The Missing Link: Product Market Regulation, Collective Bargaining and the European Unemployment Puzzle*

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Abstract

We contribute to the growing literature which aims to link product market regulation and competition to labor market outcomes, in an attempt to explain the divergent US and continental European labor market performance over the past two decades. The main contributions of this paper are threefold. First, we show that the choice of bargaining regime is crucial for the effect of product market competition on unemployment rates, being substantial under collective bargaining and considerably more modest under individual bargaining. Since the choice of bargaining institution is so important, we endogenize it. We find that the bargaining regime which emerges endogenously depends crucially on the degree of product market competition. When product market competition is low, collective bargaining is stable, while individual bargaining emerges as the stable institution under high degrees of product market competition. This also allows us to link product market competition and collective bargaining coverage rates. Our results suggest that the strong decline in collective bargaining coverage and unionization in the US and UK over the last two decades might have been a direct consequence of the Reagen/Thatcher product market reforms of the early 80's. Finally, we calibrate the model to assess the quantitative magnitude of our results. We find that moving from the low US regulation-individual bargaining economy to the high EU regulation-collective bargaining economy leads to a substantial increase in equilibrium unemployment rates from 5.5% to about 8.3%.

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1 Introduction

A growing literature examines the consequences of product market regulation and competition for labor market outcomes. Indeed, product market regulation is one of the most striking ways in which the US and continental European economies differ. To give an idea of the magnitudes involved, Table 2 presents an index of barriers to entry in the US and in the European Union, compiled by Fonseca, Lopez and Pissarides (2001) and based on OECD data. The index combines the average time required to establish a standardized firm with the number of procedures necessary into a weeks-based measure of entry delay. The measured delays range from 8.6 business days in the United States to a whopping 85 days in Spain. The population-weighted EU average of 54.7 days is many times larger than the corresponding American figure. Djankov, et.al. (2002) report data on a second dimension of entry barriers, namely the pecuniary cost of establishing a standardized firm as a percentage of the per capita GDP of the respective country. This data is also reproduced in Table 2. Once again, the gulf between the Anglo-American world and Europe is striking: establishing a firm in the US costs less than 1% of per capita GDP, while establishing the average continental European firm costs 18.4% of per capita GDP. The European barriers to entry are an order of magnitude larger. It seems reasonable that such large differences in entry barriers might translate into large differences in labor market outcomes. Krueger and Pischke (1997) also conjecture that large parts of the U.S. American employment miracle can be attributed to its flexible product markets.

Indeed, there is a growing body of empirical evidence to support the link between product market regulation and labor markets. Bertrand and Kramarz (2002) examine the impact of French legislation[1], which regulated entry into French retailing. They find that those regions (departements) which restricted entry more strongly, experienced slower rates of job growth. Boeri, Nicoletti and Scarpetta (2000), using an OECD index of the degree of product market regulation, also report a negative relationship between their regulation measure and employment. Fonseca, et. al. (2001) show that their index of entry barriers is negatively correlated with employment and positively correlated with unemployment rates. Moreover, the timing of US and UK product market deregulation efforts, which began in the late 1970's, fits neatly into the picture of labor market performance which began to diverge in the early 80's. Hence, product market deregulation is a sort of smoking gun for divergent US and European labor market performance, whose implications are worth investigating.

Relatively little previous theoretical work has analyzed whether and how product market rigidities may affect equilibrium labor market outcomes. Nickell (1999) provides an insightful overview of early work which is either partial equilibrium or employing some form of collective bargaining. Recent important contributions are the papers of Pissarides (2001) and Blanchard and Giavazzi (2003). Pissarides (2001) focuses on the impact of entry barriers on the decision

[1] Loi Royer of 1974

to become an entrepreneur or a worker, finding that entry barriers can indeed lead to lower rates of entrepreneurship and hence job creation, and ultimately to higher rates of equilibrium unemployment. However, those firms which have overcome the barriers to entry then face perfect competition. In contrast, Blanchard and Giavazzi (2003) study labor market outcomes in a model with monopolistic competition but with a more stylized labor-market setting. They find that equilibrium unemployment is decreasing in the degree of product market competition, and also emphasize that equilibrium wages are increasing in the degree of product market competition. In a similar vein, Spector (2002) studies the effects of changes in the intensity of product market competition in a model with capital and concludes that product-market and labor-market regulations tend to reinforce each other. The latter two papers consider static or two-period setups. Finally, Ebell and Haefke (2003) presents a fully dynamic model which combines monopolistic competition in goods markets and Mortensen-Pissarides-style search frictions with multi-worker firms and individual bargaining. In this earlier contribution, we show that the impact of product market reform on unemployment rates is surprisingly small under individual bargaining.

The current paper makes three main contributions. First, we show that the choice of bargaining institution is crucial for the impact of product market reform on unemployment. The impact of product market reform is negligible [less than 0.5% points of unemployment] for individual bargaining, and substantial [nearly 3 %] for collective bargaining. The reason is that under individual bargaining, firms also have strong incentives to overhire at low levels of competition. This overhiring effect, explained in detail in Ebell and Haefke (2003)[2], counteracts the otherwise salutatory effects of increasing competition on unemployment.

Since the choice of bargaining regime is crucial, we proceed to endogenize it. Hence, our second main contribution is to show how workers' endogenous choice of bargaining regime changes with the degree of product market competition. In particular, collective bargaining turns out to be the unique symmetric Nash equilibrium in the high-entry cost regime, while individual bargaining is the unique Nash equilibrium in the low-entry cost regime. The intuition for this result is straightforward: collective bargaining gives workers a profit share as their bargaining surplus. Hence, the surplus which can be gained by collective bargaining is decreasing in product market competition. In contrast, the individual bargaining surplus depends on the costs to rehiring the marginal worker. These rehiring costs are increasing in product market competition, since competition induces all firms to open more vacancies, making it more costly to find a new worker.

Taken together, we see that when the choice to bargain collectively is endogenized, then going from high to low entry costs does indeed have a substantial effect on unemployment. To quantify the effects of product market reform on equilibrium unemployment rates, we calibrate the model and run a simple pol-

[2] Overhiring effects in individual bargaining were first noted in a partial equilibrium setting by Stole and Zwiebel (1996a, 1996b).

icy experiment. The policy experiment consists of beginning with a calibration of the relevant low US entry cost [high competition] and individual bargaining setup to US data. Then, we increase the entry costs to their significantly higher continental European levels. Under continental European entry costs, collective bargaining turns out to be the appropriate bargaining institution, which can be supported as a symmetric Nash equilibrium. The resulting increase in unemployment rates when moving from the high competition-individual bargaining US case to the low competition-collective bargaining European case is indeed a substantial 2.8% points of unemployment. In particular, unemployment increases from 5.5% to about 8.3%, which accounts for about 2/3 of the total average US-continental European unemployment gap during the 90s.

Our final contribution is to the literature which aims to explain the decline of unionization and collective bargaining coverage rates [the percentage of workers covered by a collective bargaining agreement, whether they are union members or not]. Our findings suggest that the dramatic declines in both measures of union activity in the US and UK in the 80's and 90's was spurred by the product market deregulation efforts of the Reagan administration and the Thatcher government. This is supported by the fact that the decline in collective bargaining coverage rates was especially dramatic in industries which faced dramatic increases in competition, as shown in Figure 5. Importantly, the deunionization in our model is voluntary: workers choose to abstain from forming collective bargaining coalitions, because they prefer the higher wages they can obtain by bargaining individually with their employers. The relatively gradual decline in unionization rates is also supported by our model. At intermediate degrees of product market competition, both collective and individual bargaining equilibria exist. We interpret this as a state in which existing collective bargaining coalitions [unions] are stable, but in which new firms, who begin life without a union, never acquire one. This is consistent with Machin (2000)'s findings that British deunionization was largely a result of the failure of new establishments to organize, rather than the breakdown of unions in existing workplaces.

The remainder of the paper is organized as follows: Section 2 presents the basic model, and section 3 goes on to describe both the individual and the collective bargaining setups. Section 4 is concerned with short-run general equilibrium [taking the number of firms as given] for both bargaining regimes. The choice of bargaining regime is endogenized in Section 5, and is shown to depend upon the degree of competition. Section 6 considers long-run equilibria, in which the equilibrium number of firms is determined by entry costs. Section 7 presents the calibrated model and the policy experiment, while section 8 concludes.

2 The Basic Model

In this section we present the basic model. Its main elements are monopolistic competition in the goods market and Mortensen-Pissarides-style matching with multi-worker firms in the labor market. We restrict our analysis to the steady state.

2.1 Households

2.1.1 Search and Matching in the Labor Market

The labor market is characterized by a standard search and matching framework. Unemployed workers u and vacancies v are converted into matches by a constant returns to scale matching function $m(u,v) = s \cdot u^{\eta} v^{1-\eta}$. Defining labor market tightness as $\theta \equiv \frac{v}{u}$, the firm meets unemployed workers at rate $q(\theta) = s\theta^{-\eta}$, while the unemployed workers meet vacancies at rate $\theta q(\theta) = s\theta^{1-\eta}$.

In the basic model, workers are identical. Workers may be employed at firms with either of two wage bargaining institutions: individual or collective. We index the firm's wage-bargaining institution by $k \in \{I, C\}$. In addition, the aggregate bargaining environment - the bargaining institutions chosen by all other firms - is indexed by μ, which gives the measure of firms choosing collective bargaining. When $\mu = 1$, all other firms in the economy choose collective bargaining. When $\mu = 0$, all other firms choose individual bargaining. Since firms are atomistic with respect to the economy at large, they ignore the impact of their own decision on aggregate variables, such as aggregate labor market tightness θ_{μ}. For each worker, the value of employment is given by $V^E[k, \theta_{\mu}]$, which satisfies[3]:

$$rV^E[k,\theta_\mu] = w_k[\theta_\mu] - \chi\left[V^E[k,\theta_\mu] - V^U[\theta_\mu]\right] \tag{1}$$

where χ is the total separation rate. Firms and workers may separate either because the match is destroyed, which occurs with probability $\widetilde{\chi}$ or because the firm has exited, which occurs with probability δ. We assume that these two sources of separation are independent, so that the total separation probability is given by $\chi = \widetilde{\chi} + \delta - \widetilde{\chi}\delta$. Explicit firm exit is incorporated mainly for quantitative reasons. If firms were counterfactually infinitely lived, then the impact of a given level of entry costs would be greatly understated, since firms could amortize those entry costs over an infinite lifespan.

The value of unemployment is standard and is the same for all workers. In particular, the value of unemployment depends exclusively upon the aggregate choice of bargaining institution μ:

$$rV^U[\theta_\mu] = bP + \theta_\mu q(\theta_\mu)\left\{\mu V^E[C,\theta_\mu] + (1-\mu)V^E[I,\theta_\mu] - V^U[\theta_\mu]\right\} \tag{2}$$

where P denotes the aggregate price level and b real unemployment benefits. The reason that $rV^U[\theta_\mu]$ depends solely on the aggregate mix of bargaining institutions μ is that each individual firm or industry will be assumed to be

[3] We assume that all payments are made at the end of a period so that our value functions in discrete time actually coincide with their continuous time counterpart. Equation (1) can be obtained from

$$rV^E[k,\theta(\mu)] = \frac{1}{1+r}\Big(w_k[\theta(\mu)] + (1-\chi)V^E[k,\theta(\mu)] + \chi V^U[\theta(\mu)]\Big)$$

atomistic with respect to the economy at large. Hence, the probability of being rehired by one's own firm is zero, so that one's own firm's or industry's bargaining decisions are irrelevant for one's reemployment prospects.

2.1.2 Monopolistic Competition in the Goods Market

Households are both consumers and workers. As consumers they are risk neutral in the aggregate consumption good. Agents have Dixit-Stiglitz preferences over a continuum of differentiated goods. Goods demand is derived from the household's optimization problem:

$$\max \left(\int c_{i,n}^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}} \tag{3}$$

subject to the budget constraint $I_n = \int c_i \frac{P_i}{P} di$ where I_n denotes the real income of household n and $c_{i,n}$ is household n's consumption of good i. In order to focus the dynamics on the labor market, there is no saving. Thus we obtain aggregate demand for good i given as:

$$Y_i^D \equiv \int c_{i,n} dn = \left(\frac{P_i}{P} \right)^{-\sigma} I \tag{4}$$

where $I \equiv \int I_n \mathrm{d}n$ is aggregate real income and $P = \left(\int P_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$ is the price index . Equation (4) is the standard monopolistic-competition demand function with elasticity of substitution among differentiated goods given by $-\sigma$.

2.2 Modeling Competition

In principle, there are two ways in which greater competition may manifest itself: as greater competition *within* each industry or as greater competition *among* industries. Greater competition among industries would imply an increase in the elasticity of substitution among differentiated goods σ. In fact Bertrand and Kramarz (2002) find some evidence for increased product differentiation in the French retail industry in response to the Loi Royer. However, it is often argued that σ is a preference parameter rather than a measure of competition. We address this concern in the basic model by treating σ as a fixed preference parameter. That is, we will not rely on variations in σ to model differing degrees of competition. Rather, we follow Galí (1995) in assuming that each differentiated good i is produced by an industry populated by n_i firms. An increase in the number of firms in each industry leads to an increase in the degree of competition within each industry, as captured by an increase in the demand elasticity faced by each individual firm.

The firms within each industry compete by Cournot.[4] Under Cournot com-

[4]In the basic model, we focus on the collusion-free equilibrium of the dynamic Cournot game. Collusive equilibria would involve even greater output restriction at each industry size, which would generally strengthen our results.

petition, firm j in industry i has output Y_{ij} which satisfies:

$$Y_i^S = Y_{ij} + (n_i - 1)\,\overline{Y}_{i,-j}, \tag{5}$$

where Y_i^S is aggregate output of good i and $\overline{Y}_{i,-j}$ is the average output of its $n_i - 1$ competitors. From (4), firm j faces demand function

$$\frac{P_i\left(Y_{ij}|n_i, \overline{Y}_{i,-j}\right)}{P} = \left(\frac{Y_{ij} + (n_i - 1)\,\overline{Y}_{i,-j}}{I}\right)^{-\frac{1}{\sigma}}. \tag{6}$$

This leads to a definition of firm-level elasticity of demand as:

$$\xi_{ij} \equiv -\frac{\partial Y_{ij}}{\partial P_i} \cdot \frac{P_i}{Y_{ij}} = \sigma\left[1 + \frac{(n_i - 1)\,\overline{Y}_{i,-j}}{Y_{ij}}\right]. \tag{7}$$

When firms within an industry are symmetric, each firm faces a demand elasticity which depends only on the total number of firms present in the industry:

$$\xi_i = n_i \sigma. \tag{8}$$

In the basic model we will assume symmetric firms in equilibrium. In what follows we will label firms only by their industry i.[5]

2.3 Multiple-worker Firms

The standard Mortensen-Pissarides setup assumes one-worker firms. Under perfect competition in goods markets, this assumption is harmless, since the number and size of firms is indeterminate. Under monopolistic competition, however, firms react to downward sloping demand by restricting output. The only way to vary output with a given technology is to vary the amount of labor employed either on the intensive margin or on the extensive margin.[6] Consistent with stylized facts we assume that firms adjust employment by varying the number of workers [extensive margin] rather than the number of hours per worker. In our multi-worker firm model the number of workers employed is determined endogenously, as a function of the elasticity of demand ξ_i.

We consider two wage bargaining settings, each of which gives rise to a different decision-making environment for the multi-worker firm. Under **individual bargaining**, the firm bargains separately with each worker. In this individual bargaining setting, it is natural that the firm can choose freely its profit-maximizing steady-state employment level. Under **collective bargaining**, the firm bargains with a coalition of all workers employed at its firm. In the collective bargaining setting, it is natural to make the total number of workers

[5] To avoid confusion, we denote aggregate demand facing industry i by Y_i^D, while industry i's aggregate supply is denoted Y_i^S and the output of an individual firm in industry i is denoted Y_i.

[6] In a model with capital, firms could also vary output by varying only the amount of capital employed. In order to maintain an optimal capital-labor ratio, however, firms would also generally adjust by varying labor as well.

subject to negotiation as well, since the collectively bargaining workers do have the power to refuse to work at all if their hiring preferences are not respected. We index the firm-level bargaining institution by $k \in \{I, C\}$.

Nonetheless, both types of firms face the same optimization problem. Both maximize the discounted value of future profits, and in both cases the firm's state variable is the number of workers currently employed, H_i^k, where index i represents the industry and k denotes the firm's bargaining institution. Firms' key decision is the number of vacancies. Firms open as many vacancies v_i^k as necessary to hire in expectation the desired number of workers next period, while taking into account that the real cost to opening a vacancy is Φ_V. Each firm's problem becomes:

$$V_k^J(H_i) = \max_{H'_{i,k}, v_{i,k}} \frac{1}{1+r} \left\{ P_i^k(Y_i) Y_i - w_k(H_i) H_i - \Phi_V P v_i + (1-\delta) V_k^J\left(H_i^{'}\right) \right\} \tag{9}$$

subject to

$$\text{demand function:} \quad \frac{P_i^k(Y_i)}{P} = \left(\frac{Y_i + (n_i - 1)\overline{Y}_i}{I} \right)^{-\frac{1}{\sigma}} \tag{10}$$

$$\text{production function:} \quad Y_i = AH_i \tag{11}$$

$$\text{transition function:} \quad H'_i = (1 - \widetilde{\chi}) H_i + q(\theta_\mu) v_i \tag{12}$$

$$\text{wage curve:} \quad w_k(H_i) \tag{13}$$

where the wage curve represents the outcome of the wage bargaining process. Since both types of firms face the same optimization problem, we obtain the same first order condition for both:

$$\frac{1}{1-\delta} \frac{\Phi_V P}{q(\theta_\mu)} = \frac{\partial V_k^J(H'_i)}{\partial H'_i}. \tag{14}$$

By (14), the marginal value of an additional worker must equal the cost of searching for him/her, weighted by the probability of firm survival $1-\delta$, neither of which is firm-specific.

3 Bargaining

In this section we describe both the individual and the collective wage bargaining, and derive firm-level wage-employment equilibria. For each bargaining institution we consider two levels of bargaining centralization: firm-level and industry-level.[7] Under the firm-level regime, workers at each firm are free to choose whichever bargaining institution they prefer. The only restriction is that all workers of a firm must agree on [or submit to a majority vote] a bargaining

[7] Note that firm-level is the lowest level of bargaining centralization that is sensible to examine, since it is impossible for an individual worker to unilaterally deviate to collective bargaining.

structure. Given that all workers are identical, all decisions on the bargaining institution are reached with unanimity, so that this restriction is not at all limiting. Similarly, under the industry-level regime, all workers of a given industry share the same bargaining institution.

Although all firms and/or industries in an economy may end up choosing the same bargaining regime, we do not impose economywide unanimity over bargaining institutions as an a priori restriction. This implies that firms and/or industries are free to 'deviate' from the remaining firms in the economy by choosing a distinct bargaining regime. This will be important when we endogenize the choice of bargaining regime in Section 5.

3.1 Individual Bargaining

The microfoundation for individual bargaining is provided by Stole and Zwiebel (1996 RES), who show that individual bargaining may be understood as a Binmore-Rubinstein-Wolinsky alternating offer game, ensuring that the Nash-bargaining is fully microfounded. Hence the individual-bargaining wage curve (19) can be obtained either by fully modeling the pairwise bargaining structure, or by solving a standard generalized Nash bargaining problem[8]. In this sense, individual bargaining is the natural extension of the Mortensen-Pissarides framework to multi-worker firms, since it allows us to derive the wage curve by solving the Nash bargaining problem.

The key assumption of the Stole and Zwiebel (1996 RES) individual bargaining framework used here is that firms engage in pairwise negotiations with workers. When a worker joins the firm, wages are renegotiated individually with all workers. Under individual bargaining, the firm's outside option is not remaining idle, but rather producing with one worker less. The crucial point of the individual bargaining framework is that each worker is treated as the marginal worker. This can be implemented in two ways: either by defining firm's surplus to be $V^J(H_i) - V^J(H_i - 1)$ or by taking the derivative of V^J with respect to H_i and considering this to be the contribution of the marginal worker. Following Cahuc and Wasmer (2001) we will use the latter approach, as it is consistent with the assumption of a continuum of worker/consumers.

The multi-worker firm's individual bargaining problem is:

$$\max_{w_I} \beta \ln \left[V^E \left[I, \theta_\mu \right] - V^U \left[\theta_\mu \right] \right] + (1-\beta) \ln \frac{\partial V_I^J \left[H_i, \theta_\mu \right]}{\partial H_i} \tag{15}$$

To obtain an expression for firm's surplus, note that the individually bargaining firm is free to formulate its labor demand function via the envelope condition. Hence, we can use the envelope condition of the firm's problem (9), and recall that the first order condition (14) implies that $\frac{\partial V_I^J}{\partial H_i^k}$ be constant. This leads to:

$$\frac{\partial V_I^J \left[H_i, \theta_\mu \right]}{\partial H_i} = \frac{1}{r+\chi} \left(\frac{\xi_i - 1}{\xi_i} A_i P_i^I(H_i) - \frac{\partial w_I}{\partial H_i} H_i - w_I(H_i, \theta_\mu) \right). \tag{16}$$

[8] See Stole and Zwiebel (1996a) for an intuitive discussion.

The individual worker's surplus is standard:

$$V^E[I,\theta_\mu] - V^U[\theta_\mu] = \frac{w_I(H_i,\theta_\mu) - rV^U[\theta_\mu]}{r+\chi}. \tag{17}$$

Substituting the expressions for worker's and firm's surplus (16) and (17) into the first order condition of (15) leads to a first-order linear differential equation in the wage.

$$w_I[H_i,\theta_\mu] = (1-\beta)\,rV^U[\theta_\mu] + \frac{\xi_i - 1}{\xi_i}\beta P_i^I(H_i)A - \beta H_i\frac{\partial w_I}{\partial H_i} \tag{18}$$

It is straightforward to confirm that (18) has solution:

$$\frac{w_I[H_i,\theta_\mu]}{P} = (1-\beta)\,rV^U[\theta_\mu] + \beta\frac{\xi_i - 1}{\xi_i - \beta}A\frac{P_i^I(H_i)}{P}. \tag{19}$$

Equation (19) is the wage curve.

3.1.1 Firm-level Equilibrium

Under individual bargaining, the firm is free to choose its optimal employment level. Hence, the firm formulates a labor demand curve from its optimization problem (9)-(13). The labor demand function of the individually bargaining firm is found by combining (14) with the envelope condition, using the definition of demand elasticity (7) and the fact that the bargained wage adjusts to changes in the employment level according to $\frac{\partial w_I}{\partial H_i}\frac{H_i}{P} = -A\frac{\beta}{\xi_i}\frac{\xi_i-1}{\xi_i-\beta}\frac{P_i^I}{P}$:

$$\frac{w_I[H_i,\theta_\mu]}{P} = \frac{\xi_i - 1}{\xi_i}A\frac{P_i^I(H_i)}{P} - \frac{\Phi_V}{q(\theta_\mu)}\left(\frac{r+\chi}{1-\delta}\right) + .A\frac{\beta}{\xi_i}\frac{\xi_i - 1}{\xi_i - \beta}\frac{P_i^I(H_i)}{P} \tag{20}$$

Firm-level equilibrium employment H_i and the corresponding wage $w_I(H_i,\theta_\mu)$ are those at which the decisions of the firm on hiring are optimal, taking into account the bargaining outcome, and vice-versa. This firm-level equilibrium may be obtained at the intersection of the labor demand curve (20) and the wage curve (19). Formally, the firm-level equilibrium employment is described implicitly by:

$$A\frac{P_i^I[H_i,\theta_\mu]}{P} = \frac{\xi_i - \beta}{\xi_i - 1}\left[\frac{rV^U[\theta_\mu]}{P} + \frac{1}{1-\beta}\frac{\Phi_V}{q(\theta_\mu)}\left(\frac{r+\chi}{1-\delta}\right)\right] \tag{21}$$

The partial equilibrium real wage can be found by substituting (21) back into (20).

$$\frac{w_I[\theta_\mu]}{P} = \frac{rV^U[\theta_\mu]}{P} + \frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta_\mu)}\left(\frac{r+\chi}{1-\delta}\right) \tag{22}$$

We can also compute the individually bargaining firm's optimal employment explicitly by combining (21) with the demand curve facing firm i (10).

$$H_i^I[\theta_\mu] = A^{\sigma-1}I\left\{\frac{\xi_i - \beta}{\xi_i - 1}\left[\frac{rV^U[\theta_\mu]}{P} + \frac{1}{1-\beta}\frac{\Phi_V}{q(\theta_\mu)}\left(\frac{r+\chi}{1-\delta}\right)\right]\right\}^{-\sigma} - (n_i - 1)\overline{H}_i \tag{23}$$

At this point, we need to differentiate between degrees of bargaining centralization. First note that the firm-level bargaining equations derived up until now are valid under both firm- and industry-level centralization. It is only when considering the industry-level Cournot equilibrium that we must differentiate. Under industry-level centralization, all workers in an industry share the same bargaining institution. In this case, $\overline{H}_i = H_i^I[\theta_\mu]$, so that in symmetric Cournot equilibrium:

$$H_i^I(\theta_\mu) = \left[\left(\frac{\xi_i - \beta}{\xi_i - 1}\right)\left(\frac{rV^U[\theta_\mu]}{P} + \frac{1}{1-\beta}\frac{\Phi_V}{q[\theta_\mu]}\left(\frac{r+\chi}{1-\delta}\right)\right)\right]^{-\sigma} A^{\sigma-1}\frac{I}{n_i} \quad (24)$$

Under firm-level centralization, different firms in a given industry may choose different bargaining institutions. In this case, we assume that the fraction μ of individual bargaining firms is the same across all [identical] industries, so that $\overline{H}_i = \mu H_i^C(\theta_\mu) + (1-\mu) H_i^I(\theta_\mu)$. The employment equation for firm-level centralization which corresponds to (24) is derived in the appendix.

3.2 Collective Bargaining

Under collective bargaining, all workers employed by a given firm form a coalition. Essentially, they agree to negotiate wages together, and to refuse to work (to strike) in the case that negotiations break down. This joint bargaining agreement also gives workers the power to negotiate over hiring, so that the two negotiated quantities are the wage w_C and the steady-state employment level H_i. Formaly, the multi-worker firm collective bargaining problem is:[9]

$$\max_{w_C, H_i} \beta \ln\left\{H_i\left[V^E[I,\theta_\mu] - V^U[\theta_\mu]\right]\right\} + (1-\beta)\ln V_C^J(H_i) \quad (25)$$

From (9), the steady-state value of a collective bargaining firm with H_i workers is given by:

$$V_C^J[H_i,\theta_\mu] = \frac{1}{r+\delta}\left[AP_i^C(Y_i)H_i - w_C[H_i,\theta_\mu]\cdot H_i - \frac{\Phi_V P\widetilde{\chi}}{q[\theta_\mu]}H_i\right]$$

The collective workers' surplus is standard, and can be obtained by multiplying the expression in (17) by firm-level employment. The first order conditions for wages and employment are:

$$w_C[H_i,\theta_\mu] = (1-\beta)rV^U[\theta_\mu] + \beta\left[AP_i^C(Y_i) - \frac{\Phi_V P\widetilde{\chi}}{q(\theta)}\right] \quad (26)$$

[9] For a given number of firms per industry n_i, the bargaining problems for industry- and firm-level centralization are identical. The reason is that both the industry-level workers' and the firms' surplus are simply their firm-level values, multiplied by n_i.

The assumption that firms and workers take the number of firms as given is consistent with free entry. Neither firms nor workers have any explicit means of preventing new firms from entering the market, as long as that would be profitable for them. One could, however, conceive of extending the model so as to allow firms and workers to choose [or vote on] the level of entry costs, thereby implicitly voting for their preferred degree of competition in the economy.

$$w_C[H_i,\theta_\mu] = AP_i^C(Y_i)\left[1-\frac{1-\beta}{\xi_i}\right]-\frac{\Phi_V P\widetilde{\chi}}{q(\theta)} \tag{27}$$

Combining the two first order conditions (26) and (27) yields an expression for the collectively bargained real wage, as well as an implicit expression for the collectively bargained level of employment.

$$\frac{w_C[\theta_\mu]}{P} = \left[1+\frac{\beta}{\xi_i-1}\right]\frac{rV^U[\theta_\mu]}{P}+\frac{\beta}{\xi_i-1}\frac{\Phi_V\widetilde{\chi}}{q(\theta)} \tag{28}$$

$$A\frac{P_i^C(\theta_\mu)}{P} = \frac{\xi_i}{\xi_i-1}\left[\frac{rV^U[\theta_\mu]}{P}+\frac{\Phi_V\widetilde{\chi}}{q(\theta)}\right] \tag{29}$$

We can also compute the collectively bargaining firm's optimal employment explicitly by combining (29) with the demand curve facing firm i (10).

$$H_i^C[\theta_\mu] = \left\{\frac{\xi_i}{\xi_i-1}\left[\frac{rV^U[\theta_\mu]}{P}+\frac{\Phi_V\widetilde{\chi}}{q(\theta)}\right]\right\}^{-\sigma}A^{\sigma-1}I-(n_i-1)\overline{H}_i \tag{30}$$

Under industry-level centralization, $\overline{H}_i = H_i^C[\theta_\mu]$, so that in symmetric Cournot equilibrium:

$$H_i^C[\theta_\mu] = \left\{\frac{\xi_i}{\xi_i-1}\left[\frac{rV^U[\theta_\mu]}{P}+\frac{\Phi_V\widetilde{\chi}}{q(\theta_\mu)}\right]\right\}^{-\sigma}A^{\sigma-1}\frac{I}{n_i} \tag{31}$$

Under firm-level centralization, $\overline{H}_i = \mu H_i^C(\theta_\mu)+(1-\mu)H_i^I(\theta_\mu)$. The employment equation for firm-level centralization which corresponds to (31) is derived in the appendix.

3.3 Reservation Utilities

In order to complete the description of firm-level equilibrium, it is necessary to derive expressions for the reservation values of unemployment. Recall that firms are atomistic. Hence, when calculating the reservation value of unemployment, workers assume that if they were to loose their current job, they would almost surely [i.e. with probability one] not find a job in their old firm. This implies that *only* the aggregate mix of bargaining institutions μ is relevant for the reservation value of unemployment. When all firms in the economy choose individual bargaining, so that $\mu = 0$, the reservation value of unemployment can be found by combining (1) and (2):

$$\frac{rV^U[\theta_I]}{P} = \frac{r+\chi}{r+\chi+\theta_I q(\theta_I)}b+\frac{\theta_I q(\theta_I)}{r+\chi+\theta_I q(\theta_I)}\frac{w_I[\theta_I]}{P} \tag{32}$$

where $\theta_I \equiv \theta_0$. Combining (32) with the individual bargaining wage equation (22) yields a closed-form solution for the reservation wage in the :

$$\frac{rV^U[\theta_I]}{P} = b+\frac{\beta}{1-\beta}\frac{\Phi_V}{1-\delta}\theta_I \tag{33}$$

Similarly, when all firms in the economy choose collective bargaining, so that $\mu = 1$, the reservation value of unemployment becomes

$$\frac{rV^U[\theta_C]}{P} = \frac{(r+\chi)(\xi_i - 1)}{(r+\chi)(\xi_i - 1) - \beta\theta_C q(\theta_C)} b + \frac{\beta\theta_C q(\theta_C)}{(r+\chi)(\xi_i - 1) - \beta\theta_C q(\theta_C)} \frac{\Phi_V \widetilde{\chi}}{q(\theta_C)} \tag{34}$$

where $\theta_C \equiv \theta_1$. Finally, the closed form solution for arbitrary μ is derived in the appendix and given by:

$$\begin{aligned} \frac{rV^U[\theta_\mu]}{P} &= \frac{(r+\chi)(\xi_i - 1)}{(r+\chi)(\xi_i - 1) - \beta\mu\theta_\mu q(\theta_\mu)} b \\ &\quad + \frac{\beta\Phi_V \theta_\mu}{(r+\chi)(\xi_i - 1) - \beta\mu\theta_\mu q(\theta_\mu)} \left[\mu\widetilde{\chi} + \frac{(1-\mu)(\xi_i - 1)}{1-\beta}\left(\frac{r+\chi}{1-\delta}\right)\right] \end{aligned} \tag{35}$$

3.4 Equilibrium Wages

Finally, it is instructive to fully describe equilibrium wages in firm-level equilibrium. From (22) and (28), together with the reservation wage equations just derived, one can easily see that the equilibrium wage is made up of two components. The first component is the reservation utility $rV^U(\theta_\mu)$, which depends solely on the aggregate mix of bargaining institutions μ. The reason is that workers' reservation utility depends on their chances of finding a new job and on the wage to be expected in that new job. Since individual firms and industries are atomistic, the bargaining institution chosen by a worker's own firm or industry is irrelevant for such future reemployment prospects. The second component is the worker's share of bargaining surplus, whose form does indeed depend upon the own firm's or industry's choice of bargaining regime. Hence, when we later endogenize the choice of bargaining regime, it will be the relative size of individual and collective bargaining surpluses which will be crucial.

4 Short-run General Equilibrium

Now, we determine the 'short-run' general equilibrium for each bargaining institution, taking as given the number of firms n_i in each industry. In our setting, this is equivalent to pinning down all equilibrium variables as functions of the degree of competition ξ_i. This will allow us to determine the impact of increasing competition on equilibrium unemployment and wages. In what follows, we will focus on industry-level bargaining centralization.[10]

Definition 1: *Short-run General Equilibrium*
A short-run general equilibrium is defined for given (ξ_i, n_i) *and parameters* $(\beta, \sigma, b, \Phi_V, \delta, \chi, r, A)$ *as a value of* θ *which:*
(i) is a firm-level equilibrium satisfying (22) and (23) for individual-bargaining firms, (28) and (30) for collective-bargaining firms, and (35).

[10] Results for firm-level bargaining centralization are qualitatively similar and are available from the authors upon request.

(ii) is a symmetric Cournot equilibrium satisfying (24) for individual-bargaining firms and (31) for collective-bargaining firms.
(iii) satisfies the aggregate resource constraint:

$$I = \int \left[\begin{array}{c} \mu \left(\frac{w_C(\theta_\mu)}{P} H_i^C(\theta_\mu) + \frac{\pi_C(\theta_\mu)}{P} H_i^C(\theta_\mu) + \Phi_V v_i^C(\theta_\mu) \right) \\ +(1-\mu) \left(\frac{w_I(\theta_\mu)}{P} H_i^I(\theta_\mu) + \frac{\pi_I(\theta_\mu)}{P} H_i^I(\theta_\mu) + \Phi_V v_i^I(\theta_\mu) \right) \end{array} \right] n_i df(i)$$

where $\pi_k(\theta_\mu)/P$ are the real profits of a firm with bargaining institution k.

When all industries i produce with identical technology A and are distributed uniformly over the unit interval we obtain a simpler version of the aggregate resource constraint:

$$I = \left[\begin{array}{c} \mu \left\{ \frac{w_C[\theta_\mu]}{P} H_i^C[\theta_\mu] + \frac{\pi_i^C[\theta_\mu]}{P} + \Phi_V v_i^C[\theta_\mu] \right\} \\ +(1-\mu) \left\{ \frac{w_I[\theta_\mu]}{P} H_i^I[\theta_\mu] + \frac{\pi_i^I[\theta_\mu]}{P} + \Phi_V v_i^I[\theta_\mu] \right\} \end{array} \right] n_i \quad (36)$$

where firm-level profits are defined as the difference between revenues on the one hand and labor and vacancy posting costs on the other.

$$\frac{\pi_i^k[\theta_\mu]}{P} = A \frac{P_i^k[\theta_\mu]}{P} H_i^k[\theta_\mu] - \frac{w_k[\theta_\mu]}{P} H_i^k[\theta_\mu] - \Phi_V v_i^k[\theta_\mu] \quad (37)$$

Substituting in from (37) leads to a simplified aggregate resource constraint, namely that aggregate income be equal to aggregate production, valued at equilibrium prices:

$$I = \left[(1-\mu) \left[\frac{P_i^I[\theta_\mu]}{P} A H_i^I[\theta_\mu] \right] + \mu \left[\frac{P_i^C[\theta_\mu]}{P} A H_i^C[\theta_\mu] \right] \right] n_i \quad (38)$$

Substituting (21), (24), (29) and (31) into (38), leading immediately to the short-run equilibrium condition

$$A = (1-\mu)^{1/(1-\sigma)} \frac{\xi_i - \beta}{\xi_i - 1} \left(\frac{rV^U[\theta_\mu]}{P} + \frac{1}{1-\beta} \frac{\Phi_V}{q[\theta_\mu]} \left(\frac{r+\chi}{1-\delta} \right) \right) \quad (39)$$

$$+\mu^{1/(1-\sigma)} \frac{\xi_i}{\xi_i - 1} \left[\frac{rV^U[\theta_\mu]}{P} + \frac{\Phi_V \widetilde{\chi}}{q(\theta)} \right] \quad (40)$$

where $\frac{rV^U[\theta_\mu]}{P}$ is taken from equation (35).

When $\mu = 0$, so that all firms engage in individual bargaining, the equilibrium condition reduces to:

$$A = \frac{\xi_i - \beta}{\xi_i - 1} \left(b + \frac{\beta}{1-\beta} \frac{\Phi_V}{1-\delta} \theta_I + \frac{1}{1-\beta} \frac{\Phi_V}{q[\theta_I]} \left(\frac{r+\chi}{1-\delta} \right) \right) \quad (41)$$

The short-run general equilibrium condition for individual bargaining (41) is monotonically increasing in θ_μ, so that existence of equilibrium is guaranteed if

$$A > \frac{\xi - \beta}{\xi - 1} b. \quad (42)$$

When the economy approaches full competition [as $\xi \to \infty$], (42) reduces to the standard condition $A > b$ that workers' productivity be greater in employment than in unemployment.

When $\mu = 1$, so that all firms engage in collective bargaining, we have:

$$A = \frac{(r + \chi)\,\xi_i}{(r + \chi)(\xi_i - 1) - \beta\theta_C q(\theta_C)} \left[b + \frac{\Phi_V \widetilde{\chi}}{q(\theta_C)} \right] \tag{43}$$

The RHS of the collective bargaining short-run general equilibrium condition (43) is monotonically increasing in θ, so that existence of equilibrium is guaranteed if

$$A > \frac{\xi}{\xi - 1} b. \tag{44}$$

For $\theta > 0$, it must also be the case that $(r + \chi)(\xi - 1) > \beta\theta q(\theta)$. When the economy approaches full competition [as $\xi \to \infty$], (44) reduces to the standard condition $A > b$ that workers' productivity be greater in employment than in unemployment.

Equations (39) (and special cases (41) and (43)) describe the short run equilibria, since for each level of competition ξ_i and mix of bargaining institutions μ facing the individual firm it describes the equilibrium labor market tightness θ_C as a function of parameters. These equilibrium conditions are key, since they relate the degree of competition ξ to short-run equilibrium labor market tightness θ_μ. Once we have $\theta_\mu(\xi)$, we can obtain the equilibrium unemployment rate from the Beveridge curve:

$$u(\xi) = \frac{\chi}{\chi + \theta_\mu(\xi)\, q[\theta_\mu(\xi)]} \tag{45}$$

The remainder of equilibrium variables are found as follows: Given the total number of agents in the economy N, we can find equilibrium aggregate employment as $n_i \left[\mu H_i^C(\xi) + (1 - \mu) H_i^I\right] = N[1 - u(\xi)]$. We will find it convenient to normalize $N = 1$. With $H_i^C(\xi)$ and $H_i^I(\xi)$ in hand, we can find aggregate output and subsequently the equilibrium quantity of good i, and of course equilibrium prices $P_i^C(\xi)$ and $P_i^I(\xi)$, all in terms of the given degree of competition.

5 Optimal Bargaining Institution

In the previous sections, we characterized the short-run general equilibrium, taking as given the share μ of firms which engage in collective bargaining. We now examine how and when collective bargaining coalitions will arise endogenously, thereby determining μ endogenously. We will focus on symmetric Nash equilibria, in which all firms/industries in the economy find it optimal to choose the same bargaining institution. In the case of a symmetric collective bargaining Nash equilibrium, this would imply that all workers in all firms and industries find collective bargaining preferable to individual bargaining, given that all other workers in all other firms/industries also adopt collective bargaining. We assume that workers are perfectly mobile across industries. We make all of this precise by means of the following definitions:

Definition 2: Symmetric collective bargaining Nash equilibrium: Short-run

For a given industry size n_i (and hence given ξ_i), collective bargaining is a symmetric Nash equilibrium if a unilateral deviation to individual bargaining is not optimal. This is the case if:

(i) Each of the employed workers receives a higher utility under collective bargaining, given that all other workers in all other industries also engage in collective bargaining, than he/she would receive by deviating to individual bargaining. Formally:

$$V^E(C, \theta_C|\xi_i) \geq V^E(I, \theta_C|\xi_i)$$

or (iia) A deviation to individual bargaining would be profitable for each employed worker:

$$V^E(I, \theta_C|\xi_i) \geq V^E(C, \theta_C|\xi_i)$$

but (iib) the total expected utility loss due to release of workers into unemployment due to the change in bargaining institution exceeds the total expected utility gain due to the change in bargaining institution:

$$\begin{aligned} & n_i \left[H_i^C(\theta_C|\xi_i) - H_i^I(\theta_C|\xi_i) \right] \left[V^E(C, \theta_C|\xi_i) - V^U(\theta_C|\xi_i) \right] \\ \geq \quad & n_i H_i^I(\theta_C|\xi_i) \left[V^E(I, \theta_C|\xi_i) - V^E(C, \theta_C|\xi_i) \right] \end{aligned}$$

The first part of the definition is obvious: no worker will ever be in favor of deviating to individual bargaining if it decreases his utility. The second part is more subtle: even if a deviation were profitable for every worker who retains his job, it may be the case that the transition from collective to individual bargaining would involve a decrease in firm-level employment, and hence the release of some measure of workers into unemployment. Assuming that all currently employed workers face the same probability of being let go due to the change of bargaining institution, then the deviation will only be profitable if the total gain in utility to the workers who remain employed after the the deviation exceeds the total utility loss of those workers who are released in the transition to the new bargaining structure. Essentially, part (iib) states that a deviation to individual bargaining will only take place if it is possible for the retained workers to compensate the released workers [in expectation] for their utility loss.

The corresponding definition for individual bargaining symmetric Nash equilibrium is given next.

Definition 3: Stability of industry-level individual bargaining: Short-run

For a given industry size n_i (and hence given ξ_i), individual bargaining is a symmetric Nash equilibrium if a unilateral deviation to collective bargaining is not optimal. This is the case if:

(i) Each of the employed workers receives a higher utility under individual bargaining, given that all other workers in all other industries also engage in individual bargaining, than she would receive if her industry were to deviate to collective bargaining. Formally:

$$V^E(I,\theta_I|\xi_i) \geq V^E(C,\theta_I|\xi_i)$$

or (iia) A deviation to collective bargaining would be profitable for each employed worker

$$V^E(C,\theta_I|\xi_i) \geq V^E(I,\theta_I|\xi_i)$$

but (iib) the total expected utility loss due to release of workers into unemployment due to the change in bargaining institution exceeds the total expected utility gain due to the change in bargaining institution:

$$\begin{aligned} & n_i\left[H_i^I(\theta_I|\xi_i) - H_i^C(\theta_I|\xi_i)\right]\left[V^E(I,\theta_I|\xi_i) - V^U(\theta_I|\xi_i)\right] \\ \geq\ & n_i H_i^C(\theta_I|\xi_i)\left[V^E(C,\theta_I|\xi_i) - V^E(I,\theta_I|\xi_i)\right] \end{aligned}$$

The following lemma establishes a sufficient condition for a symmetric Nash equilibrium.

Lemma 1: *If $w_k[\theta_k|\xi_i] \geq w_j[\theta_k|\xi_i]$, where $k \neq j$ are two distinct bargaining institutions, then bargaining institution k is a symmetric Nash equilibrium.*
Proof: *By Definitions 2 and 3, bargaining institution k is an industry-level symmetric Nash equilibrium.if $V^E(k,\theta_C|\xi_i) \geq V^E(j,\theta_C|\xi_i)$, for all alternative bargaining institutions j. From (1), we know that:*

$$V^E[k,\theta_\mu|\xi_i] = \frac{1}{r+\chi}\left\{w_k[\theta_\mu|\xi_i] + \chi V^U[\theta_\mu|\xi_i]\right\}$$

so that $V^E(k,\theta_C|\xi_i) \geq V^E(j,\theta_C|\xi_i)$ if and only if $w_k[\theta_k|\xi_i] \geq w_j[\theta_k|\xi_i]$.

Lemma 1 makes clear that when deciding on one's own firm's or industry's bargaining institution, workers care only about the impact on their wages. The reason is that individual firms and industries are atomistic with respect to the economy, so that their decisions on bargaining institutions have no impact on aggregate variables. Hence, workers are correct in neglecting the impact of their own choice of bargaining institution on their probability of being rehired out of a future unemployment spell, on their future wage in a new job, and hence on the reservation value of unemployment. Effectively, this implies that workers may choose to 'free-ride' on the aggregate choice of bargaining institution.

Now, Lemma 2 translates the wage condition of Lemma 1 into a sufficient condition on the level of competition. At sufficiently low levels of competition, collective bargaining is a symmetric Nash equilibrium, while at sufficiently high levels of competition, individual bargaining is a symmetric Nash equilibrium. The proof of Lemma 2 can be found in the appendix.

Lemma 2: *(i) If $\xi_i \leq 1 + \frac{(1-\beta)(1-\delta)}{r+\chi}\left[b\frac{q(\theta_C)}{\Phi_V} + \widetilde{\chi}\right] + \beta\frac{\theta_C q(\theta_C)}{r+\chi}$, then collective bargaining is a symmetric Nash equilibrium.*

(ii) If $\xi_i \geq 1 + \frac{(1-\beta)(1-\delta)}{r+\chi}\left[b\frac{q(\theta_I)}{\Phi_V} + \widetilde{\chi}\right] + \beta\frac{\theta_I q(\theta_I)}{r+\chi}$*, then individual bargaining is a symmetric Nash equilibrium.*

The following two subsections establish the bargaining equilibrium in two extreme cases: the perfect competition limit and the lowest level of competition which is consistent with equilibrium.

5.1 Perfect Competition

In the perfect competition limit, the only Nash equilibrium is that in which all workers in all firms and industries choose individual bargaining. The main reason is that individual bargaining offers workers higher wages in a perfectly competitive economy. The intuition behind the higher wages for individually bargaining workers is simple, yet subtle. First recall that workers' wages are the sum of two components: their reservation utility rV^U and their share of the bargaining surplus. Next, note that workers' reservation utility depends exclusively on aggregate variables: their own choice of bargaining institution is irrelevant. Hence, the workers' choice of bargaining institution boils down to the choice between receiving the individual or the collective bargaining surplus.

Further, recall that collectively bargaining workers are essentially able to obtain a share of the firm's equilibrium profits. Under perfect competition, profits net of hiring costs converge to zero, so that the workers' wages converge to their reservation level b. Under individual bargaining, however, workers are still able to obtain a positive surplus, since their surplus is based on cost to rehiring a worker. These latter costs reach their peak under perfect competition. The reason is that under perfect competition, output expansion [and the accompanying expansion in vacancy posting] guarantees that labor market tightness θ_i reaches its maximum level. For given hiring costs Φ_V, this implies that replacing an individual worker is costliest under perfect competition, bringing an individual worker's total match surplus to its maximum value. Hence, under perfect competition, workers prefer the individual bargaining surplus, and consequently individual bargaining. As a result, individual bargaining is the appropriate bargaining framework in economies with perfect competition.

Proposition 1 formalizes the above arguments, and in addition establishes that equilibria involving collective bargaining do not exist. The accompanying proof may be found in the appendix.

Proposition 1: *In the perfect competition limit, individual bargaining is the unique Nash equilibrium.*

5.2 Imperfect Competition

Under imperfect competition, in contrast, collective bargaining coalitions may indeed arise. We begin by examining in detail the extreme case: the lowest level of competition which is consistent with existence of short-run general equilibirum under collective bargaining, $\xi_{\min}$. This minimal degree of competition is found by taking the limit as $\theta_c \to 0$ of the collective bargaining equilibrium condition (43).

$$\lim_{\theta_C \to 0} \frac{(r+\chi)\,\xi_i}{(r+\chi)(\xi_i - 1) - \beta\theta_C q(\theta_C)} \left[b + \frac{\Phi_V \widetilde{\chi}}{q(\theta_C)} \right] = \frac{\xi_{\min}}{\xi_{\min} - 1} b = A$$

so that $\xi_{\min} \equiv \frac{A}{A-b}$. Proposition 2 establishes that collective bargaining is a symmetric Nash equilibrium at $\xi_{\min}$. The intuition is similar to that of Proposition 1. When choosing between bargaining institutions, workers effectively are choosing whether they prefer to receive the collective or the individual bargaining surplus. At very low levels of competition, firms' profits are large, and hence the workers' collective bargaining surplus is also large. In contrast, at low levels of competition the individual bargaining surplus is at its minimum, since this is also where hiring and vacancy posting are at their minimum levels, actually converging to zero as competition converges to its minimum level. Hence, the minimal level of competition, workers prefer the collective bargaining surplus, and consequently collective bargaining. The proof of Proposition 2 is in the appendix.

Proposition 2: *In the imperfect competition limit $\xi_{\min}$, collective bargaining is a symmetric Nash equilibrium.*

Finally, Proposition 3 establishes a range of competition levels ξ such that collective bargaining will emerge for the special case of $\eta = \frac{1}{2}$. Formally, the proposition shows that when ξ is lower than a critical value $\widetilde{\xi}_C$, then collective bargaining is guaranteed to be a symmetric Nash equilibrium. The intuition follows that presented above. At sufficiently low levels of competition, firms' profits and hence collective bargaining surpluses are sufficiently high to exceed individual bargaining surpluses. This is illustrated in the lower right hand panel of Figure 1. As competition increases, profit-based collective bargaining surpluses decrease, while individual bargaining surpluses increase. Hence, at sufficiently low levels of competition, collective bargaining is guaranteed to be a symmetric Nash equilibrium, and hence an appropriate choice of bargaining institution.

Proposition 3: *When matching elasticity $\eta = \frac{1}{2}$, there exists a critical value of product market competition [demand elasticity] $\widetilde{\xi}_C$, so that collective bargaining is a symmetric Nash equilibrium for all $\xi \leq \widetilde{\xi}_C$.*

The proof of Proposition 3 is found in the appendix.

6 Long-run General Equilibrium

Now we are ready to endogenize the degree of competition, or equivalently, the number of firms in each industry. In the long-run, firms may enter each industry by paying a real entry cost Φ_E. Entry by firms will continue until profits net of entry costs within each industry have been competed down to zero. Hence, free entry in the presence of barriers to entry leads to equilibrium industry size n^*, which is defined implicitly by:

$$\frac{r+\delta}{1+r}\Phi_E = \frac{\pi_i(n^*)}{P} \tag{46}$$

where the firm's equilibrium profits per period are given by (37). The free entry condition (46) states that the entry cost must be amortized by profits over the firm's expected lifespan. The greater is the firm's exit probability δ, the higher must be the equilibrium profits to amortize a given level of entry costs. Since equilibrium profits are decreasing in competition, free entry forges a negative link between barriers to entry and the number of firms.

Entry barriers may take two complementary forms, time and pecuniary costs. Both the data on entry costs collected by Logotech, S.A. for the OECD (as reported in Fonseca, et. al. (2001)) and that of Djankov, et. al. (2002) report the time it takes to satisfy all regulatory entry requirements. In addition, Djankov, et. al. (2002) present data on the official fees which must be paid in order to obtain all licenses and permits, as a percentage of annual per capita GDP.

We combine the fee and regulatory delay measures to obtain a single quantification of barriers to entry. We convert the regulatory delay (measured in months) into a pecuniary opportunity cost consisting of lost profits during the setup-period, plus the wages of one worker who is charged with setting up the firm. This implies that a day of waiting is more costly in a high-profit and/or high-wage economy. Formally, total barriers to entry are found as:

$$\Phi_E(n) = (d + f) \cdot \frac{I(n)}{n}. \tag{47}$$

where d is the regulatory delay and f are entry fees as a share of aggregate monthly income. By adjusting entry costs to reflect the number of firms in the economy, we are implicitly assuming that the costs to starting a small firm are lower than those required to start a larger one. Combining (47) with the free entry condition (46) yields:

$$\frac{r+\delta}{1+r}\left[(d+f) \cdot \frac{I(n^*)}{n^*}\right] = \frac{\pi}{P}(n^*). \tag{48}$$

Equation (48) closes the long-run equilibrium. It implicitly determines the endogenous long-run industry size n^*, or equivalently, it determines the endogenous degree of competition $\xi^* = \sigma n^*$ in long-run equilibrium. As long as $d < \frac{1+r}{r+\delta}$, as is the case in all the data reported in Table 2, equation (48) defines a negative relationship between barriers to entry and the degree of competition in long-run equilibrium. Hence, an increase in entry barriers of either form leads to a long-run equilibrium decrease in industry size n^* or equivalently, to a decrease in the demand elasticity faced by firms ξ^*.

When considering long-run equilibrium, the symmetric Nash equilibrium definitions 2 and 3 must be adapted somewhat. The difference is that when an industry's workers choose to deviate from their current bargaining regime, firms' profits will generally be affected, leading to a new long-run equilibrium degree of competition. When taking the decision to deviate or adhere to a symmetric Nash equilibrium, then, agents must also take the effects on the long-run equilibrium degree of competition ξ^* in their industry into account.

6.1 Income Taxes

In order to run policy experiments, we must also take into account that unemployment benefits must generally be financed by taxes. We impose equal magnitude income and payroll taxes, which are just large enough to finance the equilibrium expenditures on unemployment benefits:

$$[\tau_I + \tau_P] \frac{w}{P} [1-u] = bu \tag{49}$$

It is straightforward to confirm that the short-run equilibrium condition for individual bargaining becomes[11]:

$$A = \frac{\xi-\beta}{\xi-1}\left(\frac{1+\tau_P}{1-\tau_I}b + \frac{\beta}{1-\beta}\frac{\theta_I \Phi_V}{1-\delta} + \frac{1}{1-\beta}\frac{\Phi_V}{q(\theta_I)}\frac{r+\chi}{1-\delta}\right) \tag{50}$$

while the corresponding equation for collective bargaining becomes:

$$A = \frac{\xi\,(r+\chi)}{(r+\chi)\,(\xi-1) - \beta\theta_C q\,(\theta_C)}\left[\frac{1+\tau_P}{1-\tau_I}b + \frac{\Phi_V \widetilde{\chi}}{q\,(\theta_C)}\right] \tag{51}$$

7 Quantitative Results

We are now in a position to calibrate our model and approach our quantitative questions. We first explain in detail how we calibrate the basic model to match a set of labor market data from the U.S.. Then, for this calibration we compare the impact of increasing competition on equilibrium labor market outcomes under collective and under individual bargaining. That is, we examine by how much unemployment decreases and by how much wages increase due to an increase in our measure of competition [demand elasticity ξ] under each bargaining framework. Next, we run a simple policy experiment, which is designed to gauge the ability of entry costs to account for the difference in US and continental European unemployment rates when the bargaining regime is chosen endogenously.

7.1 Calibration

We calibrate the individual bargaining version of the model to US data.[12] One model period is one month. All parameters are reported in Table 1. We use estimates from the literature to guide our choices for the first group of parameters. The bargaining power of workers, β, has recently been estimated between 20%, (Cahuc, Gianella, Goux and Zylberberg, 2002) and 50% (Abowd and Allain, 1996, Yashiv, 2001). Petrongolo and Pissarides (2001) report η, the elasticity of the matching function with respect to unemployment, to be in the range of

[11] The balanced-budget version of the model is a straightforward extension of the basic model. Complete derivations are available from the authors upon request.

[12] All collective bargaining results use the parameters obtained from the individual bargaining calibration to US data.

[0.4;0.7]. We set $\beta = \eta = 0.5$, thus choosing standard values and imposing the Hosios (1990) condition. For simplicity, we normalize the level of technology A to unity. Our choice for the annualized real interest rate $r = 0.04$ approximates its average value in the 1990's. Unemployment benefits in the U.S. replace 50% of the past income for half a year, so we take b at 0.274 which is roughly consistent with a replacement rate[13] of 30%. In our setting, the choice of the elasticity of substitution among goods σ has no impact on the endogenously determined elasticity of substitution facing individual firms ξ. Since $\xi = n\sigma$, our choice of σ.only serves to normalize the equilibrium number of firms per industry. We take $\sigma = 2$.

We choose the remaining parameters to match some stylized labor market data for the U.S. during the period 1989–2002. Specifically, we replicate an unemployment rate of 5.5%, an average duration of unemployment of 3.8 months, and an average vacancy duration of 4.2 months (den Haan et al, 2000). The exogenous total separation rate $\chi = 0.0154$, is pinned down by the Beveridge curve in conjunction with our values for unemployment and unemployment duration. We set $\delta = 0.01$, so that the monthly probability that a firm will cease to exist is in line with the one and five year firm survival probabilities reported in Dunne, Roberts and Samuelson (1988), Mata and Portugal (1994) and Wagner (1999). Our choices for unemployment duration and vacancy duration restrict US equilibrium labor market tightness to be $\theta = \frac{\lambda_w}{\lambda_f} = 1.11$, where λ_w and λ_f are the matching rates of workers and firms respectively.[14] This figure looks high at first glance. However, before comparing it to standard one-worker firm models and data it is necessary to adjust for the fact that firms open as many vacancies as necessary in order to fulfill their hiring needs in expectation. If we multiply the equilibrium tightness θ with the firm matching rate we find a ratio of open jobs to unemployed of 26.5%, which is in line with figures reported in OECD (2001), in the range of [0.05;0.3] for different OECD countries. Finally, the scaling parameter of the matching function s must satisfy $s = \frac{\lambda_w}{\theta^{1-\eta}}$.

We are left with a long-run equilibrium condition (48) which relates vacancy posting costs Φ_V to firm's demand elasticity ξ. We close the model by choosing a value for Φ_V. We choose that level of vacancy posting costs which leads to a long-term U.S. equilibrium unemployment rate of 5.5 %. This leads to a value of $\Phi_V = 0.549$, so that hiring costs per worker are $\frac{1}{\lambda_f}\Phi_V = 2.31$ units of output, which corresponds to about 20 % of annual payroll. This is consistent with Hamermesh and Pfann (1996), who report fixed hiring costs in the range of 20% to 100% of annual payroll expenses for a worker. Finally, our calibrations are for a balanced budget version of the model in which unemployment benefits are financed by equal magnitude income and payroll taxes (τ_I, τ_P). In the US model economy, income and payroll taxes of less than 1% are necessary to finance unemployment benefits.

[13]Rather than introducing heterogeneity among unemployed by cutting off their benefits, we prefer to adjust the generosity of unemployment compensation. This is standard, as is the choice of a 30% replacement ratio for the U.S.

[14]Recall that the value of θ does not fully describe long-run equilibrium, since the degree of competition ξ is determined endogenously.

7.2 A little bit of competition goes a long way

We begin by comparing the implications of exogenously varying the degree of product market competition under collective bargaining to those under individual bargaining. Figure 1 shows that the behavior of most variables, including wages, reservation wages, firm-level employment and per-firm profits is remarkably similar under the two bargaining regimes. The behavior of two key variables - unemployment and workers' share of match surplus - are strikingly different under the two bargaining regimes. The top left hand panel of Figure 1 shows that increasing the degree of product market competition leads to dramatic decreases in unemployment levels under collective bargaining. In contrast, increasing product market competition under individual bargaining has only negligible effects on unemployment. The reason for this discrepancy is due to the overhiring effect of individual bargaining, as explained in our companion paper Ebell and Haefke (2003)[15]. Regardless of bargaining framework, the first principles effect of increasing competition should be an expansion of output, and hence an expansion of hiring and vacancy creation. Under individual bargaining, however, an additional countervaling overhiring effect exists. Briefly, under individual bargaining all workers are treated as the marginal worker, so that if the marginal product of labor is decreasing, then the wages of all workers can be depressed by expanding employment. At low levels of competition, the overhiring effect is especially strong, and serves to counteract the positive impact on unemployment due to output expansion.

The second key variable whose behavior is strongly dependent on the bargaining framework is the worker's share of surplus component of real wages. This is important, because it is precisely the workers' share of surplus which is crucial for determining whether a given bargaining framework can be supported as a symmetric Nash equilibrium. To see this, first recall that wages are the sum of two components: the worker's reservation wage and his share of the match surplus. From equation (2), the worker's reservation wage depends solely on the aggregate bargaining institution, since this in turn determines the workers' probability of finding a new job when unemployed and their wage on any new job. Hence, the workers' reservation wage is independent of the bargaining institution of his own (atomistic) firm or industry. When choosing whether to adhere to the symmetric Nash equilibrium or to deviate, the worker is only concerned with whether his bargaining surplus would be higher under individual or collective bargaining. From the bottom right panel of Figure 1 it is easy to see that workers prefer the collective bargaining surplus at low levels of competition, making them both likely to adhere to collective bargaining equilibria and to deviate from individual bargaining equilibria. The intuition is simple: the collective bargaining surplus is essentially a profit share. As competition increases, firms' profits decrease, so that collective bargaining becomes relatively less attractive. At sufficiently high degrees of competition [around $\xi = 11$], the individual bargaining surplus becomes relatively more attractive. This makes

[15] The overhiring effect was first described in a partial equilibrium setting by Stole and Zwiebel (1996).

agents likely to adhere to individual bargaining equilibria and unlikely to deviate to collective bargaining.

7.3 Long-run Equilibria

Next, we proceed to find the long-run equilibria for both low US and high continental European entry costs, under each of the two possible bargaining regimes. This is illustrated in Figure 2. As described in section 6, the long-run equilibrium level of competition is that at which firms' profits are just high enough to recoup their entry costs. The upper left panel of Figure 2 illustrates long-run equilibrium for a collective bargaining firm facing high continental European entry costs. The solid green line gives per-firm profits at each level of competition, while the dashed blue line gives the entry costs which must be amortized each period, taking firms' exit probability into account. Long-run equilibrium is found at the intersection of these two lines, at a demand elasticity of $\xi_{EU,C} = 7.82$. Similarly, the lower left panel shows the long-run equilibrium for continental European entry costs and individual bargaining, leading to an equilibrium demand elasticity of $\xi_{EU,I} = 15.2$. The two right-hand panels repeat the exercise for low US entry costs, which predictably lead to much higher long-run equilibrium competition levels of $\xi_{US,C} = 79.9$ and $\xi_{US,I} = 478.2$.

7.4 Endogenous Bargaining Institutions

Next, we examine which bargaining institution will emerge endogenously under each entry cost regime. In particular, we check whether the necessary and sufficient conditions for a Nash equilibrium are satisfied for each of the four long-run equilibria described in the previous subsection. First, Figure 3 considers Nash equilibria under the high continental European entry cost regime. The upper left panel illustrates that collective bargaining is indeed a Nash equilibrium under high European entry costs, since the sufficient condition that the workers' wages be higher under collective bargaining than under a deviation to individual bargaining is satisfied.[16] The lower left panel is irrelevant: The utility gain to deviating to individual bargaining only becomes relevant when the sufficient wage condition fails. The right two panels illustrate that individual bargaining is not a Nash equilibrium under European entry costs. The upper right panel shows that a deviation to collective bargaining will indeed be profitable in wage terms. The lower right panel checks that the employment criterium is met: That is, the utility losses due to any employment losses due to the transition from individual to collective bargaining are outweighed by the utility gains from such a transition. Hence, even when workers take into account that a deviation may lead to job losses, they find it profitable in expected utility terms to deviate. Hence, individual bargaining cannot be a Nash equilibrium under high European entry costs.

[16] Recall that the wage critierium for a Nash equilibrium considers a deviation from collective bargaining, taking as given that all other firms/industries continue to engage in collective bargaining.

Figure 4 considers Nash equilibria under the low US entry cost regime. The upper right hand panel illustrates that under US entry costs, individual bargaining is a Nash equilibrium. This is the case because the sufficient wage criterium of Lemma 1 holds: workers are guaranteed a higher wage by adhering to individual bargaining equilibrium than by deviating to collective bargaining. Hence, the lower right hand panel of Figure 4 becomes irrelevant. The left hand panels of Figure 4 illustrate that collective bargaining is not a Nash equilibrium under US Entry costs. The upper left hand panel shows that for the high equilibrium level of competition $\xi_{US,C}$, deviating to individual bargaining is indeed profitable in wage terms. The lower left hand panel shows that the total utility gains to deviating to individual bargaining do indeed outweigh the losses for ξ in excess of 38. Hence, there exists no symmetric collective bargaining Nash equilibrium under US entry costs.

To summarize: Under high continental European entry costs, collective bargaining emerges as the unique symmetric Nash equilibrium. Under low US entry costs, however, individual bargaining is the unique symmetric Nash equilibrium. This implies that in our policy experiment, we will restrict attention to the US entry cost-individual bargaining and European entry cost-collective bargaining equilibria.

7.5 A Simple Policy Experiment

We now use the balanced budget version of the model to run a simple policy experiment, whose goal is to gauge the ability of product market institutions in accounting for the US-continental Europe unemployment differential. In particular, differing product market institutions [PMI] are represented as differing entry cost regimes $\{d_{Euro}, f_{Euro}\}$ and $\{d_{US}, f_{US}\}$.[17] For each entry cost regime, we choose that bargaining regime which can be supported as a symmetric Nash equilibrium. Under continental European entry costs, collective bargaining turns out to be the unique symmetric Nash equilibrium. Under lower US entry costs, individual bargaining is the unique symmetric Nash equilibrium, as illustrated in Figures 3 and 4. Hence, to assess the impact of product market reform, we measure the difference in unemployment between the high European entry cost and collective bargaining long run equilibrium on the one hand, and the low American entry cost and individual bargaining long run equilibrium on the other.

The long-run equilibrium for the US economy is shown in column [1] of Table 3, while column [2] represents the continental European long-run equilibrium. Recall that the model was calibrated to allow long-run equilibrium unemployment in the US entry cost individual bargaining case to equal average US unemployment in the 90's of 5.5%. When entry costs are increased to their continental European levels, collective bargaining becomes relevant, and unemployment increases quite substantially to 8.3%. Hence, stricter continental

[17] Following Fonseca, et. al. (1999) and Pissarides (2001), we use the regulatory delay index based on the Logotech/OECD data, together with Djankov, et. al. (2002)'s cost data.

European product market regulation alone is responsible for about $\Delta u_{PMI} =$ 2.8 percentage points of unemployment. This indicates that product market regulation is indeed an important factor in explaining the US-European employment differential.

8 Conclusions

The main contributions of this paper have been threefold. First, we have shown that the choice of bargaining regime is crucial for the effect of product market competition on unemployment rates, being substantial under collective bargaining and considerably more modest under individual bargaining. Since the choice of bargaining institution is so important, we endogenize it. We find that the bargaining regime which emerges endogenously depends crucially on the degree of product market competition. When product market competition is low, collective bargaining is stable, while individual bargaining emerges as the stable institution under high degrees of product market competition. This also allows us to link product market competition and collective bargaining coverage rates. Our results suggest that the strong decline in collective bargaining coverage and unionization in the US and UK over the last two decades might have been a direct consequence of the Reagen/Thatcher product market reforms of the early 80's. Finally, we calibrate the model to US data, in order to assess the quantitative impact of product market regulation on equilibrium unemployment rates. In the calibrated version of the model, low US regulation leads to very high degrees of product market competition and individual bargaining emerges as the endogenous bargaining institution. High EU regulation leads to low degrees of product market competition, and collective bargaining emerges as the endogenous bargaining institution. We find that moving from the low US regulation-individual bargaining economy to the high EU regulation-collective bargaining economy leads to a substantial increase in equilibrium unemployment rates from 5.5% to about 8.3%. This makes up about 2/3 of the total average unemployment differential of about 3.95% points between the US and continental Europe in the 90s.

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A Firm-level Bargaining

A.1 Industry-level Cournot Equilibrium

The goal is to find the firm-level employment levels which are consistent with Cournot equilibrium in the industry, taking into account that each firm in the industry may choose a different bargaining institution. For simplicity, we assume that the fraction μ of individual bargaining firms is the same across all [identical] industries. This allows us to define $\overline{H}_i$ in equations (23) and (30) as

$$\overline{H}_i \equiv (1-\mu) H_i^I [\theta_\mu] + \mu H_i^C [\theta_\mu] \tag{52}$$

Substituting into (30) and (23) and solving the resulting system of two equations in two unknowns $H_i^I [\theta_\mu]$ and $H_i^C [\theta_\mu]$ yields:

$$H_i^I [\theta_\mu] = \frac{I}{A} \left[\frac{1+\mu(n_i-1)}{n_i} \left(\frac{P_i^I(\theta_\mu)}{P} \right)^{-\sigma} - \frac{\mu(n_i-1)}{n_i} \left(\frac{P_i^C(\theta_\mu)}{P} \right)^{-\sigma} \right]$$

$$\begin{aligned} H_i^C [\theta_\mu] &= \frac{I}{A} \left\{ \frac{n_i + (n_i-1)^2 (1-\mu)\mu}{[1+\mu(n_i-1)] n_i} \right\} \left(\frac{P_i^C(\theta_\mu)}{P} \right)^{-\sigma} \\ &\quad - \frac{I}{A} \frac{(n_i-1)(1-\mu)}{n_i} \left(\frac{P_i^I(\theta_\mu)}{P} \right)^{-\sigma} \end{aligned}$$

A.2 Short-run General Equilibrium

To find the short-run general equilibrium condition for an economy with firm-level bargaining centralization, substituting (23) and (30), as well as (21), (29), (35) into (38). This yields the short-run equilibrium condition

$$1 = \left[\begin{array}{c} (1-\mu) \frac{P_i^I(\theta_\mu)}{P} \left[[1+\mu(n_i-1)] \frac{P_i^I(\theta_\mu)}{P}^{-\sigma} - [\mu(n_i-1)] \frac{P_i^C(\theta_\mu)}{P}^{-\sigma} \right] \\ +\mu \frac{P_i^C(\theta_\mu)}{P} \left[\left\{ \frac{n_i+(n_i-1)^2(1-\mu)\mu}{[1+\mu(n_i-1)]} \right\} \frac{P_i^C(\theta_\mu)}{P}^{-\sigma} - [(n_i-1)(1-\mu)] \frac{P_i^I(\theta_\mu)}{P}^{-\sigma} \right] \end{array} \right]$$

where the equilibrium prices are given by (21) and (29).

When $\mu = 1$, the short-run equilibrium condition reduces to:

$$1 = \frac{P_i^C(\theta_\mu)}{P}$$

When $\mu = 0$, the short-run equilibrium condition reduces to:

$$1 = \frac{P_i^I(\theta_\mu)}{P}$$

B Wages and Reservation Wages for Arbitrary μ

B.1 Reservation Wage

For arbitrary μ, we have

$$\begin{aligned}
\frac{w_I[\theta_\mu]}{P} &= \frac{rV^U[\theta_\mu]}{P} + \frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta_\mu)}\left(\frac{r+\chi}{1-\delta}\right) \\
\frac{w_C[\theta_\mu]}{P} &= \left[1+\frac{\beta}{\xi_i-1}\right]\frac{rV^U[\theta_\mu]}{P} + \frac{\beta}{\xi_i-1}\frac{\Phi_V\widetilde{\chi}}{q(\theta)} \\
\frac{rV^U[\theta_\mu]}{P} &= \frac{r+\chi}{r+\chi+\theta_\mu q(\theta_\mu)}b + \frac{\theta_\mu q(\theta_\mu)}{r+\chi+\theta_\mu q(\theta_\mu)}\left\{\mu\frac{w_C[\theta_\mu]}{P} + (1-\mu)\frac{w_I[\theta_\mu]}{P}\right\}
\end{aligned}$$

This gives us three equations in the three unknowns $w_C[\theta_\mu,\xi_i]$, $w_I[\theta_\mu,\xi_i]$, $rV^U[\theta_\mu]$. First, solve for the reservation utility:

$$\begin{aligned}
\frac{rV^U[\theta_\mu]}{P} &= \frac{(r+\chi)(\xi_i-1)}{(r+\chi)(\xi_i-1)-\beta\mu\theta_\mu q(\theta_\mu)}b \\
&\quad + \frac{\beta\Phi_V\theta_\mu}{(r+\chi)(\xi_i-1)-\beta\mu\theta_\mu q(\theta_\mu)}\left[\mu\widetilde{\chi} + \frac{(1-\mu)(\xi_i-1)}{1-\beta}\left(\frac{r+\chi}{1-\delta}\right)\right]
\end{aligned} \tag{53}$$

which corresponds to equation (35) in the main text. When $\mu = 0$, the reservation wage reduces to:

$$\frac{rV^U[\theta_I]}{P} = b + \frac{\beta}{1-\beta}\left(\frac{\Phi_V}{1-\delta}\right)\theta_I.$$

For $\mu = 1$, the reservation wage reduces to:

$$\frac{rV^U[\theta_C]}{P} = \frac{(r+\chi)(\xi_i-1)}{(r+\chi)(\xi_i-1)-\beta\theta_C q(\theta_C)}b + \frac{\beta\Phi_V\theta_C}{(r+\chi)(\xi_i-1)-\beta\theta_C q(\theta_C)}\widetilde{\chi}.$$

B.2 Wages

Next, substitute (35) into each of the wage equations:

$$\begin{aligned}
\frac{w_I[\theta_\mu]}{P} &= \frac{(r+\chi)(\xi_i-1)}{(r+\chi)(\xi_i-1)-\beta\mu\theta_\mu q(\theta_\mu)}b \\
&\quad + \frac{\beta\Phi_V\theta_\mu}{(r+\chi)(\xi_i-1)-\beta\mu\theta_\mu q(\theta_\mu)}\left[\mu\widetilde{\chi} + \frac{(1-\mu)(\xi_i-1)}{1-\beta}\left(\frac{r+\chi}{1-\delta}\right)\right] \\
&\quad + \frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta_\mu)}\left(\frac{r+\chi}{1-\delta}\right) \\
\frac{w_C[\theta_\mu]}{P} &= \left[1+\frac{\beta}{\xi_i-1}\right]\left\{\begin{array}{c} \frac{(r+\chi)(\xi_i-1)}{(r+\chi)(\xi_i-1)-\beta\mu\theta_\mu q(\theta_\mu)}b \\ +\frac{\beta\Phi_V\theta_\mu}{(r+\chi)(\xi_i-1)-\beta\mu\theta_\mu q(\theta_\mu)}\left[\mu\widetilde{\chi} + \frac{(1-\mu)(\xi_i-1)}{1-\beta}\left(\frac{r+\chi}{1-\delta}\right)\right] \end{array}\right\} \\
&\quad + \frac{\beta}{\xi_i-1}\frac{\Phi_V\widetilde{\chi}}{q(\theta)}
\end{aligned}$$

When $\mu = 0$, so that the aggregate bargaining institution is individual, the individual bargaining wage reduces to:

$$\frac{w_I[\theta_I]}{P} = \underbrace{b + \frac{\beta}{1-\beta}\left(\frac{\Phi_V}{1-\delta}\right)\theta_I}_{\text{ind barg res wage}} + \underbrace{\frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta_I)}\left(\frac{r+\chi}{1-\delta}\right)}_{\text{ind bargaining surplus}}$$

while the collective bargaining wage for $\mu = 0$ is:

$$\frac{w_C[\theta_I]}{P} = \underbrace{b + \frac{\beta}{1-\beta}\frac{\Phi_V\theta_I}{1-\delta}}_{\text{ind barg res wage}} + \underbrace{\frac{\beta}{\xi_i - 1}\left[b + \frac{\beta}{1-\beta}\frac{\Phi_V\theta_I}{1-\delta} + \frac{\Phi_V\widetilde{\chi}}{q(\theta_I)}\right]}_{\text{coll barg surplus}}$$

When $\mu = 1$, so that the aggregate bargaining institution is collective, the collective bargaining wage reduces to:

$$\begin{aligned}\frac{w_C[\theta_C]}{P} &= \left[1 + \frac{\beta}{\xi_i - 1}\right]\left[\frac{(r+\chi)(\xi_i - 1)}{(r+\chi)(\xi_i - 1) - \beta\theta_C q(\theta_C)}b + \frac{\beta\Phi_V\theta_C}{(r+\chi)(\xi_i - 1) - \beta\theta_C q(\theta_C)}\widetilde{\chi}\right] \\ &\quad + \frac{\beta}{\xi_i - 1}\frac{\Phi_V\widetilde{\chi}}{q(\theta_C)}\end{aligned}$$

and the individual bargaining wage reduces to:

$$\begin{aligned}\frac{w_I[\theta_C]}{P} &= \underbrace{\frac{(r+\chi)(\xi_i - 1)}{(r+\chi)(\xi_i - 1) - \beta\theta_C q(\theta_C)}b + \frac{\beta\Phi_V\theta_C}{(r+\chi)(\xi_i - 1) - \beta\theta_C q(\theta_C)}\widetilde{\chi}}_{\text{coll barg res wage}} \\ &\quad \underbrace{+\frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta_C)}\left(\frac{r+\chi}{1-\delta}\right)}_{\text{ind bargaining surplus}}\end{aligned}$$

From the above wage equations, it is easy to see that the aggregate bargaining institution [or mix of institutions μ] determines the reservation wage, while the bargaining institution of the worker's own firm or industry k determines the form of the bargaining surplus.

C Proofs

C.1 Proof of Lemma 2

(i) By Lemma 1, if $w_C[\theta_C|\xi_i] \geq w_I[\theta_C|\xi_i]$, *then collective bargaining is a symmetric Nash equilibrium. By equations (22), (28) and (34), we have that* $w_C[\theta_C|\xi_i] \geq w_I[\theta_C|\xi_i]$ *if and only if:*

$$\frac{\beta(r+\chi)}{(r+\chi)(\xi_i - 1) - \beta\theta_C q(\theta_C)}\left(b + \frac{\Phi_V\widetilde{\chi}}{q(\theta_C)}\right) \geq \frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta_C)}\left(\frac{r+\chi}{1-\delta}\right)$$

which reduces to the condition that:

$$1+\frac{(1-\beta)(1-\delta)}{r+\chi}\left[b\frac{q(\theta_C)}{\Phi_V}+\widetilde{\chi}\right]+\beta\frac{\theta_C q(\theta_C)}{r+\chi}\geq\xi_i$$

(ii) By Lemma 1, if $w_I[\theta_I|\xi_i]\geq w_C[\theta_I|\xi_i]$, *then collective bargaining is a symmetric Nash equilibrium. By equations (22), (28) and (34), we have that* $w_I[\theta_I|\xi_i]\geq w_C[\theta_I|\xi_i]$ *if and only if:*

$$\frac{\beta(r+\chi)}{(r+\chi)(\xi_i-1)-\beta\theta_C q(\theta_C)}\left(b+\frac{\Phi_V\widetilde{\chi}}{q(\theta_C)}\right)\leq\frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta_C)}\left(\frac{r+\chi}{1-\delta}\right)$$

which reduces to the condition that:

$$1+\frac{(1-\beta)(1-\delta)}{r+\chi}\left[b\frac{q(\theta_C)}{\Phi_V}+\widetilde{\chi}\right]+\beta\frac{\theta_C q(\theta_C)}{r+\chi}\leq\xi_i$$

C.2 Proof of Proposition 1

The proof proceeds in three steps. First, we show that individual bargaining is a Nash equilibrium under perfect competition. Next, we show that collective bargaining is not a Nash equilibrium in the perfect competition limit. Finally, we show that no 'mixed strategy' equilibria with $\mu\in(0,1)$ *exist.*
(i) By definition 3, to show that individual bargaining is a Nash equilibrium under perfect competition, it is sufficient to show that

$$\lim_{\xi\to\infty}w_I(\theta_I,\xi)\geq\lim_{\xi\to\infty}w_C(\theta_I,\xi)\tag{54}$$

First, from equations (33) and (28) it is straightforward to see that $\lim_{\xi\to\infty}w_C(\xi,\theta_I)=b$. *From equations (22) and (33), however, the individual bargaining wage converges to*

$$\lim_{\xi\to\infty}w_I(\theta_I,\xi)=b+\frac{\beta}{1-\beta}\frac{\Phi_V}{q(\overline{\theta}_I)}\left[\frac{r+\chi+\overline{\theta}_I q(\overline{\theta}_I)}{1-\delta}\right]$$

where $\overline{\theta}_I>0$ *is the (finite) limit of* $\theta_I(\xi)$ *as* $\xi\to\infty$. *It is easy to see that the second term of* $\lim_{\xi\to\infty}w_I(\theta_I,\xi)$ *is strictly positive, so that indeed.* $\lim_{\xi\to\infty}w_I(\xi,\theta_I)\geq\lim_{\xi\to\infty}w_C(\xi,\theta_I)$.
(ii) By definition 2, to show that collective bargaining is not a Nash equilibrium, we need to first show that $\lim_{\xi\to\infty}w_I(\theta_C,\xi)>\lim_{\xi\to\infty}w_C(\theta_C,\xi)$. *As* $\xi\to\infty$, $w_C(\theta_I,\xi)$ *once again converges to* b. *The individual bargaining wage, however, converges to*

$$\lim_{\xi\to\infty}w_I(\xi,\theta_C)=b+\frac{\beta}{1-\beta}\frac{\Phi_V}{q(\overline{\theta}_C)}\left[\frac{r+\chi+\overline{\theta}_C q(\overline{\theta}_C)}{1-\delta}\right]$$

where $\overline{\theta}_C>0$ *is the (finite) limit of* $\theta_C(\xi)$ *as* $\xi\to\infty$. *It is easy to see that the second term of* $\lim_{\xi\to\infty}w_I(\theta_C,\xi)$ *is strictly positive. Hence, in wage*

terms, deviating from collective bargaining is profitable. Next, we need to ensure that employment losses due to the change in bargaining regime do not outweigh the wage gains. This is easy to establish. Firm-level employment under both bargaining regimes becomes infinitessimal [converging to zero] as competition approaches perfect, so that the change in employment due to the switch in bargaining regimes also approaches zero.
(iii) Finally, we need to show that there exists no $\mu \in (0,1)$ that is a Nash equilibrium under perfect competition. In the perfect competition limit, a mixed equilibrium is vulnerable to deviation to a pure strategy of individual bargaining if:

$$\lim_{\xi\to\infty} V^E\left[I,\theta_\mu|\xi\right] \geq \lim_{\xi\to\infty} \mu V^E\left[C,\theta_\mu|\xi\right] + (1-\mu)\, V^E\left[I,\theta_\mu|\xi_i\right]$$

Using the results of parts (i) and (ii) of this proof, together with Lemma 1, this is clearly the case. Once again, firm size approaches zero under pefect competition in both cases, so workers neglect any impact of their choice of bargaining institution on firm size. This establishes that there is no mixed-strategy equilibrium.

C.3 Proof of Proposition 2

By Lemma 1, to establish that collective bargaining is a symmetric Nash equilibrium in the imperfect competition limit, it is sufficient to show that:

$$\lim_{\theta_C\to 0} w_C\left(\theta_C,\xi_{\min}\right) \geq \lim_{\theta_C\to 0} w_I\left(\theta_I,\xi_{\min}\right)$$

From equations (28) and (34), it is easy to see that:

$$\begin{aligned}
& \lim_{\theta_C\to 0} w_C\left(\theta_C,\xi_{\min}\right) \\
= & \lim_{\theta_C\to 0}\left[\frac{(r+\chi)\left(\xi_{\min}-1\right)}{(r+\chi)\left(\xi_{\min}-1\right)-\beta\theta_C q\left(\theta_C\right)} b + \frac{\beta\theta_C q\left(\theta_C\right)}{(r+\chi)\left(\xi_{\min}-1\right)-\beta\theta_C q\left(\theta_C\right)}\frac{\Phi_V\widetilde{\chi}}{q\left(\theta_C\right)}\right] \\
& \left[1+\frac{\beta}{\xi_{\min}-1}\right] + \frac{\beta}{\xi_{\min}-1}\frac{\Phi_V\widetilde{\chi}}{q\left(\theta_C\right)} \\
= & \; b\left[1+\frac{\beta}{\xi_{\min}-1}\right]
\end{aligned}$$

From equations (ref ind wage) and (34), one can also establish that:

$$\begin{aligned}
& \lim_{\theta_C\to 0} w_I\left(\theta_I,\xi_{\min}\right) \\
= & \lim_{\theta_C\to 0}\frac{(r+\chi)\left(\xi_{\min}-1\right)}{(r+\chi)\left(\xi_{\min}-1\right)-\beta\theta_C q\left(\theta_C\right)} b \\
& + \frac{\beta\theta_C q\left(\theta_C\right)}{(r+\chi)\left(\xi_{\min}-1\right)-\beta\theta_C q\left(\theta_C\right)}\frac{\Phi_V\widetilde{\chi}}{q\left(\theta_C\right)} + \frac{\beta}{1-\beta}\frac{\Phi_V}{q\left(\theta_\mu\right)}\left(\frac{r+\chi}{1-\delta}\right) \\
= & \; b
\end{aligned}$$

The fact that $\xi_{\min} > 1$ confirms that indeed
$\lim_{\theta_C\to 0} w_C\left(\theta_C,\xi_{\min}\right) > \lim_{\theta_C\to 0} w_I\left(\theta_C,\xi_{\min}\right)$.

C.4 Proof of Proposition 3

The wage condition of Lemma 1 guarantees the existence of collective bargaining symmetric Nash equilibria for values of θ_C such that:

$$(1-\delta)(1-\beta)\left[b+\frac{\Phi_V\widetilde{\chi}}{q(\theta_C)}\right]\geq\left[(r+\chi)(\xi_i-1)-\beta\theta_C q(\theta_C)\right]\frac{\Phi_V}{q(\theta_C)} \tag{55}$$

where ξ and θ_C are related by equation (43) as

$$\xi=A\frac{r+\chi+\beta\theta_C q(\theta_C)}{(r+\chi)\left[A-b-\frac{\Phi_V\widetilde{\chi}}{q(\theta_C)}\right]} \tag{56}$$

*Combining equations (**??**) and (**??**) yields an implicit condition on θ_C which guarantees collective bargaining symmetric Nash equilibrium:*

$$\begin{aligned}&(1-\delta)(1-\beta)b(A-b)-(r+\chi)\left[\frac{\Phi_V}{q(\theta_C)}\right]^2\widetilde{\chi} \\ &+\left[(1-\delta)(1-\beta)(A-2b)\widetilde{\chi}-b(r+\chi)\right]\frac{\Phi_V}{q(\theta_C)}-b\beta\Phi_V\theta_C-\frac{[\Phi_v]^2\widetilde{\chi}}{q(\theta_C)}\beta\theta_C \\ \geq\ & 0\end{aligned} \tag{57}$$

When $q(\theta_C)=s\theta^{-\frac{1}{2}}$, this implicit condition reduces to a cubic equation in θ_C.

$$a\theta^{\frac{3}{2}}+b\theta+c\theta^{\frac{1}{2}}+d\leq 0$$

where $a=\frac{\Phi_v^2\widetilde{\chi}}{s}\beta>0$, $b\equiv(r+\chi)[\Phi_V]^2\widetilde{\chi}s^2+b\beta\Phi_V>0$, $c=-\left[(1-\delta)(1-\beta)(A-2b)\widetilde{\chi}-b(r+\chi)-\beta\Phi_V\widetilde{\chi}\right]\frac{\Phi_V}{s}$ and $d=-(1-\delta)(1-\beta)b(A-b)$. Since $a>0$, $b>0$ and $d<0$, there exists exactly one positive root, and hence one non-complex value of labor market tightness at which the collective and individual bargaining surpluses are equal. This root is the critical value $\widetilde{\theta}_C$ such that for all $\theta_C\leq\widetilde{\theta}_C$, collective bargaining is a symmetric Nash equilibrium. Since θ_C is a monotonically increasing function of the degree of competition ξ, there also exists a critical value of competition $\widetilde{\xi}_C\equiv\xi_C\left(\widetilde{\theta}_C\right)$ such that for all $\xi\leq\widetilde{\xi}_C$, there exists a symmetric collective bargaining Nash equilibrium.

D Tables and Figures

Table 1: Calibration to U.S. data

β	0.5	Worker bargaining power
η	0.5	Elasticity of the matching function
$\bar{A}$	1	Average level of labor productivity
r	0.00327	4% Annual interest rate
b_{US}	0.27	Real unemployment benefits, US
σ	2.0	Substitution elasticity
χ	0.0154	Total separation rate
δ	0.0100	Probability of firm exit
s	0.2503	Scaling parameter of the matching function

Table 2: Entry Costs

Dataset	**OECD**			**Djankov, et. al.**		
Country	**Days**	**Procedures**	**Index**	**Days**	**Procedures**	**Fees**
Austria	40	10	35.2	37	9	27.3 %
Belgium	30	7	25.6	33	8	10.0 %
France	30	16	39.3	53	15	14.3 %
Germany	80	10	55.2	42	10	15.7 %
Greece	32.5	28	58.7	36	15	58.6 %
Italy	50	25	62.9	62	16	20.0 %
Netherlands	60	9	43.7	31	8	18.4 %
Portugal	40	10	35.2	76	12	18.4 %
Spain	117.5	17	84.5	82	11	17.3 %
Euro Average	**62.2**	–	**54.7**	**51.9**	–	18.4 %
United States	**7.5**	**3.5**	**8.6**		**4**	0.5 %

The 'Days' column gives the number of business days necessary to start a new firm, while the 'Procedures' column gives the number of entry procedures which new firms must complete. The 'Index' column combines the 'Days' and 'Procedures' measures as (days + procedures/(ave procedures/day))/2, so that the indexes' units are days. The first two columns draw on 1997 data from Logotech S.A., as reported by the OECD [Fostering Entrepreneurship] and by Fonseca,et.al. (2001). The index is taken from Fonseca, et. al. (2001). The fourth and fifth column present the respective days and procedures measures reported by Djankov, et.al. (2002) for 1997. The sixth column gives Djankov, et.al. (2002)'s measure for fees required for entry, as a percentage of per capita GDP.

Table 3: Policy Experiment

	[1]	[2]
	US Φ_E	EU Φ_E
Unemployment $u(\xi^*)$	5.5 %	8.3 %
Labor market tightness $\theta(\xi^*)$	1.11	0.47
Unemployment duration $\frac{1}{q(\theta)}$	3.8	18.1
Vacancy duration $\frac{1}{\theta q(\theta)}$	4.2	2.7
Firm demand elasticity ξ^*	480.2	7.8
Real net wage $\frac{w(\xi^*)}{P}(1-\tau_I)$	0.94	0.90
Res. Utility rV^U	0.90	0.84
Worker's Match Surplus	0.04	0.06
Profit per firm $\frac{\pi(\xi^*)}{P}$	0.0001	0.0150
Markup	0.1 %	15 %
Tax rates $\tau_I = \tau_P$	0.87 %	1.33 %
Vacancy costs Φ_V	0.549	0.549
Real unemployment benefit b	0.28	0.27
Replacement rate	0.30	0.30

This table presents the equilibrium values for main variables of two economies. Column [1] gives results for the US economy, while column [2] gives results for the same economy, but with continental European entry costs.

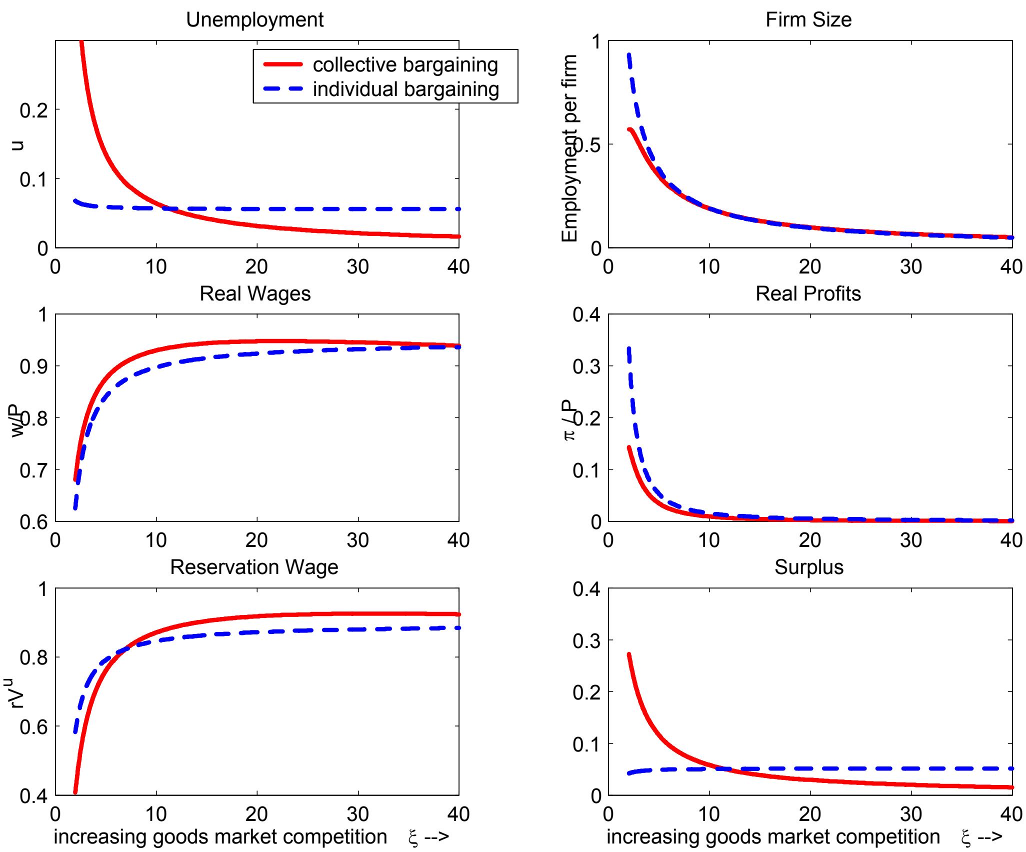

Figure 1: Short run equilibrium under collective and individual bargaining.

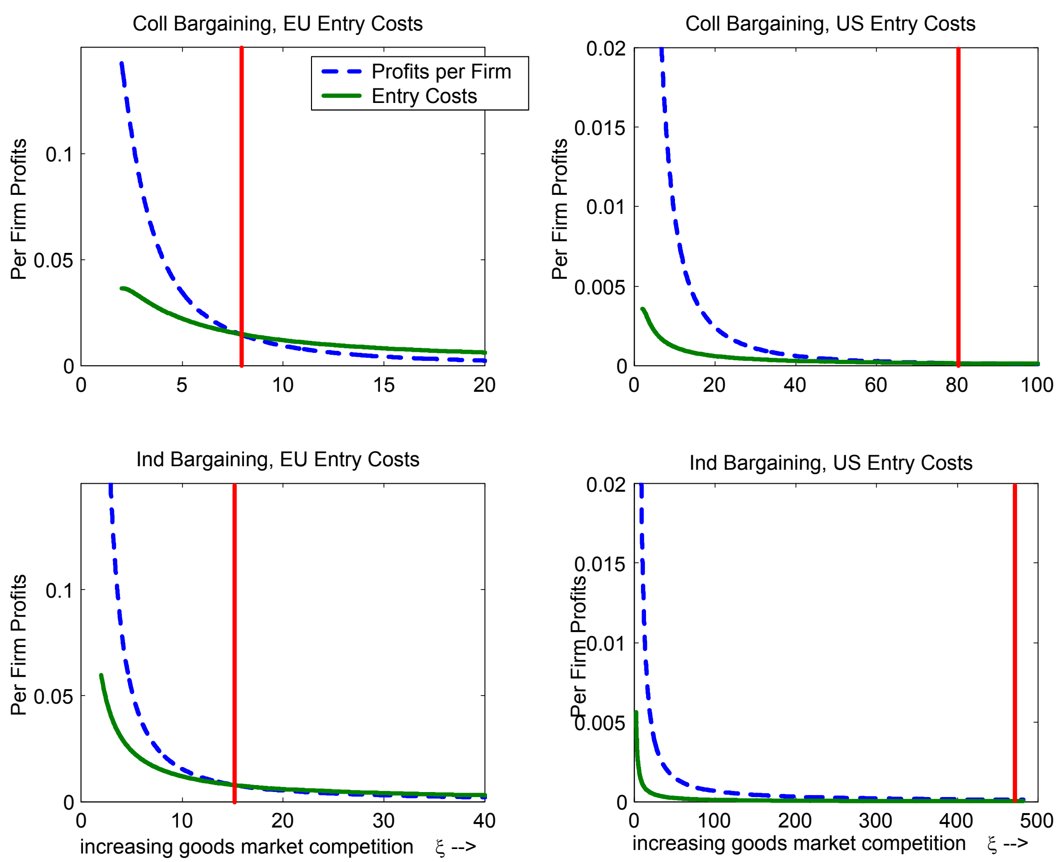

Figure 2: Determination of long-run equilibrium for each combination of entry cost and bargaining regime.

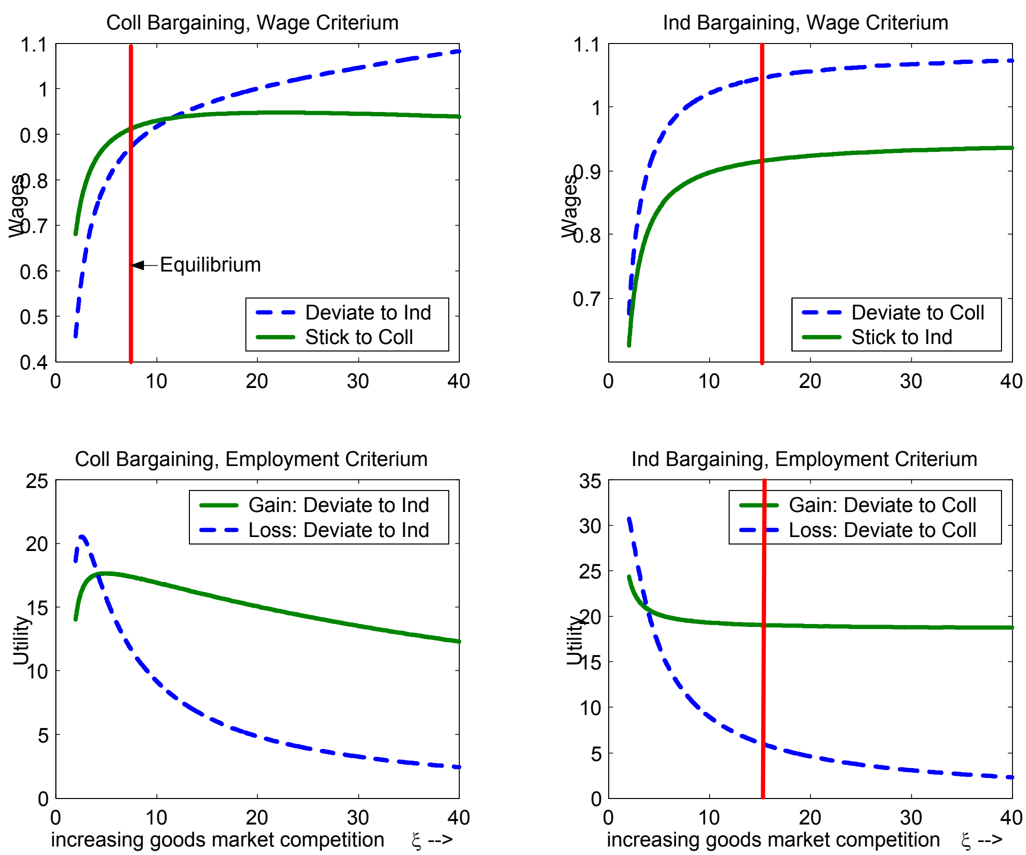

Figure 3: Conditions for symmetric Nash bargaining equilibrium under continental European entry costs.

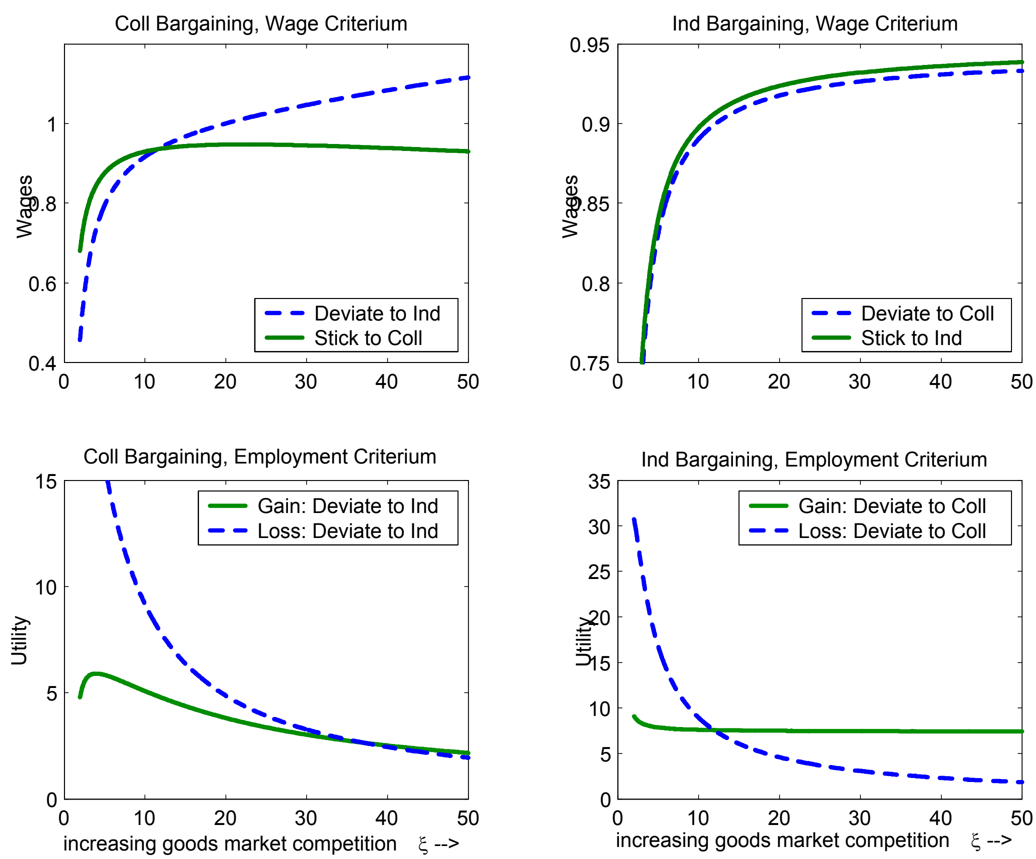

Figure 4: Conditions for symmetric Nash bargaining equilibrium under US entry costs.

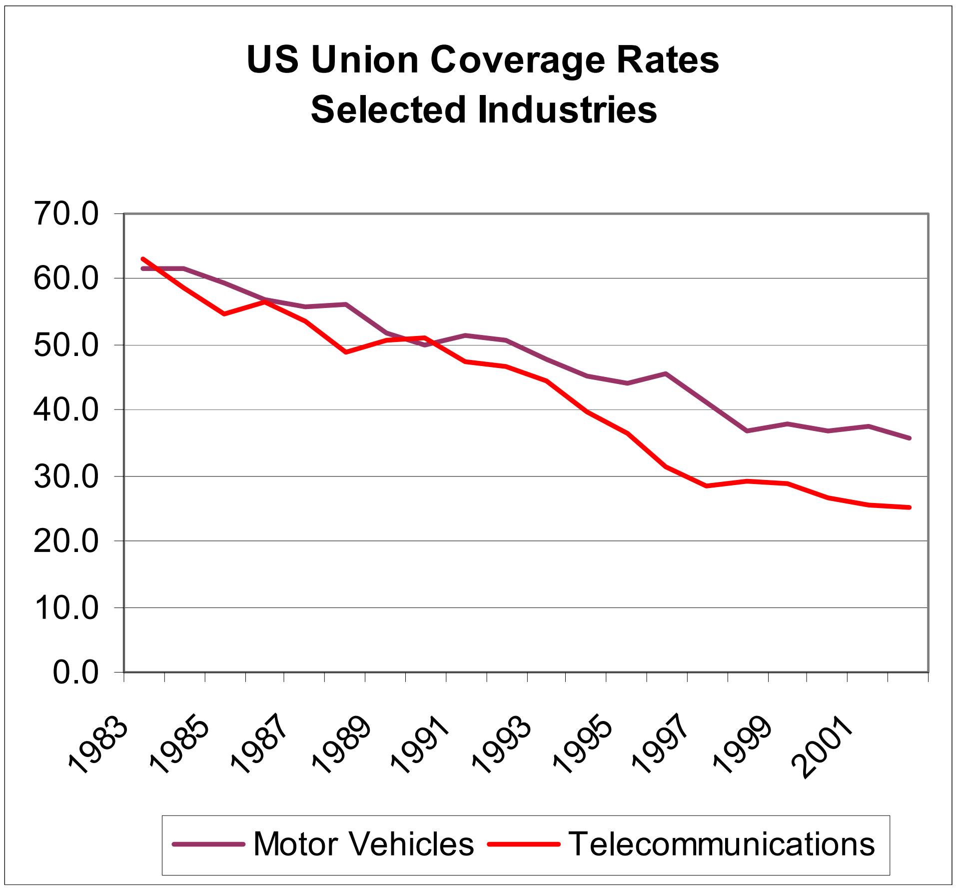

Figure 5: Data source: BLS data made available in time series form by Barry Hirsch and David Macpherson on their website www.unionstats.com and documented in Hirsch and Macpherson (2003).