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 wage bargaining. Product market competition affects unemployment by two channels: the output expansion effect and a countervailing effect due to a hiring externality. Competition is then linked to barriers to entry. 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. Our quantitative analysis suggests that under individual bargaining, a decrease of less than four tenths of a percentage point of unemployment rates can be attributed to product market deregulation, a surprisingly small amount.

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1 Introduction

This paper studies the impact of product market deregulations 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 90'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 did not undergo any substantial reform 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. At the same time, the only significant change in US labor market institutions - the 1996 welfare reform - took place after most of the gains in unemployment had already been realized. Welfare reform was implemented between September 1996 and July 1997, and unemployment in 1996 had already fallen to 5.4 %.[2] 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).

Indeed, there is some amount of empirical evidence to support the link between product market regulation 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 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 show that the effect of product market deregulation on unemployment is surprisingly weak. In our baseline model,

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

[2] In fact, one might argue that the immediate transitory effect of welfare reform should have been to increase unemployment, as welfare recipients were pushed into the labor market.

[3] Loi Royer of 1974

calibrated to match stylized facts of the US labor market, we find that increasing product market regulation from 1998 to 1978 levels can account for an increase of less than two tenth of a percentage point of unemployment, from 5.1% in 1998 to 5.42% in 1978. Our findings are highly robust to our choices of parameters and calibration targets.

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 assumptions 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. Consistent with stylized facts of the US labor market, we also assume an 'employment at will' framework in which 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 every 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 bargaining.

When every worker is the marginal worker, a hiring externality of the type first described by Stole and Zwiebel (1996, 1996a) can arise. When marginal revenue product is decreasing (as it is under imperfect competition), hiring an additional worker depresses the wages of all workers. This hiring externality gives firms an incentive to overhire, that is to hire workers beyond the point at which employment costs are recouped by marginal revenue product. The incentive to overhire is strongest when monopoly power is highest (i.e. when marginal revenue product is most steeply decreasing). As competition increases, overhiring is diminished, placing downward pressure on vacancy creation and counteracting the output expansion effect. Hence, neglecting this second overhiring channel might lead one to overestimate the potential benefits to product market reform.

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 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 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. In a similar vein, Spector (2004) studies the effects of changes in the intensity of product market competition in a partial equilibrium 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.

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. (2004). Smith (1999) and Cahuc et al. (2004) 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 illustrate that overhiring is not an issue under perfect competition and constant returns to scale, because marginal revenue product is constant. In addition, using a model without search frictions, Rotemberg (2000) argues that individual bargaining can lead to wages which are less procyclical than their neoclassical counterparts.

The remainder of the paper is organized as follows: Section 2 presents the basic 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 to account for the decline in US trend unemployment during the 80's and 90'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 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

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

is derived from the household's optimization problem:

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

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 given as:

$$Y_i^D \equiv \int c_{i,j}dj = \left(\frac{P_i}{P}\right)^{-\sigma}\frac{1}{n}I, \tag{2}$$

where $I \equiv \int I_j \mathrm{d}j$ 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 differentiated goods given by $-\sigma$. As Blanchard and Giavazzi (2003) we assume that $\sigma = \bar{\sigma}g(n), \quad g' > 0$ and $\sigma > 1$ where n is the number of firms in the economy that 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 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 $\theta q(\theta) = s\theta^{1-\eta}$.

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:

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

where χ is the total separation rate, w denotes the per period real wage, V^U 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. Firms and workers may separate either because the match is destroyed, which occurs with exogenous[6] probability $\tilde{\chi}$ 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.

[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.

The value of unemployment is standard:

$$V_U = b + \frac{1}{1+r}\left[\theta q(\theta) V'_E + [1-\theta q(\theta)] V'_U\right] \tag{4}$$

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

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

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 [extensive margin] 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

$$\text{demand function:} \quad \frac{P_i(y_i)}{P} = \left(\frac{y_i}{\frac{1}{n} I}\right)^{-\frac{1}{\sigma}} \tag{7}$$

$$\text{production function:} \quad y_i = A h_i \tag{8}$$

$$\text{transition function:} \quad h'_i = (1-\widetilde{\chi}) h_i + q(\theta) v_i \tag{9}$$

$$\text{wage curve:} \quad w(h_i) \tag{10}$$

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 $1-\delta$:

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

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

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

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 $\sigma\equiv\frac{\partial y_i}{\partial P_i}\frac{P_i}{y_i}$ yields the firm's Euler equation for employment:

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

This Euler equation describes the firm's optimal employment decision. The left hand side represents the current period cost to hiring the marginal worker: The cost per vacancy Φ_V multiplied by the number of vacancies necessary to hire a worker $\frac{1}{q(\theta)}$. 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 result of wage bargaining will depend upon the number of workers hired. In section 2.3 we will connect this third term to the hiring externality. The fourth term in brackets represents the future savings in hiring costs from having hired the worker today, discounted by the probability of separation $\widetilde{\chi}$.

2.3 Wage Bargaining

In this section we describe the wage bargaining, allowing us to generate wage curves and complete the description of the firm's optimal employment decision. In the neo-classical 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 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 by collective bargaining.[9] In the time period we consider, between 78% and 90% of

[9] In a companion paper, we compare our results to those derived under a collective bargaining framework, and show that assuming collective bargaining strengthens the impact of product market competition on unemployment and wages substantially.

private sector workers were not covered by a collective bargaining agreement, according to CPS data reported in Hirsch and Macpherson (2003). In typical union bargaining the negotiation takes place with the average worker, while individual bargaining is concerned with the marginal worker. This distinction is important for the subsequent results and gives rise to an important tradeoff that we discuss in Ebell and Haefke (2006).

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 crucial point of the individual bargaining framework is that each worker is treated as the marginal worker, so that the bargaining problem becomes:

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

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

$$w(h_i) = (1-\beta)\, b + \beta \left[\frac{\sigma-1}{\sigma} \frac{P_i(h_i)}{P} A - h_i \frac{\partial w}{\partial h_i} + (1-\widetilde{\chi}) \frac{\Phi_V}{q(\theta)} \right] - \frac{1-\beta}{1+r} \left[1 - \chi - \theta q(\theta)\right] V_W'. \tag{15}$$

The differential equation (15) has a standard solution, which is derived in appendix D.

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

This wage equation will be further refined in the following section. The important assumption made in deriving (16) is that V_W' is not a function of current firm-level employment h_i or of the current firm-level bargained wage w_i. This assumption will be confirmed in the following subsections, as the expected future value of worker's surplus will turn out to depend only upon aggregate variables.

2.3.2 Labor demand and the wage curve

We can now substitute out for the $h_i \frac{\partial w}{\partial h_i}$ term in (13) to obtain a closed form for the firm's Euler equation:

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

Equation (17) can be interpreted as a job creation condition 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:*

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

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 to 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 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 second step, we will introduce entry costs, which will serve to endogenize the degree of competition $\sigma(n)$ and hence the number of firms n in the economy. This last equilibrium will be referred to as long-run general 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 resulting from individual bargaining (18), as illustrated in Figure 2. Formally, we obtain:

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

[10] See the appendix 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.

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

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 (1996a). To see this, first recall that in the standard one-worker-one-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-level equilibrium employment equation (19) yields:

$$\underbrace{\frac{\sigma-1}{\sigma}A\frac{P_i(h_i)}{P}}_{\text{MRP}_i} = \underbrace{\frac{\sigma-\beta}{\sigma}}_{\text{Overhiring Factor}} \underbrace{\left[w(\theta) + \frac{\Phi_V}{q(\theta)}\frac{r+\chi}{1-\delta}\right]}_{\text{wage + hiring cost}} \tag{21}$$

Equation (21) equates the firm's marginal revenue product to the cost of employing a worker [equal to the wage plus the hiring cost], multiplied by an overhiring factor $\frac{\sigma-\beta}{\sigma} < 1$.[12]

The overhiring factor $\frac{\sigma-\beta}{\sigma} < 1$ expresses the fact that firms optimally hire workers beyond the point at which employment costs can be recouped by the worker's marginal product. Firms are willing to employ workers whose marginal revenue product is not high enough to cover their employment costs, because hiring these workers confers an added non-MRP benefit to firms. This added benefit or hiring externality arises because hiring more workers when MRP is declining serves to depress the wages of all workers. This can be seen from the labor demand equation (19):

$$\underbrace{\frac{\sigma-1}{\sigma}A\frac{P_i(h_i)}{P}}_{\text{MRP}_i} = \underbrace{w(h_i) + \frac{\Phi_V}{q(\theta)}\left(\frac{r+\chi}{1-\delta}\right)}_{\text{employment cost of one worker}} + \underbrace{h_i\frac{\partial w}{\partial h_i}}_{\text{hiring externality term}}. \tag{22}$$

The hiring externality term represents the wage impact of adding an extra worker, multiplied by the total number of workers. The negative hiring externality term reflects the fact that adding a worker depresses the wages of all workers, since all workers are treated as the marginal worker. Formally:

$$h_i\frac{\partial w}{\partial h_i} = -A\frac{\beta}{\sigma}\left(\frac{\sigma-1}{\sigma-\beta}\right)\frac{P_i}{P} < 0 \tag{23}$$

From (23), it is easy to see that the hiring externality is strongest when competition σ is low and worker bargaining power β is high. In the perfect competition limit, as $\sigma \to \infty$, the hiring externality disappears because MRP is constant. The hiring externality is also zero if worker bargaining power β equals zero.

[12]This breakdown is analogous to that of Cahuc et. al. (2004).

The reason that overhiring is increasing in monopoly power is simple: The stronger is monopoly power, the more steeply decreasing is marginal revenue product, so hiring an additional worker depresses wages more strongly. Hence, monopoly power increases the size of the hiring externality and drives up overhiring. In this way, the hiring externality works to dampen the negative first order effects of monopoly power on employment. When monopoly power increases, the first principles effect leads firms to decrease output and hence employment. Under high monopoly power, however, firms' incentive to overhire in order to depress wages is relatively strong, and serves to counteract the first principles effect. In some sense, then, overhiring ameliorates the negative output- and employment-restricting effects of monopoly power. Just how much the overhiring effect is able to counteract these first principles effects of monopoly power is a quantitative question which we address in section 4.

Overhiring is also increasing in workers' bargaining power β. This is intuitive, since the on average higher wages which accompany greater worker bargaining power give the firm an added incentive to depress wages.

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

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 following aggregate resource constraint

$$I = \int_0^n \frac{P_i(y_i)}{P} y_i di. \tag{24}$$

Due to symmetry the price ratio becomes unity, (24) reduces to $I = ny$, and (19) leads to the short-run equilibrium condition

$$A = \frac{\sigma - \beta}{\sigma - 1} \left(b + \frac{\beta\theta q(\theta) + r + \chi}{(1-\beta)(1-\delta)} \frac{\Phi_V}{q(\theta)} \right). \tag{25}$$

The short-run general equilibrium condition (25) is monotonically increasing in θ, so that existence of equilibrium is guaranteed if

$$A > \frac{\sigma - \beta}{\sigma - 1} b. \tag{26}$$

When the economy approaches full competition [as $\sigma \to \infty$], (26) reduces to the standard condition $A > b$ that workers' productivity be greater in employment than in unemployment.

Equation (25) is key, since it relates the degree of competition σ to short-run equilibrium labor market tightness θ. Once we have $\theta(\sigma)$, we can obtain the short-run equilibrium unemployment rate from the Beveridge curve:

$$u(\sigma) = \frac{\chi}{\chi + \theta(\sigma)\, q[\theta(\sigma)]}. \tag{27}$$

We normalize the number of agents in the economy to unity. We can find equilibrium aggregate employment as $H(\sigma) = [1 - u(\sigma)]\, n$. 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 $h(\sigma)$ and price $P_i(\sigma)$, all in terms of the given degree of competition. A complete list of all short-run steady-state equilibrium equations can be found in appendix D.

3.3.1 Comparative Statics I: Varying Competition

The characterization of short-term 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 (25) allows us to examine these two channels formally:

$$A = \underbrace{\frac{\sigma - \beta}{\sigma}}_{\text{(overhiring <1)}} \underbrace{\frac{\sigma}{\sigma - 1}}_{\text{(output exp >1)}} \left(b + \frac{\beta\theta q(\theta) + r + \chi}{(1-\beta)(1-\delta)} \frac{\Phi_V}{q(\theta)} \right). \tag{28}$$

The output expansion term is simply the markup of the monopolistically competitive firm. The greater is monopoly power, the greater is the markup $\frac{\sigma}{\sigma-1}$, the smaller is equilibrium tightness θ. By the Beveridge curve, equilibrium unemployment is decreasing in tightness, so that greater monopoly power leads to higher unemployment. The overhiring term counteracts the output expansion term. The greater is monopoly power, the smaller is the overhiring term, the greater is equilibrium tightness θ and the lower is unemployment. These two effects are illustrated in

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 result for short-term equilibrium is summarized in Lemma 2 and Proposition 3. All proofs are found in appendix A.

Lemma 2 *Short-run equilibrium labor market tightness is a strictly increasing function of demand elasticity σ.*

Proposition 3 *In short-run equilibrium:*
(i) unemployment is strictly decreasing in competition σ,
(ii) wages are strictly increasing in competition σ.

Lemma 2 also establishes that equilibrium wages are increasing in the degree of competition. This conclusion is the opposite of that drawn by the recent 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 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 new jobs. This increases the value of the worker's reservation utility rV^U, thereby improving the worker's bargaining position 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 equal to the cost of searching for him/her, which must increase with θ. Hence, equilibrium wages are increasing in competition.This is similar to the positive wage effect of competition found by Blanchard and Giavazzi (2003). It is also consistent with data on labor shares (simply computed as employee compensation over GDP) and entry regulation, as illustrated in Figure 3.

3.3.2 Comparative Statics II: Varying Parameters

Proposition 4 summarizes the impact of varying parameters on short-run equilibrium.

Proposition 4 *Effects of parameters on equilibrium θ and unemployment*

In short-run equilibrium:
(i) labor market tightness θ is decreasing in the parameters b, Φ_V, r, δ, and $\widetilde{\chi}$;
(ii) unemployment is increasing in the parameters b, Φ_V, r, δ and $\widetilde{\chi}$;
(iii) labor market tightness θ is decreasing in β and unemployment is increasing in β if either $b < \frac{\Phi_V}{1-\delta}\theta$ or $b \geq \frac{\Phi_V}{1-\delta}\theta$ and $\sigma \geq \widetilde{\sigma}$ where $\widetilde{\sigma} = \frac{b(1-\beta)^2 + \frac{\Phi_V}{1-\delta}\theta[\beta+\beta(1-\beta)] + \frac{\Phi_V}{q(\theta)}\frac{r+\chi}{1-\delta}}{\frac{\Phi_V}{q(\theta)}\frac{r+\chi}{1-\delta} + \frac{\Phi_V}{1-\delta}\theta}$.

The results of parts (i) and (ii) of Proposition 4 are standard for search and matching models. Part (iii) merits comment. Unemployment's reaction to an increase in workers' bargaining power is standard, unless the degree of competition is very low. The intuition is that higher workers' bargaining power strengthens the overhiring effect, in the sense that $\frac{\partial^2 w}{\partial h_i \partial \beta} < 0$ for given h_i and P_i. At very low levels of competition, the overhiring effect discussed in section 2.3 is particularly strong. In this case, increasing bargaining power strengthens the overhiring effect so much [i.e. increasing firms' incentives to hire more workers to depress wages], 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[13]. 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.[14] 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 an equilibrium number of firms n^*, which is defined implicitly by:

$$\Phi_E\left[\sigma\left(n^*\right)\right]+\Phi_V\frac{h_i\left[\sigma\left(n^*\right)\right]}{q\left[\theta\left[\sigma\left(n^*\right)\right]\right]}=V^J\left[h_i\left[\sigma\left(n^*\right)\right]\right]. \tag{29}$$

The free entry condition (29) states that the entry cost must be amortized by profits over the firm's expected lifespan. Since equilibrium profits are decreasing in competition, free entry forges a negative link between barriers to entry and the degree of competition/the number of firms in the economy.[15]

Entry barriers may 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 firm from the OECD 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 per capita annual GDP and the fraction of a year which is lost to entry delay. This implicitly treats the entry delay as a loss of the fraction of annual per capita GDP which would have been produced during that time period.

Formally, total barriers to entry are found as:

$$\Phi_E\left[\sigma\left(n\right)\right]=\left[d+f\right]\cdot I\left[\sigma\left(n\right)\right], \tag{30}$$

where d is the regulatory delay in months and f are entry fees as a share of aggregate monthly income. Combining (30) with the free entry condition (29) yields:

$$\left[d+f\right]\cdot I\left[\sigma\left(n^*\right)\right]+\Phi_V\frac{h_i\left[\sigma\left(n^*\right)\right]}{q\left[\theta\left[\sigma\left(n^*\right)\right]\right]}=V^J\left[h_i\left[\sigma\left(n^*\right)\right]\right]. \tag{31}$$

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

[14] 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.

[15] To forge an explicit link between barriers to entry and the number of firms, one may take two routes. First, one may 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 setup presented here, and are available upon request.

Equation (31) closes the long-run equilibrium. It determines the endogenous number of firms n^*/degree of competition $\sigma(n^*)$ in long-run equilibrium by defining a negative relationship between barriers to entry and the degree of competition in long-run equilibrium.

3.5 Balanced Budget

For our quantitative experiments we augment the model to allow for unemployment benefits to be financed by equal magnitude income and payroll taxes (τ_I, τ_P). The resulting balanced budget condition is:

$$(\tau_I + \tau_P)\, w\,(1-u) = bu. \tag{32}$$

It is straightforward to confirm that the short-run equilibrium condition (25) becomes:

$$A = \frac{\sigma - \beta}{\sigma - 1}\left(\frac{1+\tau_P}{1-\tau_I} b + \frac{\beta\theta q(\theta) + r + \chi}{(1-\beta)(1-\delta)} \frac{\Phi_V}{q(\theta)}\right), \tag{33}$$

All other equilibrium equations under taxation and a balanced budget are presented in appendix E.

4 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 United States. Then, for this calibration we ask: What is the impact of increasing competition on equilibrium unemployment and wages? In order to answer this question, we run a policy experiment which is designed to assess whether the product market deregulation of the late 1970's and 1980's could account for the decline in US unemployment during the 1980's and 1990's. Finally, we go on to quantify the overhiring effect.

4.1 Calibration

One model period is one month. All parameters are reported in Table 4. We first calibrate the model to US data in 1998. 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 [0.5;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_{98} to unity. Our choice of 4.0 % for the annualized real interest rate is standard, as our choice of the flow utility of unemployment b, which is consistent with a replacement rate of 50%.

We choose the remaining parameters to match some stylized labor market data for the U.S. in 1998. Specifically, we replicate the 1998 HP-trend value for the unemployment rate of 5.1%[16] and set the job finding rate to be 0.45 following

[16] 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.

Shimer (2005). We normalize the firm's matching rate so that the vacancy duration is 4.2 months as in den Haan, Ramey and Watson, (2000). Our choices for unemployment duration and vacancy duration restrict US equilibrium labor market tightness to be $\theta = \frac{\lambda_w}{\lambda_f} = 1.89$, where λ_w and λ_f are the matching rates of workers and firms respectively.[17] 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 45 %. The equality of tightness with the job-finding rate is in line with the findings of Shimer (2005). Finally, the scaling parameter of the matching function s must satisfy $s = \frac{\lambda_w}{\theta^{1-\eta}}$.

The exogenous total separation rate $\chi = 2.4\%$, is pinned down by the Beveridge curve in conjunction with our values for unemployment and unemployment duration. 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 firm survival probabilities reported in Mata and Portugal (1994), which imply monthly exit rates between 0.6 and 1.4%.

We are left with a short-run equilibrium condition which relates the abovementioned parameters and variables to vacancy posting costs Φ_V, and with a long-run equilibrium condition (31) which relates Φ_V to firm's demand elasticity σ. We pin down σ by the entry costs and the vacancy cost Φ_V by the unemployment rate. We choose that level of vacancy posting costs which leads to a long-run equilibrium U.S. equilibrium unemployment rate of 5.1 %. This yields a value of $\Phi_V = 0.24$, so that hiring costs per worker are $\frac{1}{\lambda_f}\Phi_V = 1.01$ units of output, which corresponds to slightly more than a worker's monthly wage.

For 1997, we can use the detailed entry cost data reported in Table 1, resulting in entry costs corresponding to 0.6 months of aggregate per capita income. For 1978 there is no such entry cost data available. However, Nicoletti and Scarpetta (2001) 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 1998 and 1978 index values are displayed in Table 2 for the subset of 17 countries for which both the index and the detailed entry cost data are available. In order to estimate US entry costs for 1978, we use the following 'triangulation' procedure. We first note that the correlation between Nicoletti's index in 1998 and our composite measure of entry costs is very high at 0.77. To estimate entry costs in 1978, we run the following regression:

$$\text{entry costs}_{1997,i} = \alpha + \beta \cdot \text{regulation index}_{1998,i} + \varepsilon_i \tag{34}$$

where i represents the country. We then combine the resulting regression coefficients (reported in Table 3) with Nicoletti's index values for 1978 to obtain an estimate for 1978 entry costs of 5.2 months of aggregate per capita income.

In a fully microfounded formulation of Cournot competition within industries, 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 $\overline{\sigma} = 1$.

[17] Pinning down the value of θ does not fully describe short-run equilibrium, as long as some other variable is left free. In our case, this variable will be Φ_V.

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 1998 US model economy, income and payroll taxes of 1.3 % are necessary to finance unemployment benefits.

4.2 Product Market Competition and the Labor Market

The results of this calibration are presented in Figure 4. The middle right panel shows that profits and the US entry costs for 1998 are equalized when demand elasticity is 6.04, which corresponds to a markup of 9.92%, while the upper right panel shows that long-run equilibrium in 1978 occurs at a demand elasticity of 3.04, corresponding to a markup of 24.5%. The upper left panel shows that unemployment could increase by maximally 2 percentage points due to an increase in monopoly power to the highest amount which is consistent with existence of equilibrium. Real wage decreases due to increases in monopoly power, on the other hand, could be very substantial, as shown in the middle left hand panel of Figure 4. The lower panels show that most of the wage increases due to increases in competition are due to improvements in the workers' reservation utility. This in turn has its origins in the increases in labor market tightness due to increased competition, which make it easier for workers to find jobs when unemployed, increasing their reservation utility. Hence, under individual bargaining there is little adjustment to monopoly power via equilibrium unemployment (and hence output), but the impact on wages and profits is substantial.

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 due to increased competition come from the entry of the first three to five competitors, with very little benefits accruing to further entry.

4.3 A Simple Policy Experiment

We now use the balanced budget version of the model to run a simple 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 starting with the model calibrated to match US HP-trend labor market data in 1998, and then examining the impact of changing the entry costs to reflect those of 1978. We emphasize that we calibrate to labor market data from which the business cycle component has been filtered out, in order to focus on the long-run impact of a change in product market regulation.

Results of the policy experiment are presented in Table 5. In the baseline calibration, changes in product market regulation can only account for a surprisingly small change in equilibrium unemployment. Raising entry costs nearly tenfold to their 1978 level leads to a decrease in competition, causing markups to increase by a factor of 2.5, to 24.5%, but resulting in an increase in unemployment of only three-tenths of one percentage point. As a result of the decrease in competition, unemployment increases only very slightly, from 5.1% to 5.42%. In contrast, in the data, trend unemployment increases from 5.1% in 1998 to 7.1% in 1978, as shown in Figure 1.

4.4 Quantifying Overhiring

In the policy experiment, we saw that the impact of monopoly power on unemployment 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. Firstly, we report the effects of product market deregulation without the overhiring effect in Table 6. Instead of 5.42% with the overhiring effect, the model would now predict an unemployment rate of 5.53% which still falls substantially short of the data. This strenghtens our findings substantially because it emphasizes that product market deregultation simply cannot account for the American employment miracle, irrespective of wether the overhiring effect is taken into account — or not.

Secondly, we use the decomposition of equation (21) in order examine the quantitative consequences of shutting down the hiring externality. We find the equilibrium in the absence of overhiring by setting the overhiring term $\frac{\sigma-\beta}{\sigma}=1$, which 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 calibration targets as in the baseline calibration. The results are given in Table 6 and are plotted in Figure 5. Clearly, the overhiring effect is quite small, as without overhiring unemployment only increases by 0.43 percentage points as opposed to 0.32 percentage points with overhiring. This allows us to conclude that the small impact of deregulation on unemployment does not depend only on the overhiring effect being operative, but is as more general phenomenon.

The bottom panel of Figure 5 shows the impact of overhiring on net wages. Although the source of the overhiring effect is individual firms' desire to depress wages, the aggregate effect of the hiring externality is to increase wages. The reason is that the expanded hiring and the posting of more vacancies makes it easier for workers to find jobs, increasing their reservation utility and thereby boosting their equilibrium wages.

Analogous to the robustness results presented in the next subsection, the only parameters which have any perceptible impact on the strength of the overhiring effect are the matching elasticity η and bargaining power β. Figure 6 compares unemployment rates with and without overhiring for values of $\eta=\beta$ ranging from 0.30 to 0.75. However, regardless of the value of $\eta=\beta$ assumed, the magnitude of the overhiring effect remains very small, never exceeding 0.5 percentage points at the 1978 equilibrium.

4.5 Robustness

We now proceed to check the robustness of our quantitative results. We first vary the calibration targets for the job-filling and job-finding rates and for the replacement rate, the monthly rate of firm exit, and the matching elasticity η and bargaining power β. We find that our choice of these parameter values is innocuous and has only negligible effects on the results that we report.

4.5.1 Setup

We take the calibration to the U.S. economy in 1998 as a starting point and vary the variable of interest over a wide range of values. For each of these values we recalibrate the model to still fit the remaining baseline calibration targets of a 5.1% unemployment rate, 45 % job-finding rate, 4.2 months vacancy duration and a replacement rate of 0.50. We then repeat the policy experiment and report the results.

4.5.2 Results

We first examine the impact of varying the calibration targets for the job-finding rate. Our alternative targets match the 1998 HP-trend values for the mean and median unemployment durations, leading to job-finding rates of 0.31 and 0.67. As shown in Table 7, the impact on the policy experiment results are barely perceptible. Similarly, the results of the policy experiment are highly robust to varying the job-filling rate targets, as reported in Table 8.

Next, we vary the target value for the replacement rate widely, increasing it to 70% and decreasing it to 30%. Once again, we find that the results of our policy experiment are very robust to the choice of replacement rate. The impact of increasing the replacement rate to a 70% would be to decrease the 1978 unemployment rate by one one-hundredth of a percentage point, as shown in Table 9.[18]

Our results are also quite robust to the choice of the firm exit rate δ and the matching elasticity/bargaining power parameters $\eta = \beta$. Table 10 shows that increasing the monthly firm exit rate by two-tenths of a percentage point (causing the annual firm exit rate to increase by about onepercentage point) leads to an increase in the unemployment change generated by our policy experiment of only about four one-hundredths of a percentage point. Table 11 repeats the policy experiment for alternative values of matching elasticity and bargaining power.[19] We vary $\eta = \beta$ between 0.30, at the lower bound of matching elasticity estimates reported in Petrongolo and Pissarides (2001), and 0.72, as recently estimated for US data by Shimer (2005). Increasing $\eta = \beta$ to 0.72 causes the unemployment impact to decline further, to less than two tenths of one percentage point, while decreasing $\eta = \beta$ to 0.30 causes the unemployment impact of the decrease in product market regulation to increase somewhat to half of a percentage point. The reason is that decreasing η increases the curvature of the Beveridge curve, increasing the impact of a given change in labor market tightness on unemployment. In addition, the strength of the overhiring effect is increasing in β, so that decreasing bargaining power will allow the output expansion effect to come out more strongly. Nonetheless, the quantitative impact of varying η and β is quite small.

To sum up, our reported result that increasing the regulation of entry to the U.S. product market to 1978 levels has only negligible employment consequences is consistent with a wide array of choices for our calibration targets and parameters and is by no means a special case.

[18] Note that we recalibrate $\Phi_{V,1998}$ to match a 5.1 % unemployment rate in 1998. Otherwise, the higher replacement rate would shift *both* 1998 and 1978 unemployment rates upwards, while leaving the gap between the two (our variable of interest) nearly unaltered.

[19] We impose the Hosios condition that $\eta = \beta$ throughout. In our setting, the Hosios condition is necessary but not sufficient for efficiency, as can be easily verified.

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 1970's and early 1980's could account for the subsequent decline in US trend unemployment rates. We find that increasing entry costs to their 1978 levels leads to a surprisingly small increase in unemployment of less than four tenths of one percentage point, compared to an increase of two full percentage points in the data.

Thus, while our qualitative finding that product market deregulation has positive repercussions on labor market outcomes is in accordance with the previous literature, we are the first to quantify the effect of deregulation in a fully microfounded dynamic model and conclude that this effect is substantially smaller than previously conjectured.

We do, however, find that product market deregulation could lead to substantial increases in real wages, supportive of political economy arguments in favor of combining labor and product market reform found in Blanchard and Giavazzi (2003). In sum, under individual bargaining, we find that product market reform alone is not sufficient to generate large improvements in labor market outcomes.

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Appendix A Proofs

A.1 Proof of Lemma 2

Proof. We need to establish that $\frac{\partial \theta}{\partial \sigma} > 0$. Applying the implicit function to equation (25) gives us:

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

The first term and the numerator of the second term are clearly positive since $\beta \in (0,1)$ and $\sigma > 1$ for equilibrium to exist. For a constant returns to scale Cobb-Douglas matching function $q'(\theta) < 0$, so that the denominator is also guaranteed to be positive. ■

A.2 Proof of Wage Curve Proposition

Proof. First, rearrange (16) to solve for $\frac{1}{1+r}[1-\chi-\theta q(\theta)]\mathrm{V}'_W$:

$$\frac{1}{1+r}[1-\chi-\theta q(\theta)]V'_W = \frac{1}{1-\beta}\left\{(1-\beta)b + \beta\left[\frac{\sigma-1}{\sigma-\beta}A\frac{P_i(y_i)}{P} + (1-\widetilde{\chi})\frac{\Phi_V}{q(\theta)}\right] - w(h_i)\right\} \tag{35}$$

Next, use (35) to substitute out for $\frac{1}{1+r}[1-\chi-\theta q(\theta)]\mathrm{V}'_W$ in the difference equation which describes worker's surplus (5)

$$V_W = \frac{\beta}{1-\beta}\left[\frac{\sigma-1}{\sigma-\beta}A\frac{P_i(y_i)}{P} - w(h_i) + (1-\widetilde{\chi})\frac{\Phi_V}{q(\theta)}\right] \tag{36}$$

This closed form expression for worker's surplus (36) can now be taken ahead one step:

$$V'_W = \frac{\beta}{1-\beta}\left[\frac{\sigma-1}{\sigma-\beta}A\frac{P_i(y'_i)}{P} - w(h'_i) + (1-\widetilde{\chi})\frac{\Phi_V}{q(\theta')}\right]$$

Now use the firm's Euler equation (17) to substitute out for the term in square brackets, yielding:

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

This confirms that future surplus depends only upon aggregate variables and parameters. Finally, substitute the expression for future surplus V'_W back into the solution to the individual bargaining problem (16) to obtain

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

Finally, use that $\chi = \widetilde{\chi} + \delta - \widetilde{\chi}\delta$ to simplify and obtain the wage curve (18)

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

■

A.3 Proof of Proposition 3

Proof. (i) From (27) and applying Lemma 2, it is straightforward to show that $\frac{\partial u}{\partial \sigma} < 0$ whenever $q(\theta) + \theta q'(\theta) > 0$. This latter condition holds for all Cobb-Douglas constant returns to scale matching functions.
(ii) From (20) , we obtain

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

where the last inequality is due to Lemma 2 and the fact that $q'(\theta) < 0$ for any CRS Cobb-Douglas matching function.
■

A.4 Proof of Proposition 4

Proof. (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 equation (25), to obtain $\frac{\partial \theta}{\partial x} = -\frac{\partial [\cdot]}{\partial x} / \frac{\partial [\cdot]}{\partial \theta}$ where x is the relevant parameter and derivatives are taken with respect to the RHS of (25). It is easy to see that the denominator is positive for all constant returns to scale matching functions, so it remains to establish that the numerator $\frac{\partial [\cdot]}{\partial x} > 0$ for all parameters x. We obtain:

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

(ii) $\frac{\partial u}{\partial b}$, $\frac{\partial u}{\partial \Phi_V}$ and $\frac{\partial u}{\partial r}$ can be shown to be positive by combining (i) with Lemma 2. For $\frac{\partial u}{\partial \widetilde{\chi}}$ and $\frac{\partial u}{\partial \delta}$ we obtain:

$$\begin{aligned}
\frac{\partial u}{\partial \widetilde{\chi}} &= \frac{\theta q[\theta](1-\delta) - \chi \frac{\partial \theta}{\partial \widetilde{\chi}}[\theta q'(\theta) + q(\theta)]}{[\chi + \theta q[\theta]]^2} \\
\frac{\partial u}{\partial \delta} &= \frac{\theta q[\theta](1-\widetilde{\chi}) - \chi \frac{\partial \theta}{\partial \widetilde{\chi}}[\theta q'(\theta) + q(\theta)]}{[\chi + \theta q[\theta]]^2}
\end{aligned}$$

In both cases, the denominator is clearly positive, as is the first term of the numerator. It remains to show that the second term of the numerator is negative: this is indeed the case because we have established in (i) that $\frac{\partial \theta}{\partial \widetilde{\chi}} < 0$ and

because $\theta q'(\theta) + q(\theta) > 0$ for CRS Cobb-Douglas matching functions.
(iii) First, note that

$$\frac{\partial [\cdot]}{\partial \beta} = \frac{\Phi_V}{q(\theta)} \frac{r+\chi}{1-\delta} \left(\frac{1}{1-\beta} \right)^2 + \frac{\Phi_V}{1-\delta} \theta \left(\frac{1}{1-\beta} \right)^2 \frac{\sigma - \beta - \beta(1-\beta)}{\sigma - 1} - \frac{b}{\sigma - 1} \tag{37}$$

In the perfect competition limit as $\sigma \to \infty$, we have that $\frac{\partial [\cdot]}{\partial \beta} = \frac{\Phi_V}{q(\theta)} \frac{r+\chi}{1-\delta} \left(\frac{1}{1-\beta} \right)^2 + \frac{\Phi_V}{1-\delta} \theta \left(\frac{1}{1-\beta} \right)^2 > 0$. Consider two mutually exclusive cases: $\frac{\partial [\cdot]}{\partial \beta}$ is either decreasing or increasing in σ. In the former case, $\frac{\partial [\cdot]}{\partial \beta} > 0$ at $\sigma \to \infty$ ensures that $\frac{\partial [\cdot]}{\partial \beta} > 0$ everywhere. We proceed by first showing that $\frac{\partial [\cdot]}{\partial \beta}$ is decreasing in σ whenever $b < \frac{\Phi_V}{1-\delta} \theta$. To see this, note that

$$\frac{\partial^2 [\cdot]}{\partial \beta \partial \sigma} = -\frac{\Phi_V}{1-\delta} \theta \frac{1}{(\sigma - 1)^2} + \frac{b}{(\sigma - 1)^2}$$

Clearly, $\frac{\partial^2 [\cdot]}{\partial \beta \partial \sigma} < 0$ whenever $b < \frac{\Phi_V}{1-\delta} \theta$. This implies that if $b < \frac{\Phi_V}{1-\delta} \theta$, then $\frac{\partial \theta}{\partial \beta} < 0$ and by Lemma 2 $\frac{\partial u}{\partial \theta} > 0$. In the latter, we can use that $\sigma \in (1, \infty)$ and check whether $\frac{\partial [\cdot]}{\partial \beta} = 0$ for a theshold value $\widetilde{\sigma}$ which is in the admissible range $(1, \infty)$. Setting (37) equal to zero and solving for $\widetilde{\sigma}$ gives us:

$$\widetilde{\sigma} = \frac{b(1-\beta)^2 + \frac{\Phi_V}{1-\delta} \theta [\beta + \beta(1-\beta)] + \frac{\Phi_V}{q(\theta)} \frac{r+\chi}{1-\delta}}{\frac{\Phi_V}{q(\theta)} \frac{r+\chi}{1-\delta} + \frac{\Phi_V}{1-\delta} \theta}$$

It is straightforward to see that whenever $b > \frac{\Phi_V}{1-\delta} \theta$, then $\widetilde{\sigma} > 1$ - so that $\frac{\partial [\cdot]}{\partial \beta}$ goes negative for some admissible value of $\sigma \in (1, \infty)$. This implies that when $b > \frac{\Phi_V}{1-\delta} \theta$, then $\frac{\partial \theta}{\partial \beta} \leq 0$ for all $\sigma \in [\widetilde{\sigma}, \infty)$ and $\frac{\partial \theta}{\partial \beta} > 0$ for all $\sigma \in (1, \widetilde{\sigma})$. The rest of the proof follows by applying Lemma 2. ■

Appendix B Tables

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 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 Pissarides. (2001). 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
US	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 the previous table, 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 reguation 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 0.78. The final column takes the 1978 index values and projects them onto entry costs, using the coefficients obtained from a regression of the 1998 index values onto the 1997 entry costs. This gives us an estimate of 1978 entry costs.

	α	β
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	0.77	

Table 3: Regression of Entry Costs and Product Market Regulation Index

Table 4: Calibration to US Data

		Interpretation	Source
β	0.50	Worker bargaining power	standard
η	0.50	Elasticity of the matching function	standard
A_{98}	1	Average labor productivity 1998	normalization
A_{78}	0.85	Average labor productivity 1978	real GDP growth data
r	0.33 %	Annual interest rate	4.0 % annual rate
b	0.47	Real unemployment benefits	50 % replacement rate
δ	0.8 %	Probability of firm exit	micro-data
λ_w	0.45	Job finding rate	Shimer (2005)
λ_f	$\frac{1}{4.2}$	Job filling rate	den Haan et. al. (2000)
$\Phi_{V,98}$	0.24	Real vacancy posting cost, 1998	$u = 5.1$ %
$\Phi_{V,78}$	$0.24 \cdot A_{78}$	Real vacancy posting cost, 1978	balanced growth
χ	2.4 %	Total separation rate	$u = \frac{\chi}{\chi+\lambda_w}$
θ	1.89	Labor market tightness	$\theta = \frac{\lambda_w}{\lambda_f}$
s	0.33	Scaling parameter of matching function	$s = \frac{\lambda_w}{\theta^{1-\eta}}$

Table 5: Baseline Results

	Φ_E 1998	Φ_E 1978
Unemployment $u(\sigma(n^*))$	5.1 %	5.42 %
Unemployment duration $\frac{1}{\theta q(\theta)}$	2.2	2.4
Vacancy duration $\frac{1}{q(\theta)}$	4.2	3.9
Replacement rate	0.50	0.50
Real unemployment benefit b	0.43	0.38
Total separation rate χ	2.4 %	2.4 %
Labor market tightness $\theta(\sigma(n^*))$	1.89	1.66
Equ. demand elasticity $\sigma(n^*)$	6.04	3.04
Markup $\frac{1-\beta}{\sigma-1}$	9.92 %	24.5 %
Real net wage $\frac{w}{P}(1-\tau_I)$	0.86	0.76
Tax rates $\tau_I = \tau_P$	1.3 %	1.4 %
Vacancy costs Φ_V	0.22	$0.22 \cdot A_{78}$

Table 6: Policy Reform without Overhiring

	Φ_E 1998	Φ_E 1978
Unemployment $u(\sigma(n^*))$	5.1 %	5.53 %
Unemployment duration $\frac{1}{\theta q(\theta)}$	2.2	2.4
Vacancy duration $\frac{1}{q(\theta)}$	4.2	3.9
Replacement rate	0.5	0.5
Real unemployment benefit b	0.42	0.35
Total separation rate χ	2.4 %	2.4 %
Labor market tightness $\theta(\sigma(n^*))$	1.89	1.56
Equ. demand elasticity $\sigma(n^*)$	8.15	3.93
Markup $\frac{1}{\sigma-1}$	13.98 %	34.18 %
Real net wage $\frac{w}{P}(1-\tau_I)$	0.83	0.70
Tax rates $\tau_I = \tau_P$	1.3 %	1.4 %
Vacancy costs Φ_V	0.21	$0.21 \cdot A_{78}$

Table 7: Robustness to Job-Finding Rate λ_w

	$\theta q(\theta) = \frac{1}{3.2}$	mean u duration	$\theta q(\theta) = \frac{1}{1.5}$	median u duration
	Φ_E 1998	Φ_E 1978	Φ_E 1998	Φ_E 1978
Unemployment $u(\sigma(n^*))$	5.1 %	5.42 %	5.1 %	5.44 %
Unemployment duration $\frac{1}{\theta q(\theta)}$	3.2	3.4	1.5	1.6
Vacancy duration $\frac{1}{q(\theta)}$	4.2	4.0	4.2	3.9
Replacement rate	0.50	0.50	0.50	0.50
Real unemployment benefit b	0.43	0.38	0.44	0.38
Total separation rate χ	1.7 %	1.7 %	3.6 %	3.6 %
Labor market tightness $\theta(\sigma(n^*))$	1.31	1.16	2.80	2.45
Equ. demand elasticity $\sigma(n^*)$	5.48	3.0	6.63	3.1
Markup $\frac{1-\beta}{\sigma-1}$	11.1 %	25.2 %	8.9 %	24.0 %
Real net wage $\frac{w}{P}(1-\tau_I)$	0.85	0.75	0.87	0.76
Tax rates $\tau_I = \tau_P$	1.3 %	1.4 %	1.3 %	1.4 %
Vacancy costs Φ_V	0.31	$0.31 \cdot A_{78}$	0.15	$0.15 \cdot A_{78}$

Table 8: Robustness to Job-Filling Rate λ_f

	$q(\theta) = 0.10$		$q(\theta) = 0.50$	
	Φ_E 1998	Φ_E 1978	Φ_E 1998	Φ_E 1978
Unemployment $u(\sigma(n^*))$	5.1 %	5.42 %	5.1 %	5.42 %
Unemployment duration $\frac{1}{\theta q(\theta)}$	2.2	2.4	2.2	2.4
Vacancy duration $\frac{1}{q(\theta)}$	10.0	9.4	2.0	1.9
Replacement rate	0.50	0.50	0.50	0.50
Real unemployment benefit b	0.43	0.38	0.43	0.38
Total separation rate χ	2.4 %	2.4 %	2.4 %	2.4 %
Labor market tightness $\theta(\sigma(n^*))$	4.50	3.95	0.90	0.79
Equ. demand elasticity $\sigma(n^*)$	6.0	3.0	6.0	3.0
Markup $\frac{1-\beta}{\sigma-1}$	9.9 %	24.5 %	9.9 %	24.5 %
Real net wage $\frac{w}{P}(1-\tau_I)$	0.86	0.76	0.86	0.76
Tax rates $\tau_I = \tau_P$	1.3 %	1.4 %	1.3 %	1.4 %
Vacancy costs Φ_V	0.09	$0.09 \cdot A_{78}$	0.46	$0.46 \cdot A_{78}$

Table 9: Robustness to Replacement Rate

	$rr = 0.30$		$rr = 0.70$	
	Φ_E 1998	Φ_E 1978	Φ_E 1998	Φ_E 1978
Unemployment $u(\sigma(n^*))$	5.1 %	5.41 %	5.1 %	5.43 %
Unemployment duration $\frac{1}{\theta q(\theta)}$	2.2	2.4	2.2	2.4
Vacancy duration $\frac{1}{q(\theta)}$	4.2	3.9	4.2	3.9
Replacement rate	0.30	0.30	0.70	0.70
Real unemployment benefit b	0.26	0.22	0.61	0.53
Total separation rate χ	2.4 %	2.4 %	2.4 %	2.4 %
Labor market tightness $\theta(\sigma(n^*))$	1.89	1.67	1.89	1.64
Equ. demand elasticity $\sigma(n^*)$	5.5	3.0	6.8	3.1
Markup $\frac{1-\beta}{\sigma-1}$	11.0 %	25.1 %	8.6 %	23.87 %
Real net wage $\frac{w}{P}(1-\tau_I)$	0.85	0.75	0.87	0.76
Tax rates $\tau_I = \tau_P$	0.8 %	0.85 %	1.8 %	2.0 %
Vacancy costs Φ_V	0.30	$0.30 \cdot A_{78}$	0.13	$0.13 \cdot A_{78}$

Table 10: Robustness to Monthly Firm Exit Rate δ

	$\delta = 0.6\%$		$\delta = 1.0\%$	
	Φ_E 1998	Φ_E 1978	Φ_E 1998	Φ_E 1978
Unemployment $u(\sigma(n^*))$	5.1 %	5.38 %	5.1 %	5.46 %
Unemployment duration $\frac{1}{\theta q(\theta)}$	2.2	2.4	2.2	2.4
Vacancy duration $\frac{1}{q(\theta)}$	4.2	4.0	4.2	3.9
Replacement rate	0.50	0.50	0.50	0.50
Real unemployment benefit b	0.43	0.39	0.43	0.37
Total separation rate χ	2.4 %	2.4 %	2.4 %	2.4 %
Labor market tightness $\theta(\sigma(n^*))$	1.89	1.68	1.89	1.63
Equ. demand elasticity $\sigma(n^*)$	6.6	3.3	5.6	2.8
Markup $\frac{1-\beta}{\sigma-1}$	8.9 %	21.6 %	10.8 %	27.3 %
Real net wage $\frac{w}{P}(1-\tau_I)$	0.87	0.78	0.85	0.74
Tax rates $\tau_I = \tau_P$	1.3 %	1.4 %	1.3 %	1.4 %
Vacancy costs Φ_V	0.22	$0.22 \cdot A_{78}$	0.22	$0.22 \cdot A_{78}$

Table 11: Robustness to Matching Elasticity $\eta = \beta$

	$\beta = \eta = 0.30$		$\beta = \eta = 0.72$	
	Φ_E 1998	Φ_E 1978	Φ_E 1998	Φ_E 1978
Unemployment $u(\sigma(n^*))$	5.1 %	5.59 %	5.1 %	5.25 %
Unemployment duration $\frac{1}{q(\theta)}$	2.2	2.4	2.2	2.3
Vacancy duration $\frac{1}{\theta q(\theta)}$	4.2	4.0	4.2	3.9
Replacement rate	0.50	0.50	0.50	0.50
Real unemployment benefit b	0.39	0.35	0.45	0.41
Total separation rate χ	2.4 %	2.4 %	2.4 %	2.4 %
Labor market tightness $\theta(\sigma(n^*))$	1.89	1.65	1.89	1.69
Equ. demand elasticity $\sigma(n^*)$	5.5	3.2	5.7	2.5
Markup $\frac{1-\beta}{\sigma-1}$	15.5 %	31.1 %	5.9 %	18.2 %
Real net wage $\frac{w}{P}(1-\tau_I)$	0.79	0.69	0.91	0.81
Tax rates $\tau_I = \tau_P$	1.3 %	1.5 %	1.3 %	1.4 %
Vacancy costs Φ_V	0.47	$0.47 \cdot A_{78}$	0.09	$0.09 \cdot A_{78}$

Appendix C Figures

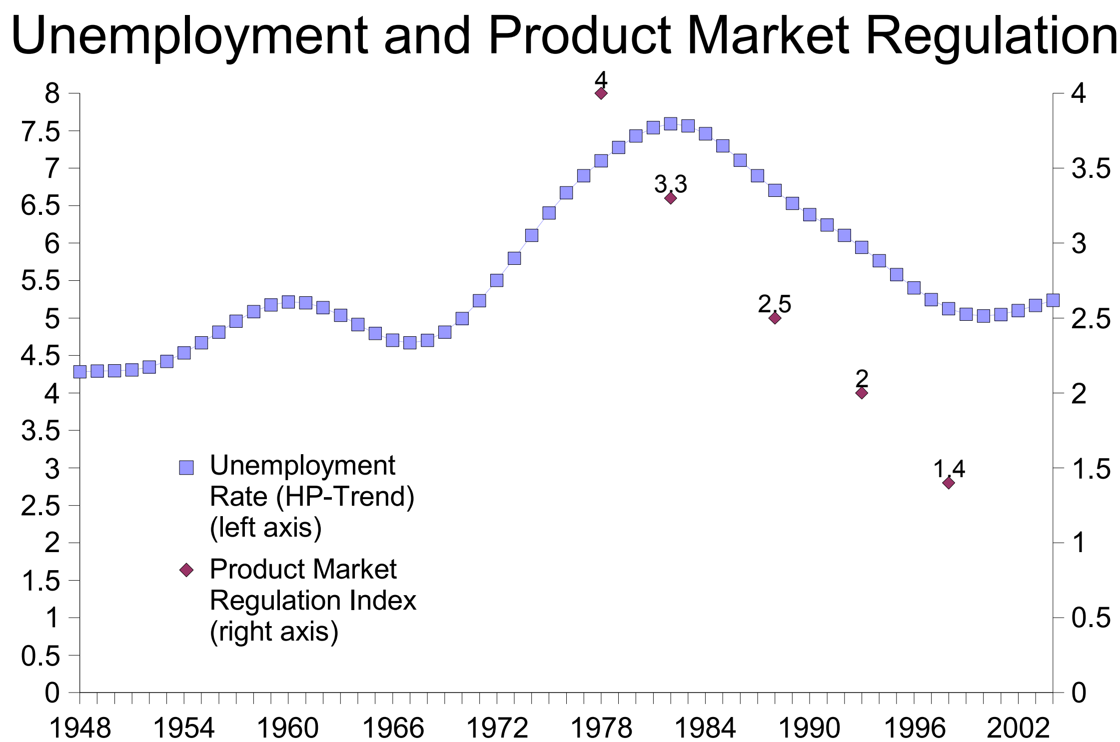

Figure 1: US HP-Trend Unemployment and Regulation Data
Source: BLS and Nicoletti and Scarpetta, 2002

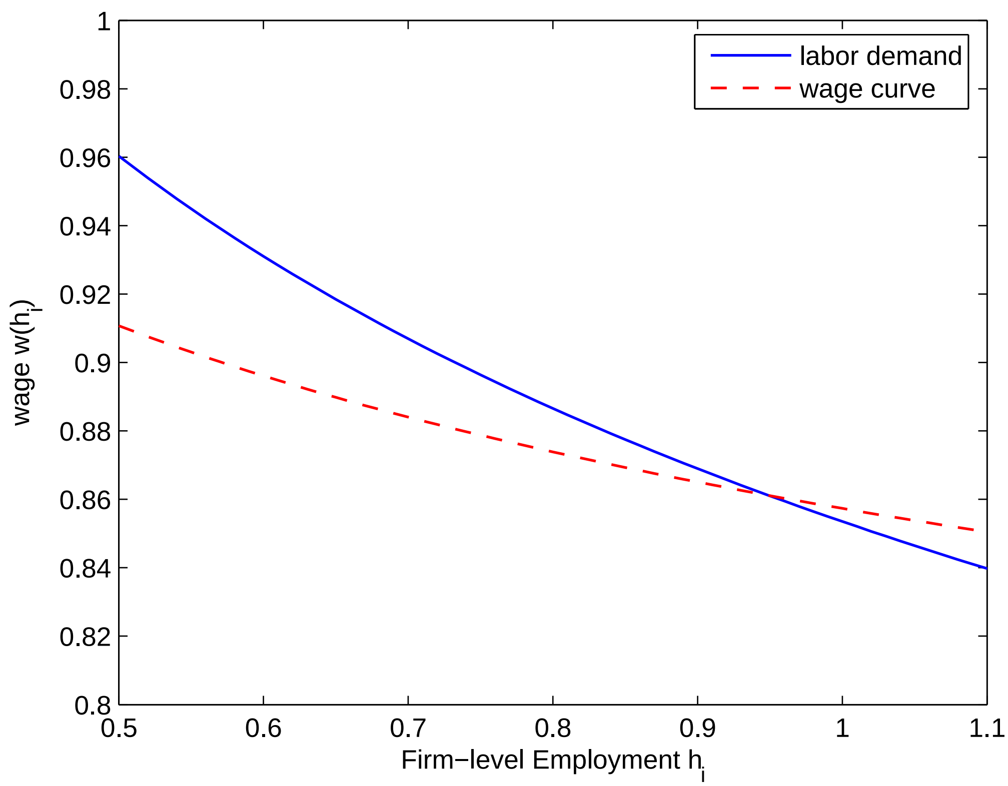

Figure 2: Firm Level Equilibrium Wages and Employment

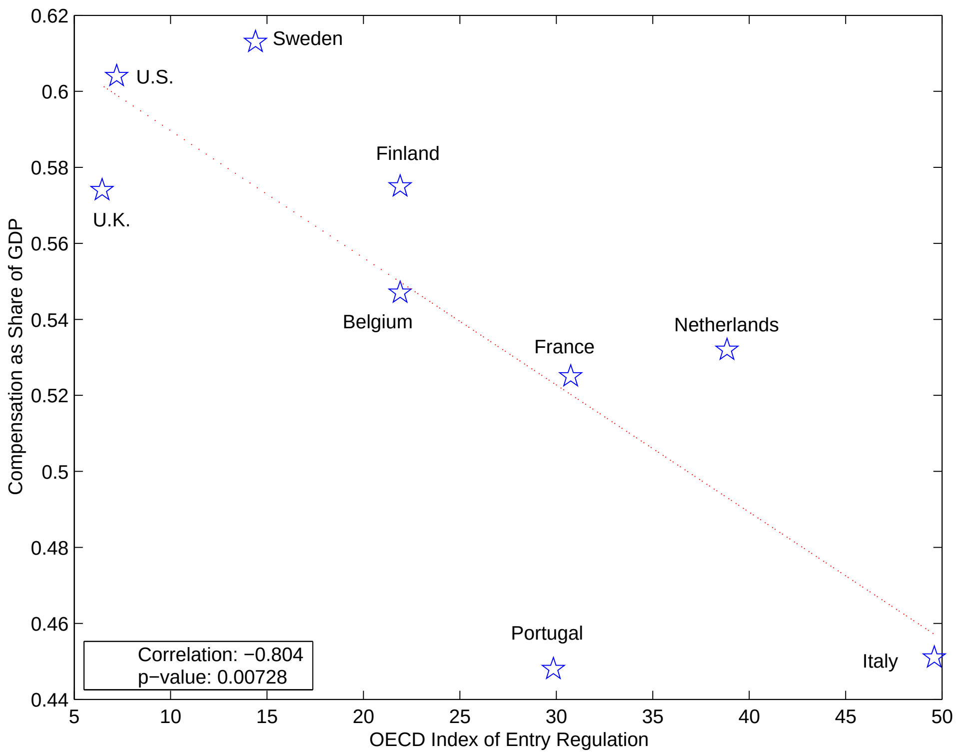

Figure 3: Entry Regulation and naive Labor Shares.

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.

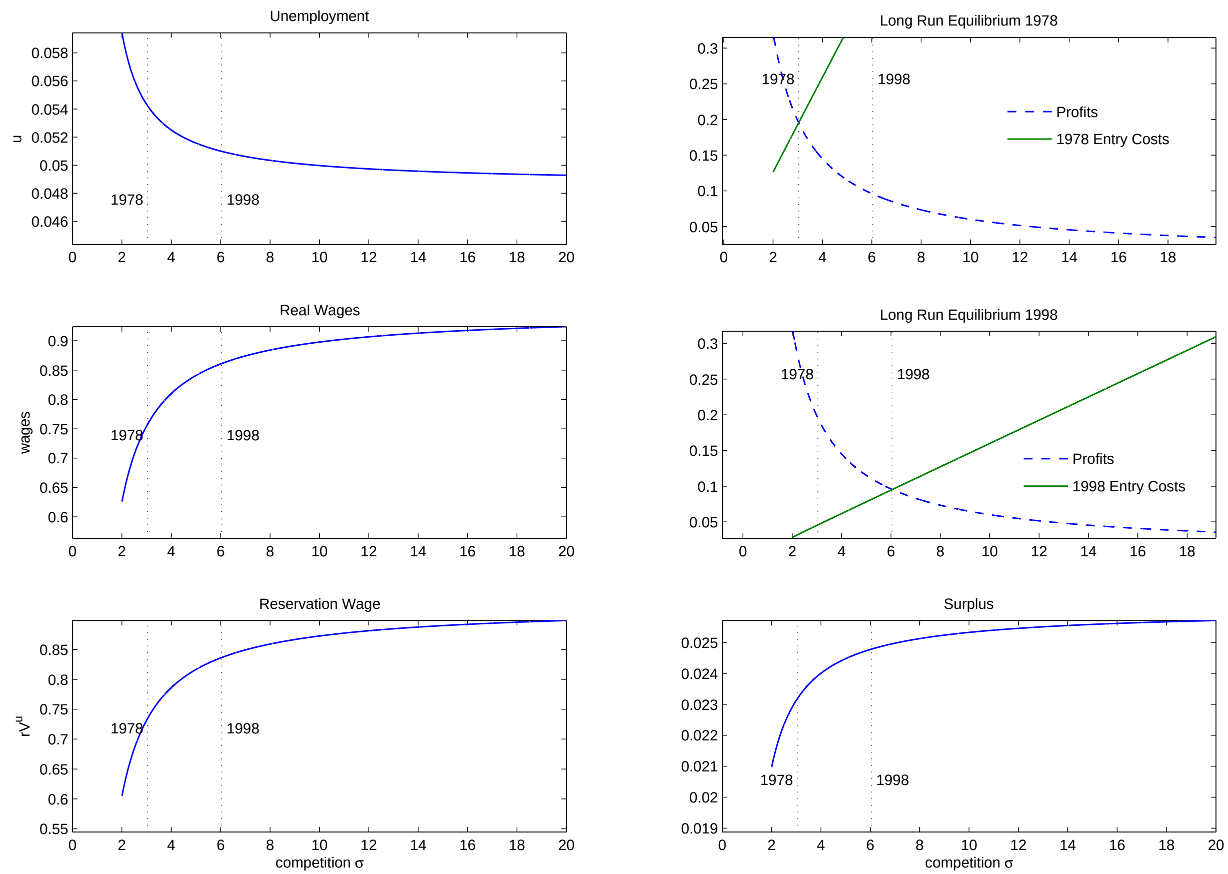

Figure 4: Baseline Calibration

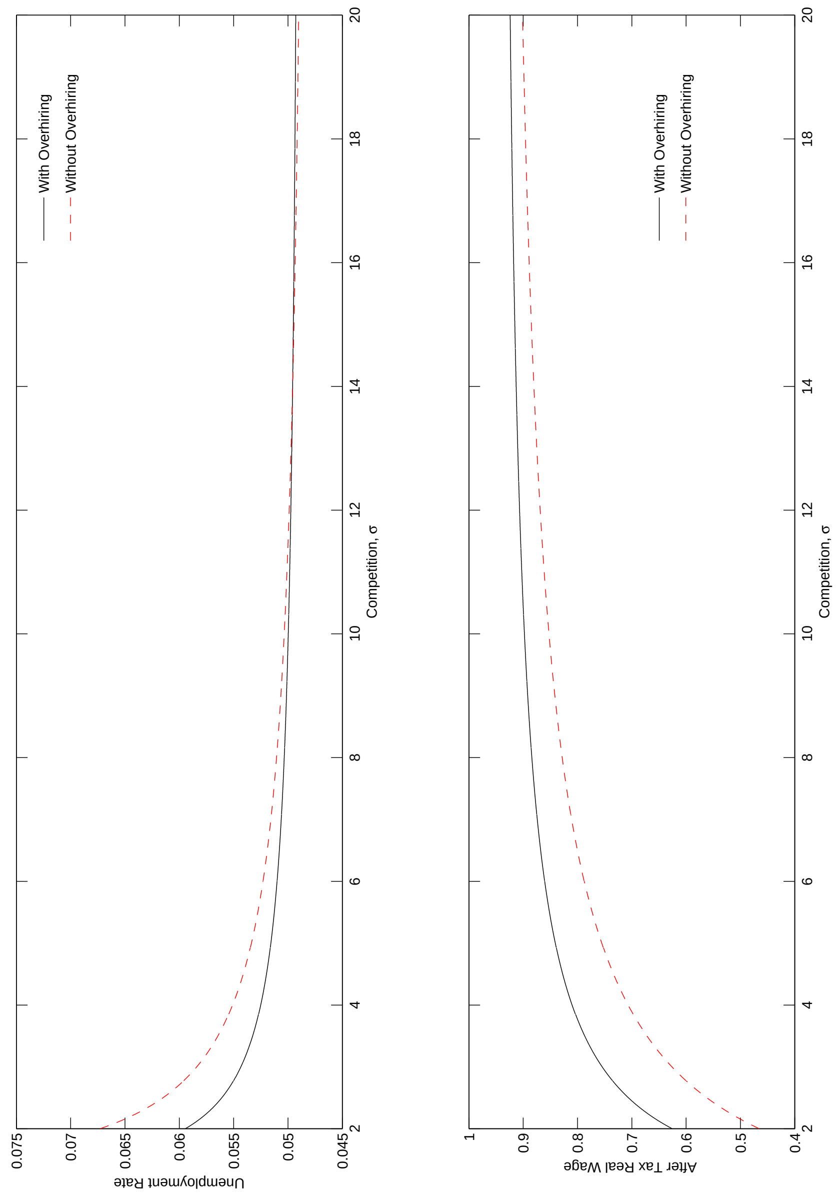

Figure 5: Quantifying the Overhiring Effect: The solid line shows the impact of competition on equilibrium unemployment (or wages). The dashed line shows how competition affects unemployment (or wages) when the hiring externality has been shut down by setting $\frac{\sigma-\beta}{\sigma}=1$.

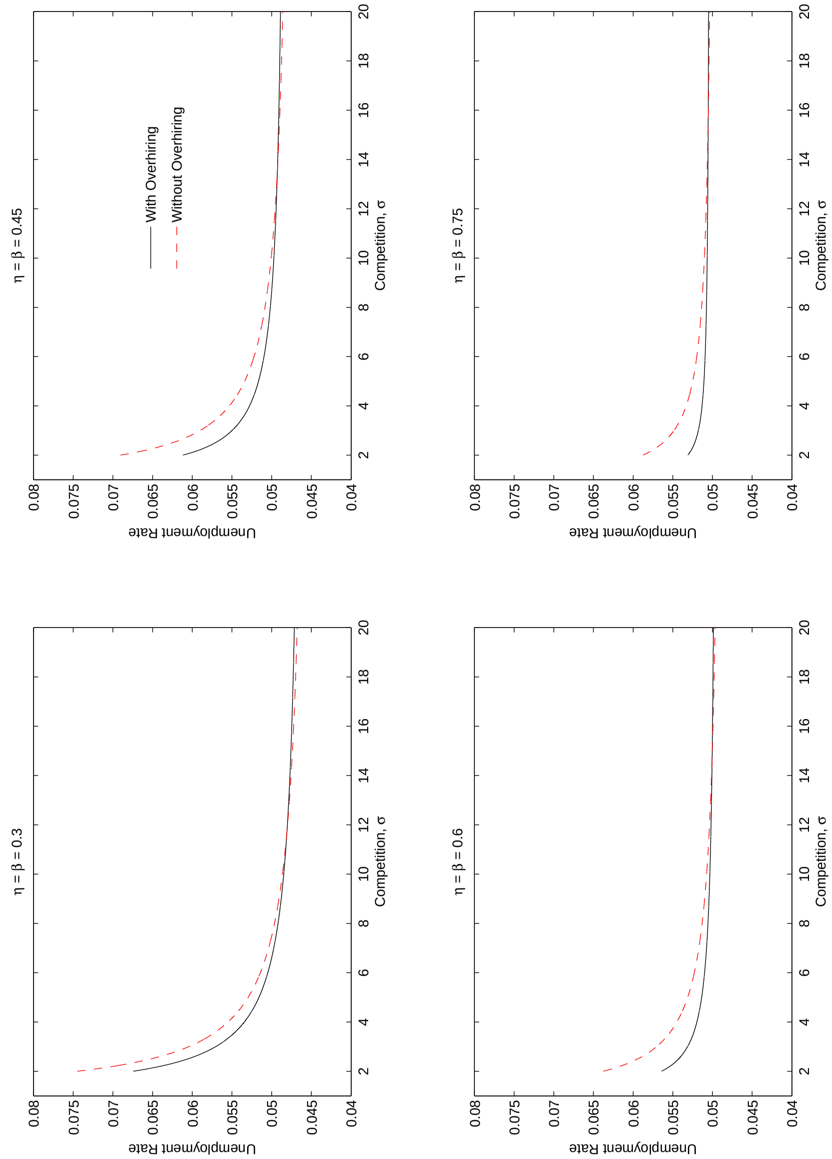

Figure 6: Quantifying Overhiring for Various $\eta = \beta$ Values: The solid line in each panel shows the impact of competition on equilibrium unemployment. The dashed lines show how competition affects unemployment when the hiring externality has been shut down by setting $\frac{\sigma-\beta}{\sigma} = 1$.

Appendix D Derivation of the Wage Curve: Solving the Differential Equation

From equation (15) we know that the wage curve is described by a differential equation of the form

$$w(h_i) = (1-\beta)rV^u + \frac{\sigma-1}{\sigma}\beta A_i P_i(h_i) - \beta h_i \frac{\partial w(h_i)}{\partial h_i}$$

which has the solution:

$$w(h_i) = h_i^{\frac{-1}{\beta}} \left\{ C + \int_0^{h_i} x^{\frac{1-\beta}{\beta}} \left[\frac{1-\beta}{\beta} rV^u + \frac{\sigma-1}{\sigma} A_i P_i(x) \right] dx \right\}$$

where C denotes some constant of integration. The first term of the integrand is easily solved and we can write:

$$w(h_i) = Ch_i^{\frac{-1}{\beta}} + (1-\beta)rV^u + \frac{\sigma-1}{\sigma}\frac{1}{\beta} h_i^{\frac{-1}{\beta}} A_i \int_0^{h_i} x^{\frac{1-\beta}{\beta}} P_i(x).$$

The last integral can be solved by parts, where we integrate the x-term and differentiate the inverse demand function.

$$\begin{aligned} \int_0^{h_i} x^{\frac{1-\beta}{\beta}} P_i(x) &= \beta h_i^{\frac{1}{\beta}} P(h_i) - \beta \int_0^{h_i} x^{\frac{1}{\beta}} \frac{\partial P(x)}{\partial x} dx \\ &= \beta h_i^{\frac{1}{\beta}} P(h_i) - \beta \int_0^{h_i} x^{\frac{1-\beta}{\beta}} P(x) \frac{\partial P(x)}{\partial x} \frac{x}{P(x)} dx \end{aligned}$$

The demand elasticity is given by $-1/\sigma$ and so we can write:

$$\int_0^{h_i} x^{\frac{1-\beta}{\beta}} P_i(x) = \frac{\sigma}{\sigma-\beta} \beta h_i^{\frac{1}{\beta}} P(h_i).$$

which gives equation 18 of the text. The condition to pin down the constant of integration is discussed in Cahuc et al. (2004) who assume that the wage remains finite as $h_i \to 0$ which implies $C = 0$. This condition is sensible. We know that in the limit of perfect competition $\sigma \to \infty$ the wage curve must coincide with the standard wage curve of the one-worker firm because the marginal revenue product is constant. Furthermore we also obtain that in the limit of $\beta \to 0$ the workers are only paid their reservation wages.

Appendix E Summary of Equations

- Partial Equilibrium – Firm Level: w_i, h_i, Y_i, P_i

  1. *Technology*
  $$Y_i = Ah_i$$
  2. *Goods Demand*
  $$\frac{P_i}{P} = \left(\frac{Y_i}{\frac{1}{n}I}\right)^{-\frac{1}{\sigma}}$$
  3. *Good Supply*
  $$A\frac{P_i}{P} = \frac{\sigma-\beta}{\sigma-1}\left(\frac{1+\tau_p}{1-\tau_I}rV^u + \frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta)}\frac{r+\chi}{1-\delta)}\right)$$
  4. *Wage*
  $$w(h_i) = \frac{1}{1-\tau_I}rV^u + \frac{1}{1+\tau_p}\frac{\beta}{1-\beta}\frac{\Phi_V}{q(\theta)}\frac{r+\chi}{1-\delta}$$
  5. *Firm Level Employment*
  by combining Goods demand and good supply;

- General Equilibrium – Short Run: $\theta, I, u, H, \tau_I, \tau_p$

  1. *Aggregate Demand and Supply*
  $$I = \frac{P_i}{P}Y_i$$
  2. *Symmetry*
  $$P_i = P_j = 1$$
  3. *Beveridge Curve*
  $$(1-u)\chi = u\theta q(\theta)$$
  4. *Aggregate Employment*
  $$H = (1-u)\,n$$
  5. *Balanced Budget*
  $$(\tau_I + \tau_p)\,w(1-u) = bu$$
  6. *Tax Policy*
  $$\tau_I = \tau_p$$
  7. *Reservation Wage*
  $$rV^u = b + \frac{1-\tau_I}{1+\tau_p}\frac{\beta}{1-\beta}\frac{\theta\Phi_V}{1-\delta}$$

- General Equilibrium – Long Run: $\sigma\,(n)$

  1. *Entry Costs*
  $$\Phi_E = (d+f)I$$
  2. *Free Entry Condition*
  $$\Phi_E + \frac{\Phi_V}{q(\theta)}H = V^J$$