further due to higher competition and therefore lower wage gains.

The model's transition dynamics are then used to analyze possible causes of the union decline. For instance, a one-time change in the legal environment (as occurred in many Southern states shortly after WW II) implies gradual adjustments in the unionization rate due to cumulative changes in organizing resources. Moreover, the induced effect on firm entry helps to explain the observed co-evolution of unions and firm reallocation (as it happened with the secular shift of manufacturing to the South).

1 Introduction

This paper develops a model of union organizing dynamics within an environment of firm turnover to understand the large variations of private sector unionization rates in the US both across sections and over time. The unionization rate in this model is shaped by the endogenous interaction of firm entry on the one hand and costly union organizing on the other. Technically speaking, the paper combines a multi-sector entry-exit framework of monopolistically competing firms with a wage-setting and organizing union within a

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general equilibrium model. Both, the case of a union with monopoly power setting only the wage and an efficiently bargaining union is considered. The comparative static results show that sectors with high entry costs, low firm death rates, or low organizing costs experience higher unionization rates. Firm reallocation plays an important amplifying role: Firm entry is higher in sectors that have a lower unionization rate. This in turn lowers the returns to organizing further due to higher competition and therefore lower wage gains. In this respect the model is useful to understand the co-evolution of union and industry dynamics over the past six decades.

When looking at the empirical patterns of US unionism a variegated picture emerges. The fraction of private sector workers in the US belonging to a union differs significantly both across sectors and states, and has changed tremendously over time. The unionization rate peaked in 1953, when about 36% of the work force belonged to a union, and gradually declined to less than 8% in 2006 (see also figure 3). Comparing different industries, huge variations of the unionization rates can be observed at all times. For instance, the current rate in manufacturing is more than 11%, whereas in the sector of hotels and restaurants it is less than 3%. Moreover, different states in the US (with similar workforces - but different labor legislations) differ strongly: California has around 17% and Texas less than 6% unionized workers. At the same time, as it is well-known, there is significant firm turnover in the US. For the more recent years the aggregate rate of annually exiting (entering) establishments is more than 11% (13%) of all establishments, and the corresponding rate of jobs lost due plant closings (openings) is around 5% (5%).¹ In contrast to many European countries, firm turnover is a crucial determinant for the unionization rate in the US. Firm entrants are typically born as non-union, so that unions have to always organize incoming firms.² This process is not frictionless because unions have to spend resources on initiating and implementing certification elections, and in addition have to overcome resistance by employers. On the outflow side, unions rarely lose members through union firms that become non-union firms. This implies that higher firm exit *ceteris paribus* lowers the rate of unionized firms. A strength of the proposed model is that it captures this specific environment of union organizing in the US. The model, however, goes beyond the pure flow mechanics of turnover of firms and unions by endogenizing both firm entry and union organizing. The optimal response of the union to higher entry is to organize less, whereas optimal entry is lower if the union decides to organize more. Higher firm entry both requires more organizing and thus increases costs,

¹See Pinker and Spletzer [2004].

²There are some exceptions, for example in the auto industry, where it has happened that newly set up plants became organized through negotiations by the unions of the mother company with its management.

and -in the case of a monopoly union - also lowers the firm's optimal labor demand due to lower profits. This leads to a lower optimal organizing response. From the entrant's perspective, higher organizing increases the threat of becoming unionized which would lower profits. In case of the monopoly union there is an interesting second effect: A higher share of unionized firms will lower an individual firm's price relative to the sector average and thus increase sales and thereby profits. It can be shown that the first effect dominates.

Unions in the model maximize net revenue, which is the number of union members times the mark up over the non-union wage minus organizing cost. They do so by deciding both about which wage level to set (or to bargain for) and how many non-union firms (not workers) to organize. The incentive to organize firms is both directly given by an increase in members, and - in case of the monopoly union - indirectly through an improvement in the ability to set a higher wage.

An important simplifying assumption is the way of how union organizing is modeled. In this respect the paper differs from most of the (theoretical) literature, which has focused on the worker's demand for unions in a static setting by weighing costs against benefits of membership.³⁴ While the purpose of this simplification is mostly to make a complex phenomenon such as organizing tractable within a general equilibrium model, there are two reasons that favor the approach taken here. First, there is evidence which suggests that the worker's part of the unionization process is perhaps not the only or even most relevant one. As mentioned above, the union status of a firm is rarely revoked, and union membership decreases usually through firm exit. This implies that many firms have been unionized a long time ago and workers become unionized simply by being hired by such a firm.⁵ Moreover, survey evidence consistently shows that there is a wide gap between the percentage of workers who would vote for a union if possible and the actual rate of workers unionized. In fact, over the past ten years, the support for unions has even been rising, while the unionization rate continued to decline.⁶

Secondly, at least in the context of the US economy there are good reasons to consider unions as separate entities that are not simply identical to the majority will of their members.⁷ Due to reputational considerations and threats of job loss made by employers,

³This literature started with Pencavel [1971]. See Kaufman [2002] for a summary. The exception is Kremer and Olken [2001], which is discussed in the literature review.

⁴In this model, from an individual perspective, the workers would always prefer to join a union.

⁵In theory, workers can of course intentionally select themselves into a union firm.

⁶See Freeman [2007]. For surveys on union support see also the Gallup report that shows an approval rate of 60 % in 2007 (Gallup poll results are available online at: <http://www.gallup.com/poll/12751/Labor-Unions.aspx>).

⁷Note, however, the model doesn't feature unemployment, so individual workers always prefer to be

individual workers within a firm have low incentives to start an organizing drive. This provides an important role for the union as an outside agent to initiate elections to unionize. Union certification in the US often entails a lengthy procedure that involves legal disputes and delay strategies on side of the employers. This is reflected in the model by introducing a cost function for organizing that summarizes both direct costs of organizing workers and the indirect costs implied by countering employers resistance to organizing.

The model is applied to analyze both the impact of parameter variations on the steady state unionization rate as well as transitions following a one-time and permanent parameter change. The steady state unionization rate is higher if 1. firm entry costs are higher; 2. firm exit rates are lower; and 3. organizing costs are lower. All of these results are in line with the stylized facts listed in the next section.

The (simulated) dynamics of the model are used to evaluate two channels of the observed union decline proposed in the literature. First, it has been conjectured that in the aftermath of the Taft-Hartley Act in 1947, organizing has become more difficult. This seems particularly true for the US states that adopted the so-called right-to-work laws. According to the model, a one time change in the organizing cost implies a gradual adjustment of the unionization rate. This is due to the (de)cumulative effect of changes in unionization on organizing resources. Thus, the change in the unionization rate is coming from a gradual change in the organizing rate (which is also observed in the data). The model therefore shows that a one time change - in contrast to a conjectured gradual worsening of the organizing environment - is sufficient to generate the long-term decline.

A second factor that has been emphasized is the deregulation of several industries in the US during the late 1970s and early 1980s. Analogously to a organizing cost change the path following a decrease in entry costs is also gradual.

In both cases, the endogenous entry response amplifies the decline: lower organizing rates trigger higher entry, implying a reallocation of firms and employment from low to high organizing cost sectors. The model therefore offers an explanation of the observed co-evolution of unionization trends and firm reallocation from the North to the South.

Since unions set (bargain for) wages, the model also has implications for the union wage premium, which are interesting to investigate quantitatively in light of the fact that despite the union decline the wage premium seems to be much more stable.

Finally, the model also offers insights into the question of whether and how unions can act as an entry deterrent, which are discussed later in the text.

The remainder of the paper is organized as follows: Section 2 discusses the related

in the union if membership is offered and therefore there is no conflict of interest between the union's objective and the individual worker's interest to join a union.

literature and summarizes some stylized facts. Section 3 and 4 describe the model and the equilibrium concept. I focus on the efficient bargaining set-up and delegate the case of the monopoly union mostly to the appendix. In section 5 the steady state and its comparative statics are analyzed to show the models ability to explain cross-sectional heterogeneity of unionization rates. Section 6 presents numerical simulations for the transition paths between steady states to evaluate different interpretations of the union decline. Section 7 summarizes and discusses how to apply the model quantitatively so as to be able to gauge the likely implications of a change of the organizing law as it is currently debated by the newly elected government. The appendix contains all of the proofs and tables.

2 Related Literature and Empirical Findings

Related Literature Although the literature on dynamic union models is relatively small (see Jones and McKenna [1994] for an overview) there are two recent papers that also consider union organizing within a environment of firm turnover. The first, by Kremer and Olken [2001], uses ideas from epidemiology to interpret observed union behavior as the outcome of an evolutionary equilibrium that selects those unions that only moderately extract rents from firms in order to reduce firm exit and thereby increase union survival. The most important difference to this paper is that there is no feedback effect between entry (or the mass of incumbent firms) and unionization due to the assumption of a fixed mass of firms and a specification of profits that do not depend on the number of firms.

Secondly, the paper by Ebell and Haefke [2006] links product market competition measured by the elasticity of substitution between monopolistic-competitively supplied goods with the support for unions by workers within a random matching model. Higher competition (e.g. due to deregulation), decreases the net gain of unionization. If competition is strong enough, workers of any newly entered firm will not support unions, and unions disappear over time due to firm exit. Even though the model is similar in that it also has endogenous union formation and firm turnover, it differs both in that firm turnover is exogenous and in the way it formulates union formation. Most importantly, the feedback effect of firm reallocation on union organizing is absent. Further, the model’s organizing mechanism is not consistent with the fact that unions lose members and at the same time constantly organize non-union firms.

Further, this paper contributes to the literature on the long-term union decline in the US. Most of this literature is using “reduced form” approaches or argues with compositional effects (see Farber and Western [2001] and the references therein). More recently some theoretical models have been proposed, which are partly motivated by the conjecture that

this decline might be related to the rise in wage inequality. Besides the already mentioned paper by Ebell and Haefke which links the union decline to deregulation, the one by Acemoglu et. al. [2001] is particularly interesting. They propose a model where workers differ by skill and where unions flatten the skill-wage profile. Skill-biased technological change implies that high-skilled workers are less willing to form a coalition with the low-skilled workers and therefore the unionization rate decreases. While this argument certainly plays a role, it seems limited by the fact that the group of workers that has most benefited from skill-biased technological change has never been unionized to a large extent. Moreover, the rents that unions capture are not only taken from better-skilled employees but also from firm owner’s profits.

Stylized Facts The following summarizes a set of stylized facts about unions and firm turnover in the private sector of the US. Facts 1 to 6 are features of the data the model attempts to capture, whereas facts 7 and 8 are used to motivate important assumptions of the model.⁸

1. Industries with higher firm entry rates have lower unionization rates (Chappell et. al. [1992]). Relatedly, unionization rates are positively correlated with industry concentration (Ebell and Haefke, 2006)
2. Unionization rates are ceteris paribus lower in US states that have adopted so-called right-to-work laws (Ellwood and Fine [1987], Holmes [1998]).
3. Unionization rates are higher in industries with lower firm exit rates (Kremer and Olken [2001]).
4. The unionization rate has declined steadily from 1953 to today (see figure 3 and the source cited there).
5. The gross union membership growth rate has been positive at all times. The average yearly rate for the last decade is about 2.4 % (Holmes and Walrath [2007]; see also figure 7 for the long-term development).⁹
6. The union wage premium has been relatively constant with a slight downward trend (Blanchflower and Bryson, 2002).¹⁰

⁸A source of disaggregated data estimated from the CPS is provided by Hirsch and Macpherson. These data can easily be accessed at <http://unionstats.com/>.

⁹This number is an upper bound since it also includes gains from poaching, i.e. unions attracting members of other already existing unions.

¹⁰The union wage premium is the percentage of the union wage over the non-union wage. Estimating the

7. The aggregate rate of union decertification is close to zero (e.g. Farber and Western, 2001).
8. Exit rates for firms do not differ significantly by union status (DiNardo and Lee 2002], Dunne and Macpherson [1994], Freeman and Kleiner [1999])

3 Model

The exposition of the model focuses on the efficient bargaining case; the formulation with a monopoly union is laid out in the appendix.

3.1 Environment

The model combines an entry-exit framework¹¹ of monopolistically competitive firms with unions that bargain with firms over wages and employment and organize non-union firms.¹² The economy is populated by a continuum of ex-ante identical workers of constant mass L . Output markets are structured by a continuum of sectors $j \in [0, 1]$, each of which produces a continuum of goods of endogenous measure μ_j . Goods within sectors differ from goods across sectors by having a higher elasticity of substitution. Moreover, entry costs, ϵ_j , and exit rates, δ_j may be different across sectors. In each sector there is one union.¹³ Thus, the union is small vis-à-vis the aggregate economy, and therefore takes aggregates and the behavior of other unions as given. However, a union is big in relation to firms within its sector, which in turn take the union's organizing decisions as given. This constellation can be interpreted as an intermediate position between centralized and decentralized bargaining, which approximates the situation observed in the US.¹⁴ On the aggregate level there are markets for the aggregate good, Q_t , and non-union labor $l_{j,t}^n$,

premium is usually done with a Mincer-type regression but in general has problems such as endogeneity of the selection into union firms etc. In addition, a major problem is the availability of data on benefits in addition to wages. The study cited here seems to give a consensus estimate but is not supported by all of the literature.

¹¹One could interpret the framework as Hopenhayn [1992] without the shocks.

¹²Firms (in this model identical to plants or bargaining units) are therefore either union free or completely unionized. This is a simplification of the US case, where some plants are partially organized (especially in states where the union shop is prohibited). However, the difference between union members and union-covered workers is small. On average the difference is around one percentage point (see the cited website by Hirsch and Macpherson for data).

¹³This abstracts from the fact, that in the US unions sometimes organize workers that are (completely) outside their sector.

¹⁴The study by Katz [1993] finds that union bargaining in the US is a mixture between multi-company and plant level bargaining. He claims that there is a trend in direction of more decentralization. Marshall and Merlo [2004] state that for the more recent time period the percentage of pattern bargaining (unions coordinate their wage bargaining across many firms) is still about 25% of all bargaining.

which clear every period. These economy-wide markets determine the non-union wage level w_t^n , which is uniform across sectors, and the aggregate output price, P , which will be used as a numeraire. The given multi-sector structure with CES demands is not only well suited to answer questions about cross-sectional heterogeneity, but also has several technical advantages. First, on a theoretical level it allows to separate general equilibrium effects of the union's behavior on the aggregate wage and output from the union's maximization problem. This is important because in this class of models the comparative statics of aggregates is sensitive to parameter assumptions.¹⁵ Further, it allows having unionized firms coexisting with non-union firms. Moreover, as mentioned above, it avoids strategic interactions between unions.

The environment for firm turnover and the dynamics of the union status of firms is the following: Time is discrete. Each period there is a sufficiently large number of potential entrants. Firms who enter pay an up-front entry cost ϵ_j . All firms exit at a fixed rate δ_j . Moreover, each period non-union firms and entrants can become unionized. Entrants always start out as non-union. However, union firms cannot change back to non-union. This asymmetry is motivated by the stylized facts.¹⁶

3.2 Agents' Static Maximization Problems

This paragraph explains the decisions of consumers, specialized and aggregate producers made within a given period. Output is produced and consumed every period. Since there is no savings market¹⁷, both each worker's utility maximization problem and each firm's profit maximization problem is static. The resulting profit and labor demand functions (π_{ijt}, l_{ijt}) of the specialized producers are then used in the formulation of the dynamic decision problems of entrants and unions given in the next subsection. Time indices are omitted in this section.

Workers/Consumers Workers in firm $i \in \mu_j$ and sector $j \in [0, 1]$ earn wages and receive profit shares, and decide about consumption each period. Labor supply is inelastic. The aggregate worker solves each period:

¹⁵See the discussion in the third paragraph of section 5.6.

¹⁶Farber and Western [2001] report that the decertification rate, that is the rate by which unionized firms lose their union status, is positive but insignificant.

¹⁷In the part about the model dynamics below, firms who enter pay a sunk cost, which have to be paid by future profits. This implicitly assumes a credit market. As usual in this kind of models I ignore the savings market. To avoid inconsistencies, this arrangement could be formally justified by the assumption that workers, in contrast to firm owners, are discriminated with respect to their ability to borrow and lend.

$$\begin{aligned} & \max Q^C \\ \text{s.t. } & PQ^C \leq \int_{j \in [0,1]} \int_{i \in \mu_j} (w_{ij} l_{ij} + \pi_{ij}^{net}) di dj \end{aligned} \quad (1)$$

where the price index is given by:¹⁸

$$P \equiv \left(\int_{j \in [0,1]} \left(\int_{i \in \mu_j} p_{ij}^{\frac{\rho_1}{\rho_1-1}} di \right)^{\frac{\rho_2(\rho_1-1)}{\rho_1(\rho_2-1)}} dj \right)^{\frac{\rho_2-1}{\rho_2}}. \quad (2)$$

The set μ_j contains all union and non-union firms in sector j . In each period and sector there is a mass u_j of identical union firms and a mass n_j of identical non-union firms, which are both determined endogenously as explained further below. The symbol π_{ij}^{net} denotes profits net of entry costs.¹⁹

Final Good Production Intermediate goods q_{ij} provided by monopolistic producers (see next paragraph) are assembled into a final good Q each period by the following constant returns production function:

$$Q = \left(\int_j \left(\int_{i \in \mu_j} q_{ij}^{\rho_1} di \right)^{\frac{\rho_2}{\rho_1}} dj \right)^{\frac{1}{\rho_2}} \quad (3)$$

It is assumed that $1 > \rho_1 > \rho_2 > 0$, which implies that goods are more substitutable within than across sectors .

The demand functions for the intermediate goods q_{ij} resulting from cost minimization of the aggregate producer are given by:

$$q_{ij}(p_{ij}) = p_{ij}^{\frac{1}{\rho_1-1}} \left(\int_{i \in \mu_j} p_{i,j}^{\frac{\rho_1}{\rho_1-1}} di \right)^{\frac{\rho_1-\rho_2}{\rho_1(\rho_2-1)}} \hat{Q} \quad (4)$$

where $\hat{Q} \equiv Q P^{\frac{1}{1-\rho_2}}$.²⁰

¹⁸All the derivations of the CES demands and resulting price formulas are standard despite the added dimension of j sectors and therefore omitted.

¹⁹See also remark 1 in appendix C.

²⁰Note that the production of the aggregate good doesn't require any labor input. Adding labor to the production process would not, however, change any of the results of the model and is omitted for simplicity.

Monopolistic Firms The following is for a non-union firm. A unionized firm will behave identically, except that unions take a (lump-sum) part of the profits. In section 5.1 it is shown that a union firm will set employment equal to that of a non-union firm, i.e. $l_u = l_n$ (thus, the output prices are also the same, $p_u = p_n$) whereas the wage is set above the non-union wage to appropriate a share of the profits: $w_u = \left(1 + \sigma\left(\frac{\alpha - \rho_1}{\rho_1}\right)\right) w_n$, where $\sigma \in [0, 1]$ is the bargaining power parameter.

Given the demand function from above and wages, the producer of specialized good i solves the problem of a monopolistic competitor:²¹

$$\max_{p_{ij}} p_{ij} q_{ij}(p_{ij}) - w_{ij} \mathcal{F}(q_{ij}(p_{ij})) \quad (5)$$

Technology is given by the labor input requirement function: $\mathcal{F}(q) = \kappa q^\alpha$, with $\alpha \geq 1$, and $\kappa > 0$. I allow for decreasing returns, which could be justified by the presence of the fixed factor implied by the entry costs.

The profit of an individual firm can be derived as a function of wages:

$$\pi_{ij}(w_{ij}) = w_{ij}^{\frac{\rho_1}{\rho_1 - \alpha}} m^{\frac{\alpha(\rho_2 - \rho_1)}{\rho_1(\alpha - \rho_2)}} \left(\frac{\rho_1}{\alpha \kappa}\right)^{\frac{\rho_2}{\alpha - \rho_2}} \hat{Q}^{\frac{\alpha(1 - \rho_2)}{\alpha - \rho_2}} \left(1 - \frac{\rho_1}{\alpha}\right) \quad (6)$$

where $i \in \{u, n\}$ is indicating the union status of the firm, and $m = u_j w_j^{\frac{\rho_1}{\rho_1 - \alpha}} + n_j \bar{w}^{\frac{\rho_1}{\rho_1 - \alpha}}$, with w_j being the union wage, $\bar{w}$ being the economy-wide non-union wage, and u_j and n_j denoting the masses of union and non-union firms in sector j .

The term $m^{\frac{\alpha(\rho_2 - \rho_1)}{\rho_1(\alpha - \rho_2)}}$ (note, that it is taken to a negative power), expresses a sectoral demand effect implied by the relation of the firm's own price (which is a function of the wage) to an index of the sectoral price. In case of the monopoly union, this sectoral price index is increasing in the share of unionized firms, denoted by $\tilde{r}$. It will turn out that in that setting it follows - leaving the total mass of firms within a sector constant, and taking the aggregates $\bar{w}$ and $\hat{Q}$ as given - that a higher share of unionized firms (which have higher wages) leads to higher profits and thereby higher labor demand (for both unionized and a non-union firms).

3.3 Dynamics of Entry, Exit, Unionization, and Wage Setting

This subsection describes the dynamic aspects of the model. First I will detail the sequence of moves within each period and the laws of motion. Then, I will describe the potential

²¹Note, that for the efficient bargaining specification, a unionized firm cannot freely choose employment.

entrant's decision problem. The last part explains the union's wage and organizing choice problem.

Timing For each sector j the timing within every period t is as follows:

1. Potential entrants decide whether or not to enter and pay entry costs ϵ_j if they enter.
2. The union chooses the organizing rate s_{jt} .
3. A fraction s_{jt} of both entrants (e_{jt}) and non-union incumbents (n_{jt}) is unionized.
4. The union and firm bargain over w_{jt} and l_{jt} .
5. Firms, both entrants and incumbents, exit at an exogenous rate δ_j .
6. Incumbent firms demand labor l_{ijt} and produce output q_{ijt} .

Laws of Motion The states of the model are the masses of union and non-union firms in each sector. Given the environment and the timing of the decisions and events, the states evolve according to the following laws of motion:²²

$$u_{j,t+1} = (1 - \delta_j) [u_{jt} + s_{jt}(n_{jt} + e_{jt})] \quad (7)$$

$$n_{j,t+1} = (1 - \delta_j)(1 - s_{jt})(n_{jt} + e_{jt}) \quad (8)$$

e_{jt} is the total mass of entrants in sector j determined by a zero profit condition introduced below.

As was emphasized in the description of the environment, in this set-up unions can gain market share from both entrants and incumbents, but can lose only through the exit of union firms. An immediate consequence of this is that older firms have a higher likelihood to be unionized, since the (steady state) probability of being non-union in period T conditional on surviving to that period is $(1 - s)^{T+1}$, which goes to zero for $T \rightarrow \infty$ as long as $s > 0$. This is a feature also reported in empirical work.²³ Note, that this result rests on the assumption (supported by empirical studies) that union and non-union firms don't differ with respect to exit rates.

²²Note that x_{t+1} , $x \in \{u, n\}$, denotes the mass of firms at the *end* of period t .

²³See for example Freeman and Rogers [2006], p. 67 and Brown and Medoff [2003]. The latter study finds that the correlation is relatively weak however.

Value of Firms and Entry Decisions Each period there is infinite or sufficiently large supply of potential entrants who upon entry have to pay an up-front sunk entry cost. Once firms have entered they don't make any intertemporal decisions. Their discounted profits are simply the discounted sum of their static profits, given the sectoral aggregate mass of entrants $e_{j\tau}$, the time path of the union's choices of organizing $\{s_{j\tau}\}_{\tau \geq t}$, the negotiated wages $\{w_{j\tau}\}_{\tau \geq t}$, and the path of the economy-wide aggregate wage $\bar{w}_\tau$ and output Q_τ for all $\tau \geq t$. Given all these future values, it is then possible to formulate the value of each firm as a function only of the states and the time period. The value function of a unionized firm is:

$$V_{jt}^u(u_{jt}, n_{jt}) = \pi_{ujt}(u_{jt}, n_{jt}) + \beta^f(1 - \delta_j)V_{j,t+1}^u(u_{j,t+1}, n_{j,t+1}) \quad (9)$$

where δ_j is the exogenous firm exit rate.

The value function of a non-union firm is given by:

$$V_{jt}^n(u_{jt}, n_{jt}) = \pi_{jnt}(u_{jt}, n_{jt}) + \beta^f(1 - \delta_j)[s_{j,t+1}V_{j,t+1}^u(u_{j,t+1}, n_{j,t+1}) + (1 - s_{j,t+1})V_{j,t+1}^n(u_{j,t+1}, n_{j,t+1})] \quad (10)$$

With probability s_j an entrant will become unionized, with probability $(1 - s_j)$ it will stay non-union this period. The value of an entrant is therefore given by:

$$V_{jt}^e(u_{jt}, n_{jt}) = s_{jt}(1 - \delta_j)V_{j,t}^u(u_{jt}, n_{jt}) + (1 - s_{jt})(1 - \delta_j)V_{j,t}^n(u_{jt}, n_{jt}) - P_t\epsilon_j \quad (11)$$

where ϵ_j are real entry costs in sector j . In order to make their decisions, potential entrants have to anticipate what the future path of both the union's choices within the sector, what the future equilibrium mass of entrants will be and how the aggregate output and the non-union wage will evolve.

In equilibrium the mass of entrants e_{jt} is determined by the following zero-profit condition:²⁴

$$V_{jt}^e \leq 0, \quad = 0 \text{ if } e_{jt} > 0 \quad (12)$$

The equilibrium entry response as a function of the states will be denoted by $f_{jt}^e(u_{jt}, n_{jt})$.

²⁴Note, the numerical simulations for the transition dynamics currently use a modified entry condition. See remark in Appendix C.

Union Organizing and Wage Setting In each period the union of sector j decides about the rate s_{jt} at which to organize non-union firms and bargains over wages w_{jt} and employment l_{jt}^u . As mentioned, the appendix discusses an alternative wage setting assumption so that both of the commonly used approaches in the literature are covered here.²⁵

In the theoretical union literature following the work by Pencavel [1971] union formation has mostly focused on the worker's decision on the costs and benefits of joining a union. Here, I complement this view by focusing on the costly organizing process carried out by the union as an autonomous agent.²⁶

The organizing decision is modeled as a trade-off between employment gains on the extensive margin (additional firms) and the cost of organizing $\mathcal{C}(s)$.

The union's Bellman equation in case of the efficient bargaining union is given by:²⁷

$$W_{jt}(u_{jt}, n_{jt}) = \max_{s_{jt} \in [0,1]} \{U(u_{jt}, n_{jt}, s_{jt}) - P_t \mathcal{C}_j(u_{jt}, n_{jt}, s_{jt}) + \beta W_{j,t+1}(u_{j,t+1}, n_{j,t+1})\} \quad (13)$$

with $U(\cdot) = (w_{jt}^{eb} - \bar{w}_t)u_{jt}l_{ujt}^{eb}$, where $\{w^{eb}, l_u^{eb}\}$ is the solution to the period-by-period axiomatic Nash bargaining problem with share parameter $\sigma \in [0, 1]$:

$$\max_{w, l_u} \sigma \ln \{(w - w_n)l_u\} + (1 - \sigma) \ln \{p(q(l_u))q(l_u) - wl_u\} \quad (14)$$

The union's net payoff is the difference in wages times employment (that is the outside option is to take the competitive wage), whereas the firm's net payoff is simply profits (the outside option is to not produce in that period). This set-up abstracts from features of real world bargaining like strikes, hold-outs and hiring of replacement workers.

Returning to the dynamic problem of choosing s , the maximization is subject to the laws of motion and the time path of the equilibrium entry response $\{e_{j\tau}\}_{\tau \geq 0}$ and the aggregates $\bar{w}_t$ and Q_t for all $t \geq 0$. Further, it is assumed that the union cannot borrow so that the period payoff has to be non-negative.²⁸ Denote the union's policy function for organizing by $f_{jt}^s(u_{jt}, n_{jt})$.

²⁵The evidence on the union's objective function is mixed at best. See Kaufman [2002] for a summary of the literature.

²⁶With the only exception of Chezum and Garen [1997], who consider a partial equilibrium framework, no other union models consider the simultaneous choice of organizing and wages.

²⁷Note, that for (mostly technical) reasons to be explained later I allow the discount factor of firms (β^f) to be different than that of unions (β).

²⁸In terms of the data, the union's income through the dues seems to be even more restricted since dues typically are not more than 2 or 3% of the wage, which is strictly below the average wage premium of about 15%.

Considering the observed practice that unions as institutions get a (fixed) percentage of their members' wages, a straightforward interpretation of U is that the union maximizes its revenues net of organizing costs.²⁹

Organizing costs are in terms of the aggregate output³⁰ and are specified by:

$$\mathcal{C}_j(u_{jt}, n_{jt}, s_{j,t}) = (n_{jt} + e_{jt})\eta_j s_{j,t}^\gamma,$$

where cost parameter $\eta_j > 0, \gamma > 1$ and entry is a function of the states: $e_{jt} = f_{jt}^e(u_{jt}, n_{jt})$.

The cost function is strictly convex and increasing in s (for some of the results, more stringent conditions on γ are imposed). The costs for a given organizing rate s are proportional to the total mass of firms, $n_{jt} + e_{jt}$, that can potentially be organized. This means that costs are independent of firm size (implying that organizing larger firms yield a higher return to unions). The costs of organizing in this model can be interpreted as a summation of several factors. First, there are actual costs which have to be paid to union employees for the organizing drive.³¹ Secondly, the success of organizing depends on the firm behavior. Firms can (illegally) dismiss workers joining the union organizers at low cost. Moreover, there are many possibilities to delay the organizing procedure. Once organized, firms can further delay the bargaining process, which is supported by the fact that a significant portion of certifications do not achieve a wage agreement. All of the firm's counter measures make it harder for the union to organize.³² The model in this paper does not attempt to map these obstacles in an explicit manner and treats a firm's union avoidance as part of the organizing cost function.³³ Rather, the model is used to show how this friction is qualitatively relevant in the context of firm turnover.

²⁹Alternatively, the union's objective can be understood as the payoff of its end-of-period members. One problem with this interpretation is, however, that the model is silent about how individual workers are allocated to firms after a firm exits (or its labor force is reduced after a wage increase). Thus, this second interpretation would have to impose further assumptions on where workers can go after leaving a firm to pin down the exact value of union membership for a worker.

³⁰On the aggregate, organizing costs are $Q_t^U = \int_j \mathcal{C}_j(\cdot) \cdot u_{j,t} dj$. This part of the output is subtracted from output for consumption. For the remainder of the model I will leave this cost implicit, i.e. will only deal with gross aggregate consumption Q^C (but I report the wage premium net of the organizing cost in the section with the numerical results).

³¹See Voos [1984] as the only paper known to me that presents data on union organizing expenditures.

³²See Kleiner [2001] for more details and further literature about management resistance.

³³For an empirical investigation of how organizing cost and anti-union resistance together determine the unionization outcome see Abowd and Farber [1990].

4 Equilibrium

The equilibrium of the economy is defined in three steps. The first two describe the sector equilibrium of entrants and the union given the aggregate outcomes. The third step is concerned with the aggregate markets for the final output good and labor given the outcomes of the industry equilibrium.

The equilibrium chosen here is one where the union can commit to a sequence of future organizing decisions (which imply a sequence of wage and entry decisions, since each entry behaves competitively). A more natural concept in this context that also avoids time inconsistency would have been a Markov-Perfect equilibrium. In order to get some analytic results and hence better intuition of the model implications the commitment case has been chosen.³⁴

Definition. Normalize $P_t = 1$ for all t . Given some initial state vector $\{u_{j0}, n_{j0}\}_{j \in [0,1]}$, an equilibrium consists of prices $\left\{ \{p_{ujt}^*, p_{njt}^*, w_{jt}^*\}_{j \in [0,1]}, \bar{w}_t^* \right\}_{t \geq 0}$, quantities

$\left\{ \{u_{jt}^*, n_{jt}^*, e_{jt}^*, s_{jt}^*, l_{jt}^*\}_{j \in [0,1]}, Q_t^*, Q_t^{C*}, Q_t^{\epsilon*}, Q_t^{\pi_{net}*}, \right\}_{t \geq 0}$, demand functions $\{q_{jt}(\cdot), l_{njt}(\cdot)\}_{j \in [0,1]}$, value functions $V_{jt}^u, V_{jt}^n, V_{jt}^e, W_{jt}$, and the equilibrium entry response function f_{jt}^e such that for all $t \geq 0$:³⁵

1. Given the aggregate variables $\{\bar{w}_t^*, Q_t^*\}_{t=0}^\infty$, for each sector j :
 - (a) For each specialized goods producer, given the demand function (4), the maximand of (5) is given by the profit function (6), and the labor demands give the corresponding optimal input demands.
 - (b) Given the value function of an entrant as defined by (9)-(11), and given (u_{jt}^*, n_{jt}^*) and $\{e_{jt}^*, s_{jt}^*, w_{jt}^*\}_{t \geq 0}$ the potential entrant solves $\max_{enter, don't} \{V_{jt}^e, 0\}$.
 - (c) Given (u_{jt}^*, n_{jt}^*) and $\{e_{j\tau+1}^*, s_{j\tau}^*, w_{j\tau}^*\}_{\tau \geq t}$, f_{jt}^e gives the total mass of entrants e_{jt} such that the zero profit condition (12) holds.
 - (d) $f_{jt}^e = e_{jt}^*$.
2. Given the aggregate variables $\{\bar{w}_\tau, Q_\tau\}_{\tau \geq t}$, the laws of motion for u_{jt} and n_{jt} , and $\{e_{j\tau}^*\}_{\tau \geq t}$, for all t , for each sector j :
 - (a) W_{jt} solves the Bellman equation (20).

³⁴My numerical simulations indicate that there is not much of a difference in the results for either equilibrium concept.

³⁵The time index of the value and policy functions is understood as a time argument of these functions.

- (b) w_{jt}^* and l_{jt}^* solve the bargaining problem in (14)
 - (c) The policy function f_{jt}^s attains the RHS of (20).
 - (d) $f_{jt}^s = s_{jt}^*$.
3. Given $\{w_{jt}^*, u_{jt}^*, n_{jt}^*\}_{j \in [0,1]}$, $\{p_{ujt}^*, p_{njt}^*\}_{j \in [0,1]}$, and labor demands $\{l_{jt}^*, l_{njt}(\cdot)\}_{j \in [0,1]}$ as determined in 1. and 2., $\bar{w}_t^*$ and $\left\{ \{q_{jt}(p_{ijt})\}_{j \in [0,1]} \right\}_{i \in \{u,n\}}$, Q_t^{C*} , $Q_t^{\epsilon*}$, $Q_t^{\pi_{net}*}$, and Q_t^* are such that:
- (a) Q_t^{C*} solves the consumers problem in (1).
 - (b) The demand functions for specialized goods in (4) solve the final goods producer's cost minimization problem for a given price p_{ijt} , $i \in \{u, n\}$, and output Q_t^* .
 - (c) The goods market clears: $Q_t^* = Q_t^{C*} + Q_t^{\pi_{net}*} + Q_t^{\epsilon*}$ (where Q_t^* is defined in (3), the aggregate entry costs are $Q_t^{\epsilon*} \equiv \int_j \epsilon_j \cdot [u_{j,t+1}^* + n_{j,t+1}^*] dj$, and $Q_t^{\pi_{net}*}$ is the consumption from aggregate profits net of entry costs).
 - (d) The labor market clears: $L = \int_j [u_{j,t+1}^* l_{jt}^*(\bar{w}_t^*, \cdot) + n_{j,t+1}^* l_{njt}(\bar{w}_t^*, \cdot)] dj$ (where the LHS is the time invariant and inelastic total labor supply).

Note, that the equilibrium is not well-defined if the unions were able to completely unionize the economy, since then the labor market would not clear. This problem is not relevant for interesting parameter values, and could easily be avoided by either assuming that at least some sectors have high enough organizing cost, ruling out the possibility $s = 1$ or that some positive mass of sectors by default doesn't have a union.

5 Cross-Sectional Heterogeneity

This section analyzes the steady state equilibrium and its comparative statics with respect to entry cost, union organizing cost, and the firm exit rate for the case where the union bargains every period with each firm individually. Where relevant I add comments how results are affected when considering the monopoly union case.

5.1 Steady State Equilibrium

In the following I will analyze the problem assuming that the union in each sector bargains with each firm over both wages and employment. Before discussing existence and uniqueness, I will characterize the outcome of the bargaining game. The first order conditions of the problem given in (14) yield the following result:

Lemma 1. *The bargaining solution is the union choosing employment equal to the non-union employment: $l_u = l_n$. The wage is given by: $w_u = \sigma p_n l_n^{(1/\alpha)-1} + (1 - \sigma)\bar{w} = \left[1 + \sigma\left(\frac{\alpha-\rho_1}{\rho_1}\right)\right] \bar{w}$.*

Thus, the union doesn't alter employment and simply takes a share σ of the firm's profits (which is easy to see for the case where note, that if $\alpha = 1$).

Given the solution to wages and employment, the union's optimal (interior) choice for s is given by the solution to the FOC w.r.t. s of the corresponding sequential version of the union's problem in (13)³⁶, where the laws of motions for u and n have been substituted in and steady state has been imposed:

$$[1 + \beta(1 - \delta)(1 - s)](w_u - w_n)(1 - \delta)(n + e)l_u(e) = \eta(n + e)[\gamma - \beta(1 - \delta)s]s^{\gamma-1}$$

This expression, roughly speaking, equates marginal benefits of organizing with marginal costs. Solving for the indirect response function (e as a function of s) we get (using the steady state expression for l_u , u and n):³⁷

$$g^u(s) = \left(\frac{\eta[\gamma - \beta(1 - \delta)s]s^{\gamma-1}}{[1 + \beta(1 - \delta)(1 - s)]\sigma\frac{\alpha-\rho_1}{\rho_1}(1 - \delta)\left(\frac{1-\delta}{\delta}\right)^{x_2}\bar{w}^{x_1(1+x_2)}K_L} \right)^{1/x_2} \quad (15)$$

If e increases, marginal cost of organizing go up whereas there are two countervailing effects on marginal benefits. Marginal costs go up, because more firms have to be organized for given s . Marginal benefits go up for the same reason. However, benefits also decrease, since more entrants mean lower profits per firm and thereby fewer workers per firm. In addition, there is an intertemporal effect: Higher s today means that the union needs only a lower s tomorrow in order to maintain a constant unionization rate, which implies that the optimal s for a given e is lower in the dynamic compared to the single period case. In order for the reaction function to be decreasing it is required that marginal costs go up by more than the benefits when increasing e . It can be shown, that the total effect is negative if $\gamma > 1 + \beta^2(1 - \delta)^2$, that is if the organizing cost function is sufficiently convex. Note, for $s \rightarrow 0$ the function tends to ∞ , whereas for $s = 1$, it takes on some finite positive value. A sufficient condition for strict convexity of the response function is $y > 2$.³⁸

³⁶The proof for the equivalence of the sequential problem and the value function formulation is omitted.

³⁷Further details and the shorthand symbols x_1, x_2, x_3, K_L and K_π used here and later are defined in the appendix. The first three are terms are consisting only of parameters, whereas the latter two also contain aggregate output and aggregate price.

³⁸This condition seems to be more restrictive than necessary, my numerical tests indicate that for

Turning to the potential entrant's problem, given the formulas for V^u and V^n , and the steady state expressions for u and n , the steady state value for an entrant is:

$$V^e = \frac{1 - \delta}{1 - \beta^f(1 - \delta)(1 - s)} \left(\frac{s}{1 - \beta^f(1 - \delta)} \pi_u + (1 - s) \pi_n \right) - P\epsilon$$

where π_n is the steady state version of (6), and $\pi_u = (1 - \sigma)\pi_n$. Solving this for entry we get

$$g^e(s) = \left(\frac{\epsilon}{(1 - \delta) \left(\frac{1 - \delta}{\delta}\right)^{x_2} \bar{w}^{x_1(1+x_2)} K_\pi s [\beta(1 - \delta) - \sigma] + 1 - \beta(1 - \delta)} \right)^{1/x_2} \quad (16)$$

Note, that at the endpoints of this function take on finite values with $g^e(0) > g^e(1)$. The function is strictly decreasing in s , because, a higher organizing rate increases the probability of becoming a less profitable firm (higher wage). A sufficient condition for strict convexity is $\beta^f(1 - \delta) > \sigma$, which is not very restrictive from an empirical point of view.

The following proposition establishes the existence of a unique sector equilibrium.³⁹

Proposition 1. *If $\epsilon \leq \frac{1 - \sigma}{\sigma} \eta(\gamma - \beta(1 - \delta))$ holds, a sector equilibrium for given aggregates $\bar{w}$ and Q exists. Further, if both $\gamma > 2$ and $\beta^f(1 - \delta) > \sigma$ the equilibrium is unique. If in addition $\beta^f = 1$ and all sectors are identical then a general equilibrium exists and is unique for interior values.*

The existence proof can be extended to the case of heterogeneous sectors, but this case is omitted here.

In the following, I study the comparative statics with respect to entry costs (ϵ), organizing costs (η) and exit rates (δ) across sectors, i. e. I take the aggregate variables as given.⁴⁰ A discussion of these results follows in section . Note, however, since organizing s and the unionization rate r do not depend on the aggregates, all the comparative static results regarding these variables hold true for the aggregate economy (which is not necessarily the case for firm entry).⁴¹

$\gamma > 1 + \beta^2(1 - \delta)^2$ the function is both decreasing and convex.

³⁹The aggregate equilibrium requires that there is a solution to the equations for aggregate entry, output and the non-union wage. The solutions to s and r do not depend, however, on the aggregate variables.

⁴⁰I analyze the same exercise numerically for the aggregate economy. Table 3 and the following one confirm that the same results go through for the aggregate economy (in the given examples it is assumed that all sectors are identical).

⁴¹See the discussion about the general equilibrium effects below.

5.2 Entry Costs

The first result states that higher entry costs (ϵ) for entering firms lead to more organizing and a higher unionization rate.

Proposition 2. *Given an interior solution and the conditions for a unique equilibrium, if firm entry costs are higher, entry e is lower, the organizing rate s and the unionization rate r are higher.*

Higher entry costs obviously lower entry. At the same time each entrant will have higher profits and therefore a greater number of workers. This implies that the benefits of organizing per firm increase (whereas the costs per firm stay constant), and thus it is optimal to increase organizing. The unionization rate r is defined by $r_{jt} \equiv \frac{L_{ujt}}{L_{ujt} + L_{njt}}$. Using the formula for the sectoral labor demand:

$$L_i(w_i) = i(w_n)^{\frac{\alpha}{\rho_1 - \alpha}} \left[u(w)^{\frac{\rho_1}{\rho_1 - \alpha}} + n(\bar{w}_t)^{\frac{\rho_1}{\rho_1 - \alpha}} \right]^{\frac{\alpha(\rho_2 - \rho_1)}{\rho_1(\alpha - \rho_2)}} \kappa \left(\frac{\rho_1}{\alpha \kappa} \right)^{\frac{\alpha}{\rho_1 - \rho_2}} \hat{Q}^{\frac{\alpha(1 - \rho_2)}{\alpha - \rho_2}} \quad (17)$$

where $i \in \{u, n\}$, and making use of the steady state versions of the laws of motions (given in the appendix) one can write the steady state unionization rate as:

$$r_j^* = \left\{ 1 + \left[\frac{1}{\delta_j} \frac{s_j^*}{1 - s_j^*} \right]^{-1} \right\}^{-1} \quad (18)$$

Thus, higher s implies a higher unionization rate r . Note that for the efficient bargaining case the rate of firms unionized, $\tilde{r}$, and the unionization rate are identical because employment is the same across union and non-union firms.

5.3 Organizing Costs

Next, I turn to the effect of lowering organizing costs, measured by the scaling parameter η .

Proposition 3. *Given an interior solution and the conditions for a unique equilibrium, lower organizing costs η increase s and therefore r , but lower entry e .*

Higher organizing costs will increase costs relative to benefits of organizing, thereby decreasing the optimal s for any given value of entry e . By the same argument as before this will also decrease r .

5.4 Exit Rates

The effect of a change in the exit rate δ is not clear-cut. A change in δ moves both curves similarly. However, δ also directly affects the firm unionization rate $\tilde{r}$ ($=r$) through the laws of motion for u and n , because over time higher exit rates lead to less accumulation of union firms (see also equation 18). It turns out that this direct effect is dominating so that the ambiguous outcome of the union-entry equilibrium doesn't affect the overall result very much. Table 3 and the following present numerical results for a range of parameters which confirm that a higher exit rate leads to a lower unionization rate. The dominating effect is that a higher exit/turnover rate makes it harder for the union to accumulate firms.

5.5 Bargaining Power

The last result is concerned with variations of the exogenous bargaining power parameter.

Proposition 4. *Given an interior solution and the conditions for a unique equilibrium, higher bargaining power for the union σ increases s and therefore r , but lowers entry e .*

Higher σ lowers the payoff of an entrant, therefore lowers entry for any given s , but for the union, it increases marginal benefit without changing marginal cost, therefore, allows for a higher e given any s . Thus both effects lead to a higher equilibrium value of s . In the next section, wages will be set by the union. It turns out that here the causality runs the other way round: Higher organizing will imply a higher wage due to a union share effect that says that the higher the union share in the output market, the higher is the sector-wide average output price, and thus the higher profits and optimal labor demand.

5.6 Discussion of Results

The previous two sections have shown that the model is able to rationalize the observed facts discussed in the introductory chapter: Sectors with a higher level of entry due to 1. higher entry costs, 2. lower exit rates, and 3. lower cost of organizing have a higher organizing and unionization rate. The numerical results indicate that all the results also hold when taking the general equilibrium effects into account.⁴² I will briefly discuss each of the comparative statics result in turn.

1. Higher entry cost imply lower entry and thus fewer firms. Typical examples of more more concentrated industries with a low entry are the still relatively high unionized

⁴²See also the discussion about the general equilibrium outcomes further below.

industries of automobiles and aircraft manufacturing. The interpretation given by this model complements the ones frequently given in the literature, namely that in higher concentrated industries there is a higher chance of union “contagion” and/or that high fixed costs create a hold-up problem that is exploited by unions. Here instead, the higher unionization directly comes from the interaction with entry. That is, both low entry and high unionization have the common cause of high entry costs.

2. As was discussed in section 5.4, the impact of δ on the equilibrium interaction between entry and organizing is ambiguous and likely to be small. The exit rate does however have also a direct impact on the flow movements: Everything else constant, a higher exit rate increases the (out)flow from union firms relatively to the stock of incumbents, thereby directly lowering the firm unionization rate. This direct impact on the flows is the driving force for the total effect. Kremer and Olken [2001] regress sectoral unionization (coverage) rates on firm exit rates, controlling for several industry characteristics and find that a 1 percentage point increase in the exit rate implies a 3.4 percentage point decrease in the unionization rate. Regarding the example in the introduction, in manufacturing the (recent) job loss rate due to plant closings is .7%, whereas in the service subsector of hotels and restaurants it is about 2%.⁴³

3. As expected, lower organizing costs increase the share of firms unionized $\tilde{r}$ and the unionization rate r . The direct effect is that lower costs make it more worthwhile to organize more. In addition, there is also an induced effect that higher organizing deters entry, which in turn increases optimal organizing. The differences in the legal environment across states imply differences in the organizing costs. In particular, most of the southern states in the US adopted the so-called right-to-work legislation have lower unionization rates on average compared to states without such a legislation.

To sum up, costly union organizing together with firm entry and exit is an important mechanism that potentially drives unionization outcomes in the US. Future work is aimed at investigating its quantitative relevance. The next paragraphs focus on other interesting implications and aspects of the model.

Wage Outcomes and Union Share Effects The two formulations of the model differ in the way wages are determined. In the efficient bargaining formulation the mark-up over the non-union wage depends directly on the parameters, in particular bargaining power σ . In contrast, as lemma 2 shows, the wage of the monopoly union is itself a function of

⁴³The numbers for firm exit go in the same direction. Data are available online at <http://www.bls.gov>. Looking at low-skill service jobs compared to goods producing jobs, an additional factor to the higher firm turnover rates is that the job turnover rates for existing firms are also higher, making it even more difficult to organize for unions.

the organizing rate (and therefore of the firm unionization rate). In this case the model exhibits a union share effect. If the union has control over a bigger part of the sector's firms it can demand a higher wage due to the fact that competition from non-union firm with lower prices is less severe (that is the difference of the union firm's price to the sector average is smaller). Even though intuitive and often cited by union leaders, it is difficult to isolate such an effect in the data, not last because it is not always easy to find sectors with clear boundaries (especially if competition also comes from foreign firms). A study by Coggins and Johansson [2002] is able to confirm this share effect for the case of grocery stores, which compete only locally.

In case of the efficient bargaining approach there is a fixed mark-up over the competitive wage, and thus the model does not have any share effect as in the monopoly formulation. It is interesting however, as lemma 4 shows, that in this case the causality runs the other way round - higher exogenous bargaining power allows the union to capture more firms, because it is more beneficial to do so. Thus the same correlation between the wage premium and the union share holds but for different reasons.

So far the focus has been on gross wages for union members, because this is usually the wage used to estimate union wage premia. Union members in the model (implicitly) pay, however, union dues to cover the organizing expenses. The numbers for the net wage numbers are reported in tables 6, and suggest that union wages are still higher than non-union wages (note however, that due to the general equilibrium feedback effects, the level of the union wage is higher if organizing costs are higher).

Induced Effects of Endogenous Entry (to be re-done) Firm entry and union organizing are endogenously determined in this model. As it has been shown, the union's organizing response is decreasing in the level of entry, as well as entry is decreasing in union organizing. One implication is that changes that affect union organizing, in particular changes in union organizing cost η , will be amplified by the endogenous entry response (see diagram 1 for an illustration). Compared to a model where entry was fixed, the model here has an induced effect of entry. Consider a decrease in the cost of organizing. Unions will increase their organizing activity. Since higher organizing depresses the value of an entrant and thereby the level of entry, it will in turn make organizing even more beneficial because each firm now makes higher profits. Table 19 presents an example comparison between the endogenous entry and the fixed entry case (for the efficient bargaining scenario). The numbers give the elasticities of a change in η

and their ratio.⁴⁴ The elasticity is higher if entry is endogenous. The difference in this example is relatively small (the elasticity for the endogenous case is between .5% to 2.5% higher). One reason for this is that the benchmark parameters set the bargaining power to a relatively low value, $\sigma = .1$. The examples for the monopoly union version that I inspected show a much higher curvature of the entry response function and thus a bigger impact of the endogeneity of entry.

Unions as an Entry Deterrent A second implication of the endogenous interaction between entry and organizing is that unions act as a deterrent to potential entrants. In both specifications of the model, a higher rate of organizing will decrease the number of entrants through reduced expected profits (the profits of the incumbents, however, can increase). Since non-union firms coexist with union firms in this model, the support for or opposition to unions by incumbent firms can be conflicting. Both types of firms gain from higher unionization due to reduced entry⁴⁵ (see tables 8, 9, 17, and 18 for numerical examples). This is in accordance with the result in Williamson [1968] who started the literature on unions and entry deterrence.⁴⁶ Here however, non-union firms always have (significantly) higher profits than unionized firms. Thus, while unions and non-union firms (conditional on staying non-union this period) always gain from lower organizing cost, unionized firms are only better off given that they would have to stay union. Therefore, unionized firms would not support unionization, whereas non-union firms (after the organizing drive has taken place) might not oppose lower organizing cost (given the risk neutrality assumption). This suggests that political pressure against unions is high if the unionization rate is high, because a majority of firms could gain from deunionization. At low unionization rates in contrast, most pressure against unions is expected to come from individual firms that are affected by organizing. This is in accordance with the events in the US. The main legal change in favor of firms occurred in the late 1940s when unionization was at its peak. In the 1970s and 1980s unions had to suffer from increased employer resistance, as some authors suggest, but no major legal changes occurred.⁴⁷

⁴⁴To compute the elasticity for the fixed entry case I take the entry from the endogenous case and keep it constant when increasing η . This means that for each number, entry is different.

⁴⁵And in the monopoly union case also through the union share effect, which increases both types of firms' profits.

⁴⁶For a brief summary of the literature see the article by Robin Naylor in Addison and Schnabel [2003].

⁴⁷As emphasized above, the difference in the evaluation of the impact of unionization for union versus non-union firms only occurs in this way at the end of the period, i.e. when organizing has already taken place. This means that the comparison with respect to s is not really meaningful within the model, since s cannot be changed at this point. However, think of a model, where some firms believe that it is hard to organize them, i.e. there is some heterogeneity in union resistance. Then the comparison who would

Another related question is whether firms would support a reduction of the barriers to entry in order to reduce union power. In this model, all the numerical results suggest that the direct negative effect of lower entry costs on profits is outweighing the gains from lower unionization.⁴⁸ This is in contrast to the result in Naylor [2002], where firms have an interest in increasing entry in order to lower the impact of unions on labor cost.

Sensitivity of the General Equilibrium Effects This section discusses some of the general equilibrium implications of the model. I limit myself to the case of identical sectors and focus mainly on the case of efficient bargaining.⁴⁹

First, inspecting the response function for the union 15 and aggregate entry 16 it is noteworthy that by setting them equal to determine s all the terms involving aggregate variables cancel out. Table (7) and the following ones⁵⁰ present an example of the comparative statics for the aggregate variables Q and $\bar{w}$. In the given parametric example, Q is increasing in η and decreasing in ϵ . The appendix shows that Q is increasing in e but also increasing in s . This comes from the fact that due to the CES specification, the factor shares are constant and that all current sector profits are spent on entry costs if the firms' $\beta^f = 1$. Since the aggregate firm profit share decreases if there are more union firms (through higher s) total output has to be scaled up for a given level of entry e to cover the fixed entry costs. Thus, higher entry costs ϵ will lead to two countervailing effects: First lower entry will lower Q . Indirectly, also s increases and thus Q . In fact there exist parameter values for which the indirect effect via s is dominant and thus e and Q go in opposite directions.

Furthermore, the results concerning the aggregate variables are sensitive to the parameters for the within (ρ_1) and across sector elasticities of substitution (ρ_2), as well as the returns to scale of the intermediate goods production (α). There are cases possible where higher entry cost lead to higher entry on the aggregate. The ambiguity comes from the fact that the entry response function is decreasing in the non-union wage $\bar{w}$ but increasing in aggregate output Q . However, both $\bar{w}$ and Q are increasing in e , so that the total general effect how entry is affected by itself depends on which effect is stronger.

As it is the case in the standard monopolistic competition model, statements about the aggregate variables are parameter dependent. Therefore, an evaluation of welfare effects has to be based on empirically supported parameter values. A strength of this model,

favor which policy towards unions would apply in a more straightforward manner.

⁴⁸Dewatripont [1988] discusses the related issue whether or to what degree the entry deterring effect of sunk capital has to be traded off with the simultaneous increase in the union's bargaining power.

⁴⁹All the technical details are in the appendix in the section "Computation of the Steady State Aggregates".

⁵⁰Table 16 and following for the monopoly union.

however, is that the unionization rate does not depend on the aggregate variables. Moreover, the multisector structure allows to analyze the model for given aggregate variables and focus on the interaction of firm turnover and organization within a sector without the described ambiguities. Sectors can be compared within one equilibrium, so that all sectors face the same aggregate variables and the within sector results are thus not (as much) affected by the ambiguity of the aggregate effects.

6 Union Decline and Firm Reallocation

This section studies numerical simulations of the sectoral transition dynamics after a one-time change in either the entry or the organizing costs for given (and constant) aggregate output and non-union wage. I will limit myself to the case of a wage setting union.

Unions in the US have been in a long-term decline since the early 1950s. Figure 3 shows the paths of the aggregate unionization rate and membership numbers. The popular perception is that the major cause is the structural change from manufacturing to services. Several authors, however, have long recognized that from a simple accounting perspective the role of this structural change and other changes in the composition of the workforce is limited.⁵¹ While it is true that services have been growing and traditionally have a lower unionization rate than goods producing industries, it is also the case that in many goods producing sectors the rate of the decline has been much stronger, which diminishes the relative importance of the structural change. For example, comparing durable goods manufacturing with retail trade for 1983 and 2006, the aggregate unionization rate (for these 2 sectors) drops from 17.7% to 7.8 %. If we keep the employment weight of the manufacturing sector constant it drops to 8.0 %. This small difference comes from the fact that while the durable goods sector employment share is lowered by about 10 %, the drop in the durable goods unionization rate is from 29.2 % to 11.9 %, whereas in the retail trade sector it is only from 8.6% to 5%.⁵²

Other causes have to come from either organizing (including the worker's willingness to join that is not modeled here), or firm turnover, or differences in the growth rates of union versus non-union firms. The first two channels are discussed in more detail in the following sections. Regarding the possibility of different growth rates, the (little) evidence given in the literature suggests that this is quantitatively not a very important factor (see Bronars and Deere [1993]).

⁵¹See e.g. Farber [1990].

⁵²The numbers are estimates from the CPS, provided by Barry Hirsch and David Macpherson on their website <http://www.trinity.edu/Hirsch/unionstats/>.

6.1 Organizing Environment and Union Decline

The union's costs of organizing depend both on the direct expenditures for union organizers and indirectly on the legal environment for union organizing and bargaining. In particular, they depend on the implied possibilities for employers to counter union organizing.⁵³ The most important modification of the National Labor Relations Act from 1935 was the Taft-Hartley Act in 1947. The main changes affected the strike rules and the possibility for individual states to enact so-called right-to-work (RTW) laws, that prohibit union shops (i.e. unionized plants where union membership is mandatory). This prohibition creates a free rider problem because workers can benefit from unions without contributing. Even though there is no consensus of how exactly the Taft-Hartley Act diminishes union power, both the event study by Ellwood and Fine [1987] and the comparison of union outcomes across state borders by Holmes [1998] support the hypothesis that unions are less successful in the presence of RTW laws.

This paragraph studies the dynamic implications of a permanent increase in organizing costs (scale parameter η). I will look at the transition path from a low η to a high η while keeping the aggregates constant. For the example it is assumed that the initial steady state has 50 % lower (marginal) organizing costs than the final steady state. The out-of-steady state unionization rate for given states u_t and n_t is given by:

$$r_{jt} = \left\{ 1 + \left(\left(\frac{w_{jt}}{\bar{w}_t} \right)^{\frac{\alpha}{\rho 1 - \alpha}} \left[\frac{u_{jt}}{(1 - s_{jt})(n_{jt} + e_{jt})} + \frac{s_{jt}}{1 - s_{jt}} \right] \right)^{-1} \right\}^{-1} \quad (19)$$

Thus, factors that affect the entry level e not only impact r through s and the wage w , but also directly. The direct effect of e is absent in the steady state version of this formula given in equation (22), since the entry rate is solely determined by the exogenous exit rate δ .

Starting at the values of the state variables for the lower cost case, I simulate the transition path using the policy functions for s , w , and e . Figure 2 shows the transition path for the unionization rate. The model implies a slow transition. The new steady state is reached only after 50 periods, whereby half of the total difference in the unionization rate is already reached after 10 periods.

The US data of the unionization rate are given in figure 3. The decline is gradual and has taken several decades (and is still continuing). The decline doesn't follow immediately after the enactment of Taft-Hartley, which could partly be explained by the fact

⁵³These union avoidance strategies have been discussed extensively in the literature. See for example Kleiner [2001].

that one important provision, the “right-to-work” was only adopted gradually across the US states.⁵⁴ Moreover, the southern states which are the main adopters, increased their employment shares only gradually - although steadily - over time.⁵⁵ The next figures compare the wage premium and the organizing rate in the model with the data. Interestingly, also the organizing rate follows a path of gradual decline that can also be seen in the data. About the wage premium in figure 4 it is noteworthy that even though it follows the same pattern as the unionization rate, the absolute movement is relatively small: whereas the unionization rate in this example falls from 58 % to 11%, the wage premium decreases from 41 % to 24 %. This feature is interesting because it could help to understand why the observed trend in the data is relatively flat in spite of the long term decline in the unionization rate (see Figure 5). Finally, looking at the organizing rate, both the trend and the pattern of the decline from the simulation fits with the data (see figures 6 and 7).⁵⁶ Another explanation of how changes in organizing costs might have contributed to the long-term decline could be that during the years of WW II unions were not resisted as much in order to avoid labor unrest that could disrupt defense operations. According to the data in Freeman [1997] the aggregate unionization rate in 1940 was 26%, whereas in 1945 it was 34%. Thus, one could argue that during wartime organizing costs were lower, and that after returning to a normal state of the economy with higher organizing cost the achieved unionization rate was no longer sustainable. The model therefore has an explanation of how a change in the environment a long time ago could have triggered the long-term decline. Thus, the model does not rely on a continuous worsening of the organizing environment that has often been claimed but which is hard to substantiate with facts.

It has often been emphasized that the union decline in the US is not unique since more recently most other industrialized countries have experienced such a downward trend. However, the US shows the strongest decline as well as the one that started the earliest. Since the proposed mechanism in this model is (almost) unique to the US case, an explanation for the cross country timing difference could be that even though there is

⁵⁴Eleven States (mostly southern states) enacted the RTW during the 1940s right after the Taft-Hartley Act. Five more states enacted the law in the 1950s. For each decade from 1960-1989 one state was added. During the 1990s two states and in 2001 one state enacted the RTW legislation. Data are provided by the US Department of Labor.

⁵⁵In addition, the southern states which were the main adopters of the RTW legislation, also were the states that had relative low unionization rates initially. A unionization drive in the second half of the 1940s and early 1950s (“Operation Dixie”) failed, most likely because of the political economy of the Jim Crow laws. Therefore, unions never gained much strength in the southern states due to a more difficult organizing environment.

⁵⁶The graph of the organizing rate is taken from Farber and Western [2001]. They use data from NLRB elections which don’t include all of the organizing activity.

a general trend of e.g. a declining demand for union services, the mechanism based on the organizing friction and firm turnover on the unionization rate only applies for the US case.

6.2 “Deregulation” and Union Decline

Several authors claim that deregulation of entry barriers is an important reason for the decline of unions in the US. Wachter [2006] in a descriptive study interprets the post-war economic history of the US as one that moved from a “corporatist” to a “competitive” environment, where the corporatist regime entails not only barriers to entry in certain industries but also general price controls that were enacted e.g. during the Korean war. More specific deregulations occurred in the late 1970s and early 1980s in trucking, telecommunications, construction, utilities, and the airline industry. In the case of the trucking industry unionization as well as the wage premium decreased rapidly after the Motor Carrier Act from 1980 (see e.g. Clark et. al. [2002]). In the airline industry on the other hand, unionization didn’t suffer as much (ibid.), which could be the result of that even though more smaller carriers exist now and thus on average there are about 25% more airlines operating on a given route, the number of bigger carriers decreased substantially.⁵⁷

In the model of this paper we can study the impact of deregulation by permanently decreasing the cost of entry in a sector.⁵⁸ The model delivers a similar response to the one discussed in the previous paragraph where organizing costs were increased: Both the unionization rate and the organizing rate decline along a gradual transition path. The wage premium also declines, but again at a very low rate.⁵⁹

Assessing the overall impact of deregulation it can be argued within this model that since only a relatively small fraction of sectors experienced an effective change of the regulatory environment, the impact of deregulation on the aggregate unionization rate is small. However, deregulation could potentially have contributed to the acceleration of the decline observed during the late 1970s and early 1980s.

⁵⁷For a summary of the outcomes of the Airline Deregulation Act see the Encyclopedia of Economics article by Alfred E. Kahn [<http://www.econlib.org/library/Enc/AirlineDeregulation.html>].

⁵⁸The paper by Ebell and Haefke [2006] which also studies deregulation as a cause for the union decline models deregulation as an increase of the elasticity of substitution between specialized goods. Their mechanism for the unionization choice is however very different from the one proposed here.

⁵⁹Graphs are omitted for this case.

6.3 The Role of Firm Reallocation

In this section I conduct an experiment in which firm entry is held constant at its initial level, so that firm turnover becomes exogenous. I then compare this to the case with endogenous entry in order to evaluate the induced effect of firm-reallocation on the transition process from high to low unionization. I then discuss how the model helps to understand the empirically observed co-evolution of union decline and employment/industry shifts to the south. (to be completed by 3/1/09).

7 Conclusions

This paper developed a dynamic general equilibrium model of unions that decide about organizing and wages in an environment with firm entry. This environment mimics the case of the US, where unions permanently organize firms and lose membership primarily through firm exit. The model is able to qualitatively explain important cross-sectional and time series facts of unionization in the US. Higher unionization rates can be found in sectors where 1. entry costs are higher, 2. exit rates are lower, and 3. organizing costs are lower. Further, due to the stock-flow approach to the unionization rate, one time changes in the parameters imply gradual adjustments in the unionization rates. A feature, which offers new interpretations of the steady long-term decline of unions in the US.

Most importantly, the endogenous interaction between unions and firm entry in the model helps to understand the co-evolution of the union decline and the shift of firms towards states with high organizing costs. The paper has shown that this induced effect through firm reallocation implies a significant amplification of the unionization dynamics.

Further, the model also makes predictions about the union wage premium that depend on the assumed specification of the wage setting process. A quantitative assessment of the model could be useful to better understand the surprisingly small (measured) changes in the union wage premium in spite of the strong decline in the unionization rate.

The main obstacle to such a quantitative approach is to come up with a meaningful procedure to estimate the organizing friction. To measure this friction the model is well suited to exploit the variations in organizing laws across US states. However, a more realistic specification of the friction should include some kind of decision on the workers' side, which in turn would make it desirable to also include unemployment into the model. Furthermore, one could explicitly consider strategic behavior on the side of the firm (see e.g. Lazear [1983] and Dickens [1986]).

Concerning the reallocation process, firms can only “move” in the model through entry

and exit. One could include an explicit re-location decision, for instance by introducing capital that has a positive scrap value. Moreover, population growth during the period under consideration certainly accelerated the reallocation of employment and thereby affected unionization rate dynamics, and should be taken into account for a quantitative study.

Although such a quantitative exercise would not be a simple task - also due to limited historical data, it would be very useful in order to quantitatively account for the decline of unions. Last, but not least, it would allow to assess the impact of President Obama's election promise to push for the "Employee Free Choice Act", which is likely to lower organizing costs for unions in the US.

Appendix

A. Case of Unilateral Wage-Setting

In this section the union is assumed to set the wage for the whole sector, whereas each firm decides about the optimal employment level (the firm has the “right to manage” once the wage is set). In contrast to the previous set-up, here both the wage as well as union firm employment exhibit a share effect: An economy with a higher percentage of firms unionized (or with a higher organizing rate) c.p. will have higher profits, higher employment, and higher union wages. This implies that the (worker) unionization rate r now differs from the firm unionization rate $\tilde{r}$ by the intensive margin, i.e. the difference in workers per firm. If s moves up both $\tilde{r}$ and the union wage w , the effect on r is ambiguous in principle. It turns out, however, that the direct effect of s is always stronger, i.e. higher s will lead to higher r .

The union’s problem is now to simultaneously set the wage and the optimal organizing rate. The union’s Bellman equation is now:⁶⁰

$$W_{jt}(u_{jt}, n_{jt}) = \max_{s_{jt} \in [0,1], w_{jt}} \{U(u_{jt}, n_{jt}, s_{jt}) - P_t \mathcal{C}_j(u_{jt}, n_{jt}, s_{jt}) + \beta W_{j,t+1}(u_{j,t+1}, n_{j,t+1})\} \quad (20)$$

with period payoff: $U(.) = (w_{jt} - \bar{w}_t)u_{jt}l_{ujt}(u_{jt}, n_{jt}, w_{jt}, s_{jt})$ and costs as before.

I will first turn to wage determination. Wages do not directly involve an intertemporal trade-off. In steady state the FOC for the union’s wage can be written as:

$$x_3 + \frac{x_1 x_2}{1 + \delta(\frac{1}{s} - 1)(\frac{w}{\bar{w}})^{-x_1}} + \frac{1}{1 - (\frac{w}{\bar{w}})^{-1}} = 0 \quad (21)$$

The following lemma shows that the wage is increasing in organizing, and that the wage is bounded.

Lemma 2. *Assume an interior solution. The union wage is increasing in s . Moreover, the wage is bounded: $\frac{w}{\bar{w}} \in [\frac{\alpha}{\rho_1}, \frac{\alpha}{\rho_2}]$.*

To see where this share effect comes from, it is useful to rewrite the profit of a union

⁶⁰Notice, there is a slight difference in timing for the efficient vs. monopoly case. The latter simultaneously decides about wage and organizing, whereas the former first sets s and then later bargains about w . The main reason is that it simplifies the problems considerably in each case so that analytic results can be obtained.

firm function given in (6) as:

$$\pi_u(w) = w^{\frac{\rho_2}{\rho_2-\alpha}} \mu^{\frac{\alpha(\rho_2-\rho_1)}{\alpha(\alpha-\rho_2)}} \left(\tilde{r} + (1-\tilde{r})k^{\frac{\rho_1}{\rho_1-\alpha}} \right)^{\frac{\alpha(\rho_2-\rho_1)}{\rho_1(\alpha-\rho_2)}} \cdot K_\pi$$

where it is assumed that $k = \frac{\bar{w}}{w} < 1$ (i.e. the union wage is bigger than the competitive wage), and $\mu = u + n$ denotes the total mass of firms in sector j , and K_π is a term containing aggregate output. Thus, increasing the firm unionization rate $\tilde{r}$ will increase the share of the high price union firms and therefore lower the relative price of each firm, which will increase their demand. A further implication is that the elasticity of labor demand will be lower for higher $\tilde{r}$ (or s) as well, allowing for a higher wage for any given employment level. The result rests on the fact that each sector is small vis-a-vis the aggregate economy, so that the indirect output effect does not matter.

Next, I turn to the union's (indirect) entry response for s , which is, again, derived from the FOC of the corresponding sequential formulation of the union's problem:

$$\tilde{g}^u(s) = \left(\frac{[\eta\gamma s^{\gamma-1} - \eta(1-\delta)\beta s^\gamma][1-\beta(1-\delta)]^{x_2} [\frac{s}{\delta} w^x(1-s)\bar{w}^{x_1}]^{x_2} (1-\delta)^{-(1+x_2)}}{[1+\beta(1-\delta)(1-s)]K_L(w(s)-\bar{w})w^{x_3} [\frac{s}{\delta}(1+x_2)w^{x_1} + (1-(1+\frac{x_2}{\delta})s)\bar{w}^{x_1}]} \right)^{1/x_2}$$

where $w(s)$ is the optimal wage implied by the FOC w.r.t. the wage given above. Unfortunately, the shape of the response function - besides the results that its left endpoint tends to infinity, whereas its right endpoint takes on a finite positive value - cannot easily be constrained by simple conditions on the parameters. The complication comes from the fact that now the marginal benefit is not only affected by s through an increase in the number of unionized firms but also by two indirect effects: First, higher s raises the sectoral price index as explained above, thereby increasing the marginal benefits of higher s . Secondly, it increases the optimal wage, which in turn has an ambiguous effect on the union's utility. On the one hand it raises the benefit directly, on the other hand, a higher wage also implies lower firm level employment.

The firm entry response function can be solved from the steady state version of the value of an entrant:

$$\tilde{g}^e(s) = \left(\frac{\epsilon}{K_\pi} \right)^{1/x_2} (1-\delta)^{\frac{-x_2-1}{x_2}} \left(\frac{[1-\beta^f(1-\delta)(1-s)][(1-(1-\delta)(1-s))]^{x_2}}{[\frac{s}{1-\beta^f(1-\delta)}w(s)^{x_1} + (1-s)\bar{w}^{x_1}][\frac{s}{\delta}x_1 + (1-s)\bar{w}^{x_1}]^{x_2}} \right)^{1/x_2}$$

The response function in this case is also more complicated due to the share effect. How-

ever, it can be shown that for the case of $\beta^f = 1$, $\tilde{g}^e$ is strictly decreasing in s .⁶¹

It is still possible to show existence in this setting. However, it is difficult to give simple conditions for uniqueness and the comparative statics. Therefore, all comparative statics are analyzed numerically.

Proposition 5. *A steady state sector equilibrium exists if*

$$\frac{\epsilon}{\eta} \frac{(1-\beta(1-\delta))}{(\gamma-\beta(1-\delta))} \left(\frac{\rho_1}{\alpha}\right)^{x_1+1} \left((1+x_2) \left(\frac{\rho_1}{\alpha}\right)^{x_1} - x_2\right) \leq 1$$

The more complicated response functions make it hard to guarantee uniqueness. All comparative static results in this section are therefore explored numerically, where only such parameter constellations are considered that exhibit unique equilibria.

It should be noted, that in the case of the monopoly union the comparative static effects on the unionization rate r are not only dependent on s but also on the relative firm employment levels of union and non-union firms. Thus, the unionization has both an intensive margin (workers per firm) and an extensive margin (firms unionized). In contrast to the efficient bargaining scenario the corresponding formula for the unionization rate is:

$$r^* = \left\{ 1 + \left(\left(\frac{w^*}{\bar{w}^*} \right)^{\frac{\alpha}{\rho_1 - \alpha}} \left[\frac{1}{\delta} \frac{s^*}{1 - s^*} \right] \right)^{-1} \right\}^{-1} \quad (22)$$

In this case, higher s will directly increase r , but through the positive effect of s on the union's wage, w , (see lemma 2) it decreases r . The following lemma shows that the direct effect is always dominating the indirect effect.

Lemma 3. *An increase in the organizing rate s implies an increase of the unionization rate r .*

An example for the comparative static result is presented in table 11 and the following. The numerical example confirms all the results that have been established for the efficient bargaining case. Higher entry costs, lower organizing costs, and lower exit rates all imply higher unionization rates. In addition, the wage premium is positively correlated with unionization rate, as has been shown in Lemma 2.⁶²

B. Proofs of the Propositions

Preliminaries To simplify the arguments I introduce some additional notation:

⁶¹It is possible to generalize the result for values of $\beta^f < 1$. However, since for all the computational results it is assumed that the discount factor equals unity, the proof is omitted.

⁶²The results have been tested for a broad range of parameters; additional results are available on request.

$$\begin{aligned}
x_1 &\equiv \frac{\rho_1}{\rho_1 - \alpha}; \\
x_2 &\equiv \frac{\alpha}{\rho_1} \frac{(\rho_2 - \rho_1)}{(\alpha - \rho_2)}; \\
x_3 &\equiv \frac{\alpha}{\rho_1 - \alpha}; \\
K_\pi &\equiv (QP^{\frac{1}{\rho_2 - 1}})^{\frac{\alpha(1 - \rho_2)}{\alpha - \rho_2}} \left(\frac{\rho_1}{\alpha\kappa}\right)^{\frac{\rho_2}{\alpha - \rho_2}} \left(1 - \frac{\rho_1}{\alpha}\right); \\
K_L &\equiv (QP^{\frac{1}{\rho_2 - 1}})^{\frac{\alpha(1 - \rho_2)}{\alpha - \rho_2}} A_o \left(\frac{\rho_1}{\alpha\kappa}\right)^{\frac{\alpha}{\alpha - \rho_2}};
\end{aligned}$$

Note that given the assumptions on the parameters, we can infer that:

$$x_1, x_2, x_3 < 0, \quad x_2 > -1, \quad x_3 < -1, \text{ and } x_1 - x_3 = 1.$$

For future reference, the steady state values of u and n are given by: $u = \frac{s(1-\delta)}{\delta(1-(1-\delta)(1-s))}$ and $n = \frac{(1-s)(1-\delta)}{1-(1-\delta)(1-s)}$.

Proofs

Proof of Lemma 1. From the FOCs it directly follows that $\frac{d}{dl_u} p(q(l_u))q(l_u) = \bar{w}$, i.e. marginal revenue equals the competitive wage as is the case for the non-union firm. Thus, the union firm has the same amount of employment as the non-union firm. The wage can be expressed as a mark-up over the non-union wage by combining the solutions to the monopolist's optimal choice for (as given in 17 with $w_u = \bar{w}$), the production function ($q(l) = \kappa l^\alpha$), and the solution for the monopolist's optimal price (given that both types set employment compatible with the competitive wage):

$$p_n = (\bar{w})^{\frac{\rho_1 - 1}{\rho_1 - \alpha}} \left[(u + n)(\bar{w})^{\frac{\rho_1}{\rho_1 - \alpha}} \right]^{\frac{(1-\alpha)(\rho_2 - \rho_1)}{\rho_1(\alpha - \rho_2)}} \left(\frac{\rho_1}{\alpha\kappa} \right)^{\frac{\rho_2 - 1}{\alpha - \rho_2}} \hat{Q}^{\frac{(\alpha - 1)(1 - \rho_2)}{\alpha - \rho_2}}. \quad \square$$

Proof of Proposition 1. In order to show existence given aggregates, we have to insure that an intersection point of the two reaction functions exists. First note that both functions are continuous. Further, at $s = 0$, the union's value for e is ∞ whereas the entrant's value is positive and finite. Thus, it is required to have $g^e(1) \geq g^U(1)$. Using the formulas for g^e and g^u one can show that this is the case if and only if $\epsilon \leq \frac{1-\sigma}{\sigma} \eta(\gamma - \beta(1 - \delta))$, i.e. entry costs have to be small enough relatively to organizing cost (note, if the union has all bargaining power, and $s = 1$ then all firms are unionized in steady state and no profits are generated on the aggregate so that entry costs would have to be zero in that case). Uniqueness follows if we impose the sufficiency criteria for strict convexity of both functions. Since two convex functions can intersect at most twice, having $g^e(0) < g^U(0)$ and $g^e(1) \geq g^U(1)$ insures uniqueness. For existence of the general equilibrium, I refer to the discussion in the section about computation of the aggregates. There it is argued that s doesn't depend on the aggregates, so that $\{e, Q, \bar{w}\}$ can be determined for a given s . It is

also shown that both $\bar{w}$ and Q can be written as functions of e only. Thus, an equilibrium exist if a solution to $g^e(e) - e = 0$ exist. Given the result in the mentioned section, the entry reaction function can be written as $g^e(e) = Ae^x$, where $x \leq 0$ if $\frac{\rho_2^2}{\alpha\rho_1} \frac{\alpha-\rho_1}{(\alpha-\rho_2)(1-\rho_2)} \geq 1$. If it is less than zero, then a solution is guaranteed, since $g^e(e)$ tends to ∞ at $e = 0$ and goes to zero for $e \rightarrow \infty$, so it has to intersect with $f(e) = e$. In case $x = 0$, $g^e(e)$ will be some positive constant, again guaranteeing an intersection point. Finally, if x is positive, g^e is either concave or convex and $g^e(0) = 0$. At $e = 0$ there will be a trivial steady state (since all firms are of measure 0, there will no demand even if an individual firm would enter and employ workers). In both the strict convex and the strict concave case there has to be an intersection with the 45-degree line. Thus a non-trivial steady state exists. Disregarding the trivial case, all the equilibria are unique. $\square$

Proof of Proposition 2. I will employ the following informal argument: Both reaction functions are downward sloping given the conditions for a unique equilibrium. Entry costs only affect the entrant's reaction function. Higher ϵ moves the curve down. This implies that the intersection point moves to the right, i.e. s increases. Since union and non union firms have the same amount of employment the firm unionization rate and unionization rate are identical and r increases with s according to (1.20). $\square$

Proof of Proposition 3. Lower η moves up the union's reaction function, and thus shifts the intersection point to the right, and to a lower e . This further implies that r increases. $\square$

Proof of Proposition 4. Higher σ lowers the payoff of an entrant, therefore lowers entry for any given s , but for the union, it increases marginal benefit without changing marginal cost, therefore, allows a higher e for any s . Geometrically, the union's curve shifts up, whereas the entrant's curve shifts down. Both shifts imply higher s and lower e , thus the total effect must be higher s and lower e . This in turn implies higher r . $\square$

Proof of Lemma 2. The FOC can be solved for $s = \left(1 + \frac{x_3 + x_1 x_2 - (x_3 + x_1 x_2 + 1) \frac{w}{\bar{w}}}{\delta x_1 (\frac{w}{\bar{w}})^{1-x_1} - \delta x_3 (\frac{w}{\bar{w}})^{-x_1}}\right)^{-1}$. The result follows from the assumptions on the parameters and taking the first derivative of s w.r.t. $\frac{w}{\bar{w}}$. The bounds then follow from substituting in $s = 0$ and $s = 1$ into to original FOC given above. $\square$

Proof of Proposition 5. From $\tilde{g}^e$ and $\tilde{g}^u$ and the results about the optimal wage, it follows that at $s = 0$ the union's response function tends to ∞ whereas the entrant's response function is a finite positive number. The given condition on the parameters holds if and only if $\tilde{g}^e(1) \geq \tilde{g}^u(1)$. Since both response functions are continuous for $s \in (0, 1)$ this insures an equilibrium. $\square$

Proof of Lemma 3. The proof is based on taking the derivative of 22 w.r.t. the wage ratio, $k = w/\bar{w}$, where the FOC given in 21 has been solved for s and substituted in. Given the assumptions on the parameters algebra shows the result. $\square$

C. Computation

Computation of Steady State Aggregates with full commitment The following lemma gives a conditions which simplifies the computation of the steady state variables considerably. If the firm's discount factor equals unity, then the sum of the sector's profits in a given period equal to the sum of the factual entrant's expected profits.⁶³

Lemma 4. *If the firm's discount factor is $\beta^f = 1$, then in steady state the sum of all entrants' profits equal to the sector's aggregate period profits.*

Proof. The result follows from applying the formulas for the steady state equations of u and n to the sum of the period profits:

$$\begin{aligned} eV_{gross}^e &= e(s(1-\delta)V^u + (1-s)(1-\delta)V^n) \\ &= e\left(\frac{(1-\delta)}{1-\beta(1-\delta)(1-s)}\left[\frac{s}{1-\beta(1-\delta)}\pi_u + (1-s)\pi_n\right]\right) \\ &= e\left(\frac{(1-\delta)}{1-(1-\delta)(1-s)}\left[\frac{s}{\delta}\pi_u + (1-s)\pi_n\right]\right) \\ &= u\pi_u + n\pi_n \end{aligned} \quad \square$$

In the following I discuss the solution to the steady state aggregates for the efficient bargaining case and further assume for simplicity that all sectors j are identical. The monopoly union case is similar.

The aggregates are determined by the following market clearing conditions:

$$Q^S = Q^C + Q^{\sigma\pi} + Q^\epsilon$$

and

$$L = ul_u(\bar{w}) + nl_n(\bar{w})$$

Consider first the goods market clearing condition. Using the optimal labor demand 17, the definition of the price index 2, and the relationship $PQ^C = \int_i w_i l_i di$ it can be shown that due to the CES assumption 3 that the factor shares are constant $Q^C = \frac{\rho_1}{\alpha} Q^S$. In the efficient bargaining version, the unionized workers also get a share σ of the (non-union) firms' profits, so that the additional income is $Q^{\sigma\pi} = \sigma \frac{u}{u+n} (1 - \frac{\rho_1}{\alpha}) Q^S$.

⁶³Note, that technically even with $\beta^f = 1$ there is still discounting of profits, since firm's exit at rate δ . This assumption has been employed previously by Melitz [2003].

Given assumption of the Lemma 4, all the firms period profits equal to the expected discounted value of the entrants which in turn equal to sum of the entry costs given the zero profit condition. This means that $Q^s = \frac{\rho_1}{\alpha} Q^S + \sigma \frac{u}{u+n} (1 - \frac{\rho_1}{\alpha}) Q^S + e\epsilon$ or $Q^S = \frac{e\epsilon}{(1 - \frac{\rho_1}{\alpha})(1 - \frac{\sigma u}{u+n})}$ (in case of the monopoly union this reduces to $Q^S = \frac{e\epsilon}{1 - \frac{\rho_1}{\alpha}}$ since here workers are not taking part of the profits). Thus aggregate output is linear in e (for given s in the efficient bargaining version).

Turning to the labor market clearing condition, using the optimal labor demand 17 (note that in the efficient bargaining case both types of firms have the same labor demand), we can solve for the competitive wage:

$$\bar{w} = \left(L(u+n)^{-(x_2+1)} Q^{-\frac{\alpha(1-\rho_2)}{\alpha-\rho_2}} \kappa^{-1} \left(\frac{\rho_1}{\alpha\kappa} \right)^{-\frac{\alpha}{\alpha-\rho_2}} \right)^{1/(x_3+x_1x_2)}$$

Thus $\bar{w}$ is increasing in e .

Now, to compute all the aggregates, first note by setting the union's and the entry reaction function equal to each other all terms with aggregate variables cancel out so that s doesn't depend on them. Taking for example the entry reaction function, using the formulas for Q^S and $\bar{w}$ given above, one can show that

$$g^e(e) = Ae \underbrace{-\frac{1}{x_2(x_3+x_1x_2)}}_{<0} \left(\underbrace{x_1(1+x_2)^2}_{<0} + \underbrace{\frac{\alpha(1-\rho_2)}{\alpha-\rho_2}}_{>0} \right)$$

where A is a term involving parameters and s . The exponent is ≤ 0 if and only if $\frac{\rho_2^2}{\rho_1} \frac{\alpha-\rho_1}{(\alpha-\rho_2)(1-\rho_2)} \geq 1$. The sign comes from countervailing effects of Q and $\bar{w}$ on entry. Higher wage decreases entry, whereas higher output increases it. Therefore the total general equilibrium effect depends on both the marginal rates of substitution, ρ_1 and ρ_2 as well as the returns to scale α . In particular, the condition always holds if $\alpha = 1$.

Once we have found e from $g^e(e) - e = 0$, we can compute Q and $\bar{w}$ from the given equations.

Computation of the Transition Dynamics The following describes the steps of computation of the transtion dynamics in general equilibrium.

For the states (u, n) I use a grid, but I interpolate the future values bilinearly.

Remark: Currently I modify the entry part in the following way to avoid kink points in the entry policy function. First, I assume that each period there is a unit mass of *potential* entrants which face an idiosyncratic i.i.d. cost draw from an exponential distri-

bution with parameter λ . I identify entry costs now with the mean value, i.e. $\epsilon = 1/\lambda$. This new assumption implies that there is always some positive mass of entrants since gross profits are always greater than zero for any finite mass of firms. The marginal firm then has zero expected profits, but all inframarginal have positive profits.

1. Compute the initial and final steady states. Assume a sufficiently large transition period T
2. Guess a path for the non-union wage $\{\bar{w}_\tau\}_{\tau=1}^T$.
3. Guess a path of entry decisions for each sector type: $\left\{\{e_{j\tau}\}_{j \in I}\right\}_{\tau=1}^T$
4. Compute the union's decision for each sector type $\left\{\{w_{j\tau}, l_{j\tau}, s_{j\tau}\}_{j \in I}\right\}_{\tau=1}^T$ by backward iteration.
5. Given union's decisions compute optimal entry.
6. Iterate on 3.-5. until convergence.
7. Iterate on 2.-6. until convergence.

D. Numerical Results

Efficient Bargaining

Parameter	β	β^f	ρ_1	ρ_2	α	κ	γ	σ	L	θ
Value	1.0	1.0	.95	.8	1.2	1.0	2.5	.1	1000	1

Table 1: Benchmark Parameters for Efficient Bargaining Case

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	.3	.4	.5	.3	.4	.5	.3	.4	.5
.1	208.18	158.41	128.16	261.74	198.76	160.44	318.73	241.75	194.83
.5	225.28	172.31	139.84	282.82	216.58	175.90	343.09	263.04	213.82
2.5	234.86	180.78	147.48	292.92	225.69	184.27	353.46	272.53	222.65

Table 2: Comparative Statics for e

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	.3	.4	.5	.3	.4	.5	.3	.4	.5
.1	0.5567	0.6288	0.6866	0.4842	0.5572	0.6178	0.4223	0.4934	0.5543
.5	0.2443	0.2871	0.3243	0.1972	0.2341	0.2667	0.1626	0.1943	0.2227
2.5	0.0922	0.1104	0.1268	0.0720	0.0866	0.0998	0.0580	0.0700	0.0808

Table 3: Comparative Statics for r

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	.3	.4	.5	.3	.4	.5	.3	.4	.5
.1	0.7428	0.6836	0.6410	0.7596	0.6991	0.6554	0.7577	0.6974	0.6539
.5	0.7496	0.6905	0.6479	0.7660	0.7057	0.6622	0.7634	0.7035	0.6602
2.5	0.7529	0.6940	0.6516	0.7687	0.7087	0.6654	0.7657	0.7060	0.6629

Table 4: Comparative Statics for w

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	.3	.4	.5	.3	.4	.5	.3	.4	.5
.1	0.7237	0.6661	0.6245	0.7401	0.6812	0.6386	0.7383	0.6795	0.6371
.5	0.7304	0.6728	0.6313	0.7463	0.6876	0.6453	0.7438	0.6855	0.6433
2.5	0.7335	0.6763	0.6349	0.7490	0.6805	0.6483	0.7461	0.6879	0.6459

Table 5: Comparative Statics for $\bar{w}$

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	.3	.4	.5	.3	.4	.5	.3	.4	.5
.1	1.991	1.999	2.006	1.878	1.886	1.894	1.783	1.791	1.798
.5	1.969	1.971	1.973	1.854	1.856	1.859	1.759	1.762	1.764
2.5	1.962	1.962	1.963	1.846	1.847	1.848	1.751	1.752	1.753

Table 6: Comparative Statics for net premium $100[w^{net}/\bar{w}] - 1$. (Gross premium = 2.63 for all (ϵ, η, δ))

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	.3	.4	.5	.3	.4	.5	.3	.4	.5
.1	365.67	336.56	315.56	467.43	430.22	403.35	559.54	515.02	482.86
.5	369.03	338.96	318.96	471.35	434.30	407.53	563.76	519.52	487.56
2.5	370.63	341.69	320.78	473.04	436.14	409.48	565.43	521.36	489.54

Table 7: Comparative Statics for Q

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	.3	.4	.5	.3	.4	.5	.3	.4	.5
.1	1.1913	1.6606	2.0132	1.1350	1.5250	1.9185	1.1746	1.5779	1.9850
.5	1.1532	1.5443	1.9379	1.1017	1.4745	1.8493	1.1436	1.5297	1.9177
2.5	1.1355	1.5167	1.8991	1.0878	1.4526	1.8181	1.1316	1.5106	1.8903

Table 8: Comparative Statics for V^u

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	.3	.4	.5	.3	.4	.5	.3	.4	.5
.1	1.2795	1.7114	2.1448	1.2305	1.6472	2.0658	1.2831	1.7186	2.1567
.5	1.2625	1.6864	2.1113	1.2121	1.6192	2.0274	1.2624	1.6865	2.1118
2.5	1.2547	1.6741	2.0940	1.2044	1.6070	2.0101	1.2544	1.6737	2.0935

Table 9: Comparative Statics for V^n

Unilateral Wage Setting

Parameter	β	β^f	ρ_1	ρ_2	α	κ	γ	L	θ
Value	1.0	1.0	.95	.8	1.2	1.0	2.5	1000	1

Table 10: Benchmark Parameters for Monopoly Union Case

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	1	5	15	1	5	15	1	5	15
5	0.1344	0.3806	0.6638	0.1248	0.3610	0.6577	0.1174	0.3455	0.6551
20	0.0527	0.1562	0.3198	0.0488	0.1452	0.3012	0.0458	0.1267	0.2866
80	0.0208	0.0613	0.1287	0.0192	0.0568	0.1195	0.0180	0.0533	0.1123

Table 11: Comparative Statics for r

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	1	5	15	1	5	15	1	5	15
5	0.0203	0.0894	0.2868	0.0231	0.1000	0.3273	0.0257	0.1097	0.3653
20	0.0070	0.0245	0.0669	0.0081	0.0278	0.0749	0.0090	0.0308	0.0823
80	0.0026	0.0083	0.0193	0.0030	0.0095	0.0219	0.0034	0.0106	0.0244

Table 12: Comparative Statics for s

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	1	5	15	1	5	15	1	5	15
5	1.2857	1.3346	1.4037	1.2840	1.3303	1.4020	1.2827	1.3270	1.4013
20	1.2717	1.2896	1.3215	1.2710	1.2876	1.3177	1.2705	1.2861	1.3147
80	1.2665	1.2731	1.2847	1.2662	1.2723	1.2830	1.2660	1.2718	1.2818

Table 13: Comparative Statics for $w/\bar{w}$

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	1	5	15	1	5	15	1	5	15
5	2.3910	1.4172	0.9768	2.2462	1.3339	0.9158	2.1328	1.2688	0.8680
20	2.4572	1.5109	1.0578	2.3042	1.4199	0.9956	2.1850	1.3487	0.9470
80	2.4850	1.5589	1.1195	2.3285	1.4622	1.0516	2.2066	1.3867	0.9984

Table 14: Comparative Statics for w

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	1	5	15	1	5	15	1	5	15
5	508.20	63.01	15.48	476.68	59.07	14.49	452.10	56.01	13.72
20	515.77	64.45	15.49	483.40	60.46	14.52	458.18	57.35	13.78
80	519.22	65.53	15.85	486.40	61.42	14.86	460.87	58.22	14.10

Table 15: Comparative Statics for e

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	1	5	15	1	5	15	1	5	15
5	2439.4	1512.2	1114.6	2288.1	1417.7	1043.3	2170.1	1344.2	988.1
20	2475.7	1546.9	1115.0	2320.3	1451.1	1045.8	2199.3	1376.4	991.9
80	2492.2	1572.6	1141.1	2334.7	1474.1	1070.3	2212.2	1397.3	1015.0

Table 16: Comparative Statics for Q

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	1	5	15	1	5	15	1	5	15
5	0.5075	3.3023	12.6245	0.5071	3.2742	12.6987	0.5079	3.2588	12.808
20	0.4592	2.6033	9.3283	0.4617	2.5971	9.2495	0.4648	2.5986	9.208
80	0.4407	2.3209	7.5617	0.4444	2.3319	7.5574	0.4484	2.3464	7.573

Table 17: Comparative Statics for V^u

	$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$	1	5	15	1	5	15	1	5	15
5	1.0528	5.3955	16.8319	1.0655	5.4843	17.2931	1.0785	5.5729	17.770
20	1.0458	5.2737	16.0763	1.0574	5.3393	16.3193	1.0693	5.4056	16.563
80	1.0433	5.2324	15.7836	1.0545	5.2912	15.9742	1.0659	5.3510	16.167

Table 18: Comparative Statics for V^n

		$\delta = .04$			$\delta = .05$			$\delta = .06$		
$\eta \backslash \epsilon$		.3	.4	.5	.3	.4	.5	.3	.4	.5
.1	end. e	-.6603	-.6552	-.6498	-.6620	-.6583	-.6543	-.6640	-.6615	-.6589
	fi. e	-.6438	-.6379	-.6321	-.6458	-.6406	-.6356	-.6485	-.6441	-.6399
	ratio	1.0256	1.0271	1.0280	1.0251	1.0276	1.0294	1.0238	1.0270	1.0295
.5	end. e	-.6691	-.6688	-.6684	-.6681	-.6681	-.6677	-.6677	-.6676	-.6675
	fi. e	-.6599	-.6583	-.6568	-.6604	-.6604	-.6589	-.6611	-.6598	-.8586
	ratio	1.0140	1.0160	1.0177	1.0118	1.0138	1.0155	1.0100	1.0119	1.0135
2.5	end. e	-.6684	-.6686	-.6688	-.6678	-.6679	-.6680	-.6674	-.6675	-.6676
	fix. e	-.6646	-.6641	-.6637	-.6648	-.6643	-.6639	-.6650	-.6646	-.6642
	ratio	1.0057	1.0068	1.0077	1.0045	1.0054	1.0062	1.0037	1.0044	1.0051

Table 19: Comparison of fixed vs. endogenous entry of the elasticity of s w.r.t. η .

Parameter	β	β^f	ρ_1	ρ_2	α	κ	γ	L	θ	δ	ϵ	η
Value	1.0	1.0	.95	.8	1.2	1.0	2.5	1000	1	.06	30	20

Table 20: Benchmark Parameters (initial steady state) for transition dynamics

E. Graphs

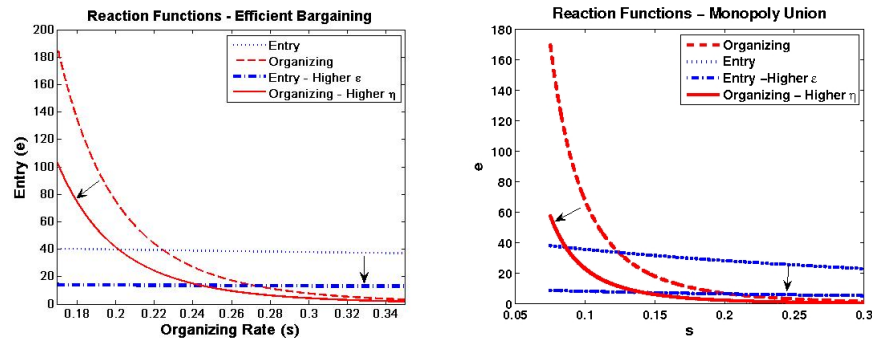


Figure 1: Reaction Functions for Entry and Organizing

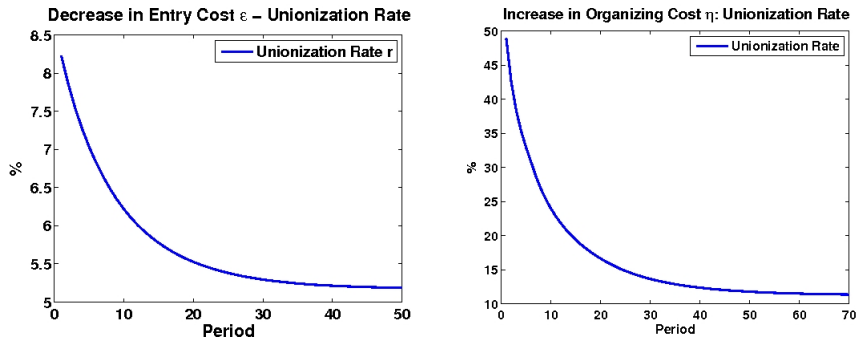
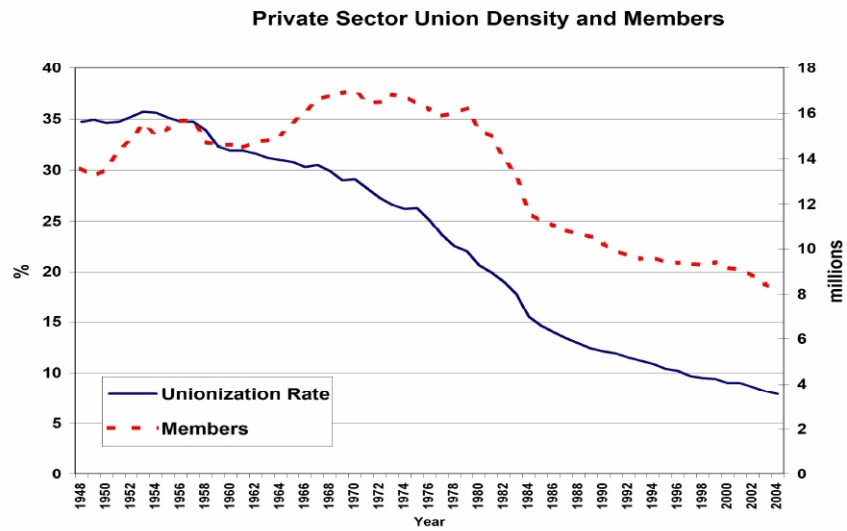


Figure 2: Transition after change in ϵ or η : unionization rate r



Source: Union Sourcebook 1947-1983; U.S. Bureau of Labor Statistics

Figure 3: US Unionization Rate

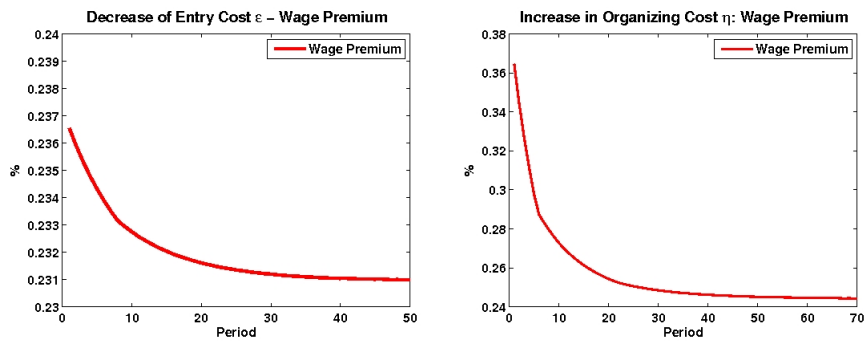


Figure 4: Transition after change in ϵ or η : Wage Premium

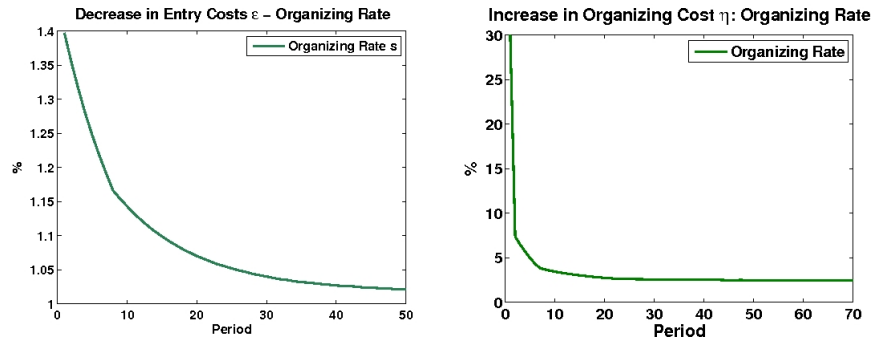
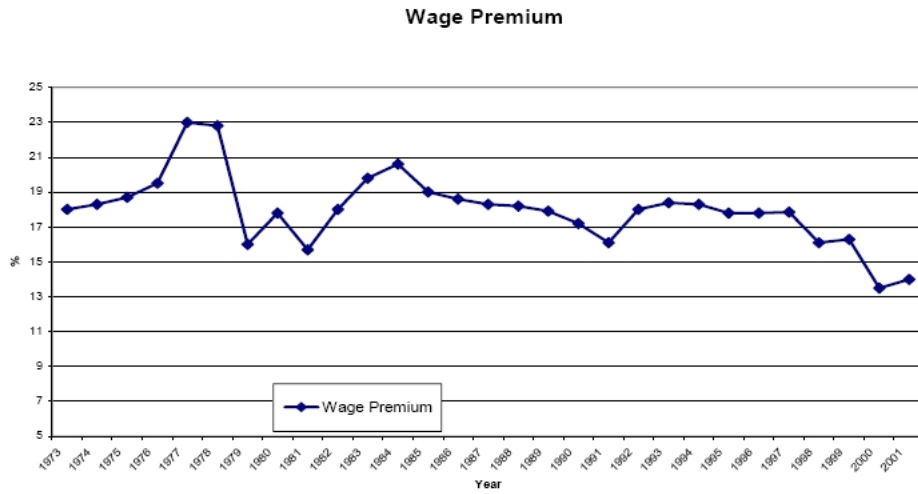
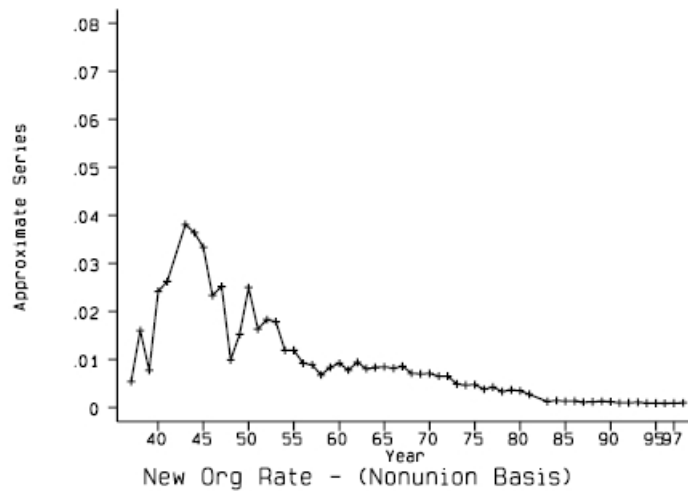


Figure 6: Transition after change in ϵ or η : organizing rate s



Source: Blanchflower and Bryson [2002]

Figure 5: US Wage Premium



Source: Farber and Western [2001]

Figure 7: US organizing rate

Bibliography

- Abowd, John M. and Farber, Henry S. Product market competition, union organizing activity, and employer resistance. *NBER Working Paper*, 3353, May 1990.
- Acemoglu, Daron , Aghion, P., and Violante, G. Technical Change, Deunionization and Inequality. *Carnegie-Rochester Conference Series on Public Policy*, 55(1):229–264, December 2001.
- Addison, John T. and Schnabel, Claus , editors. *International Handbook of Trade Unions*. Edward Elgar, 2003.
- Blanchflower, David .G. and Bryson, Alex. Changes over Time in Union Relative Wage Effects in the UK and the US Revisited. *NBER Working Paper*, 9395, 2002.
- Bronars, Stephen G. and Deere, Donald R. Union Organizing Activity, Firm Growth, and the Business Cycle. *The American Economic Review*, 83(1):203–220, March 1993.
- Brown, Charles and Medoff, James L. Firm Age and Wages. *Journal of Labor Economics*, 21(3), 2003.
- Chappell, W.F., Kimenyi, M.S., and Mayer, W.J. The Impact of Unionization on the Entry of Firms: Evidence from US Industries. *Journal of Labor Research*, 13(3):273–283, 1992.

- Chezum, Brian and Garen, John. *Eastern Economic Journal*, 23(2), Spring 1997.
- Clark, Paul F., Delaney, John T., and Frost, Ann C., editors. *Collective Bargaining in the Private Sector*. Industrial Relations Research Association, 2002.
- Coggins, Jay and Johansson, R.C. Union Density Effects in the Supermarket Industry. *Journal of Labor Research*, 23(4):673–684, 2002.
- Dewatripont, Mathias. The Impact of Trade Unions on Incentives to Deter Entry. *The RAND Journal of Economics*, 19(2):191–199, 1988.
- Dickens, William T. Wages, Employment and the Threat of Collective Action by Workers. *NBER Working Paper*, 1856, March 1986.
- DiNardo, John and Lee, David S. The Impact of Unionization on Establishment Closure: A Regression Discontinuity Analysis of Representation Elections. *NBER Working Paper*, 8993, June 2002.
- Dunne, Timothy and Macpherson, David A. Unionism and Gross Employment Flows. *Southern Economic Journal*, 60(3):727–738, Jan 1994.
- Ebell, Monique and Haefke, Christian. Product Market Regulation and Endogenous Union Formation. *IZA Working Paper*, 2222, 2006.
- Ellwood, David T. and Fine, Glenn. The impact of right-to-work laws on union organizing. *The Journal of Political Economy*, 95(2):250–273, apr 1987.
- Farber, Henry S. The Decline of Unionization in the United States: What can be Learned from Recent Experience? *Journal of Labor Economics*, 8(1):S75–S105, jan 1990.
- Farber, Henry S. and Western, Bruce. Accounting for the Decline of Unions in the Private Sector, 1973-1998. *Journal of Labor Research*, 22(3):459–485, 2001.
- Freeman, Richard B. Spurts in Union Growth: Defining Moments and Social Processes. *NBER Working Paper*, 6012, 1997.
- Freeman, Richard B. Do Workers Still Want Unions? More Than Ever. *Economic Policy Institute Briefing Paper*, 182, February 2007.
- Freeman, Richard B. and Kleiner, Morris M. Do Unions Make Enterprises Insolvent? *Industrial and Labor Relations Review*, 52(4):510–527, July 1999.

- Freeman, Richard B. and Rogers, Joel. *What Workers Want*. Cornell University Press, 2006.
- Holmes, Thomas J. The Effect of State Policies on the Location of Manufacturing: Evidence from State Borders. *The Journal of Political Economy*, 106(4):667–705, Aug. 1998.
- Holmes, Thomas J. and Walrath, Michael. Dynamics of Union Organizations: A Look at Gross Flows in the LORS Files. June 2007.
- Hopenhayn, Hugo A. Entry, Exit, and firm Dynamics in Long Run Equilibrium. *Econometrica*, 60(5):1127–1150, Sep 1992.
- Jones, Stephen R. G. and McKenna, C. J. A Dynamic Model of Union Membership and Employment. *Economica*, 61(242):179–189, may 1994.
- Katz, Harry C. The Decentralization of Collective Bargaining: A Literature Review and Comparative Analysis. *Industrial and Labor Relations Review*, 47(1):3–22, oct 1993.
- Kaufman, Bruce E. Models of Union Wage Determination: What Have We Learned Since Dunlop and Ross? *Industrial Relations*, 41(1), 2002.
- Kleiner, Morris M. Intensity of Management Resistance: Understanding the Decline of Unionization in the Private Sector. *Journal of Labor Research*, 22(3):519–540, 2001.
- Kremer, Michael and Olken, Benjamin A. A Biological Model of Union Politics. *NBER WP*, 8257, 2001.
- Lazear, Edward P. A Competitive Theory of Monopoly Unionism. *The American Economic Review*, 73(4):631–643, September 1983.
- Marshall, Robert C. and Merlo, Antonio. Pattern Bargaining. *International Economic Review*, 45(1):239–255, 2004.
- Melitz, Marc J. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, 71(6):1695–1725, November 2003.
- Naylor, Robin A. The Effects of Entry in Bilateral Monopoly. *Warwick Economic Research Papers*, 638, April 2002.
- Pencavel, John H. The Demand for Union Services: An Exercise. *Industrial and Labor Relations Review*, 24(2):180–190, January 1971.

- Pinkston, Joshua C. and Spletzer, James R. Annual Measures of Gross Job Gains and Gross Job Losses. *Monthly Labor Review*, November 2004.
- Voos, Paula B. Trends in Union Organizing Expenditures, 1953-1977. *Industrial and Labor Relations Review*, 38(1):52-63, oct 1984.
- Wachter, Michael. Labor Unions: A Corporatist Institution in a Competitive World. *ILE Research Paper*, (06-17), 2006.
- Williamson, Oliver E. Wage Rates as a Barrier to Entry: The Pennington Case in Perspective. *The Quarterly Journal of Economics*, 82(1):85-116, feb 1968.