Unionization Rate, Organizing, and Firm Turnover

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Abstract

The unionization rate in the US varies widely both across sectors and states as well as over time. This paper shows that the interaction of firm turnover on the one hand and costly union organizing on the other might play an important role for unionization outcomes in the US. I develop a model that combines an entry-exit framework of monopolistically competing firms with costly union organizing. A novel feature of the model is that the union both decides about wages and organizing, and moreover, organizing is motivated by the fact that a higher union share allows for higher wages by decreasing product market competition by non-union firms.

Firm turnover is a crucial determinant of the unionization rate in the US because entering firms are typically born as non-union and have to first be organized by unions. Moreover, the union's firm share usually diminishes only through exit of unionized firms. Thus, higher firm turnover requires more union organizing to sustain a given level of unionization. In the model, the unionization rate and the union wage are shaped not only by the flow mechanics of union organizing and firm turnover, but also by the equilibrium interaction of endogenous firm entry with the union's organizing decision: Higher union organizing deters firm entry, and conversely higher entry lowers the incentives for organizing.

Numerical results show that the steady state unionization rate is higher if 1. firm entry costs are higher, 2. exit rates are lower, and 3. organizing costs are lower. Further, the transition dynamics of the model support two explanations of the long-term union decline in the US: First, an increase in the cost of organizing, and secondly, deregulation understood here as a decrease in the cost of firm entry.

1 Introduction

This paper develops a model of union organizing dynamics in an environment of firm turnover to understand the large variations of private sector unionization rates in the US

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both across sections and over time. The unionization rate (and the union wage premium) in this model is shaped by the endogenous interaction of firm turnover on the the one hand and costly union organizing on the other. Technically speaking, the paper combines an entry-exit framework of monopolistically competing firms with a wage-setting and organizing union within a rich general equilibrium model.

The fraction of private sector workers in the US belonging to a union differs significantly both across sectors, states, and over time. The unionization rate has 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 6). 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 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]

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. 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 firms unionized. A strength of the 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. In particular, the unionization rate is the outcome of a game between the organizing union and the potential (aggregate) firm entrant. 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 entry both requires more organizing and thus higher costs, and 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. On the other hand, the firm benefits from a higher unionization rate since this increases the average sectoral price level in the output market (due to the fact that union firms charge a higher price). The total

[1] See Pinker and Spletzer [2004].

effect of organizing on entry is, however, negative.

The main ingredients of the model are union organizing and entry and exit of firms. Unions in the model maximize net revenue, which is the number of union members times the mark up over the non-union wage. They do so by choosing both which wage level to set and how many non-union firms to organize. The incentive for organizing firms is both directly given by an increase in members, and indirectly through an improvement in the ability to set a higher wage. The latter effect is a novel feature and formalizes the intuition that a union which monopolizes the market has improved wage setting power. In the model this follows from the fact that a higher share of union firms implies that the average price in the output market will rise relatively to the individual's firm price. This in turn will increase increase profits and lower the elasticity of the firm's labor demand.

This paper differs from the approach to unionization taken in 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 union membership.[2][3] While the purpose of this paper is to mainly complement the standard approach to unionization, there is also evidence which suggests that the worker's part of the unionization process is of limited impact. First, as mentioned above, the union status of a firm is rarely be revoked, and exit 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.[4] Secondly, 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.[5] Due to reputational consequences or threats of job loss, 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 is 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 for organizing workers and the indirect costs implied by countering employers resistance to organizing. Costs are increasing in the number of firms to be organized, and thus higher firm turnover will make it costlier to sustain a given unionization rate. In particular, higher entry given firm

[2] This literature started with Pencavel [1971]. See Kaufman [2002] for a summary of the literature.

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

[4] In theory, workers can of course intentionally select themselves into a union firm.

[5] See 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).

exit will lower the optimal organizing rate since both direct organizing costs increase as well as a higher mass of incumbent firms will lower profits and in turn lower the intensive employment margin (worker per firm) and thereby union membership.

Concerning firms, exit is exogenous so that the main decision whether or not to enter the market. The entrant's decision depends on the union's organizing rate in two ways. First, a higher organizing rate increases the risk to become a unionized firm with higher labor costs. Secondly, a higher share of unionized firms will also increase expected profits due to an increase in the output demand for all firms. Looking only at the current payoff, it can be shown that the first effect dominates and thus entry decreases with union organizing.

The model is applied to numerically 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 (within a sector). 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. Further, older firms are more likely to be unionized. All of these results correspond to the stylized facts.

The dynamics of the model allow to evaluate two channels of 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 my model, a one time change in the organizing cost implies a gradual adjustment of the unionization rate. The model supports the hypothesis that a change in the legal environment at one point in time can have contributed profoundly to the long-term decline of unions. A second factor that has been emphasized is the derregulation of several industries in the US during the late 1970s and early 1980s. The path of the unionization rate following a decrease in entry costs also follows a gradual adjustment over time. The feature of the gradual adjustment follows from the fact that the unionization rate is based on the stocks of (non-)union firms, and thereby adjustments only come through changes in the flow variables.

Finally, the model also contributes to the literature on unionism and entry deterence. Unions in this model deter entry, but only for an already unionized firm it would be beneficial to support further unionization. Profits for both union and non-union firms increase with unionization. However, the expected profit of a non-union firm is lower under higher unionization.

The remainder of the paper is organized as follows: Section 2 discusses the related literature. Section 3 and 4 describe the model and the equilibrium concept. In section 5 the choices made by the unions and firms and their equilibrium interaction is analyzed within a simplified one-period setting. Section 6 presents numerical results for the steady state comparisons and the transition paths. Section 7 concludes. Most of the proofs are in the appendix.

2 Related Literature and Empirical Findings

Related Literature This paper relates to several strands of literature. First, in terms of the model it contributes to the literature on dynamic union models (see Jones and McKenna [1994] for an overview). Two papers are more directly related in terms of the model. Kremer and Olken [2001] use ideas from epidemiology to analyze union behavior as the 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 union survival. Their model is similar in that it also has organizing unions and firm turnover. It differs in that exit is endogenous while entry and organizing is exogenous. The outcome of their model that union firms exit at a higher rate than non-union firms is not supported by the data (see stylized facts below). Further, in contrast to this paper, their model neither takes into account effects of unions on firm level employment nor on the mass of incumbent firms (which impacts profits and therefore the union's ability to extract rents). Both of these margins are important determinants for the resulting aggregate unionization rate.

Secondly, a recent paper by Ebell and Haefke [2006] links product market competition measured by the elasiticy of substitution between monopolistic-competitively supplied goods with the support for unions by workers within a matching model. Higher competition (due to e.g. deregulation), decreases the net gain of unionization. If deregulation is strong enough, workers of any newly entered firm will not support unions, and unions disappear over time due to firm turnover. Even though the model is similar in that it also has union formation and firm turnover, it differs both by having firm turnover exogenous and in the way it models union formation. The model is used to explain union decline as a result of a higher elasticity of substition which is interpreted as deregulation. In contrast to the proposed model here, it cannot account for the fact that at the same time unions decline and constantly organize new firms.

Another connection to the literature is concerned with the IO side of the model. First, this paper is built on a simplified version of the Hopenhayn [1992] model of industry dynamics. The main difference is that here there are no productivity shocks and thus exit is exogenous. Secondly, this model relates to the literature on unions and entry deterence that started with work by Williamson [1968].[6] In the model here, unions deter firm entrance. A higher rate of organizing will decrease the number of entrants. Due to the fact that non-union firms coexist with union firms, the support for unions by incumbent firms can be conflicting. While unionized firms gain from higher unionization, non-union firms lose and thus only in case of a majority of firms being unionized, the interests between the union and the incumbent firms coincide (from an individual firm's perspective). This result relates to the one of Naylor [2002], where firms have an interest in increasing entry in order to lower the impact of unions on labor cost and thereby increase profits.

Finally, this paper contributes to the recent attempts to single out the reasons for the long-term union decline in the US. This emerging interest is partly motivated by the conjecture that this decline might have caused 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 is limited by the fact that the group of workers that has most benefited from skill-biased technological change has never been unionized to large degree. 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, which are either used to motivate assumptions of the model or as points of reference for the model's outcomes.

1. Unionization rates differ widely across industries (see data provided by Hirsch and Macpherson).[7]

2. Unionization rates differ significantly across US states (again, see data provided by Hirsch and Macpherson). This is strongly correlated with the adoption of right-to-work laws (see e.g. Farber [1984]).

3. The unionization rate has declined continuously from 1953 to today (see figure 6).

[6] For a brief summary of the literature see the article by Robin Naylor in Addison and Schnabel [2003].
[7] These data can easily be accessed at http://unionstats.com/.

4. 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 10 for the long-term development).

5. The rate of union decertification is close to zero (e.g. Farber and Western, 2001).

6. The union wage premium has been relatively constant with a slight downward trend (Blanchflower and Bryson, 2002).[8]

7. Industries with higher entry rates have lower unionization rates (Chappell et. al. [1992]). Related to this, unionization rates positively correlated with industry concentration (Ebell and Haefke, 2006)

8. Unionization rates are higher in industries with lower firm exit rates (Kremer and Olken [2001]).

9. 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

3.1 Environment

The model combines a Hopenhayn-style entry-exit framework of monopolistically competitive firms[9] with monopoly unions that set wages and organize firms. 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. Thus, the union is small vis-à-vis the aggregate economy, and therefore taking aggregates and the behavior of other unions as given. However, it is big in relation to firms within its sector, which in turn take the union's decisions as given. This constellation can be interpreted as an intermediate position between centralized and decentralized bargaining,

[8]The union wage premium as the percentage of the union wage over the non-union wage. Estimating the 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.

[9]This feature is similar to Melitz [2003].

which approximates the situation observed in the US.[10] On the aggregate level there are markets for the aggregate good, Q_t, and non-union labor $l_{j,t}^{nu}$, which clear every period. These economy-wide markets determine the non-union wage level w_t^{nu}, which is uniform across sectors, and the aggregate output price, P, which will be used as a numeraire. The given multi-sector structure has two 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. For empirical purposes, with this richer structure the model can be easily adjusted to the cases of cross-sector heterogeneity (e.g. with respect to entry costs or exit rates). This better facilitates to account for the aggregate unionization rate and union wage premium given the pronounced hetergogeneity of union outcomes across sectors.

The environment for firm turnover and the dynamics of the union status of firms is the following: 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 possibly become unionized. Entrants always start out as non-union. However, union firms cannot change back to non-union. This is asymmetry is motivated by the stylized facts.[11]

The multi-sector structure with CES demands proposed here has several purposes. First, CES demands make it possible to have unionized firms coexisting with non-union firms. Secondly, the multi-sector structure allows to separate the aggregate effects from the within sector- actions (becauses agents within a sector take aggregates as given), and moreover it avoids strategic interactions between unions. This second aspect has important implications: For one, the mass of firms within a sector will affect prices, whereas in the standard monopolistic competition model the price is a fixed markup. Related to that effect, this structure implies that a higher unionization rate within a sector will ceteris paribus decrease the output price gap between the sector average and the inidividual unionized firm and thereby allowing for a higher union wage. This formalizes the intuition that a union is better off if it monopolizes the market.

3.2 Agents' static maximization problems

This part explains the decision of consumers, specialized and aggregate producers made within a period. Ouput is produced and consumed every period. Since there is no savings

[10] The 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.

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

market[12], 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 recieve profit shares, and decide about consumption each period. Labor supply is inelastic. The representative worker solves each period:

$$\begin{gathered} max\ Q^C \\ s.t. \quad PQ^C \leq \int_{j\in[0,1]} \int_{i\in\mu_j} \left(w_{ij}l_{ij} + \pi_{ij}^{net}\right) didj \end{gathered} \tag{1}$$

where the price index is given by:[13]

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

The set μ_j contains all union and non-union firms in sector j. In each period (time index omitted) 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.[14]

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

$$Q = (\int_j (\int_{i\in\mu_j} q_{ij}^{\rho_1} di)^{\frac{\rho_2}{\rho_1}} dj)^{\frac{1}{\rho_2}} \tag{2}$$

[12]In 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.

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

[14]See also remark 1 in appendix C.

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 this are given by:

$$q_{ij}(p_{ij}) = p_{ij}^{\frac{1}{\rho_1 - 1}} \left(\int_{i \in \mu_j} p_{i,j}^{\frac{\rho_1}{\rho_1 - 1}} di \right)^{\frac{\rho_1 - \rho_2}{\rho_1(\rho_2 - 1)}} \hat{Q} \tag{3}$$

where $\hat{Q} \equiv QP^{\frac{1}{1-\rho_2}}$.[15]

Monopolistic Firms Given the demand function derived above and wages (which depend on the union status), the producer of specialized good i solves the problem of a monopolistic competitor[16]:

$$\max_{p_{ij}} p_{ij} q_{ij}(p_{ij}) - w_{ij} \mathcal{F}(q_{ij}(p_{ij})) \tag{4}$$

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 because of 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:

$$\pi_{ij}(w_{ij}) = w_{ij}{}^{\frac{\rho_1}{\rho_1 - \alpha}} m^{\frac{\alpha(\rho_2 - \rho_1)}{\rho_1(\alpha - \rho_2)}} (\frac{\rho_1}{\alpha\kappa})^{\frac{\rho_2}{\alpha - g}} \hat{Q}^{\frac{\alpha(1-\rho_2)}{\alpha - \rho_2}} (1 - \frac{\rho_1}{\alpha}) \tag{5}$$

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 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. This sectoral price index is increasing in the share of unionized firms, denoted by $\tilde{r}$. From that 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

[15] Note 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.

[16] Throughout the the paper I use the terms firm and plant synonymously.

of unionized firms (which have higher wages) leads to higher profits and thereby higher labor demand (for both unionized and a non-union firms):

Lemma 1. *Taking the aggregates $\bar{w}$ and $\hat{Q}$ as given, and assuming that the union wage is greater than the non-union wage, a higher share of unionized firms,$\tilde{r} \in (0, 1)$, implies higher profits.*

Proof. Rewriting the profit function of a union firm as:

$$\pi_{u,j}(w_j) = w_j^{\frac{\rho_2}{\rho_2-\alpha}} \mu_j^{\frac{\alpha(\rho_2-\rho_1)}{a(\alpha-\rho_2)}} \left(\tilde{r_j} + (1-\tilde{r_j}) k_j^{\frac{\rho_1}{\rho_1-\alpha}}\right)^{\frac{\alpha(\rho_2-\rho_1)}{\rho_1(\alpha-\rho_2)}} \cdot K$$

where $k_j = \frac{\bar{w}}{w_j} < 1$, and $\mu_j = u_j + n_j$ denotes the total mass of firms in sector j, and K are some aggregate variables, the result follows (for interior solutions) from taking the first derivative with respect to $\tilde{r}$. The argument for a non-union firm is similar. □

This effect is important for the results of the model: it implies that the elasticity of labor demand is a function of the share of firms that are unionized (as well as of the total mass of firms) within the sector. Given the total mass of firms within a sector and taking the economy-wide aggregates as given, the union has an incentive to organize non-union firms in order to lessen the negative employment impact of higher wage demands. This is of course a partial equilibrium result and hinges on the fact that the income effect of a higher sector price is accounted for by the aggregate term $\hat{Q}$. From a single sector perspective the result even holds on the aggregate since each sector is of measure 0. Moreover, the result has an intuitive interpretation. Considering goods like cars, according to the model firms (and unions) are better off if the share of unions is higher (everything else constant). Indirectly, a higher sector price also has an effect on total sector spending, but if the varieties in one sector are difficult to substute by varieties of another sectore (which is the defining criterion of a sector here), then most of price increase is spread evenly across the other sectors. This effect is stronger the stronger the complementarity, which is reflected in lower value for ρ_2.

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 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 choses 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 sets the wage w_{jt} .
5. Firms (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:[17]

$$u_{j,t+1} = (1 - \delta_j)\left[u_{jt} + s_{jt}(n_{jt} + e_{jt})\right] \tag{6}$$

$$n_{j,t+1} = (1 - \delta_j)(1 - s_{jt})(n_{jt} + e_{jt}) \tag{7}$$

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-uion in period T conditional on surviving is $\prod_{t=0}^{T}(1-s)$, which goes to zero for $T \to \infty$ as long as $s > 0$.

Proposition 1. *In a steady state with $s \in (0,1]$, the older the firm the higher is the likelihood that the firm is unionized.*

This is a feature also reported in empirical work.[18] 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.

[17]Note that I am following the convention that μ_t^x , $x \in \{u, nu\}$, denotes the mass of firms determined last period, thus $\mu_{t+1}^x$is the stock of firms at the end of period t.

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

Implied Path for r_t The focus of this paper is the determination of the (aggregate) unionization rate. In each sector the rate of workers belonging to a union is defined by $r_{jt} \equiv \frac{L_{ujt}}{L_{ujt}+L_{njt}}$, where sectoral labor demand for both types $i \in \{u, n\}$ is: $L_{ijt} \equiv i_{jt} l_{ijt}(w_{ijt})$, with firm level labor demand given by:

$$l_{ijt}(w_{ijt}) = (w_{ijt})^{\frac{\alpha}{\rho_1-\alpha}} \left[u_{j,t+1}(w_{j,t})^{\frac{\rho_1}{\rho_1-\alpha}} + n_{j,t+1}(\bar{w}_t)^{\frac{\rho_1}{\rho_1-\alpha}} \right]^{\frac{\alpha(\rho_2-\rho_1)}{\rho_1(\alpha-\rho_2)}} \kappa \left(\frac{\rho_1}{\alpha\kappa} \right)^{\frac{\alpha}{\rho_1-\rho_2}} \hat{Q}^{\frac{\alpha(1-\rho_2)}{\alpha-\rho_2}}. \quad (8)$$

Thus, the sectoral unionization rate has an intensive margin given by employment per firm and determined by the union's wage decision, and an extensive margin given by the rate $\tilde{r}_{jt}$of unionized firms which directly depends both on the union's organizing decision and the sectoral entry response. Using the laws of motion and noting that $L_{ujt}/(L_{ujt} + L_{nj,t}) = (1 + (L_{ujt}/L_{njt})^{-1})^{-1}$, we can express the path for r_{jt} as follows:

$$r_{jt} = \left\{ 1 + \left(\left(\frac{w_{jt}}{\bar{w}_t} \right)^{\frac{\alpha}{\rho_1-\alpha}} \left[\frac{u_{jt}}{(1-s_{jt})(n_{jt}+e_{jt})} + \frac{s_{jt}}{1-s_{jt}} \right] \right)^{-1} \right\}^{-1} \quad (9)$$

From this equation it follows that r_{jt} is increasing in s_{jt} and and decreasing in e_{jt}, and w_{jt}. Thus, in principle, given the amount of entry e_{jt}, a higher organizing rate and a higher wage together have an ambiguous effect on the resulting unionization rate. The effect of e and s on the firm unionization rate $\tilde{r}$ are clear, since here there is no countervailing wage effect:

$$\tilde{r}_{jt} = \left\{ 1 + \left(\frac{u_{jt}}{(1-s_{jt})(n_{jt}+e_{jt})} + \frac{s_{jt}}{1-s_{jt}} \right)^{-1} \right\}^{-1}. \quad (10)$$

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.[19] 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 sectorial aggregate mass of entrants M^e_{j,t^*}, the unions choices of s_{jt^*} and w_{jt^*}, and the path of the economy-wide aggregate wage $\bar{w}_{jt^*}$and output Q_{t^*} for all $t^* \geq t$. 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:

[19]The numerical simulations currently use a modified entry condition. See remark 2 in Appendix C.

$$V^u_{jt}(u_{jt}, n_{jt}) = \pi_{ujt}(u_{jt}, n_{jt}) + \beta(1-\delta_j)V^u_{j,t+1}(u_{j,t+1}, n_{j,t+1}) \tag{11}$$

where δ_j is the exogenous firm exit rate.

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

$$\begin{aligned} V^n_{jt}(u_{jt}, n_{jt}) &= \pi^n_{jt}(u_{jt}, n_{jt}) + \\ \beta(1-\delta_j)[s_{j,t+1}V^u_{j,t+1}(u_{j,t+1}, n_{j,t+1}) &\quad +(1-s_{j,t+1})V^n_{j,t+1}(u_{j,t+1}n_{j,t+1})] \end{aligned} \tag{12}$$

where $s_{jt} = f^s(u_{jt}, n_{jt})$ is also a function of the states.

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:

$$V^e_{jt}(u_{jt}, n_{jt}) = s_{jt}(1-\delta_j)V^u_{j,t}(u_{jt}, n_{jt}) + (1-s_{jt})(1-\delta_j)V^n_{j,t}(u_{jt}, n_{jt}) - P_t\epsilon_j \tag{13}$$

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 equlibrium 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:

$$V^e_{jt} \leq 0, \quad = 0 \text{ if } e_{jt} > 0 \tag{14}$$

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

Union Organizing and Wage Setting In each period the union of sector j first decides about at what rate s_{jt} to organize non-union firms and then what wage w_{jt} to set. When making the organizing decision the union anticipates the wage decision it will make afterwards.[20] Regarding wage-setting I follow the right-to-manage approach in the literature: the union has monopoly power over the wage, but the firm is free to choose employment.[21] Thus, on the firm level the union faces the standard wage-employment

[20]Besides being the natural order of moves, this set-up also simplifies the computation of the model.

[21]The evidence on the union's objective function is mixed at best. The two standard approaches are the right-to-manage model and the efficient bargaining model where the union choses (or bargains for)

trade-off. The other choice made by the union is how many firms to organize. 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. Modeling both the wage and the organizing decision simultanously has not been explored much in the literature.[22]

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 is:

$$W_{jt}(u_{jt}, n_{jt}) = \max_{s_{jt} \in [0,1]} \{U(u_{jt}, n_{jt}, s_{j,t}) - P_t \mathcal{C}_j(u_{jt}, n_{jt}, s_{j,t}) + \beta W_{j,t+1}(u_{j,t+1}, n_{j,t+1})\} \quad (15)$$

The maximization is subject to the laws of motion given the equilibrium entry response $e_{j,t} = f^e_{jt}(u_{jt}, n_{jt})$ and the aggregates $\bar{w}_t$ and Q_t. The period payoff is:

$$U(.) = \max_{w_{jt}} (w_{jt} - \bar{w}_t) L_{ujt}(u_{jt}, n_{jt}, w_{jt}, s_{jt})$$

, which already incorporates the optimal wage choice subject to the sector's labor demand.[23] 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.[24]

Organizing costs are in terms of the aggregate output[25] and are specified by:

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

where $\eta_j > 0, \gamma > 1$ and $e_{jt} = f^e_{jt}(u_{jt}, n_{jt})$.

both wage and employment. Besides the fact that at least explicitly most bargaining is firstly about wages, the efficient bargaining model has not been supported by empirical studies (see Kaufman [2002] for a summary of the literature)

[22] With the exception being the partial equilibrium model in Chezum and Garen [1997].

[23] For the formula for labor supply see equation 8 above.

[24] Alternatively, 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 shrinks). Thus, this second interpretation would have to impose further assumptions on where workers can go after leaving a firm to pin down the outside option of a worker.

[25] On the aggregate, organizing costs are $Q^U_t = \int_j \mathcal{C}_j(.) \cdot u_{j,t} dj)$. This part of the output is substracted 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.

The cost function is strictly convex and increasing in s. 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. 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.[26] Secondly, the success of organizing depends on the firm behavior. Firms can (illegally) dismiss workers joining the union organizers. 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 makes it harder for the union to organize.[27] The model in this paper does not attempt to map these obstacles in precise manner and treats firm's union avoidance as part of the organizing cost function.[28] Rather, the model is used to show how this friction is qualitatively relevant in the context of firm turnover. I further assume that the union is borrowing constrained so that the current payoff has to be non-negative each period.[29]

Denote the union's policy functions for the wage and for organizing by $f^w_{jt}(u_{jt}, n_{jt})$ and $f^s_{j,t}(u_{jt}, n_{jt})$ respectively.

4 Equilibrium

The equilibrium of the economy is defined in three steps. The first two describe the industry equilibrium and the union's response in each sector. The third step is concerned with the aggregate decisions of the representative consumer and the aggregate goods producer, and the market clearing conditions for the aggregate good and labor given the outcomes of the industry equilibrium. If one would interpret the sector-wide entry response as the decision of an aggregate player, the equilibrium of the interaction between the aggregate entrant and the union is equivalent to a Markov perfect equilibrium.

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 $\left\{\{u_{jt}, n_{jt}\}_{j\in[0,1]}, Q_t, Q^C_t, Q^\epsilon_t\right\}_{t\geq 0}$, demand functions $\{q_{jt}(.), l_{ujt}(.), l_{njt}(.)\}_{j\in[0,1]}$, value functions V^u_{jt}, V^n_{jt}, V^e_{jt}, W_{jt}, policy functions f^w_{jt} and f^s_{jt} and the equilibrium entry response

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

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

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

[29] In 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 much below the average wage premium of about 15%.

function f^e_{jt} such that for all $t \geq 0$:[30]

1. Given the aggregate variables $\{\bar{w}_{t^*}, Q_{t^*}\}_{t^*=t}^{\infty}$ for each sector j:

   (a) For each specialized goods producer, given the demand function (3) , the maximand of (4) is given by the profit function (5), and the labor demands give the corresponding optimal input demands.

   (b) Given the value function of an entrant as defined by (11)-(13), the potential entrant solves $\underset{enter,don't}{max}\left\{V^e_{jt}, 0\right\}$.

   (c) Given f^w_{jt} and f^s_{jt}, f^e_{jt} gives the total mass of entrants e_{jt} such that the zero profit condition (14) holds.

2. Given the aggregate variables $\{\bar{w}_{t^*}, Q_{t^*}\}_{t^*=t}^{\infty}$ and f^e_{jt} for all t, for each sector j:

   (a) W_{jt} solves the Bellman equation (15).

   (b) The policy functions f^w_{jt} and f^s_{jt} attain the RHS of (15).

3. Given $\{w_{jt}, u_{jt}, n_{jt}\}_{j\in[0,1]}$, $\{p_{ujt}, p_{njt}\}_{j\in[0,1]}$, and labor demands$\{l_{ujt}(.), l_{njt}(.)\}_{j\in[0,1]}$ 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^C_t, Q^ϵ_t, and Q_t are such that:

   (a) Q^C_tsolves the consumers problem in (1).

   (b) The demand functions for specialized goods in (3) 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: $Q_t = Q^C_t + Q^\epsilon_t$ (where Q_t is defined in (2), the aggregate entry costs are $Q^\epsilon_t \equiv \int_j \epsilon_j \cdot [u_{j,t+1} + n_{j,t+1}]dj$.

   (d) The labor market clears: $L = \int_j [u_{j,t+1} l_{ujt}(\bar{w}_t, .) + n_{j,t+1} l_{njt}(\bar{w}_t, .)]dj$ (where the LHS is the time invariant and inelastic total labor supply).

Since most of the subsequent analysis is focused on the outcomes for a single sector for given aggregates, I will briefly describe the role of the aggregate (non-union) wage. The full version of the model implies two general equilibrium effects: one through the non-union wage $\bar{w}$and another through aggregate production Q. Given Q, and considering the static case, the aggregate labor market clearing implies that if for a positive measure of

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

sectors the union wage increases (exogenously), fewer people are employed in union firms, and given that the number of union firms doesn't increase, more people have to look for employment in the non-union sector which will depress the non-union wage.[31] Thus, the effect of a union wage increase is potentially amplified in relative terms through this wage decrease for the non-union workforce.

5 Entry, Wage-Setting, and Organizing

Before numerical results are presented for the dynamic model in the next section, this section will analyze the interaction between entry on the one hand and wage setting and organizing on the other hand. That is, I consider a single-sector, single-period version of the model where either the organizing choice s or the wage setting decision w is exogenous. This mainly serves an expository purpose to better understand the equilibrium interaction between the union and the entering firms, and also to show how the results of the model depend on these choices being endogenous rather than being given exogenously.

I first describe the response functions of the union and the aggregate entrant and then do comparative statics with respect to the parameters of interest: the scaling paramter of the organizing costs, η, the firm exit rate δ, and entry costs ϵ. As mentioned in the introduction, the comparative statics of *steady states*, will depend both on the endogenous responses (policy functions) and the flow mechanics of the model given by the laws of motion. The static environment in this section enables me to focus on the effects coming from the choices.

Wage Setting and Firm Entry Holding the organizing rate fixed at some $s > 0$, first consider the aggregate entry response to a wage increase. A higher union wage w_j implies two opposing effects on the profits of a prospective entrant: On the one hand it makes operating a unionized firm costlier. On the other hand, through the relative price effect (implied by Lemma 1), which raises the sectoral price level, it increases output demand and thus profits for both types of firms. In general, either effect could outweigh the other.[32] The union's wage response to entry on the other hand is strictly decreasing. The intuition for this is that a higher level of entry decreases the sectoral price index and thus lowers the elasticity of labor demand, making a wage increase costlier in terms of

[31] Note that this effect is similar to a standard result in a model with unions and (search) unemployment (see e.g. Delacroix 2006): a union wage increase can lead to higher unemployment and therefore a lower outside option for the union worker.

[32] In the case of both a and αclose enough to 1, entry will increase in the wage. Properties of the response functions are summarized in Lemma 2 in the Appendix.

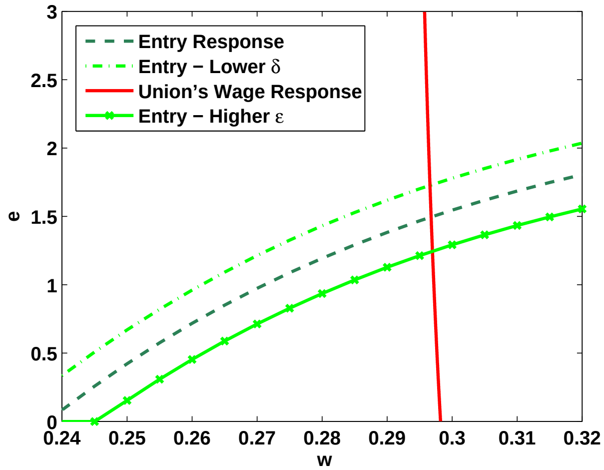


Figure 1: Equilibrium with Wage-Setting and Entry

employment. Given some assumptions on the entry costs ϵ an equilibrium can be shown to exist (figure 1 depicts a typical equilibrium).

Proposition 2. *If ϵ is sufficiently small an equilibrium with $e > 0$ exists. If ϵ is sufficiently large an equilibrium with $e = 0$ exists.*

Comparative static results for ϵ and δ are easy to obtain because both parameters shift only the aggregate entrant's response function.

Since aggregate entry is decreasing in entry costs, at a given wage w fewer firms will enter if entry costs go up. We thus move downward along the decreasing response function of the union to an equilibrium with lower e and higher w (see fig. 1). Since organizing is fixed, a higher number of entrants implies a lower rate of firms unionized (see also formula (10)).

Proposition 3. *Given an inital level of entry $e > 0$, if ϵ increases then e goes down, and w and $\tilde{r}$ go up.*

Similarly, an increase in the firm exit rate also shifts down the entrant's curve, because a higher exit risk lowers the expected payoffs. Therefore, in case of an increase in δ entry goes down, whereas the union wage and the rate of firms unionized go up (fig. 1 illustrates the effect of a *de*crease in δ).

Proposition 4. *Given an initial level $e > 0$, then if δ increases e goes down, and w and $\tilde{r}$ go up.*

From the analysis so far it is not possible to draw conclusions about the unionization rate r. The unionization rate is determined by two factors: first the firm unionization rate $\tilde{r}$ which is directly affected by entry, and second by the wage the union sets. The first determines the extensive, the second the intensive margin of the unionization rate. In the comparative static exercises above, we always have that both $\tilde{r}$ and w are moving in the same direction leaving the total effect ambiguous.[33]

Finally, since in the full version of the model the wage decision is made sequentially after the organizing choice, it is instructive to consider an exogenous change of s within this setting: The entrant's response function will shift down (as explained in the next subsection), whereas the union's curve will shift up. The shift of the union's response comes from the fact that higher s directly increases $\tilde{r}$ and therefore allows for a higher wage due to a less elastic labor demand. Inspecting the graph, in both the case of a decreasing and increasing response function of aggregate entry, we will have a higher union wage w in equilibrium. This is one incentive for the union to spend resources on organizing (the others being that it increases the total mass of incumbent union firms and that it increases the labor demand of an individual union firm).

Organizing and Entry This section studies the case where the union's wage w is taken as given and the union only decides about organizing s. Consider first the entry response to the union's choice of s. A higher rate of organizing has two opposing effects: On the one hand increasing the unionization rate implies for both types of firms higher profits through the demand effect implied by the higher average price in the sector. On the other hand it also implies that a higher share of entrants will become unionized thus increasing the risk of getting the lower profits of a union firm. The total effect is unambigously negative: a higher level of s implies lower e (see Lemma 2).

For its choice of s the union has to balance benefits with costs of organizing. On the benefit side there are two effects: First higher s increases the total mass of union firms, which is the extensive margin of union labor. The intensive margin is affected by s through the relative price effect which in this case increases labor demand of an individual firm if s goes up. We obtain the union's response function implicitly from the FOC of the union's utility function w.r.t. s. It can be shown that the optimal s is strictly decreasing in e given that the curvature parameter in the cost function is large enough: $\gamma > -\frac{\alpha}{\rho_1}\frac{(\rho_2-\rho_1)}{(\alpha-\rho_2)}$.[34] A higher level of e on the one hand increases the marginal gains of organizing, but it also increases the marginal costs. The given (sufficient) condition ensures that the marginal costs increase by more than the marginal benefits. The following

[33] My numerical simulations of this case, however, always indicated that $\tilde{r}$ and r go in the same direction.
[34] This is only a sufficient condition.

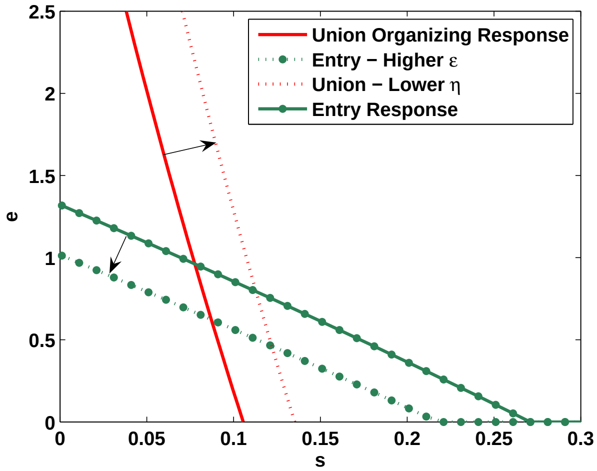


Figure 2: Equilibrium with Organizing and Entry

proposition gives conditions for the existence of an intersection point of the two response functions (see fig. 2 for a typical equilibrium):[35]

Proposition 5. *Given that the organizing cost parameter η is sufficiently low and entry costs $\epsilon \in [\epsilon^{low}, \epsilon^{high}]$ for some ϵ^{low} , ϵ^{high} an equilibrium exists for the fixed wage case.*

There are two comparative statics results: one for a change in entry costs ϵ, the second for a change in the cost parameter η. First, consider an increase in the entry costs ϵ. Since ϵ only shifts the response function of the aggregate entrant it is easy to see the following result:

Proposition 6. *An increase in entry costs implies a higher value for s, lower e and higher r.*

Considering interior solutions, higher ϵ implies a lower mass of entrants at a given s, which in equilibrium increases s but decreases e (see fig. 2). In contrast to the previous setting where s was held fixed, it is now possible to draw a conclusion about the unionization rate r: With a constant wage r moves in the same direction as $\tilde{r}$, which is higher if e is lower (see (10)).

Organizing costs (η) on the other hand only affect the union's response function. Higher costs (higher η) leads to downward shift causing s to decrease, and e to go up in equilibrium.

Proposition 7. *An increase in organizing costs implies a lower value for s, higher e and lower r.*

[35]In addition, for the examples I analyzed, it is always the case that the union's response function is steeper than the entry response function (in the $M^e - s$-space).

Again, since the wage is fixed the intensive margin doesn't change and thus u and $\tilde{u}$ move in the same direction (see fig. 2 for the case of lower organizing costs).

Note, that from the mere direction of shifts it is not possible to conclude anything about the effect of an increase in δ. Both curves are on a lower level if δ is higher, implying that the effects on both s and e are ambiguous.

Induced Effects of Endogenous Entry Figures 3 and 4 (in the appendix) illustrate the additional effect of endogenous entry on the organizing response. In the given examples here both the entry and organizing response function already include the optimal union wage decision. In figure 3 the induced effect of entry on organizing after a reduction in organizing costs (lower η) can be seen. If entry was fixed, the resulting organizing response s was lower: lower organizing costs directly increases s because of the union's direct gains. In an equilibrium with endogenous organizing in contrast, s is further increased because higher s lowers the value of an entrant. In case of a decrease in the exit rate δ the depicted example in figure 4 shows that the induced effect even can change the direction of the total effect. If entry was fixed at the initial value, then lower δ results in a higher organizing rate, whereas if both organizing and entry are endogenous, the equilibrium outcome would be a lower organizing rate s. [36]

Similar differences can be seen for the case where organizing was fixed. Steady state comparisons for fixed versus endogenous entry are analyzed in section 6.1.

6 Numerical Results: Steady States and Transitions

This section studies numerical simulations of the infinite horizon model. I present examples that illustrate typical cases of steady states and within sector transitions. [37] I compare the qualitative outcomes to results reported in empirical studies. These comparisons however are not meant as a quantitative accounting exercise. A calibration of the model is left for future research.

In contrast to the previous section the analysis presented here includes the dynamics of the state variables u and n. For one, this will amplify the effects of changes in the organizing costs and the entry costs. In case of the exit rate δ the dynamics are also

[36]Note that the effect in both cases is relatively small - in the given example δ has been lowered by 40%.

[37]The benchmark parameters are given in table 1. The model has computed so far only for a limited number of parameter constellations. Currently, I am working on a calibration in order to compute cases for sensible parameter values. Further, I tested for stability of the computed steady states by perturbing the starting values for the laws of motion. All results turned out to be stable steady states.

directly affected through the laws of motion. This direct effect of δ can even change the direction of the effect coming from the within period equilibrium outcome as described in the previous section. The benefit of the dynamic analysis is that one can look at the transition path of the unionization rate and the wage premium. This is of particular relevance for judging the long-term impact of a one-time policy change concerning organizing costs on the unionization rate.

The first subsection analyzes steady state comparisons for different parameter values governing the firm turnover process (ϵ and δ) and compares this to empirical findings. In line with empirical observations, the model predicts higher unionization rates for industries that have higher entry costs or/and lower exit rates. A further implication is that higher wage premia are correlated with higher unionization rates. To emphasize the role of the endogeneity of organizing a comparison to a model where organizing is fixed is given. In the second subsection I focus on the (within-sector) transition path of the unionization rate and the union wage premium following a one-time change in either the entry or the organizing costs. The model implications support two suggested explanations of the long-term decline of unionism in the US. First, it has been conjectured that the Taft-Hartley Act in 1947 made it more difficult for unions to organize. In the model, a one time change in the organizing costs produces a gradual decline of both the unionization rate and the union wage preming spanning a relatively long time interval. Moreover, the decline in the union wage premium is relatively small as is suggested in empirical work. Secondly, "deregulation" both in the specific sense of deregulation of certain industries, and a broader sense of a more "competitive environment" has been proposed as an explanation of the union decline. If deregulation in the sense of losening the barriers to entry is understood as a lowering of the entry costs, the model also supports this interpretation of the union decline.

6.1 Cross-Sectional Comparisons: Entry Costs, and Exit Rates, and Organizing Costs

This subsection studies steady states with cross-sectoral variations of entry costs, exit rates and organizing costs. I consider economies with two types of sectors, where a fixed fraction θ of the sectors differs from a the remaining mass of sectors, $1-\theta$, with regard to one parameter. I refer to them as sectors of type 1 and type 2 respectively.

To better understand the results in this section, the following gives the steady state version of the formula for the unionization rate given in 9:

$$r_j^* = \left\{ 1 + \left(\left(\frac{w_j^*}{\bar{w}^*} \right)^{\frac{\alpha}{\rho_1 - \alpha}} \left[\frac{1}{\delta_j} \frac{s_j^*}{1 - s_j^*} \right] \right)^{-1} \right\}^{-1}$$

Here, entry does not appear directly anymore. Entry only indirectly enters the unionization rate through its impact on organizing: higher entry lowers organizing. In contrast to formula 9, here the exit rate dierectly enters the equation. Higher exit lowers the unionization rate.

Impact of Entry Costs The steady state outcomes for the case of heterogeneity in entry costs are given in *Experiment 1* (see table 2, Appendix D). Type 2 sectors have 50 % lower entry costs than sectors of type 1. This imediately leads to the result that the mass of entrants in type 2 sectors as well as the total mass of incumbents ($u_j + n_j$) is higher as for type 1 sectors.

Intuitively, higher entry costs imply lower net benefits of entry and thereby less entry. Since organizing is decreasing in entry as explained in the previous section, this implies a higher organizing and therefore a higher firm-unionization rate $\tilde{r_j}$. This effect on the firm unionization rate in turn lowers the elasticity of labor demand, thereby allowing an increase in the wage premium (WP) from 23.1 % to 23.7%. As explained in the section describing the model, higher $\tilde{r}_j$ increases the unionization rate, while a higher union wage decreases it. As in all other cases analyzed, r_j goes in the same direction as $\tilde{r_j}$. Sectors with low entry costs have a unionization rate of 5.2 %, whereas sectors with high entry costs have a rate of 8.7 %.

As reported in stylized fact 7, this result is supported by the empirical evidence. Industries with more entry (or, related to that, with a lower concentration ratio) have lower unionization rates. Typical examples of more more concentrated industries with low entry are the still relatively high unionized industries of automobiles and aircraft manufacturing. The interpretation given by this model complements the ones frequently given in the literature 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 lower entry and higher unionization have the common cause of higher entry costs.

Impact of exit rates Even though exit rates are exogenous in this model, it is instructive to look at the implications of a variation in the exit rates, especially since there is no evidence that union firms differ significantly from non-union firms in this respect.[38] *Experiment 2* (see table 2) gives an example where sectors of type 2 have a 17 % lower exit rate ($\delta_1 = .06$ and $\delta_2 = .05$). Sectors with lower δ have a higher total mass of incumbents but a slightly lower mass of entrants. The organizing rate s is higher for the case of higher firm exit, whereas the firm unionization rate $\tilde{r}$ and the unionization rate r are lower.

The example shown in section 5 suggested that the impact of δ on the equilibrium interaction between entry and organizing is ambiguous and also relatively 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 imnpact on the flows seems to be the driving force for the total effect.

The implied negative correlation between exit rates and unionization rates is also found in empirical studies. 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 in crease 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 hotels and restaurants it is about 2 %. [39]

Differences in Organizing Cost Experiment 3 (see table 2 column 3) compares sectors with high (marginal) costs of organizing ($\eta_1 = 20$) with sectors that have low costs ($\eta_2 = 10$). As expected, lower organizing costs increase $\tilde{r}$, r, and the wage premium. The direct effect is that lower costs make it more worthwile to organize more. In addition, there is also an induced effect that higher organizing deters entry, which in turn increases the optimal organizing choice. The differences in the legal environment across states imply differences in the organizing costs. In particular, most of he southern states in the US adopted the so-called right-to-work legislation, all of which have lower unionization rates on average compared to states without such a legislation (for further details see also the discussion in the chapter about the transition dynamics following an organizing cost change). The model delivers an explanation how exactly such cost differences can

[38] In a companion paper (in progress) I consider a similar model where I simplify the organizing side but allow for endogenous exit. Using a model with productivity shocks that cause exit makes it also possible to analyze the impact of unionization on firm productivity. Tentative results indicate that unionization rate and firm productivity (of a union firm) are related in a non-monotone way.

[39] The numbers for firm exit go in the same direction. Data are online available at http://www.bls.gov .Looking at low-skill service jobs compared to goods producing jobs, and 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.

translate into differences in the unionization outcomes.

Induced Effects of Endogenous Organizing[40] To highlight the role of endogenous organizing this paragraph compares the effects of changes in ϵ and δ to a model where organizing is fixed at some $s > 0$. If organizing is exogenous, analytic results can be obtained which are presented in appendix B.

First, consider the comparative statics with respect to entry costs ϵ. If s is fixed, then the steady state firm unionization rate is independent of e (see the argument in proposition 8 in the appendix). Moreover, the union wage (for a secoral equilibrium) only depends on $\tilde{r}$. Hence the unionization rate r is also independent of entry and entry costs have no effect on both r and w (taking the aggregates as given).

The exit rate δ on the other hand has an effect even if s is fixed. In table (3) I compare the elasticities of changes in exit rates with respect to the main variables (for a sectoral equilibrium given the aggregates). For these comparisons I compute the steady state organizing rate s for the initial parameter value of δ and then compute the steady state for both the endogenous and the exogenous organizing model given a small change in the parameter. The effect of an increase in δ has a negative impact on entry in the fixed organizing case, whereas it is positive in the other case. The elasticities of the union wage and the unionization rate are in both cases negative. However, in the endogenous case, the elasticity (in absolute value) is bigger for the unionization rate, while it is smaller for the wage.

6.2 Organizing costs, entry costs and the long-term decline of US unions

Unions in the US have been in a long-term decline. Fig. 6 shows the paths of the aggregate unionization rate and membership numbers. The popular perception is that the major cause is the structural change from manfucturing to services. Economists, however, have long recognized that the role of this structural change and other changes in the composition of the workforce is limited.[41] 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

[40] This section uses a comparison with a previous version of the model where $\beta = 0$. This section will soon be up-dated.

[41] See e.g. Farber [1990].

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 lowerd 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%.[42]

Other causes have to come from either organizing, 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 not a very important (see Bronars and Deere [1993]) factor.

Organizing Environment and Union Decline The union's cost of organizing depend both on the direct expenditures for union organizeers and indirectly on the legal environment for union organizing and bargaining. In particular, they depend on the implied possibilities for employer to counter union organizing.[43] 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 laws, that prohibit union shops. The prohibition of union shops 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 sucessful in the presence of right-to-work laws.

This paragraph studies the consequences of a permanent increase of the organizing costs (cost parameter η). I will look at the transition path from a low η to a high η while keeping the aggregates constant.[44] As a starting point I will use the results from Experiment 3 (see table 2) which computes the outcomes given sector heterogeneity in η. Sectors of type 2 have 50 % lower (marginal) organizing costs than type 1 sectors (see the discussion in the previous subsection). Starting at the state variables for the lower cost case, I simulate the transition path using the policy functions for s, w, and e. Figure 5 shows the transition path for the unionization rate. The model implies a slow transition; the new steady state is only reached after 50 periods, whereby half of the total difference

[42]The numbers are estimates from the CPS, provided by Barry Hirsch and David Macpherson on their website http://www.trinity.edu/bhirsch/unionstats/.

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

[44]Doing the same simulation for the whole economy is more complicated since the iteration is then over the whole sequence of aggregates. That exercise is left for future research.

in the unionization rate is reis already reached after 10 periods.

The US data of the unionization rate are given in figure 6. The decline is gradual and takes several decades (and is still continuing). The decline doesn't follow immediately after the enactment of Taft-Hartley, which could partly be explained that one important provision, the "right-to-work" was only adopted gradually across the US states. Moreover, the southern states which are the main adopters, increased their employment shares gradually over time.[45] The next figures compare the wage premium and the organizing rate in the model with the data. About the wage premium in figure 7 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 undertand why the observed trend in the data is relatively flat (see Figure 8) in spite of the long term decline in the unionization rate. Finally, looking at the organizing rate, both the trend and the pattern of the decline from the simulation fits with the data (see figures 9 and 10).[46]

Comparing different countries, a general trend can be seen towards lower unionization over the past decades. 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 evidence could be that there is a general trend of declining demand for union services, but that this trend is amplified only in the US case due the impact of firm turnover on the unionization rate.

"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 as one that moved from a "corporatist" to a "competitive" environment, where the corporartist 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 occured 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

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

[46]The 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.

airline industry on the other hand, unionization didn't suffer as much (ibid.), which most likely can be explained by the fact that only few of the new entrants after the Airline Deregulation Act of 1978 survived and hence competition increased only gradually.

In the model of this paper we can study the impact of deregulation by assuming a permanent decrease of entry costs in a subset of the sectors.[47] For the initial and final steady states I take the two sectoral results from experiment 1. The model delivers a similar response as 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.

It has been conjectured that unionization itself can act as a barrier to entry and therefore be supported by incumbent firms (e.g. Chappell et. al. [1992]). In this model however, high entry costs benefit both unions and succesful entrants, but firms are always better off if there are no unions. Thus, in terms of the political economy, both firms and unions prefer higher regulation, and would therefore lobby against deregulation, but firms don't regard unions as a strategic complement.

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, but potentially has contributed to the acceleration of the decline observed during the late 1970s and early 1980s.

7 Conclusions

This paper developed a rich general equilibrium model of organizing and wage-setting unions in an environment with firm turnover. Unions in this framework have an incentive to organize firms because it allows them to set higher wages. This comes from the fact that a higher unionization rate both lowers entry and lowers competition from incumbent non-union firms.

The model helps to account for the large observed variations of unionization rates across industries, states, and over time. The steady state unionization rate is higher if 1. entry costs are highe, 2. exit rates are lower, and 3. if 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. The paper supports two

[47] The 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.

possible explanations of the long-term union decline in the US: First, a change in the legal environment in the late 1940s that is likely to have increased the cost of organizing, and secondly the deregulation of barriers to entry in several industries right before and after 1980.

Moreover, the paper models the union wage premium explicitly. Due to the general equilibrium structure the indirect effect on the non-union wage is also accounted for. The model shows that higher unionization rates coincide with higher wage premia.[48] Further, the adjustment path of the wage premium following for instance changes in the organizing costs exhibits only relatively small changes in wages for large changes in the unionization rate, which might explain why the wage premium in the data has been relatively flat over time.

In order to use this model to quantitatively account for the data, it would be desirable to integrate three further aspects. First, concerning the union organizing process, also the worker's side plays a role, even though - as has been argued in this paper - this role seems to be limited. For a quantitative assessment however, this factor also should be considered. Further, the organizing cost function used in the model implicitly accounts for union avoidance measures on the firm side. One important strategy on the firm side that has been recognized in the literature is the so-called threat effect, which means that the firm strategically increases wages to avoid unionization (see e.g. Lazear [1983] and Dickens [1986]). Third, the model only partly captures the reallocation of firms following say a change in organizing costs in some part of the economy (e.g. due to adoption of right-to-work laws) since there is no growth in the model. If the economy grows then changes in the difficulty to organize become even more amplified. This is important in light of the fact that most of the manufacturing growth in the second half of the 20th century has taken place in the southern states, which are predominantly righ-to-work states. Exploring these extensions is left for future research.

One other possible variation already mentioned is allowing for endogenous exit. Currently I am exploring a model with productivity shocks and endogenous exit, where the organizing side has been simplified. The additional gain is that then predictions about unionization and firm productivity are possible.

[48] This is not easy to detect in the data. A study by Coggins and Johansson [2002] , confirms this effect. They look at unionization in the grocery sector, which due to the limited geographical scope of grocery stores allows to better isolate the effect of unionization on the wage premium.

Appendix

A. Proofs of the Propositions

Preliminaries To simplify the arguments I introduce some additional notation and summarize a couple of simple results in Lemma 2. First, to simplify notation the following definitions will be used:

$x_1 \equiv \frac{\rho_1}{\rho_1-\alpha}$;

$x_2 \equiv \frac{\alpha}{\rho_1}\frac{(\rho_2-\rho_1)}{(\alpha-\rho_2)}$;

$x_3 \equiv \frac{\alpha}{\rho_1-\alpha}$;

$K_\pi \equiv (QP^{\frac{1}{\rho_2-1}})^{\frac{\alpha(1-\rho_2)}{\alpha-\rho_2}}(\frac{\rho_1}{\alpha\kappa})^{\frac{\rho_2}{\alpha-\rho_2}}(1-\frac{\rho_1}{\alpha})$;

$K_L \equiv (QP^{\frac{1}{\rho_2-1}})^{\frac{\alpha(1-\rho_2)}{\alpha-\rho_2}}A_o(\frac{\rho_1}{\alpha\kappa})^{\frac{\alpha}{\alpha-\rho_2}}$;

$T_1 = sw^{x_1} + (1-s)\bar{w}^{x_1}$;

$T_2 = uw^{x_1} + n\bar{w}^{x_1}$

Note that given the assumptions on the parameters, we can infer that:
$x_1, x_2, x_3 < 0$, $x_2 > -1$, $x_3 < -1$,and $x_1 - x_3 = 1$.

Further, the proofs make frequent use of the following equations:

- The FOC wrt to w^u coming from the period-utility function of the Union can be written as: $g^w \equiv x_3 + \frac{x_1x_2}{1+\left(\frac{w_t}{\bar{w}_t}\right)^{-x_1}\left(\frac{u_{t-1}}{(1-s_t)(n_t+e_t)}+\frac{s_t}{1-s_t}\right)^{-1}} + \frac{1}{1-\left(\frac{w_t}{\bar{w}_t}\right)^{-1}} = 0$

- Solving g^w for e_t: $g^U \equiv \left(\left[\left(x_1x_2\left\{-x_3-\frac{1}{1-\frac{w_t}{\bar{w}_t}}\right\}^{-1}-1\right)\left(\frac{w_t}{\bar{w}_t}\right)^{x_1}\right]^{-1}-\frac{s}{1-s}\right)^{-1}\frac{u_t}{1-s} - n_t (= e_t)$

- The FONC for union's choice of s is (given that $s \in [0,1)$): $g^s = (1-\delta)(w-\bar{w})w^{x_3}K_L(n+e)\left[T_2^{x_2} + x_2u_{t+1}T_2^{x_2-1}(w^{x_1}-\bar{w}^{x_1})\right] - \frac{\gamma\eta(n+e)}{(1-s)^{\gamma+1}} = 0$

- It is convenient to reformulate this as : $\tilde{g}^s = (1-s)^{\gamma+1}\left[T_2^{x_2} + x_2u_{t+1}T_2^{x_2-1}(w^{x_1}-\bar{w}^{x_1})\right] - \frac{\gamma\eta}{(1-\delta)(w-\bar{w})w^{x_3}K_L} = 0$

- Finally, the entry condition $V^e = 0$ solved for e in the single period case is: $g^e \equiv \left(\frac{\epsilon}{K_\pi}\right)^{\frac{1}{x_2}}((1-\delta)T_1)^{-1-\frac{1}{x_2}} - \frac{u_0(w_1)^{x_1}}{T_1} - n_0(= e_1)$

The following contains a few results used in the proofs below. In all cases, only interior solutions (in particular with $w > \bar{w}$) are considered.

Lemma 2. *1. Given a solution $e > 0$ for $V^e = 0$, e is strictly increasing in w^u: $\frac{\partial g^E}{\partial w} > 0$ if and only if $T_2 < -x_2\ nT_1$*

2.Given a solution $e > 0$ for $V^e = 0$ at some $w > \bar{w}$, e is strictly decreasing in s: $\frac{\partial g^E}{\partial s} < 0$.

3. Given s the entrants' response function is strictly decreasing in the entry cost ϵ.

4. Given s the entrants' response function is strictly decreasing in the exit rate δ.

5. In case of a constant s, the union's response to increased entry is negative: $\frac{\partial g^U}{\partial w} < 0$.

6. Changing s exogenously shifts the union's wage response function up: $\frac{\partial g^U}{\partial s} > 0$.

7. The union's organizing response function is decreasing in e given that the sufficient condition $\gamma \geq -x_2$ holds: $\frac{\partial e}{\partial s} = -\frac{\frac{\partial g^s}{\partial s}}{\frac{\partial g^s}{\partial e}} < 0$.

8. The union's organizing response function is decreasing in δ for given s.

9. For a given s there is a unique maximizer $w > \bar{w}$ of $U(w, .)$.

10. $U(s, .)$ is locally concave in s for some s close to s^* such that $\frac{\partial U(s^*,.)}{\partial s} = 0$.

Proof. The results directlyif follow from the assumptions on the parameters and taking the first derivates or applying the implicit function theorem on the respective function. Remark: The condition for part 1 holds if ρ_1 and α are both sufficiently close to 1. The proof uses the fact that e is bounded. □

Proofs

Proof of Proposition 2. For given s it is sufficient to guarantee that the response functions in the $M^e - W^u$-space intersect. Based on some of properties of both response functions given in Lemma 2 I will establish a sufficiency criterion on entry costs so that an intersection of the functions is guarenteed. Denote the (inverse) response function for the unions $g^U(w^u)$ amd the response function of the (aggregate) entrant by $g^E(w^u)$. The former can be derived from the FOC for the optimal wage, whereas the latter is the entry condition solved for M^e. For $g^U(w)$ it can be shown that: 1. It is strictly decreasing (Lemma 2). 2. Has a discontinuity at some $w_1 > \bar{w}$, where $g^U \to \infty$ for $w \to w_1^+$ 3. Is continuous for $w > w_1$. 4. For $w^u \to \infty$ we have $g^U \to e*$, where $e* < 0$. From this it follows that g^U is unbounded on $[w, \infty)$, and that there is one unique w_2 at which $g^U(w_2) = 0$. For g^E we can only establish the following: 1. For any $w \geq \bar{w}$, g^E is well defined, continous and bounded. 2. g^E is strictly decreasing in ϵ. 3. For a given w^u, there always exists an ϵ such that $g^E > 0$. Now, we consider two cases: (a) Since g^E is bounded on $[w, \infty)$ there exists an ϵ such that entry is non-positive, i.e. there is no entry. Then $g^E = 0$ on the relevant range and an intersection with g^U exists at w_2. (b) A sufficient condition for an equilibrium with positive entry is to ensure that ϵ is small enough such that at w_2 we have $g^E(w_2) > 0$. (Remark: in the numerical examples I analyzed this sufficient condition was always more restrictive than necessary).

□

Proof of Proposition 3. Using the results in the previous proof, the result follows from the facts that 1. Only g^E depends on ϵ 2. g^E shifts downward if ϵ goes up 3. g^U is strictly decreasing. Thus, given that we start at a sufficienlty low ϵ for which $e > 0$, and increase in ϵ will shift the equilibrium downwards along the g^U-curve, thereby increasing the wage w and decreasing e. The second effect implies that the firm-unionization rate $\tilde{r}$ will increase.

□

Proof of Proposition 4. One can easily show that it follows from $V^e = 0$ that e is increasing in δ. The result then follows from the same kind of argument given in the previous proposition. □

Proof of Proposition 5. I will show the result for the case where $\gamma_1 > -\frac{\alpha}{\rho_1}\frac{(\rho_2-\rho_1)}{(\alpha-\rho_2)}$, i.e. the union's response function is decreasing. The proof for the increasing case is similar and omitted. The proof shows that an intersection of the the union's response function (implicitly derived from $g^s = 0$) with the entry response function exists. I focus on interior cases. First, we have to insure that the organizing costs are sufficiently small such that an interior equilibrium can exist. Since the left term of $\tilde{g}$ is positive and the right (cost) term is always negative, and $\tilde{g}$ is decreasing in e, we can for a given $s^* \in (0,1)$ choose η such that $e > 0$. Denote the corresponding mass of entrants e^*. Next, note that the entry response function for a given s is strictly decreasing in ϵ. Moreover, by changing ϵ we can make e as small or big as we want. Thus, we can choose ϵ such that at s^* we have $e = e^*$. Further, for a given η, since the union's response function is decreasing, we can find a range for ϵ for which equilibria exist. □

Proof of Proposition 6. The result follows directly from the union's response function being decreasing and the formula for the unionization rate. □

Proof of Proposition 7. The result follows directly from the entrant's response function being decreasing and the formula for the unionization rate. □

B. Steady State Results for Exogenous Organizing

This section provides results for a steady with fixed s within a sector given the aggregates.

Proposition 8. *For given $s \in (0,1)$ a steady state with $u > 0$ exists. Moreover, if $s = 0$, there is always a steady state with $u = 0$.*

Proof of Proposition . First note that the firm unionization rate is given by: $\tilde{r} = \left(1 + [\frac{1}{\delta}\frac{s}{1-s}]^{-1}\right)^{-1}$ and the wage is determined by the FOC: $x_3 + \frac{x_1 x_2}{1+(\frac{w}{\bar{w}})^{-x_1}\left(\frac{1}{\tilde{r}}-1\right)} + \frac{1}{1-(\frac{w}{\bar{w}})^{-1}} = 0$ Thus, in steady state $\tilde{r}$ and w don't depend on e, which is just computed as residual. We only have to check if for the steady state value of $\tilde{r}$ a solution to the union's FOC exists. Solve the FOC in the following way: $(\tilde{r}^{-1} - 1)^{-1} = \frac{\left(\frac{w}{\bar{w}}\right)^{-x1}\left[1+x3\left(1-\left(\frac{w}{\bar{w}}\right)^{-1}\right)\right]}{(x3+x1x2)\left(\left(\frac{w}{\bar{w}}\right)^{-1}-1\right)}$ Note that the LHS is monotone in $\tilde{r}$: for $\tilde{r} \to 0$ it goes to 0, and for $\tilde{r} \to 1$ it goes to infinity. Now, the RHS is monotone in the relative wage: $\frac{w}{\bar{w}}$. For $\frac{w}{\bar{w}} \to 1^+$ the RHS goes to infinity, whereas for $\frac{w}{\bar{w}} \to \infty$ it goes to 0. Thus, for a given $\tilde{r} < 1$ determined by the first equation, there will always exist a corresponding $w > \bar{w}$. The steady state for $s = 0$ is trivial. □

Proposition 9. *Given that $\frac{\alpha}{\rho_1} < 2$ both w and u will increase if δ decreases.*

Proof of Proposition . First note, if we omit the second term in the FOC g^{w_s}, we obtain the inequality: $x_3 + \frac{1}{1-\left(\frac{w}{\bar{w}}\right)^{-1}} < 0$ which can solved for: $\frac{w}{\bar{w}} < \frac{\alpha}{\rho_1}$ where the RHS is by assumption less than 2 (concerning the empirically value of the wage premium, which is less than 20% this assumption is not very restrictive and could be relaxed). Next, for convenience, define $d \equiv \frac{\bar{w}}{w}$ and $b \equiv (\frac{w}{\bar{w}})^{-x_1}(\tilde{r}^{-1} - 1)$. We can rewrite the FOC then in the following way: $x_3\frac{(1+b)(b^{-1}+1)}{(d^{-1}-1)} + x_1x_2\frac{b^{-1}+1}{d^{-1}+1} + \frac{(1+b)(b^{-1}+1)}{(d-1)(d^{-1}-1)} = 0$. Since $-x_3 > x_1x_2$ the following inequality follows: $-bx_1x_2\frac{b^{-1}+1}{d^{-1}+1} + \frac{(1+b)(b^{-1}+1)}{(d-1)(d^{-1}-1)} > 0$. Given the previous result following from the assumption of $\frac{\alpha}{\rho_1} < 2$, we can conclude that $\frac{1+b}{d^{-1}-1} > 1$ and thus $x_1x_2 < \frac{(1+b)(b^{-1}+1)}{(d-1)(d^{-1}-1)}$. Now, one can show by taking the first derivative w.r.t. δ of equation (2) determining r, that $\frac{\partial r}{\partial \delta} < 0 \Leftrightarrow x_1x_2(x_1 - x_3)\frac{(1-d)^2}{d}\frac{b}{(1+b)^2} < 1$. Since $x_1 - x_3 = 1$, we get: $x_1x_2 < \frac{(1+b)(b^{-1}+1)}{(d-1)(d^{-1}-1)}$, which proves the proposition.

□

C. Computational Algorithm

The following describes the steps of compuation. I use a grid for the states (u, n), but I interpolate the future values bilinearly. For a typically example of the resulting policy functions for entry and organizing see figure 11.

Remark 1: To compute the up-date for the aggregate output (Q) I use the following approximation: Each period it holds: $\int_j e_j\epsilon_j \approx \int_j \int_i \pi_{ij}$. Both sides are exactly equal if the discount factor for firm $\beta = 1$.

Remark 2: 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 distribution with parameterλ. 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. Guess the aggregate wage $\bar{w}$ and output Q.

2. For a grid of (u, n), guess $f^w(u, n)$ and $f^s(u, n)$.

3. For a grid of (u, n), guess $f^e(u, n)$.

4. Compute $V^u(u, n)$ and $V^n(u, n)$ using linear interpolation for future states.

5. Solve for $f^e(u,n)$ from $V^e = 0$.

6. Solve for $f^w(u,n)$ and $f^s(u,n)$ given new $f^e(u,n)$.

7. Iterate on 4. - 6. until policy functions converge

8. Compute steady state values by iterating on the laws of motion using policy functions f^e and f^s.

9. Compute new $\bar{w}$ and Q. Iterate on 2. - 9. to find fixed point.

D. Simulation Results

Parameter	Value
β	0.95
ρ_1	.9
ρ_2	.7
α	1.1
κ	1.0
γ	1.5
L	248
θ	.8
δ	.06
ϵ	30
η	20

Table 1: Benchmark Parameters

	Experiment 1		Experiment 2		Experiment 3	
	$\epsilon_1 = 30$	$\epsilon_2 = 15$	$\delta_1 = .06$	$\delta_2 = .05$	$\eta_1 = 20$	$\eta_2 = 10$
$\bar{w}$	1.00		.993		.966	
Q	46.01		51.37		51.25	
u	1.09	.98	1.34	1.73	1.47	3.92
n	3.55	5.70	3.54	4.15	3.53	.43
e	.30	.43	.311	.309	.32	.28
s	.018	.010	.022	.020	.024	.353
$\tilde{r}$	.234	.146	.275	.294	.294	.900
r	.087	.052	.104	.112	.112	.583
w	1.24	1.23	1.233	1.234	1.20	1.36
WP	.237	.231	.241	.243	.243	.405
WP^{net}	.129	.141	.124	.156	.126	.223
π_u	.435	.393	.448	.482	.473	.650
π_n	1.134	1.000	1.182	1.280	1.26	3.01

Table 2: Numerical Experiments

	endogenous s			exogenous s		
δ	u	w	e	u	w	e
.04	-.70	-.07	.70	-.24	-.09	-.52
.06	-1.28	-.08	.35	-.65	-.17	-1.62
.08	-2.54	-.09	.03	-.14	-.14	-.34

Table 3: Elasticity Comparison for a Change in δ

E. Graphs

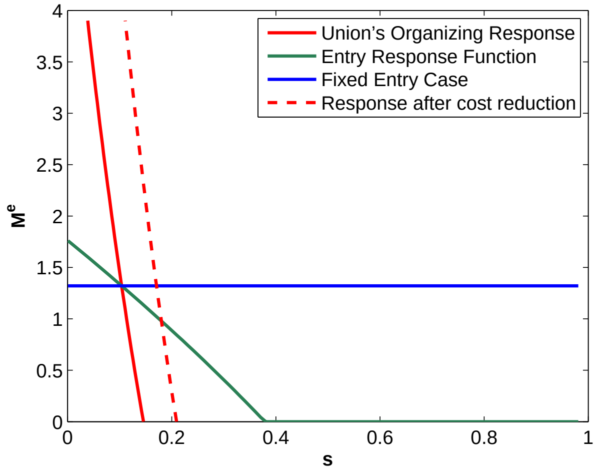


Figure 3: Induced Effects of Entry - Change in A

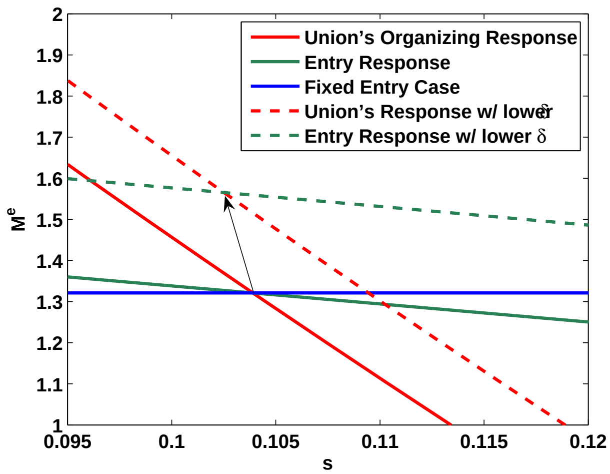


Figure 4: Induced Effects of Entry - Change in δ

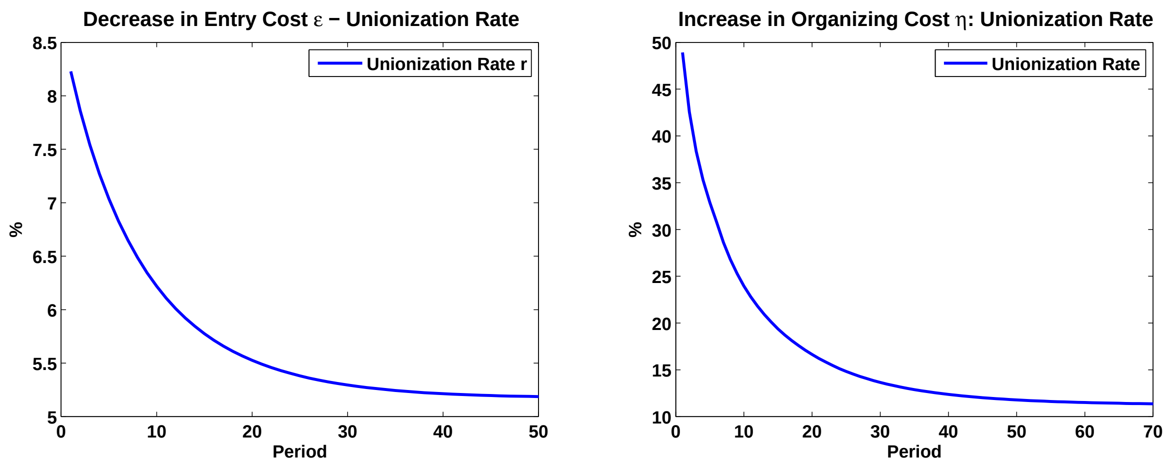
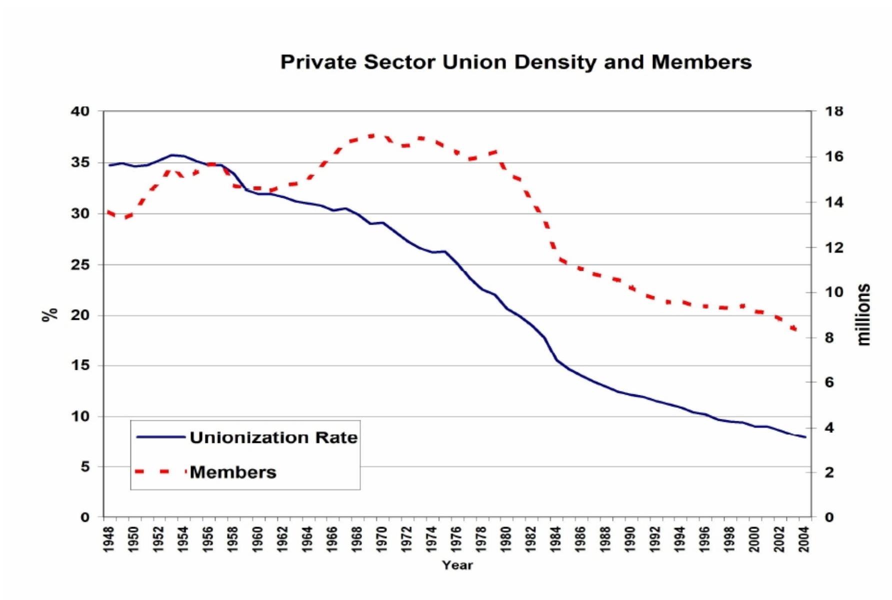
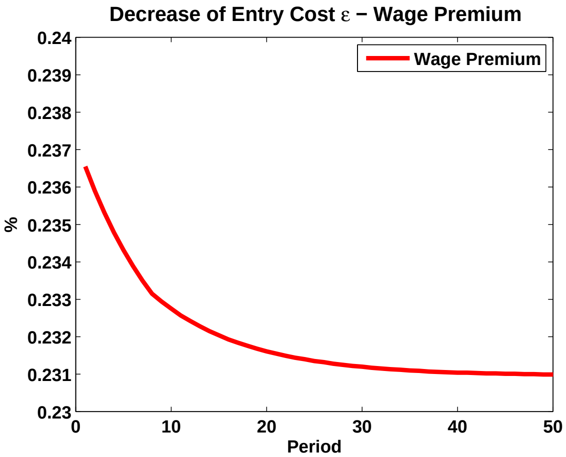


Figure 5: Transition after change in ϵ or η: unionization rate r



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

Figure 6: US Unionization Rate



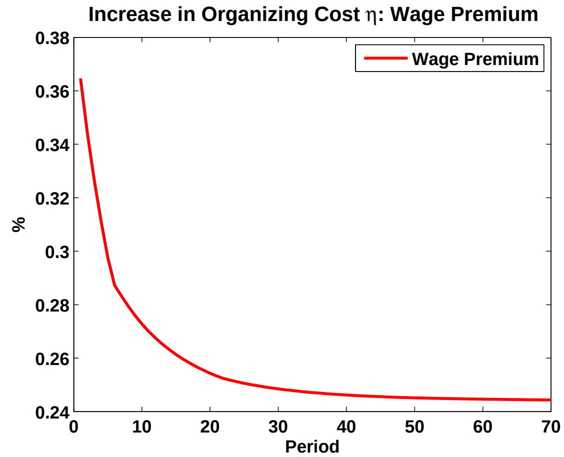
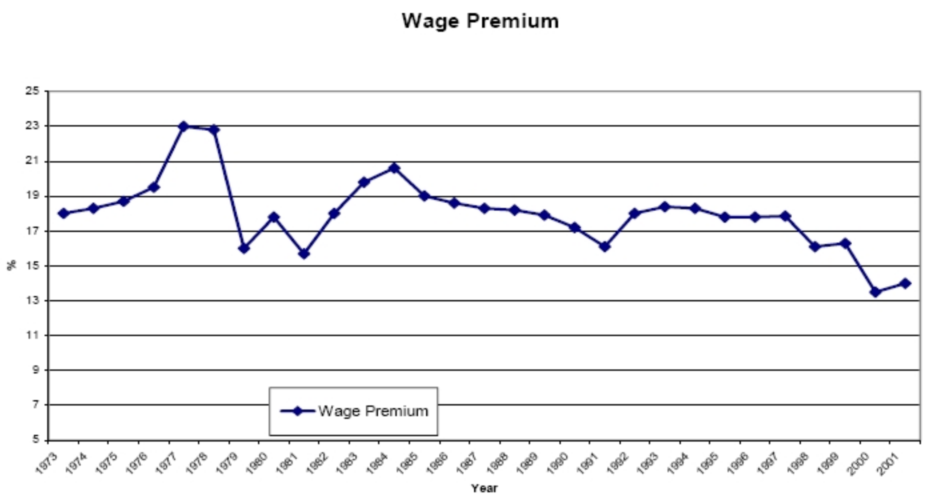


Figure 7: Transition after change in ϵ or η: Wage Premium



Source: Blanchflower and Bryson [2002]

Figure 8: US Wage Premium

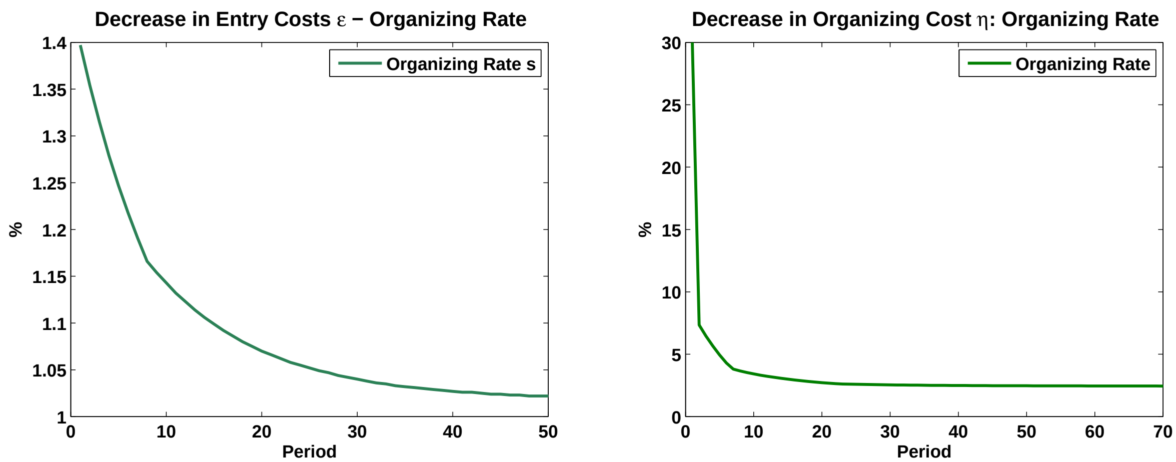
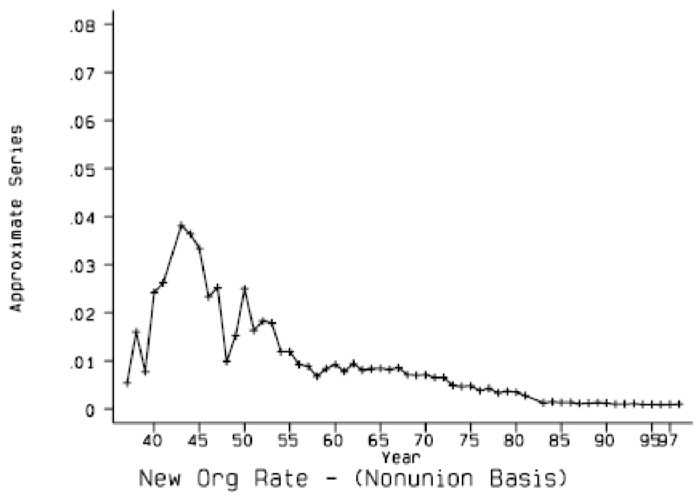


Figure 9: Transition after change in ϵ or η: organizing rate s



Source: Farber and Western [2001]

Figure 10: US organizing rate

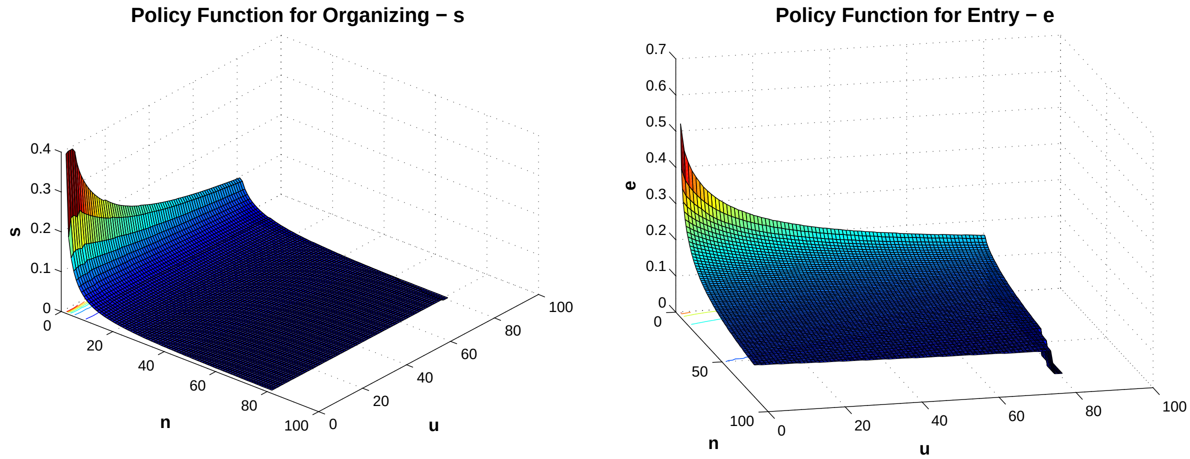


Figure 11: Typical Examples of Policy Functions for Organizing and Entry

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