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Structural unemployment and the regulation of product market*

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Abstract

I assess the impact of product market regulation on unemployment in a large-firm model of the labor market with search frictions and firm entry and exit. Two regulatory frictions are considered: administrative costs of establishing a new firm and the share of capital entrepreneurs recover when exiting. Product market regulation explains half the unemployment gap between Continental Europe and the United States in the calibrated model. More precisely, exit regulation is responsible for the entire explained gap, entry regulation playing no role. The degree of returns to scale and the presence of fixed capital in the model are important assumptions behind those results.

1 Introduction

Identifying the specific factors behind unemployment in each OECD country is not an easy task. Many candidate variables have been proposed as an explanation for the high rate of unemployment in some economies. Labor market institutions have naturally been studied, including unemployment benefits, labor tax wedges, employment protection legislation

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(EPL), minimum wage regulations, union density and the level at which wage bargaining occurs[1]. But labor economists have also looked beyond the labor market and focused on differences in regulation of the goods market, credit-market imperfections, macroeconomic shocks or even regulation of the housing market and social capital to explain differences in rates of unemployment[2]. An extensive literature has tried to assess the importance of each of those factors by running series of cross country regressions, including Nickell (1997), Nickell and Layard (1999), Blanchard and Wolfers (2000) and more recently Bassanini and Duval (2006). Nevertheless a difficulty with looking at cross-country correlations is that a correlation does not necessarily illustrate the causal impact of an institution to unemployment.

In this paper, I focus on one particular candidate, product market regulation, and I ask to what extent a model involving such regulatory friction is able to replicate the positive correlation between product market regulation indicators and unemployment that is observed across OECD countries. Specifically, I build a large-firm model of the labor market with search and matching frictions along the lines of Cahuc et al. (2008)[3]. I differ from their framework by allowing for entry and exit of firms. This allows me to study the effect of two types of product market regulations on steady-state unemployment: administrative

[1]For papers giving a large importance to unemployment benefits in the rise of European unemployment see Ljungqvist and Sargent (1998, 2008). Nice arguments regarding the role of taxes can be found in Rogerson (2008). Reviews of the vast literature on the effects of EPL on unemployment include Bertola (1999) and Ljungqvist (2002). For a broad review of the implications of labor market institutions, see Cahuc and Zylberberg (2004) and Boeri and van Ours (2008).

[2]On product market regulation, see Blanchard and Giavazzi (2003), Messina (2006), Felbermayr and Prat (2007), Ebell and Haefke (2009) and empirical evidence by Bertrand and Kramarz (2002). Wasmer and Weil (2004) investigate implications of credit market frictions for unemployment. Rupert and Wasmer (2010) focus on housing market and David et al. (2010) analyze the role of social capital.

[3]The large-firm literature dates back to Bertola and Caballero (1994). Other contributions include Smith (1999), Pissarides (2000), Bertola and Garibaldi (2001), Cahuc and Wasmer (2001), Felbermayr and Prat (2007) and Ebell and Haefke (2009). Most of the discussion in the literature have been around the determination of wages in the models: because of the presence of search frictions, firms do not take wages as given. Hence, the firm chooses the amount of posted vacancies ex ante, in order to influence the value of the wage ex post (once hire occurs) and so increase profits. In a context where production functions are concave, firms typically choose to overemploy as compared to a situation where it is assumed that firms do not take the wage as given. See e.g. Cahuc et al. (2009).

costs that firms have to pay upon entering an industry and regulations involving capital loss when firms have to exit[4]. This analysis cannot be done in the standard matching model with one worker per firm because, by contruction, vacancy costs are confounded with firm entry costs. By allowing for several workers per firm, I can separate the firm entry decision with the vacancy creation decision[5].

I calibrate the model to the US economy by using data on entry and exit regulation of the product market from the Doing Business database. Specifically I use the regulatory cost of establishing a new firm as a share of output per capita and the expected recovery rate on capital when a business is about to default[6]. I then follow standard practice in development accounting. I vary the parameters describing the stringency of product market regulation as they do vary in the data. This allows me to generate a sample of simulated OECD economies. Those economies differ from the benchmark calibrated economy only in the regulation of product market. I then compare the distribution of unemployment in those economies with the actual OECD distribution.

Several results come out of this quantitative analysis. First, product market regulation matters for unemployment. However, I show that only exit regulation is relevant, entry regulation plays no role: 32% of the cross-country variance in unemployment in the OECD is explained by exit regulation, while entry regulation generates almost zero variance. Furthermore, if I run an OLS regression of unemployment on my product market indicators with the simulated data and I compare the estimated slope with the slope of another OLS regression ran with the observed data, they are very similar in the case of exit regulation; however, the slope is almost zero in the case of entry regulation. Second, I ask what share of the unemployment gap between Continental Europe and the United States my model is able to generate. My results suggest that product market regulation is responsible for

[4]Both regulatory frictions have also been considered in the model of Bergoeing et al. (2010). These authors analyze the implications of product market regulation to explain cross-country differences in income. Barseghyan and DiCecio (2009), Moscoso Boedo and Mukoyama (2009) and Poschke (2010) analyze entry costs.

[5]Two exceptions are Ebell and Haefke (2009) and Felbermayr and Prat (2007). Both papers analyze product market regulation in a large-firm framework. In Fonseca et al. (2001), the authors add to the standard model a prior decision of being an entrepreneur vs. a worker. This allows them to distinguish between firm entry and vacancy creation.

[6]See Djankov et al. (2002) and Djankov et al. (2008).

half the gap between the two continents, exit regulation being responsible for almost the entire explained gap. Finally, conclusions regarding the effects on output and capital accumulation are similar: exit regulation depresses both variables, but entry regulation does not affect them significantly.

The fact that product market regulation causes unemployment is not a new finding. The seminal paper by Blanchard and Giavazzi (2003) discusses this mechanism as well as its political economy implications. My paper is more connected to the literature that quantitatively assesses the impact of regulation on unemployment. Two important contributions are Ebell and Haefke (2009) and Felbermayr and Prat (2007). While entry regulation has already been studied, I contribute to the literature by emphasizing the importance of exit regulation, an element which has been neglected in the literature on unemployment.

In Ebell and Haefke (2009), the authors ask whether the Carter/Reagan deregulation of the late 1970s and early 1980s in the United States was responsible for the observed decline in unemployment. Their finding is that little can be explained by deregulation. My results extend their analysis to an OECD context and suggest that entry regulation does not explain much of the cross-county variance in unemployment neither. However, I show the quantitative relevance of exit regulation.

In Felbermayr and Prat (2007), two types of product market regulation are considered: entry regulation and ex-post regulation that generates recurrent fixed costs. In their model, firms differ in productivity. They show the importance of a selection effect, regulation-induced changes in productivity generating changes in unemployment. While my work disregards selection issues, it contributes to the literature by borrowing from the macro literature on firm dynamics. Part of this literature has studied the impact of entry regulation on cross-country differences in income and TFP. Most importantly, it recognizes that the quantitative impact of entry regulation is sensitive to the whole structure of entry costs. This issue is discussed for instance in Barseghyan and DiCecio (2009). In my model, I allow for a rich structure of entry costs. In particular, I consider too types of physical capital: fixed and variable capital. Fixed capital is bought upon entry and part of the purchase of this capital stock is sunk because of exit regulation (entrepreneurs do not recover all the stock when they exit)[7].

[7]Barseghyan and DiCecio (2009) rely on the IO literature in order to calibrate their model properly. A particular issue in their calibration is the ratio of entry costs to fixed operating costs. The paper by

The presence of fixed capital explains why entry regulation has such a small impact in my model. When I recalibrate the model so that no fixed capital is considered, the effects of entry regulation are huge: the model predicts 100% unemployment rate for many OECD economies such as Germany, Greece, Italy, Spain and others. I conclude that it is important to know the relative importance of the costs resulting from entry regulation as compared to other entry costs when assessing the quantitative impact of entry regulation on the macroeconomy; if not, unrealistic unemployment rates may be generated.

The rest of the paper is organized as follows. I introduce the large-firm model with firm entry and exit in the next Section. In Section 3, I present the equilibrium conditions. This Section also presents three theoretical results: i) the analysis of the evolution of employment at the firm level is described, ii) it is determined under which assumptions the model is still equivalent to the standard matching model with one worker per firm in Pissarides (2000), iii) comparative statics of the effect of product market regulation are presented. The benchmark calibration is presented in Section 4 and quantitative results are finally shown in Section 5.

2 The model

2.1 Firms

Time is continuous and discounted at a rate r. One good is produced in the economy, the market of which is competitive. This good has many purposes. It can be invested, consumed and covers other expenses of firms such as vacancy costs and the administrative burden.

I denote by M_t the mass of firms that operate on this market at time t. They are all characterized by the same production function F, which depends on two factors of production: variable capital K_t and labor N_t. The production function is Cobb-Douglas, i.e. $F(K, N) = AK^{\alpha}N^{\nu}$, with $\nu > 0$, $\alpha > 0$, $A > 0$ and $\nu + \alpha \leq 1$.

The economy is similar to the one described in Cahuc et al. (2008) with one type of

Moscoso Boero and Mukoyama (2009) consider two types of entry costs (entry regulation and other sunk entry costs), while in Poschke (2010) and Bergoeing et al. (2010) physical capital plays a similar role than the fixed capital of my model.

worker, but it is augmented with a process of firm entry and exit. In particular, firms die at an exogenous rate λ. They also choose to leave the industry if their profits are negative and others choose to enter if profits (net of the sunk entry cost[8]) are positive.

2.2 Labor

There is a unit mass of workers, who can be either employed or unemployed. The presence of search and matching frictions explains the existence of unemployment (in quantities u_t). Firms post vacancies at a flow cost c in order to hire workers. I denote by V_t the mass of posted vacancies at the firm level, while v_t refers to the aggregate mass of vacancies. Vacancies are filled at a rate $h(\theta_t)$ that depends negatively on the labor market tightness $\theta_t \equiv \frac{v_t}{u_t}$, i.e. the vacancy-unemployment ratio. This rate is derived from a matching function $m(u_t, v_t)$ with constant returns to scale, increasing in both its arguments, concave and satisfying the property $m(u_t, 0) = m(0, v_t) = 0$, implying that $h(\theta_t) = \frac{m(u_t, v_t)}{v_t} = m(\theta_t^{-1}, 1)$. Jobs are destroyed at an exogenous rate s and firm exit also forces workers to come back to the pool of unemployed.

I denote by $w_t(K_t, N_t)$ the paid wage, which is determined under Nash bargaining with $\beta \in (0, 1)$ denoting the bargaining power of workers. Notice that I explicitly emphasize that the wage depends on the capital stock of the firm and its employment level: because of the existence of search frictions on the labor market, a given firm does not take the wage as given and can influence its value by overemploying or underemploying capital and labor.

2.3 Capital

Firms buy two sorts of capital: fixed and variable. As I explain below, part of the capital stock is sunk depending on the regulation of the product market. Fixed capital has to be purchased upon firm creation in quantities K^f. I_t is investment in variable capital, which depreciates at a rate δ. Fixed capital does not depreciate.

[8]See below.

2.4 Regulation

Regulation is of two types. First, in addition to the purchase of fixed capital, a sunk administrative cost $\kappa \geq 0$ has to be paid upon entry. Second, only part of the capital stock is recovered when a firm exits. I denote by $\varphi \in (0,1)$ the share of capital that can be sold when a firm is destroyed. This part of the stock is sold to other firms demanding capital for their own production. The rest of the capital stock disappears with the firm.

2.5 Value functions

To analyze the steady-state equilibrium of this economy, I proceed recursively: consider first the situation of an incumbent firm, derive its optimal behavior and then analyze the entry decision. For this purpose, I need to define the Bellman equations characterizing the behavior of firms and workers. Specifically, the value at time t of an incumbent firm with employment N_t and capital K_t is

$$\Pi(K_t, N_t) = \tag{1}$$
$$\max_{V_t, I_t} \frac{1}{1+rdt} \left\{ [F(K_t, N_t) - w_t(K_t, N_t)N_t - cV_t - I_t]dt + (1-\lambda dt)\Pi(K_{t+dt}, N_{t+dt}) + \lambda dt \varphi(\bar{K}_{t+dt}) \right\}$$

subject to the constraints

$$N_{t+dt} = (1 - sdt)N_t + h(\theta_t)dtV_t, \tag{2}$$

$$K_{t+dt} = (1 - \delta dt)K_t + I_t dt, \tag{3}$$

where $\bar{K}_t \equiv K_t + K^f$ and dt is an arbitrarily small interval of time. I will specifically consider the case where dt tends to zero.

The values of being unemployed and employed follow a standard formulation and respectively write as

$$rU_t = b + \theta_t h(\theta_t) [W_t - U_t] + \dot{U}_t \tag{4}$$

and

$$rW_t = w_t(K_t, N_t) + (s + \lambda) [U_t - W_t] + \dot{W}_t \tag{5}$$

with b the flow utility of being unemployed.

3 Equilibrium

I analyze the equilibrium in this Section. Three results are derived. First, I study employment dynamics at the firm level. Though the economies I study are in steady state with aggregate employment being constant over time, the presence of firm entry and exit implies that employment at the firm level is not constant. An entering firm may for instance experience some adjustment before reaching its long-run employment target. Hence the analysis of the dynamics of firm-level employment is required. I show that employment at the firm level follows a two-tier structure: starting with zero employment, an entering firm posts an impressive amount of vacancies so as to immediatly reach its long-run employment target. Consequently, part of the entry costs a firm has to pay is made of these search costs.

Second, I also determine under which circumstances my model is equivalent to the standard one-worker-per-firm matching model. Works by Pissarides (2000), Cahuc and Wasmer (2001) and Cahuc et al. (2008) have already shown that the large-firm model is equivalent to the standard model under constant returns to scale production function. I extend those results by allowing for firm entry and exit and determine what should the particular structure of entry costs be for this equivalence to hold. This is why the Section first begins with the case where the function F displays constant returns to scale (that is, $\alpha + \nu = 1$).

Third, I then consider decreasing returns to scale in Section 3.2. I study the effect of product market regulation on several macroeconomic variables such as unemployment, output, the aggregate capital stock and also firm-level variables. This analysis is purely qualitative. Quantitative analysis is done in the next Sections.

3.1 Constant-return-to-scale production function

3.1.1 First-order conditions, wage determination and steady-state profits

The first-order conditions are

$$\frac{\partial \Pi(K_{t+dt}, N_{t+dt})}{\partial N_{t+dt}} = \frac{c}{h(\theta_t)}$$

for vacancies and

$$\frac{\partial \Pi(K_{t+dt}, N_{t+dt})}{\partial K_{t+dt}} = 1$$

for investment. From the enveloppe theorem, we also have that[9]

$$\frac{\partial \Pi(K_t, N_t)}{\partial N_t} = \frac{1}{1+rdt}\left([F_2(K_t, N_t) - w]\, dt + \frac{\partial \Pi(K_{t+dt}, N_{t+dt})}{\partial N_{t+dt}}(1-sdt)(1-\lambda dt) \right)$$

where F_i, $i = 1, 2$, denotes the first derivative of F with respect to its i-th argument, and

$$\frac{\partial \Pi(K_t, N_t)}{\partial K_t} = \frac{1}{1+rdt}\left(F_1(K_t, N_t)dt + \frac{\partial \Pi(K_{t+dt}, N_{t+dt})}{\partial K_{t+dt}}(1-\delta dt)(1-\lambda dt) + \lambda\varphi dt \right).$$

Hence,

$$F_1(k_t, 1) = r + \lambda(1-\varphi) + \delta \tag{6}$$

and

$$\frac{c}{h(\theta_t)} = \frac{1}{1+rdt}\left([F_2(k_t, 1) - w]\, dt + \frac{c}{h(\theta_{t+dt})}(1-sdt)(1-\lambda dt) \right), \tag{7}$$

where $k_t \equiv \frac{K_t}{N_t}$ is the capital-labor ratio.

By letting $dt \longrightarrow 0$, equation (7) can be rewritten as

$$(r+\lambda+s)\frac{c}{h(\theta)} + \frac{h'(\theta)}{h(\theta)^2}c\dot{\theta} = F_2(k, 1) - w, \tag{8}$$

where the time subscript has been removed for notational convenience.

By combining (6), (8) and the fact that F is homogeneous of degree one, I have that

$$(r+\lambda+s)\frac{c}{h(\theta)} + \frac{h'(\theta)}{h(\theta)^2}c\dot{\theta} = F(k, 1) - (r + \lambda(1-\varphi) + \delta)k - w$$

Under Nash bargaining and from equations (4) and (5),

$$w = \beta\, [F(k, 1) - k(r + \delta + \lambda(1-\varphi))] + (1-\beta)b + \beta\theta c, \tag{9}$$

leading to

$$[r + \lambda + s + \beta\theta h(\theta)]\frac{c}{h(\theta)} = (1-\beta)\, [F(k, 1) - (r + \lambda(1-\varphi) + \delta)k - b]\, . \tag{10}$$

In the above equation, I made use of the fact that k is at any time fixed according to (6) and implies with (8) and (9) that $\dot{\theta} = 0$ along the unique stable path of the labor market tightness (Pissarides, 1985).

[9]Remember that, under constant returns to scale, we have in equilibrium that $\frac{dw}{dN} = 0$, implying that the firm cannot influence the wage by modifying its size (Cahuc and Wasmer 2001). Under an alternative framework, i.e. decreasing returns to scale, firms could use their monopsonistic power to overemploy and so extract larger rent from workers (see Cahuc et al., 2008, Stole and Zwiebel, 1996a and 1996b). In Section 3.2 I allow for decreasing returns to scale and strategic interactions in wage bargaining.

Since, $V = \frac{s}{h(\theta)}N$ and $I = \delta K$ in steady state, the steady-state present-discounted profits per employee $\pi \equiv \frac{\Pi}{N}$ evaluated at k can be written as[10]

$$(r+\lambda)\pi = (1-\beta)\left[F(k,1)-b\right] - \frac{s+\beta\theta h(\theta)}{h(\theta)}c + \left[\beta(r+\lambda(1-\varphi)) - (1-\beta)\delta\right]k + \lambda\varphi\bar{k}, \quad (11)$$

with $\bar{k} \equiv \frac{\bar{K}}{N}$.

Equation (11) corresponds to per employee profits of an *incumbent* firm, which has already reached its steady-state level of employment. But what about the convergence path at the firm level? I turn now to the analysis of firm-level dynamics, which will allow me to derive the entry behavior of firms.

3.1.2 Firm-level dynamics and implications for entry decisions

The conditions (6) and (10) imply that, after entry, adjustment in employment and capital at the firm level follows a two-tier structure. Hence, the following Proposition:

PROPOSITION 1. *Employment at the firm level follows a two-tier structure. At time of entry t_0, a firm posts an amount $V_0 = \frac{N}{h(\theta)dt}$ of vacancies so as to reach immediately its steady-state level, with $dt \to 0$, and invests a quantity $I_0 = \frac{K}{dt}$ in physical capital. Then, at time $t > t_0$, it posts $V = \frac{sN}{h(\theta)}$ vacancies and invests $I = \delta K$ so that the employment and capital stocks keep constant over time.*

This two-tier structure implies that upon entry firms pay a cost C_0 (in terms of investment and vacancies) so that their employment level reaches immediately its steady-state level, with C_0 defined as

$$C_0 \equiv c_0 N \equiv \lim_{\epsilon \to 0} \int_0^{\epsilon} e^{-(r+\lambda)x} \left(\frac{cN}{h(\theta)\epsilon} + \frac{K}{\epsilon} \right) dx \quad (12)$$

From a technical standpoint, the issue is to know whether the cost (12) converges to some finite value. If it is not the case, then no firm enters the market and the economy disappears.

[10] As I will discuss in Section 3.1.2 below, firms adjust their level of employment and capital after entry so that they immediately reach their steady-state level. This also implies that employment and capital jump following an exogenous shock that pushes their value upward, suggesting that (11) may also refer to profits on the transition path. However, this is not necessarily true if the shock makes firm-level employment to decrease, especially if s is low enough. In this case, firms simply freeze their hirings. See Garibaldi (2006). Given that I analyze the steady state of the economy and firms enter the industry with zero employment, I can discard these cases.

If the cost is finite, then remains the issue of whether it is low enough for firms to have incentive to enter.

After some calculations, one can rewrite the entry cost as

$$c_0 = \lim_{\epsilon \to 0} \frac{c/h(\theta) + k}{\epsilon} \frac{-e^{-(r+\lambda)\epsilon} + 1}{r + \lambda} = \frac{c/h(\theta) + k}{r + \lambda} \lim_{\epsilon \to 0} \frac{-e^{-(r+\lambda)\epsilon} + 1}{\epsilon}$$

From l'Hôpital rule, one can compute the limit in the above equation. Hence,

$$c_0 = \frac{c/h(\theta) + k}{r + \lambda}(r + \lambda),$$

which can be simplified as

$$c_0 = \frac{c}{h(\theta)} + k, \tag{13}$$

implying that the cost is finite.

I now turn to the entry decision of firms. After imputing the cost (13) into (11) as well as the other entry costs (i.e. the administrative cost κ and the fixed capital requirement K^f), one has

$$(r + \lambda)\left(\pi - c_0 - \kappa - k^f\right) = (1 - \beta)\left[F(k, 1) - b\right]$$
$$-(1 - \beta)(r + \delta + \lambda(1 - \varphi))k - (r + s + \lambda + \beta\theta h(\theta))\tfrac{c}{h(\theta)} - (r + \lambda(1 - \varphi))k^f - (r + \lambda)\kappa,$$

where $k^f \equiv \frac{K^f}{N}$ and $\left(\pi - c_0 - \kappa - k^f\right)$ on the left hand side refers to discounted profits net of the entry costs $(c_0 + \kappa + k^f)$ (in per capita terms). From (10), this equation can be rewritten as

$$(r + \lambda)\left(\pi - c_0 - \kappa - k^f\right) = -(r + \lambda(1 - \varphi))k^f - (r + \lambda)\kappa, \tag{14}$$

meaning that the entry cost c_0 is exactly equal to discounted profits in the case that no other sunk costs have to be paid upon entry (that is, when $\kappa + K^f = 0$). Consequently, under constant returns to scale and no sunk entry costs, adding a process of firm entry and exit to the large firm's matching model does alter the main features of the model: it is still equivalent to the one-worker firm framework of Pissarides (2000). Firm size is not determined and neither the mass of firms. An implication of (14) is also that any additionnal sunk entry cost $\bar{\kappa} \equiv \kappa + K^f$ other than c_0 would make the economy to shut down since $\Pi < C_0 + \bar{\kappa}$ in this case. Hence, the following Proposition:

PROPOSITION 2. *Define $\bar{\kappa} \equiv \kappa + K^f$ and consider the steady state of the economy under constant returns to scale.*

1. *When $\bar{\kappa} = 0$, the large-firm model with entry and exit is equivalent to the standard one-worker matching model from Pissarides (2000).*

2. *When $\bar{\kappa} > 0$, there is no firm in activity in the economy.*

Notice that the above Proposition holds for any constant-returns-to-scale production function and does not rely on the particular Cobb-Douglas assumption.

To conclude, the model is solved recursively. First, equation (6) gives the capital-labor ratio. Second, (8) determines the labor-market tightness given the capital-labor ratio. Finally, unemployment can be obtained thanks to its law of motion as in Pissarides (2000), which leads to the following steady-state formulation:

$$U = \frac{s+\lambda}{s+\lambda+\theta h(\theta)}. \tag{15}$$

3.2 Decreasing returns to scale

I now investigate the effect of product market regulation in the case where the production function displays decreasing returns to scale. Under decreasing returns to scale, Proposition 1 also applies (the evolution of employment at the firm level follows the two-tier structure) and most of the calculations in Section 3.1 are still valid. For these reasons I do not detail all the calculations in this Section. These are reported to the Appendix.

I also consider two cases: in the first situation, the firm does not take the wage as given and can act strategically when employing factors of production as in Cahuc et al. (2008); in the second case, the wage is given. Denote by $P_k = \frac{\partial F(K,N)}{\partial K}$ and $P_n = \frac{\partial F(K,N)}{\partial N}$, the steady-state equilibrium is described by the following set of equations:

$$P_k = \Omega_k(r + \lambda(1-\varphi) + \delta) \tag{16}$$

$$(r+s+\lambda)\frac{c}{h(\theta)} = (1-\beta)\left[\Omega_n P_n - b\right] - \beta\theta c \tag{17}$$

$$U = \frac{s+\lambda}{s+\lambda+\theta h(\theta)} \tag{18}$$

$$(r+\lambda)\kappa + (r+\lambda(1-\varphi))K^f = \frac{1-\nu-\alpha}{\alpha}(r+\lambda(1-\varphi)+\delta)K \tag{19}$$

where $\Omega_k = \frac{1-\beta+\beta\nu}{1-\beta}$ and $\Omega_n = \frac{1}{1-\beta+\beta\nu}$ if a firm is allowed to employ factors strategically (i.e, it does not take the wage as given) and $\Omega_k = \Omega_n = 1$ when a firm takes the wage as given.

Equations (16), (17), (18) and (19) are respectively the analogues of (6), (10), (15) and (14). Notice that, from (19), the capital stock at the firm level is the same whether strategic interactions in wage bargaining are allowed or not. Moreover the model can be solved recursively. First, (19) gives the firm-level capital stock. Then, given K, one can determine employment at the firm level with (16). Firm-level employment and capital in turn imply a particular value for the labor-market tightness in (17). Finally, the unemployment rate is given by (18).

The following Proposition summarizes the effect of regulation on the aggregates[11]:

PROPOSITION 3. *Consider the economy in steady state with $\nu + \alpha < 1$.*

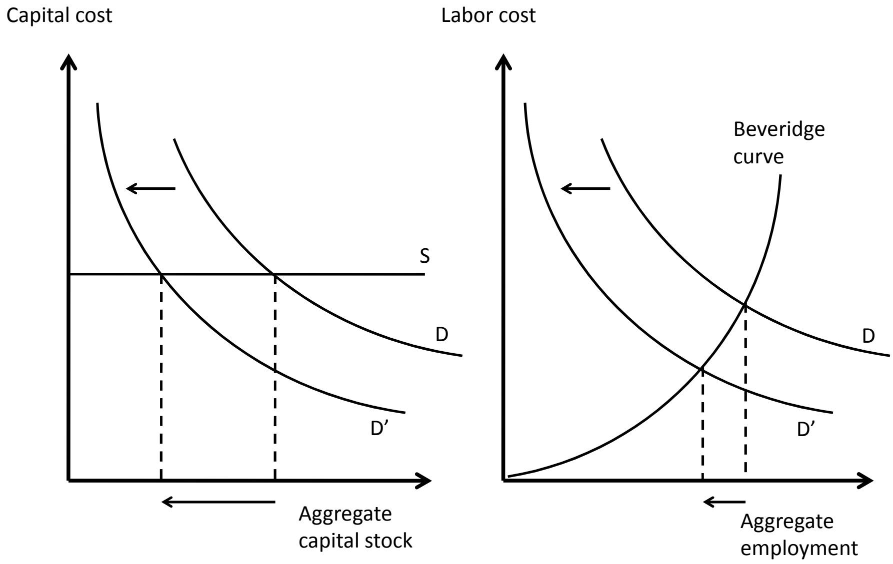
- *An increase in the administrative cost κ implies an increase in firm-level employment N and capital K, an increase in unemployment u, a decrease in the capital-labor ratio k, no change in the capital-output ratio $\frac{K}{F(K,N)}$ and a decrease in aggregate output Y.*
- *A decrease in the recovery rate φ implies an increase in firm-level employment N and ambiguous effects on capital K, an increase in unemployment u, a decrease in the capital-labor ratio k, the capital-output ratio $\frac{K}{F(K,N)}$ and the aggregate output Y.*

The intuition behind the comparative statics is the following. An increase in κ corresponds to an increase in sunk entry cost. As the sunk entry cost increases, firms need to make larger profits in equilibrium. This can be done by increasing their size, which explains the increase in firm-level employment and capital stock. But, given the presence of decreasing returns to scale, the increase in size implies a drop in the marginal productivities of labor and capital. Hence, as labor and capital get concentrated in fewer firms, aggregate output falls. Moreover, the decrease in the marginal product of labor generates lower incentives to open up vacancies, which implies lower labor-market tightness and explains the rise in unemployment.

The reason behind the fall in the capital-labor ratio is less intuitive, but it can easily be understood by recalling a standard feature of real-business-cycle models. As emphasized in the previous paragraph, when the sunk entry cost increases, the aggregate demands for capital and labor decrease. Hence, both aggregate capital stock and employment level decrease, implying an a prioiri ambiguous effect on the capital-labor ratio. What is the

[11]See the Appendix A.2 for the proof.

Figure 1: Effect of regulation on the capital and labor markets



Notes: The S curve is the supply curve of the capital market and the D and D' curves are demand curves before and after the increase in the sunk entry cost respectively.

actual net impact on the capital-labor ratio? It depends on the elasticity of supply on these two markets. Given that the discount rate is assumed exogenous, the supply of capital is infinitely elastic. This would also be true in an otherwise standard real-business-cycle model[12]: r would be given by the consumer discount rate. On the other hand, the long-run elasticity of labor supply is not infinite in this economy: because of the existence of search frictions, a Beveridge curve exists, which implies a labor supply elasticity different from infinity. This can be seen graphically on Figure 1, where both aggregate capital and labor markets are represented. Thus, as aggregate labor and capital demands fall, the capital stock decreases more than aggregate employment because of different elasticity of supply on these two markets. As a result, the capital-labor ratio drops as the cost of entry increases.

In the case of a decrease in φ, there are two effects: i) a change in sunk entry cost and ii) a change in the relative user cost of capital to labor. The intuition behind the consequences of the first effect are the same as in the case of an increase in κ, while the second effect exacerbates the effect on capital. This explains why the capital-output ratio is affected negatively by a decrease in φ and consequences for firm-level capital are ambiguous (though they are not for the aggregate stock of capital). Moreover the complementarity between

[12]See for instance King and Rebelo (2000) for a discussion.

capital and labor in the production function also implies a larger effect on unemployment: the marginal productivity of labor decreases by more because of this second effect, implying that less vacancies are posted[13].

Proposition 3 describes some comparative statics related to product market regulation. The next Sections are devoted to quantitative analysis. I will try to answer two types of questions. First, by how much are unemployment, output and the capital stock affected by changes in the administrative entry cost and the capital recovery rate? Second, to what extent can product market regulation reproduce the cross-country dispersion of unemployment in the OECD? To answer those questions I first need to calibrate the model before proceeding to policy analysis. This is the purpose of the next Section.

4 Calibration

4.1 Parameter values

I consider as a benchmark the calibration from Pissarides (2009), who focuses on the standard one-worker-per-firm matching model in the context of the US economy (for monthly data)[14]. It appears that the steady state of the economy I have just described is exactly the same as in Pissarides (2009) when $\Omega_n P_n = 1$ and $\lambda = 0$. For this reason, I take most of the parameter values from his calibration and fix other values so that I have the same equilibrium unemployment rate. In particular, I choose a Cobb-Douglas structure for the matching function, i.e. $m(u, v) = m_0 u^{\eta} v^{1-\eta}$ with $\eta \in (0, 1)$, and regarding the parameters values that do not change with respect to Pissarides (2009), I fix the discount rate r at 0.4 percent, the value of leisure b at 0.71, the vacancy cost c at 0.356, the matching function

[13] In Section 5 I show that this second effect is quantitatively less important than the first effect.

[14] An alternative calibration strategy is proposed by Hagedorn and Manovskii (2008). Their so-called "small surplus" calibration reproduces better the volatility of unemployment. However, I choose not to follow this strategy because of several reasons. The most important one has to do with the work by Costain and Reiter (2008). They show that this calibration strategy tends to overstate the effect of policies on unemployment. See also Ebell and Haefke (2009). Other critiques have to do with the fact that it generates job destruction rates that are too large (Bils et al., 2010) and it implies wages for newly formed matches that are too rigid (Haefke et al., 2007, and Pissarides, 2009).

Table 1: Parameters: summary of the benchmark calibration

Notation	Value	Parameter	Target/Source
r	0.004	Discount rate	Pissarides (2009)
b	0.71	Value of leisure	Pissarides (2009)
c	0.356	Vacancy cost	Pissarides (2009)
m_0	0.7	Scale parameter (matching)	Pissarides (2009)
η	0.5	Elasticity (matching)	Pissarides (2009)
β	0.5	Bargaining power	Pissarides (2009)
λ	0.0072	Firm death rate	Pissarides (2009)/Davis et al. (2006)
s	0.0288	Separation rate	Pissarides (2009)/Davis et al. (2006)
A	0.9951	Total factor productivity	$\Omega_n P_n = 1$
δ	0.0087	Capital depreciation rate	10% annual depreciation
κ	0.1095	Administrative entry cost	$\kappa / [MF(K,N)] = 0.007$ x 12
φ	0.767	Recovery rate	Djankov et al. (2008)
K^f	569.96	Fixed capital requirement	$\left[\lambda M K^f\right] / [MF(K,N)] = 0.16$

scale parameter m_0 at 0.7 and the elasticity of the matching function η and the bargaining power β at 0.5.

Pissarides (2009) also chooses the job separation rate to be 3.6 percent. Given that here I distinguish between firm destruction and worker separation, I need to modify this value. Specifically, because Davis et al. (2006) report that one fifth of job destruction occurs at establishments that shut down, I fix $\lambda = 0.036/5$ and $s = \frac{4}{5}$ x 0.036. Further, since I want my benchmark calibration to be identical to Pissarides (2009), I choose the total factor productivity parameter A such that $\Omega_n P_n = 1$. This allows me to get the same labor market tightness and unemployment rate as in his calibration exercise.

To calibrate the the regulatory cost of establishing a new firm κ and the recovery rate φ, I rely on the Doing Business database[15]. The Doing Business database reports that creating a new firm in the US costs 0.7 percent of income per capita. Their estimation is based on the number of procedures, official time, and official cost that a start-up must bear

[15] See Djankov et al. (2002) for more details on how entry costs are calculated and Djankov et al. (2008) for recovery rates.

before it can operate legally. In their data, several areas are covered: safety and health, environment, taxes, labor, and series of screening procedures that are required to comply with the previous areas. Those include all identifiable official expenses such as fees, costs of procedures and forms, photocopies, fiscal stamps, legal and notary charges, etc... In my calibration, I choose κ by targeting the 0.7 percent statistic in the model.

The Doing Business database also provides data on recovery rates when a business is about to default, i.e. the amount that a creditor would receive in final satisfaction of the claims on a defaulted credit. I use this data to calibrate the φ parameter. In the case of the United States it is equal to 0.767. The data takes into account several aspects. First, the estimated cost of the debt enforcement proceeding for the firm is considered. This includes court/bankrupcy authority costs, attorney fees, bankrupcy administrator fees, accountant fees, notification and publication fees, assessor or inspector fees, asset storage and preservation costs, auctionneer fees, government levies and other associated insolvency costs. Second, the data accounts for the time it takes to recover: interests are included. Third, it also considers whether the creditor has absolute priority: in some countries other claimants have priority over the creditor, such as tax authorities, employees, suppliers or shareholders. Finally, several procedures may be followed leading to different outcomes, such as foreclosure, liquidation or rehabilitation of the business in financial distress. The data considers these aspects as well.

To calibrate the value of K^f, I follow Bergin and Corsetti (2008). These authors calibre a macro model involving firm entry. They consider that the share of industry sales spent on fixed costs is 16%. They refer to the study by Domowitz et al. (1988) who provide such statistics for major US industries and notice that this value is within the range of values Domowitz et al. (1988) provide.

There are alternative ways to calibrate K^f. Because my results are sensitive to this parameter value, I choose to discuss them here. Hopenhayn and Rogerson (1993) use firm size from the Manufacturing Establishments Longitudinal Research Panel, which reports the average number of employees in manufacturing establishments to be about 62 employees. Incumbent firms in my calibrated economy have 24 employees. This means that my calibration strategy implies a value for K^f that is lower than the value which would have been obtained following Hopenhayn and Rogerson (1993). As a consequence, my calibration tends to give more importance to the effect of κ on unemployment than this alternative strategy and less importance to φ. Given that my results stress that entry regulation seems not to matter, while exit regulation does, a robustness exercise following Hopenhayn and Rogerson (1993) would actually reinforces this result. Another possibility is proposed by Barseghyan and DiCecio (2009), who use estimates on the ratio of entry costs to fixed operating costs from the IO literature. Calibrating this ratio is not an issue in the context of my model because I do not consider firm heterogeneity (as they do).

Two sets of parameters remain to be chosen: the returns to scale in the production function (the parameters α and ν) and the depreciation rate δ. The latter is determined by assuming 10 percent depreciation per year, giving $\delta = 1 - 0.9^{(1/12)}$. This is consistent with evidence reported by Gomme and Rupert (2007). Regarding the returns to scale, many papers assume that $\alpha + \nu = 0.85$. For instance, the papers by Veracierto (2001), Atkeson and Kehoe (2005), Restuccia and Rogerson (2008) and Barseghyan and DiCeccio (2009) consider returns to scale that are equal (or close) to 0.85. I consider this value in my benchmark calibration and then assign one third of the returns to capital and two thirds to labor. However, the consensus for a 0.85 value is not strong and some assign different returns to scale. For example, Guner et al. (2008) consider 0.8, while Gollin (2008) and Khan and Thomas (2008) assume returns to scale around 0.9. Moreover, the range of values implied by the estimations by Basu and Fernald (1997) is also substantially large. Because results are sensitive to the returns to scale (e.g, see Janiak and Santos Monteiro, 2010), I check their robustness for a wider range in Section 5.4.

Table 1 summarizes the benchmark calibration.

4.2 Description of the benchmark economy

I provide some descriptive statistics of the calibrated economy in Table 2. Specifically, the Table shows how aggregate output is decomposed. Moreover in order to understand this decomposition, I also provide statistics for the incumbents and entrants. Remember that, in the model, incumbents have all reached their long run level of employment and capital, while entrants do not produce yet and only pay entry costs. Part of these entry costs corresponds to the sunk administrative cost and investment in fixed capital, while the rest of the costs paid by the entrants represents investment in variable capital and vacancies that are posted in order to reach the long run target of capital and employment respectively. Notice that in this Table the total in each column is normalized to 100.

Table 2: Description of the benchmark economy

	Aggregate output	Incumbent's output	Entry costs
Total	100	100	100
Labor	71.1	71.1	/
Total investment	14.4	11.0	98.9
Fixed capital	2.83	11.0	56.7
Variable capital	11.6	0	42.2
Profits*	13.4	17.0	/
Vacancy costs	1.12	0.90	1.10
Administrative costs	0.00	/	0.01

Notes: The total in each column is normalized to 100.
* In the case of aggregate output, profits refer to the sum of incumbents' profits minus the sum of entry costs paid by entrants.

The first column illustrates how aggregate output decomposes. The labor share represents 71.1% of aggregate income. This is very close to the number Gomme and Rupert (2007) provide (71.7%). The investment-output ratio is 14.4% in the calibrated economy. This ratio is a bit above the one observed in the data: for the period 1947-2010, the ratio of investment to GDP in NIPA tables is 12.8%. Notice that, when calculating this ratio, capital sold by dying firms to new entrants is not taken into account: it would not be considered in national accounts since it has not been produced in the relevant period. Hence, this explains why only 2.8% of aggregate ouput is spent on fixed capital instead of 16% as the calibration suggests: the 16% includes both the capital sold by dying firms and the inflow.

By looking at the other two columns, which describe the behavior of incumbents and entrants, one can see that a substantital share of aggregate investment comes from entrants since investment by incumbents represents 11% of their output, while it is almost the total cost entrants pay. The reason for this difference is because incumbents have already reached their capital long-run target; they only need to compensate capital depreciation, while entrants have to invest much more to reach the long-run target and also invest in fixed capital. This is consistent with the evidence that the extensive margin plays an important role in shaping aggregate investment: in this economy, 31% of aggregate investment corresponds to investment by entrants, while the rest is made by incumbents. Those numbers are not far from the statisitcs reported in Cooper et al. (1999) and Gourio and Kashyap (2007) for the US economy, who show that an important proportion of aggregate investment is accounted for by the extensive margin[16].

In Table 2, profits in the "aggregate output" column represents the sum of profits by incumbents minus the sum of entry costs, that is, I assume that entry of new firms is financed by existing incumbents. Under this assumption, profits by incumbents are 17.0% of their output, while the share is 13.4% at the aggregate level. There are two questions that one can ask from these figures. The first question is, given that returns to scale are fixed at 0.85 in the calibration, why is it that profits for an incumbent are larger than 15%? The second question is, once entry costs are financed, why are aggregate profits still positive?

The answer to the first question has to do with the fact that here I look at output in a given period, while part of the costs are paid ex ante (upon entry). If one considers the discounted sum of profits, it indeed represents 15% of the discounted sum of output. It also equals the value of the administrative entry cost. This can be seen by manipulating equation (19):

$$\underbrace{\kappa + \frac{r+\lambda(1-\varphi)}{r+\lambda}K^f}_{\text{Sunk entry costs}} = \underbrace{(1-\nu-\alpha)\frac{F(K,N)}{r+\lambda}}_{\text{Discounted sum of profits}} \tag{20}$$

The reason why aggregate profits are not zero once entry costs have been substracted is again because of intertemporal considerations. Call $E \equiv \left[\kappa + \frac{c}{h(\theta)}N + K + K^f\right]\lambda M$ the sum of entry costs in the economy[17] and $\tilde{\pi} \equiv F(K,N) - wN - cV - I$ flow profits for a given incumbent. Free entry implies

$$E = \frac{\tilde{\pi}}{r+\lambda}\lambda M. \tag{21}$$

It can be shown that E equals the sum of profits by incumbents, that is equal to $M\tilde{\pi}$, only if the discount rate r is zero.

[16]In Cooper et al. (1999), they report that the share of investment accounted for by plants having investment spikes ranges from 40 to 50 percent. They define a plant as having an investment spike if its investrnent rate is greater than 20 percent.

[17]The cost upon entry has four components: the administrative cost κ, the vacancy cosy $\frac{c}{h(\theta)}N$, investment in variable capital K and investment in fixed capital K^f. Given that there are λM entrants in steady state, the sum of those four components has to be multiplied by this term in order to get the sum of all entry costs in the economy.

Finally, vacancy costs represent 1.1% of aggregate output. To understand whether they make sense, Hall and Milgrom (2008) follow Silva and Toledo (2009) and consider that recruiting costs are 14 percent of quarterly pay per hire. In my calibrated economy, they represent 11.0%. This number is not far from the number used by Hall and Milgrom (2008).

5 Quantitative effect of regulation

5.1 Unemployment

I now assess quantitatively the impact of regulation. I interpret more stringent regulation either as an increase in κ or a decrease in φ. Figure 2 shows two scatter plots for the OECD where the measures of product market regulation I used for the calibration are displayed against the unemployment rate. Each dot on the graphs represents an OECD country and the strait lines are the predictions of an OLS regression. In these graphs I consider the 2004 cross section for two reasons. First the unemployment rate for the US is close to the rate Pissarides (2009) calibrates (5.5% in the data versus 5.7% in the model). Second I do not want the data to be contaminated by the Great Recession.

Broadly the picture confirms standard evidence on the fact that entry regulation measures and unemployment are positively correlated, such as in Bassanini and Duval (2006) for instance. The correlation is not strong, but it is significant: it is 0.38 in the case of entry costs and -0.50 in the case of recovery rates. My model predicts such correlations. This is illustrated in Proposition 3. However Proposition 3 only refers to one particular causality, i.e. the effect of product market regulation. It is obvious that the displayed correlations may be the outcome of other causalities. For instance, it is well known that product market regulation is positively correlated with employment protection[18] or taxes on labor, and it has been argued by some that labor market institutions affect employment negatively[19]. Moreover, my two measures of product market regulation are also correlated between them (-0.44). Hence it still remains the question to what extent my model quantitatively reproduces those relations.

[18]See e.g. Blanchard and Giavazzi (2003).

[19]See for instance Hopenhayn and Rogerson (1993) and Saint-Paul (1995) for the negative effect of employment protection on employment and Prescott (2004) and Rogerson (2008) for the effect of taxes.

To answer this question I apply standard practice in development accounting. I depart from my benchmark calibration, which fits the US economy, and I vary the κ parameter so that the cost of establishing a new firm reaches a level similar to those observed in each OECD country. I then calculate the unemployment rate in each of the economies with a different value for κ. I can then compare the distribtuion of unemployment among the simulated economies with the actual cross-country distribution of unemployment. I make a similar exercise with φ too.

Figures 3 and 4 constrast the information contained in Figure 2 with the information obtained with this exercise. The dots are the same dots that appear on Figure 2 and the blue lines are the same OLS regressions obtained from the data as those depicted on Figure 2. In Figure 3 the thick black line refers to the relation between unemployment and the regulatory cost of establishing a new firm (as a share of output per capita) that holds in the model by varying κ. The thick black line in Figure 4 corresponds to the relation between unemployment and the recovery rate that is obtained with φ that varies. Additionnally each of the Figures 3 and 4 reports an OLS regression for the simulated data, that is, to produce these regressions I generate a sample where my measures of product market regulation are the same as in the Doing Business database, but the unemployment rate is the one obtained in the model. The regressions with the simulated data correspond to the black thin lines[20].

Two results come out of these Figures. First, product market regulation matters for unemployment in the OECD. But, only one type of regulatory friction seems to have a significant impact: recovery rates. Administrative entry costs have a tiny impact: though the slope of the black lines in Figure 3 is positive, it visually looks horizontal. The quantitative importance of exit regulation to explain the OECD cross-country dispersion of unemployment is confirmed by the value of R squared: the cross-country variance of unemployment for the simulated data represents 32% of the variance for the observed data. The R squared is obviously close to zero in the case of entry regulation.

As an illustration of the quantitative impact of regulation, we can ask what would be in the model the unemployment rate for the US if it was given the product market regulation of another OECD country, say Italy. Remember, in the calibrated model, the

[20]Notice that the black thin line is confounded with the black thick line in Figure 3.

US has an unemployment rate equal to 5.72%, the administrative entry cost represents 0.7 % of output per capita and entrepreneurs recover 76.7% of the capital they invest when exiting. In Italy, the recovery rate is 56.6% and the regulatory cost of entry represents 17.9% of output per capita. If the US were given the Italian recovery rate, they would be characterized by an unemployment rate equal to 7.8%, which is about 2 percentage points above the initial rate. On the other hand, if the US were given the same regulatory cost of establishing a firm as in Italy, the unemployment rate would be 5.74%, which is barely the initial calibrated rate.

Second, the Figures give information on the quantitative importance of the causality that goes from regulation to unemployment for the correlations displayed in Figure 2. This information can be extracted by comparing the slope of the OLS regressions in the data with the slope of the OLS regressions for the simulated data. In the case of the administrative entry cost this ratio is barely zero, while it is 1.14 in the case of recovery rates. Hence, the exercise suggests that the positive correlation between entry regulation and unemployment in the data is the consequence of the existence of other variables that are positively correlated with both entry regulation and unemployment. On the other hand, since the slopes in the case of recovery rates are almost equal, the exercise suggests that one can trust the value of the estimated impact of recovery rates on unemployment from the data: it represents the causality that goes from recovery rates to unemployment.

Those results help reconcile opposite evidence on the role of product market regulation for unemployment. On the one hand, OECD studies that run cross-country regressions to determine the main factors behind unemployment dispersion tend to find product market regulation indicators as being important. See for instance the work by Bassanini and Duval (2006). Felbermayr and Prat (2007) also present similar evidence. On the other hand, the paper by Ebell and Haefke (2009), who looks at the Carter/Reagan product market deregulation of the late 1970s and early 1980s in the US, attributes a limited role to deregulation for the decline in US unemployment. Ebell and Haefke (2009) specifically looks at entry costs in a calibrated model. To the extend that their results can be extended to a cross-country OECD context, both types of approach seem to contradict. My results allow to explain the tension between the two approaches by stressing that the type of product market regulation that seems important is the one that operates on the exit margin. While Ebell and Haefke (2009) find that entry regulation is not relevant, the positive correlation between unemployment and entry regulation that Bassanini and Duval (2006) find might be the consequence of the correlation between entry and exit regulation. I illustrate this claim in Figure 5, where I reproduce the exercise in Figure 3, but, instead of varying only the κ parameter as in Figure 3, I vary both κ and φ. The resulting correlation between entry costs and unemployment appears much stronger than in Figure 3: the slope of the OLS regression in the simulated data represents now 64% of the slope of the OLS regression with the observed data. This larger slope is the direct consequence of cross-country differences in exit regulation.

5.2 Other macro variables

Proposition 3 predicts that product market regulation also has negative consequences for aggregate output and the aggregate stock of capital and leaves the capital-output ratio unchanged. The previous exercise can also be made with these alternative macro indicators. Figure 6 shows the cross-country correlation between product market regulation and output (or capital) both in the model and the data. To build those graphs, I use the same data on product market regulation as previously together with data from Caselli (2005). In particular, Caselli (2005) constructs measures of "output per worker" and "capital per worker" from the 6.1 version of the Penn World Tables. Those variables are expressed as a ratio to the size of the active working population.

The graphs suggest effects similar to those observed in the case of unemployment. Regulation depresses output and desincents capital accumulation. Administrative entry costs have limit effect on the macro variables, while recovery rates have a stronger effect than the correlation observed in the data. If one compares the slopes of the OLS regressions in the model with those in the data, they are 23% larger in the case of the effect of recovery rates on output, 120% in the case of the effect of recovery rates on capital and the ratio is zero whenever regulatory entry costs are considered as regulation.

Regarding capital-output ratios, Figure 7 displays the data correlation with product market regulation. The correlations are rather weak[21]: the correlation coefficient with the

[21]Poschke (2010) documents a postive correlation between administrative entry costs and capital-output ratio. Here the absence of correlation is due to the fact that I focus on a larger sample than Poschke (2010), who considers Germany, France, Italy, Netherlands and the United States. If I only keep those countries,

Table 3: The model under alternative returns to scale: unemployment in Continental Europe and share of the US-Europe gap explained by product market regulation

Returns to scale		0.75	0.80	0.85	0.90	0.95
Administrative	Unemp. rate	41.1%	6.91%	5.72%	5.72%	5.72%
entry cost	Share of the gap	na	60%	0%	0%	0%
Recovery	Unemp. rate	7.01%	6.95%	6.68%	6.45%	6.26%
rate	Share of the gap	66%	63%	49%	37%	28%

entry cost is -0.09, while it is 0.18 in the case of the recovery rate, slightly larger.

5.3 Continental Europe

Here I ask what share of the gap in unemployment my calibrated model is able to explain by focusing on the two market regulations. For this I need to define Continental Europe first. I calculate statistics for Continental Europe in the data as the (unweighted) average of the statistics reported for the following countries: Austria, Belgium, France, Germany, Greece, Italy, Luxembourg, the Netherlands, Portugal and Spain. Under this definition, Continental Europe has a 7.7% rate of unemployment, the regulatory cost of establishing a new firm represents 7.4% of output per capita in Continental Europe and investers recover 62.3% of their capital.

If I recalculate the unemployment rate in the model by inputing those regulatory frictions, I obtain that it is 5.7% when I change κ and 6.7% when I change φ. It is also 6.7% when I change both parameters. The rate in the calibrated economy is 5.7%. Hence, product market regulation explains 50% of the unemployment gap between the US and Continental Europe[22].

5.4 The importance of returns to scale

Atkeson et al. (1996) forcefully show that the choice of the returns to scale in models with industry dynamics is an important determinant of the size of the effect of policy distortions.

the correlation is indeed positive.

[22]The model also predicts that output is 9% lower in Continental Europe and capital 20% lower.

Therefore, I ask how sensitive my results are to changes in the returns to scale. This is an important thing to consider because, while it is standard to assume returns to scale equal to 0.85 in the literature on firm dynamics, those value do not appear to be estimated with high precision. For instance, in Basu and Fernald (1997), the range of estimated values are very dependent on the level of aggregation of the data. Moreover, several papers wander from the 0.85 benchmark. For example, Guner et al. (2008) consider 0.8, while Gollin (2008) and Khan and Thomas (2008) assume returns to scale around 0.9.

As expected, as $\alpha + \nu$ approaches one, unemployment is no longer affected by changes in regulation and the share of the unemployment gap between Continental Europe and the US explained by these frictions diminishes. However, the contribution of regulation increases as the returns to scale are lowered. This quantitative difference can be explained by recalling the mechanism that implies larger unemployment. Remember that an increase in κ or a decrease in φ can be interpreteed as an increase in sunk entry cost. When the sunk entry cost gets larger, firms have to become larger too: more has to be produced in order to cover entry costs. The increase in size implies a decrease in the marginal productivity of labor, lowering the incentives to open up vacancies and increasing the rate of unemployment. Hence, by changing the returns to scale, one changes the concavity of the production function and so the marginal impact of entry costs on the marginal productivity of labor.

This is illustrated in Figure 8, where I make the same exercise as in Figures 3 and 4 by changing the returns to scale in the calibration. I consider returns to scale ranging from 0.75 to 0.95. The Figure shows that regulation becomes more stringent as returns to scale are lower: the slope of the dipected relations gets steeper.

Table 3 gives similar information. The Table gives the rate of unemployment in the model by inputting the regulation parameters κ and φ for Continental Europe as I do in Section 5.3. It also shows the share of the unemployment gap between Continental Europe and the US this exercise explains. Consistently with Figure 8, regulation explains a larger share of the gap as the returns to scale are lowered. For instance, recovery rates are responsible only for 28% of the gap when returns to scale are equal to 0.95, while they explain two third when returns are equal to 0.75. In the case of the regulatory cost of establishing a new firm, differences are more strinking. While this regulatory friction does not explain anything for returns to scale above 0.85, it predicts an unemployment rate for

Continental Europe equal to 41% when returns to scale are fixed to 0.75.

5.5 The importance of fixed capital

There is another parameter that influences the importance of the effect of product market regulation on unemployment in the model: the fixed capital requirement K^f. This parameter affects the marginal effect of the recovery rate on unemployment because part of the costs entrepreneurs have to pay upon entry is made of capital in the model. The presence of φ merely makes this cost sunk. Hence, by increasing K^f, one increases the amount of entry costs that are sunk. The K^f parameter also affects the marginal impact of κ on unemployment: as K^f increases the relative importance of κ in the sum of all sunk entry costs diminishes, lowering its marginal effect on the rate of unemployment[23].

In Figure 9, I make the same exercise as in Figures 3 and 4 by fixing K^f to zero in the calibration. The Figure confirms that the relation between regulation and unemployment becomes steeper in the case of administrative entry costs, while the slope diminishes in the case of recovery rates. Moreover, the changes in slopes are important. In the case of recovery rates, the slope of the OLS regression for the simulated data represents 33% of the slope of the OLS regression with the observed data, while it is 14% larger under the benchmark calibration. The difference in the case of the administrative entry cost is even more impressive as the rate of unemployment rapidly tends to 100%. As a result, I cannot even compare the slope of the OLS regression for the simulated data with of the slope of the OLS regression with the observed data in this case: for entry costs larger than 4% of output per capita, there is no firm in activity, implying that no data can be generated.

Two results come out of this analysis. First, it is important to consider alternative entry costs in the calibration when one assesses the effect of entry regulation on the macroeconomy. Some papers consider models where the only entry cost that is paid is the administrative cost. This assumption clearly overstates the effect of entry regulation. In my model, it would imply rates of unemployment equl to 100% for many countries in the sample; those

[23]For a formal proof, see the Appendix A.2. This appendix shows that the effect of κ is larger, the larger ξ parameter is, ξ being defined as $\xi \equiv \frac{(r+\lambda)\kappa}{(r+\lambda)\kappa+(r+\lambda(1-\varphi))K^f}$, i.e. the share of administrative costs in the entry cost made by fixed capital and administrative costs. On the other hand, the Appendix shows that the effect of φ on the economy is lower, the larger ξ is.

rates are clearly non realistic.

Second, this exercise helps determine which is the dominant mechanism behind the effect of φ on unemployment. Remember φ affects unemployment for two reasons. The first reason is because it determines the share of entry capital that is sunk. The second reason is because it influences the user cost of capital: to the extent that capital and labor are complements, the decrease in the stock of variable capital under lower φ implies lower marginal productivity of labor and higher unemployment. When K^f is fixed to zero only the first effect remains. Hence given that the slope of the relation in Figure 9 (in the case of the recovery rate) is much lower than in Figure 4, it turns out that the second mechanism is not dominant.

5.6 The role of intrafirm wage bargaining

The results I have documented in the paper had been calculated in a context with intrafirm wage bargainaing. This corresponds to the case where $\Omega_k = \frac{1-\beta+\beta\nu}{1-\beta}$ and $\Omega_n = \frac{1}{1-\beta+\beta\nu}$. It turns out that, whether strategic interactions in wage bargaining are allowed for or not, the effect of increasing κ or decreasing φ is always the same. This can be shown analytically from equations (16)-(19). The idea for the proof is that the labor-market tightness and the rate of unemployment are directly determined by the term $Q = \Omega_n P_n$ (this can be seen from equations (17) and (18)). Given that in the calibration exercise Q takes value one so that I am in the same situation as Pissarides (2009), the effect of κ (or φ) on Q directly identifies the effect of κ (or φ) on U. Put differently, intra-firm wage bargaining does not matter for the quantitative effect of κ (or φ) on U if $\hat{Q}$ is the same in both cases (with and without intrafirm wage bargaining).

It can be shown that

$$\hat{Q} = -\frac{1-\alpha-\nu}{\nu}\hat{\kappa} \tag{22}$$

both in the case with and without intrafirm wage bargaining, implying that strategic interactions in wage bargaining do not matter for the quantitative impact of the sunk entry cost on unemployment when the production function is Cobb-Douglas.

Of course, this result is a consequence of the particular structure characterizing my economy and is certainly not robust to alternative assumptions. An example where the effect of intrafirm bargaining is not zero is Ebell and Haefke (2009). In their work, they consider a model similar to mine and ask whether the product market deregulation observed in the US at the end of the 70s and at the begining of the 80s was quantitatively responsible for the subsequent decline in unemployment. A difference characterizing their model as opposed to mine is that they consider monopolistic competition on the product market in a Dixit and Stiglitz (1977) fashion. In particular, they assume that the elasticity of substitution between product varieties is increasing in the mass of firms in the economy as in Blanchard and Giavazzi (2003). In this context, the curvature of a firm income function is affected by the size of the market. Thus, given that deregulation affects the mass of firms in the economy, it also changes the curvature of a firm income function, implying that intrafirm bargaining may be relevanty. However, their calibration results indicate that the effect is not large.

Another possibility is to consider several types of workers as Cahuc et al. (2008) suggest, e.g. skilled and unskilled. In this framework, one may think that depending on the substitution between workers and capital, intrafirm bargaining may be quantitatively relevant. I leave those considerations for future research.

5.7 Imperfect competition

A last issue regarding the robustness of my results has to do with the particular industrial organization I consider in the model. The model considers perfect competition, but it is also common in macroeconomics to consider models with monopolistic competition. This is the case in Ebell and Haefke (2009), Felbermayr and Prat (2007), or Blanchard and Giavazzi (2003) for example. Those papers also look at the effect of product market regulation on labor market and unemployment.

It turns out that extending my model to allow for monopolistic competition is equivalent to playing with the returns to scale. This claim is illustrated in Janiak and Santos Monteiro (2010). This paper considers a model similar to mine with no labor-market search frictions and perfect competition on the product market. The model is also extended to allow for monopolistic competition as in Dixit and Stiglitz (1977). It is shown that this exercise is equivalent to making the production more concave. For instance, by assuming a production function with returns to scale close to constant and an elasticity of substitution equal to 6 as in Rotemberg and Woodford (1992), the effect of entry costs in this context are similar to a situation with perfect competition and returns to scale equal to 0.85.

This also helps understand why the papers by Felbermayr and Prat (2007) and Ebell and Haefke (2009) present a lower impact of entry regulation on unemployment than the one displayed in Figure 9, where no fixed capital is considered. The reason has to do with the value of the elasticity of substitution between varieties that they choose. The larger the elasticity of substitution is, the more linear the profit function is. For instance, in Felbermayr and Prat (2007), the elasticity of substitution[24] is equal to 11. Assuming an elasticity of substitution equal to 11 is similar to a situation of perfect competition and returns to scale equal to 0.91. This means that the profit function that they assume is much less concave than what is typically assumed in models with firm dynamics[25].

6 Conclusion

I study to what extent the large-firm model of the labor market can reproduce the positive correlation between the stringency of product market regulation and unemployment that is observed across OECD countries. I allow for entry and exit of firms in the model so that two types of regulations can be analyzed: i) the regulatory cost of creating a new firm and ii) regulations involving capital loss when firms have to exit. The model is calibrated to the US economy. The quantitative exercise that is achieved consists of varying the parameters describing the stringency of regulation as they do vary in the data. The cross-country distribution of unemployment that is obtained through this exercise can be compared with the actual distribution in the OECD. It is shown that half the unemployment gap between the US and Continental Europe can be explained by cross-country differences in product market regulation. Further one third of the cross-country variance in unemployment is explained by these regulatory frictions.

It turns out that differences in exit regulation between countries are responsible for the entire variance in unemployment generated by the quantitaive exercise. Entry regula-

[24]This corresponds to their case with exogenous σ.

[25]A particularity of the paper by Ebell and Haefke (2009) is that they focus on the US deregulation, i.e. a decrease in entry costs. It turns out that the effect of entry in their model is asymetric: increases in entry costs predict larger changes in unemployment (in absolute value) than decreases. See the Figure 5 in their paper. Given that most OECD countries have more stringent regulation than the US, one may conjecture that their model would predict stronger effect of product market regualtion on unemployment when taken to an OECD context.

tion plays no role. The degree of returns to scale and the presence of fixed capital in the model are important assumptions behind those results. On the one hand the limited role of entry regulation for unemployment is at odd with cross-country regression from OECD studies. On the other hand it extends results by Ebell and Haefke (2009) for the US to a cross-country perspective. I reconcile both evidence by emphasizing the importance of exit regulation. The positive correlation between unemployment and entry regulation in the data can be explained by the correlation between entry and exit regulation. However, my calibration suggests that the correlation between unemployment and entry regulation cannot be interpreted as evidence of a causality that goes from entry regulation to unemployment, most of the correlation is rather the consequence of the causality that goes from exit regulation to unemployment.

A Appendix

A.1 Steady-state under decreasing returns to scale

This Appendix shows how to obtain equations (16)-(19). I only focus on the steady state of the economy. Call J the marginal value of a worker and H the marginal value of capital. The first-order conditions are the following:

$$J = \frac{c}{h(\theta)} \tag{23}$$

and

$$H = 1. \tag{24}$$

Moreover, from the enveloppe theorem, we have

$$(r + \lambda + s)J = F_2(K, N) - w(K, N) - Iw_2(K, N)N, \tag{25}$$

where F_i and w_i, $i = 1, 2$, denote the first derivative of F and w with respect to their i-th argument respectively, and I is an indicator function, which takes value zero if the firm takes the wage as given and one if not, and

$$(r + \lambda(1 - \varphi) + \delta)H = F_1(K, N) - Iw_1(K, N)N. \tag{26}$$

Combining the first-order conditions with those obtained by applying the enveloppe theorem implies

$$(r + \lambda + s)\frac{c}{h(\theta)} = F_2(K, N) - w(K, N) - Iw_2(K, N)N \tag{27}$$

and

$$F_1(K,N) = r + \lambda(1-\varphi) + \delta + Iw_1(K,N)N. \tag{28}$$

Given the surplus for a worker is

$$(r+\lambda+\delta)\,[W-U] = w(K,N) - rU, \tag{29}$$

Nash bargaining yields

$$w(K,N) = (1-\beta)rU + \beta F_2(K,N) - I\beta w_2(K,N)N. \tag{30}$$

In the case where firms do not take the wage as given, Cahuc et al. (2008) show that the solution to the above differential equation is

$$w(K,N) = (1-\beta)b + \beta\theta c + \int_0^1 z^{\frac{1-\beta}{\beta}} F_2(K,Nz)dz \tag{31}$$

after one replaces rU by its equilibrium value, and, more precisely, in the Cobb Douglas case, this equation reduces to

$$w(K,N) = (1-\beta)b + \beta\theta c + \Omega_n\beta\nu AK^{\alpha}N^{\nu-1}, \tag{32}$$

where $\Omega_n = \frac{1}{1-\beta+\beta\nu}$. Notice that the above solution holds in the case where firms take the wage as given by fixing $\Omega_n = 1$.

Replacing (32) and its derivative in (27) and (28) respectively gives (16) and (17).

Equation (18) is standard: it is obtained by equating flows into unemployment to flows out of unemployment.

To obtain equation (19), follow the next steps. Consider the steady-state formulation of (1), where the wage is replaced by (32) and the mass of posted vacancies and investment are taken from (2) and (3) in steady state. Thus,

$$(r+\lambda)\Pi(K,N) = (1-\beta\Omega_n\nu)\,F(K,N) - (1-\beta)bN - \beta\theta cN - s\frac{c}{h(\theta)}N - \delta K + \lambda\varphi(\bar{K}). \tag{33}$$

Free entry of firms implies

$$(r+\lambda)\kappa = (1-\beta\Omega_n\nu)\,F(K,N) - (1-\beta)bN - \beta\theta cN - s\frac{c}{h(\theta)}N - \delta K - (r+\lambda)C_0 + \lambda\varphi(\bar{K}). \tag{34}$$

Combining the above equation with (17) yields

$$(r+\lambda)\kappa + (r+\lambda(1-\phi))K^f = (1-\Omega_n\nu)\,F(K,N) - (r+\lambda(1-\phi)+\delta)K. \tag{35}$$

Finally, this last equation combined with (16) gives (19).

A.2 The impact of regulation under decreasing returns to scale

A.2.1 Entry cost κ

The proof relies on equations (16)-(19). Denote by $\hat{X}$ the log deviation of the variable X in steady state from its initial value after one vary the parameter κ. It follows that

$$\hat{K} = \xi\hat{\kappa}, \tag{36}$$

$$\hat{N} = \frac{1-\alpha}{\nu}\xi\hat{\kappa}, \tag{37}$$

$$\hat{k} = -\frac{1-\alpha+\nu}{\nu}\xi\hat{\kappa} \tag{38}$$

and

$$\hat{u} = \frac{1-\alpha-\nu}{\nu}\frac{m_0(1-\eta)\theta^{-\eta}}{s+\lambda+m_0\theta^{1-\eta}}\frac{(1-\beta)\Omega_n P_n}{(r+s+\lambda)cm_0\eta\theta^{\eta-1}+\beta c}\xi\hat{\kappa}, \tag{39}$$

where $\xi \equiv \frac{(r+\lambda)\kappa}{(r+\lambda)\kappa+(r+\lambda(1-\varphi))K^f}$ is the share of administrative costs in the entry cost made by fixed capital and administrative costs.

Similarly, to know the effect on aggregate output, notice that $Y = MF(K,N)$, where Y is aggregate output, which implies $\hat{Y} = \hat{M} + \alpha\hat{K} + \nu\hat{N}$. Given that $M = \frac{1-u}{N}$, it follows that

$$\hat{Y} = -\frac{1-\alpha-\nu}{\nu}\xi\hat{\kappa} - \frac{u}{1-u}\hat{u}, \tag{40}$$

implying a negative effect of the entry cost on aggregate output. Finally, it is straightforward to show from (41)-(40) that the capital-output ratio is not affected by a change in the entry cost.

A.2.2 Recovery rate φ

A decrease in the recovery rate affects the economy through two effects. The first effect affects sunk entry costs and appears on the left-hand side of equation (19), while the second effect operates throught the relative price between capital and labor and explains the presence of φ on the right-hand sides of equations (16) and (19). To illustrate these two effects, I use the following notation. Define $\Delta_1 \equiv r + \lambda(1-\varphi)$ and $\Delta_2 \equiv r + \lambda(1-\varphi) + \delta$. Denoting by $\hat{X}$ the log deviation of the variable X in steady state from its initial value after one vary the parameter φ, it follows that

$$\hat{K} = (1-\xi)\hat{\Delta}_1 - \hat{\Delta}_2, \tag{41}$$

$$\hat{N} = \frac{1-\alpha}{\nu}(1-\xi)\hat{\Delta}_1 + \frac{\alpha}{\nu}\hat{\Delta}_2, \tag{42}$$

$$\hat{k} = -\frac{1-\alpha+\nu}{\nu}(1-\xi)\hat{\Delta}_1 - \frac{\alpha+\nu}{\nu}\hat{\Delta}_2, \tag{43}$$

$$\hat{u} = \frac{m_0(1-\eta)\theta^{-\eta}}{s+\lambda+m_0\theta^{1-\eta}} \frac{(1-\beta)\Omega_n P_n}{(r+s+\lambda)cm_0\eta\theta^{\eta-1}+\beta c}\left[\frac{1-\alpha-\nu}{\nu}(1-\xi)\hat{\Delta}_1 + \frac{\alpha}{\nu}\hat{\Delta}_2\right], \tag{44}$$

and

$$\hat{Y} = -\frac{1-\alpha-\nu}{\nu}(1-\xi)\hat{\Delta}_1 - \frac{\alpha}{\nu}\hat{\Delta}_2 - \frac{u}{1-u}\hat{u}. \tag{45}$$

Finally, from the above equations, the resulting percent decrease in capital-output ratio is equal to $\hat{\Delta}_2$.

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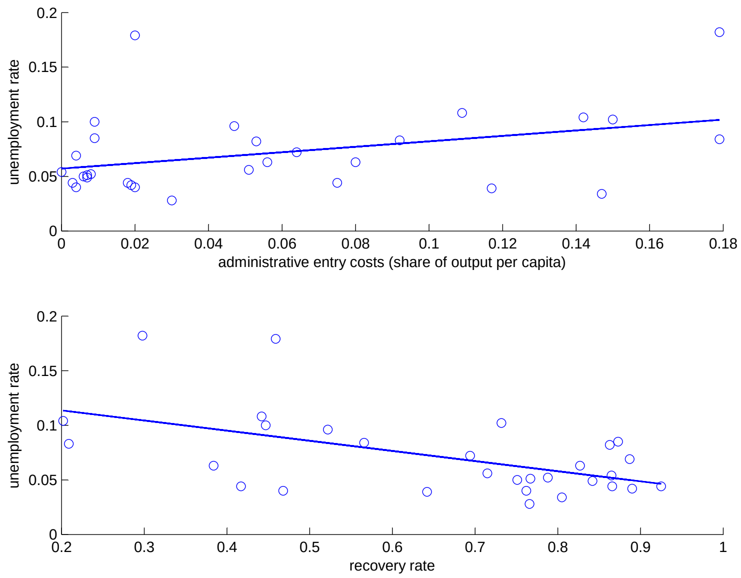
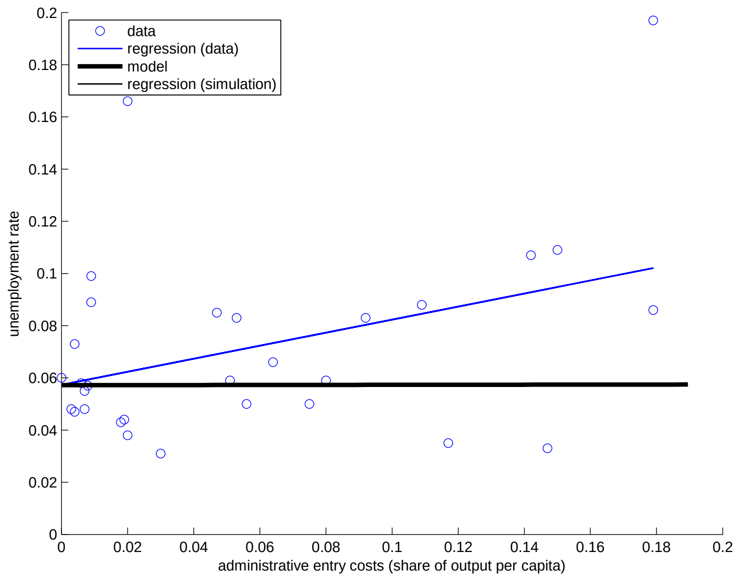
Figure 2: Unemployment and product market regulation: OECD data



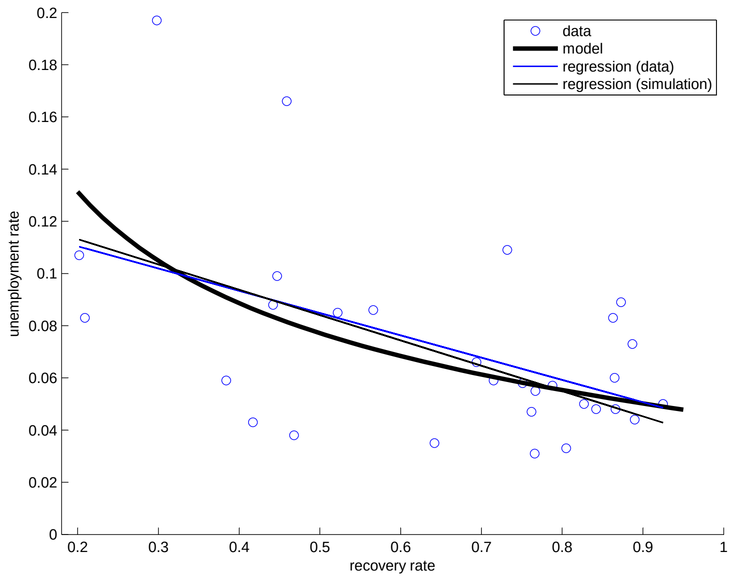
Notes: The data on the cost of entry and recovery rates is from the Doing Business database, while the unemployment rates correspond to the 2004 rate from the OECD Economic Outlook database.

Figure 3: Unemployment and administrative entry costs: model vs data



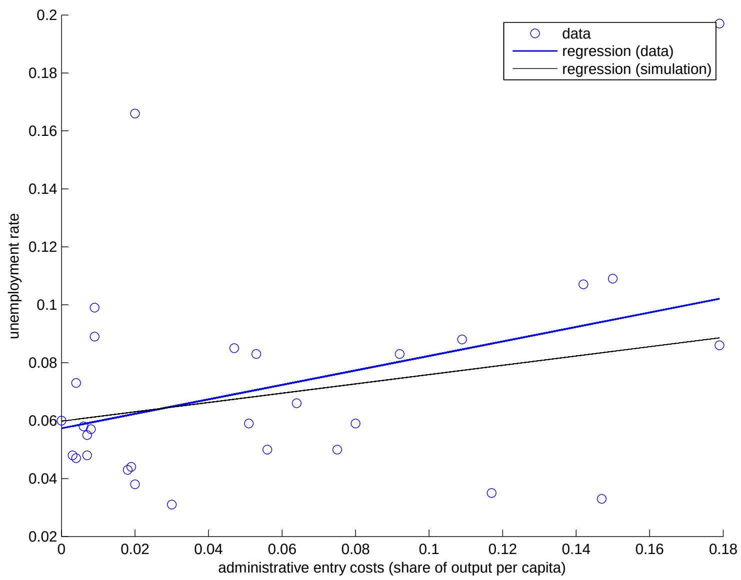
Notes: The data on the cost of entry and recovery rates is from the Doing Business database, while the unemployment rates correspond to the 2004 rate from the OECD Economic Outlook database.

Figure 4: Unemployment and recovery rates: model vs data



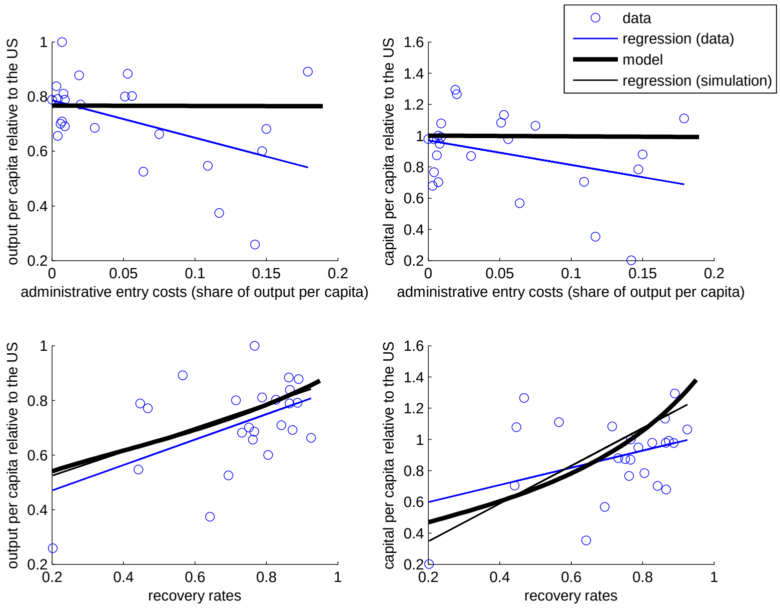
Notes: The data on the cost of entry and recovery rates is from the Doing Business database, while the unemployment rates correspond to the 2004 rate from the OECD Economic Outlook database.

Figure 5: Can recovery rates explain the positive correlation between unemployment and administrative entry costs in the data?



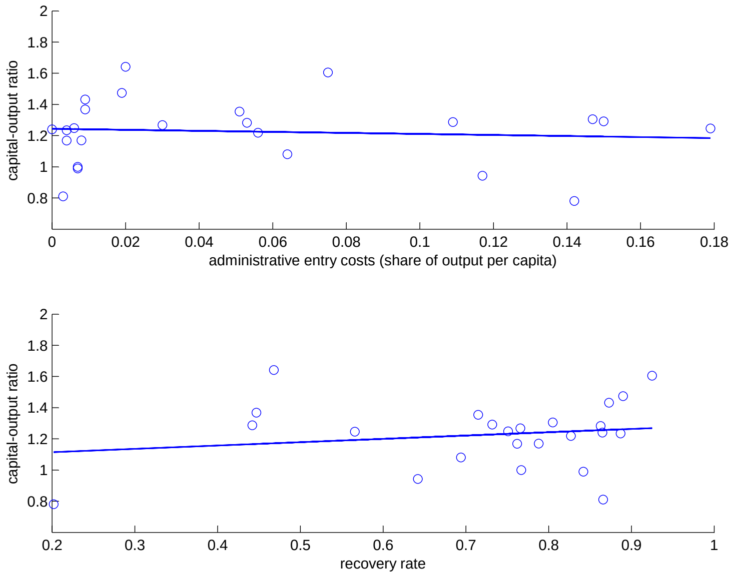
Notes: The data on the cost of entry and recovery rates is from the Doing Business database, while the unemployment rates correspond to the 2004 rate from the OECD Economic Outlook database.

Figure 6: Entry regulation, output and capital in the OECD: model vs data



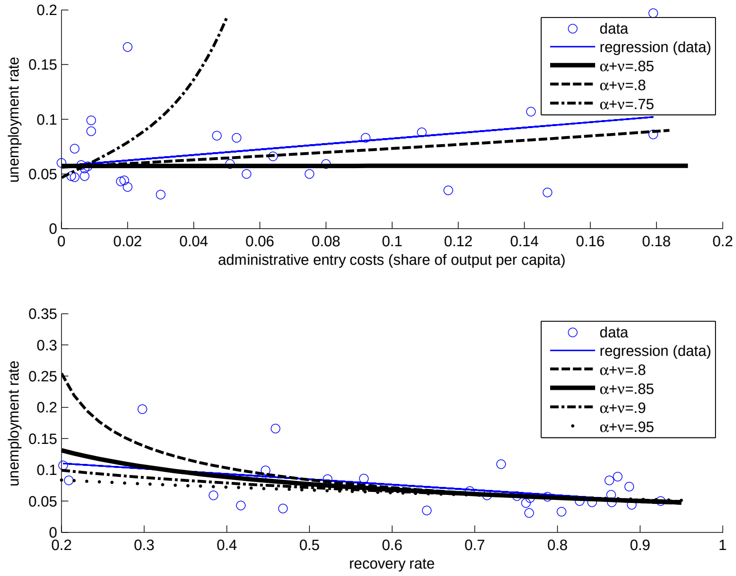
Notes: The data on product market regulation is from the Doing Business database, while the data on capital and output is from Caselli (2005). The countries represented on this Figure are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Figure 7: Entry regulation and capital-output ratio in the OECD: cross-country correlation



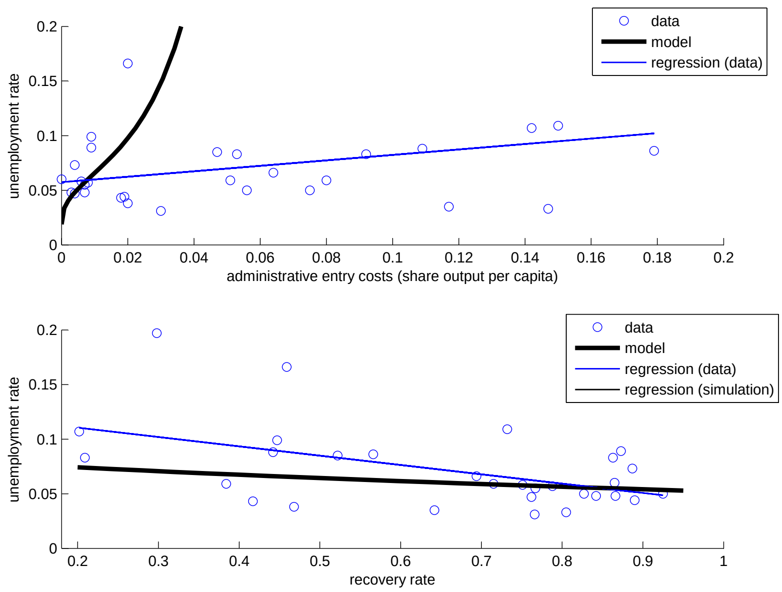
Notes: The data on product market regulation is from the Doing Business database, while the data on capital and output is from Caselli (2005). The depicted lines are the OLS predictions of regresssions of the capital-output ratio on the regulation measures. The correlation coefficient with the entry cost is -0.09, while it is 0.18 in the case of the recovery rate. The countries represented on this Figure are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Figure 8: Unemployment and product market regulation for different returns to scale: model vs data



Notes: The data on the cost of entry and recovery rates is from the Doing Business database, while the unemployment rates correspond to the 2004 rate from the OECD Economic Outlook database.

Figure 9: Unemployment and product market regulation when there is no fixed capital: model vs data



Notes: The data on the cost of entry and recovery rates is from the Doing Business database, while the unemployment rates correspond to the 2004 rate from the OECD Economic Outlook database.

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