

The Macroeconomic Effects of Goods and Labor Markets Deregulation*

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April 20, 2012.

First Version: July 2009.

Abstract

We develop a dynamic stochastic general equilibrium model with endogenous producer entry and labor market frictions to study the macroeconomic effects of deregulating product and labor markets in rigid economies. Three results emerge. First, deregulation has positive welfare effects, but it can involve short-run costs, including higher unemployment and lower output and consumption. Second, the effects of deregulating one market depend on the level of regulation in the other. Policymakers can exploit this interdependence to increase the welfare gains of reforms. Third, deregulation changes the business cycle properties of the economy, amplifying impact responses to shocks but reducing persistence.

JEL Codes: E24, E32, J64.

Keywords: Deregulation; Endogenous entry; Search and matching frictions; Business cycle fluctuations.

*We would like to thank Florin Bilbiie, Fabio Ghironi, Francesco Giavazzi, Federico Ravenna, Antonella Trigari and Francesco Zanetti and seminar participants for very valuable comments and suggestions. We also thank all the participants at the Boston University/Boston College Green Line Workshop, the 8th Workshop on Macroeconomic Dynamics: Theory and Applications, FGV-São Paulo, the University of São Paulo, University of Montreal, University of Bonn, the Dutch Central Bank, North Carolina State University, the Cleveland Fed, Collegio Carlo Alberto, the Bank of Italy, and Paris School of Economics. All errors are ours.

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1 Introduction

The recent financial and economic crisis that hit European countries generated a new surge in the debate on the link between market regulation and economic performance. Once again, thick regulation has been indicated as detrimental to economic outcomes and the call for reforms has been vigorous.¹

Theoretical work has extensively studied the role of regulation in macroeconomic outcomes. However, the analysis focused on the separate role of regulation in the goods and labor markets in long-run unemployment, output and productivity. Such an approach is not exhaustive when evaluating the overall desirability of reforms. First, the adjustment to deregulation cannot be instantaneous and transition costs might arise. Second, deregulation can affect not only the mean value around which the economy fluctuates, but it might also change the propagation of aggregate shocks, with consequences for business cycle dynamics. Finally, the effects of deregulating one market could depend on the level of regulation prevailing in the other. Policymakers might exploit such interdependence to design reforms in a welfare-improving manner.

In this paper we take a step toward the evaluation of the dynamic consequences of deregulation: we study the adjustment to policy changes, consider the business cycle implications of reforms and account for potential interactions between institutional arrangements. Our contribution adds to the existing literature along three dimensions. First, we develop an original theoretical framework able to quantitatively study the dynamic effects of market deregulation. Second, we highlight the importance of institutional interactions. Third, we contribute to the political economy literature on reforms, which tries to explain the (dis)incentives to deregulate rigid economies.

We build a dynamic stochastic general equilibrium model featuring an endogenous determination of the number of producers, labor market frictions, and aggregate and idiosyncratic uncertainty.

The endogenous variation of monopolistically competitive firms is modeled as in Bilbiie, Ghironi,

¹European data show that both product and labor markets are indeed characterized by high levels of regulation - significant regulatory impediments to competition, stringent employment protection legislation (EPL) and generous unemployment benefits. As documented in Table 1, in the four largest economies of the Euro Area—Germany, France, Italy and Spain—the number of business days it takes (on average) to fulfill entry requirements is about six times higher than in the United States. Labor market regulation is roughly 30 percent higher.

and Melitz (forthcoming) — BGM henceforth. Labor markets are characterized by search and matching frictions, with endogenous job creation and destruction as in Mortensen and Pissarides (1994). Since variations in the number of producers induce changes in the competitive environment, we allow markups to endogenously vary because of demand-side pricing complementarities. A key feature of the model is the explicit link between product and labor market dynamics. Profitability of entry depends on the (expected) costs of hiring and firing workers. Barriers to entry, in turn, affect the evolution of job creation and destruction by determining the size and number of producers at each point in time. Despite the presence of endogenous producer entry, labor market frictions and idiosyncratic productivity shocks, model tractability is preserved, since aggregate dynamics can still be summarized by the mean of average, representative firms.²

In the paper we follow the language convention of most of the macroeconomic literature and assume coincidence between a producer, a product and a firm. However, as in BGM, each unit in the model is best interpreted as a production line that could be part of a multi-product firm whose boundary is left undetermined. In this interpretation, producer entry and exit capture the product-switching dynamics within firms documented by Bernard, Redding, and Schott (2010). Thus, policy changes in the model affect the number of products available to consumers, whether supplied by new or existing producers.

We begin our analysis by showing that the model successfully reproduces several features of the business cycle in the Euro Area. Then we turn to the study of deregulation in goods and labor markets. We consider both single policy changes and global market reforms. The stringency of product market regulation is identified with the size of sunk entry costs paid to access the market. Labor market regulation, instead, is proxied by reductions of unemployment benefits and employment protection (firing costs and workers' bargaining power).³ The size of reforms is

²The model can be viewed as a large firm version of the Diamond, Mortensen and Pissarides framework in which the number of producers endogenously varies together with the stock of labor. By retaining multiple-worker firms we are able to distinguish employment outcomes from the behavior of the number of producers in the economy. Under perfect competition in good markets and constant returns to scale the one-worker firm assumption would be harmless, since the number and size of firms are indeterminate. Under monopolistic competition firms' size is determinate and it varies according to the demand elasticity faced by the firms. Shao and Silos (2008) introduce a sunk vacancy cost into the one-firm one-worker search and matching model. In their setup entry of workers into production coincides with entry of new producers.

³We restrict our attention to these two dimensions of labor market regulation, since they are widely considered to

determined by lowering policy parameters to their corresponding U.S. levels, a flexible, developed benchmark economy.

We find that lower barriers to entry reduce markups and boost employment in the long run. Less stringent employment protection and less generous unemployment benefits stimulate job creation with positive effects on unemployment. These results are in line with existing empirical evidence.⁴ The key message of the paper is that deregulation can trigger significant dynamic effects, over and above steady-state outcomes. Three results in particular emerge.

First, deregulation can involve up-front costs, including frictional unemployment and a temporary drop in GDP and consumption. Transition costs can reach up to 40 percent of long-run welfare gains. Importantly, the nature of adjustment costs is quite different across reforms. Product market deregulation requires a time-consuming reallocation of workers between shrinking and expanding plants, increasing frictional unemployment. Moreover, such a reform requires investment (entry of new firms) that needs to be financed by reducing consumption. Labor market deregulation, instead, affects the hiring and firing incentives of existing firms, without triggering large firm dynamics. In the aftermath of the reform, the layoff of workers operated by incumbents raises unemployment and reduces GDP. However, unlike product market deregulation, aggregate consumption is not negatively affected along the transition, since agents can reduce savings in anticipation of future higher permanent income, more than offsetting negative employment outcomes.

Second, reforms are interdependent. In the long run, product and labor market reforms are substitutes: the gains from deregulating one market are higher when the other market is more regulated to begin with. In the short run, however, flexibility in one market can reduce the adjustment costs of reforming another rigid market. The interdependence of policy changes also has important implications for global market reforms. Starting from a fully regulated economy, joint deregulation in goods and labor markets maximizes long-run gains. Moreover, a simultaneous global market

be among the major contributors to the rigidity of continental European labor markets. See, for instance, Bentolila and Bertola (1990) and Ljungqvist and Sargent (2005); among others.

⁴Bertrand and Kramarz (2002) find that barriers to entry negatively affect employment. Griffith, Harrison, and Macartney (2007) document the positive relationship between markups and product market regulation. For the detrimental effect of labor market regulation on employment see Nickell, Nunziata, and Ochel (2005), Fiori, Nicoletti, Scarpetta, and Schiantarelli (2012) and references therein.

reform lowers transition costs relative to sequential deregulation in which one market is reformed after the other.

Third, market deregulation affects the business cycle properties of the economy. In rigid economies, aggregate shocks are propagated through the slow, initial response of the labor market due to the presence of high firing costs. At the same time, higher barriers to entry, higher unemployment benefits and larger rents accruing to workers negatively affect the incentives to create new firms and jobs, inducing a sluggish adjustment. The impact response of employment and GDP is instead magnified in a flexible labor market, since the costs of adjusting the labor force are smaller. However, the effects of aggregate shocks are also shorter-lived because of the greater incentives to create firms and jobs in the presence of flexible regulation. Deregulation, in any of its forms, unambiguously reduces the persistence of all macroeconomic series, indicating that rigidities in goods and labor markets can increase economic resilience to shocks.⁵ The welfare costs of the business cycle decline following market reforms.

Our findings suggest that deregulation is beneficial. At the same time our results provide a new rationale for the historical aversion of governments to implement reforms that would be welfare improving: the presence of short-run adjustment costs. For example, joint deregulation in product and labor markets, despite being highly beneficial in the long run, would take about six years to display positive welfare effects: governments that want to be re-appointed might not be willing to tolerate short-run costs that are misaligned with the electoral cycle. This argument adds to the political economy literature on reforms which traditionally explained the difficulty in deregulating product and labor markets with reference to the conflict between insiders and outsiders (see Saint-Paul (1999) and Blanchard and Giavazzi (2003)).⁶

The present paper builds on important contributions. Our starting point is BGM. Unlike their setup, we allow for search and matching frictions in the labor market, with (costly) endogenous

⁵This is consistent with Balakrishnan and Michelacci (2001), who use a VAR analysis to document that labor markets in some countries of the Euro Area might be dynamically sclerotic. See also the empirical evidence provided by Duval, Elmeskov, and Vogel (2007).

⁶Saint-Paul (1999) suggests that any reform that would make outsiders more competitive on the labor market are opposed by insiders. Blanchard and Giavazzi (2003) instead emphasize how workers may obstruct product market reforms that would reduce the size of rents to be shared between firms and workers.

job creation and destruction. Moreover, we focus on the dynamic implications of deregulation, while they investigate the role of producer entry in business cycle dynamics. Another related contribution is Blanchard and Giavazzi (2003). They highlight the channel through which product and labor market regulation can affect long-run aggregate outcomes, focusing on the political economy aspects of reforms. Ebell and Haefke (2009) quantitatively assess whether product market deregulation can explain the observed reduction in the U.S. trend unemployment. Felbermayr and Prat (2011) reconsider Ebell and Haefke’s results using a model with heterogeneous firms. Bentolila and Bertola (1990), Hopenhayn and Rogerson (1993) and Alessandria and Delacroix (2008) study instead the long-run effects of firing costs on economic activity. We view our work as complementary to those contributions since we build a dynamic and stochastic model to study the adjustment to deregulation, explore the possible interdependence of reforms and consider the business cycle implications of policy changes. Finally, Zanetti (2009) considers the separate role of product and labor market regulation for the cyclical behavior of output and inflation. Unlike us, he assumes a constant number of producers in the economy and interprets product market deregulation as an exogenous change in the (constant) elasticity of substitution across goods.⁷

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 discusses the calibration. Sections 4 and 5 study the adjustment to deregulation. Section 6 presents the business cycle implications of market reforms. Section 7 discusses the political economy implications of deregulation and Section 8 concludes.

2 The Model

Household Preferences

The economy is populated by a unit mass of atomistic households. All contracts and prices are written in nominal terms and prices are flexible.⁸ Each household is thought of as a large extended family containing a continuum of members along a unit interval. In equilibrium some members

⁷Other contributions focusing on the consequences of labor market deregulation in isolation include Veracierto (2008), Thomas and Zanetti (2009), Christoffel, Kuester, and Linzert (2009) and Campolmi and Faia (2011).

⁸For this reason we do not model demand for currency and resort to a cashless economy as in Woodford (2003).

will be unemployed; while some others will be producing. As in Andolfatto (1996) and Merz (1995), members in each family perfectly insure each other against variation in labor income due to employment or unemployment. There is no ex-post heterogeneity across individuals.

The representative household maximizes the following utility function:

$$u(C) = E_t \left\{ \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{1-\gamma}}{1-\gamma} \right\}, \quad (1)$$

where C_t represents a basket of goods defined over a continuum Ω . At any given point in time only a subset of goods $\Omega_t \in \Omega$ is available. We assume that the aggregator C_t takes a translog form following Feenstra (2003b). As a result, the elasticity of substitution across varieties within the basket C_t is an increasing function of the number of goods available. The translog assumption allows us to capture the pro-competitive effect of deregulating in the goods market on markups, documented by the empirical literature (see Griffith, Harrison, and Macartney (2007)).⁹ Translog preferences are characterized by defining the unit expenditure function (i.e., the price index) associated with the preference aggregator. Let $p_{\omega t}$ be the nominal price for the good $\omega \in \Omega_t$. The unit expenditure function on the basket of goods C_t is given by:

$$\ln P_t = \frac{1}{2\sigma} \left(\frac{1}{N_t} - \frac{1}{\tilde{N}} \right) + \frac{1}{N_t} \int_{\omega \in \Omega_t} \ln p_{\omega t} d\omega + \frac{\sigma}{2N_t} \int_{\omega \in \Omega_t} \int_{\omega' \in \Omega_t} \ln p_{\omega t} (\ln p_{\omega t} - \ln p_{\omega' t}) d\omega d\omega' \quad (2)$$

where $\sigma > 0$, N_t is the total number of products available at time t , and \tilde{N} is the mass of Ω .

⁹Lower entry barriers in the production of goods result in increased entry, a larger number of available goods, and—by inducing higher substitutability—lower markups. The assumption of translog preferences has been found to have appealing empirical properties in a variety of contexts. For a review of its applications in the trade literature, see Feenstra (2003a). BGM find that translog preferences and endogenous producer entry result in markup dynamics that are remarkably close to U.S. data. Bergin and Feenstra (2000) and Bergin and Feenstra (2001) show that a translog expenditure function makes it possible to generate empirically plausible endogenous persistence in macro and international macro models by virtue of the implied demand-side pricing complementarities. (Feenstra (2003b) shows that the properties of the translog function used by Bergin and Feenstra also hold when the number of goods varies.) Rodríguez-López (2011) extends Ghironi and Melitz’s (2005) model to include translog preferences and nominal rigidity. He obtains plausible properties for exchange rate pass-through, markup dynamics, and cyclical responses of firm-level and aggregate variables to shocks.

Firms and Labor Market

There is a continuum of monopolistically competitive firms, each producing a different variety ω . Production requires only labor and it is characterized by constant returns to scale. We model labor market frictions within the context of a large firm setup, in order to allow product and labor market regulation to affect both the size and the number of producing firms. Each producer employs a continuum of workers. The stock of labor varies because of the endogenous variation in hiring and separation rates (job creation and destruction). To hire a new worker, firms have to post a vacancy, incurring a fixed cost κ . The probability of finding a worker depends on a constant returns to scale matching technology, which converts aggregate unemployed workers U_t and aggregate vacancies V_t into aggregate matches $M_t = \chi U_t^\varepsilon V_t^{1-\varepsilon}$, where $0 < \varepsilon < 1$. Define labor market tightness as $\theta_t \equiv V_t/U_t$. Each firm meets unemployed workers at a rate $q_t \equiv M_t/V_t$ while each unemployed worker faces a probability of employment equal to $s_t \equiv M_t/U_t$. Following Krause and Lubik (2007b), we assume that newly created matches become productive only in the next period. For an individual firm, the inflow of new hires in $t + 1$ is therefore $q_t v_{\omega t}$, where $v_{\omega t}$ is the number of vacancies posted by an incumbent ω .

Firms and workers can separate for exogenous and endogenous motives. When the firm finds that a match is no longer profitable, it can fire the worker, incurring a firing cost F .¹⁰

Each filled job produces $Z_t z_{it}$ units of output, where i indexes a particular job. Production is subject to both aggregate and idiosyncratic shocks. Aggregate productivity Z_t is common to all firms, while job-specific productivity z_{it} is idiosyncratic. We assume that z_{it} is an *i.i.d.* draw from a time-invariant distribution with *cdf* $G(z)$, positive support and density $g(z)$.

Total output for producer ω is determined by the measure $l_{\omega t}$ of jobs, aggregate productivity

¹⁰Firing costs in the model are not a transfer from the firm to the worker. As discussed by Mortensen and Pissarides (1994), severance payments would have no allocative effects in the present setup. Our definition of F includes only the non-transfer components of firing costs, such as legal costs, sanctions for delayed payments, costs of advance notice requirements and penalties due when terminating a redundant worker and forgone health insurance and Social Security contributions.

Z_t and a weighted average of idiosyncratic job-specific shocks, $\bar{z}_{\omega t}$:

$$y_{\omega t} = Z_t \int_{z_{\omega t}^c}^{\infty} z \frac{dG(z)}{1 - G(z_{\omega t}^c)} l_{\omega t} \equiv Z_t \bar{z}_{\omega t} l_{\omega t}, \quad (3)$$

where $z_{\omega t}^c$ is the (endogenous) critical threshold below which firm ω destroys non-profitable jobs with $z < z_{\omega t}^c$. This results in an endogenous job destruction rate $G(z_{\omega t}^c)$.

At the beginning of each period, a fraction λ^x of jobs are exogenously separated in each firm. Total *within* firm separation is then given by $\lambda_{\omega t} \equiv \lambda^x + \lambda_{\omega t}^e$, where $\lambda_{\omega t}^e \equiv (1 - \lambda^x)G(z_{\omega t}^c)$ represents the fraction of jobs endogenously destroyed.

The law of motion of employment for producer ω is given by:

$$l_{\omega t} = (1 - \lambda_{\omega t})(l_{\omega t-1} + q_{t-1}v_{\omega t-1}). \quad (4)$$

Prior to entry, firms face an entry cost $f_{E,t}$, to be specified later on. There are no fixed costs of production. Hence, all firms that enter the economy produce every period until they are hit by a "death" shock, which occurs with probability $\delta \in (0, 1)$ in every period. When a firm leaves the market, its entire stock of workers becomes unemployed, joining the pool of searchers. We assume that exiting firms bear no costs associated with the workers' layoff.

Incumbent Firms

Let's consider a generic firm ω producing at time t . The incumbent ω minimizes the following cost function:

$$E_t \sum_{s=t}^{\infty} \left\{ \beta^{s-t} (1 - \delta)^{s-t} \left(\frac{C_s}{C_t} \right)^{-\gamma} [W_{\omega s} + \kappa v_{\omega s} + \lambda_{\omega s}^e (l_{\omega t-1} + q_{t-1}v_{\omega t-1}) F] \right\}, \quad (5)$$

subject to (3) and (4).¹¹ The first term in the cost function, $W_{\omega t}$, is the total wage bill of the firm. If workers were paid identical wages, this would simply equal the wage times employment, $w_{\omega t} l_{\omega t}$. However, wages are not identical but depend on the idiosyncratic productivities of the jobs.

¹¹Each producer discounts future expected costs taking into account the positive probability of exit in each period.

Therefore, the wage bill of firm ω is given by the aggregate of individual wages:

$$W_{\omega t} = l_{\omega t} \int_{z_{\omega t}^c}^{\infty} w_{\omega}(z) \frac{dG(z)}{1 - G(z_{\omega t}^c)}. \quad (6)$$

The precise expression for the aggregate wage is derived below. The last two terms in the cost function represent hiring and firing costs, respectively.¹²

Let $\varphi_{\omega t}$ and $\phi_{\omega t}$ be the Lagrange multipliers associated with the constraint (3) and (4). First-order, necessary conditions for $z_{\omega t}^c$, $l_{\omega t}$ and $v_{\omega t}$ are, respectively:

$$\varphi_{\omega t} Z_t z_{\omega t}^c - \frac{\partial W_{\omega t}}{\partial z_{\omega t}^c} + \frac{\kappa}{q_t} = F, \quad (7)$$

$$\phi_{\omega t} = \varphi_{\omega t} Z_t \bar{z}_{\omega t} - \frac{\partial W_{\omega t}}{\partial l_{\omega t}} + E_t \left\{ \beta_{t,t+1} \left[(1 - \lambda_{\omega t+1}) \phi_{\omega t+1} - \lambda_{\omega t+1}^e F \right] \right\}, \quad (8)$$

$$\frac{\kappa}{q_t} = E_t \left\{ \beta_{t,t+1} (1 - \lambda_{\omega t+1}) \phi_{\omega t+1} - \lambda_{\omega t+1}^e F \right\}, \quad (9)$$

where $\beta_{t,t+1} = \beta(1 - \delta)(C_{t+1}/C_t)^{-\gamma}$ is the stochastic discount factor, adjusted for the exogenous exit probability. The multiplier $\phi_{\omega t}$ gives the current period average value of workers across job-specific productivities z . The multiplier $\varphi_{\omega t}$ is the contribution of an additional unit of output to the firm's revenue, equal to the firm's real marginal cost. Note that firms take individual wages as given when choosing employment.¹³

Equation (7) defines the optimality condition for job destruction: the cost of shedding workers equals the benefit. Equation (8) defines the current period average value of workers, which is given

¹²Firing costs are paid only when the job is endogenously terminated by the firm.

¹³This is a standard assumption in dynamic stochastic general equilibrium models featuring monopolistic competition and search and matching frictions in the labor market (see, among others, Krause and Lubik (2007b) and Faia (2009)). Since the firm takes individual wages as given when choosing employment, intra-firm bargaining is ruled out by assumption, i.e., the firm does not internalize the effect of changing the stock of labor on the aggregate wage cost. The possibility of intra-firm bargaining arises whenever the scale of the firm changes non-linearly with its labor input, in our case because of the downward sloping producer demand. We follow the traditional approach in the literature, since the presence of a time-varying demand elasticity significantly complicates the intra-firm bargaining solution. Moreover, the quantitative importance of intra-firm bargaining has been shown to be very modest for both steady-state outcomes and business cycle dynamics (see Krause and Lubik (2007a) and Ebell and Haefke (2009)). In the Appendix we present an alternative version of the model featuring CES preferences and intra-firm bargaining. None of the results are affected by employing this alternative setup.

by the average marginal revenue product augmented by its expected continuation value, net of wage costs and expected firing costs. Equation (9) equalizes the cost of an open vacancy with the expected benefit of hiring a new worker. Substituting equation (9) into equation (8) yields a job creation condition for producer ω :

$$\frac{\kappa}{q_t} = E_t \left\{ \beta_{t,t+1} \left[(1 - \lambda_{\omega t+1}) \left(\bar{\pi}_{\omega t+1} - \frac{\partial W_{\omega t+1}}{\partial l_{\omega t+1}} + \frac{\kappa}{q_{t+1}} \right) - \lambda_{\omega t+1}^e F \right] \right\}. \quad (10)$$

where $\bar{\pi}_{\omega t} \equiv \varphi_{\omega t} Z_t \bar{z}_{\omega t}$ represents the average marginal revenue product in firm ω . The job creation condition states that, at the optimum, the vacancy creation cost incurred by the firm per current match is equal to the expected discounted value of the vacancy creation cost per future match, further discounted by the probability of current match survival $1 - \lambda_{\omega t+1}$, plus expected profits from the time- t match. Expected profits take into account the future marginal revenue product from the match, its wage cost and possible firing costs. Forward iteration of equation (10) implies that, at the optimum, the vacancy creation cost per match, κ/q_t , is equal to the expected present discounted value of the stream of profits generated by the match over its expected lifetime.

The producer ω faces the following demand for its output:

$$y_{\omega t} = \sigma \ln \left(\frac{\bar{p}_t}{p_{\omega t}} \right) \frac{P_t Y_t^C}{p_{\omega t}}, \quad (11)$$

where

$$\ln \bar{p}_t = \frac{1}{\sigma N_t} + \frac{1}{N_t} \int_{\omega \in \Omega_t} \ln p_{\omega t} d\omega$$

is the maximum price that a domestic producer can charge while still having a positive market share. In the demand expressions (11), Y_t^C denotes aggregate demand of the final consumption basket: it takes the same translog form as the bundle C_t but it includes sources other than household consumption. This ensures that the price index for the translog consumption aggregator is also the price index for aggregate demand.¹⁴

¹⁴To gain some intuition about the demand structure implied by equation (11); notice that firm revenue, $p_t(\omega)y_t(\omega)$, is a time-varying fraction of the aggregate demand $P_t Y_t^C$. The time-varying market share is given by $\sigma \ln(\bar{p}_t/p_t(\omega))$ and so it depends on the price chosen by the firm relative to the maximum admissible price.

Per-period real profits are given by

$$d_{\omega t} = \left(\frac{p_{\omega t}}{P_t} - \varphi_{\omega t} \right) y_{\omega t}.$$

The firm chooses price $p_{\omega t}$ to maximize the present discounted value of current and future real profits $E_t \sum_{s=t}^{\infty} \{ \beta_{t,t+s} d_{\omega t} \}$, subject to (11). The first-order condition with respect to $p_{\omega t}$ implies that the (real) output price $\rho_{\omega t} \equiv p_{\omega t}/P_t$ is equal to a markup $\mu_{\omega t}$ over marginal cost $\varphi_{\omega t}$: $\rho_{\omega t} = \mu_{\omega t} \varphi_{\omega t}$. The endogenous time-varying markup $\mu_{\omega t}$ is given by:

$$\mu_{\omega}(N_t) \equiv \frac{\alpha_{\omega t}}{\alpha_{\omega t} - 1},$$

where $\alpha_{\omega t} \equiv -\partial \ln(y_{\omega t}) / \partial \ln \rho_{\omega t}$ denotes the price elasticity of demand for variety ω . Translog preferences imply that substitutability across varieties increases with the number of available varieties. As a consequence, the price elasticity of total demand facing producer ω increases when the number of producers is larger.

Wage Setting

The discussion so far has left the wage unspecified. In what follows, we derive a match-specific wage that depends on the idiosyncratic productivity of the job. Following Cooley and Quadrini (1999) and Krause and Lubik (2007b), we assume surplus splitting between an individual worker and the firm rather than Nash bargaining. The surplus-splitting rule divides the surplus of each match in shares determined by an exogenous bargaining weight η . Without loss of generality, consider a worker with idiosyncratic productivity z employed by producer ω . The sharing rule is such that:

$$\eta \Delta_{\omega t}^F(z) = (1 - \eta) \Delta_{\omega t}^W(z). \tag{12}$$

where $\Delta_{\omega t}^W(z)$ and $\Delta_{\omega t}^F(z)$ denote, respectively, worker's and firm's real surplus from the match. We refer the reader to the Appendix for the definitions of $\Delta_{\omega t}^W(z)$ and $\Delta_{\omega t}^F(z)$ and the analytical derivation of the wage schedule. Here we just report the result and provide intuition. The real

wage for a worker with idiosyncratic productivity z is given by:

$$w_{\omega t}(z) = \eta \pi_{\omega t}(z) + (1 - \eta) \varpi_t, \quad (13)$$

where $\pi_{\omega t}(z) = \varphi_{\omega t} Z_t z$ is the marginal revenue product generated by worker z and ϖ_t denotes the worker's outside option. The surplus splitting rule implies that the wage paid to the worker is a linear combination of the firm's and the worker's outside options. When the firm is not matched with the worker, it loses its output. The worker's outside option is instead given by:

$$\varpi_t \equiv \tilde{b} + s_t \int_{\omega \subset \Omega_t}^{\infty} \frac{v_{\omega t}}{V_t} E_t \left\{ \beta_{t,t+1} (1 - \lambda_{\omega t+1}) \bar{\Delta}_{\omega t+1}^W \right\} d\omega. \quad (14)$$

The first term in equation (14) represents the current value of unemployment \tilde{b} , where $\tilde{b} \equiv h_p + b$ is the sum of home production, h_p , and unemployment benefits, b , a transfer from the government financed with lump sum taxes. The second term in (14) represents the value of searching for other jobs, which corresponds to the expected surplus from employment. Notice that $\bar{\Delta}_{\omega t}^W$ is the average surplus accruing to the worker in firm ω and $s_t v_{\omega t} / V_t$ is the probability of being matched to producer ω when searching for jobs.

The average of individual wages, weighted according to the distribution of idiosyncratic productivity, is:

$$\bar{w}_{\omega t} = \int_{z_{\omega t}^c}^{\infty} w_{\omega t}(z) \frac{dG(z)}{1 - G(z_{\omega t}^c)}. \quad (15)$$

Symmetry Among Producers

An important aspect of the model is the choice, upon entry, of the initial stock of labor required to start production (firms have zero workers when they are created). The question is whether new entrants find it optimal to choose an initial number of workers that is different from that of existing incumbents. If this were the case, there would be ex-post heterogeneity across different cohorts of firms entering the market at different points in time. In our framework tractability is preserved, since we demonstrate that a symmetric, unique equilibrium still exists: new entrants optimally

choose to have the same stock of labor of incumbents and there is no need to keep track of different cohorts of producers across time. In the Appendix we show that a necessary and sufficient condition for the symmetric equilibrium to exist is that the productivity cutoff $z_{\omega t}^c$ and the real marginal cost $\varphi_{\omega t}$ depend only on aggregate outcomes, i.e., $z_{\omega t}^c = z_t^c$ and $\varphi_{\omega t} = \varphi_t$.¹⁵ Essential for this result is linearity in the production function, together with linearity in hiring and firing costs.

In the symmetric equilibrium the endogenous markup is equal to $\mu(N_t) = 1 + (1/\sigma N_t)$.¹⁶ Using the welfare-based price index P_t , we can write the relative price of each variety as $\rho_t = e^{-\frac{\tilde{N} - N_t}{2\sigma \tilde{N} N_t}}$. Notice that an increase in the number of firms implies that the relative price of each good, ρ_t , increases: when there are more goods available for consumption, households derive more welfare from spending a given nominal amount, i.e., the price index P_t decreases.

Labor market dynamics are summarized by three equations determining aggregate wages, job creation and destruction. First, notice that in the symmetric equilibrium the worker's outside option simplifies to:

$$\varpi_t = \tilde{b} + \frac{\eta}{(1 - \eta)} k \theta_t. \quad (16)$$

Substituting equation (16) into equation (13), we have:

$$w_t(z) = \eta(\pi_t(z) + \kappa \theta_t) + (1 - \eta) \tilde{b}. \quad (17)$$

Combining equations (15) and (17), we obtain the following equation for the average wage:

$$\bar{w}_t = \eta(\bar{\pi}_t + \kappa \theta_t) + (1 - \eta) \tilde{b}. \quad (18)$$

The aggregate job creation condition is then given by:

$$\frac{\kappa}{q_t} = E_t \left\{ \beta_{t,t+1} (1 - \lambda_{t+1}) \left[(1 - \eta) \left(\bar{\pi}_{t+1} - \frac{\lambda_{t+1}^e F}{1 - \lambda_{t+1}} - \tilde{b} \right) - \eta \kappa \theta_{t+1} + \frac{\kappa}{q_{t+1}} \right] \right\}, \quad (19)$$

¹⁵Intuitively, firms with an identical marginal cost charge the same relative price ρ_t , face the same demand schedule and produce the same amount of output. Since the firm's output is given by $Z_t \bar{z}_t l_t$ it is enough to show that z_t^c is identical across firms to conclude that all firms in the market have the same stock of labor.

¹⁶The elasticity of substitution across varieties is $1 + \sigma N_t$. As the number of producers N_t increases, the elasticity of substitution increases and the markup falls.

Finally, substituting the wage paid to the marginal worker in equation (9), we obtain the following job destruction equation:

$$(1 - \eta) \left(\varphi_t Z_t z_t^c - \tilde{b} \right) - \eta \kappa \theta_t + \frac{\kappa}{q_t} = F. \quad (20)$$

Firm Entry and Exit

The entry-exit decision is modelled as in BGM. Prior to entry, firms face a sunk entry cost $f_{E,t}$:

$$f_{E,t} = f_{R,t} + f_{T,t} + \kappa (l_t + q_t v_t) / q_t. \quad (21)$$

The first term in equation (21), $f_{R,t}$, represents the cost associated with regulatory and administrative barriers to entry. The second component of sunk entry costs reflects the technological cost of product creation, $f_{T,t}$.¹⁷ The last term in $f_{E,t}$ corresponds to the cost of recruiting workers to begin production.¹⁸ This cost is endogenous and responds to aggregate labor market conditions. In particular, it is procyclical: when the labor market is tighter, the expected cost of filling a vacancy, κ/q_t , is higher. Other things equal, entry is more costly due to congestion in the labor market.

In every period t , there is an unbounded mass of prospective entrants. Prospective entrants are forward looking and form rational expectations of their future profits d_s in any period $s > t$ subject to the exogenous probability δ of incurring an exit-inducing shock at the end of each period. As in BGM, we introduce a time-to-build lag in the model and assume that entrants at time t will start producing only at $t + 1$. Prospective entrants compute their expected post-entry value e_t , given by the expected present discounted value of the stream of per-period profits d_s : $e_t = E_t \sum_{s=t}^{\infty} \{\beta_{t,t+s} d_s\}$. Entry occurs until firm value is equalized to the entry cost, leading to the free-entry condition $e_t = f_{E,t}$.¹⁹ Our assumptions on exit shocks and the timing of entry and production imply that the law of motion for the number of producing firms is given by $N_t =$

¹⁷Both $f_{R,t}$ and $f_{T,t}$ are expressed in units of aggregate output: to pay for regulatory and technology costs each firm has to purchase a basket of materials that has the same composition as the basket Y_t^C .

¹⁸Upon entry, a new producer posts vacancies to match the end-of-period size of existing incumbents. In a given period t , each incumbent has a stock of producing workers equal to l_t . Moreover, at time t each incumbent creates $q_t v_t$ new matches that will become productive in $t + 1$. Thus, at the end of period t , the size of an incumbent is $l_t + q_t v_t$.

¹⁹This condition holds as long as the mass of new entrants $N_{E,t}$ is positive. We verify that this condition is never violated in our exercises.

$(1 - \delta)(N_{t-1} + N_{E,t-1})$. The number of producing firms represents the stock of capital of the economy. It behaves much like physical capital in a standard RBC model, but it has an endogenously fluctuating price given by e_t .

Household Budget Constraint and First-Stage Budgeting

The representative household can invest in two types of assets: shares in a mutual fund of firms²⁰ and risk-free bonds. Let x_t be the share in the mutual fund of firms held by the representative household entering period t . The representative household buys x_{t+1} shares in a mutual fund of all the firms existing at time t - $N_t + N_{E,t}$ - even though only a fraction $(1 - \delta)$ of those will be producing in $t + 1$. The price of one share at time t is equal to the price of claims to future firms real profits e_t . The per-period household's budget constraint can be written as:

$$B_{t+1} + C_t + e_t(N_t + N_{E,t})x_{t+1} = (1 + r_t)B_t + (d_t + e_t)N_t x_t + \bar{w}_t L_t + \tilde{b}(1 - L_t) + T_t, \quad (22)$$

where r_t is the real interest rate on bond holdings (known with certainty as of $t - 1$) and T_t are lump sum taxes. The household maximizes (1) subject to (22). The Euler equations for bond and share holdings are respectively:

$$\begin{aligned} 1 &= (1 + r_t)\beta E_t \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma}, \\ e_t &= E_t \{ \beta_{t,t+1} (d_{t+1} + e_{t+1}) \}. \end{aligned}$$

Equilibrium

We are now able to characterize the equilibrium of our model economy. First, we derive aggregate variables in the labor market. Aggregate employment is $L_t = N_t l_t$. Aggregate vacancies, V_t , are the sum of vacancies posted by producing firms and vacancies posted by new entrants. The law of

²⁰New entrants finance entry on the stock market in this model.

motion of aggregate employment is:

$$L_t = (1 - \lambda_t^T)(L_{t-1} + q_{t-1}V_{t-1}),$$

where $\lambda_t^T = (1 - \lambda_t)(1 - \delta)$ is the economy-wide total separation rate, reflecting job destruction both within and across firms. Accordingly, searching workers in period t are equal to the stock of unemployed workers: $U_t = (1 - L_t)$.

In equilibrium it must be that $B_t = B_{t+1} = 0$, $x_t = x_{t+1} = 1$ and $T_t = -b(1 - L_t)$. The aggregate resource constraint implies that total output (which includes home production) must be equal to consumption C_t plus regulatory entry costs, and the costs of hiring and firing workers:

$$\rho_t Z_t \bar{z}_t L_t + h_p(1 - L_t) = C_t + N_{E,t} f_{R,t} + \kappa V_t + \frac{\lambda_t^e L_t}{1 - \lambda_t} F.$$

Model equations are summarized in Table 2.

3 Calibration and Model Properties

Calibration

We interpret periods as quarters and calibrate the model to match Euro Area macroeconomic data from 1997:Q1 to 2007:Q4. As a proxy for regulation we consider an average of regulatory costs in Germany, France, Italy and Spain, countries that represent roughly the 80 percent of Euro Area total GDP.

We set the discount factor $\beta = 0.99$, implying an annual real interest rate of 4 percent. The value of the risk-aversion coefficient γ is equal to 1, while σ is chosen to produce a steady-state markup of 10 percent. The implied steady-state elasticity of demand is equal to 11.

We keep technological entry costs not related to bureaucratic procedures constant: $f_{T,t} = f_T$ in all periods. Following Barseghyan and DiCecio (2011), we assume that f_T is 18 percent of quarterly output. Pissarides (2003) compiles an index for entry delay as the number of business days that it takes (on average) to fulfill entry requirements, weighted by the number of procedures that must

be performed. Following Ebell and Haefke (2009), we convert this index in months of lost output to get a value of f_R . The average value of the regulation index is 60 (days required to fulfill entry requirements), corresponding to 0.66 quarters of lost output.

Turning to the labor market, we set the elasticity of the matching function ε equal to 0.4, as in Blanchard and Diamond (1989). Total separation λ^T is set to 3.5 percent to reproduce the empirical evidence in Hobijn and Sahin (2009).²¹ To calibrate the fraction of workers exogenously separated, λ^x , we follow the procedure in den Haan, Ramey, and Watson (2000) and set $\lambda^x = 0.68$. To pin down the exogenous exit of plants - δ - we target the portion of job destruction that is due to the exit of firms. This number ranges between 25 to 55 percent in countries belonging to our sample (see Haltiwanger, Scarpetta, and Schweiger (2008)). We choose a midpoint of those estimates and set δ so that the exit of plants accounts for 40 percent of overall job destruction. We calibrate unemployment benefits so that the replacement rate, $b/\bar{w} \equiv \psi_R$, is equal to 0.66, as reported by the OECD (2004). As is common practice in the literature, we assume that firing costs are proportional to the steady-state average wage, $F = \psi_F \bar{w}$. Following Thomas and Zanetti (2009) we set $\psi_F = 0.2$. Empirical estimates for the worker's bargaining power η are not readily available for European countries. However, Flinn (2006) estimates η between 0.36 and 0.4 for the U.S. In the data, U.S. employment protection legislation (adjusted for workers' coverage) is approximately 25 percent less stringent than in Europe.²² Thus, we set $\eta = 0.5$, which is the same value used by Christoffel, Kuester, and Linzert (2009).

Three labor market parameters are left to calibration. The cost of posting a vacancy κ , the flow value of home production h_P , and the efficiency of the matching function χ . As is common practice in the literature, we choose κ , h_P and χ in order to match the steady-state unemployment rate U , the probability of filling a vacancy q and the total separation rate λ_t^T . We set $U = 8.3$ percent and $q = 0.7$, in line with estimates reported by the ECB (2002) and Weber (2000).

The idiosyncratic productivity shock z is lognormally distributed with mean ξ and standard

²¹The average of the monthly separation rates for France, Germany, Italy and Spain reported by Hobijn and Sahin (2009) is 1.2. At quarterly frequencies, it implies a target of 3.5 percent.

²²We combine EPL data taken from OECD (2004), excluding regulation for temporary workers, with a measure that takes into account the coverage of these provisions (see Schneider and Enste (2000)). Table 1 provides the details.

deviation σ_z . We normalize ξ to 0 and calibrate σ_z to match the volatility of unemployment relative to GDP, as in den Haan, Ramey, and Watson (2000).

The persistence of the AR(1) technology shock Z_t is set to 0.64, the value estimated by Christofel, Kuester, and Linzert (2009). The standard deviation of the technology innovation is chosen to reproduce the volatility of GDP observed in the data. Table 3 summarizes the model calibration.

Model Properties

Before studying the effects of reforms, we validate the model by testing its ability to reproduce the cyclical behavior of key macroeconomic variables in the Euro Area. To do so, we compute HP-filtered, model-implied second moments, with a smoothing parameter set to 1600. Notice that in our model aggregate prices P_t can fluctuate just because of changes in the number of available products, even if average prices remain constant. In the data, however, aggregate prices are not measured taking into account variety effects. For this reason, when computing second moments, we deflate variables using a data-consistent price index, i.e., for any real variable X_t , its data-consistent counterpart $X_{R,t}$ is obtained as $X_{R,t} = P_t X_t / p_t = X_t / \rho_t$.²³

The volatility of unemployment and GDP, defined as $Y_{R,t} = \bar{w}_{R,t} L_t + N_t d_{R,t}$, is matched by construction. Table 4 shows that the model reproduces rather well the relative volatility (with respect to GDP) of consumption and real wages and it generates a negative correlation between job creation, $JC_t \equiv q_{t-1} V_{t-1} - [\delta + \lambda^x (1 - \delta)] (L_{t-1} + q_{t-1} V_{t-1})$, and job destruction, $JD_t \equiv \lambda_t^e (L_{t-1} + q_{t-1} V_{t-1})$. Moreover, the model correctly reproduces higher volatility of vacancies and labor market tightness relative to unemployment volatility, as observed in the data.²⁴ We interpret these findings as a success given the difficulties of the standard search and matching model along these dimensions. In particular, Fujita and Ramey (forthcoming) have recently shown that while endogenous job destruction helps the standard model to generate more volatile unemployment fluctuations, it also induces a counterfactual low volatility of vacancies and labor market tightness, which are both significantly less volatile than unemployment and at odds with the data. Our model

²³See Ghironi and Melitz (2005) for a detailed discussion.

²⁴Data about the cyclical volatility of labor market tightness are not available for the Euro Area.

improves along these dimensions without relying on any degree of real wage rigidity.²⁵ The reason is that producer entry subject to sunk entry costs magnifies the impact effect of shocks on vacancy posting since new producers need to build their stock of labor to begin production. In our model the volatility of vacancies is 50 percent of what observed in the data, five times larger than what is predicted by models with exogenous product market dynamics.

Finally, notice that the model is also successful in replicating the contemporaneous correlation between GDP and the other macroeconomic variables. In particular, the model closely reproduces the contemporaneous correlation between GDP and unemployment and it generates countercyclical markups and procyclical profits.

4 Market Reforms: Inspecting the Mechanism

Before studying the quantitative implications of reforms, we characterize the theoretical link between product and labor market regulation. To simplify the analysis, we abstract from the presence of aggregate uncertainty and focus on steady-state relationships. Consider the expression for the long-run unemployment rate:

$$U = \frac{\lambda^T}{\lambda^T + (1 - \lambda^T)\chi\theta^{1-\epsilon}},$$

Long-run unemployment depends on unemployment duration, $\frac{1}{\chi\theta^{1-\epsilon}}$, which is a negative function of labor market tightness θ , and steady-state job flows, λ^T , which depend on the reservation productivity z^c . As a result, the effects of policy reforms on equilibrium unemployment depend on their relative impact on θ and z^c , i.e., on the relative shifts of job creation and job destruction. These two curves can be written as:

$$\text{JC: } \frac{\kappa}{\chi}\theta^\epsilon = \frac{\beta(1-\delta)(1-\lambda)}{1-\beta(1-\delta)(1-\lambda)} \left[(1-\eta) \left(\Phi(N)\bar{z} - \frac{\lambda^e F}{1-\lambda} - \tilde{b} \right) - \eta\kappa\theta \right]$$

$$\text{JD: } z^c = \frac{1}{(1-\eta)\Phi(N)} \left(\eta\kappa\theta - \kappa\theta^{-\epsilon} + \tilde{b} + F \right),$$

²⁵See Gertler and Trigari (2009) for the importance of real wage rigidity in generating realistic fluctuations in unemployment, vacancies and labor market tightness.

where $\Phi(N) \equiv \rho(N)/\mu(N) = \left(\sigma N e^{-\frac{\tilde{N}-N}{2\sigma\tilde{N}N}} \right) / 1 + \sigma N$. With respect to the standard Mortensen and Pissarides model with a fixed number of producers, there is an extra term, $\Phi(N)$, appearing in the job creation and job destruction equations. This term captures the effect of variations in the competitive environment on equilibrium unemployment, manifested through changes in job flows and unemployment duration. To gain some intuition, observe that as N increases, the real marginal benefit of a match increases.²⁶ This leads, other things equal, to a decrease in the reservation productivity z^c , since each existing match becomes more valuable to the firm. At the same time, a higher N increases vacancy posting, raising labor market tightness θ .

Let's now focus on the steady-state free-entry condition, which determines N . Using the steady-state values of q and l , we have:

$$e = f_R + f_T + \kappa\theta^{-\varepsilon} \frac{L}{N} + \frac{V}{N}.$$

This equation shows that in equilibrium the price of investment (the value of entry) is related to labor market tightness. Changes in labor market conditions trigger variations in the cost of recruiting workers, affecting the profitability of entry. As a result, N itself depends on θ and z^c .

Our analysis reveals that product and labor market regulation jointly determines structural unemployment and the number of producers in the economy. Therefore, in order to understand the consequences of deregulation, it is important to take into account the interdependent nature of policy changes: the effects of a given reform might depend on other institutional settings.

5 Dynamic Adjustment to Market Deregulation

We begin to investigate the consequences of structural reforms by studying the dynamic adjustment to the new long-run equilibrium. We first characterize the consequences of individual changes in the regulation of goods and labor markets. Then we address the possible interdependence of structural reforms.

Product market deregulation is a permanent decrease of regulatory entry barriers, f_R . Labor

²⁶This is the case, since the relative price ρ rises when N increases.

market deregulation is a permanent reduction of unemployment benefits and employment protection. The size of unemployment benefits is captured by the replacement rate ψ_R . Concerning employment protection, we follow Blanchard and Giavazzi (2003) and focus on reductions of workers' bargaining power together with reductions in firing costs. The rationale is that in the data, employment protection refers to all types of employment protection measures, whether grounded primarily in legislation, court rulings, collectively bargained conditions of employment or customary practice. In our model those forms of protection are jointly proxied by firing costs and workers' bargaining power.²⁷

We assume that policy parameters are lowered to their corresponding U.S. levels, a standard benchmark of a flexible, developed economy. To determine the size of U.S. entry costs related to regulation, $f_{R,t}$, we follow the same procedure described in Section 3. Pissarides (2003) reports that in the U.S. it takes (on average) 9 days to fulfill entry requirements. The implied share of lost output is 0.16. The U.S. replacement rate reported by OECD (2004) is $\psi_R = 0.54$. Firing costs are set to zero as in Veracierto (2008). The workers' bargaining power η is set to 0.38, a midpoint of the estimates in Flinn (2006). Table 5 summarizes the value of policy parameters before and after market deregulation.

Throughout this section we consider a perfect foresight, unanticipated permanent reduction of policy parameters. Given the large size of shocks we do not rely on approximation methods. Instead, we exactly solve the model using a Newton-type algorithm, first proposed by Laffargue (1990). The details of the algorithm can be found in Juillard (1996).

Individual Reforms

Our dynamic exercise reveals that deregulation in product and labor market can induce a trade-off between short and long-run outcomes. Importantly, the nature of adjustment costs is quite different across reforms. Figure 1 shows the effects of a decrease in barriers to entry. In the aftermath of the reform, GDP, employment and consumption fall relative to their initial pre-reform equilibrium.

²⁷We model a change in labor market regulation as a *simultaneous* reduction of employment protection and unemployment benefits but we also present separate results.

This result reflects the combination of investment and labor market dynamics: entry of new producers is financed by households who need to save more; at the same time, incumbents anticipate the future reduction in their market shares and begin to downsize by destroying unproductive matches. The slow reallocation of workers together with the drop in aggregate consumption increases unemployment for several quarters. As the number of firms in the market grows and markups drop, GDP and consumption recover. Trend unemployment is reduced by 1.8 percent.

Figure 2 plots the dynamic adjustment to a labor market reform. Deregulation in this case presents a different intertemporal trade-off. Employment is negatively affected on impact since smaller firing costs reduce the profitability of low productive matches, increasing job destruction. At the same time, lower workers' protection and unemployment benefits boost job creation as the workers' outside option deteriorates and the expected cost of terminating a match is reduced. Since destroying existing jobs is an instantaneous process while matching firms and workers takes time, employment and GDP decrease in the aftermath of the reform but recover gradually over time.

Labor market deregulation does not trigger large firm dynamics. Even if the long-run effect on unemployment is similar to a product market reform, the adjustment takes place along the intensive margin. This is the case because a flexible labor market boosts incumbents' incentives to expand production by increasing the stock of labor. Congestion externalities in the labor market increase the entry cost: incumbents have a competitive advantage with respect to potential entrants, since they do not have to incur sunk costs in order to benefit from the labor market reform. Notice that, despite the negative unemployment dynamics, consumption immediately increases in response to labor market deregulation: households reduce savings to smooth consumption in anticipation of the future permanent increase in income.²⁸

By exploiting the microfoundation nature of our model, we can measure the welfare consequences of reforms, taking into account the transitory adjustment. We compute the percentage increase of steady-state consumption Δ that would make the household indifferent between not implementing

²⁸Figure 3 and Figure 4 plot, respectively, the adjustment to individual changes in unemployment benefits and employment protection legislation. The two reforms share similar patterns with the exception of unemployment, which does not rise on impact when only ψ_R is reduced. This happens because lower unemployment benefits boost job creation but do not increase job destruction.

a given reform (consuming C , constant, in each period) and deregulating (consuming C_t , time varying until the economy reaches the new steady state):²⁹

$$\left[C \left(1 + \frac{\Delta}{100} \right) \right]^{(1-\gamma)} = (1 - \beta) \sum_{t=0}^{\infty} \beta^t C_t^{1-\gamma}. \quad (23)$$

Columns (i) and (ii) in Table 6 show that the welfare effects of individual market reforms are always positive. Consumption should increase by 3.8 percent to make the household indifferent between implementing or not implementing product market deregulation. It is important to notice that transition costs are sizable, as they amount to 40 percent of pure steady-state gains. Concerning labor market reform, the consumption gain is 1.88 percent. In this case transition costs are much smaller, as they correspond to only 2 percent of long-run gains: since aggregate consumption does not fall along the transition, adjustment costs only depend on the length of convergence.

Interdependence of Reforms

After studying the dynamic adjustment and the long-run properties of individual deregulation in goods and labor markets, we now investigate whether reforms can have interdependent effects. We ask the following questions: (i) What are the consequences of deregulating one market when the other has already been reformed? (ii) Starting from a fully regulated equilibrium, what are the effects of global market deregulation? Does the timing of the implementation of reforms matter for welfare? Addressing these questions is important, since policymakers might exploit interdependence to design reforms in a welfare-improving manner.

Columns (iii) and (iv) in Table 6 show that starting from a situation of partial rigidity, i.e., one market has already been deregulated, the gains (including transition) from reforming the rigid market become smaller. In other words, reforms are substitutes. This result provides theoretical support for the empirical findings in Fiori, Nicoletti, Scarpetta, and Schiantarelli (2012).³⁰ Notice,

²⁹Our model features perfect risk sharing among family members and no ex-post heterogeneity between employed and unemployed workers. As a result, our calculations are meant to capture the aggregate welfare effects of market deregulation.

³⁰In the theoretical literature there was an earlier debate about the interdependence of alternative labor market policies aimed at reducing high unemployment rates (see Coe and Snower (1996) and Belot and van Ours (2004)). Our results, obtained in the context of a fully dynamic general equilibrium model, generalize to the relationship

however, that the substitutability of reforms tends to be a long-run phenomenon: flexibility in one market can still reduce the transition costs of reforming another rigid market. Figure 5 considers the case of product market reforms. A flexible labor market favors the reallocation of workers across plants by raising the incentives of new entrants to create jobs in the aftermath of the reform. Thus, the negative short-run effects of product market reforms on GDP, unemployment and consumption are mitigated. However, as unemployment begins to fall along the transition, the expected costs of recruiting workers rise more when the labor market is flexible, since the labor market was already tighter to begin with. Congestion externalities imply that product and job creation are smaller compared to the case in which product markets are deregulated in the presence of a rigid labor market. The same mechanism explains why the overall gains from labor market deregulation are smaller when the reform is implemented with a flexible product market (see Figure 6).

Our results indicate that reforms do not have purely additive effects. Hence, it is natural to investigate the consequences of global market deregulation, starting from rigid regulation in both markets. We begin by considering a simultaneous reform in goods and labor markets. Column (v) in Table 6 shows that increased flexibility in product and labor markets is more beneficial than individual policy changes. Figure 6 describes the dynamic adjustment: the combined effect of simultaneously relaxing barriers to entry and firing costs makes incumbents downsize heavily, with large employment losses in the first months after the reform. Larger incentives to create jobs, however, imply a fast recovery in the labor market, boosting consumption and welfare. Long-run benefits materialize soon enough to compensate for short-run costs. As a result, a faster transition and larger long-run gains imply that joint market deregulation ensures larger gains than individual policy changes.

So far, we have established that a simultaneous market reform is highly beneficial. However, a global reform can be implemented in alternative ways, i.e., policy changes can be undertaken sequentially rather than simultaneously. Even if long-run gains do not depend on the specific timing of the implementation of reforms, transition costs might be a function of the particular ordering of policy interventions. To understand whether this is the case, we compare the adjustment following

between product and labor market institutions.

a simultaneous reform with the adjustment to a reform in which product and labor markets are lowered sequentially.³¹ Columns (v) to (vii) in Table 6 show that a simultaneous reform is more beneficial than sequential policy changes by reducing overall transition costs. Once again, even if short-run losses in GDP and unemployment are magnified by simultaneous deregulation, the quicker transition to the new steady state ensured by joint flexibility has a first-order positive effect. This result is of particular interest for policymakers: the interdependent effects of the regulation of goods and labor markets imply that reforms can be designed in a welfare-enhancing way.

6 The Impact of Deregulation on Business Cycles

To evaluate the desirability of reforms, a second important aspect to consider is the effect of deregulation on business cycle fluctuations. As we have seen, market regulation affects business formation as well as the incentives to create and destroy jobs. Hence, changes in the level of regulation might alter the way the economy adjusts to aggregate shocks. The last question we want to address is whether a flexible economy would respond differently to shocks, with consequences for the welfare cost of business cycles.

From a theoretical point of view, deregulation in product and labor markets affects business cycle dynamics through different channels. When barriers to entry are relaxed, the response to shocks along the extensive margin (the number of available products) changes since the economy fluctuates around a steady state with a larger number of firms, smaller markups and smaller profits at the producer level. In response to aggregate disturbances, the present discounted value of entry varies less, dampening fluctuations in markups. The volatility and persistence of GDP and employment are reduced, as incumbents have fewer incentives to change their stock of labor for a given shock.

Changes in labor market regulation have contrasting effects on aggregate fluctuations. On one hand, labor market flexibility makes job creation less responsive to shocks, since lower replacement rates and smaller workers' bargaining power worsen the workers' outside option: real wages become

³¹We first lower product (labor) market regulation. Then, after the economy has completed the transition to the new steady state, we deregulate the labor (product) market.

more sensitive to shocks, reducing job flows. At the same time, though, lower firing costs increase the elasticity of job destruction to aggregate disturbances, amplifying labor market dynamics.

Overall, we find that an economy with a more flexible regulation in goods and labor markets would adjust differently to aggregate shocks. Figure 7 contrasts the dynamic response to a negative, temporary productivity shock in the rigid benchmark economy with the adjustment in the presence of flexible market regulation. In the rigid economy, the drop in productivity is mainly propagated through the slow initial response of the labor market. As productivity falls, incumbents reduce production by increasing job destruction. Due to the presence of large firing costs, employment falls moderately and aggregate demand and GDP do not drop abruptly. Conversely, in a flexible scenario downsizing is cheaper for incumbents and the initial drop in GDP and employment is more severe. Despite mitigating the initial negative effect of the recession, strict regulation implies a sluggish recovery: higher barriers to entry, generous unemployment benefits and larger rents accruing to workers compress the incentives to create new firms and jobs.³² After market deregulation instead, the adjustment is much quicker because of the smaller costs of creating firms and jobs. Table 7 reveals that the persistence of all macroeconomic series is significantly reduced by the flexibility in goods and labor markets, while the volatility would be mildly affected. Our results point out that strict regulation can increase economic resilience to shocks.³³

To complete the analysis, we investigate whether the different propagation mechanism implied by market deregulation affects the welfare costs of business cycles. To do so, we solve the model with a second-order approximation of the policy functions around the deterministic steady state. We compute the welfare cost of business cycles as the percentage increase in consumption (τ) that is required to make the household indifferent between living in a stochastic or a deterministic world:

$$\sum_{t=0}^{\infty} \beta^t \left[C_t \left(1 + \frac{\tau}{100} \right) \right]^{(1-\gamma)} = \frac{C^{1-\gamma}}{1-\beta}.$$

³²For a given change in the profitability of entry, larger entry costs reduce the equilibrium number of perspective entrants willing to pay the sunk entry cost. Larger replacement rates and higher workers' bargaining power instead make the real wage absorb less of the change in productivity, discouraging entry and job creation.

³³See the empirical evidence provided by Duval, Elmeskov, and Vogel (2007). This is also consistent with Balakrishnan and Michelacci (2001), who use a VAR analysis to document that labor markets in some countries of the Euro Area might be dynamically sclerotic.

Table 7 shows that τ declines significantly in relative terms following deregulation (it is more than halved). The gain in absolute terms, however, is small, since the welfare cost is already small in the regulated regime.

7 Market Reforms and Political Economy Considerations

Our findings suggest that market deregulation is beneficial. Historically, however, implementing reforms has proved to be difficult. The traditional explanation in the political economy literature refers to the conflict between insiders and outsiders. For example, Saint-Paul (1999) suggested that reforms that would make outsiders more competitive in the labor market are opposed by insiders. Blanchard and Giavazzi (2003) emphasized how workers may obstruct product market reforms that would reduce the size of rents that are shared between firms and workers.

By studying the dynamic adjustment to deregulation, a new explanation for governments' aversion to structural reforms emerges. Policymakers might decide not to implement welfare enhancing reforms due to the presence of short-run costs in terms of unemployment, GDP and consumption. Figure 8 captures this point by contrasting the cumulative consumption effects of individual and global reforms. For example, despite being highly beneficial in the long run, a joint reform in goods and labor markets would take almost seven years to display positive welfare effects. Due to electoral constraints, governments might evaluate the effects of deregulation over the length of the legislation as opposed to considering their lifetime benefits. As a result, politicians who want to be re-appointed might not be willing to tolerate short-run losses in unemployment and GDP that are misaligned with the electoral cycle.³⁴ Put differently, reforms aimed at reducing unemployment and boosting GDP display their positive effects after some time and involve an initial decline in economic activity. The political costs implied by short-run dynamics could be another deterrent to the implementation of reforms, beyond the traditional arguments discussed in the political economy literature.

³⁴From a pure welfare standpoint, short-sighted policymakers should still be willing to implement labor market reforms alone, given that such policies have no short-run welfare costs. However, the fact that GDP and unemployment are negatively affected along the transition can still explain the government's aversion to such reforms. GDP and unemployment dynamics are, in fact, very important macroeconomic indicators used by governments to anticipate electoral sentiment.

As a final remark, notice that our analysis is also related to the political economy considerations in Blanchard and Giavazzi (2003). They show that product market deregulation may trigger labor market deregulation. Intuitively, reducing rents in the goods markets reduces workers' incentives to fight for a share of these rents: the benefits may no longer be worth the costs. Our results complement their analysis. While it is surely the case that deregulation in the product market would reduce the opposition to labor market reforms, our dynamic simulations reveal that a flexible labor market significantly reduces the transition costs of product market deregulation. In this perspective, policymakers need to tradeoff the beneficial effects of using product market reforms alone to reduce the conflict between insiders and outsiders in the labor market with the larger costs of implementing product market reforms in the presence of rigid labor markets.

8 Conclusions

We have developed a model with endogenous producer entry and labor market frictions to study the effects of deregulation on goods and labor market. Despite the model's rich microfoundation, we have shown that aggregate dynamics can still be summarized by mean of representative, average firms, preserving model tractability.

Calibrating our model to the Euro Area, we find that market reforms can have important consequences for the overall behavior of the economy. Deregulation, in any of its forms, is welfare-improving, but there can be up-front costs in terms of GDP, employment and consumption. Importantly, reforms are interdependent. Product market regulation and labor market regulation tend to be substitutes and joint deregulation is welfare improving relative to individual policy changes. The timing of deregulation matters, and policymakers can exploit policies' interdependence to strengthen the beneficial effects of reforms. Finally, market deregulation affects the propagation of aggregate shocks. The impact responses to aggregate disturbances are amplified, but the absorption of shocks becomes faster.

Our findings provide a new insight into the political economy literature on reforms. The difficulty of implementing reforms in rigid economies like the Euro Area might also depend on the fact

that governments typically have temporal horizons that are too short to politically capitalize on the long-run benefits of reforms.

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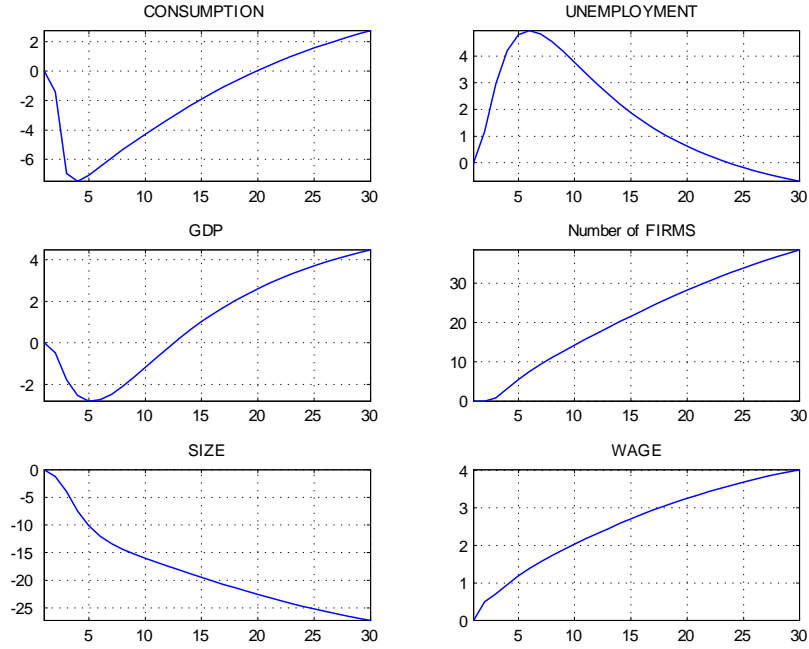


Figure 1. Product Market Reform - % deviations from steady state except U (deviations from steady state).

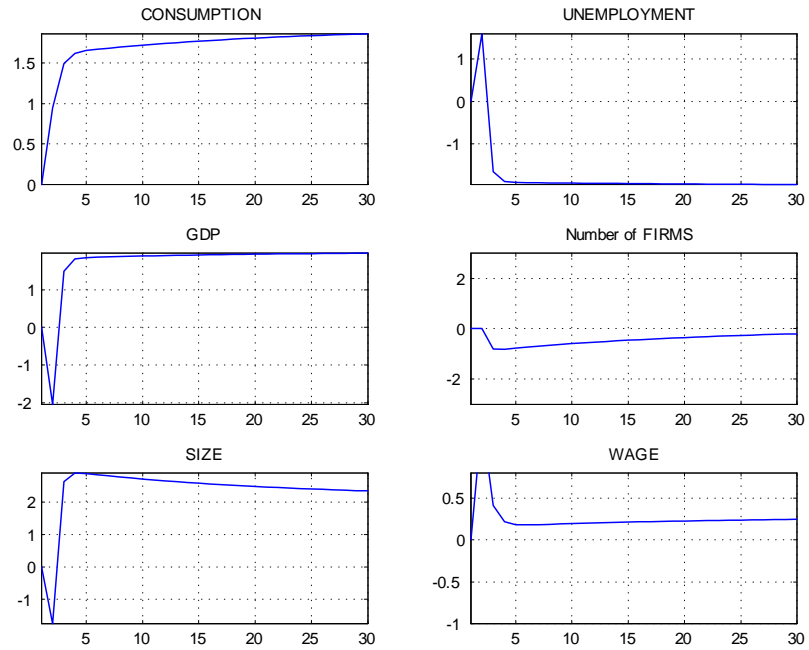


Figure 2. Labor Market Reform - % deviations from steady state except U (deviations from steady state).

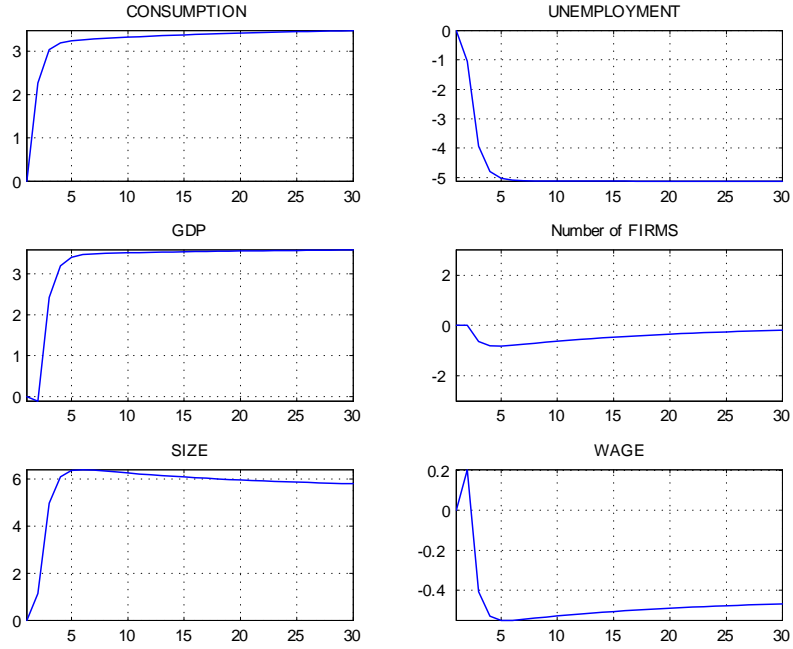


Figure 3. Unemployment Benefits Reform - % deviations from steady state except U (deviations from steady state).

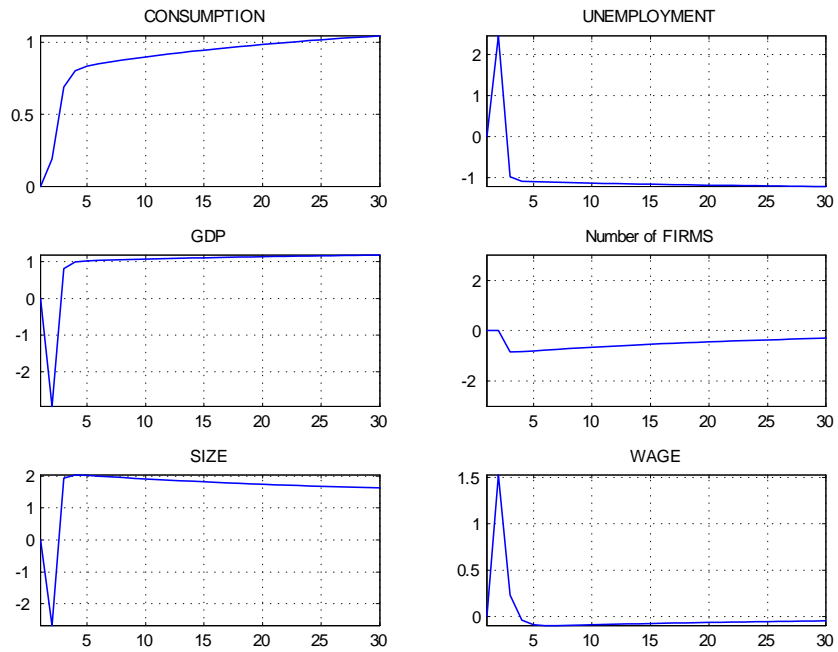


Figure 4. Employment Protection Legislation Deregulation - % deviations from steady state except U (deviations from steady state).

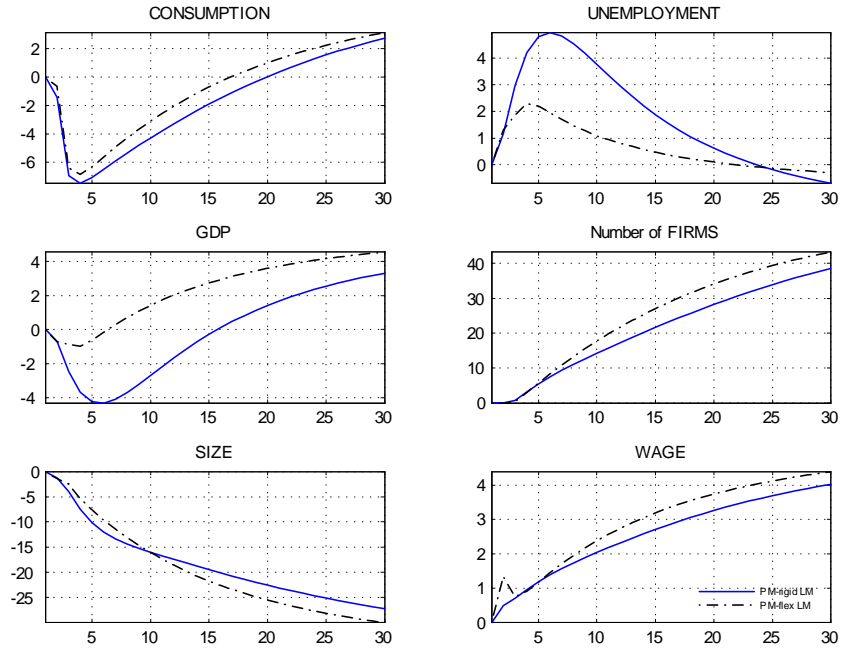


Figure 5. Product Markets Deregulation when Labor Market is Flexible.- % deviations from steady state except U (deviations from steady state).

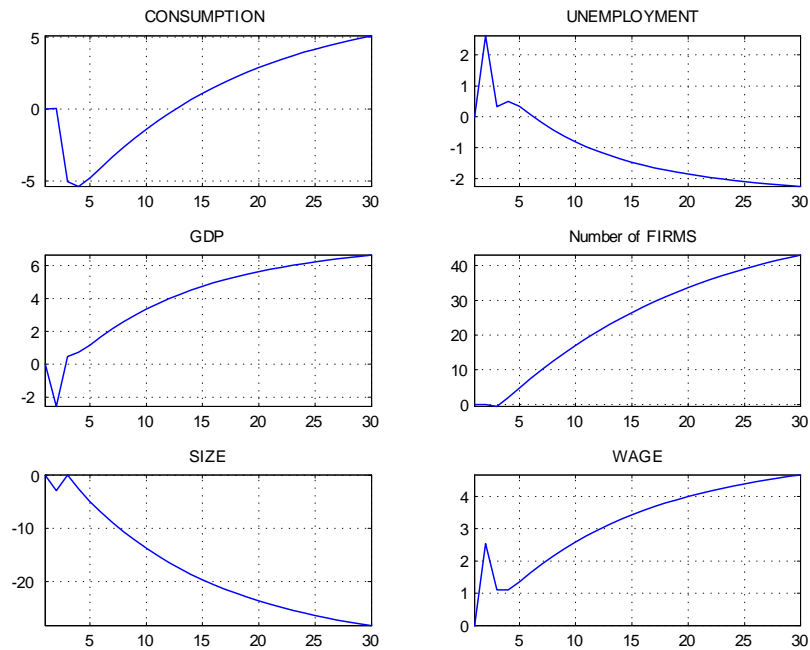


Figure 6. Simultaneous Reform in Product and Labor Markets - % deviations from steady state except U (deviations from steady state).

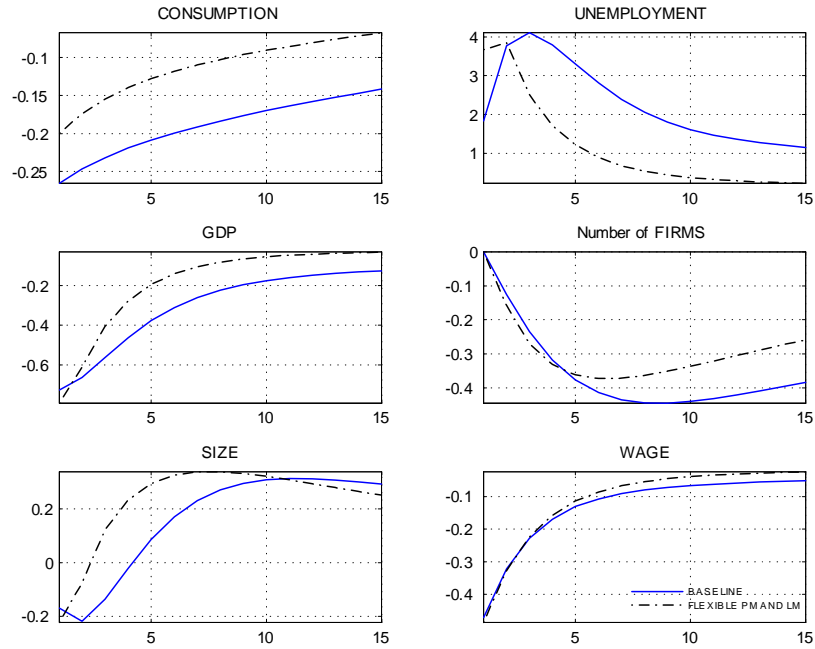


Figure 7. Negative, aggregate productivity shock: rigid versus flexible regulation - % deviations from steady state

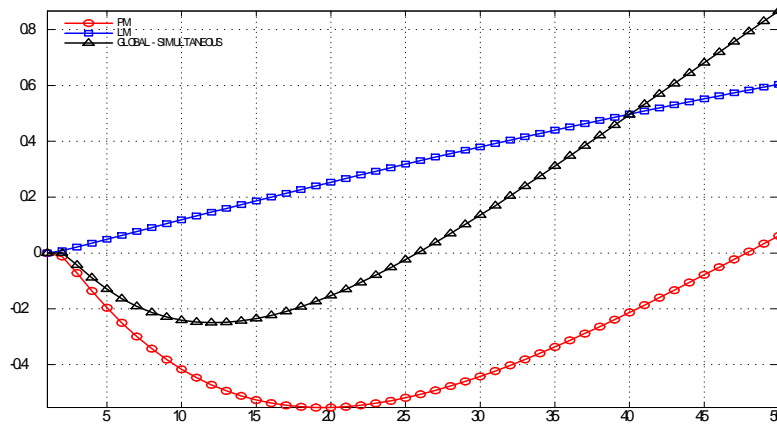


Figure 8. Cumulative Consumption Effects of Alternative Reforms.

TABLE 1: MARKET REGULATION IN EUROPE

	Entry Cost ¹	EPL ² (coverage ³)	Unemployment Benefits ⁴
France	30	3.17 (76%)	0.75
Germany	84	2.74 (76%)	0.69
Italy	62	3.28 (65%)	0.51
Spain	55	2.75 (54%)	0.67
U.S.	9	1.72 (86%)	0.54

¹Ebell and Haefke (2009), business days required to fulfill regulation.

²OECD (2004), index from 0 (EPL low) to 6 (EPL high);

³Schneider and Enste (2000), EPL workers' coverage

⁴OECD (2004); fraction of wages.

TABLE 2: MODEL SUMMARY

Aggregate Employment	$L_t = (1 - \lambda_t^T) (L_{t-1} + q_{t-1} V_{t-1})$
Job Creation	$\frac{\kappa}{q_t} = E_t \left\{ \beta_{t,t+1} (1 - \lambda_{t+1}) \left[(1 - \eta) \left(\bar{\pi}_{t+1} - \frac{\lambda_{t+1}^e F}{1 - \lambda_{t+1}} - \tilde{b} \right) - \eta \kappa \theta_{t+1} + \frac{\kappa}{q_{t+1}} \right] \right\}$
Job Destruction	$(1 - \eta) \left(\varphi_t Z_t z_t^c - \tilde{b} \right) - \eta \kappa \theta_t + \frac{\kappa}{q_t} = F$
Pricing	$\rho_t = \left(1 + \frac{1}{\sigma N_t} \right) \varphi_t$
Variety Effect	$\rho_t = \exp \left\{ -\frac{\tilde{N} - N_t}{2\sigma \tilde{N} N_t} \right\}$
Free Entry	$e_t = f_{T,t} + f_{R,t} + \frac{\kappa}{q_t} (l_t + q_t v_t)$
Number of Firms	$N_t = (1 - \delta)(N_{t-1} + N_{E,t-1})$
Euler equation (bonds)	$1 = (1 + r_t) \beta E_t \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma}$
Euler equation (shares)	$e_t = (1 - \delta) \beta E_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} (d_{t+1} + e_{t+1}) \right\}$
Aggregate Output	$\rho_t Z_t \bar{z}_t L_t + h_p (1 - L_t) = C_t + N_{E,t} f_{R,t} + \kappa V_t + \frac{\lambda_t^e}{1 - \lambda_t} L_t F.$

Note: $C, \rho, L, V, \varphi, N, N_E, e, r,$ and z^c are the 10 endogenous variables determined by these equations. Other variables that appear in the table are defined in the text.

TABLE 3: CALIBRATION

	Parameter	Source/Target
Variety Elasticity	$\sigma = 2.43$	$\mu = 10\%$
Discount Factor	$\beta = 0.99$	$r = 4\%$
R&D Entry Cost	$f_T = 0.19$	<i>Data</i>
Regulation Entry Cost	$f_R = 0.64$	<i>Data</i>
Plant Exit	$\delta = 0.014$	$\frac{JD^{EXIT}}{JD} = 0.40$
Exogenous separation	$\lambda^x = 0.009$	$\frac{JD}{L} = 0.036$
Replacement Rate	$\psi_R = 0.84$	<i>Data</i>
Firing Costs	$\psi_F = 0.18$	<i>Lit</i>
Elasticity Matching Function	$\varepsilon = 0.4$	<i>Lit</i>
Workers' Bargaining Power	$\eta = 0.5$	<i>Lit</i>
Home Production	$h_P = 0.26$	$U = 8.3\%$
Matching Efficiency	$\chi = 0.56$	$q = 0.7$
Vacancy Cost	$k = 0.083$	$\lambda^T = 0.035$
Std Idiosyncratic Shock	$\sigma_z = 0.26$	σ_U/σ_{Y_R}

TABLE 4: SECOND MOMENTS - BENCHMARK ECONOMY

Variable X	σ_X		$Corr(Y_t, X_t)$		$Corr(X_t, X_{t-1})$	
	Data	Baseline	Data	Baseline	Data	Baseline
Y_R	0.85	0.85	1	1	0.92	0.66
C_R	0.60	0.45	0.81	0.95	0.88	0.73
W_R	0.52	0.53	0.59	0.93	0.72	0.47
U	4.95	4.95	-0.90	-0.84	0.96	0.85
V	12.13	5.17	0.71	0.45	0.95	0.25
θ	n.a.	6.90	n.a.	0.95	n.a.	0.49
$corr(JC, JD)$	n.a.	-0.23				

TABLE 5: SIZE OF REFORMS

		U.S.	Euro Area
Entry Cost (Share of GDP)	f_R	0.16	0.66
Replacement Rate	ψ_R	0.54	0.65
Firing Costs	ψ_F	0	0.2
Bargaining Power	η	0.38	0.5

TABLE 6: WELFARE EFFECTS OF MARKET REFORMS

	(i) PM (rigid LM)	(ii) LM (rigid PM)	(iii) PM (flex LM)	(iv) LM (flex PM)	(v) GLOBAL (simult.)	(vi) GLOBAL (PM first)	(vii) GLOBAL (LM first)
ΔW	6.43	1.93	5.49	0.80	7.54	7.54	7.54
ΔW_t	3.83	1.89	3.56	0.78	5.50	4.23	2.32
ΔU	-1.87	-1.98	-0.75	-0.64	-2.62	-2.62	-2.62

Note: ΔW denotes the change in long-run welfare (excluding transition dynamics); ΔW_t denotes the change in welfare including transition dynamics; ΔU denotes the change in unemployment. PM denotes product market, LM denotes labor market. Brackets report the level of regulation in the non-reformed market.

TABLE 7: BUSINESS CYCLE IMPLICATIONS OF MARKET REFORMS

	Baseline	Flexible PM	Flexible LM	Fully Flexible
σ_{Y_R}	0.95	0.87	0.93	0.89
σ_{C_R}	0.45	0.33	0.34	0.30
σ_U	4.95	4.16	4.89	4.65
$Corr(Y_{R,t}, Y_{R,t-1})$	0.66	0.61	0.55	0.53
$Corr(C_{R,t}, C_{R,t-1})$	0.73	0.71	0.63	0.62
$Corr(U_t, U_{t-1})$	0.85	0.83	0.67	0.64
τ	0.006	0.004	0.001	0.001

Appendix

Wage Equation

Consider a worker with idiosyncratic productivity z employed by a producer ω . The sharing rule implies:

$$\eta\Delta_{\omega t}^F(z) = (1 - \eta)\Delta_{\omega t}^W(z), \quad (24)$$

where $\Delta_{\omega t}^W(z)$ and $\Delta_{\omega t}^F(z)$ denote, respectively, worker's and firm's real surplus, and η is the worker's bargaining weight. The worker's surplus is given by:

$$\Delta_{\omega t}^W(z) = w_{\omega t}(z) - \varpi_t + E_t\beta_{t,t+1}(1 - \lambda_{\omega t+1})\bar{\Delta}_{\omega t+1}^W, \quad (25)$$

where

$$\bar{\Delta}_{\omega t}^W \equiv \int_{z_{\omega t}^c}^{\infty} \Delta_{\omega t}^W(z) \frac{g(z)dz}{(1 - G(z_{\omega t}^c))}$$

represents the average surplus accruing to the worker when employed in firm ω . The term ϖ_t is the worker's outside option, defined in the text:

$$\varpi_t \equiv \tilde{b} + s_t \int_{\omega \subset \Omega_t} \frac{v_{\omega t}}{V_t} E_t \left\{ \beta_{t,t+1} (1 - \lambda_{\omega t+1}) \bar{\Delta}_{\omega t+1}^W \right\} d\omega.$$

The firm's surplus from being matched with a worker z is given by $\Delta_{\omega t}^F(z) \equiv \phi_{\omega}(z)$, the Lagrange multiplier evaluated at the productivity level z :

$$\Delta_{\omega t}^F(z) = \pi_{\omega t}(z) - w_{\omega t}(z) + E_t \left\{ \beta_{t,t+1} \left[(1 - \lambda_{\omega t+1}) \bar{\Delta}_{\omega t+1}^F - \lambda_{\omega t+1}^e F \right] \right\}, \quad (26)$$

where $\pi_{\omega t}(z) \equiv \varphi_{\omega t} Z_t z$ is the marginal revenue product generated by worker z and

$$\bar{\Delta}_{\omega t}^F \equiv \int_{z_{\omega t}^c}^{\infty} \Delta_{\omega t}^F(z) \frac{g(z)dz}{(1 - G(z_{\omega t}^c))} = \phi_{\omega}$$

is the average surplus accruing to firm ω at time t . Equation (26) states that the value of a worker with productivity z for producer ω is the sum of the per-period real revenue generated by the

worker plus the expected discounted continuation value of the match, net of wage costs. Using equation (9) in the text, we can further simplify equation (26):

$$\Delta_{\omega t}^F(z) = \pi_{\omega t}(z) - w_{\omega t}(z) + \frac{k}{q_t}. \quad (27)$$

Moreover, using the sharing rule we have that $\bar{\Delta}_{\omega t}^W = \bar{\Delta}_{\omega t}^F \eta / (1 - \eta)$, implying:

$$\Delta_{\omega t}^W(z) = w_{\omega t}(z) - \varpi_t + \frac{\eta}{(1 - \eta)} \frac{k}{q_t}.$$

Inserting equations (26) and (25) into the sharing rule (24), we finally obtain:

$$w_{\omega t}(z) = \eta \pi_{\omega t}(z) + (1 - \eta) \varpi_t,$$

which is equation (13) in the text.

Symmetric Equilibrium

Here we show that all incumbent firms are symmetric, regardless of their period of market entry. We do so in two steps. First, we show that both the reservation productivity z_t^c and the marginal cost φ_t are identical across firms in all periods, regardless of whether the firm is a new producer. Then we complete the proof by showing that symmetry in marginal costs and average workers' productivity implies that new entrants optimally choose to be identical to incumbents.

Without loss of generality, consider two generic producers ω and ω' (we make no assumption about their timing of entry). The ratio of their job destruction equations implies:

$$\frac{\varphi_{\omega t}}{\varphi_{\omega' t}} = \frac{z_{\omega' t}^c}{z_{\omega t}^c}. \quad (28)$$

Using equation (28) we can write the average marginal revenue product in firm ω as

$$\bar{\pi}_{\omega t} \equiv \varphi_{\omega t} Z_t \bar{z}_{\omega t} = \varphi_{\omega' t} Z_t \bar{z}_{\omega t} (z_{\omega' t}^c / z_{\omega t}^c). \quad (29)$$

Equation (29) implies that the job creation equations for the producer ω , defined by equation (10)

in the text, can be written as:

$$\frac{\kappa}{q_t} = E_t \left\{ \beta_{t,t+1} (1 - \lambda_{t+1}(z_{\omega,t+1}^c)) \left[\Theta_{t+1} \frac{\bar{z}_{t+1}(z_{\omega,t+1}^c)}{z_{\omega,t+1}^c} - \frac{\lambda_{t+1}^e(z_{\omega,t+1}^c)}{1 - \lambda_{t+1}(z_{\omega,t+1}^c)} F + \Lambda_{t+1} \right] \right\}, \quad (30)$$

where $\Lambda_t = \kappa/q_t - \eta\kappa\theta_t - (1 - \eta)\tilde{b}$ and $\Theta_t = (1 - \eta)(\varphi_{\omega'_t} Z_t z_{\omega'_t}^c)$ group terms that are independent of $z_{\omega,t}^c$.³⁵

Proceeding in a similar way for the producer ω' we obtain:

$$\frac{\kappa}{q_t} = E_t \left\{ \beta_{t,t+1} (1 - \lambda_{t+1}(z_{\omega',t+1}^c)) \left[\Theta_{t+1} \frac{\bar{z}_{t+1}(z_{\omega',t+1}^c)}{z_{\omega',t+1}^c} - \frac{\lambda_{t+1}^e(z_{\omega',t+1}^c)}{1 - \lambda_{t+1}(z_{\omega',t+1}^c)} F + \Lambda_{t+1} \right] \right\}. \quad (31)$$

We now show that equations (30) and (31) can be jointly satisfied if and only if $z_{\omega,t+1}^c = z_{\omega',t+1}^c$. First, observe that $z_{\omega,t+1}^c = z_{\omega',t+1}^c$ implies $F(z_{\omega,t+1}^c) = F(z_{\omega',t+1}^c)$, where:

$$F(z_{\omega,t+1}^c) = E_t \left\{ \beta_{t,t+1} (1 - \lambda_{t+1}(z_{\omega,t+1}^c)) \left[\Theta_{t+1} \frac{\bar{z}_{t+1}(z_{\omega,t+1}^c)}{z_{\omega,t+1}^c} - \frac{\lambda_{t+1}^e(z_{\omega,t+1}^c)}{1 - \lambda_{t+1}(z_{\omega,t+1}^c)} F + \Lambda_{t+1} \right] \right\}.$$

Moreover, $F(z_{\omega,t+1}^c)$ is monotonic in $z_{\omega,t+1}^c$, since $\frac{\partial F(z_{\omega,t+1}^c)}{\partial z_{\omega,t+1}^c} < 0$. To see this, notice that:

$$\text{sign} \left[\frac{\partial F(z_{\omega,t+1}^c)}{\partial z_{\omega,t+1}^c} \right] = - \underbrace{\frac{\partial \lambda_{t+1}}{\partial z_{\omega,t+1}^c}}_{>0} \Gamma_1 + \underbrace{\frac{\partial [(z_{\omega,t+1}^c)^{-1}]}{\partial z_{\omega,t+1}^c}}_{<0} \Gamma_2 - \underbrace{\frac{\partial [\lambda_{t+1}^e / (1 - \lambda_{t+1})]}{\partial z_{\omega,t+1}^c}}_{>0} \Gamma_2 F + \underbrace{\frac{\partial \bar{z}_{t+1}}{\partial z_{\omega,t+1}^c}}_{<0} \Gamma_2 < 0, \quad (32)$$

where Γ_1 and Γ_2 are positive and defined as follows:

$$\Gamma_1 = \Theta_{t+1} \frac{\bar{z}_{t+1}(z_{\omega,t+1}^c)}{z_{\omega,t+1}^c} - \frac{\lambda_{t+1}^e(z_{\omega,t+1}^c)}{1 - \lambda_{t+1}^e(z_{\omega,t+1}^c)} F + \Lambda_{t+1} > 0,$$

$$\Gamma_2 = \beta_{t,t+1} (1 - \lambda_{t+1}(z_{\omega,t+1}^c)) > 0.$$

The sign of the first three derivatives on the right-hand side of equation (32) is straightforward to compute. To obtain $\partial \bar{z}_{t+1}(z_{\omega,t+1}^c) / \partial z_{\omega,t+1}^c$, apply the Leibniz rule together with the fact that z

³⁵For any variable x that directly depends on $z_{\omega,t}^c$ we use the notation $x(z_{\omega,t}^c)$. Moreover, recall that $\lambda_t(\omega) \equiv \lambda^x + \lambda_t^e(\omega)$ and $\lambda_t^e(\omega) \equiv (1 - \lambda^x)G(z_t^e(\omega))$.

has a lognormal distribution with zero mean and variance σ_z^2 :

$$\frac{\partial \bar{z}_{t+1}(z_{:,t+1}^c)}{\partial z_{:,t+1}^c} \equiv \frac{\partial \left[\int_{z_{:,t+1}^c}^{\infty} \frac{1}{\sigma_z \sqrt{2\pi}} \exp^{-\frac{|\ln z|^2}{2\sigma_z^2}} dz \right]}{\partial z_{:,t+1}^c} = -\frac{1}{z_{:,t+1}^c \sigma_z \sqrt{2\pi}} \exp^{-\frac{|\ln z_{:,t+1}^c|^2}{2\sigma_z^2}} dz < 0.$$

Since $F(z_{:,t+1}^c)$ is monotonic in $z_{:,t+1}^c$, there exists only one $z_{:,t+1}^c$ that satisfies $F(z_{:,t+1}^c) = \frac{\kappa}{q_t}$. As a result, $\bar{z}_{\omega,t} = \bar{z}_{\omega',t} = \bar{z}_t$, and, using equation (28), $\varphi_{\omega t} = \varphi_{\omega' t} = \varphi_t$.

To complete the proof, we show that symmetry in φ_t and z_t^c implies a symmetric stock of labor. Consider the pricing equation of a producer ω :

$$p_{\omega t} = \left(1 + \ln \frac{\bar{p}_t}{p_{\omega t}} \right) \varphi_{\omega t} P_t. \quad (33)$$

Using the Lambert function, it is possible to obtain a closed-form solution for equation (33):

$$\rho_{\omega t} = \Upsilon \left(\frac{\bar{p}_t}{\varphi_{\omega t}} e \right) \varphi_{\omega t},$$

where Υ is the Lambert function.³⁶ Since $\varphi_{\omega t} = \varphi_t$, each incumbent charges the same relative price ρ_t and faces the same demand schedule $y_{\omega t} = y_t$. Since $y_{\omega t} = Z_t \bar{z}_t l_{\omega t}$, symmetry in $y_{\omega t}$ requires that all producers have the same stock of labor, $l_{\omega t} = l_{\omega' t} = l_t$.

Intra-Firm Bargaining

In the model described in the text we abstract from intra-firm bargaining to preserve model tractability. Here we present an alternative version of the model with two modifications: (i) households' preferences feature a constant elasticity of substitution across consumption varieties (hence we abstract from the pro-competitive effects of reforms); (ii) there is intra-firm bargaining as described by Stole and Zwiebel (1996). Specifically, wages are the result of pairwise Nash bargaining between individual workers and firms. This individual Nash-bargaining setup has been shown by Stole and Zwiebel (1996) to be the appropriate one for multi-worker firms, in the sense that pairwise individual bargaining is representable as a Binmore-Rubinstein-Wolinsky alternating offer game,

³⁶The Lambert function has the following property: if $x = ye^y$ then $\Upsilon(x) = y$.

providing a microfoundation for the use of Nash bargaining.³⁷

Let the consumption basket C_t be defined over a continuum Ω :

$$C_t = \left(\int_{\omega \in \Omega} c_{\omega t}^{\frac{\theta-1}{\theta}} d\omega \right)^{\frac{\theta}{\theta-1}},$$

where $\theta > 1$ is the symmetric elasticity of substitution across goods. As before, at any given point in time only a subset of goods $\Omega_t \in \Omega$ is available. Let $p_{\omega t}$ be the nominal price for the good $\omega \in \Omega_t$.

The consumption-based price index is:

$$P_t = \left(\int_{\omega \in \Omega} p_{\omega t}^{1-\theta} d\omega \right)^{\frac{1}{1-\theta}}. \quad (34)$$

Equation (34) replaces equation (2) in the benchmark model. The demand for a variety ω is now given by $y_{\omega t} = \rho_{\omega t}^{-\theta} Y_t^C$, which replaces equation (11) in the text.

We now relax the assumption that the firm takes the individual wage as given when solving its cost minimization problem. Intra-firm bargaining implies that when the producer chooses the stock of workers he or she internalizes the hiring effects on aggregate wages:

$$\frac{\partial W_{\omega t}}{\partial l_{\omega t}} = \bar{w}_{\omega t} + \frac{\partial \bar{w}_{\omega t}}{\partial l_{\omega t}} l_{\omega t},$$

The average value of a job for firm z , previously defined by equation (8), now becomes:

$$\phi_{\omega t} = \bar{\pi}_{\omega t} - \bar{w}_{\omega t} - \frac{\partial \bar{w}_{\omega t}}{\partial l_{\omega t}} l_{\omega t} + E_t \{ \beta_{t,t+1} [(1 - \lambda_{\omega t+1}) \phi_{\omega t+1} - \lambda_{\omega t+1}^e F] \}.$$

Notice that $y_{\omega t} = Z_t \bar{z}_{\omega t} l_{\omega t}$ together with $\rho_{\omega t} = y_{\omega t}^{-\frac{1}{\theta}} Y_t^{\frac{1}{\theta}}$ implies that:

$$\bar{\pi}_{\omega t}(\bar{z}_{\omega t}, l_{\omega t}) \equiv \frac{\partial (\rho_{\omega t} y_{\omega t})}{\partial l_{\omega t}} = \frac{\theta - 1}{\theta} (Z_t \bar{z}_{\omega t})^{\frac{\theta-1}{\theta}} l_{\omega t}^{-\frac{1}{\theta}} Y_t^{\frac{1}{\theta}}. \quad (35)$$

The crucial point of the individual bargaining framework is that each worker is treated as the

³⁷ Before production takes place, employees and the firm can engage in an arbitrary number of pairwise negotiations. Wage contracts are unenforceable: the firm may fire any employee and symmetrically any employee may decide to quit. In other words, prior to production, individual negotiations over wage contracts can be re-opened by any worker or the firm. Stole and Zwiebel (1996) formally characterize the stable division of production into wages and profits such that renegotiating does not improve either the firm's or the workers' pay-offs.

marginal worker. Consider again a worker with productivity z employed by producer ω . The worker's surplus $\Delta_{\omega t}^W$ is unchanged with respect to before. The firm's surplus, instead, is now given by:

$$\Delta_{\omega t}^F(z) = \pi_{\omega t}(z, l_{\omega t}) - w_{\omega t}(z, \omega) - \frac{\partial \bar{w}_{\omega t}}{\partial l_{\omega t}} l_{\omega t} + E_t \left\{ \beta_{t,t+1} \left[(1 - \lambda_{\omega t+1}) \bar{\Delta}_{\omega t+1}^F - \lambda_{\omega t+1}^e F \right] \right\}, \quad (36)$$

where

$$\pi_{\omega t}(z, l_{\omega t}) = \frac{\theta - 1}{\theta} (Zz)^{\frac{\theta-1}{\theta}} l_{\omega t}^{-\frac{1}{\theta}} Y_t^{\frac{1}{\theta}}.$$

The key difference between equation (36) and its counterpart in the benchmark model (equation (26)), is that now $\Delta_{\omega t}^F(z)$ depends on $\partial \bar{w}_{\omega t} / \partial l_{\omega t}$. Notice that the definition of $\pi_{\omega t}(z, l_{\omega t})$ is also different due to the CES assumption in the definition of C_t .

The multi-worker firm's bargaining problem between producer ω and worker z solves:

$$\underset{w_{\omega t}(z)}{\text{Max}} \left(\Delta_{\omega t}^F(z) \right)^{1-\eta} \left(\Delta_{\omega t}^W(z) \right)^{\eta},$$

where, as before, η represents the worker's bargaining power. Notice that even if workers are risk averse we can directly assume that the bargaining takes place over income rather than utility, since workers and firms have the same discount factor (firms are owned by households in the model). There would be no difference if we assumed that bargaining is over utility.

The bargaining solution splits the surplus according to the following sharing rule:

$$\eta \Delta_{\omega t}^F(z) = (1 - \eta) \Delta_{\omega t}^W(z).$$

Inserting the definitions of $\Delta_{\omega t}^F(z)$ and $\Delta_{\omega t}^W(z)$ into the sharing rule we obtain:

$$w_{\omega t}(z) = \eta \left(\pi_{\omega t}(z, l_{\omega t}) - \frac{\partial \bar{w}_{\omega t}}{\partial l_{\omega t}} l_{\omega t} \right) + (1 - \eta) \varpi_t. \quad (37)$$

In order to solve for the wage rate $w_{\omega t}(z)$, we need to determine $(\partial \bar{w}_{\omega t} / \partial l_{\omega t})$. To do so, we need to compute the average wage by aggregating individual wages in equation (37) using equation (6):

$$\bar{w}_{\omega t} = \eta \left(\bar{\pi}_{\omega t}(\bar{z}_{\omega t}, l_{\omega t}) - \frac{\partial \bar{w}_{\omega t}}{\partial l_{\omega t}} l_{\omega t} \right) + (1 - \eta) \varpi_t.$$

The solution to this differential equation is:

$$\bar{w}_{\omega t} = \eta \left(\frac{\theta - 1}{\theta - \eta} (Z \bar{z}_{\omega t})^{\frac{\theta-1}{\theta}} l_{\omega t}^{-\frac{1}{\theta}} Y_t^{\frac{1}{\theta}} \right) + (1 - \eta) \varpi_t.$$

Recall that $(Z_t \bar{z}_{\omega t} l_{\omega t})^{-\frac{1}{\theta}} = y_{\omega t}^{-\frac{1}{\theta}}$ and $\rho_{\omega t} = y_{\omega t}^{-\frac{1}{\theta}} Y_t^{\frac{1}{\theta}}$. Moreover, the optimal pricing equation implies $\rho_{\omega t} = \theta / (\theta - 1) \varphi_{\omega t}$. Thus we have:

$$\bar{w}_{\omega t} = \frac{\eta \theta}{\theta - \eta} \varphi_{\omega t} Z_t \bar{z}_{\omega t} + (1 - \eta) \varpi_t.$$

If we instead assumed that each firm takes as given individual wages when making its hiring decision, we would have had $(\partial \bar{w}_{\omega t} / \partial l_{\omega t}) = 0$ and so:

$$\bar{w}_{\omega t} = \frac{\eta \theta}{\theta - 1} \varphi_{\omega t} Z_t \bar{z}_{\omega t} + (1 - \eta) \varpi_t,$$

which is identical to equation (13). Importantly, the model continues to feature a symmetric equilibrium as none of the proof presented above is affected.

To summarize, when we allow for intra-firm bargaining, the coefficient that multiplies the average marginal revenue product in the average wage equation changes. Since $\eta < 1$, the equilibrium average wage in the presence of intra-firm bargaining is lower than the equilibrium wage derived under the assumption that the average wage is not influenced by the size of the firm. Since the firm faces a downward sloping demand, each producer has an incentive to over-hire workers to lower their average marginal revenue product and compress the average wage in equilibrium. This is the over-hiring effect first described by Stole and Zwiebel (1996).³⁸ Our result extends Ebell and Haefke (2009) and Krause and Lubik (2007a), who previously illustrated the over-hiring effect related to market power in the context of models that feature a constant number of producers and exogenous job destruction.

Our simulations reveals that the quantitative importance of intra-firm bargaining for understanding the effects of deregulation is negligible. None of our result changes whether or not we abstract from intra-firm bargaining considerations. Results are available upon request.

³⁸Stole and Zwiebel (1996) have shown this effect using a model in which firms have a perfectly elastic demand but decreasing marginal product of labor. In our model, the marginal product of labor is constant, since the production function features constant returns to scale, but firms have monopoly power.