Structural unemployment and the costs of firm entry and exit ☆

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HIGHLIGHTS

- I contribute to the literature on unemployment in the OECD.
- I use a large-firm search model of the labor market with firm entry and exit.
- 2 regulations: entry cost and capital loss upon exit.
- Half of the unemployment gap between Continental Europe and the US is explained.
- Exit regulation is responsible for the explained gap, entry cost playing no role.

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ABSTRACT

I build a large-firm model of the labor market with matching frictions and firm turnover. Firms hire both labor and capital. The model allows me to assess the impact of two regulatory frictions on unemployment: i) the administrative costs of establishing a new firm and ii) the share of capital entrepreneurs recover when exiting. These regulations explain 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, with entry regulation playing no role. The degree of returns to scale and the presence of fixed capital in the model are important assumptions behind these results.

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1. Introduction

Identifying the specific factors contributing to 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 (EPL), minimum wage regulations, union density and the level at which wage bargaining occurs.[1] However, 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 set of regulations, those affecting the entry decision of firms, and I ask to what extent a model involving such regulatory frictions is able to replicate the positive correlation between product market regulation indicators and unemployment that is observed across OECD countries. Specifically, I build

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[1] For papers focusing on unemployment benefits in the rise of European unemployment, see Ljungqvist and Sargent (1998, 2008). Interesting 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), Fang and Rogerson (2011) and empirical evidence by Bertrand and Kramarz (2002). Wasmer and Weil (2004) investigate implications of credit market frictions for unemployment. Rupert and Wasmer (2012) focus on the housing market and David et al. (2010) analyze the role of social capital.

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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 regulation on steady-state unemployment: administrative 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 construction, vacancy costs are confounded with firm entry costs. By allowing for several workers per firm, I can separate the firm entry decision from the vacancy creation decision.[5]

I calibrate the model to the US economy by using data on entry and exit regulation 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] Both sets of regulation should matter for unemployment because they affect the incentives to create new firms. This is natural in the case of entry regulation, but exit regulation has similar effects: because entrepreneurs anticipate they will not recover part of their capital stock upon exit, they consider a share of capital purchases as a sunk cost when they enter the industry. Inappropriate exit regulation may generate substantial capital losses for several = reasons,[7] perhaps forcing the firm is forced to sell its equipment piecemeal,[8] the significant administrative costs that an exit process may require, or even the long time it takes for the process to be finalized.

I then follow standard practice in the development accounting literature. I vary the parameters describing the stringency of regulation as observed 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 size of their regulatory frictions. I then compare the distribution of unemployment in those economies with the actual OECD distribution.

Several results come out of this quantitative analysis. First, the costs of firm entry and exit matter for unemployment. However, I show that only exit regulation is relevant, while 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 regulation indicators with the simulated data and I compare the estimated slope with the slope of another OLS regression run 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. This suggests that the observed correlation between entry regulation and unemployment may be the result of unobservables, while the correlation between exit regulation and unemployment may be interpreted as causality. Second, I ask what share of the unemployment gap between Continental Europe and the United States is my model able to generate. My results suggest that regulations are responsible for half the gap between the two continents, with 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 (2011). 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 either. In contrast, I find quantitative relevance for exit regulation.

In Felbermayr and Prat (2011), two types of product market regulations 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, whereby 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 (2011). In my model, I allow for a rich entry cost structure. In particular, I consider two 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).[9]

The presence of fixed capital explains why entry regulation has such a small impact in my model. I follow Bergin and Corsetti (2008) who use data from major US industries to calibrate this parameter. When I recalibrate the model so that no fixed capital is considered, the effects of entry regulation are huge: the model predicts a 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 model in the next section. In Section 3, I present the equilibrium conditions. The benchmark calibration is presented in Section 4, while

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[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 (2011) and Ebell and Haefke (2009). Most of the discussion in the literature has dealt with the determination of wages: 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. (2008).

[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 (2011), Moscoso Boedo and Mukoyama (2012) and Poschke (2010) analyze entry costs.

[5] Two exceptions are Ebell and Haefke (2009) and Felbermayr and Prat (2011). 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). Hereafter, I will refer to the types of regulation as "entry" and "exit" regulation respectively.

[7] See e.g. Aghion et al. (1992), La Porta et al. (1998), Djankov et al. (2008) and Biais and Mariotti (2009) among others.

[8] Asplund (2000) and Ramey and Shapiro (2001) document that capital specificity is important, implying large losses when capital is sold piecemeal.

[9] Barseghyan and DiCecio (2011) 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 Moscoso Boedo and Mukoyama (2012) considers 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 as the fixed capital of my model.

quantitative results are shown in Section 5. Section 6 discusses robustness and Section 7 finally concludes.

2. The model

2.1. Firms

Time is discrete and discounted at rate r. One good is produced in the economy, the market for which is competitive. This good 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 in 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.[10] The production function is Cobb–Douglas and is characterized by decreasing returns to scale, i.e. $F(K,N) = AK^\alpha N^\nu$, with $\nu > 0$, $\alpha > 0$, $A > 0$ and $\nu + \alpha < 1$.

The economy is similar to the one described in Cahuc et al. (2008) with one type of 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[11]) 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 $h(\theta_t) = \frac{m(u_t, v_t)}{v_t} = m\left(\theta_t^{-1}, 1\right)$. Jobs are destroyed at an exogenous rate s and firm exit also forces workers to come back to the pool of unemployed.

I denote the paid wage by $w_t(K_t, N_t)$, 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 in 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 (see e.g. Cahuc et al. (2008)).

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 the investment in variable capital, which depreciates at a rate δ. Fixed capital does not depreciate.

2.4. Regulation

Regulation is of two types. First, in addition to the purchase of fixed capital, a sunk administrative cost κ has to be paid upon entry. Second, only part of the capital stock is recovered when a firm exits. I denote by $rphi \in (0,1)$ the share of capital that can be sold when a firm is destroyed. This fraction of the stock is sold to other firms

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[10] The distinction between fixed and variable capital is described below.
[11] See below.

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: I first consider the situation of an incumbent firm, derive its optimal behavior and then analyze the entry decision. For this purpose, I define 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

$$\Pi(K_t, N_t) =$$
$$max_{V_t, I_t} \frac{1}{1+r}\left\{F(K_t, N_t) - w_t(K_t, N_t)N_t - cV_t - I_t + (1-\lambda)\Pi(K_{t+1}, N_{t+1}) + \lambda\frac{\varphi\overline{K}_{t+1}}{1+r}\right\} \quad (1)$$

subject to the constraints

$$N_{t+1} = (1-s)N_t + h(\theta_t)V_t, \quad (2)$$

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

where $\overline{K}_t \equiv K_t + K^f$.

The values of being unemployed and employed follow a standard formulation:

$$rU_t = b + \theta_t h(\theta_t)\left[W_{t+1} - U_{t+1}\right] + \Delta U_{t+1}, \quad (4)$$

where b is the flow utility of being unemployed and $\Delta U_{t+1} \equiv U_{t+1} - U_t$, and

$$rW_t = w_t(K_t, N_t) + [s(1-\lambda) + \lambda]\left[U_{t+1} - W_{t+1}\right] + \Delta W_{t+1}. \quad (5)$$

3. Equilibrium

In this section, I analyze the equilibrium of the economy. Moreover, I study the effect of 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 following sections.

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 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 a large amount of vacancies so as to immediately reach its long-run employment target. This result is due to the fact that vacancy costs are linear, which is convenient because it produces closed form solutions.

This result on the dynamics of employment at the firm level is not new to the literature. For example, Smith (1999) shows that similar dynamics occur in a model without capital. It does, however, allow me to distinguish between two types of firms: incumbents and entering firms. This distinction becomes key later when the effect of regulation is analyzed from a quantitative perspective.

3.1. Incumbents: first-order conditions, wage determination and profits

I first study the steady state of the economy. For this reason, time subscripts are removed in what follows. I also consider two cases: in the first situation, the firm does not take the wage as given and acts strategically when employing factors of production as in Cahuc et al. (2008); in the second case, a firm considers the wage as given

when posting vacancies. For this reason, an indicator function χ is defined, which takes value zero if the firm takes the wage as given and one if not.

The first-order conditions are

$$r = (1-\lambda)\left(\frac{\partial F(K,N)}{\partial K} - \delta - \chi\frac{\partial w(K,N)}{\partial K}N\right) + \lambda(\varphi - 1), \tag{6}$$

in the case of investment, and

$$\frac{c}{h(\theta)} = (1-\lambda)\frac{\frac{\partial F(K,N)}{\partial N} - w(K,N) - \chi\frac{\partial w(K,N)}{\partial N}N}{r + \lambda + s(1-\lambda)} \tag{7}$$

for vacancies. Appendix A describes in more detail how those conditions are obtained.

Condition (6) equalizes the opportunity cost of capital r to the expected marginal income. The latter is simply the right-hand side of the equation. It can be understood as follows. First, with probability $(1-\lambda)$, the firm survives and produces. In this case, it earns the marginal product net of depreciation, from which one removes the increase in wages brought by the marginal unit of capital when $\chi = 1$ (this is the standard hold-up problem). Second, with probability λ, the firm goes bankrupt and sells the unit of capital, but it only recovers a share φ.

Condition (7) is standard in the literature. It equalizes the search cost with the present discounted value of hiring the marginal worker. When $\chi = 1$, a strategic effect indicates that firms may choose to overemploy in order to decrease the wage paid to workers by decreasing the marginal product of labor.

Nash bargaining implies that wages are a linear combination of the flow value of being unemployed and the marginal product of labor and takes the form

$$w(K,N) = (1-\beta)b + \beta\theta c + \Omega_n\beta\frac{\partial F(K,N)}{\partial N}, \tag{8}$$

where $\Omega_n = \frac{1}{1-\beta+\beta\psi}$ when $\chi = 1$ and $\Omega_n = 1$ when $\chi = 0$. Wages are affected by strategic effects through the term Ω_n.

Replacing Eq. (8) and its derivative in the first-order conditions respectively gives:

$$\Omega_k\frac{\partial F(K,N)}{\partial K} = \frac{r + \delta(1-\lambda) + \lambda(1-\varphi)}{1-\lambda} \tag{9}$$

$$\frac{c}{h(\theta)} = (1-\lambda)\frac{(1-\beta)\left[\Omega_n\frac{\partial F(K,N)}{\partial(N)} - b\right] - \beta\theta c}{r + s(1-\lambda) + \lambda} \tag{10}$$

where $\Omega_k = \frac{1-\beta}{1-\beta+\beta\psi}$ if a firm is allowed to employ factors strategically (i.e. $\chi = 1$) and $\Omega_k = \Omega_n = 1$ when a firm takes the wage as given.

Since $V = \frac{s}{h(\theta)}N$ and $I = \delta K$ for a firm which has reached its steady state, the present-discounted profits for such a firm can be written as

$$(r+\lambda)\Pi(K,N) = F(K,N) - wN - s\frac{c}{h(\theta)}N - \delta K + \lambda\frac{\varphi\overline{K}}{1+r}. \tag{11}$$

Eq. (11) corresponds to 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? In the following subsection, I analyze firm-level dynamics, from which I derive the entry behavior of firms.

3.2. Firm-level dynamics and implications for entry decisions

Conditions (6) and (7) hold at any time after entry occurs. Hence, the following Lemma:

Lemma 1. *Employment at the firm level follows a two-tier structure. At time of entry t_0, a firm posts an amount $V_{t_0} = \frac{N}{h(\theta)}$ of vacancies and invests*

a quantity $I_{t_0} = K$ in physical capital so as to reach its steady-state in the period $t_0 + 1$. 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 and capital levels reach their steady-state in the next period, with C_0 satisfying[12]

$$C_0 = \frac{cN}{h(\theta)} + K. \tag{12}$$

I now turn to the entry decision of firms. After substituting the cost Eq. (12) into Eq. (11) and accounting for the other entry costs (i.e. the administrative cost κ and the fixed capital requirement K^f), free entry implies that

$$(r+\lambda)\kappa + \left[r + \lambda\left(1 - \frac{\varphi}{1+r}\right)\right]K^f = \frac{1-\lambda}{1+r}(1-\nu\Omega_n - \alpha\Omega_k)F(K,N). \tag{13}$$

The intuition behind Eq. (13) can be understood as follows. First, consider the case where $\Omega_n = \Omega_k = 1$ (wages are taken as given). The term $(1-\nu-\alpha)F(K,N)$ on the right-hand side gives the flow of profits an incumbent earns in each period: it is a share $(1-\nu-\alpha)$ of production because of the Cobb–Douglas specification of the production function. When Ω_n and Ω_k are allowed to differ from one, the strategic behavior of firms distorts factor allocation. These inefficiencies imply that incumbents get a share lower than $(1-\nu-\alpha)$.[13] Second, the presence of the discount factor $\frac{1-\lambda}{1+r}$ on the right-hand side is due to the fact that production occurs one period after entry occurs. Finally, the flow profits have to equal the opportunity cost of fixed entry outlays, which depend on the sunk administrative cost κ and the investment in fixed capital K^f. Those are expressed in flow terms: they are multiplied by the appropriate discount rates. Notice that the discount rate associated with fixed capital is lower because part of the capital stock is recovered when firm destruction occurs.

Regulation affects entry in two ways. First, the administrative cost makes entry more costly. As a result, profits have to be large when κ is large because firms have to recover the initial investment. Second, a similar mechanism occurs for low values of φ since a larger share of the investment in fixed capital cannot be recovered. These channels imply that firms are larger in equilibrium when κ is larger or φ lower.

3. The macroeconomic impact of regulation

I now investigate the effect of entry and exit regulation for the steady-state equilibrium of the economy. The latter is defined as follows:

Definition 1. A steady-state equilibrium is a wage rate w, a labor-market tightness θ, an unemployment rate u, a mass of firms M,

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[12] In a standard one-worker-per-firm matching model, such as in Pissarides (1985), aggregate employment only responds slowly to shocks: congestion in the labor market implies that hiring is smooth over time. Hence the question: how can firm size, which is a stock variable, jump discretely in this model? In the context of a large firm, it is also true that aggregate employment slowly adjusts (also because of congestion). However, the behavior of employment at the firm level can be different because each firm is atomistic: firms cannot affect search costs individually. This implies that the search cost per unit of labor does not increase as (firm-level) employment increases, justifying why employment of an entry firm reaches the level of incumbents only one period after entry occurs. Put differently, while search costs are a convex function of employment at the macro level, they are linear at the individual level. The difference between the behavior of aggregate and firm-level employment is simply brought by an adjustment in the mass of firms.

[13] When there is no intrafirm wage bargaining, having frictions does not seem to matter for the share of profits. This can be explained as follows. Labor costs have two components in the model: a wage component and a turnover cost component. Although these two components are not paid at the same time—the latter is paid ex ante, before labor is hired—the firm simply calculates the present discounted value of the total labor cost and equals it to the marginal product of labor.

value functions Π, U and W, and employment and capital stocks for incumbents N and K, such that

- value functions are given by Eqs. (1), (4) and (5);
- incumbents optimize: Eqs. (9) and (10) hold;
- wages are negotiated à la Nash: they solve Eq. (8);
- there is free-entry of firms: Eq. (13) holds;
- flows into unemployment equal flows out of unemployment, implying:

$$u = \frac{s(1-\lambda) + \lambda}{s(1-\lambda) + \lambda + \theta h(\theta)}; \tag{14}$$

- the identity $MN = 1 - u$ holds.

The following Proposition summarizes the effect of regulation on the aggregates[14]:

Proposition 1. *Consider the steady-state equilibrium of the economy.*

- *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 $k \equiv K/N$, 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, and decreases in the capital–labor ratio $k \equiv K/N$, the capital–output ratio $\frac{K}{F(K,N)}$, and 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. However, 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 less incentive 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 demand for capital and labor decrease. Hence, both the aggregate capital stock and employment level decrease, implying a seemingly ambiguous effect on the capital–labor ratio. What is the actual net impact on the capital–labor ratio? It depends on the elasticity of supply in 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[15]: 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 in Fig. 1, where both aggregate capital and labor markets are represented. Thus, as aggregate labor and capital demand fall, the capital stock decreases more than aggregate employment because of different supply elasticities in 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 costs and ii) a change in the relative user cost of capital to

labor. The intuition behind the consequences of the first effect is 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 negatively affected by a decrease in φ and why the consequences for firm-level capital are ambiguous (though they are not for the aggregate stock of capital). Moreover the complementarity between 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.[16]

While Proposition 1 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 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).[17] It appears that the steady state of the economy I have just described is exactly the same as in Pissarides (2009) when $\Omega_n \frac{\partial F(K,N)}{\partial N} = 1$ 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 $\eta \in (0,1)$. Regarding the parameters that are as in Pissarides (2009), I fix the discount rate r at 0.4%, the value of leisure b at 0.71, the vacancy cost c at 0.356, the matching function 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%. 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 $s(1-\lambda) = \frac{4}{5} \times 0.036$. Further, since I want my benchmark calibration to be identical to Pissarides (2009), I choose the total factor productivity parameter A such that $\Omega_n \frac{\partial F(K,N)}{\partial N} = 1$. This allows me to get the same labor market tightness and unemployment rate as in his calibration exercise.

To calibrate the regulatory cost of establishing a new firm κ and the recovery rate φ, I rely on the Doing Business database.[18] The Doing Business database reports that creating a new firm in the US costs 0.7% of income per capita. Their estimation is based on the number of procedures, official time, and official cost that a start-up must complete before it can operate legally. Their data includes regulations concerning: safety and health, environment, taxes and labor. Their
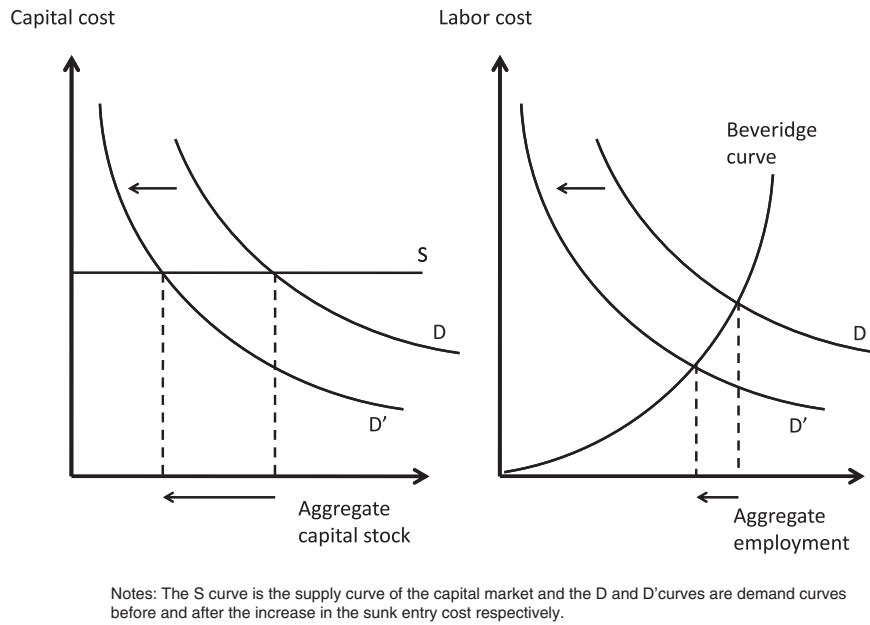
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[14] See Appendix B for the proof.
[15] See for instance King and Rebelo (2000) for a discussion.

[16] In Section 5, I show that this second effect is quantitatively less important than the first effect.
[17] An alternative calibration strategy is proposed by Hagedorn and Manovskii (2008). Their so-called "small surplus" calibration better reproduces 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., 2011) and it implies wages for newly formed matches that are too rigid (Haefke et al., 2007, and Pissarides, 2009).
[18] See Djankov et al. (2002) for more details on how entry costs are calculated and Djankov et al. (2008) for recovery rates.

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.

Fig. 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.

estimates include all identifiable official expenses such as fees, costs of procedures and forms, photocopies, fiscal stamps, legal and notary charges. In my calibration, I choose κ by targeting the 0.7% 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. The data takes into account several aspects related to the difficulty of bankruptcy procedures, which I describe in details in Appendix B. I use this data to calibrate the φ parameter. In the case of the United States, it is equal to 0.767.

To calibrate the value of K^f, I follow Bergin and Corsetti (2008). These authors calibrate 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. in their analysis.

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 31 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 reinforce this result. Another possibility is proposed by Barseghyan and DiCecio (2011), 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% 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 DiCecio (2011) 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, there is no strong consensus for a value of 0.85 and some papers 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 of Basu and Fernald (1997) is quite large. Because my results are sensitive to the returns to scale (e.g., see Janiak and Santos Monteiro, 2011), I check their robustness for a wider range of parameter values in Section 1.

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. In order to understand this decomposition, I also provide statistics for incumbents and entrants. Remember that, in the

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	0.0290	Separation rate	Pissarides (2009)/ Davis et al. (2006)
A	1.0311	Total factor productivity	$\Omega_n \frac{\partial F(K,N)}{\partial N} = 1$
$\alpha + \nu$	0.85	Returns to scale	Atkeson and Kehoe (2005)
δ	0.0087	Capital depreciation rate	10% annual depreciation
κ	0.1095	Administrative entry cost	$\kappa/[MF(K,N)] = 0.007 \times 12$
φ	0.767	Recovery rate	Djankov et al. (2008)
K^f	707.52	Fixed capital requirement	$[\lambda M K^f]/[MF(K,N)] = 0.16$

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	10.9	98.9
Fixed capital	2.79	0	56.4
Variable capital	11.6	10.9	42.5
Profits*	13.4	17.1	/
Vacancy costs	1.13	0.90	1.06
Administrative costs	0.00	/	0.04

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.

model, incumbents have all reached their long run level of employment and capital, while entrants do not produce yet and pay only 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 targets for capital and employment. Notice that in this table the total in each column is normalized to 100.

The first column illustrates the decomposition of aggregate output. The labor share comprises 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 output is spent on fixed capital instead of 16% as the calibration suggests: the 16% includes both the capital sold by dying firms and new inflows.

By looking at the other two columns, which describe the behavior of incumbents and entrants, one can see that a substantial share of aggregate investment comes from entrants. 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 long-run capital target; they only need to compensate for capital depreciation, while entrants have to invest much more to reach their long-run target while also investing 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 similar to the statistics 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.[19]

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% of their output, while the share is 13.4% at the aggregate level. This naturally leads to two questions. 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 Eq. (13). In the case where $\Omega_k = \Omega_n = 1$, it gives:

$$\underbrace{\kappa + \frac{r + \lambda\left(1 - \frac{\varphi}{1+r}\right)}{r + \lambda} K^f}_{\text{Sunk entry costs}} = \underbrace{\frac{1-\lambda}{(1+r)(r+\lambda)}(1-\nu-\alpha)F(K,N)}_{\text{Discounted sum of profits}}. \quad (15)$$

The reason why aggregate profits are not zero once entry costs have been subtracted 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[20] and $\tilde{\pi} \equiv F(K,N) - wN - cV - I$ flow profits for a given incumbent. Free entry implies

$$E = \frac{\tilde{\pi}}{r + \lambda}\lambda M. \quad (16)$$

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

Finally, vacancy costs represent 1.1% of aggregate output. To understand whether this is reasonable, Hall and Milgrom (2008) follow Silva and Toledo (2009) who estimate that recruiting costs are 14% 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 quantitatively assess the impact of regulation. I interpret more stringent regulation either as an increase in κ or a decrease in φ. Fig. 2 shows two scatter plots for the OECD where the measures of regulation I used for the calibration are displayed against the unemployment rate. Each dot on the graphs represents an OECD country and the straight lines are the predictions yielded by 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 to (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 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.[21] My model predicts the sign of these correlations. This is illustrated in Proposition 1. However, Proposition 1 only refers to one particular causality, i.e. the effect of 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[22] or taxes on labor, and it has been argued by some that labor market institutions affect employment negatively.[23] Moreover, my two measures of regulation are also correlated (−0.44). Hence,

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

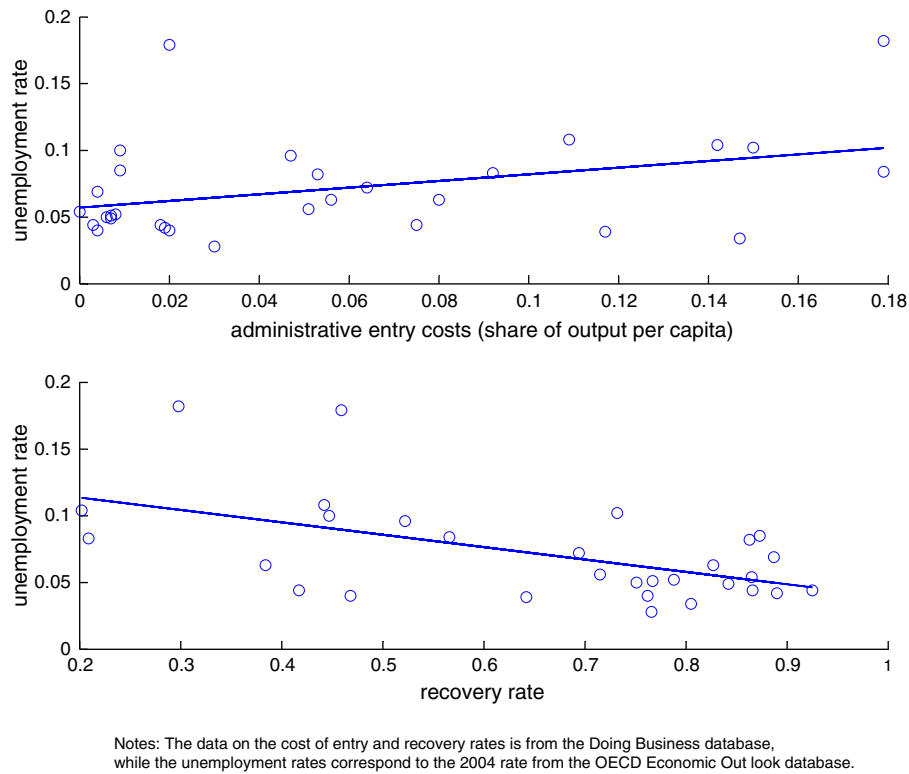[20] The cost upon entry has four components: the administrative cost κ, the vacancy cost $\frac{c}{h(\theta)}N$, investment in variable capital K, and investment in fixed capital K^f. Given that there are λM entrants in the steady state, the sum of those four components has to be multiplied by this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

[21] In Appendix B, I report regression results for the effect of entry and exit regulation on unemployment when labor market institutions are considered as control variables.

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

[23] 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.

Fig. 2. Unemployment and 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. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

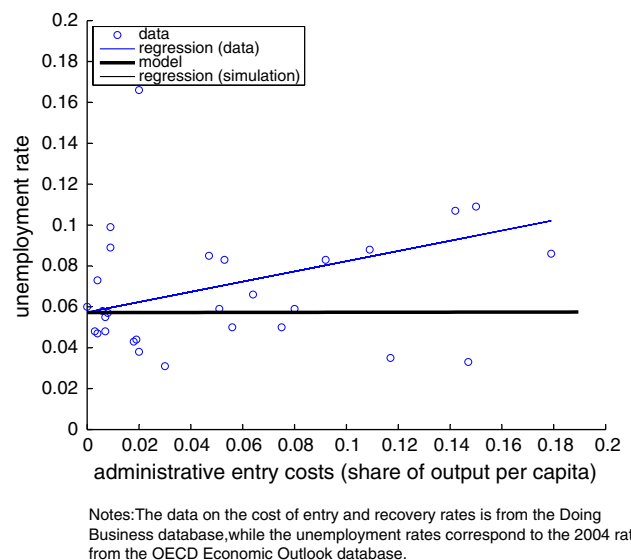it remains an open question to what extent my model quantitatively reproduces these relations.

To answer this question, I apply a 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 is 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 distribution of unemployment among the simulated economies with the actual cross-country distribution of unemployment. I also complete a similar exercise with φ.

Figs. 3 and 4 contrast the information contained in Fig. 2 with the information obtained from this exercise. The dots are the same dots that appear in Fig. 2 and the blue lines are the same OLS regressions obtained from the data as those depicted in Fig. 2. In Fig. 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 Fig. 4 corresponds to the relation between unemployment and the recovery rate that is obtained by varying φ. Additionally, Figs. 3 and 4 each report an OLS regression for the simulated data. To produce these regressions I generate a sample where the measures of 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.[24]

Two results come out of these figures. First, these regulations matter for unemployment in the OECD. However, 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 Fig. 3 is positive, it visually looks horizontal. The quantitative importance of exit regulation in explaining 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 captures 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 the model unemployment rate be for the US if it was given the regulation indicators of another OECD country, say

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.

Fig. 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. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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[24] Notice that the black thin line overlaps with the black thick line in Fig. 3.

Notes: The data onthe 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.
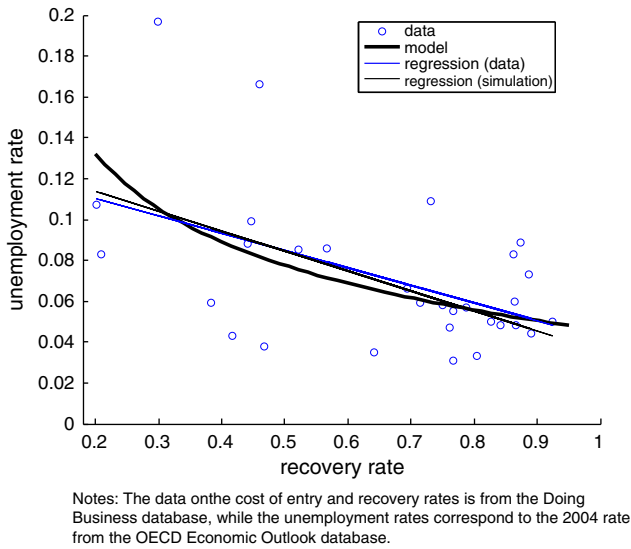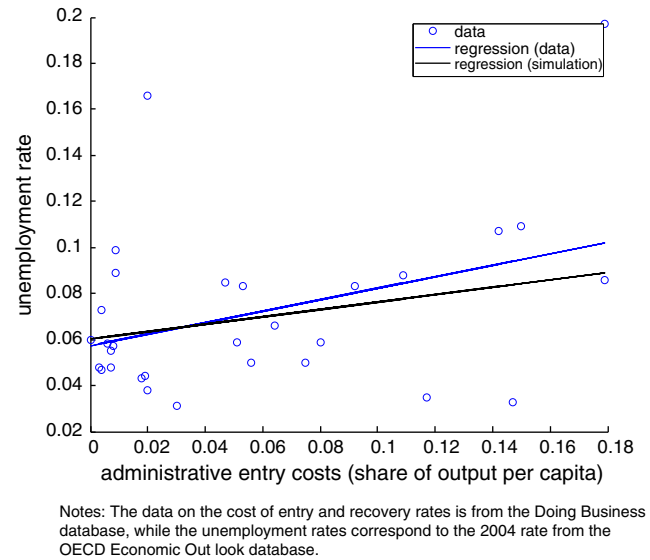
Fig. 4. Unemployment and recovery rates: model vs. data. Notes: The data on the cost of entry and recovery rates is from the Doing Business database, while the unemployment rates correspond to the 2004 rate from the OECD Economic Outlook database. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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 Out look database.

Fig. 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.

Italy. Remember, in the calibrated model, the US has an unemployment rate equal to 5.76%, 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, it would be characterized by an unemployment rate equal to 7.15%, which is about 1.4 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 5.77%, which is effectively identical to 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 Fig. 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 a 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.

These results help reconcile evidence on the role of product market regulation for unemployment. 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 (2011) also present similar evidence. On the other hand, the paper by Ebell and Haefke (2009), who look at the Carter/Reagan product market deregulation of the late 1970s and early 1980s in the US, attribute a limited role to deregulation for the decline in US unemployment. Ebell and Haefke (2009) specifically look at entry costs in a calibrated model. To the extent that their results can be extended to a cross-country OECD context, both approaches seem contradictory. My results explain the tension between the two approaches by stressing that the type of 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 Fig. 5, where I reproduce the exercise in Fig. 3, but, instead of varying only the κ parameter as in Fig. 3, I vary both κ and φ. The resulting correlation between entry costs and unemployment appears much stronger than in Fig. 3: the slope of the OLS regression in the simulated data now represents 65% 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 1 predicts that regulation also has negative consequences for aggregate output and the aggregate stock of capital but leaves the capital–output ratio unchanged. The previous exercise can also be carried out with these alternative macro indicators. Fig. 6 shows the cross-country correlation between regulation and output (or capital) both in the model and the data. To build these graphs, I use the same regulation data as previous 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.[25]

The graphs suggest effects similar to those observed in the case of unemployment. Regulation depresses output and capital accumulation. Administrative entry costs have a limited 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, the ratio is equal to 94% in the case of the effect of recovery rates on output. The model clearly overpredicts the effect on capital accumulation, while the effect is zero whenever regulatory entry costs are considered as representative of the regulation in question.

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[25] Notice that in Fig. 6, there are fewer data points than in the previous graphs. This is because some values are missing in the data used in Caselli (2005). This is also the case for Fig. 7.
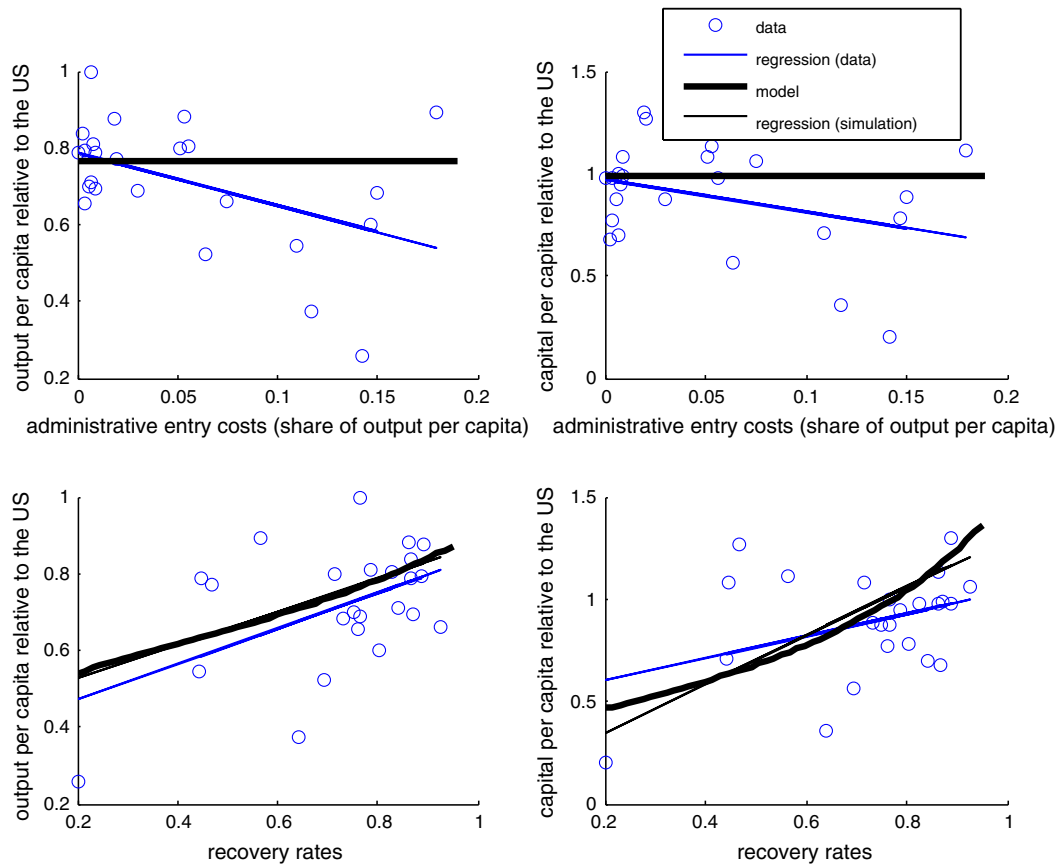
Notes: The data on product market regulation is from the Doing Business database, while the data on capital and output is from Caselli (2005). The countries represented in this figure are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Ireland, Italy, Japan, Korea, Mexico, Netherlands, NewZealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, UnitedStates.

Fig. 6. 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 in 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, the United Kingdom, and the United States.

Regarding capital–output ratios, Fig. 7 displays the data correlation with a measure of product market regulation. The correlations are rather weak[26]: the correlation coefficient with the entry cost is −0.09, while it is 0.18 in the case of the recovery rate, slightly larger.

5.3. Continental Europe

In this subsection, I ask what share of the gap in unemployment between the United States and Continental Europe can be explained by the calibrated model considering only the two regulation measures. For this, I first need to define Continental Europe. 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 investors recover 62.3% of their capital.

If I recalculate the unemployment rate in the model by inputting those regulatory frictions, I obtain a value of 5.77% when I change κ and 6.72% when I change φ. It remains 6.72% when I change both

parameters. The unemployment rate in the calibrated economy is 5.76%. Hence, regulation explains 50% of the unemployment gap between the US and Continental Europe.[27]
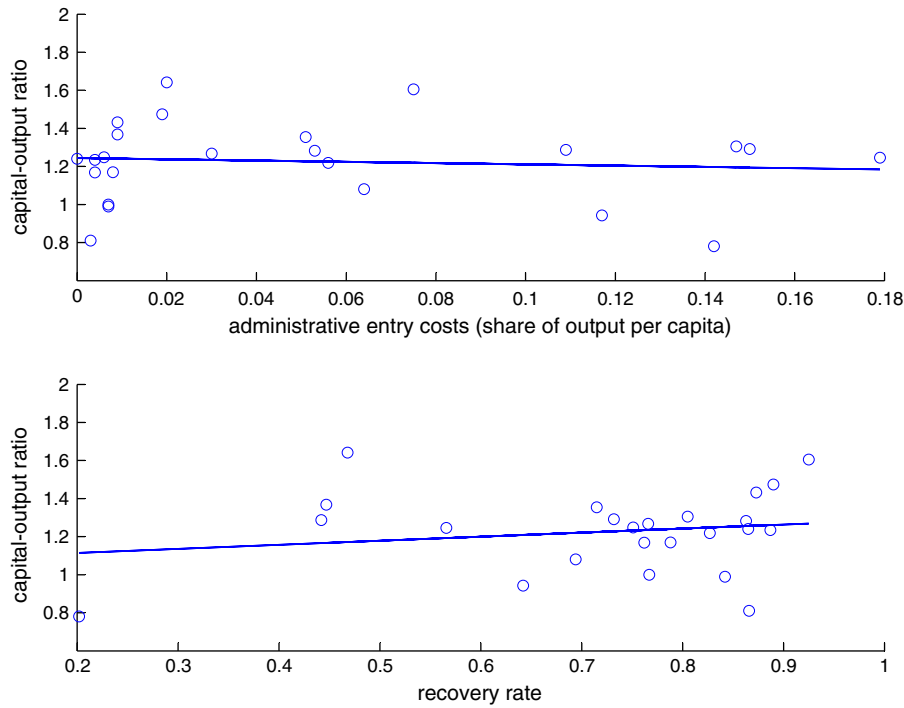
6. Robustness

I now analyze the robustness of the results of the previous section. The aim is to identify the parameters to which the quantitative analysis is sensitive. The goal is not only to roughly examine the error bars for the effect of regulation, it also builds intuition concerning the comparative statics displayed in Section 5. Two assumptions turn out to be important: the degree of returns to scale and the presence of fixed capital in the model.

6.1. 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. This is an important consideration because, while it is standard to assume returns to scale equal to 0.85 in the literature on firm dynamics, those values do not appear to be estimated with high precision. For instance, in Basu and Fernald (1997), the range of estimated values is very dependent on the level of aggregation of the data. Moreover, several papers do

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[26] Poschke (2010) documents a positive correlation between administrative entry costs and the capital–output ratio. Here the absence of correlation is due to the fact that I focus on a larger sample than Poschke (2010), who solely considers Germany, France, Italy, Netherlands and the United States. If I restrict my sample to those countries, the correlation is indeed positive.

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

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 regressions 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 in 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.

Fig. 7. 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 regressions 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 in 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, the United Kingdom, and the United States.

not conform the 0.85 benchmark: 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 interpreted 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 Fig. 8, where I carry out the same exercise as in Figs. 3 and 4 by changing the returns to scale in the calibration. I consider returns to scale ranging from 0.78 to 0.95. Except for the size of the returns to scale, the rest of the calibration for this exercise is identical to the procedure described in Section 4. The figure shows that regulation becomes more stringent as returns to scale are lower: the slope of the depicted 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 3. It also shows the

share of the unemployment gap between Continental Europe and the US explained by this exercise. Consistent with Fig. 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 thirds when returns are equal to 0.78. In the case of the regulatory cost of establishing a new firm, differences are more striking. 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 11.4% when returns to scale are fixed to 0.78.

Table 3 also shows that the relative importance of entry regulation becomes stronger than exit regulation as the returns to scale are lowered. This may appear surprising because both regulations affect unemployment through a similar mechanism. However, this can be explained as follows. The calibrated value for K^f is positively associated with the level of returns to scale. Remember how this parameter is calibrated: it is such that the share of the economy's (steady-state) output spent on fixed costs is 16%, that is,

$$\frac{\lambda M K^f}{M F(K, N)} = 0.16.$$

Hence, because output drops quickly with K^f when returns to scale are low,[28] the calibration in this case only requires low values of K^f to

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[28] When K^f increases, firm size increases. Given that returns to scale are decreasing, output per worker (and hence aggregate output) decreases when firm size increases. This effect is stronger the lower returns to scale are.
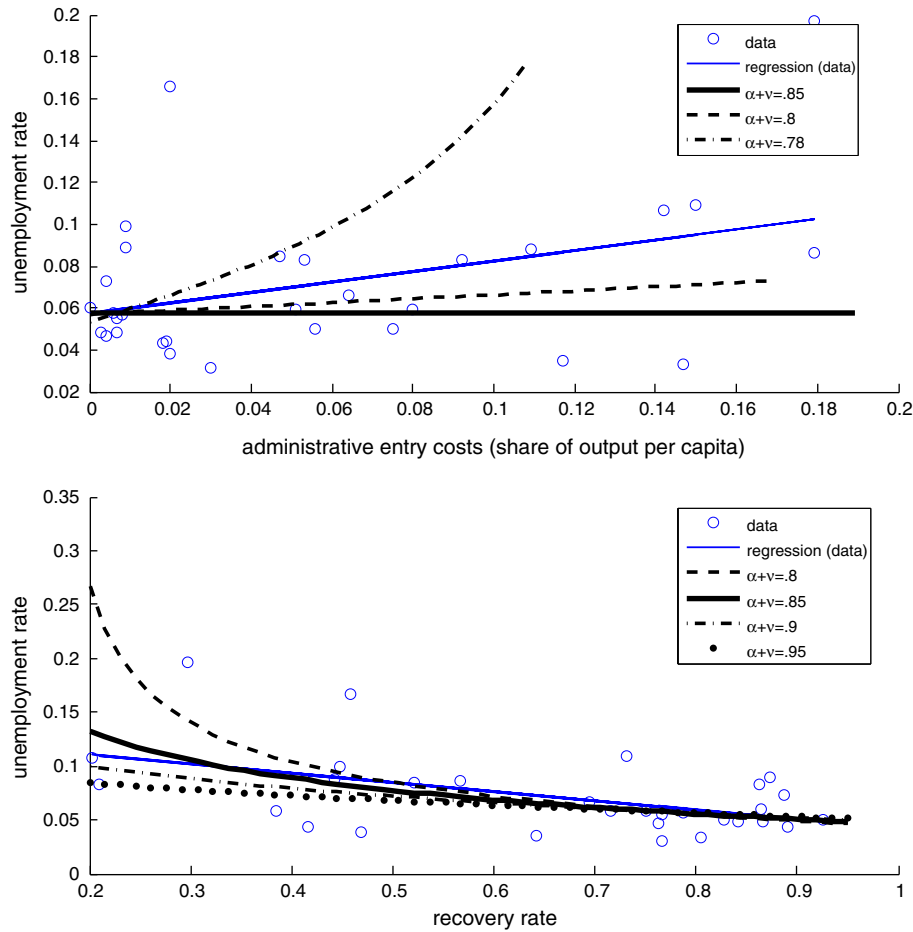
Notes: The data on the cost of entry and recovery rates is from the Doing Business database, while the unemployment rates correspond to the 2004 rate from the OECD Economic Outlook database.

Fig. 8. Unemployment and 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.

obtain the 16% share. This in turn diminishes the importance of exit regulation for the structure of sunk costs in the economy. Moreover, given that the effect of exit regulation will always be bounded by the size of the parameter K^f, we have an explanation for the importance of entry regulation under low returns to scale. This idea is illustrated in Fig. 9, where the structure of sunk costs in the model is displayed as a function of the two regulatory frictions. The graphs are similar to those in Fig. 8 with the difference that, instead of having the unemployment rate as a dependent variable, we now consider the structure of sunk costs. More specifically, the upper panel shows the variable $\xi \equiv \frac{(r+\lambda)\kappa}{(r+\lambda)\kappa + (r+\lambda(1-\frac{\kappa}{1+\varphi}))K^f}$ (i.e., the share of entry regulation in sunk costs) as a function of administrative entry costs, while the lower panel shows the share of exit regulation in sunk costs as a function of φ. The figure confirms that sunk costs are much more sensitive to

entry regulation under low returns to scale, while they depend relatively more on exit regulation under high returns to scale.[29]

6.2. The importance of fixed capital

Given the discussion of Fig. 9, it is natural to think that the fixed capital requirement K^f also influences the impact of regulation on unemployment in the model. This parameter affects the marginal effect of the recovery rate on unemployment because part of the costs entrepreneurs have to pay upon entry consists 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.[30]

In Fig. 10, I execute the same exercise as in Figs. 3 and 4 by fixing K^f to zero in the calibration. The figure confirms that the relation

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

Returns to scale		0.78	0.80	0.85	0.90	0.95
Administrative	Unemp. rate	11.4%	6.39%	5.76%	5.76%	5.76%
Entry cost	Share of the gap	291%	33%	0%	0%	0%
Recovery	Unemp. rate	7.02%	7.00%	6.72%	6.49%	6.30%
Rate	Share of the gap	66%	64%	50%	38%	28%

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[29] Notice that, in the lower panel of the figure, three curves effectively overlap.
[30] For a formal proof, see Appendix A.2. This appendix shows that the effect of κ is larger, the larger the ξ parameter is, ξ being defined as $\xi \equiv \frac{(r+\lambda)\kappa}{(r+\lambda)\kappa + (r+\lambda(1-\frac{\kappa}{1+\varphi}))K^f}$, i.e. the share of administrative costs in the total entry cost comprised of 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. The model of Felbermayr and Prat (2011) considers technological and administrative fixed operating costs in addition to the administrative entry cost. The presence of these other costs in their model influences the impact of entry costs.
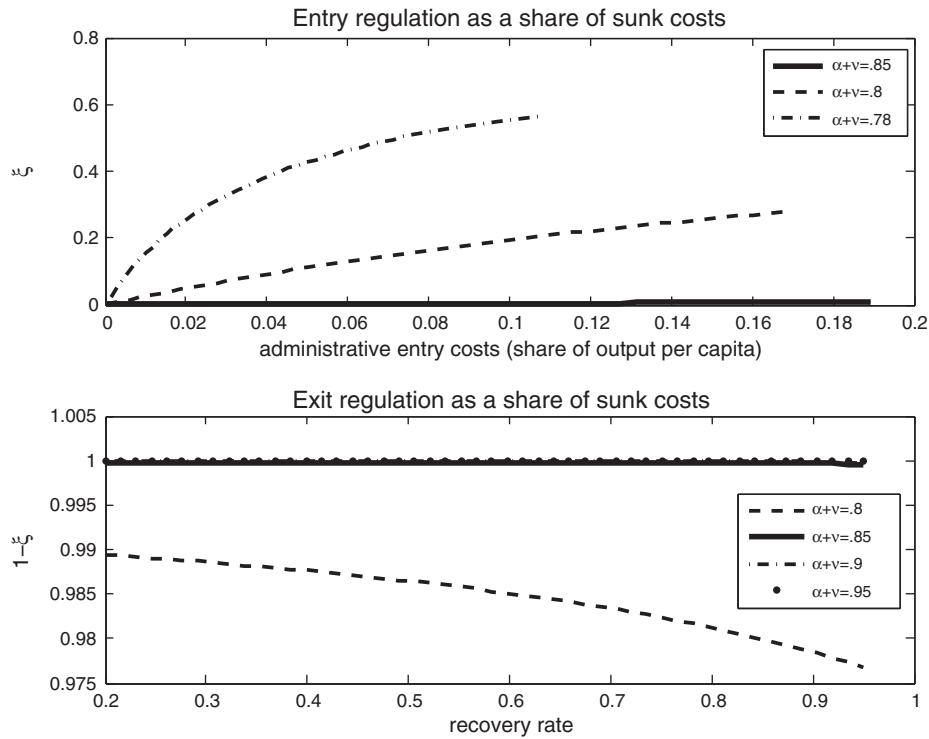
Fig. 9. Structure of sunk costs and regulation.

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 significant as the rate of unemployment rapidly tends to 100%. As a result, I cannot even compare the slopes of the OLS regressions for the simulated and observed data in this case: for entry costs larger
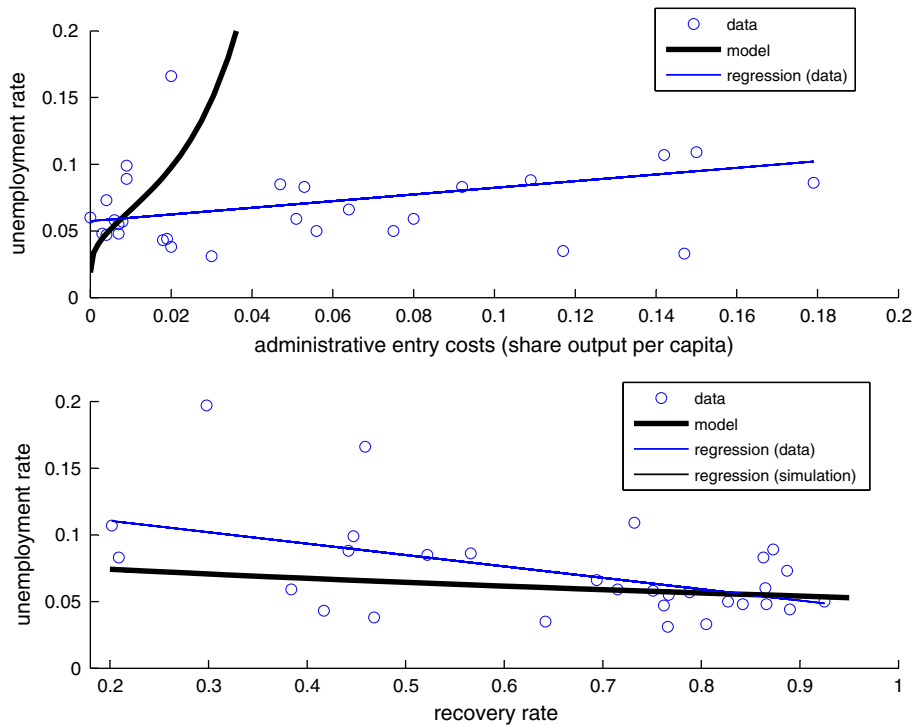
Notes: The data on the cost of entry and recovery rates is from the Doing Business database, while the unemployment rates correspond to the 2004 rate from the OECD Economic Outlook database.

Fig. 10. Unemployment and 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.

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 equal to 100% for many countries in the sample; such rates are clearly unrealistic.

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 a 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 Fig. 10 (in the case of the recovery rate) is much lower than in Fig. 4, it turns out that the second mechanism is not dominant.

6.3. Capital specificity

Capital specificity is an element that is central for understanding the impact of inappropriate exit regulation. Djankov et al. (2008) show that in some countries when firms face an unexpected downturn they may be forced to sell their capital equipment piecemeal, while in other economies the same firm continues operating as a going concern. Inappropriate regulation thus distorts incentives to invest in capital ex ante and thus firm creation. This distortion grows the larger the specific component of capital is: with capital specificity, the value of capital depreciates at a higher rate when sold piecemeal.

In the data I use for the calibration exercise, Djankov et al. (2008) assume that the value of capital drops by 30% when it is sold piecemeal. How does this compare to estimates from the literature? Some papers have tried to estimate the importance of capital specificity. The seminal study by Ramey and Shapiro (2001) exploits equipment-level data from an anonymous plant in Southern California in the aerospace industry that closed during the nineties. Their dataset allows them to observe the price at which the plant bought the equipment as well as the price at which it has been resold (whether through private liquidation or public auction). They estimate ratios of resale to original price ranging from 20 to 60% depending on the type of equipment, with an average of 28%. Their results suggest that capital specificity is important. In spite of the richness of their database, the information only concerns a single plant in a specific industry—aerospace. It is difficult to know how these estimates may extend to any capital equipment in the economy. Moreover, the database focuses on a period during which the aerospace industry underwent significant downsizing. This aspect possibly generates a downward bias in the estimates, the same authors assign lower rate of capital specificity when calibrating a macro model: in Ramey and Shapiro (1998), they consider *industry* specificity to be between 25% and 50%. In another paper that focuses on Swedish data from ten firms in the manufacturing industry, Asplund (2000) obtains results that are in the range of estimates of Ramey and Shapiro (2001). He estimates depreciation to be between 50% and 80%.

In sum, even though the range of available estimates is large, it appears that second-hand capital markets are imperfect, since a substantial share of the original value is lost when capital is resold. This certainly sheds some light on the reasons for the large impact of exit regulation on the economy. Further, if one considers depreciation as estimated by Ramey and Shapiro—a 72% rate instead of the 30% that Djankov et al. (2008) rely on, the impact of exit regulation in the quantitative exercise of Section 5 would even be larger.

6.4. The role of intrafirm wage bargaining

The results I have documented have been calculated in a context with intrafirm wage bargaining. This corresponds to the case where $\Omega_k = \frac{1-\beta}{1-\beta+\beta\nu}$ 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 Eqs. (9), (10), (13) and (14). The idea for the proof is that the labor-market tightness and the rate of unemployment are directly determined by the term

$$Q = \Omega_n \frac{\partial F(K,N)}{\partial N}. \tag{17}$$

This can be seen from Eqs. (10) and (14). Given that in the calibration exercise Q takes value one, as in Pissarides (2009), the effect of κ (or φ) on Q directly identifies the effect of κ (or φ) on u. In other words, denote by $\hat{X}$ the log deviation of the variable X in steady state from its initial value after varying the parameter κ. Then intra-firm wage bargaining does not matter for the quantitative effect of κ (or $rphi$) on u if $\hat{Q}$ is the same in both cases (with and without intrafirm wage bargaining).

It can be shown that

$$\hat{Q} = -\frac{1-\alpha-\nu}{\nu}\xi\hat{\kappa} \tag{18}$$

with and without intrafirm wage bargaining, where $\xi \equiv \frac{(r+\lambda)\kappa}{(r+\lambda)\kappa + (r+\lambda(1-\frac{a}{1+a}))K^f}$. This implies 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 of the production function 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 beginning 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 in the product market in a Dixit and Stiglitz (1977) fashion. In particular, they assume that the elasticity of substitution between product varieties is increasing inthe mass of firms in the economy as in Blanchard and Giavazzi (2003). In this context, the curvature of a firm's 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's income function, implying that intrafirm bargaining may be relevant. 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.

6.5. 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 (2011), or Blanchard and Giavazzi (2003) for example. These papers also look at the effect of product market regulation on the labor market and unemployment.

It turns out that extending my model to allow for monopolistic competition is very similar to varying the returns to scale. This claim is illustrated in Janiak and Santos Monteiro (2011). Their paper considers a model similar to mine with no labor-market search frictions and perfect competition in the product market. Their model also allows for monopolistic competition as in Dixit and Stiglitz (1977). It is shown that this exercise is similar to making the production function more concave.[31] 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 (2011) and Ebell and Haefke (2009) present a lower impact of entry regulation on unemployment than the one displayed in Fig. 10, 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 (2011), the elasticity of substitution[32] 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 a production function that assumes returns to scale equal to 0.85.[33]

7. Conclusion

I study to what extent a large-firm model of the labor market can reproduce the positive correlation between measures of the stringency of regulation on the entry and exit of firms and unemployment that is observed across OECD countries. Two types of regulations are analyzed: i) the regulatory cost of creating a new firm and ii) regulations involving capital loss when firms exit. The model is calibrated to the US economy. The quantitative exercise consists of varying the parameters describing the stringency of regulation as observed in the data. The cross-country distribution of unemployment that is obtained through this exercise is 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 regulation. Furthermore, one third of the cross-country variance in unemployment is explained by these regulatory frictions.

Under the benchmark calibration, differences in exit regulation between countries are responsible for the entire variance in unemployment generated by the quantitative exercise. Entry regulation plays no role. The degree of returns to scale and the presence of fixed capital in the model are important assumptions behind these results. On the one hand, the limited role of entry regulation for unemployment is at odds with cross-country regressions 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 pieces of 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.

It is unclear whether the conclusions of this paper will hold under other theoretical frameworks. We can think of several mechanisms that may give more importance to entry regulation and others that would reinforce the impact of exit frictions. For example, my model disregards recurrent administrative fixed costs as Felbermayr and Prat (2011) consider. Indeed, Section 6 showed that the calibration of fixed costs is an important element to consider when drawing quantitative conclusions. Similarly, the inclusion of additional entry costs such as "entrepreneurship education" would certainly lower the contribution of both regulatory frictions. Further, the model I consider generates firm dynamics that are very simple. The ideal firm size is reached only one period after entry occurs. In a sense, firms are "young" for too short a period of time. Introducing any form of learning, heterogeneity or discounting would certainly alter my quantitative conclusions. All these ingredients should matter for the impact of regulation on firm dynamics and the macroeconomy. I leave them as open questions for future research.

Appendix A. Steady state and comparative statics

A.1. Steady state

This Appendix shows how to obtain Eqs. (6)–(14). I only focus on the steady state of the economy. The first-order conditions are

$$(1-\lambda)\frac{\partial \Pi(K_{t+1},N_{t+1})}{\partial N_{t+1}} = \frac{c}{h(\theta_t)}$$

for vacancies and

$$\frac{\partial \Pi(K_{t+1},N_{t+1})}{\partial K_{t+1}} = \frac{1+r-\varphi\lambda}{(1-\lambda)(1+r)}$$

for investment. From the envelope theorem,

$$\frac{\partial \Pi(K_t,N_t)}{\partial N_t} = \frac{1}{1+r}\left(\begin{array}{l}\frac{\partial F(K_t,N_t)}{\partial N_t}-w_t(K_t,N_t)-\chi\frac{\partial w_t(K_t,N_t)}{\partial N_t}N_t \\ \qquad +\frac{\partial \Pi(K_{t+1},N_{t+1})}{\partial N_{t+1}}(1-s)(1-\lambda)\end{array}\right)$$

and

$$\frac{\partial \Pi(K_t,N_t)}{\partial K_t} = \frac{1}{1+r}\left(\begin{array}{l}\frac{\partial F(K_t,N_t)}{\partial K_t}-\chi\frac{\partial w_t(K_t,N_t)}{\partial K_t}N_t \\ \qquad +\frac{\partial \Pi(K_{t+1},N_{t+1})}{\partial K_{t+1}}(1-\delta)(1-\lambda)+\frac{\lambda\varphi(1-\delta)}{1+r}\end{array}\right).$$

Hence, we have in steady state that

$$\frac{\partial F(K,N)}{\partial K} = \frac{r+\delta(1-\lambda)+\lambda(1-\varphi)}{1-\lambda}+\chi\frac{\partial w(K,N)}{\partial K}N \qquad (19)$$

and

$$\frac{r+\lambda+s(1-\lambda)}{1-\lambda}\frac{c}{h(\theta)} = \frac{\partial F(K,N)}{\partial N}-w(K,N)-\chi\frac{\partial w(K,N)}{\partial N}N, \qquad (20)$$

where the time subscript has been removed for notational convenience. The first-order conditions (6) and (7) can be obtained from these two equations by rearranging terms.

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[31] Monopolistic competition also introduces general-equilibrium effects through price determination. Janiak and Santos Monteiro (2011) show that this externality is quantitatively very small when consumers' preferences do not depend on product variety.

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

[33] A particularity of the paper by Ebell and Haefke (2009) is that they focus on US deregulation, i.e. a decrease in entry costs. It turns out that the effect of entry in their model is asymmetric: increases in entry costs predict larger changes in unemployment (in absolute value) than decreases. See Fig. 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 regulation on unemployment when applied to an OECD context.

Given the surplus for a worker is

$$[r + \lambda + s(1-\lambda)][W-U] = w(K,N) - rU, \tag{21}$$

then Nash bargaining yields

$$w(K,N) = (1-\beta)rU + \beta\frac{\partial F(K,N)}{\partial N} - \chi\beta\frac{\partial w(K,N)}{\partial N}N. \tag{22}$$

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

$$w(K,N) = (1-\beta)b + \beta\theta c + \int_0^1 z^{\frac{1-\beta}{\beta}}\frac{\partial F(K,Nz)}{\partial(Nz)}dz \tag{23}$$

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

$$w(K,N) = (1-\beta)b + \beta\theta c + \Omega_n\beta\nu AK^\alpha N^{\nu-1}, \tag{24}$$

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 Eq.(8) and its derivative in Eqs. (6) and (7) respectively gives Eqs. (9) and (10):

$$\Omega_k\frac{\partial F(K,N)}{\partial K} = \frac{r + \delta(1-\lambda) + \lambda(1-\varphi)}{1-\lambda} \tag{25}$$

$$\frac{r + \lambda + s(1-\lambda)}{1-\lambda}\frac{c}{h(\theta)} = (1-\beta)\left[\Omega_n\frac{\partial F(K,N)}{\partial(N)} - b\right] - \beta\theta c. \tag{26}$$

Eq. (14) is standard: it is obtained by equating flows into unemployment to flows out of unemployment.

Eq. (13) is obtained as follows. Consider the steady-state formulation of Eq. (1), where the mass of posted vacancies and investment are replaced by their expressions in Eqs. (2) and (3) in steady state, that is,

$$(r+\lambda)\Pi(K,N) = F(K,N) - wN - s\frac{c}{h(\theta)}N - \delta K + \lambda\frac{\varphi\overline{K}}{1+r}. \tag{27}$$

From the first-order condition (7), notice that the following relation holds in equilibrium:

$$w = \Omega_n\frac{\partial F(K,N)}{\partial N} - \frac{r + \lambda + s(1-\lambda)}{1-\lambda}\frac{c}{h(\theta)}. \tag{28}$$

By replacing wages in Eq. (27) with the expression above, we obtain

$$(r+\lambda)\Pi(K,N) = F(K,N) - \Omega_n\frac{\partial F(K,N)}{\partial N}N + \frac{r+\lambda}{1-\lambda}\frac{c}{h(\theta)}N - \delta K + \lambda\frac{\varphi\overline{K}}{1+r}. \tag{29}$$

This is the value of an incumbent.

Now, consider the value of an entering firm,

$$\Pi(0,0) = \frac{1}{1+r}\left(-C_0 + (1-\lambda)\Pi(K,N) + \lambda\frac{\varphi\overline{K}}{1+r}\right). \tag{30}$$

Given the information in Eq. (29), this value can be rewritten as

$$\frac{(1+r)(r+\lambda)}{1-\lambda}\Pi(0,0) = F(K,N) - \Omega_n\frac{\partial F(K,N)}{\partial N}N \tag{31}$$
$$- K\frac{r + \delta(1-\lambda) + \lambda(1-\varphi)}{1-\lambda} + \frac{\varphi\lambda K^f}{1-\lambda}.$$

And by using the equilibrium relation Eq. (6), it can also be rewritten as

$$\frac{(1+r)(r+\lambda)}{1-\lambda}\Pi(0,0) = F(K,N) - \Omega_n\frac{\partial F(K,N)}{\partial N}N - \Omega_k\frac{\partial F(K,N)}{\partial K}K + \frac{\varphi\lambda K^f}{1-\lambda}. \tag{32}$$

Finally, invoking free entry of firms,

$$\Pi(0,0) = \kappa + K^f, \tag{33}$$

yields Eq. (13).

A.2. The impact of regulation

A.2.1. Entry cost κ
The proof relies on Eqs. (9), (10), (13) and (14). Denote by $\hat{X}$ the log deviation of the variable X in steady state from its initial value after varying the parameter κ. It follows that

$$\hat{K} = \xi\hat{\kappa}, \tag{34}$$

$$\hat{N} = \frac{1-\alpha}{\nu}\xi\hat{\kappa}, \tag{35}$$

$$\hat{k} = -\frac{1-\alpha-\nu}{\nu}\xi\hat{\kappa} \tag{36}$$

and

$$\hat{u} = \frac{1-\alpha-\nu}{\nu}\frac{m_0(1-\eta)\theta^{-\eta}}{s(1-\lambda)+\lambda+m_0\theta^{1-\eta}}\frac{(1-\beta)\Omega_n\frac{\partial F(K,N)}{\partial N}}{(r+s(1-\lambda)+\lambda)cm_0\eta\theta^{\eta-1}+\beta c}\xi\hat{\kappa}, \tag{37}$$

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

Similarly, to determine 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

$$\hat{Y} = -\frac{1-\alpha-\nu}{\nu}\xi\hat{\kappa} - \frac{u}{1-u}\hat{u}, \tag{38}$$

implying a negative effect of the entry cost on aggregate output. Finally, it is straightforward to show from Eqs. (34)–(38) 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 mechanisms. The first effect affects sunk entry costs and appears on the left-hand side of Eq. (13), while the second effect operates through the relative price between capital and labor and explains the presence of φ on the right-hand sides of Eqs. (9) and (13). To illustrate these two effects, I use the following notation. Define $\vartheta_1 \equiv r + \lambda\left(1 - \frac{\varphi}{1+r}\right)$ and $\vartheta_2 \equiv \frac{r+\lambda(1-\varphi)+\delta(1-\lambda)}{1-\lambda}$. Denoting by $\hat{X}$ the log deviation of the variable X in steady state from its initial value after varying the parameter φ, it follows that

$$\hat{K} = (1-\xi)\hat{\vartheta}_1 - \hat{\vartheta}_2, \tag{39}$$

Table 4
Regression results for unemployment.

	OLS	OLS	OLS	OLS	OLS	RE
Administrative entry cost	0.123[***]		−0.032	−0.037	−0.040	−0.057
	(0.028)		(0.032)	(0.038)	(0.038)	(0.044)
Recovery rate		−0.067[***]	−0.060[***]	−0.048[***]	−0.041[***]	−0.059[***]
		(0.010)	(0.012)	(0.014)	(0.013)	(0.020)
EPL Index				0.710	0.988[*]	0.049
				(0.549)	(0.520)	(0.739)
Net replacement ratio				−0.030	−0.048[**]	−0.002
				(0.025)	(0.023)	(0.028)
Tax wedge				0.055[**]	0.051[*]	0.093[**]
				(0.027)	(0.026)	(0.039)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Denmark dummy	No	No	No	Yes	No	No
Observations	129	129	129	129	129	129
No countries	28	28	28	28	28	28

Notes: "OLS" refers to regressions done with ordinary least squares and "RE" refers to regressions done with random effects.
   [*] Significant at the 10% level.
  [**] Significant at the 5% level.
 [***] Significant at the 1% level.

$$\hat{N} = \frac{1-\alpha}{\nu}(1-\xi)\hat{\vartheta}_1 + \frac{\alpha}{\nu}\hat{\vartheta}_2, \tag{40}$$

$$\hat{k} = -\frac{1-\alpha-\nu}{\nu}(1-\xi)\hat{\vartheta}_1 - \frac{\alpha+\nu}{\nu}\hat{\vartheta}_2, \tag{41}$$

$$\hat{u} = \frac{m_0(1-\eta)\theta^{-\eta}}{s(1-\lambda)+\lambda+m_0\theta^{1-\eta}}\frac{(1-\beta)\Omega_n\frac{\partial F(K,N)}{\partial N}}{(r+s(1-\lambda)+\lambda)cm_0\eta\theta^{\eta-1}+\beta c}\left[\frac{1-\alpha-\nu}{\nu}(1-\xi)\hat{\vartheta}_1 + \frac{\alpha}{\nu}\hat{\vartheta}_2\right], \tag{42}$$

and

$$\hat{Y} = -\frac{1-\alpha-\nu}{\nu}(1-\xi)\hat{\vartheta}_1 - \frac{\alpha}{\nu}\hat{\vartheta}_2 - \frac{u}{1-u}\hat{u}. \tag{43}$$

Finally, from the above equations, the resulting percentage decrease in the capital–output ratio is equal to $\hat{\vartheta}_2$.

Appendix B. Data

B.1. Recovery rates

For a complete description of the data, see the paper by Djankov et al. (2008), which initiated the data project.

The data is based on the responses to a questionnaire completed by 344 lawyers and 34 judges from 88 countries. These practitioners are members of the International Bar Association, Section J (specialized in the areas of insolvency, restructuring and creditors rights). They consider the case of a business that face an unexpected operating loss and is about to default on a loan. Their task is to identify the outcome that most likely results from this situation and deduce the recovery rate from it. The business has identical characteristics across all questionnaires and consensus answers are required.

Three types of procedures may be chosen to resolve the insolvency: i) foreclosure, ii) liquidation and iii) attempt to reorganize before proceeding to liquidation. They may lead to two types of outcomes: i) the business continues operating as a going concern both throughout and upon completion of the insolvency process, or ii) the business is sold piecemeal. The first outcome is the most efficient because production is not stopped. Moreover, if a substantial share of capital is firm specific, a loss is generated when the capital is sold piecemeal.

When calculating the recovery rate, Djankov et al. (2008) assume that 30% of the value is lost if the business is sold piecemeal, while depreciation is zero under the "going concern" outcome. They also account for three additional elements in their calculations: i) the administrative cost of the procedure, ii) the financial opportunity cost and iii) the possibility that another claimant group—tax

authority, workers or suppliers—has absolute priority over the creditor. More precisely, the recovery rate is given by

$$R = \frac{100 \times GC + 70 \times (1-GC) - 12 \times (P-1) - 100 \times c}{(1+r)^{\tau}},$$

where GC is a dummy variable that takes value one under the "going concern" outcome, while it takes value zero under the "piecemeal sale" outcome. In the formula above, "100" is the value of the loan. The presence of the "70" term is due to the assumed 30% depreciation if the business is sold piecemeal. c is the administrative cost of the procedure as a percentage of the value of capital. It includes the following elements: court/bankruptcy authority costs, attorney fees, bankruptcy administrator fees, accountant fees, notification and publication fees, assessor or inspector fees, asset storage and preservation costs, auctioneer fees, government levies and other associated insolvency costs. r is the nominal lending rate, which is used to calculate the financial opportunity cost, and τ is the time (in years) it takes for the creditor to get paid.

Finally, P gives the priority ranking of the creditor over other claimant groups: it takes value one if the creditor has absolute priority, it takes value two if it is second, and so on. The maximum value P can take is 4. The presence of the "12" term can be explained as follows. The authors set the total amount of debt outstanding to 136 units: 100 units represent the amount of the initial loan, while the 36 other units are held by other creditors, namely suppliers, tax authorities and employees. This explains why "12" appears in the formula: it corresponds to these 36 other units divided by the number of other creditors (which is 3). Notice that these additional claims correspond to trade credit due in the case of suppliers, tax due in the case of tax authorities and wages in the case of workers. For example, costs related to employment protection are not included in the case of workers.[34]

B.2. Regressions

In this Appendix, we present cross-country regressions, where the dependent variable is the OECD harmonized unemployment rate. The included explanatory variables are the entry and exit regulation measures from the Doing Business database that have been used in the

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[34] When labor is an absolute priority, the impact of exit regulation may be weakened because these effects should be internalized under wage negotiation (see e.g. Lazear, 1990). In the data, labor is an absolute priority in the case of France and Greece. The variable on the "priority ranking" does not affect the French recovery rate much (see Djankov et al., 2008). It nevertheless has a substantial impact on the Greek recovery rate.

paper and some controls for labor market institutions, such as the OECD EPL stringency index (version 2), the net replacement ratio and a measure of the labor tax wedge (i.e. the sum of income tax plus employee and employer contributions less cash benefits for a one-earner married couple with two children, as a percentage of average earnings), and time dummies.

The database gathers 28 OECD countries for the period 2004–2009. The list of countries include Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Turkey, the United Kingdom and the United States. Net replacement ratio data was not available for Mexico. Switzerland could not be included in the regressions because data on harmonized rates was not available for some years, while the EPL stringency index was not available for other years.

Notice that, when EPL stringency and the net replacement ratio are included, a dummy variable for Denmark (the flexicurity country) is added to the list of controls: when not included, the net replacement ratio is significant at the 5% and appears to reduce unemployment.

Table 4 shows the results. Entry and exit regulation significantly affect unemployment when they are introduced in the regression individually. When they are introduced at the same time or with controls for labor market institutions, only exit regulation affects unemployment. A random effect specification confirms the OLS results.

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