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Product Market Deregulation and the U.S. Employment Miracle

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Abstract
We consider the dynamic relationship between product market entry regulation and equilibrium unemployment. The main theoretical contribution is combining a job matching model with monopolistic competition in the goods market and individual bargaining. We calibrate the model to US data and perform a policy experiment to assess whether the decrease in trend unemployment during the 1980's and 1990's could be attributed to product market deregulation. Under a traditional calibration, our results suggest that a decrease of less than two-tenths of a percentage point of unemployment rates can be attributed to product market deregulation, a surprisingly small amount. Under a small surplus calibration, however, product market deregulation can account for the entire decline in US trend unemployment over the 1980's and 1990's.

Keywords: Product market competition, barriers to entry, wage bargaining
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1 Introduction

This paper studies the impact of product market deregulation on labor markets, with special emphasis on the Carter/Reagan deregulation of the late 1970's and early 1980's.

There has been quite some interest recently in the impact of product market institutions on labor markets. However, the focus of this literature has been to use differences in US and European product market regulation to try to explain the divergent performance of US and European labor markets over the 1980's and 1990's. One obstacle faced by this literature is that the presence of a multitude of rigidities (and attempts at reform) in European labor markets makes it difficult to disentangle the roles of product and labor market institutions in accounting for high European unemployment rates. In contrast, the US labor market is both highly flexible and its institutions were relatively stable during the period of interest. This allows us to focus only on changes in product market regulation, while holding labor market institutions constant.

Consider the graph of HP-trend unemployment rates in Figure 1.[1] US unemployment rates began trending downward in the early 1980's, falling from a peak of 7.6% in 1982 to only 5.0% in 2000. The deregulation of US product markets runs parallel to this decrease in unemployment, as shown by the OECD data on product market regulation plotted in Figure 1. This, together with the fact that deregulation took place around the time of the trend reversal in unemployment, makes it worth investigating whether product market deregulation could explain what has widely been termed the 'employment miracle' (Krueger and Pischke (1997)).[2]

Indeed, there is some amount of empirical evidence to support the link between product markets and labor markets. At a micro level, Bertrand and Kramarz (2002) examine the impact of French legislation[3] which regulated entry into retailing. They find that those regions (departements) which restricted entry more strongly experienced slower rates of job growth. At the cross-country macro level, Boeri, Nicoletti and Scarpetta (2000), using an OECD index of the degree of product market regulation, also report a negative relationship between their countrywide 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. However, the high degree of correlation between labor and product market regulation documented in Nicoletti, Scarpetta and Boylaud (2000) makes it difficult to disentangle the effects of each

[1]We emphasize that these are *trend* unemployment rates, whose business cycle component has been filtered out.

[2]*At the same time, the major change in US labor market institutions - the 1996 welfare reform - took place after most of the gains in unemployment had already been realized. Unemployment in 1996 had already fallen to 5.4%. In fact, one might argue that the immediate transistory effect of welfare reform should have been to increase unemployment, as welfare recipients were pushed into the labor market.*

[3]Loi Royer of 1974

type of regulation in a cross-country setup.

The main contributions of this paper are both quantitative and theoretical. Our main quantitative contribution is to quantify the effect of product market deregulation on unemployment. We find that whether product market deregulation is able to account for the decline in trend US unemployment in the 1980's and 1990's depends crucially on the method of calibration employed. Using a traditional calibration, along the lines of Shimer (2005), we find that increasing product market regulation from 1998 to 1978 levels can account for only a surprisingly small increase in unemployment of less than two-tenths of a percentage point, from 5.10% in 1998 to 5.26% in 1978. Using a small surplus calibration similar to Hagedorn and Manovskii (2008), however, we find that decreased product market regulation between 1978 and 1998 can account for the entire decline in trend unemployment in the United States from 7.2% in 1978 to 5.1 % in 1998.

In addition, we also examine alternative explanations for the drop in unemployment, namely tax reform and a decline worker's bargaining power. We do this by allowing for both product market deregulation and tax reform or a decline in worker's bargaining power. We find that our result that product market deregulation is unable to account for most of the decline in unemployment is robust to the inclusion of both tax reform and declining worker's bargaining power. In order to account for the full 2.1 percentage point decline in trend unemployment, product markets would need to be deregulated and labor taxes would have had to decrease from 56.6% in 1978 to 32.0% in 1998. In this case, the product market deregulation would have accounted for less than one-fifth of the decline in unemployment. Alternatively, product market deregulation combined with a decline in worker's bargaining power from 66.6% in 1978 to 50% in 1998 could generate the drop in unemployment from 7.2% to 5.1%. However, product market deregulation only account for only about one-tenth of the drop in unemployment.

On the theoretical side, we specify a dynamic general equilibrium model which combines monopolistic competition in the goods market with unemployment arising from Mortensen-Pissarides-style matching frictions and individual wage bargaining between multiple-worker firms and workers. We identify two countervailing channels by which product market competition affects unemployment: the first-principles output expansion effect and the overhiring effect. From first principles, firms with monopoly power maximize profits by restricting output with respect to its full competition level. As competition increases, profit-maximizing output expands, and along with it the demand for labor. This in turn implies a greater rate of vacancy creation, which leads to a lower rate of unemployment. The second channel is the countervailing overhiring effect, which arises due to the interplay of imperfect competition and individual bargaining in multi-worker firms.

First, note that the assumption of multiple-worker firms and individual bargaining are sensible ones to model changes in product market competition in the US economy. Under perfect competition in goods markets and constant returns to scale, the number and size of firms is indeterminate, so the one-worker firm assumption is innocuous. Under monopolistic competition, however, firm size is determinate, and varies according to the competition faced by the firm, making a multiple-worker setup preferable. Individual bargaining is consistent with the 'employment at will' framework which is dominant in the United States. Under individual bargaining, workers bargain individually with firms, and firms cannot commit to long-term contracts. In such a setting, first analyzed by Stole and Zwiebel (1996, 1996a), the firm may choose to renegotiate the wage at any time with any worker, effectively making each worker the marginal worker. It is important to note that such a setup is the natural extension of paying marginal products to a framework with wage bargaining.

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 Blanchard and Giavazzi (2003) and Fonseca, et. al. (2001), both of which find unemployment to be increasing in the degree of product market regulation. Fonseca, et. al. (2001) focuses on the impact of entry barriers on the decision to become an entrepreneur or a worker, finding that entry barriers can indeed lead to lower rates of entrepreneurship and hence job creation. However, in their setup, those firms which have overcome the entry barriers then face perfect competition. In contrast, Blanchard and Giavazzi (2003) study labor market outcomes in a model with monopolistic competition in the goods market, but with a more stylized labor market setting. In a similar vein, Spector (2004) 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 one another. The latter two papers consider static or two-period setups.

In theoretical terms, our paper is most closely related to Stole and Zwiebel (1996, 1996a), Smith (1999), Cahuc and Wasmer (2001) and Cahuc et. al. (2007). Smith (1999) and Cahuc et. al. (2007) present models with multiple-worker firms and individual bargaining with decreasing returns to scale, which also leads to an overhiring effect. Cahuc and Wasmer (2001) also show that overhiring is not an issue under perfect competition and constant returns to scale in production, because marginal revenue product is constant. In addition, using a model without search frictions, Rotemberg (2000) argues that individual bargaining can lead to wages that are less procyclical than their neoclassical counterparts.

The remainder of the paper is organized as follows: Section 2 presents the model. Section 3 characterizes short and long run equilibrium, and presents analytic results on the impact of product market competition on labor market equilibrium. Section 4 focuses on quantitative analysis, and examines the ability of product market deregulation, tax reform and the decline of union bargaining power to account for the decline in US trend unemployment during the 1980's and 1990's. Section 5 concludes.

2 The Basic Model

In this section, we present the basic general equilibrium model. Its main elements are monopolistic competition in the goods market and Mortensen-Pissarides-style matching frictions in the labor market. Our innovation lies in defining and solving the multi-worker firm's problem under monopolistic competition and individual bargaining. The households' problems are standard. We restrict our analysis to the steady-state.

2.1 Households

2.1.1 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. We use Blanchard and Giavazzi (2003)'s formulation, which allows us to connect demand elasticity σ to the number of firms n, while also allowing us to focus on the direct effects of increased competition on the demand elasticity facing firms.[4] Goods demand each period is derived from the household's optimization problem:

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

subject to the budget constraint $I_j = \int c_i \frac{P_i}{P} di$ where I_j denotes the real income of household j and $c_{i,j}$ is household j'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 as:

$$Y_i^D \equiv \int c_{i,j} dj = \left(\frac{P_i}{P} \right)^{-\sigma} \frac{I}{n} \tag{2}$$

where $I \equiv \int I_j dj$ is aggregate real income and $P = \left(\frac{1}{n} \int P_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ is the inverse shadow price of wealth, typically interpreted as a price index. Equation (2) is the standard monopolistic competition demand function with elasticity of substitution among

[4] A previous version of this paper, Ebell and Haefke (2006), used the standard Dixit-Stiglitz preferences. The results are nearly indistinguishable.

differentiated goods given by $-\sigma$. As in Blanchard and Giavazzi (2003), we assume that $\sigma = \overline{\sigma} g(n)$, $g' > 0$ and $\sigma > 1$ where n is the number of firms in the economy. n is given in the short run and endogenously determined in the long run.

2.1.2 Search and Matching in the Labor Market

The labor market is characterized by a standard search and matching framework (e.g. Pissarides (2000)). Unemployed workers u and vacancies v are converted into matches by a constant returns to scale matching function[5] $m(u,v) = s \cdot u^{\eta} v^{1-\eta}$. Defining labor market tightness to 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 $f(\theta) = s\theta^{1-\eta}$.

Workers and firms are identical so that all jobs are identical. For each worker, the value of employment is given by V_E, which satisfies

$$V_E = w(1-\tau_L) + \frac{1}{1+r}\left[\chi V_U' + (1-\chi) V_E'\right] \tag{3}$$

where χ is the total separation rate, w denotes the per period real wage, V_U is the value of being unemployed in the current period and V_E' and V_U' are the values of being employed and unemployed in the next period respectively. τ_L is a labor tax, which is returned to agents in the form of a lump-sum transfer. Firms and workers may separate either because the match is destroyed, which occurs with exogenous[6] 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:

$$V_U = b + \frac{1}{1+r}\left\{f(\theta) V_E' + [1-f(\theta)] V_U'\right\} \tag{4}$$

where b denotes real benefits to unemployment. It will also be useful for the bargaining to define the worker's surplus V_W as the difference between the value function when

[5] As is quite standard in the literature, s denotes a scaling parameter which serves to bring matching rates within the $[0,1]$ interval, while η denotes the elasticity of matches with respect to the number of unemployed.

[6] Recently, Koeniger and Prat (2006) have extended our model to allow for endogenous separations and study effects of firing costs and on the job search.

employed and when unemployed:

$$V_W = (1-\tau_L)\,w - b + \frac{1}{1+r}\left[1-\chi - f(\theta)\right]V'_W \tag{5}$$

2.2 Multiple-worker Firms

Firms are monopolistically competitive. We abandon the one-worker-per-firm assumption in favor of a more general framework with multiple-worker firms. Under perfect competition in goods markets and constant returns to scale, the one-worker firm assumption is harmless, since the number and size of firms is indeterminate[7]. Under monopolistic competition, however, firm size is determinate, and varies according to the demand elasticity σ faced by the firm, among others. The only way to vary firm size with a given technology is to vary the amount of labor employed either on the intensive margin or on the extensive margin[8]. Consistent with the long run focus of our paper, we assume that firms adjust employment by varying the number of workers rather than the number of hours per worker.

Firms maximize the discounted value of future profits. Firm i's state variable is the number of workers currently employed h_i. The firm's key decision is the number of vacancies. Firms open as many vacancies 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. The firm's problem becomes:

$$V^J(h_i) = \max_{h'_i, v_i}\left\{\frac{P_i(y_i)}{P}y_i - w(h_i)\,h_i - \Phi_V v_i + \frac{1-\delta}{1+r}V^J(h'_i)\right\} \tag{6}$$

subject to

$$\begin{aligned}
\text{demand function:} \quad & \frac{P_i(y_i)}{P} = \left(\frac{y_i}{\frac{1}{n}I}\right)^{-\frac{1}{\sigma}} & (7)\\
\text{production function:} \quad & y_i = Ah_i & (8)\\
\text{transition function:} \quad & h'_i = (1-\widetilde{\chi})\,h_i + q(\theta)\,v_i & (9)\\
\text{wage curve:} \quad & w(h_i) & (10)
\end{aligned}$$

where the wage curve is the result of individual bargaining as described in section 2.3.1. The firm's problem takes into account that a measure δ of firms exits each period.

[7] This argument is formalized in Cahuc and Wasmer (2001). Smith (1999) examines individual bargaining in a multi-worker firm under perfect competition and decreasing returns to scale, the other case in which the one-worker-per-firm assumption breaks down.

[8] 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.

The first order condition states that the marginal value of an additional worker must equal the cost of searching for him/her, weighted by the probability of firm survival $1-\delta$:

$$\frac{\Phi_V}{q(\theta)} \frac{1+r}{1-\delta} = \frac{\delta V^J(h_i')}{\partial h_i'} \tag{11}$$

while the envelope condition gives the value of the marginal worker to the firm:

$$\frac{\partial V^J(h_i)}{\partial h_i} = \frac{\sigma-1}{\sigma} A \frac{P_i(y_i)}{P} - w(h_i) - h_i \frac{\partial w}{\partial h_i} + (1-\widetilde{\chi}) \frac{\Phi_V}{q(\theta)} \tag{12}$$

This latter equation will be useful in the treatment of wage bargaining in the following subsection, as it gives the firm's surplus in the bargaining problem.

Combining (11) with the envelope condition and using the definition of demand elasticity $-\frac{1}{\sigma} = \frac{\partial P_i}{\partial y_i} \frac{y_i}{P_i}$ yields the firm's Euler equation for employment:

$$\frac{\Phi_V}{q(\theta)} = \frac{1-\delta}{1+r} \left[\frac{\sigma-1}{\sigma} A \frac{P_i(y_i')}{P} - w(h_i') - h_i' \frac{\partial w}{\partial h_i'} + (1-\widetilde{\chi}) \frac{\Phi_V}{q(\theta')} \right] \tag{13}$$

This Euler equation describes the firm's optimal employment decision. The left hand side represents the cost to hiring the marginal worker, the cost per vacancy Φ_V multiplied by the number of vacancies to hire a worker $\frac{1}{q(\theta)}$.[9] The right hand side represents the discounted future benefits to hiring the marginal worker. The first two terms in brackets are standard, representing the worker's marginal revenue product net of wages. The third term, $h_i' \frac{\partial w}{\partial h_i'}$, reflects firms' correct anticipation that the bargained wage (i.e. the wage curve) will be a function of the firm's employment level h_i. In section 2.3 we will connect this wage bargaining term to the hiring externality. The fourth term in brackets represents the future savings in hiring costs from having hired the worker today, taking into account the probability of separation $\widetilde{\chi}$.

2.3 Wage Bargaining

In this section we describe the wage bargaining, allowing us to generate the wage curve and complete the description of the firm's optimal employment decision. In the neoclassical framework, workers are paid their marginal products. The natural extension to a bargaining environment is the individual bargaining setup introduced by Stole and Zwiebel (1996). The key assumption of the individual bargaining framework is that firms cannot commit to long-term employment contracts, and may renegotiate wages with

[9] In a one-worker firm model, $\frac{1}{q(\theta)}$ represents the average duration to fill a vacancy. In the multi-worker firm model, however, $q(\theta) v_i$ is the number of workers hired by posting v_i vacancies. To hire one worker, then, the firm should post $\frac{1}{q(\theta)}$ vacancies.

each worker at any time, making each worker effectively the marginal worker. The firm's inability to commit is the key characteristic of the 'employment at will' environment dominant in US labor markets. Also, individual bargaining involves bargaining over wages only, since an individual worker can only deprive the firm of her own marginal product, which does not give the worker sufficient leverage to negotiate hiring.

We later calibrate to US labor markets, in which 'employment at will' is dominant, and which are hence better characterized by individual than collective bargaining. In the time period we consider, between 78% and 90% of private sector workers were not covered by a collective bargaining agreement, according to CPS data reported in Hirsch and Macpherson (2003).

2.3.1 Individual Bargaining Solution

Under individual bargaining, the firm's outside option is not remaining idle, but rather producing with one worker less. The key point of the individual bargaining framework is that each worker is treated as the marginal worker, so that the bargaining problem becomes:

$$\max_{w} \beta \ln V_W + (1-\beta) \ln \frac{\partial V_J}{\partial h_i} \tag{14}$$

where β is the worker's bargaining power. Substituting the expressions for worker's surplus (5) and firm's surplus (12) into the first order condition of (14) leads to a first-order linear differential equation in the wage

$$\begin{aligned}(1-\tau_L)\, w(h_i) &= (1-\beta)\, b - \frac{1-\beta}{1+r}\left[1-\chi-f(\theta)\right] V_W' \\ &\quad +\beta(1-\tau_L)\left[\frac{\sigma-1}{\sigma}\frac{P_i(y_i)}{P}A - h_i\frac{\partial w}{\partial h_i} + (1-\widetilde{\chi})\frac{\Phi_V}{q(\theta)}\right]\end{aligned} \tag{15}$$

The differential equation (15) has a standard solution, which is derived in the appendix. The important assumption made in deriving (16) is that future surplus V_W' is not a function of current firm-level employment h_i or of the current firm-level bargained wage $w(h_i)$. This assumption will be confirmed in the following subsections, as the future value of worker's surplus V_W' will turn out to depend only on aggregate variables.

$$\begin{aligned}(1-\tau_L)\, w(h_i) &= (1-\beta)\, b - \frac{1-\beta}{1+r}\left[1-\chi-f(\theta)\right] V_W' \\ &\quad +\beta(1-\tau_L)\left[\frac{\sigma-1}{\sigma-\beta}\frac{P_i(y_i)}{P}A + (1-\widetilde{\chi})\frac{\Phi_V}{q(\theta)}\right].\end{aligned} \tag{16}$$

2.3.2 Labor demand and the wage curve

We can now obtain a closed form for the firm's Euler equation (13) by taking the slope of (16) $h_i' \frac{\partial w}{\partial h_i'} = -\frac{\beta}{\sigma}\frac{\sigma-1}{\sigma-\beta} A \frac{P_i(y_i)}{P}$ to obtain a closed form for the firm's Euler equation:

$$\frac{\Phi_V}{q(\theta)} = \frac{1-\delta}{1+r}\left[\frac{\sigma-1}{\sigma-\beta} A \frac{P_i(y_i')}{P} - w(h_i') + (1-\widetilde{\chi})\frac{\Phi_V}{q(\theta')}\right] \tag{17}$$

Equation (17) can be interpreted as a job creation or as a labor demand expression which relates the firm's wage $w(h_i)$ to its employment level h_i.

Proposition 1: *The wage curve takes the form:*

$$(1-\tau_L) w(h_i) = (1-\beta) b + \beta (1-\tau_L)\left[\frac{\sigma-1}{\sigma-\beta}\frac{P_i(y_i)}{P} A + \frac{1}{1-\delta}\Phi_V \theta\right] \tag{18}$$

Proof. See the appendix. ■

The derivation of the wage curve exploits that the value of worker's surplus depends only upon aggregate variables[10]:

$$\frac{1}{1+r} V_W' = \frac{\beta}{1-\beta}\frac{1}{1-\delta}\frac{\Phi_V}{q(\theta)}$$

The intuition is that worker's surplus derives from the worker's threat to leave the firm, depriving the firm of the worker's contribution to profits and imposing hiring costs on the firm. The hiring costs depend only upon aggregate labor market conditions, as summarized by labor market tightness θ. The firm's optimal employment choice guarantees that the marginal contribution to profits (the right hand side of (17)) is equal to the cost of hiring that worker (the left hand side of (17)). This implies that both components of the worker's surplus can be expressed in terms of hiring costs, which depend only upon the aggregate variable θ and parameters.

3 Equilibrium

At this point, we impose steady-state and proceed to find the equilibrium in three steps[11]. First, we find the firm-level equilibrium, that is, the wage-employment pairs that result from the interplay of the firm's optimal hiring decision and the wage bargaining. The firm's optimal hiring decision involves overhiring due to a hiring externality, which is described analytically. Next, we find the short run general equilibrium, which amounts

[10] See the proof of Proposition 1 for a detailed derivation.

[11] Note that our framework can easily handle shocks, and we could solve the model by log-linearizing or by applying a variety of other numerical methods. Since our quantitative analysis focuses on long-run changes in the competitive environment facing firms, we concentrate on the steady state here.

to finding the equilibrium degree of labor market tightness θ while holding the degree of competition σ facing the firms constant. This will allow us to obtain expressions for all equilibrium variables as functions of competition σ. In a final step, we will introduce entry costs, which will serve to endogenize the degree of competition $\sigma(n)$ and hence the number of firms in the economy n. This last equilibrium will be referred to as long-run equilibrium.

3.1 Firm-level Equilibrium

In this section, we find the firm's optimal employment-wage pair when it takes the aggregate variables (labor market tightness θ and competition σ) as given.

Definition 1 *Firm-level Equilibrium*
A firm-level equilibrium is defined as a pair of real wages and firm-level employment h_i which satisfies both labor demand (17) and the individual bargaining wage curve (18), taking aggregate variables (θ, σ, I) as given.

This firm-level equilibrium is found at the intersection of steady-state labor demand (17) and the wage curve (18), as illustrated in Figure 4. Formally, we obtain:

$$A\frac{P_i(y_i)}{P} = \frac{\sigma-\beta}{\sigma-1}\left[\frac{1}{1-\tau_L}b + \frac{\beta}{1-\beta}\frac{1}{1-\delta}\Phi_V\theta + \frac{1}{1-\beta}\frac{\Phi_V}{q(\theta)}\frac{r+\chi}{1-\delta}\right] \tag{19}$$

$$(1-\tau_L)\,w(h_i) = b + \frac{\beta}{1-\beta}\frac{1}{1-\delta}(1-\tau_L)\frac{\Phi_V}{q(\theta)}\left[r+\chi+f(\theta)\right] \tag{20}$$

Equation (19) expresses firm-level employment implicitly, while equation (20) gives the firm-level equilibrium wage. Also note that although firm-level equilibrium wages do not depend explicitly on σ, they will depend on competition indirectly, via equilibrium labor market tightness θ.

3.2 Hiring Externality

The individual bargaining solution presented above displays a hiring externality of the type first explored in partial equilibrium by Stole and Zwiebel (1996). To see this, first recall that in the standard one-worker firm setup, optimal hiring implies that marginal (revenue) product is equated to the cost of employing a worker. In our case, however, this equilibrium relationship is modified by the presence of an overhiring term. Specifically, rearranging the firm's Euler equation (17) yields

$$\underbrace{\frac{\sigma-1}{\sigma}A\frac{P_i(y_i)}{P}}_{\text{MRP}_i} = \underbrace{\frac{\sigma-\beta}{\sigma}}_{\text{overhiring factor}}\underbrace{w(h_i) + \frac{\Phi_V}{q(\theta)}\frac{r+\chi}{1-\delta}}_{\text{wage + hiring cost}} \tag{21}$$

The overhiring factor $\frac{\sigma-\beta}{\sigma}<1$ expresses the fact that firms optimally hire workers beyond the point at which employment costs are recouped by marginal product[12]. Firms are willing to hire the marginal worker whose MRP does not cover their employment costs, because hiring more workers when MRP is declining serves to depress wages due to $h_i \frac{\partial w}{\partial h_i}<0$. Formally

$$h_i \frac{\partial w}{\partial h_i}=-\frac{\beta}{\sigma} \frac{\sigma-1}{\sigma-\beta} A \frac{P_i\left(y_i\right)}{P}<0 \tag{22}$$

From (22), it is easy to see that the hiring externality is increasing in worker's bargaining power β and decreasing in competition σ. The steeper is MRP, the greater the wage decline to a marginal increase in the firm's employment. The hiring externality disappears in the perfect competition limit as $\sigma \rightarrow \infty$ or if $\beta=0$.

This is analogous to the overhiring results in Stole and Zwiebel (1996) and Smith (1999). In these papers, however, the source of decreasing MRP is not monopoly power but decreasing returns to scale in production. Also, our finding that overhiring disappears under perfect competition is in line with the results of Cahuc and Wasmer (2001).

3.3 Short Run General Equilibrium

Now, we determine the short-run general equilibrium, taking as given the degree of competition. In our setting, this is equivalent to pinning down all equilibrium variables as functions of the degree of competition $\sigma(n)$. This will allow us to determine the impact of increasing competition on equilibrium unemployment and wages. We assume a continuum of identical firms that are uniformly distributed over the unit interval.

Definition 2 *Short-run General Equilibrium*
A short-run general equilibrium is defined for given n and parameters $(\beta, b, \Phi_V, \delta, \chi, \sigma, r, A)$ as a value of θ which:
(i) is a firm-level equilibrium satisfying (19)-(20)
(ii) satisfies the aggregate resource constraint

$$I=\int_0^n \frac{P_i\left(y_i\right)}{P} y_i d i \tag{23}$$

Due to symmetry, the price ratio becomes unity, (23) reduces to $I=n y_i$ and (19) leads to the short-run equilibrium condition

$$A=\frac{\sigma-\beta}{\sigma-1}\left(\left(1-\tau_L\right) b+\frac{r+\chi+\beta f(\theta)}{(1-\beta)(1-\delta)} \cdot \frac{\Phi_V}{q(\theta)}\right) \tag{24}$$

[12] This breakdown is due to Cahuc, et. al. (2007).

The short-run general equilibrium condition (24) is monotonically increasing in θ, so that existence of equilibrium is guaranteed if

$$A > \frac{\sigma - \beta}{\sigma - 1}\left(1 - \tau_L\right) b \tag{25}$$

When the economy approaches full competition as $\sigma \to \infty$, (25) reduces to the standard condition $A > b$ that workers' productivity productivity be greater in employment than in unemployment.

Equation (24) is key, since it relates the degree of competition σ to short-run equilibrium labor market tightness θ. Once we have tightness as a function of competition $\theta(\sigma)$, we can obtain the short-run equilibrium unemployment rate from the Beveridge curve:

$$u(\sigma) = \frac{\chi}{\chi + f(\theta(\sigma))} \tag{26}$$

We normalize the number of agents in the economy to unity. We can find equilibrium aggregate employment as $H(\sigma) = 1 - u(\sigma)$. With $H(\sigma)$ in hand we can find aggregate output and subsequently the equilibrium quantity of good i, and of course short-run equilibrium employment per firm $h_i(\sigma)$ and price $P_i(y_i)$, all in terms of the given degree of competition.

3.3.1 Comparative Statics I: Varying Competition

The characterization of short-run equilibrium allows us to examine the qualitative impact of varying the degree of competition σ on short-term equilibrium unemployment and wages. We identify two main channels by which an increase in competition affects employment and unemployment: (1) the first principles output-expansion channel, which has been discussed by Blanchard and Giavazzi (2003) and (2) the hiring externality channel, which is unique to our analysis of product market deregulation. Via the output expansion channel, increased competition leads to increased employment and decreased unemployment, while the hiring externality channel works in the opposite direction.

Expanding equation (24) allows us to examine these two channels formally:

$$A = \underbrace{\frac{\sigma - \beta}{\sigma}}_{\text{overhiring} <1} \underbrace{\frac{\sigma}{\sigma - 1}}_{\text{output expansion} >1} \left(\frac{1}{1 - \tau_L} b + \frac{r + \chi + \beta f(\theta)}{(1-\beta)(1-\delta)} \cdot \frac{\Phi_V}{q(\theta)}\right) \tag{27}$$

The output expansion term is simply the markup of the monopolistically competitive firm $\frac{\sigma}{\sigma-1} > 1$. The greater is monopoly power, the greater is the markup, and the smaller is equilibrium tightness θ for given technology A. By the Beveridge curve (26), equilibrium unemployment is decreasing in tightness, so greater monopoly power leads to higher unemployment.

The hiring externality term $\frac{\sigma-\beta}{\sigma} < 1$ is the overhiring factor discussed in the previous subsection. When the overhiring term decreases (if monopoly power or bargaining power β increase), then equilibrium tightness θ increases and unemployment decreases. The overhiring factor counteracts the output expansion effect.

The combined effect of output expansion and overhiring is given by $\frac{\sigma-\beta}{\sigma-1} > 1$, so that the net effect of increasing monopoly power (i.e. decreasing σ) is to increase unemployment. Clearly, however, since $\frac{\sigma-\beta}{\sigma-1} < \frac{\sigma}{\sigma-1}$, the increase in unemployment is smaller than it would be in the absence of the overhiring effect. By just how much overhiring dampens the impact of monopoly power on unemployment is a quantitative question which we will address in the next section.

This comparative static results for short-term equilibrium is summarized in Lemma 1 and Proposition 2. All proofs are found in the appendix.

Lemma 1: *Short-run equilibrium labor market tightness is a strictly increasing function of demand elasticity σ.*

Proposition 2: *In short-run equilibrium:*
(i) unemployment is strictly decreasing in competition σ,
(ii) wages are strictly increasing in competition σ.

Proposition 2 also establishes that equilibrium wages are increasing in the degree of competition. This conclusion is the opposite of that drawn by the literature on wages and the sharing of monopoly rents (e.g. van Reenen (1996)). The source of the disparity is that the rent-sharing papers typically look at the partial impact on only one isolated industry, while we consider broader increases in competition which affect all industries at once. The general equilibrium effect of greater competition is to increase vacancies and tightness in all sectors, making it easier for unemployed workers to find jobs. This increases the value of the worker's reservation utility V^U, thereby improving the worker's threat point and increasing his/her wage. In addition, equilibrium match surplus, given by $\frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta)}\frac{r+\chi}{1-\delta}$, is also increasing in competition. The reason is that in equilibrium the value of the marginal worker is the cost of searching for him/her, which increases with θ and hence with σ (see Lemma 1). Hence, equilibrium wages are increasing in the economywide degree of competition.

The empirical literature is silent on the impact of the economywide degree of competition on wages (or wage shares). To get an idea of whether the wage share might be increasing in competition (e.g. whether the wage share is decreasing in regulation), we regress a measure of entry regulation on the wage share for a group of OECD countries, as illustrated in Figure 3[13]. The correlation is highly negative (-0.804) and significant

[13]The data on labor share is the compensation to GDP ratio taken from Gollin (2002), table 2, column 4. The data on entry regulation is the regulation index of Fonseca, et. al. (2001), table 2, table 4.

at the 1% level. Although this is only illustrative of the data, it is suggestive that wage shares might be indeed be increasing in competition in the data. It is also consistent with the positive wage effect of competition suggested by Blanchard and Giavazzi (2003).

3.3.2 Comparative Statics II: Varying Parameters

Proposition 3 summarizes the impact of varying parameters on short-run equilibrium.

Proposition 3: *In short-run equilibrium:*
(i) labor market tightness θ is decreasing in b, Φ_V, r, δ, and $\widetilde{\chi}$;
(ii) unemployment is increasing in b, Φ_V, r, δ, and $\widetilde{\chi}$;
(iii) labor market tightness is decreasing in β and unemployment is increasing in β as long as $\sigma > \widetilde{\sigma}$ where

$$\widetilde{\sigma} \equiv \frac{(1-\tau_L)\, b + \frac{\Phi_V}{q(\theta)} \frac{1}{(1-\delta)(1-\beta)} \left[\frac{r+\chi+\beta f(\theta)}{1-\beta} + \beta f(\theta) \right]}{\frac{\Phi_V}{q(\theta)} \frac{1}{(1-\delta)(1-\beta)} \left[\frac{r+\chi+\beta f(\theta)}{(1-\beta)} + f(\theta) \right]}$$

The results of parts (i) and (ii) of Proposition 3 are standard for search and matching models. Higher unemployment benefits, hiring costs, interest rates and separation rates all increase unemployment. Part (iii) merits comment. Unemployment increases in worker's bargaining power (as is standard), unless the degree of competition is very low. The intuition is that when competition is low, higher worker's bargaining power strengthens the overhiring effect (i.e. increases firms' incentives to hire more workers in the sense that $\frac{\partial^2 w_i}{\partial h_i \partial \beta} - \frac{\sigma-1}{(\sigma-\beta)^2} \frac{A}{h_i} \frac{P_i(y_i)}{P} < 0$) so much, that the end result is lower unemployment.

3.4 Long-run General Equilibrium

Now we are ready to endogenize the degree of competition. In the long-run, firms may enter each industry by paying a real entry cost Φ_E and by posting enough vacancies to hire the steady-state workforce. The details of firm entry and exit are as follows: Each period a measure δ of firms exits, and is replaced by a measure δ of new entrants[14]. New entrants begin production immediately with their steady-state workforce. Hence, we assume that entering firms know far enough in advance that they will be entering to complete all entry formalities. During this (these) pre-entry period(s) firms pay the entry cost. Because of the constant marginal vacancy posting cost they optimally post enough vacancies to hire their steady-state workforce immediately[15]. Entry by firms will continue

[14] Recently, Felbermayr and Prat (2006) have extended our framework to allow for endogenous firm entry and exit.

[15] Note that it is not necessary to take the measure δ of pre-entry firms into account in aggregate income. They do not yet produce, and only incur vacancy costs. Hence the firm's profits and vacancy costs sum to zero.

until profits net of entry costs have been competed down to zero. Hence, free entry in the presence of barriers to entry leads to an equilibrium number of firms n^*, which is defined implicitly by:

$$\Phi_E\left(\sigma\left(n^*\right)\right)+\Phi_V \frac{h_i\left(\sigma\left(n^*\right)\right)}{q\left(\theta\left(\sigma\left(n^*\right)\right)\right)}=V^J\left(h_i\left(\sigma\left(n^*\right)\right)\right) \tag{28}$$

The free entry condition states that the entry cost plus initial hiring costs must be amortized by profits over the firm's expected lifespan. Since equilibrium profits are decreasing in competition $\frac{\partial V^J}{\partial \sigma}<0$, free entry forges a negative link between barriers to entry and the degree of competition/the number of firms in the economy[16].

Entry barriers take two complementary forms, time and pecuniary costs. For 1997 we have detailed data on the number of business days it takes to set up a standardized OECD firm as reported by Pissarides (2001) and on entry fees as a percentage of per capita GDP from Djankov, et. al. (2002). We combine the two measures into a single one by adding up the entry costs as a percentage of monthly per capita GDP and the lost output of a single firm during the entry delay period. Formally, total barriers to entry are found as:

$$\Phi_E\left(\sigma\left(n\right)\right)=d\cdot y_i+\varphi\cdot I\left(\sigma\left(n^*\right)\right) \tag{29}$$

where d is the regulatory delay in months, y_i is firm-level output, φ are entry fees as a percentage of monthly per capita GDP, and $I\left(\sigma\left(n^*\right)\right)$ is aggregate income. Combining (29) with the free entry condition (28) yields:

$$d\cdot y_i+\varphi\cdot I\left(\sigma\left(n^*\right)\right)+\Phi_V \frac{h_i\left(\sigma\left(n^*\right)\right)}{q\left(\theta\left(\sigma\left(n^*\right)\right)\right)}=V^J\left(h_i\left(\sigma\left(n^*\right)\right)\right) \tag{30}$$

Equation (30) closes the long-run equilibrium. It determines the endogenous number of firms n^* and the degree of competition $\sigma\left(n^*\right)$ in long-run equilibrium by defining a negative relationship between barriers to entry and the degree of competition in the long-run.

4 Quantitative Results

We are now in a position to calibrate our model and approach our quantitative questions. We explore two alternative calibrations: a traditional calibration along the lines of Shimer (2005) and a small surplus calibration similar to that in Hagedorn and Manovskii (2008). For each calibration we ask: What is the impact of increasing competition on equilibrium

[16] To forge an explicit link between barriers to entry and the number of firms, one may take two routes. We follow Blanchard and Giavazzi (2003) and assume that σ is an increasing function of the number of firms. Alternatively, one may hold σ constant, and allow for n firms competing via Cournot in each industry. In a previous version of this paper, we followed this second setup. Results are very similar to those of the simpler Blanchard and Giavazzi (2003) setup presented here, and are available upon request.

unemployment and wages? In order to answer the question, we run policy experiments designed to assess whether the product market deregulation of the late 1970's and early 1980's could account for the subsequent decline in US unemployment during the 1980's and 1990's. In addition, we examine whether other factors, such as the decline in labor taxation or the waning of union bargaining power could account for the decline in unemployment. Finally, we go on to quantify the overhiring effect.

4.1 Calibration

Our model period is one month. All parameters for both the traditional and the small surplus calibration are reported in Table 4. In both cases, we calibrate the model to US data in 1998.

The majority of parameters is common to both calibrations. We normalize the level of technology A to unity. Our choice of 4.0% for the annualized real interest rate is standard. We set the job-finding rate $f(\theta)$ to be 0.45 monthly following Shimer (2005), and target the 1998 HP-trend value for unemployment of 5.1%[17] by setting the total separation rate $\chi = 0.024$ monthly, roughly in line with the estimates in Shimer (2004). We set $\delta = 0.8\%$, so that the monthly probability that a firm will cease to exist implies an annual firm survival rate of 90.8%. This matches the average five-year survival probability reported by Wagner (1994) and is in line with the four-year survival probabilities reported in Mata and Portugal (1994), which imply monthly exit rates between 0.6 and 1.4%. We set worker's bargaining power so that $\beta = 0.50$[18], in line with the estimates of Abowd and Allain, 1996 and Yashiv, 2001. We let matching elasticity take the value, $\eta = 0.50$[19], in the range reported by Petrongolo and Pissarides (2001). We also choose $q(\theta) = 0.238$, as in den Haan, Ramey and Watson (2000). Our choices for job-finding and job-filling rates pin down US equilibrium labor market tightness in 1998 to be $\theta = \frac{f(\theta)}{q(\theta)} = 1.89$.[20] This value for tightness looks high at first glance. However, 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's matching rate, we find a ratio of open jobs to unemployed of 45%, in line with the findings of Shimer (2005). We set the scaling parameter of the matching function to satisfy $s = \frac{f(\theta)}{\theta^{1-\eta}}$. In

[17] We wish to concentrate on the long-run impact of regulation, abstracting from business cycle considerations. Hence, we use the HP-trend value, in which the business cycle component has been filtered out.

[18] Hagedorn and Manovskii (2008) choose β to match the wage elasticity of productivity. They obtain a very small value of $\beta = 0.052$. We will discuss the impact of such low values of bargaining power on our results later in the paper.

[19] In a previous version of the paper, we established that the Hosios condition is a necessary but not a sufficient condition for efficiency in our setup.

[20] Pinning down the value of θ does not fully describe short-run equilibrium, as long as some other variables or parameters are left free. In our case, these parameters will be Φ_V and b.

both the traditional and small surplus baseline calibrations, we set labor taxes to 32% to match the 1998 labor wedge reported in Prescott (2002)[21]. Tax revenues are redistributed to households in the form of lump-sum transfers. Finally, we need to parameterize the function relating demand elasticity to the number of firms. In a fully microfounded formulation of Cournot competition within industries[22], the demand elasticity faced by the firm is given by $\overline{\sigma} \cdot n$, where n is the number of firms. For this reason, we choose $g(n) = n$ and normalize $\overline{\sigma} = 1$.

4.1.1 Traditional vs Small Surplus Calibration

At this point, we are left with a short-run equilibrium condition (24) which relates the utility from unemployment b to the vacancy posting costs Φ_V. We first decompose[23] total utility from unemployment b into an unemployment benefits component b_b and a home production or leisure component b_h, so that $b = b_b + b_h$. Next, we choose the benefits component $b_b = 0.187$ so that the net benefit replacement rate $\frac{b_b}{w(1-\tau_L)} = 0.30$, in line with US data. Finally, for the traditional calibration we choose the home production or leisure component $b_h = 0.198$ so that the model's semi-elasticity of unemployment with respect to benefits is equal to 2.0, as estimated by Costain and Reiter (2008). The resulting total replacement rate $\frac{b}{w(1-\tau_L)}$ is 0.62[24].

In the small surplus calibration, targeting a semi-elasticity of benefits of 14.0 leads to a home production component of benefits of $b_h = 0.326$ and a total replacement rate $\frac{b}{w(1-\tau_L)} = 0.95$, as in Hagedorn and Manovskii (2008). Hence, the only difference between the traditional and small surplus calibrations is the home production component of utility b_h and hence the total utility from unemployment b.

4.1.2 Entry Costs

For 1997, we can use the detailed entry cost data reported in Table 1, resulting in entry costs for the US corresponding to 0.6 months of aggregate per capita income. Djankov, et. al. (2003) report entry fees of 1.0% of annual per capita income, or 12% of monthly per capital income. Pissarides (2001) compiles an index for entry delay as the number of business days it takes (on average) to fulfill entry requirements, weighted by the number of procedures that must be performed. The US entry delay index is 8.6 days, or 0.47

[21] We also looked at a setting with both a labor tax and a consumption tax, and the results were very similar.

[22] cf. Gali and Zilibotti (1994) for such a framework.

[23] Due to linear utility, of course, only the total utility from unemployment b matters for our calibration. The breakdown into benefit and home production components will be useful later, however, in the policy experiments.

[24] Note that we could also target the total benefit replacement rate directly, and report the implied semi-elasticity of unemployment with respect to benefits.

months of lost output, based on 220 business days in a year. Adding the two measures yields total entry costs equal to 0.59 months of output. In what follows, we will call our composite measure of entry fees and entry delay costs for 1997 the Djankov/Pissarides index.

For 1978, such detailed entry cost data is unavailable. However, Nicoletti and Scarpetta (2003) have compiled an index on product market regulation for a set of 21 countries whose starting date is 1978 and whose ending date is 1998. These 1978 and 1998 index values are displayed in the middle columns of Table 2 for the subset of 17 countries for which both Nicoletti and Scarpetta (2001)'s panel index for 1978-1998 and the detailed cross section data for 1997 is available.

In order to estimate US entry costs, we use a triangulation procedure. To estimate entry costs in 1978, we first run the following regression:

$$\text{Djankov/Pissarides}_{1997,i} = \alpha_0 + \alpha_1 \cdot \text{Nicoletti/Scarpetta}_{1998,i} + \varepsilon_i \tag{31}$$

The results of the regression are reported in Table 3. We first note that the correlation between Nicoletti and Scarpetta's index in 1998 and our combined Pissarides/Djankov index (first column of Table 2) is very high at 0.77. Hence, both indices seem to be measuring the same things. The estimate of $\widehat{\beta}$ is highly significant, with a $t-$Statistic of 4.7, while the estimate for $\widehat{\alpha}$ is marginally significant. Next, we use the estimates $\widehat{\alpha}$ and $\widehat{\beta}$ to transform the Nicoletti and Scarpetta index value for 1978 into a Djankov/Pissarides-style index for 1978, by taking

$$\text{Djankov/Pissarides}_{1978,i} = \widehat{\alpha}_0 + \widehat{\alpha}_1 \cdot \text{Nicoletti/Scarpetta}_{1978,i} \tag{32}$$

The results of the projection (32) are displayed in the last column of Table 2. For the US, the resulting measure of entry costs for 1978 is 5.2 months of per capita output, a nearly 9-fold increase.

4.1.3 Baseline 1998 Calibrations

The results of the traditional and small surplus baseline calibrations to the US economy in 1998 are presented in Figures 5 and 6 respectively. The bottom right panel of Figure 5 shows that under the traditional calibration, 1998 US entry cost and profits are equalized when demand elasticity σ is 8.2, which corresponds to a markup of 7.0%[25]. The bottom right panel of Figure 6 shows that under the small surplus calibration, the 1998 US long-run equilibrium implies demand elasticity of 18.8 and a somewhat smaller markup of

[25] Under individual bargaining, the markup is given by $\frac{\sigma-\beta}{\sigma-1}$.

2.8%[26].

Figures 5 and 6 also show how unemployment and wages respond to varying degrees of product market competition. As expected, unemployment is decreasing and real wages are increasing in competition, where competition is measured as demand elasticity σ. We note that the bulk of the impact of monopoly power on wages and unemployment occurs under very low levels of demand elasticity. This is consistent with the empirical results of Bresnahan and Reiss (1991), who find that most of the benefits to increased competition come from the entry of the first three to five competitors, with very little benefits accruing to further entry.

4.2 Product Market Deregulation and the Labor Market

We now use the model to run a policy experiment, in order to assess to what extent product market deregulation can account for the decline in U.S. unemployment during the 80's and 90's. We do this by taking the 1998 US baseline model calibrated above as a starting point, and then examining the impact of raising entry costs to 1978 levels. We emphasize that we are interested in matching the unemployment differential from HP-trend data from which the business cycle component has been filtered out, in line with our focus on the long-run impact of a change in product market regulation.

To run the experiments, we hold the utility from home production b_h fixed in 1998 and 1978, and adjust b_b so that the benefit replacement rate $\frac{b_b}{w(1-\tau_L)}$ remains fixed at 30%. All other parameters are held fixed at their 1998 levels.

Results of the deregulation policy experiment are presented in Tables 5 and 6. In the traditional calibration, changes in product market regulation can only account for a surprisingly small change in equilibrium unemployment. Raising entry costs nearly nine-fold to their 1978 levels does lead to a substantial decrease in competition, causing markups to increase by about 50%, from 7.0% to 10.6%. The resulting increase in unemployment is very small, however, at less than two-tenths of one percentage point, causing unemployment to rise from 5.10% to 5.26%. In contrast, in the data, trend unemployment increases from 5.1% in 1998 to 7.2% in 1978, as shown in Figure 1.

Under the small surplus calibration, however, we find that product market deregulation can account for nearly the entire decrease in unemployment between 1978 and 1998. In particular, raising entry costs to their 1978 levels causes unemployment to rise from 5.10% to 7.2%, an increase of 2.1 percentage points[27]. However, the small surplus calibration is controversial. As emphasized by Costain and Reiter (2008), it involves counterfactually high benefit semi-elasticities. In our case, the benefit semi-elasticity is

[26] *The greater degree of equilibrium competition (higher σ) and lower markups are due to the smaller profits in the small surplus calibration.*

[27] Markups increase from 2.8% in 1998 to 6.9% in 1978.

14.0, while Costain and Reiter (2008)'s estimates place it at 2.0. This tension between the small and large surplus calibration is the same as in the unemployment volatility puzzle, where a small surplus calibration can explain high unemployment variation over the business cycle, but a large surplus calibration cannot.

In both calibrations, the quantitative impact of product market deregulation on wages is modest. Under the traditional calibration, deregulation increases net real wages by about 3.3%, from 0.602 in 1978 to 0.622 in 1998. Using the small surplus calibration leads to a slightly larger deregulation induced wage increase of 3.8%, as wages increase from 0.635 to 0.659.

4.3 Interactions

4.3.1 Labor taxation

Next, we examine the role of tax reform and interactions between product market deregulation and tax reform in accounting for the decline in unemployment between 1978 and 1998. In order to do this, we increase entry costs to their 1978 levels, and also increase the labor tax rate τ_L as much as necessary to generate the higher 1978 level of unemployment of 7.2%.

Results of this experiment are reported in Table 8. In order to generate the entire 1998 to 1978 unemployment differential of $\Delta u = 2.1\%$, labor tax rates would have had to be 56.6% in 1978, compared with 32.0% in 1998. In this case, tax reform would account for 81.1% of the unemployment difference, while the change in entry costs would only account for 18.9%.

4.3.2 Worker's bargaining power

Now we examine the role of a decline in worker's bargaining power over the 1980's and 1990's, and interactions between bargaining power and product market deregulation in accounting for the 1978-1998 decline in unemployment. Again, we both set entry costs to their 1978 levels and increase bargaining power as much as necessary to generate the higher 1978 level of unemployment of 7.2%.

Results of this experiment are reported in Table 9. The combined effect of increased entry costs and increasing worker's bargaining power from 50% to 66.6% would be to generate a 1978 unemployment rate of 7.2%. In this case, the increase in entry costs would only account for 10.7% of the unemployment change, while the increase in union bargaining power would account for 89.3%. From Table 9, one can see that this result is quite robust to the initial 1998 worker's bargaining power assumed.

The results in Table 9 are consistent with the econometric results of Fiori, et. al.

(2007), who report that employment gains in a panel of OECD countries have been larger when workers' bargaining power was initially high. As we increase the level of bargaining power, the contribution of product market deregulation in explaining the unemployment differential increases from 7 to 17%.

4.3.3 Matching efficiency

Finally, we consider an increase in matching efficiency during the 1980's and 1990's, and interactions between increased matching efficiency and product market deregulation. We run the experiment by both increasing entry costs to their 1978 levels and allowing matching efficiency to decrease sufficiently in 1978 so as to explain the entire 2.1 percentage point 1978-1998 unemployment differential.

Results of this experiment are reported in Table 10. In order to generate the increase in unemployment to its 1978 level of 7.2%, matching efficiency in 1978 would need to be about 50% lower in 1978 than in 1999, taking on a 1978 value of 0.24. In this case, the increase in entry costs would only account for about 10.1% of the unemployment change, while an decrease in matching efficiency would account for nearly 90%.

4.4 Quantifying Overhiring

In the policy experiment, we saw that the impact of monopoly power on unemployment under the traditional calibration was surprisingly small. In order to assess which role the hiring externality is playing in counteracting the first principles output expansion effect of increasing competition, we proceed to quantify the overhiring effect. To this end, we repeat our deregulation policy experiment while shutting down the overhiring effect. Formally, this is accomplished by replacing $\frac{\sigma-\beta}{\sigma-1} = \frac{\sigma}{\sigma-1}$ in equations (18), (19) and (24)[28]. This guarantees that firm-level equilibrium equates marginal revenue product and employment cost (wages plus hiring costs), as would be the case in a standard one-worker firm matching model. Of course, we also recalibrate the model, using the same targets as in the baseline traditional calibration. The results are given in Table 7 and Figure 7. The overhiring effect has essentially no impact on the increase in unemployment which can be attributed to higher 1978 entry costs. The reason is that although shutting down overhiring rotates the unemployment curve upwards somewhat, this non-optimal firm behavior also reduces firm's profits[29], so that equilibrium demand elasticities are increased and markups decreased in both 1978 and 1998. Now, moving from 1998 to 1978 increases markups from 4.9 % to 6.7 %, while in the presence of overhiring markups in 1998 and 1978 were 7.0% and 10.6% respectively. As a result, the decline in unemployment which

[28] This is equivalent to setting the overhiring factor $\frac{\sigma-\beta}{\sigma} = 1$.

[29] Recall that overhiring is optimal in our setting, while setting MRP to employment costs is suboptimal.

can be attributed to product market deregulation is nearly the same as in the presence of an overhiring effect.

Alternatively, one can shut down the overhiring effect, and examine the impact on unemployment of moving from a markup of 7.0% in 1998 (corresponding to a demand elasticity of 8.2) to a markup of 10.6% in 1978 (corresponding to a demand elasticity of 5.7 in 1978). Now, the impact on unemployment does increase slightly to 0.30 percentage points, compared to an increase of 0.16 percentage points in the presence of overhiring.

Hence, we conclude that the small impact of deregulation on unemployment under the traditional calibration does not depend only on the overhiring effect being operative.

4.5 Robustness

We now proceed to check the robustness of our quantitative results. We vary the calibration targets for the job-finding rates f, for the monthly rate of firm exit δ, the matching elasticity η, worker's bargaining power β and the semi-elasticity of unemployment to benefits ξ_b^u one-by-one, all in the traditional calibration. We do not vary the targeted job-filling rate q, as this would only renormalize the model.

The results of the robustness exercises are presented in Tables 11 and 12, both with and without overhiring. We find that our choice for all of these parameters is innocuous, with the exception of the semi-elasticity of unemployment to benefits ξ_b^u. As the semi-elasticity increases (i.e. as the total replacement rate $\frac{b}{w(1-\tau_L)}$ increases), the importance of deregulation in explaining the 2.1 percentage point unemployment difference between 1978 and 1998 also increases, as we have already seen from our results on the small surplus calibration.

The interaction between worker bargaining power β and the semi-elasticity of unemployment with respect to benefits ξ_b^u is especially noteworthy and depicted in Figure 9. For very low worker bargaining power (as assumed in Hagedorn and Manovskii, 2008), $\xi_b^u \approx 30$ would be needed to generate the 1978-1998 unemployment differential, while $\xi_b^u \approx 10$ is sufficient for $\beta = 0.95$.

5 Conclusions

The main objective of this paper has been to study the relationship between product market regulation and labor market outcomes. Our main contribution is twofold. First, we develop a dynamic model with imperfect competition and search frictions, which is well suited for the quantitative analysis of the present paper. Our model contains the interesting feature that the standard monopoly distortion of underproduction is partially offset by an overhiring incentive, especially when monopoly power is high.

We then use our model to ask whether the Carter/Reagan deregulation of the late 1970s and early 1980s could account for the subsequent decline in US trend unemployment rates. Our answer depends crucially on whether we employ a traditional or a small surplus calibration. Under the traditional calibration, increasing entry costs from their 1998 to their 1978 levels results in a very small increase in unemployment of less than two-tenths of one percentage point. Under the small surplus calibration, in contrast, the same increase in entry costs leads to an increase of 2.1 full percentage points in unemployment, accounting for the entire difference in HP-trend unemployment between 1978 and 1998.

We also interact product market deregulation with tax reform and a possible decline in worker's bargaining power. We find that our result that product market deregulation is unable to account for most of the decline in unemployment is robust to the inclusion of tax reform and declining worker's bargaining power. In order to account for the full 2.1 percentage point decline in trend unemployment, labor taxes would have had to decrease from 56.6% in 1978 to 32.0% in 1998, or worker's bargaining power would have had to decline from 66.6% in 1978 to 50% in 1998. In either case, the direct contribution from deregulation remains less than 20% of the entire differential. These theoretical findings are in line with the empirical results of Fiori, et. al. (2007), who find no significant employment effect of product market deregulation in countries where labor market policies are loose. This observation leads us to expect stronger effects for the more heavily regulated European economies.

Finally, we find that product market regulation could lead to modest increases in real wages, providing some support for the political economy arguments in favor of combining labor and product market reform found in Blanchard and Giavazzi (2003).

Table 1

Detailed Entry Costs for 1997

Dataset	OECD	OECD		Djankov, et. al.
Country	Days	Procedures	Index	Fees
Australia	5	6.5	12.3	2.1 %
Austria	40	10	35.2	45.4 %
Belgium	30	7	25.6	10.0 %
Denmark	5	2	5.6	1.4 %
Finland	30	7	25.6	1.2 %
France	30	16	39.3	19.7 %
Germany	80	10	55.2	8.5 %
Greece	32.5	28	58.7	48.0 %
Ireland	15	15	30.2	11.4 %
Italy	50	25	62.9	24.7 %
Japan	15	14	28.7	11.4 %
Netherlands	60	9	43.7	19.0 %
Portugal	40	10	35.2	31.3 %
Spain	117.5	17	84.5	12.7 %
Sweden	15	7	18.1	2.5 %
UK	5	4	8.6	0.6 %
United States	7.5	3.5	8.6	1.0 %

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 index's units are days. The first two columns draw on 1997 from Logotech S.A., as reported by the OCED [Fostering Entrepreneurship] and by Pissarides (2003). The fourth column gives Djankov, et. al. (2002)'s measure for fees required for entry in 1997, as a percentage of annual per capita GDP.

Table 2

Entry Costs in 1978 and 1998

Source →	OECD/Djankov	Nicoletti/Scarpetta	Nicoletti/Scarpetta	Projected
Units →	Months	Index	Index	Months
Country ↓	1997	1998	1978	1978
Australia	0.8	1.6	4.5	6.1
UK	0.5	1.0	4.3	5.7
United States	0.6	1.4	4.0	5.2
Denmark	0.4	2.9	5.6	8.1
Finland	1.4	2.6	5.6	8.1
Sweden	1.2	2.2	4.5	6.1
Austria	7.1	3.2	5.2	7.3
Belgium	1.3	3.1	5.5	7.9
France	4.2	3.9	6.0	8.8
Germany	3.7	2.4	5.2	7.3
Greece	8.6	5.1	5.7	8.3
Ireland	2.8	4.0	5.7	8.3
Italy	6.0	4.3	5.8	8.4
Japan	2.7	2.9	5.2	7.3
Netherlands	4.4	3.0	5.3	7.5
Portugal	5.4	4.1	5.9	8.6
Spain	5.6	3.2	4.7	6.4

The first column summarizes the entry costs of Table 1 by adding up the entry delay (as a fraction of a year) and the fees (as a fraction of annual per capita GDP) and then converting to months by multiplying by 12 to obtain a composite entry cost measure for 1997. The second and third columns present the product market regulation indices reported in Nicoletti and Scarpetta (2000) for 1998 and 1978. The correlation between the 1997 entry-cost based figures and the 1998 index is 0.77. The final column is the result of taking the 1978 index values and projecting them onto entry costs, using the coefficients from a regression of the 1998 index values onto 1997 entry costs (reported in Table 3 below). This gives an estimate of 1978 entry costs, denominated in months.

Table 3

Regression of Entry Costs and Product Market Regulation Index

	α_0	α_1
Estimated Coefficient	-2.09	1.81
Standard Error	1.22	0.39
t-Statistic	-1.71	4.70
Adjusted R^2	0.57	
Multiple R^2	0.77	

The regression equation is:

$$\text{Djankov/Pissarides}_{1997,i} = \alpha_0 + \alpha_1 \cdot \text{Nicoletti/Scarpetta}_{1998,i} + \varepsilon_i$$

Table 4

Calibration to US Data

Calibration Targets		Traditional	Small Surplus
Trend Unemployment Rate (%) 1998	u	5.10	5.10
Monthly Job Finding Rate	f	0.45	0.45
Monthly Job Filling Rate	q	0.24	0.24
Net Benefit Replacement Rate	$\frac{b_b}{(1-\tau_L)w}$	0.30	0.30
Semi-elasticity of unemployment/benefits	$\xi_b^u = \frac{\partial \ln u}{\partial b}$	2.0	14.0
Calibrated Parameters			
Vacancy Posting Cost	Φ_V	0.173	0.025
Unemployment Benefits	b_b	0.187	0.198
Utility from Home Production/Leisure	b_h	0.198	0.428
Total Replacement Rate	$\frac{b}{(1-\tau_L)w}$	0.62	0.95
Total Monthly Separation Rate	χ	0.024	0.024
Scale of Matching Function	s	0.327	0.327
Directly Observable Parameters			
Annual Real Interest Rate (%)	r	4.0	4.0
Labor Tax Wedge (%)	τ_L	32	32
Monthly Firm Death Probability (%)	δ	0.8	0.8
Entry Cost, 1998, (in months of firm's output)	$\Phi_{E,98}$	0.6	0.6
Entry Cost, 1978, (in months of firm's output)	$\Phi_{E,78}$	5.2	5.2
Other Parameters			
Worker Bargaining Power	β	0.5	0.5
Elasticity of Matching Function	η	0.5	0.5

Table 5

Baseline Results, Traditional Calibration

		Φ_E 1998	Φ_E 1978
Unemployment (%)	u	5.10	5.26
Unemploy. Duration	$\frac{1}{f}$	2.22	2.30
Vacancy Duration	$\frac{1}{q}$	4.20	4.07
Tightness	θ	1.89	1.77
Demand Elasticity	σ	8.18	5.72
Markup	$\frac{1-\beta}{\sigma-1}$	6.97	10.60
Net wage	$(1-\tau_L)\,w$	0.622	0.602

Table 6

Baseline Results, Small Surplus Calibration

		Φ_E 1998	Φ_E 1978
Unemployment (%)	u	5.10	7.21
Unemploy. Duration	$\frac{1}{f}$	2.22	3.21
Vacancy Duration	$\frac{1}{q}$	4.20	2.91
Tightness	θ	1.89	0.91
Demand Elasticity	σ	18.77	8.25
Markup (%)	$\frac{1-\beta}{\sigma-1}$	2.81	6.90
Net wage	$(1-\tau_L)\,w$	0.659	0.635

Table 7

Deregulation without Overhiring

		Φ_E 1998	Φ_E 1978
Unemployment (%)	u	5.10	5.25
Unemploy. Duration	$\frac{1}{f}$	2.22	2.29
Vacancy Duration	$\frac{1}{q}$	4.20	4.08
Tightness	θ	1.89	1.78
Demand Elasticity	σ	11.17	8.48
Markup (%)	$\frac{1-\beta}{\sigma-1}$	4.92	6.68
Net wage	$(1-\tau_L)\,w$	0.605	0.587

Table 8

Interactions with Tax Reform

	$\beta_{98} = 0.05$	$\beta_{98} = 0.30$	$\beta_{98} = 0.50$	$\beta_{98} = 0.70$	$\beta_{98} = 0.95$
Tax Rate on Labor in 1978	0.749	0.594	0.566	0.548	0.528
Fraction of Δu due to Entry Costs:	0.126	0.164	0.189	0.222	0.289

Table 9

Interactions with Worker Bargaining Power

	$\beta_{98} = 0.05$	$\beta_{98} = 0.30$	$\beta_{98} = 0.50$	$\beta_{98} = 0.70$	$\beta_{98} = 0.95$
Worker Bargaining Power in 1978	0.122	0.472	0.666	0.818	0.972
Fraction of Δu due to Entry Costs:	0.069	0.091	0.107	0.130	0.169

Table 10

Interactions with Matching Efficiency

	$\beta_{98} = 0.05$	$\beta_{98} = 0.30$	$\beta_{98} = 0.50$	$\beta_{98} = 0.70$	$\beta_{98} = 0.95$
Worker Bargaining Power in 1978	0.257	0.243	0.241	0.240	0.242
Fraction of Δu due to Entry Costs:	0.079	0.091	0.101	0.117	0.164

Table 11

Robustness to r, δ, β, η

	With Overhiring		Without Overhiring	
	Increase in u from 98–78	% of 98-78 differential	Increase in u from 98–78	% of 98-78 differential
$r = 0.01$	0.12	5.7	0.11	5.3
$r = 0.02$	0.13	6.3	0.12	5.8
$r = 0.03$	0.15	6.9	0.13	6.3
$r = 0.04$	0.16	7.5	0.14	6.9
$r = 0.05$	0.17	8.1	0.16	7.4
$\delta = 0.000$	0.04	2.0	0.04	1.9
$\delta = 0.005$	0.11	5.3	0.10	4.9
$\delta = 0.010$	0.19	9.0	0.17	8.2
$\delta = 0.015$	0.27	13.0	0.25	11.7
$\delta = 0.020$	0.37	17.4	0.36	15.6
$\beta = 0.05$	0.12	5.5	0.12	5.5
$\beta = 0.30$	0.14	6.6	0.13	6.3
$\beta = 0.50$	0.16	7.5	0.15	6.9
$\beta = 0.70$	0.19	8.9	0.16	7.6
$\beta = 0.95$	0.26	12.5	0.21	9.9
$\eta = 0.10$	0.15	7.0	0.14	6.6
$\eta = 0.20$	0.15	7.1	0.14	6.6
$\eta = 0.30$	0.15	7.2	0.14	6.7
$\eta = 0.40$	0.15	7.3	0.14	6.8
$\eta = 0.50$	0.16	7.5	0.15	6.9
$\eta = 0.60$	0.16	7.7	0.15	7.0
$\eta = 0.70$	0.17	8.0	0.15	7.2
$\eta = 0.80$	0.18	8.6	0.16	7.6
$\eta = 0.90$	0.22	10.4	0.18	8.8

Table 12

Robustness to ξ_b^u, f

	With Overhiring		Without Overhiring	
	Increase in u from 98–78	% of 98-78 differential	Increase in u from 98–78	% of 98-78 differential
$\xi_b^u = 0.5$	0.03	1.6	0.03	1.5
$\xi_b^u = 2.0$	0.16	7.5	0.15	6.9
$\xi_b^u = 4.0$	0.36	16.9	0.32	15.3
$\xi_b^u = 6.0$	0.59	28.2	0.53	25.0
$\xi_b^u = 8.0$	0.87	41.5	0.76	36.2
$\xi_b^u = 10.0$	1.21	57.4	1.04	49.3
$f = 0.10$	0.13	6.3	0.12	5.8
$f = 0.25$	0.15	7.0	0.14	6.4
$f = 0.40$	0.16	7.4	0.14	6.8
$f = 0.55$	0.16	7.7	0.15	7.1
$f = 0.70$	0.17	7.9	0.15	7.3

A Proofs and Derivations

A.1 Solving the Differential Equation

The differential equation to be solved is given by equation (15):

$$\begin{aligned}(1-\tau_L)\,w(h_i) &= (1-\beta)\,b-\frac{1-\beta}{1+r}\left[1-\chi-f(\theta)\right]V_W' \\ &\quad +\beta(1-\tau_L)\left[\frac{\sigma-1}{\sigma}\frac{P_i(y_i)}{P}A-h_i\frac{\partial w}{\partial h_i}+(1-\widetilde{\chi})\frac{\Phi_V}{q(\theta)}\right]\end{aligned}$$

Ignoring the constant terms for now, the equation becomes[30]

$$w(h_i)=\beta\left[\frac{\sigma-1}{\sigma}\frac{P_i(y_i)}{P}A-h_i\frac{\partial w}{\partial h_i}\right] \tag{33}$$

Begin by focusing attention on the homogenous equation

$$\frac{w(h_i)}{\beta h_i}+\frac{\partial w}{\partial h_i}=0 \tag{34}$$

which has solution

$$w(h_i)=Kh_i^{-1/\beta} \tag{35}$$

where K is a constant of integration. Next, assume that $K=K(h_i)$ and take the derivative of both sides of (35) to obtain

$$\frac{\partial w}{\partial h_i}=h_i^{-1/\beta}\frac{\partial K}{\partial h_i}-\frac{1}{\beta}Kh_i^{\frac{-1-\beta}{\beta}} \tag{36}$$

Now substitute (36) and (35) into (33) to obtain

$$\frac{\partial K}{\partial h_i}=h_i^{\frac{1-\beta}{\beta}}\frac{\sigma-1}{\sigma}\frac{P_i(y_i)}{P}A \tag{37}$$

where $\frac{P_i(y_i)}{P}=\left(\frac{Ah_i}{\frac{1}{n}Y}\right)^{-\frac{1}{\sigma}}$. Integrating (37) yields

$$K=A\left(\frac{A}{\frac{1}{n}Y}\right)^{-\frac{1}{\sigma}}\frac{\sigma-1}{\sigma}\int h_i^{\frac{1-\beta}{\beta}-\frac{1}{\sigma}}dh_i+J$$

[30] This solution follows Cahuc, Marque and Wasmer (2004).

which has solution

$$\begin{aligned} K &= A\left(\frac{A}{\frac{1}{n}Y}\right)^{-\frac{1}{\sigma}}\frac{\sigma-1}{\sigma}\int h_i^{\frac{1-\beta}{\beta}-\frac{1}{\sigma}}dh_i+J \\ &= A\left(\frac{A}{\frac{1}{n}Y}\right)^{-\frac{1}{\sigma}}\frac{\sigma-1}{\sigma}\frac{\beta\sigma}{\sigma-\beta}h_i^{\frac{1}{\beta}-\frac{1}{\sigma}}+J \end{aligned} \tag{38}$$

Finally, substituting (38) back into (35) yields

$$w(h_i)=\beta\frac{\sigma-1}{\sigma-\beta}A\frac{P_i(y_i)}{P}+Jh_i^{-1/\beta}$$

Assuming that $\lim_{h_i\to 0} h_i w(h_i)=0$ pins down the constant $J=0$. Adding back the constant terms gives the solution to the differential equation given by (16).

$$\begin{aligned} (1-\tau_L)\,w(h_i) &= (1-\beta)\,b-\frac{1-\beta}{1+r}\left[1-\chi-f(\theta)\right]V_W' \\ &\quad +\beta(1-\tau_L)\left[\frac{\sigma-1}{\sigma-\beta}\frac{P_i(y_i)}{P}A+(1-\widetilde{\chi})\frac{\Phi_V}{q(\theta)}\right]. \end{aligned}$$

A.2 Proof of Proposition 1

Proof: Begin by solving (16) for $\frac{1}{1+r}\left[1-\chi-\theta q(\theta)\right]V_W'$ and substituting back into the worker's surplus equation (5) to obtain

$$V_W=\frac{\beta}{1-\beta}(1-\tau_L)\left[\frac{\sigma-1}{\sigma-\beta}\frac{P_i(y_i)}{P}A-w(h_i)+(1-\widetilde{\chi})\frac{\Phi_V}{q(\theta)}\right] \tag{39}$$

Taking ahead one period and using the firm's optimality condition (17), one obtains

$$\frac{1}{1+r}V_W'=(1-\tau_L)\frac{\beta}{1-\beta}\frac{1}{1-\delta}\frac{\Phi_V}{q(\theta)} \tag{40}$$

Using (40) to substitute out for V_W' in (16) yields the wage curve (18)

$$(1-\tau_L)\,w(h_i)=(1-\beta)\,b+\beta(1-\tau_L)\left[\frac{\sigma-1}{\sigma-\beta}\frac{P_i(y_i)}{P}A+\frac{1}{1-\delta}\Phi_V\theta\right]$$

A.3 Proof of Lemma 1

Proof: We need to establish that $\frac{\partial\theta}{\partial\sigma}>0$. Applying the implicit function theorem to equation (24) gives us:

$$\frac{\partial\theta}{\partial\sigma}=\frac{1-\beta}{(\sigma-1)(\sigma-\beta)}\frac{(1-\tau_L)\,b+\frac{r+\chi+\beta f(\theta)}{(1-\beta)(1-\delta)}\cdot\frac{\Phi_V}{q(\theta)}}{\frac{\Phi_V}{(1-\beta)(1-\delta)}\left[\beta\Phi_V-(r+\chi)\frac{q'(\theta)}{q(\theta)^2}\right]}>0$$

where the numerator is clearly positive. The denominator is also positive due to due to $\beta \in (0,1)$, $\sigma > 1$ by (25) and $q'(\theta) < 0$ for a constant returns to scale Cobb-Douglas matching function.

A.4 Proof of Proposition 2

Proof: (i) Differentiating the Beveridge curve (26) with respect to θ yields that

$$\frac{\partial u}{\partial \theta} = -\chi \frac{f'(\theta)}{[\chi + f(\theta)]^2} < 0$$

since the job-finding rate is increasing in tightness $f'(\theta) > 0$ for all constant returns to scale Cobb-Douglas matching functions. By Lemma 2, $\frac{\partial \theta}{\partial \sigma} > 0$. Application of the chain rule yields that $\frac{\partial u}{\partial \sigma} = \frac{\partial u}{\partial \theta}\frac{\partial \theta}{\partial \sigma} < 0$.

(ii) Differentiating the equilibrium wage (20) with respect to θ yields that

$$\frac{\partial w}{\partial \theta} = \frac{\beta}{1-\beta}\frac{1-\tau_L}{1-\delta}\Phi_V \left[1 - (r+\chi)\frac{q'(\theta)}{q(\theta)^2}\right] > 0$$

where the inequality follows because $q'(\theta) < 0$ for all CRS Cobb-Douglas matching functions. By Lemma 2 and the chain rule, we have that $\frac{\partial w}{\partial \sigma} = \frac{\partial w}{\partial \theta}\frac{\partial \theta}{\partial \sigma} > 0$.

A.5 Proof of Proposition 3

(i) We need to establish that $\frac{\partial \theta}{\partial b}$, $\frac{\partial \theta}{\partial \Phi_V}$, $\frac{\partial \theta}{\partial r}$, $\frac{\partial \theta}{\partial \delta}$ and $\frac{\partial \theta}{\partial \widetilde{\chi}}$ are all negative. In each case we apply the implicit function theorem to (24), to obtain $\frac{\partial \theta}{\partial x} = -\frac{\partial[\cdot]/\partial x}{\partial[\cdot]/\partial \theta}$ where x is the relevant parameter, and the derivatives are taken with respect to the right hand side of (24). It is easy to see that the common denominator $\frac{\partial[\cdot]}{\partial \theta} > 0$ is positive for all constant returns to scale Cobb-Douglas matching functions, so it remains to establish that the numerator $\frac{\partial[\cdot]}{\partial x} > 0$ for all parameters x. We obtain:

$$\begin{aligned}
\frac{\partial[\cdot]}{\partial b} &= \frac{\sigma-\beta}{\sigma-1}(1-\tau_L) > 0 \\
\frac{\partial[\cdot]}{\partial \Phi_V} &= \frac{\sigma-\beta}{\sigma-1}\left[\frac{1}{(1-\beta)(1-\delta)}\left(\frac{r+\chi}{q(\theta)} + \beta\theta\right)\right] > 0 \\
\frac{\partial[\cdot]}{\partial r} &= \frac{\sigma-\beta}{\sigma-1}\frac{1}{(1-\beta)(1-\delta)}\frac{\Phi_V}{q(\theta)} > 0 \\
\frac{\partial[\cdot]}{\partial \delta} &= \frac{\sigma-\beta}{\sigma-1}\frac{\Phi_V}{1-\beta}\left(\frac{1}{q(\theta)}\frac{(1-\delta)(1-\widetilde{\chi}) + (r+\chi)}{(1-\delta)^2} + \beta\theta\frac{1}{(1-\delta)^2}\right) > 0 \\
\frac{\partial[\cdot]}{\partial \widetilde{\chi}} &= \frac{\sigma-\beta}{\sigma-1}\frac{1}{1-\beta}\frac{\Phi_V}{q(\theta)} > 0
\end{aligned}$$

where the last two equations make use of the definition of the total separation rate as $\chi = \widetilde{\chi} + \delta - \widetilde{\chi}\delta$.

(ii) $\frac{\partial u}{\partial b}$, $\frac{\partial u}{\partial \Phi_V}$ and $\frac{\partial u}{\partial r}$ can be shown to be negative by first noting that by part (i) $\frac{\partial \theta}{\partial x} < 0$ where x represents b, Φ_V or r. Applying the chain rule and using that $\frac{\partial u}{\partial \theta} < 0$ by Lemma 2 yields $\frac{\partial u}{\partial x} = \frac{\partial u}{\partial \theta}\frac{\partial \theta}{\partial x} < 0$.

For $\frac{\partial u}{\partial \widetilde{\chi}} = \frac{\partial u}{\partial \chi}\frac{\partial \chi}{\partial \widetilde{\chi}} + \frac{\partial u}{\partial \theta}\frac{\partial \theta}{\partial \widetilde{\chi}}$ we obtain

$$\frac{\partial u}{\partial \widetilde{\chi}} = \frac{f(\theta)(1-\delta)}{[\chi + f(\theta)]^2} + \underbrace{\frac{\partial u}{\partial \theta}}_{<0}\underbrace{\frac{\partial \theta}{\partial \widetilde{\chi}}}_{<0} > 0$$

where the last term uses the results of (i) and of Lemma 2.

For $\frac{\partial u}{\partial \delta} = \frac{\partial u}{\partial \chi}\frac{\partial \chi}{\partial \delta} + \frac{\partial u}{\partial \theta}\frac{\partial \theta}{\partial \delta}$ we have:

$$\frac{\partial u}{\partial \delta} = \frac{f(\theta)(1-\widetilde{\chi})}{[\chi + f(\theta)]^2} + \underbrace{\frac{\partial u}{\partial \theta}}_{<0}\underbrace{\frac{\partial \theta}{\partial \delta}}_{<0} > 0$$

where once again the last term uses the results of (i) and of Lemma 2.

(iii) We are interested in the behavior of $\frac{\partial \beta}{\partial \theta}$ and $\frac{\partial u}{\partial \beta}$. First, obtain an expression for $\frac{\partial \beta}{\partial \theta}$ by once again applying the implicit function theorem to (24) to get $\frac{\partial \beta}{\partial \theta} = -\frac{\partial[\cdot]/\partial \theta}{\partial[\cdot]/\partial \beta}$ where $\partial[\cdot]/\partial\theta > 0$ was established in (i). This leaves

$$\begin{aligned}\frac{\partial[\cdot]}{\partial \beta} &= \frac{\sigma-\beta}{\sigma-1}\frac{\Phi_V}{q(\theta)}\left[\frac{(1-\beta)(1-\delta)f(\theta) + (1-\delta)(r+\chi+\beta f(\theta))}{(1-\beta)^2(1-\delta)^2}\right] \\ &\quad -\frac{1}{\sigma-1}\left[(1-\tau_L)b + \frac{r+\chi+\beta f(\theta)}{(1-\beta)(1-\delta)}\cdot\frac{\Phi_V}{q(\theta)}\right]\end{aligned}$$

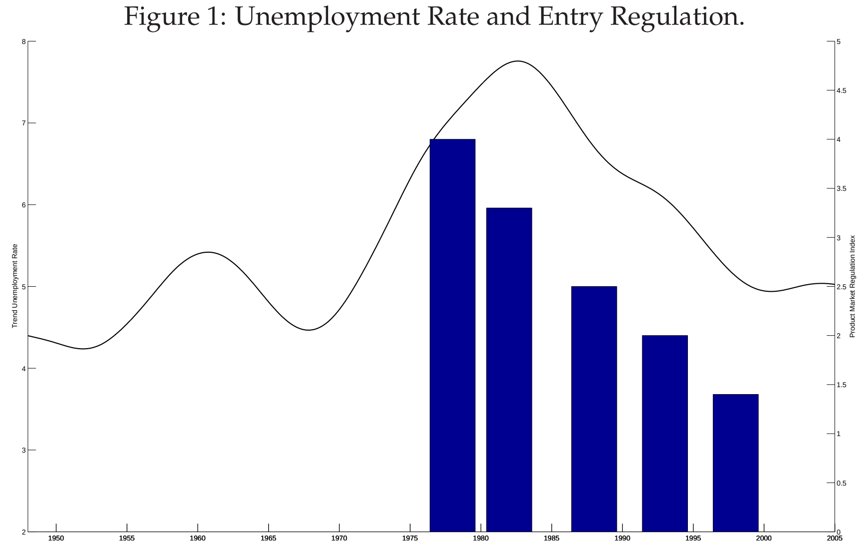
The first term is positive, and on its own would cause $\frac{\partial \beta}{\partial \theta} < 0$ and $\frac{\partial \beta}{\partial u} > 0$ as is standard in matching models. The second negative term is due to the overhiring/monopoly coefficient $\frac{\sigma-\beta}{\sigma-1}$. In the perfect competition limit, the second negative term approaches zero, so that $\frac{\partial \beta}{\partial \theta} < 0$ and $\frac{\partial \beta}{\partial u} > 0$. For some smaller values of competition it is possible that $\frac{\partial[\cdot]}{\partial \beta} < 0$. To establish that a critical value for competition $\widetilde{\sigma}$ exists for which $\sigma > \widetilde{\sigma}$ implies that $\frac{\partial[\cdot]}{\partial \beta}$ is positive we look for a condition on σ that guarantees that $\frac{\partial[\cdot]}{\partial \beta} > 0$. $\frac{\partial[\cdot]}{\partial \beta} > 0$ whenever

$$\sigma > \frac{(1-\tau_L)b + \frac{\Phi_V}{q(\theta)}\frac{1}{(1-\delta)(1-\beta)}\left[\frac{r+\chi+\beta f(\theta)}{1-\beta} + \beta f(\theta)\right]}{\frac{\Phi_V}{q(\theta)}\frac{1}{(1-\delta)(1-\beta)}\left[\frac{r+\chi+\beta f(\theta)}{(1-\beta)} + f(\theta)\right]} \equiv \widetilde{\sigma}$$

Hence, when $\sigma > \widetilde{\sigma}$, then $\frac{\partial[\cdot]}{\partial \beta} > 0$, $\frac{\partial \beta}{\partial \theta} < 0$ and by Lemma 2 $\frac{\partial \beta}{\partial u} > 0$, as is standard in matching models.

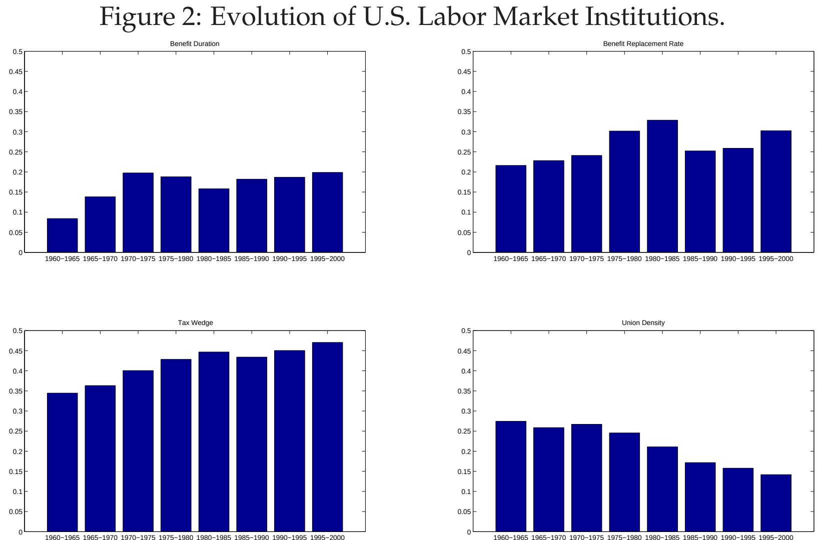
Appendix C Figures

Figure 1: Unemployment Rate and Entry Regulation.



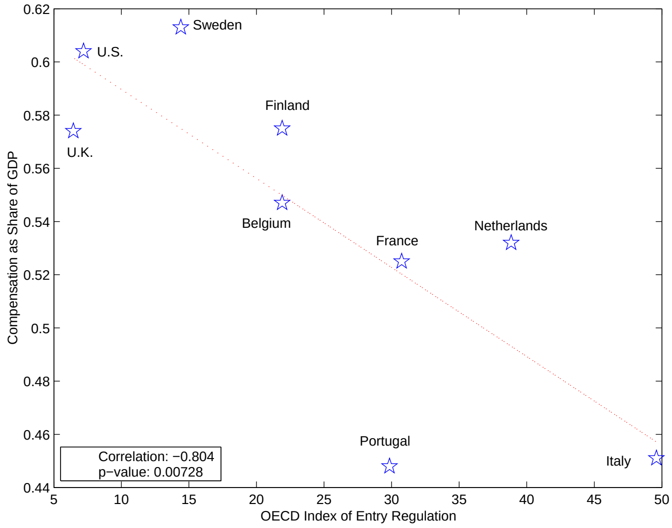
Source: BLS and Nicoletti and Scarpetta (2003).

Figure 2: Evolution of U.S. Labor Market Institutions.



Source: OECD and Jim Costain's and Michael Reiter's webpage: http://www.econ.upf.es/~reiter/webbcui/bcui.html.

Figure 3: Entry Regulation and naive Labor Shares.



Data on compensation/GDP is taken from Gollin (2002), Table 2, column 4. Data on entry regulation is the regulation index of Fonseca et al. (2001), table 2, column 4, multiplied by 5 to convert to days. The negative correlation is highly significant even for the small number of observations. This plot is merely meant to be an illustration of the data.

Figure 4: Firm Level Equilibrium: Wages and Employment.

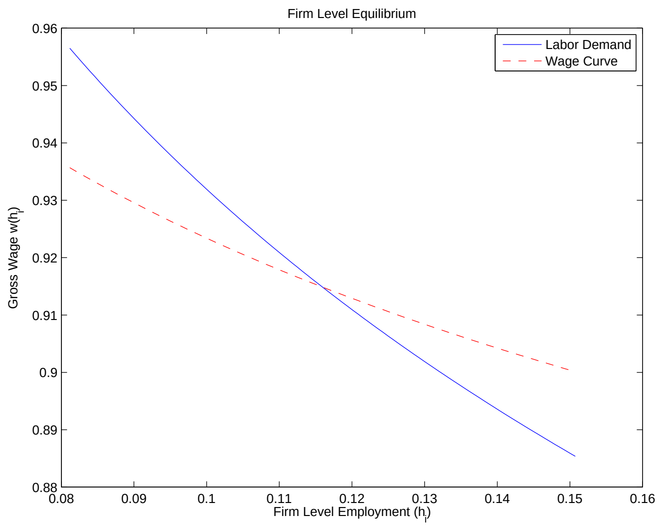


Figure 5: Long Run Equilibrium: Baseline Calibration.

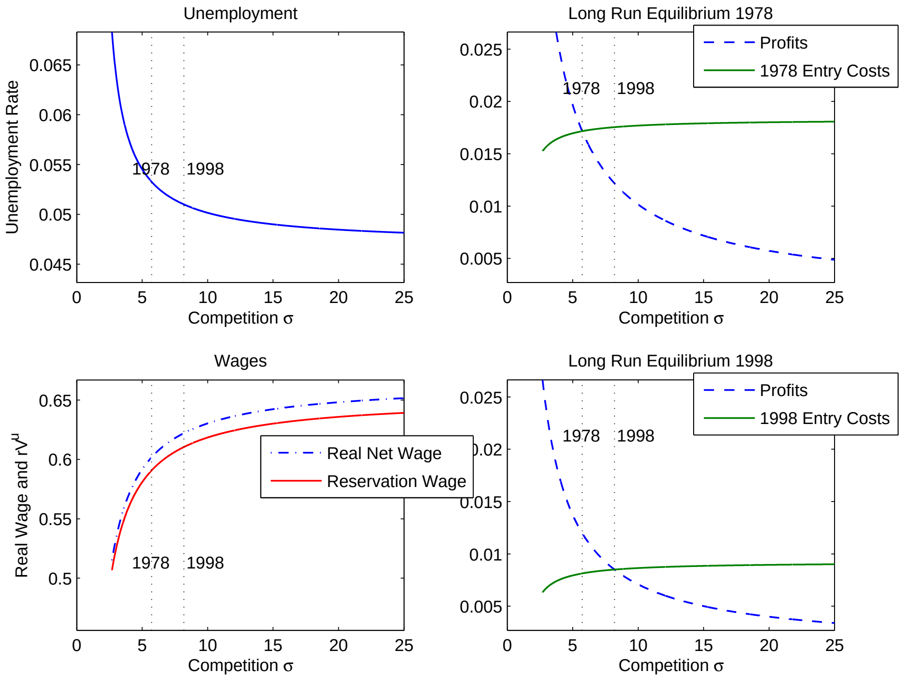


Figure 6: Long Run Equilibrium: Small Surplus Calibration.

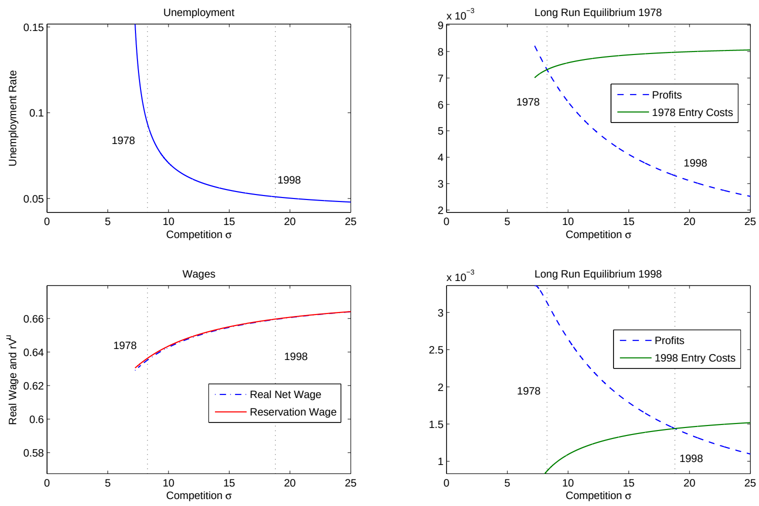
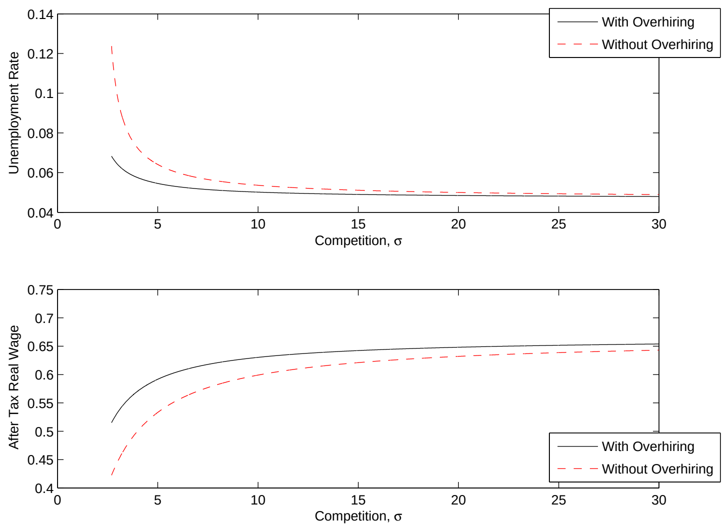
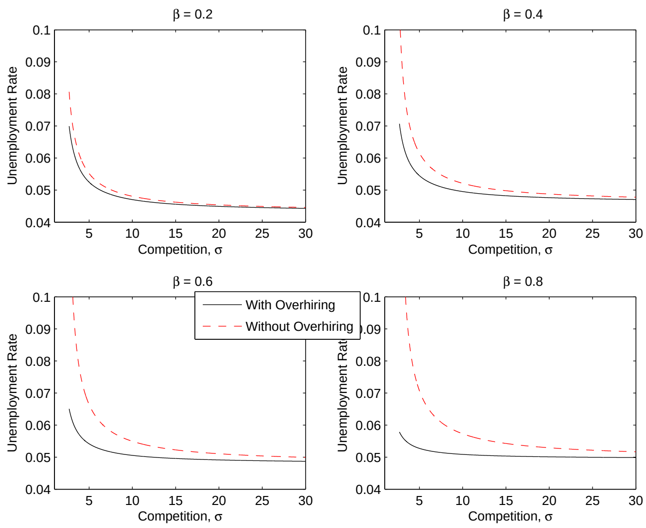


Figure 7: Quantifying the Overhiring Effect.



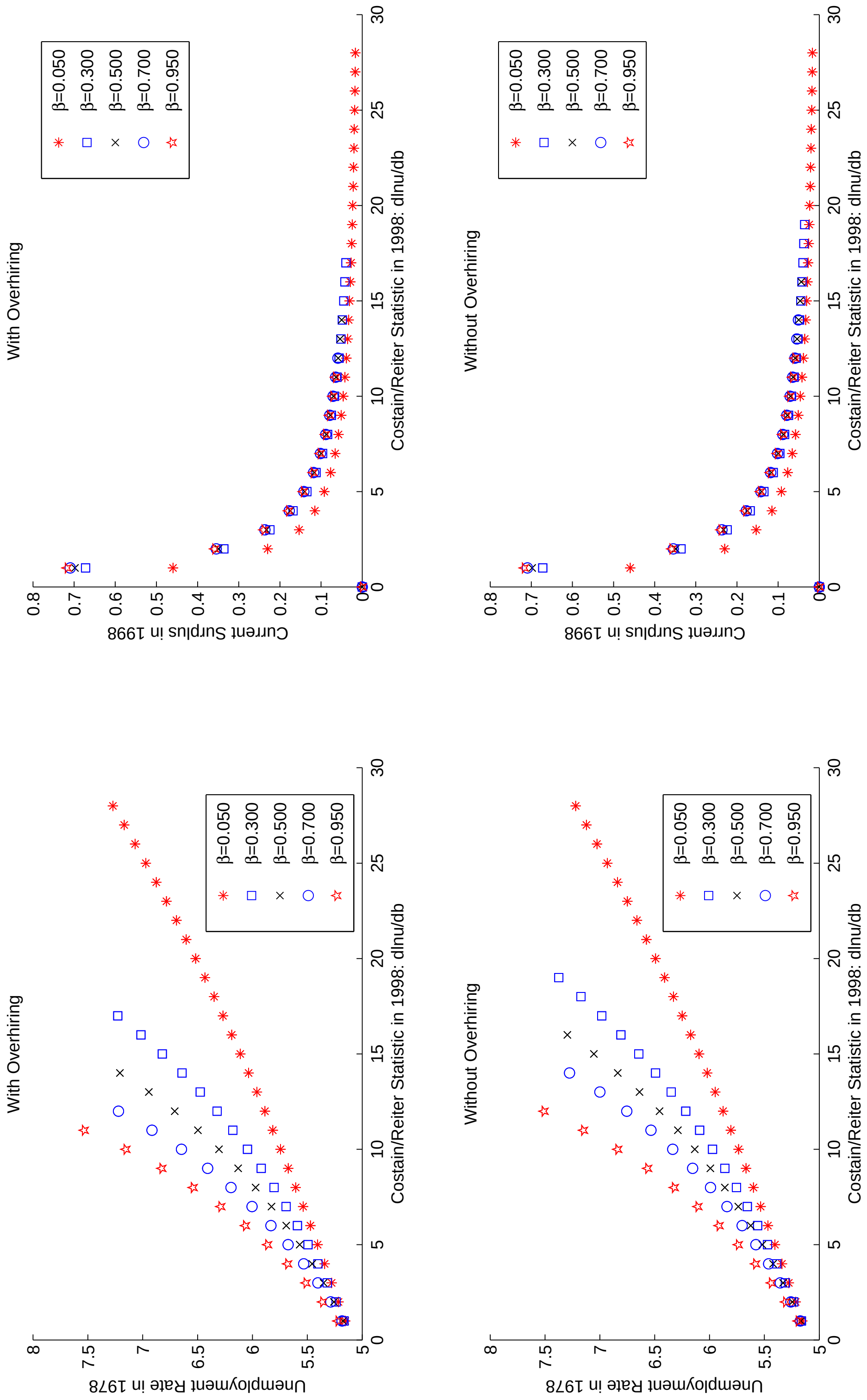
The solid line shows the impact of competition on equilibrium unemployment (or wages). The dashed line shows how competition affects unemployment (or wages) when the hiring externality has been shut down by setting $\frac{\sigma-\beta}{\sigma} = 1$.

Figure 8: The Overhiring Effect and Worker Bargaining Power.



The solid line in each panel shows the impact of competition on equilibrium unemployment. The dashed lines show how competition affects unemployment when the hiring externality has been shut down by setting $\frac{\sigma-\beta}{\sigma} = 1$. Throughout this experiment the unemployment elasticity of the matching function, η, has been kept at it's baseline value equal to 0.5, i.e. no Hosios condition has been imposed.

Figure 9: Response of Deregulation to u-b semi-elasticity, ξ_b^u.



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