Technical Appendix to "The Macroeconomic Effects of Goods and Labor Markets Deregulation"

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A Constant Returns to Scale in Production

Here we show that perfectly mobile capital rented in a competitive market implies that producer output exhibits constant returns to scale in labor, $l_{\omega t}$, and capital, $k_{\omega t}$. Furthermore, we show that, owing to full capital mobility and price-taker firms in the capital market, it is irrelevant whether producers optimally select the amount of capital for each job, $k_{\omega t}(z)$, or whether instead they optimally determine the total amount of capital, $k_{\omega t}$, which is then allocated across individual jobs (our assumption in the main text).

Consider the maximization problem solved by producer ω. The firm chooses the price of its product $\rho_{\omega t}$, employment $l_{\omega t}$, the capital stock for each producing match $k_{\omega t}(z)$, the number of vacancies to be posted $v_{\omega t}$, and the job destruction threshold $z^c_{\omega t}$ to maximize the present discounted value of real profits:

$$E_t \sum_{s=t}^{\infty} \beta_{s,t} (1-\delta)^{s-t} \left\{ \begin{array}{c} \rho_{\omega s} y_{\omega s} - l_{\omega s} \int_{z^c_{\omega s}}^{\infty} [w_{\omega s}(z) + r_s k_{\omega s}(z)] \frac{g(z)dz}{1-G(z^c_{\omega s})} \\ -\kappa v_{\omega s} - G(z^c_{\omega s}) (1-\lambda^x) (l_{\omega s-1} + q_{s-1} v_{\omega s-1}) F \end{array} \right\},$$

subject to the following constraint:

$$y_{\omega t} = Z_t l_{\omega t} \int_{z^c_{\omega t}}^{\infty} k^{\alpha}_{\omega t}(z) z \frac{g(z)}{1-G(z^c_{\omega t})} dz, \tag{A-1}$$

$$y_{\omega t} = \sigma \ln \left(\frac{\bar{p}_t}{p_{\omega t}} \right) \frac{P_t Y_t}{p_{\omega t}}, \tag{A-2}$$

$$l_{\omega t} = (1-\lambda_{\omega t}) (l_{\omega t-1} + q_{t-1} v_{\omega t-1}). \tag{A-3}$$

As in the main text, $\varphi_{\omega t}$ denotes the Lagrange multiplier associated with the constraint (A-1), corresponding to the firm's real marginal cost of production. The first-order necessary condition for $k_{\omega t}(z)$ implies:

$$\alpha \varphi_{\omega t} Z_t z k^{\alpha-1}_{\omega t}(z) = r_t. \tag{A-4}$$

Intuitively, for each job, the producer equates the marginal revenue product of capital to its rental cost. Let $\tilde{k}_{\omega t} \equiv [1 - G(z^c_{\omega t})]^{-1} \int_{z^c_{\omega t}}^{\infty} k_{\omega t}(z) g(z) dz$ be the average capital stock per worker. Equation (A-4) implies:

$$\tilde{k}_{\omega t} = \left(\frac{r_t}{\alpha \varphi_{\omega t} Z_t} \right)^{\frac{1}{\alpha-1}} \tilde{z}^{\frac{1}{1-\alpha}}_{\omega t}, \tag{A-5}$$

where $\tilde{z}_{\omega t}$ is defined as in the main text: $\tilde{z}_{\omega t} \equiv \left[\int_{z^c_{\omega t}}^{\infty} z^{1/(1-\alpha)} \frac{g(z)}{1-G(z^c_{\omega t})} dz \right]^{1-\alpha}$. By combining equations (A-4) and (A-5), we obtain

$$k_{\omega t}(z) = \tilde{k}_{\omega t} \left(\frac{z}{\tilde{z}_{\omega t}} \right)^{\frac{1}{1-\alpha}}. \tag{A-6}$$

Using equation (A-6), the firm production function becomes:

$$y_{\omega t} = Z_t \tilde{z}_t l_{\omega t} \tilde{k}_{\omega t}^{\alpha}. \tag{A-7}$$

Finally, since $k_{\omega t} = l_{\omega t} \tilde{k}_{\omega t}$, we obtain equation (6) in the text: $y_{\omega t} = Z_t \tilde{z}_{\omega t} k_{\omega t}^{\alpha} l_{\omega t}^{1-\alpha}$.

We now show that the first-order conditions for $l_{\omega t}$, $v_{\omega t}$, $z_{\omega t}^c$ and $\rho_{\omega t}$ imply the same job creation, job destruction and pricing equations derived in the main text. Let $\psi_{\omega t}$ be the Lagrange multiplier on the constraint (A-3), corresponding to the average marginal revenue product of a job. The first-order condition for $v_{\omega t}$ and $l_{\omega t}$ imply, respectively:

$$\frac{\kappa}{q_t} = E_t \left\{ \tilde{\beta}_{t,t+1} \left[(1 - G\left(z_{\omega t+1}^c\right)) \psi_{\omega t+1} - G\left(z_{\omega t+1}^c\right) F \right] \right\}, \tag{A-8}$$

$$\psi_{\omega t} = \varphi_{\omega t} \frac{y_{\omega t}}{l_{\omega t}} - \tilde{w}_{\omega t} - r_t \tilde{k}_{\omega t} + \frac{\kappa}{q_t}, \tag{A-9}$$

where $\tilde{\beta}_{t,t+1} \equiv (1-\delta)(1-\lambda^x)\beta_{t,t+1}$ (as in the main text, $\beta_{t,t+1} \equiv \beta \left(C_{t+1}/C_t\right)^{-\gamma}$). By combining equation (A-8) and (A-9), we obtain the following job creation equation:

$$\frac{\kappa}{q_t} = E_t \left\{ \tilde{\beta}_{t,t+1} \left[\left(1 - G\left(z_{\omega t+1}^c\right)\right) \left(\varphi_{\omega t+1} \frac{y_{\omega t+1}}{l_{\omega t+1}} - \tilde{w}_{\omega t+1} - r_{t+1} \tilde{k}_{\omega t+1} + \frac{\kappa}{q_{t+1}} \right) - G\left(z_{\omega t+1}^c\right) F \right] \right\}. \tag{A-10}$$

Now observe that equation (A-5) implies $r_t \tilde{k}_{\omega t} = \alpha \varphi_{\omega t} Z_t^{\alpha} \tilde{k}_{\omega t}^{\alpha} \tilde{z}_{\omega t} \equiv \alpha \varphi_{\omega t} y_{\omega t}/l_{\omega t}$. Thus, equation (A-10) simplifies to:

$$\frac{\kappa}{q_t} = (1-\delta)(1-\lambda^x) E_t \left\{ \beta_{t,t+1} \left[\left(1 - G\left(z_{\omega t+1}^c\right)\right) \left((1-\alpha) \varphi_{\omega t+1} \frac{y_{\omega t+1}}{l_{\omega t+1}} - \tilde{w}_{\omega t+1} + \frac{\kappa}{q_{t+1}} \right) - G\left(z_{\omega t+1}^c\right) F \right] \right\},$$

which is identical to equation (8) in the main text.

The first-order condition for $z_{\omega t}^c$ implies

$$\tilde{w}_{\omega t} + \psi_{\omega t} - w_{\omega t}(z_{\omega t}^c) + r_t \tilde{k}_{\omega t} - \varphi_{\omega t} \frac{y_{\omega t}}{l_{\omega t}} - r_t k_{\omega t}\left(z_{\omega t}^c\right) + \varphi_{\omega t} Z_t z_{\omega t}^c \left[k_{\omega t}\left(z_{\omega t}^c\right)\right]^{\alpha} = -F. \tag{A-11}$$

Moreover, from equation (A-6) we have that $k_{\omega t}\left(z_{\omega t}^c\right) = \tilde{k}_{\omega t}\left(z_{\omega t}^c/\tilde{z}_{\omega t}\right)^{\frac{1}{1-\alpha}}$. Therefore, using again equation (A-4) we obtain:

$$r_t k_{\omega t}\left(z_{\omega t}^c\right) = \alpha \varphi_{\omega t} \frac{y_{\omega t}}{l_{\omega t}} \left(\frac{z_{\omega t}^c}{\tilde{z}_{\omega t}} \right)^{\frac{1}{1-\alpha}}. \tag{A-12}$$

By using equations (A-9) and (A-12), equation (A-11) can be further simplified to the following job destruction equation:

$$(1-\alpha) \varphi_{\omega t} \frac{y_{\omega t}}{l_{\omega t}} \left(\frac{z_{\omega t}^c}{\tilde{z}_{\omega t}} \right)^{\frac{1}{1-\alpha}} - w_{\omega t}(z_{\omega t}^c) + \frac{\kappa}{q_t} = -F,$$

which is identical to equation (9) in the main text.

Finally, the first-order condition with respect to $p_{\omega t}$ is unaffected, implying that the (real) output price $\rho_{\omega t}$ is equal to an endogenous, time-varying markup $\mu_{\omega t}$ over marginal cost $\varphi_{\omega t}$: $\rho_{\omega t} = \mu_{\omega t} \varphi_{\omega t}$, where, as in the main text, $\mu_{\omega t} \equiv \theta_{\omega t}/\left(\theta_{\omega t} - 1\right)$.

B Wage Determination

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

$$\eta\Delta^F_{\omega t}(z) = (1-\eta)\Delta^W_{\omega t}(z), \tag{A-13}$$

where $\Delta^W_{\omega t}(z)$ and $\Delta^F_{\omega t}(z)$ denote, respectively, worker's and firm's real surplus, and η is the worker's bargaining weight.

The worker's surplus is given by

$$\Delta^W_{\omega t}(z) = w_{\omega t}(z) - \varpi_t + E_t\tilde{\beta}_{t,t+1}\left(1 - G\left(z^c_{\omega t+1}\right)\right)\tilde{\Delta}^W_{\omega t+1}, \tag{A-14}$$

where $\tilde{\beta}_{t,t+1} \equiv (1-\delta)(1-\lambda^x)\beta_{t,t+1}$ (as in the main text, $\beta_{t,t+1} \equiv \beta\left(C_{t+1}/C_t\right)^{-\gamma}$), and

$$\tilde{\Delta}^W_{\omega t} \equiv \left[1 - G\left(z^c_{\omega t}\right)\right]^{-1}\int_{z^c_{\omega t}}^{\infty}\Delta^W_{\omega t}(z)g(z)dz$$

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:

$$\varpi_t \equiv h_p + b + \int_{\omega\subset\Omega_t}^{\infty} s_t\frac{v_{\omega t}}{V_t}E_t\left[\tilde{\beta}_{t,t+1}\left(1 - G\left(z^c_{\omega t+1}\right)\right)\tilde{\Delta}^W_{\omega t+1}\right]d\omega. \tag{A-15}$$

The firm surplus corresponds to the value of the job to the firm, $J_{\omega t}(z)$, plus savings from firing costs F, i.e., $\Delta^F_{\omega t}(z) = J_{\omega t}(z) + F$—as pointed out by Mortensen and Pissarides (2002), the outside option for the firm in wage negotiations is firing the worker, paying firing costs. The value of the job to the firm corresponds to the revenue generated by the match, plus its expected discounted continuation value, net of the cost of production (the wage bill and the rental cost of capital):

$$J_{\omega t}(z) = \varphi_{\omega t}Z_t z k^{\alpha}_{\omega t}(z) - w_{\omega t}(z) - r_t k_{\omega t}(z) + E_t\tilde{\beta}_{t,t+1}\left[\left(1 - G\left(z^c_{\omega t+1}\right)\right)\tilde{\Delta}^F_{\omega t+1} - G\left(z^c_{\omega t+1}\right)F\right],$$

where $\tilde{\Delta}^F_{\omega t} \equiv \left[1 - G\left(z^c_{\omega t}\right)\right]^{-1}\int_{z^c_{\omega t}}^{\infty}\Delta^F_{\omega t}(z)g(z)dz$ corresponds to the Lagrange multiplier $\psi_{\omega t}$ in the firm profit maximization. Using equations (A-4), (A-6), and (A-9), $J_{\omega t}(z)$ can then be written as

$$J_{\omega t}(z) = \pi_{\omega t}(z) - w_{\omega t}(z) + \frac{k}{q_t}. \tag{A-16}$$

where

$$\pi_{\omega t}(z) \equiv (1-\alpha)\varphi_{\omega t}\frac{y_{\omega t}}{l_{\omega t}}\left(\frac{z}{\tilde{z}_t}\right)^{1/(1-\alpha)}$$

denotes the marginal revenue product of the worker. Therefore, the firm surplus is equal to

$$\Delta^F_{\omega t}(z) = \pi_{\omega t}(z) - w_{\omega t}(z) + \frac{k}{q_t} + F. \tag{A-17}$$

Since the sharing rule in (A-13) implies that $\tilde{\Delta}_{\omega t}^{W} = \tilde{\Delta}_{\omega t}^{F}\eta/(1-\eta)$, the worker surplus can be written as:

$$\Delta_{\omega t}^{W}(z) = w_{\omega t}(z) - \varpi_t + \frac{\eta}{1-\eta}E_t\left\{\tilde{\beta}_{t,t+1}\left[1 - G\left(z_{\omega t+1}^{c}\right)\right]\left(\tilde{J}_{\omega t+1}(z) + F\right)\right\}.$$

Using equation (A-8), we obtain:

$$\Delta_{\omega t}^{W}(z) = w_{\omega t}(z) - \varpi_t + \frac{\eta}{1-\eta}\left[\frac{\kappa}{q_t} + E_t\left(\tilde{\beta}_{t,t+1}F\right)\right]. \tag{A-18}$$

Inserting equations (A-17) and (A-18) into the sharing rule (A-13), we finally obtain:

$$w_{\omega t}(z) = \eta\left\{\pi_{\omega t}(z) + \left[1 - (1-\delta)(1-\lambda^{x})E_t\beta_{t,t+1}\right]F\right\} + (1-\eta)\varpi_t,$$

which is identical to (11) in the main text. The average wage $\tilde{w}_{\omega t}$ is then given by

$$\tilde{w}_{\omega t} = \eta\left\{\tilde{\pi}_{\omega t} + \left[1 - (1-\delta)(1-\lambda^{x})E_t\beta_{t,t+1}\right]F\right\} + (1-\eta)\varpi_t. \tag{A-19}$$

C Symmetric Equilibrium

Here we show that producers are symmetric at each point in time in two steps. First, we show that both the reservation productivity $z_{\omega t}^{c}$, the marginal cost $\varphi_{\omega t}$, and the average capital stock $\tilde{k}_{\omega t}$ 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 z_t^c and φ_t implies that, upon entry, producers optimally hire the same mass of workers employed by existing incumbents.

To begin, use equation (11) evaluated at the productivity threshold $z_{\omega t}^{c}$ to eliminate $w_{\omega t}(z_{\omega t}^{c})$ from equation (9). Rearranging terms, the job destruction equations can be written as:

$$\varphi_{\omega t}\frac{y_{\omega t}}{l_{\omega t}}\left(\frac{z_{\omega t}^{c}}{\tilde{z}_{\omega t}}\right)^{\frac{1}{1-\alpha}} = -\frac{\Lambda_t}{(1-\eta)(1-\alpha)}, \tag{A-20}$$

where the term Λ_t does not depend on firm-specific characteristics:

$$\Lambda_t = \frac{\kappa}{q_t} - (1-\eta)\varpi_t + \left[(1-\eta) + \eta E_t\tilde{\beta}_{t,t+1}\right]F,$$

where $\tilde{\beta}_{t,t+1} \equiv (1-\delta)(1-\lambda^{x})\beta_{t,t+1}$ (as in the main text, $\beta_{t,t+1} \equiv \beta\left(C_{t+1}/C_t\right)^{-\gamma}$). Moreover, using equation (A-19), it is possible to eliminate the average wage $\tilde{w}_{\omega t}$ from equation (8). Rearranging terms, the job creation equation can be written as:

$$\frac{\kappa}{q_t} = E_t\tilde{\beta}_{t,t+1}\left\{(1-\eta)(1-\alpha)\left[1 - G\left(z_{\omega t+1}^{c}\right)\right]\varphi_{\omega t+1}\frac{y_{\omega t+1}}{l_{\omega t+1}}\left[1 - \left(\frac{\tilde{z}_{\omega t+1}}{z_{\omega t+1}^{c}}\right)^{\frac{1}{\alpha-1}}\right] - F\right\}.$$

Using equation (A-20), the above expression can be simplified to:

$$\mathsf{Q}\left(z^c_{\omega t+1}\right) \equiv E_t\tilde{\beta}_{t,t+1}\left\{\left[1-G\left(z^c_{\omega t+1}\right)\right]\Lambda_{t+1}\left[1-\left(\frac{\tilde{z}_{\omega t+1}}{z^c_{\omega t+1}}\right)^{\frac{1}{1-\alpha}}\right]\right\} = \Omega_t, \tag{A-21}$$

where $\Omega_t \equiv \kappa/q_t + E_t\tilde{\beta}_{t,t+1}F$ does not depend on firm-specific characteristics.

We now show that the function $Q\left(z^c_{\omega t+1}\right)$ is monotonic in $z^c_{\omega t+1}$, which implies that there exists a unique $z^c_{\omega,t+1} = z^c_{t+1}$ that satisfies equation (A-21). First, using the definition of $\tilde{z}_{\omega t}$, we can write $Q\left(z^c_{\omega t+1}\right)$ as follows:

$$\mathsf{Q}\left(z^c_{\omega t+1}\right) = E_t\tilde{\beta}_{t,t+1}\Lambda_{t+1}\left\{\left[1-G\left(z^c_{\omega t+1}\right)\right]-\left(\frac{1}{z^c_{\omega t+1}}\right)^{\frac{1}{1-\alpha}}\int_{z^c_{\omega t+1}}^{\infty} z^{1/(1-\alpha)}g(z)dz\right\}.$$

Therefore, we have:

$$\frac{\partial\mathsf{Q}\left(z^c_{\omega t+1}\right)}{\partial z^c_{\omega t+1}} = \frac{1}{1-\alpha}\left(\frac{1}{z^c_{\omega t+1}}\right)^{\frac{2-\alpha}{1-\alpha}}\left[1-G\left(z^c_{\omega t+1}\right)\right]\tilde{z}^{1/(1-\alpha)}_{\omega t+1} > 0.$$

Since $Q\left(z^c_{\omega t+1}\right)$ is monotonic in $z^c_{\omega t+1}$, there exists a unique $z^c_{\omega t+1} = z^c_{t+1}$ such that $Q\left(z^c_{\omega t+1}\right) = \Omega_t$. It also follows that $\tilde{z}_{\omega,t} = \tilde{z}_t$ is symmetric across producers.

We now show that $\tilde{z}_{\omega,t} = \tilde{z}_t$ implies symmetry in the real marginal cost of production across producers: $\varphi_{\omega t} = \varphi_t$. First, notice that due to symmetry in z^c_t, equation (A-20) simplifies to:

$$\varphi_{\omega t}\frac{y_{\omega t}}{l_{\omega t}} = \Gamma_t, \tag{A-22}$$

where $\Gamma_t \equiv -\left[\Lambda_t/Z_t\left(1-\eta\right)\left(1-\alpha\right)\right]\left(\tilde{z}_t/z^c_t\right)^{1/(1-\alpha)}$ does not depend on firm-specific characteristics. Now recall that the first-order condition for $k_{\omega t}$ implies:

$$\varphi_{\omega t}\frac{y_{\omega t}}{k_{\omega t}} = \frac{r_t}{\alpha}. \tag{A-23}$$

By combining equations (A-22) and (A-23), it is straightforward to observe that the capital-labor ratio is identical across producers: $l_{\omega t}/k_{\omega t} = r_t/\alpha\Gamma_t$. Therefore, equation (A-23) implies symmetry in the real marginal cost:

$$\varphi_{\omega t} = \frac{r^\alpha_t}{\alpha Z_t}\left(\frac{\tilde{z}_t}{\alpha\Gamma_t}\right)^{1-\alpha}.$$

Furthermore, using equation (A-5), symmetry in $\tilde{z}_t$ and φ_t implies that the average capital stock allocated to a job is symmetric:

$$\tilde{k}_{\omega t} = \left(\frac{r_t}{\alpha\varphi_t Z_t}\right)^{\frac{1}{\alpha-1}}\tilde{z}_t^{\frac{1}{1-\alpha}} \equiv \tilde{k}_t.$$

To complete the proof, we have to show that symmetry in z^c_t, φ_t, and $\tilde{k}_t$ result in symmetric employment across firms. To this end, notice that a symmetric real marginal cost implies that each incumbent charges the same relative price $\rho_{\omega t} = \rho_t$ and faces the same demand schedule $y_{\omega t} = y_t$; see equations (5) and (10) in the main text. This concludes the proof, since, from equation (A-7):

$$l_{\omega t} = \frac{y_t}{\tilde{z}_t Z_t \tilde{k}_t^{\alpha}} = l_t.$$

Finally, notice that in the symmetric equilibrium the worker outside option reduces to:

$$\varpi_t \equiv h_p + b + \frac{\eta}{1-\eta}\left[\kappa\vartheta_t + s_t E_t\left(\tilde{\beta}_{t,t+1} F\right)\right].$$

Therefore, in equilibrium, the average wage is given by:

$$\tilde{w}_{\omega t} = \eta\left\{\tilde{\pi}_{\omega t} + \kappa\vartheta_t + \left[1 - (1-\delta)(1-\lambda^x)(1-s_t) E_t\beta_{t,t+1}\right] F\right\} + (1-\eta)(h_p + b).$$

D Steady-State Relationships

Job Creation and Destruction

In this Section, we show how goods and labor market regulation jointly determine the unemployment rate and the number of producers in the long run.

To begin, notice that the unemployment rate, $U = \lambda^{tot} / \left(\lambda^{tot} + s\right)$, depends on the job-finding probability $s \equiv \chi\vartheta^{1-\varepsilon}$, a positive function of labor market tightness $\vartheta \equiv V/U$, and on steady-state job flows, captured by $\lambda^{tot} \equiv [1 - (1-\lambda)(1-\delta)] / [(1-\lambda)(1-\delta)]$, a positive function of the reservation productivity z^c (since $\lambda \equiv \lambda^x + (1-\lambda^x) G(z^c)$). As a result, the effect of policy changes on equilibrium unemployment depends on the relative shifts of job creation and destruction. In steady state, these two curves are, respectively:

$$\vartheta = \left\{\chi\tilde{\beta}\kappa^{-1}\left[\Phi(N)\int_{z^c}^{\infty}\left(z^{1/(1-\alpha)} - z^{c^{1/(1-\alpha)}}\right) g(z) dz - F\right]\right\}^{1/\varepsilon}, \tag{A-24}$$

and

$$z^{c^{1/(1-\alpha)}} + \tilde{\beta}\left[\int_{z^c}^{\infty}\left(z^{1/(1-\alpha)} - z^{c^{1/(1-\alpha)}}\right) g(z) dz\right] = \left\{[\Phi(N)]^{-1}\left[\begin{array}{c}(1-\eta)(b+h_p) + \eta\kappa\vartheta \\ + \left[\tilde{\beta} - \left(1 - \eta + \eta(1-s)\tilde{\beta}\right)\right] F\end{array}\right]\right\}, \tag{A-25}$$

where the term $\Phi(N) \equiv \tau\left[\sigma N (1+\sigma N)^{-1} \exp\left[-\left(\tilde{N} - N\right) / \left(2\sigma\tilde{N}N\right)\right]\right]^{1/(1-\alpha)}$ captures the effect of variations in the competitive environment on equilibrium unemployment. (In the expressions above, $\tilde{\beta} \equiv (1-\lambda^x)(1-\delta)\beta$ and $\tau \equiv (1-\eta)(1-\alpha)\left\{[1 - \beta(1-\delta_K)] / (\alpha\beta)\right\}^{\alpha/(\alpha-1)}$.)

The left panel in Figure A-1 plots equations (A-24) and (A-25) as two curves in the $\vartheta \times z_c$ space, keeping the number of producers N constant. The job creation curve slopes downward: as in Mortensen and Pissarides (2002), higher reservation productivity z_c implies a shorter expected life of a new job, reducing job creation and with it market tightness. The job destruction curve slopes upward: an increase in labor market tightness increases the reservation productivity, since the worker's outside option improves with ϑ, leading to more job destruction.

Equation (A-24) shows that, for a given level of market competition, higher firing costs, F, reduce job creation (by increasing the expected cost of terminating a match). Equation (A-25) shows that more generous unemployment benefits, b, induce higher job destruction (by increasing wages and reducing the average firm's surplus from a match); higher firing costs have an opposite effect. These results, illustrated in Figure A-2, mirror the findings in Mortensen and Pissarides (2002). However, in contrast to the standard search and matching model, the unemployment effects of deregulation also depend upon how reforms affect the number of producers N. Other things equal, since $\partial\Phi(N)/\partial N > 0$, a reform that increases N reduces job destruction and increases job creation, i.e., z^c falls, while ϑ increases—see the right panel in Figure A-1. Intuitively, an increase in the number of products N, increases the elasticity of substitution between products and, by implication, the elasticity of demand facing firms. In turn, markups fall, boosting the marginal revenue product of labor. Moreover, since households' preferences exhibit a love of variety, an increase in the number of producers implies that the relative price of each good increases, raising the marginal return from a match.[1]

Product Creation

To understand how deregulation affects N, combine the free entry condition with the Euler equations for product creation and capital accumulation, obtaining:

$$N = \left[\frac{\Phi(N)\tilde{z}^{1/(1-\alpha)}\,(1-U)}{\sigma\varrho\,(f_T + f_R)}\right]^{1/2}, \tag{A-26}$$

where $\varrho \equiv \left[\beta^{-1}(1-\delta)^{-1} - 1\right](1-\eta)(1-\alpha)$. Intuitively, profitable market entry depends on the regulation cost f_R (over and above the technological investment f_T) and on labor market conditions, since the latter affect aggregate demand and the cost of recruiting workers to start production. Equations (A-24) through (A-26) jointly determine the equilibrium values of N, ϑ, and z^c.

To obtain equation (A-26) above, start by combining the free entry condition and the Euler equation for product creation:

$$(f_T + f_R) + \kappa\left(\frac{l_t}{qt} + v_t\right) = (1-\delta)\,E_t\beta_{t,t+1}\left[(f_T + f_R) + \kappa\left(\frac{l_{t+1}}{q_{t+1}} + v_{t+1}\right) + d_{t+1.}\right] \tag{A-27}$$

Notice that using the first-order conditions for capital accumulation and optimal pricing, firm profits can be re-written as:

$$d_t = \left(1 - \frac{1}{\mu_t}\right)\rho_t y_t + (1-\alpha)\,\varphi_t y_t - \tilde{w}_t l_t - \kappa v_t - \frac{G(z_t^c)}{(1-G(z_t^c))} l_t F. \tag{A-28}$$

[1] As pointed out by Bilbiie, Ghironi, and Melitz (2012), when there are more goods in the market, households derive more welfare from spending a given nominal amount, i.e., *ceteris paribus*, the price index P_t decreases. It follows that the relative price of each individual good must rise, i.e., $\rho'(N) > 0$.

Recall that the average value of a job to the firm, ψ_t (the Lagrange multiplier in the firm profit maximization), is given by equation (A-17) evaluated at the average job productivity $\tilde{z}_t$:

$$\psi_t = (1-\alpha)\,\varphi_t \frac{y_t}{l_t} - \tilde{w}_t + \frac{\kappa}{q_t}. \tag{A-29}$$

Using equation (A-29), firm profits can be written as:

$$d_t = \left(1 - \frac{1}{\mu_t}\right) \rho_t y_t + \psi_t l_t - \kappa \left(v_t + \frac{l_t}{q_t}\right) - \left[\frac{G(z_t^c)}{(1-G(z_t^c))}\right] F l_t.$$

Thus, equation (A-27) becomes:

$$(f_T + f_R) + \kappa \left(v_t + \frac{l_t}{q_t}\right) - \Upsilon_{E,t} = (1-\delta)\, E_t \beta_{t,t+1} \left[(f_T + f_R) + \left(1 - \frac{1}{\mu_{t+1}}\right) y_{t+1}\right],$$

where

$$\Upsilon_{E,t} \equiv (1-\delta)\, E_t \beta_{t,t+1} \psi_{t+1} l_{t+1} - (1-\delta)\, E_t \beta_{t,t+1} \left[\frac{G(z_t^c)}{(1-G(z_t^c))}\right] l_{t+1} F. \tag{A-30}$$

It is straightforward to show that $\Upsilon_{E,t} = \kappa\,(v_t + l_t/q_t)$. First, recall that

$$l_{t+1} = \left(1 - G(z_{t+1}^c)\right)(1-\lambda^x)\left[l_t + q_t v_t\right]. \tag{A-31}$$

Using the expression above, equation (A-30) becomes:

$$\Upsilon_{E,t} \equiv E_t \tilde{\beta}_{t,t+1} \left(1 - G(z_{t+1}^c)\right) \psi_{t+1} \left[l_t + q_t v_t\right] - (1-\delta)\, E_t \beta_{t,t+1} \left[\frac{G(z_t^c)}{(1-G(z_t^c))}\right] l_{t+1} F, \tag{A-32}$$

where $\tilde{\beta}_{t,t+1} \equiv (1-\delta)(1-\lambda^x)\,\beta_{t,t+1}$. The firm job creation, equation (A-8) in the Appendix, implies:

$$E_t \tilde{\beta}_{t,t+1} \psi_{t+1} \left(1 - G(z_{t+1}^c)\right) = \frac{\kappa}{q_t} + E_t \tilde{\beta}_{t,t+1} G(z_{t+1}^c) F. \tag{A-33}$$

Substituting equation (A-33) into equation (A-32), and using again equation (A-31), we obtain:

$$\Upsilon_{E,t} \equiv \frac{\kappa}{q_t}\left[l_t + q_t v_t\right].$$

Thus, the product creation equation is:

$$(f_T + f_R) = (1-\delta)\, E_t \beta_{t,t+1} \left[(f_T + f_R) + \left(1 - \frac{1}{\mu_{t+1}}\right) \frac{Y_{t+1}^c}{N_{t+1}}\right],$$

since $y_t = Y_t / (\rho_t N_t)$. This is equation (5) in Table 1.

In steady state, the above expression simplifies to:

$$\frac{1-(1-\delta)\,\beta}{(1-\delta)\,\beta} = \frac{(\mu-1)\,\rho}{(f_T + f_R)\,\mu N} Z \tilde{z} K^{\alpha} L^{1-\alpha}, \tag{A-34}$$

since $Y = \rho Z \tilde{z} K^{\alpha} L^{1-\alpha}$. Combining the Euler equation for physical capital and the firm optimality condition for the choice of K we obtain:

$$K = \left[\frac{1-\beta\left(1-\delta_K\right)}{\beta\alpha}\right]^{\frac{1}{\alpha-1}}\left(\frac{\rho}{\mu}\right)^{\frac{1}{1-\alpha}}\tilde{z}^{\frac{1}{1-\alpha}}L, \tag{A-35}$$

where $Z = 1$ is omitted. Substituting equation (A-35) into equation (A-34), we obtain:

$$\frac{\left[1-\beta(1-\delta)\right](1-\eta)(1-\alpha)}{\beta(1-\delta)} = \frac{\Phi(N)}{(f_T+f_R)}\frac{1}{\sigma N^2}\left(1-U\right)\tilde{z}^{\frac{1}{1-\alpha}},$$

where $\Phi(N)$ is defined as above.

E Social Planner Allocation and Inefficiency Wedges

The Planner's Problem

Here we derive the first-best, efficient allocation chosen by a benevolent social planner, and we define the distortions that characterize the market economy. In what follows, we assume that the cost of vacancy posting, κ, the distribution of workers' idiosyncratic productivity, $G(z)$, and the investment adjustment cost $\nu\left(I_{Kt}/I_{Kt-1}-1\right)^2/2$ are all features of technology—the technology for job creation, job destruction, and capital accumulation—that also characterizes the planner's environment. Moreover, we assume that firing costs, unemployment benefits, and regulation costs associated to market entry are zero in the planner economy. Thus, the only entry costs that are relevant to the social planner are the technological component of the overall entry cost $f_{E,t}$ and the costs of recruiting labor to begin production facing firms in the decentralized economy. Finally, note that the planner correctly anticipates that all the incumbent firms are symmetric at each point in time when solving the maximization problem.[2]

The benevolent social planner faces seven constraints. The first constraint is that the stock of labor of each producer is equal to the number of workers that were not separated plus previous period matches that become productive in the current period:

$$l_t = \left(1-\lambda^x\right)\left[1-G\left(z_t^c\right)\right]\left[l_{t-1}+q_{t-1}v_{t-1}\right]. \tag{A-36}$$

The second constraint is given by the aggregate matching function $M_t = \chi\left(1-L_t\right)^{\varepsilon} V_t^{1-\varepsilon}$, which implicitly defines the probability of filling a vacancy $q_t \equiv M_t/V_t$:

$$q_t = \chi(1-L_t)^{\varepsilon} V_t^{-\varepsilon}. \tag{A-37}$$

The third constraint is that the total number of producing workers in each period, L_t, is equal to total employment in incumbent firms:

$$L_t = N_t l_t. \tag{A-38}$$

[2]This is the case since the production technology in the planner economy is identical to the market economy.

The fourth constraint is that the total number of vacancies posted in each period, V_t, is the sum of the vacancies posted to create new matches in existing firms, $v_t N_t$, plus the vacancies required to build the stock of labor of new entrants:

$$V_t = N_t v_t + \left(\frac{N_{t+1}}{1-\delta} - N_t\right)\left(v_t + \frac{l_t}{q_t}\right). \tag{A-39}$$

The fifth constraint is that total output is used to produce consumption of market goods, investment in physical capital, create new product lines, and form new matches in the labor market:

$$\rho_t N_t \left[\int_{z_t^c}^{\infty} \frac{z^{1/(1-\alpha)} g(z)}{1-G(z_t^c)} dz\right]^{1-\alpha} Z_t k_t^{\alpha} l_t^{1-\alpha} + h_p(1-N_t l_t) = C_t + I_{Kt} + \left(\frac{N_{t+1}}{1-\delta} - N_t\right) f_T + \kappa V_t, \tag{A-40}$$

where $\rho_t \equiv \exp\left\{-\left(\tilde{N} - N_t\right)/2\sigma \tilde{N} N_t\right\}$ converts units of output into units of consumption.

The last two constraints for the planner are the market clearing condition in the capital market:

$$K_t = N_t k_t, \tag{A-41}$$

and the law of motion for aggregate physical capital:

$$K_{t+1} = (1-\delta_K) K_t + I_{Kt}\left[1 - \frac{\nu}{2}\left(\frac{I_{Kt}}{I_{Kt-1}} - 1\right)^2\right]. \tag{A-42}$$

The benevolent social planner chooses $\{C_t, L_t, I_{Kt}, K_{t+1,} z_t^c, V_t, N_{t+1}, v_t, l_t, k_t, q_t\}_{t=0}^{\infty}$ to maximize households' welfare in (1) subject to the constraints (A-36) through (A-42).

Notice that the planner problem can be simplified by eliminating the firm-level variables v_t, l_t, k_t and the probability of filling a vacancy q_t. To do so, we solve for l_t and v_t the constraints (A-38) and (A-39) and substitute those variables in the constraint (A-36). After a few algebraic steps, and using the constraint (A-37), we obtain the following law of motion for aggregate employment:

$$L_t = (1-\delta)(1-\lambda^x)\left[1 - G(z_t^c)\right]\left[L_{t-1} + \chi(1-L_{t-1})^{\varepsilon} V_{t-1}^{1-\varepsilon}\right]. \tag{A-43}$$

By the same token, we use equations (A-38) and (A-41) to further simplify the constraint (A-40):

$$\rho_t \left[\int_{z_t^c}^{\infty} \frac{z^{1/(1-\alpha)} g(z)}{1-G(z_t^c)} dz\right]^{1-\alpha} Z_t K_t^{\alpha} L_t^{1-\alpha} + h_p(1-L_t) = C_t + I_{Kt} + \left(\frac{N_{t+1}}{1-\delta} - N_t\right) f_T + \kappa V_t. \tag{A-44}$$

The planner problem now consists in choosing $\{C_t, L_t, I_{Kt}, K_{t+1}, K_t, z_t^c, V_t, N_{t+1}\}_{t=0}^{\infty}$ to maximize (1) subject to the constraints (A-42) through (A-44). Let ζ_t denote the Lagrange multiplier associated with the constraint (A-42), and let ξ_t denote the Lagrange multiplier associated with the constraint (A-44).

The first-order condition for consumption implies that $\xi_t = u_{C,t}$. The optimality condition for

N_{t+1} equates the cost of creating a new product to its expected discounted benefit:

$$f_T = (1-\delta) E_t \left\{ \beta_{t,t+1} \left[f_T + \frac{1}{2\sigma N_{t+1}} \left(\frac{Y_{t+1}}{N_{t+1}} \right) \right] \right\}, \tag{A-45}$$

where

$$Y_t \equiv \left[C_t - h_p (1-L_t) + I_{Kt} + \left(\frac{N_{t+1}}{1-\delta} - N_t \right) f_T + \kappa V_t \right],$$

and $\beta_{t,t+1} \equiv \beta (C_{t+1}/C_t)^{-\gamma}$.

The first-order conditions for aggregate vacancies, V_t, and aggregate employment, L_t, yield the following job creation condition:

$$\frac{\kappa}{q_t} = E_t \left\{ \tilde{\beta}_{t,t+1} (1-\varepsilon)(1-\alpha) \left[1 - G\left(z_{t+1}^c\right) \right] \rho_{t+1} Z_{t+1} \tilde{z}_{t+1} \left(\frac{K_{t+1}}{L_{t+1}} \right)^{\alpha} \left[1 - \left(\frac{z_{t+1}^c}{\tilde{z}_{t+1}} \right)^{\frac{1}{1-\alpha}} \right] \right\}, \tag{A-46}$$

where $\tilde{\beta}_{t,t+1} \equiv (1-\delta)(1-\lambda^x)\beta_{t,t+1}$. Equation (A-46) shows that the expected cost of filling a vacancy κ/q_t must be equal to its (social) expected benefit. The latter is given by the expected value of output produced by one worker net of home production (the outside option of unemployment), augmented by the continuation value of the match.

The first-order condition for the worker's productivity cutoff, z_t^c, implies:

$$(1-\varepsilon) \left[(1-\alpha) \rho_t Z_t \tilde{z}_t \left(\frac{K_t}{L_t} \right)^{\alpha} \left(\frac{z_t^c}{\tilde{z}_t} \right)^{\frac{1}{1-\alpha}} - h_p \right] - \varepsilon \kappa \vartheta_t + \frac{\kappa}{q_t} = 0, \tag{A-47}$$

where $\vartheta_t \equiv V_t/(1-L_t)$ denotes the labor market tightness. Equation (A-47) implies that, at the margin, the social cost of shedding a worker with productivity z_t^c equals the social benefit.

The first-order condition for K_t implies the following Euler equation for physical capital accumulation:

$$1 = E_t \left\{ \beta_{t,t+1} \left[\frac{\alpha \rho_{t+1} Z_{t+1} \tilde{z}_{t+1}}{\zeta_{Kt}} \left(\frac{K_{t+1}}{L_{t+1}} \right)^{\alpha-1} + (1-\delta_K) \frac{\zeta_{Kt+1}}{\zeta_{Kt}} \right] \right\}, \tag{A-48}$$

where $\zeta_{Kt} \equiv \zeta_t / C_t^{-\gamma}$ denotes the shadow value of capital in units of consumption. Finally, the first-order conditions for I_{Kt} implies:

$$1 = \zeta_{Kt} \left\{ \left[1 - \frac{\nu}{2} \left(\frac{I_{Kt}}{I_{Kt-1}} - 1 \right)^2 \right] - \nu \left(\frac{I_{Kt}}{I_{Kt-1}} - 1 \right) \left(\frac{I_{Kt}}{I_{Kt-1}} \right) \right\}. \tag{A-49}$$

Table A-1 summarizes the key equilibrium conditions of the planning economy. The table contains 10 equations that determine 10 endogenous variables: C_t, ρ_t, N_{t+1}, L_t, V_t, M_t, z_t^c, K_{t+1}, I_{Kt}, ζ_{Kt}. (The variables q_t and $\tilde{z}_t$, that appear in the table depend on the above ten variables as described in the main text.)

Inefficiency Wedges

In order to derive the inefficiency wedges presented in the main text, we use the efficient allocation as the "zero-wedge" benchmark allocation. Specifically, the inefficiency wedges measure the difference between the efficient allocation and the allocation that characterizes the decentralized economy.

Product Creation. Comparing the term in curly brackets in equation (6) in Table 1 to the term in curly brackets in equation (6) in Table A-1 implicitly defines the inefficiency wedge along the market economy's product creation margin. Specifically, the product creation wedge is defined as:

$$\Sigma_{PC,t} \equiv (1-\delta)\, E_t \left\{ \beta_{t,t+1} \frac{Y_{t+1}}{N_{t+1}} \left[\frac{1}{2\sigma N_{t+1} f_T} - \frac{(1-1/\mu_{t+1})}{(f_T \ + f_R\ )} \right] \right\},$$

where all variables are evaluated at the decentralized allocations.

The wedge reflects the misalignment between the private return on product creation—the profit rate $(1-1/\mu_t)$ per unit unit of investment $(f_T\ + f_R\ )$—and its socially efficient level—the benefit of product variety to consumers $1/(2\sigma N_t)$ per unit of efficient investment f_T. Using the fact that $\Upsilon_{N,t} \equiv (1-(1/\mu_t)) - 1/(2\sigma N_t)$ and $\Upsilon_R \equiv f_R$, we obtain:

$$\Sigma_{PC,t} \equiv \frac{(1-\delta)}{f_T} E_t \left\{ \beta_{t,t+1} \frac{Y_{t+1}}{N_{t+1}} \left[\Upsilon_{N,t+1} - \frac{\Upsilon_R}{(f_T + \Upsilon_R)(1+\sigma N)} \right] \right\}.$$

Job Creation. Comparing the term in curly brackets in equation (7) in Table 1 to the term in curly brackets in equation (7) in Table A-1 implicitly defines the inefficiency wedge along the market economy's job creation margin:

$$\Sigma_{JC,t} \equiv E_t \frac{q_t}{\kappa} \beta_{t,t+1} \left(1-\lambda_{t+1}^{tot}\right) \left\{ (1-\varepsilon)(1-\alpha) \frac{Y_{t+1}}{L_{t+1}} \left[1 - \left(\frac{z_{t+1}^c}{\tilde{z}_{t+1}} \right)^{1/(1-\alpha)} \right] \Upsilon_{\mu,t+1} + \frac{\Upsilon_F}{\left[1-G\left(z_{t+1}^c\right)\right]} \right\},$$

where $\Upsilon_{\mu,t} \equiv 1 - 1/\mu_t$ and $\Upsilon_F = F$.

Job Destruction. Comparing the term in curly brackets in equation (8) in Table 1 to the term in curly brackets in equation (8) in Table A-1 implicitly defines the inefficiency wedge along the market economy's job destruction margin:

$$\Sigma_{JD,t} \equiv \frac{q_t}{\kappa\left(q_t \varepsilon \vartheta_t - 1\right)} \left\{ (1-\varepsilon)(1-\alpha) \frac{Y_t}{L_t} \left(\frac{z_t^c}{\tilde{z}_t} \right)^{1/(1-\alpha)} \Upsilon_{\mu,t} + (1-\varepsilon)\Upsilon_b - \left[1 - \eta\left(1 - E_t \tilde{\beta}_{t,t+1}(1-s_t)\right)\right] \Upsilon_F \right\},$$

where, as before, $\tilde{\beta}_{t,t+1} \equiv (1-\delta)(1-\lambda^x)\, \beta_{t,t+1}$ and $\Upsilon_b \equiv b$.

Capital Accumulation. Comparing the term in curly brackets in equation (9) in Table 1 to the term in curly brackets in equation (9) in Table A-1 implicitly defines the inefficiency wedge along the market economy's capital accumulation margin:

$$\Sigma_{K,t} \equiv \alpha E_t \beta_{t,t+1} \frac{Y_{t+1}}{\zeta_{Kt} K_{t+1}} \Upsilon_{\mu,t+1}.$$

Consumption Resource Constraint. Firing costs and "red tape" imply diversion of resources from consumption and creation of new product lines and vacancies, resulting in the consumption output inefficiency wedge—compare equation (10) in Table 1 and equation (10) in Table A-1.

$$\Sigma_{Y,t} \equiv \frac{G(z_t^c)}{1-G(z_t^c)} L_t \Upsilon_F + \Upsilon_R N_{E,t}.$$

Market Deregulation and Inefficiency Wedges

Table A-2 computes the steady-state response of the inefficiency wedges to market deregulation. Table A-3 computes the mean and volatility effects over the business cycle.

F Panel VAR

Data Description

The analysis is based on harmonized annual data for a sample of 19 OECD countries over the period 1982-2005.[3] The source of all data employed is the OECD.

Gross Domestic Product

Data are in constant prices (2005). For the Euro Area countries, the data in national currency for all years are calculated using the fixed conversion rates against the euro. Source: OECD Statistics (http://stats.oecd.org/).

Aggregate Investment

Data are in constant prices (2005). For the Euro Area countries, the data in national currency for all years are calculated using the fixed conversion rates against the euro. The series is obtained subtracting investment in structures and dwellings (series P51N1111 in the OECD data set) and intangible fixed assets (P51N112) from Gross Capital Formation (series P5). Source: OECD Statistics (http://stats.oecd.org/).

Unemployment Rate

The OECD harmonized unemployment rate gives the number of unemployed workers as a percentage of the labor force (working-age population). The variable refers to the 15-64 age group. Source: OECD, Database on Labour Force Statistics; OECD, Annual Labour Force Statistics.

Product Market Regulation

We use the OECD summary indicator of regulatory impediments to product market competition in seven non-manufacturing industries. The data covers regulations and market conditions in seven

[3]The countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, the United Kingdom, and the United States.

non-manufacturing industries: gas, electricity, post (basic letter, parcel, express mail), telecommunications (fixed and mobile services), passenger air transport, railways (passenger and freight services) and road freight. Detailed qualitative and quantitative data on several dimensions of ownership, regulation and market or industry structure are coded and aggregated into synthetic indicators that are increasing in the degree of restrictions to private ownership and competition. Dimensions covered are the degree of public ownership, legal impediments to competition, degree of vertical integration of natural monopoly and competitive activities in network industries, market share of incumbent or new entrants in network industries, and price controls in competitive activities. The index takes values between 0, extremely flexible, and 6, extremely rigid. Source: OECD, Product Market Database.

Labor Market Regulation

Benefit Replacement Rate The average unemployment benefit replacement rate is the average unemployment benefit replacement rate across two income situations (100 percent and 67 percent of the average production worker's earnings), three family situations (single, with dependent spouse, with spouse in work) and three different unemployment durations (1st year, 2nd and 3rd years, and 4th and 5th years of unemployment). Source: OECD, Benefits and Wages Database.[4]

Employment Protection Legislation This index is a summary indicator of the stringency of employment protection legislation for: indefinite contract (regular) workers, fixed-term contract (temporary) workers, and all contracts (measured as a simple average of indefinite and fixed-term contracts). Information on regular contracts includes procedural inconveniences that employers face when trying to dismiss a worker; notice and several payments at different job tenures; and prevailing standards of, and penalties for, unfair dismissals. Information on fixed-term and temporary work agency contracts includes: the objective reasons under which they can be offered; the maximum number of successive renewals; and the maximum cumulated duration of the contract. The index takes values between 0, extremely flexible, and 6, extremely rigid. Source: OECD, Indicators of Employment Protection.[5]

Robustness

First, we include all the three regulation variables in the VAR, together with the three macroeconomic variables. As before, we identify the structural disturbances by assuming that regulation variables are not contemporaneously affected by shocks to macroeconomic variables. By contrast, we adopt an agnostic approach concerning the contemporaneous relationship among the three measures of regulation. Figure A-3 corresponds to the case in which (i) product market regulation decisions contemporaneously affect labor market regulation (but not vice versa), and (ii) shocks to

[4] The series available from the OECD website starts from 1985. Bassanini and Duval (2009) provide data from 1982 onward. The data are available at sites.google.com/site/bassaxsite.

[5] The series available from the OECD website starts from 1985. Bassanini and Duval (2009) provide data from 1982 onward. The data are available at sites.google.com/site/bassaxsite.

employment protection legislation contemporaneously affect the benefits replacement rate (but not vice versa). As shown in the figure, short-run macroeconomic dynamics following each regulation shock are very similar to those obtained in Figure 7 in the main text. We then consider all the alternative possible recursive ordering of the three regulation measures. (Impulse responses are omitted for brevity, but they available upon request.) It turns out that the ordering makes little difference to the impulse response of macroeconomic variables. This result is not surprising, since the legislative delays associated to the approval and implementation of each regulation policy are likely to be independent across the different dimensions of regulation considered.

Next, even though the panel-unit-root tests described above reject the presence of unit roots in the data, we consider the case in which macroeconomic and regulation variables enter the VAR in first difference, allowing for the presence of stochastic trends in the variable of interest. We do so, since this exercise is the closest counterpart to the model simulations presented in the main text (in which we study permanent shocks to regulation).[6] Consistent with previous results, a negative shock to product market regulation or to employment protection legislation reduces GDP growth and it increase unemployment in the short run. (See Figure A-4.) These results are consistent with the model-implied impulse responses of the relevant macroeconomic growth rates, summarized in Figure A-5.

Finally, we consider sign restrictions upon the impulse responses as an alternative way of identifying structural shocks. Our approach follows Faust (1998), Canova and De Nicolo (2002), Pappa (2009), and Uhlig (2005), among others. Instead of imposing parametric restrictions by reducing the number of parameters to be estimated on the impact matrix, the sign restrictions approach generates many candidate impulse responses for any given shock, and then retains only those responses whose impulses agree with the postulated sign. The behavior of all the unrestricted macroeconomic variables is consistent with the model implications and in line with the impulse responses obtained by imposing a recursive ordering of the structural shocks. For brevity, we do not report the details here. They are available upon request.

G Welfare Computations in the Absence of Aggregate Uncertainty

We define short-run welfare as the consumption equivalent Δ_{SR} that would leave the household indifferent between implementing or not a given market reform in the first three years (12 quarters) following deregulation:

$$\frac{\left[C^n\left(1+\frac{\Delta}{100}\right)\right]^{(1-\gamma)}}{1-\gamma}\sum_{t=1}^{12}\beta^{t-1}=\sum_{t=1}^{12}\beta^{t-1}\frac{C_t^{1-\gamma}}{1-\gamma},$$

where, as in the main text, C_t denotes per-period consumption in the economy subject to market deregulation (and no aggregate shocks), and C^n is steady-state consumption in the rigid economy.

[6]Notice also that in the model, the impulse responses following temporary deregulation shocks (available upon request) feature short-run dynamics that are very similar to those following permanent deregulation shocks.

Medium-to-long-run welfare, Δ_{LR}, is the difference between the overall welfare effect of a given market reform absent business cycle shocks Δ and the short-run welfare impact Δ_{SR}, i.e. $\Delta_{LR} = \Delta - \Delta_{SR}$. Since Δ is given by

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

it is straightforward to verify that Δ_{LR} solves:

$$\frac{\left[C^n\left(1+\frac{\Delta}{100}\right)\right]^{(1-\gamma)}}{1-\gamma} \sum_{t=13}^{\infty} \beta^{t-1} = \sum_{t=13}^{\infty} \beta^{t-1} \frac{C_t^{1-\gamma}}{1-\gamma}.$$

H Sensitivity Analysis

Alternative Parameterizations

As explained in the text, since our calibration strategy combines values from the literature and parameters that are chosen to match selected targets in the data, we investigate the robustness of our results along both dimensions. We focus on parameters and targets whose value is controversial in the literature.

For the parameters that are calibrated using independent evidence, we consider two alternative values for the matching function elasticity, setting ε equal to 0.7 and 0.4, respectively the upper end of the range of estimates that Petrongolo and Pissarides (2006) report, and the value in Blanchard and Diamond (1989); we also consider higher and lower values for the workers' bargaining power η, setting $\eta = 0.4$, the value estimated by Flinn (2006), and $\eta = 0.7$, an upper bound of the value used in the literature; finally, we consider a higher degree of risk aversion, setting $\gamma = 2$. Concerning the selected targets, there is no conclusive evidence regarding the appropriate value of steady-state markups, the average cost of posting a vacancy, and the fraction of job destruction accounted for by firm exit. In particular: Bilbiie, Ghironi, and Melitz (2012) argue that in a model with entry costs, a steady-state markup of 35 percent is a plausible choice (implying that the steady-state elasticity of substitution is equal to 3.8);[7] the available estimates of hiring costs in euro area countries range from 13 percent of average wages (in France, our benchmark choice) up to 20 percent (in Italy, as estimated by Boca and Rota (1998)); and Haltiwanger, Scarpetta, and Schweiger (2006) report that the fraction of job destruction accounted for by firm exit ranges between 21 percent (in France and Germany) and 30 percent (in Italy). Thus, we target $\mu - 1 = .35$, $\kappa/(q\tilde{w}) = .20$ and set δ so that $N_E l/JD = 0.30$. Finally, we study how the the investment adjustment cost, ν, and the technological sunk entry cost, f_T, affect our results. We set ν equal to zero and consider two alternative targets for the calibration of f_T. Consistent with Barseghyan and DiCecio (2011), we set f_T such that the implied cost of non-regulatory entry barriers is either 20 percent or 95 percent

[7] The authors argue that although a steady-state elasticity of substitution equal to 3.8 implies a fairly high markup over marginal cost, this parametrization delivers reasonable results with respect to pricing and average costs.

of output per worker. These figures imply that, at the aggregate level, technological entry costs amount to 1.04 and 2.35 percent of GDP, respectively.

In conducting the sensitivity analysis, an important aspect involves the treatment of all the other parameters whose value was initially calibrated to match a specific target in the data. Had we used the aforementioned alternative values for ε, η, γ, ν, and f_T, or had we targeted different values for the net markup $(\mu - 1)$, $\kappa/(q\tilde{w})$, and δ, the values of all the parameters calibrated to reproduce selected (unchanged) targets would have been different. For this reason, we consider one change at a time in ε, η, γ, ν, f_T, $(\mu - 1)$, κ/q and δ, and, for internal consistency, we recalibrate the model each time so that all the targets discussed in Section 4 continue to hold true.

Table A.4 and A-5 present the result of the sensitivity analysis. For brevity, we do not present impulse responses; they are available upon request. From a quantitative point of view, higher values for the elasticity of substitution and technological entry costs reduce the quantitative effects of lowering entry barriers, both in the long run and over the business cycle. Nevertheless, the effects of product market deregulation remain sizable across the alternative scenarios we consider. A lower value of the matching function elasticity relative to unemployment and smaller workers' bargaining power increase the quantitative importance of reducing unemployment benefits. (Although, in both cases, the semi-elasticity of unemployment relative to b is higher than what is observed in the data.)

Finally, notice that when $\eta \neq \varepsilon$ there is an additional distortion relative to those described in the main text, since the so-called Hosios condition does not hold. By contrast, the number of inefficiency wedges that distort agents' equilibrium decisions is obviously not affected. Importantly, even when the workers' bargaining power is inefficiently low or high, the main features of the welfare analysis presented in the main text are not significantly affected, i.e., the very nature of the efficiency tradeoffs that characterize deregulation remains the same.

Alternative Timing of Events in Product and Labor Markets

We also consider an alternative version of the model that features a different timing of events in the product and labor markets. Specifically, we assume that new producers and new matches start producing immediately upon their creation. Below we refer to this alternative timing as "instantaneous production." For brevity, we do not report the analytical details of the new model and the corresponding simulations. They are available upon request.

The following is a brief overview of the new model: In the labor market, at the beginning of each period, a fraction λ^x of last period's workers are exogenously separated from each firm. Aggregate shocks are then realized, and firms post vacancies $v_{\omega t}$, which are filled with probability q_t. Once the hiring round has taken place, both newly created and continuing matches receive an idiosyncratic productivity shock, and firms optimally determine the job-productivity cutoff $z^c_{\omega t}$. All the workers surviving job destruction produce within the period. This timing of events implies the following law of motion of employment for a producer :

$$l_{\omega t} = \left(1 - G\left(z^c_{\omega t}\right)\right)\left[(1 - \lambda^x) l_{\omega t-1} + q_t v_{\omega t}\right].$$

In the product market, new entrants N_{Et} start to produce immediately. This alternative timing implies that the law of motion for the number of producing firms is given by:

$$N_t = (1 - \delta)N_{t-1} + N_{Et}.$$

The alternative timing of markets affects three equilibrium conditions—the job creation equation, the job destruction equation, and the Euler equation for product creation—together with the law of motion for aggregate employment and the number of producers. Relative to the benchmark model, five equations in Table 1 are affected: (2), (6), (7), (8), and (10). Notice that in the new model, product and job creation remain subject to frictions: hiring is costly due to costly vacancy posting, while market entry requires irreversible investment costs. However, assuming instantaneous production amounts to partly reducing product and labor market frictions: In the labor market, firms can achieve a given level of production by using both hiring and firing margins within the period, balancing out the productivity effects of job destruction with the change in the stock of labor brought about by filled vacancies; in the product market, new producers can immediately exploit profit opportunities. By contrast, in the benchmark model, delays in production following labor matching and producer entry act, de facto, as implicit adjustment costs in job and product creation.

We evaluate the robustness of our results to the alternative timing assumptions by repeating all the exercises considered in the paper. In order to isolate the consequences of introducing instantaneous production in the model, we use the same calibration as the benchmark model.

The results are very similar to those obtained in the paper. The sole difference is that the removal of firing costs no longer induces an appreciable short-run increase in unemployment. Nevertheless, despite the reduction in transition costs, the removal of firing restrictions in the presence of high barriers to entry and unemployment benefits continues to be highly detrimental for welfare. This happens because, as in the benchmark model, the increase in the welfare cost of business cycles remains substantial.

The different result of short-run unemployment dynamics following the removal of firing restrictions is not surprising. First, a given cut in firing costs increases vacancy posting by more when job creation leads to instantaneous production, since the benefits from match formation accrue immediately to the firm. Second, since newly matched workers immediately receive labor income, the increase in job creation counteracts the reduction in aggregate demand implied by higher job destruction. As a result, unemployment remains essentially unchanged in the aftermath of the reform and then slowly declines toward its new long-run level. This result indicates that frictions in job creation play an important role for unemployment dynamics following a reduction in firing costs.

Concerning product market deregulation, the reason why the short-run adjustment is not significantly affected by the new timing assumptions is the following: On one side, the fact that new entrants start producing immediately boosts labor and capital demand on impact. On the other hand, as competition increases immediately, incumbents downsize more aggressively. On net, these two effects offset each other, leaving aggregate dynamics essentially unchanged.

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TABLE A-1: EFFICIENT ALLOCATION

(1)	$L_t = (1-\lambda_t)(1-\delta)(L_{t-1} + M_{t-1})$
(2)	$K_{t+1} = (1-\delta_K) K_t + I_{Kt}\left[1 - \frac{\nu}{2}\left(\frac{I_{Kt}}{I_{Kt-1}} - 1\right)^2\right]$
(3)	$1 = \zeta_{Kt}\left[1 - \frac{\nu}{2}\left(\frac{I_{Kt}}{I_{Kt-1}} - 1\right)^2 - \nu\left(\frac{I_{Kt}}{I_{Kt-1}} - 1\right)\left(\frac{I_{Kt}}{I_{Kt-1}}\right)\right] + \nu\beta_{t,t+1}E_t\left[\zeta_{Kt+1}\left(\frac{I_{Kt+1}}{I_{Kt}} - 1\right)\left(\frac{I_{Kt+1}}{I_{Kt}}\right)^2\right]$
(4)	$\rho_t = \exp\left(-\frac{\tilde{N} - N_t}{2\sigma\tilde{N}N_t}\right)$
(5)	$M_t = \chi U_t^{\varepsilon} V_t^{1-\varepsilon}$
(6)	$1 = (1-\delta) E_t\left\{\beta_{t,t+1}\left[1 + (2\sigma N_{t+1} f_T)^{-1}\left(\frac{Y_{t+1}}{N_{t+1}}\right)\right]\right\}$
(7)	$1 = E_t\left\{\frac{q_t}{\kappa}\tilde{\beta}_{t,t+1}(1-\varepsilon)(1-\alpha)\left[1 - G\left(z_{t+1}^c\right)\right]\rho_{t+1}Z_{t+1}\tilde{z}_{t+1}\left(\frac{K_{t+1}}{L_{t+1}}\right)^{\alpha}\left[1 - \left(\frac{z_{t+1}^c}{\tilde{z}_{t+1}}\right)^{\frac{1}{1-\alpha}}\right]\right\}$
(8)	$1 = \frac{q_t}{\kappa(q_t\varepsilon\vartheta_t - 1)}\left\{(1-\varepsilon)\left[(1-\alpha)\rho_t Z_t\tilde{z}_t\left(\frac{K_t}{L_t}\right)^{\alpha}\left(\frac{z_t^c}{\tilde{z}_t}\right)^{\frac{1}{1-\alpha}} - h_p\right]\right\}$
(9)	$1 = E_t\left\{\beta_{t,t+1}\left[\alpha\rho_{t+1}Z_{t+1}\tilde{z}_{t+1}\left(\frac{K_{t+1}}{L_{t+1}}\right)^{\alpha-1}\frac{1}{\zeta_{Kt}} + (1-\delta_K)\frac{\zeta_{Kt+1}}{\zeta_{Kt}}\right]\right\}$
(10)	$\rho_t Z_t\tilde{z}_t K_t^{\alpha} L_t^{1-\alpha} + h_p(1-L_t) = C_t + I_{Kt} + \left(\frac{N_{t+1}}{1-\delta} - N_t\right) f_T + \kappa V_t$

Note: $\beta_{t,t+1} \equiv \beta(C_{t+1}/C_t)^{-\gamma}$; $\tilde{\beta}_{t,t+1} \equiv (1-\delta)(1-\lambda^x)\beta_{t,t+1}$, and $\vartheta_t \equiv V_t/U_t$.

TABLE A-2: INEFFICIENCY WEDGES AND MARKET REFORMS—NON-STOCHASTIC STEADY STATE

	Baseline	Entry Cost (f_R)	Firing Cost (F)	Benefit (b)	Joint (f_R, F, b, simultaneous*)	Joint (f_R, F, b, f_R first*)	Joint (f_R, F, b, F, b first*)
Product Creation							
Σ_N	0.002	0.006	0.002	0.002	0.006	0.006	0.006
Job Creation							
Σ_{JC}	0.670	0.553	0.099	0.523	0.075	0.075	0.075
Job Destruction							
Σ_{JD}	2.183	1.976	2.232	1.545	1.605	1.605	1.605
Capital Accumulation							
Σ_K	0.004	0.003	0.003	0.003	0.003	0.003	0.003
Resource Constraint							
Σ_{RC}	0.051	0.018	0.051	0.051	0.018	0.018	0.018

Note: $\Sigma_i \equiv$ steady-state value of the wedge i; *Timing of implementation of joint reforms.

TABLE A-3: INEFFICIENCY WEDGES AND MARKET REFORMS—BUSINESS CYCLE

	Baseline		Entry Cost (f_R)		Firing Cost (F)		Benefit (b)		Joint (f_R,F,b)	
Product Creation										
	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}
Σ_{PC}	0.003	0.003	0.006	0.006	0.003	0.004	0.003	0.002	0.006	0.005
Job Creation										
	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}
Σ_{JC}	0.699	5.894	0.574	4.026	0.099	0.027	0.537	2.679	0.075	0.024
Job Destruction										
	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}
Σ_{JD}	2.273	18.408	2.044	13.068	2.295	10.717	1.586	7.441	1.636	5.273
Capital Accumulation										
	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}
Σ_K	0.003	0.004	0.003	0.003	0.003	0.005	0.003	0.003	0.003	0.002
Resource Constraint										
	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}	μ_{Σ_i}	σ_{Σ_i}
Σ_Y	0.049	0.572	0.016	0.248	0.050	0.629	0.048	0.616	0.016	0.277

$\sigma_{\Sigma i} \equiv$ standard deviation of wedge Σi (in percentage terms); $\mu_{\Sigma_i} \equiv$ unconditional mean of wedge Σi.

TABLE A-4: SENSITIVITY ANALYSIS—NONSTOCHASTIC STEADY STATE

		f_R (rigid F,b)*	F (rigid f_R,b)*	b (rigid f_R,F)*	f_R, F, b
		Change in Long-Run Welfare (Δ)**			
Baseline		1.79%	0.16%	1.11%	3.29%
Alternative Parameter					
Coefficient of risk aversion	$\gamma = 2$	1.63%	0.24%	1.10%	3.10%
Matching function elasticity	$\varepsilon = 0.4$	1.96%	0.26%	1.69%	3.69%
	$\varepsilon = 0.7$	1.72%	0.15%	0.83%	2.81%
Workers' bargaining power	$\eta = 0.4$	1.94%	0.02%	1.58%	3.65%
	$\eta = 0.7$	1.75%	0.07%	0.91%	2.64%
	$\varepsilon = \eta = 0.4$	2.15%	0.06%	2.32%	4.60%
	$\varepsilon = \eta = 0.7$	1.65%	0.07%	0.68%	2.34%
Investment adjustment costs	$\nu = 0$	1.74%	0.25%	1.12%	3.16%
Alternative Target					
Technological entry cost	$\frac{f_T}{Y^g} = 0.20$	1.66%	0.17%	1.11%	3.13%
	$\frac{f_T}{Y^g} = 0.95$	1.57%	0.16%	1.10%	3.08%
Markup	$\mu = 1.35$	1.67%	0.20%	1.22%	3.72%
Hiring cost	$\frac{\kappa}{q\tilde{w}} = 0.19$	1.42%	0.10%	0.89%	2.34%
Job destruction due to firm exit	$\frac{\delta L}{(1-\delta)M} = 0.21$	1.67%	0.05%	1.28%	2.86%
	$\frac{\delta L}{(1-\delta)M} = 0.29$	1.90%	0.55%	1.03%	3.14%

*Other dimensions of regulation.

**Δ includes transition dynamics; percentage of C in the rigid economy.

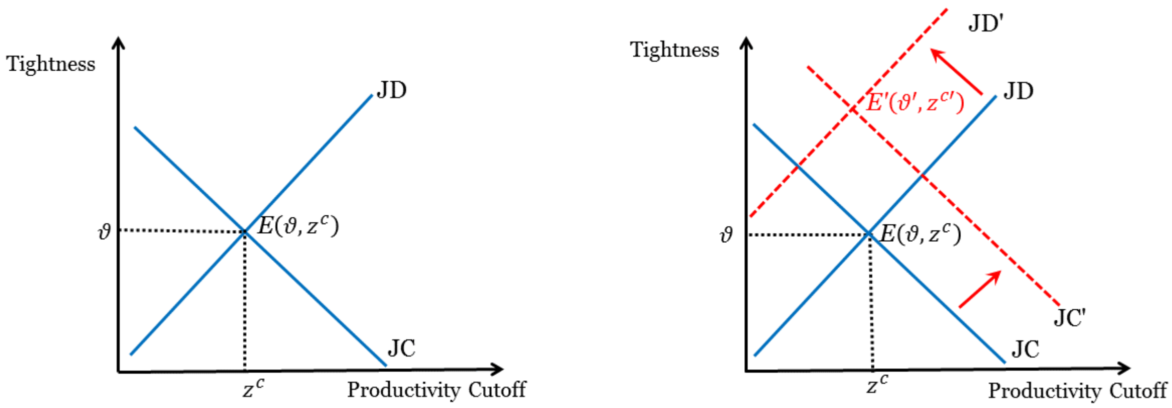
TABLE A-5: SENSITIVITY ANALYSIS—STOCHASTIC STEADY STATE

		f_R (rigid F,b)*	F (rigid f_R,b)*	b (rigid f_R,F)*	f_R, F, b
		Change in the Welfare Cost of Business Cycles (Δ_{BC})**			
Baseline		0.82%	-2.03%	1.29%	1.38%
Alternative Parameter					
Coefficient of risk aversion	$\gamma = 2$	1.05%	-1.58%	1.53%	1.56%
Matching function elasticity	$\varepsilon = 0.4$	0.72%	-0.34%	1.08%	1.18%
	$\varepsilon = 0.7$	1.09%	-2.19%	1.57%	1.67%
Workers' bargaining power	$\eta = 0.4$	1.18%	-2.28%	1.47%	1.56%
	$\eta = 0.7$	0.59%	-0.29%	1.03%	1.08%
	$\varepsilon = \eta = 0.4$	0.78%	-1.13%	1.04%	1.11%
	$\varepsilon = \eta = 0.7$	0.99%	-0.22%	1.39%	1.42%
Investment adjustment costs	$\nu = 0$	0.81%	-1.43%	1.20%	1.29%
Alternative Target					
Technological entry cost	$\frac{f_T}{Y^g} = 0.20$	0.80%	-2.04%	1.29%	1.37%
	$\frac{f_T}{Y^g} = 0.95$	0.76%	-2.04%	1.28%	1.36%
Markup	$\mu = 1.35$	2.36%	-5.40%	2.95%	3.20%
Hiring cost	$\frac{\kappa}{q\tilde{w}} = 0.19$	0.89%	-0.38%	1.43%	1.49%
Job destruction due to firm exit	$\frac{\delta L}{(1-\delta)M} = 0.21$	1.07%	-0.19%	1.38%	1.41%
	$\frac{\delta L}{(1-\delta)M} = 0.29$	0.52%	-0.41%	0.79%	0.92%

*Level of regulation in the non-reformed markets; Status Quo≡no reforms..

**$\Delta_{BC} > 0$ implies a reduction in the welfare cost of business cycles (in percentage of C)

Job Creation and Job Destruction | **An Increase in the Number of Producers**

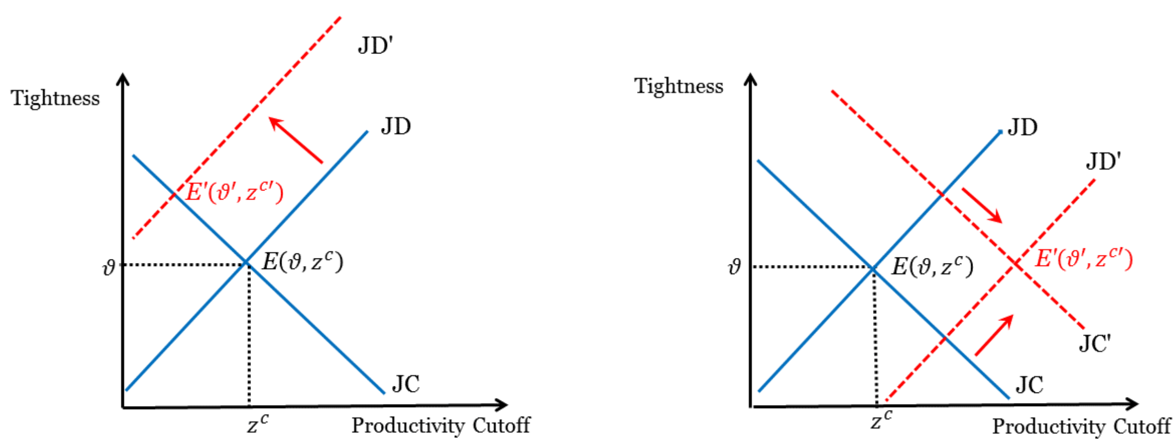


Note: JC ≡ Job Creation; JD ≡ Job Destruction. The curves JC and JD plot, respectively, equations (15) and (16) in the main text, keeping constant the number of producers (N).

Note: In the new long-run equilibrium, $z^{c\prime} < z^c$ provided that the reduction in JD is sufficiently large relative to the increase in JC; $\vartheta' > \vartheta$ always.

Figure A-1.

A Reduction in Unemployment Benefits | **A Reduction in Firing Costs**



Note: In the new long-run equilibrium, $z^{c\prime} < z^c$ and $\vartheta' > \vartheta$ always. The figure assumes that the number of producers (N) remains constant.

Note: In the new long-run equilibrium, $z^{c\prime} > z^c$ always; $\vartheta' > \vartheta$ if the increase in JC more than compensates the increase in JD. The figure assumes that the number of producers (N) remains constant.

Figure A-2.

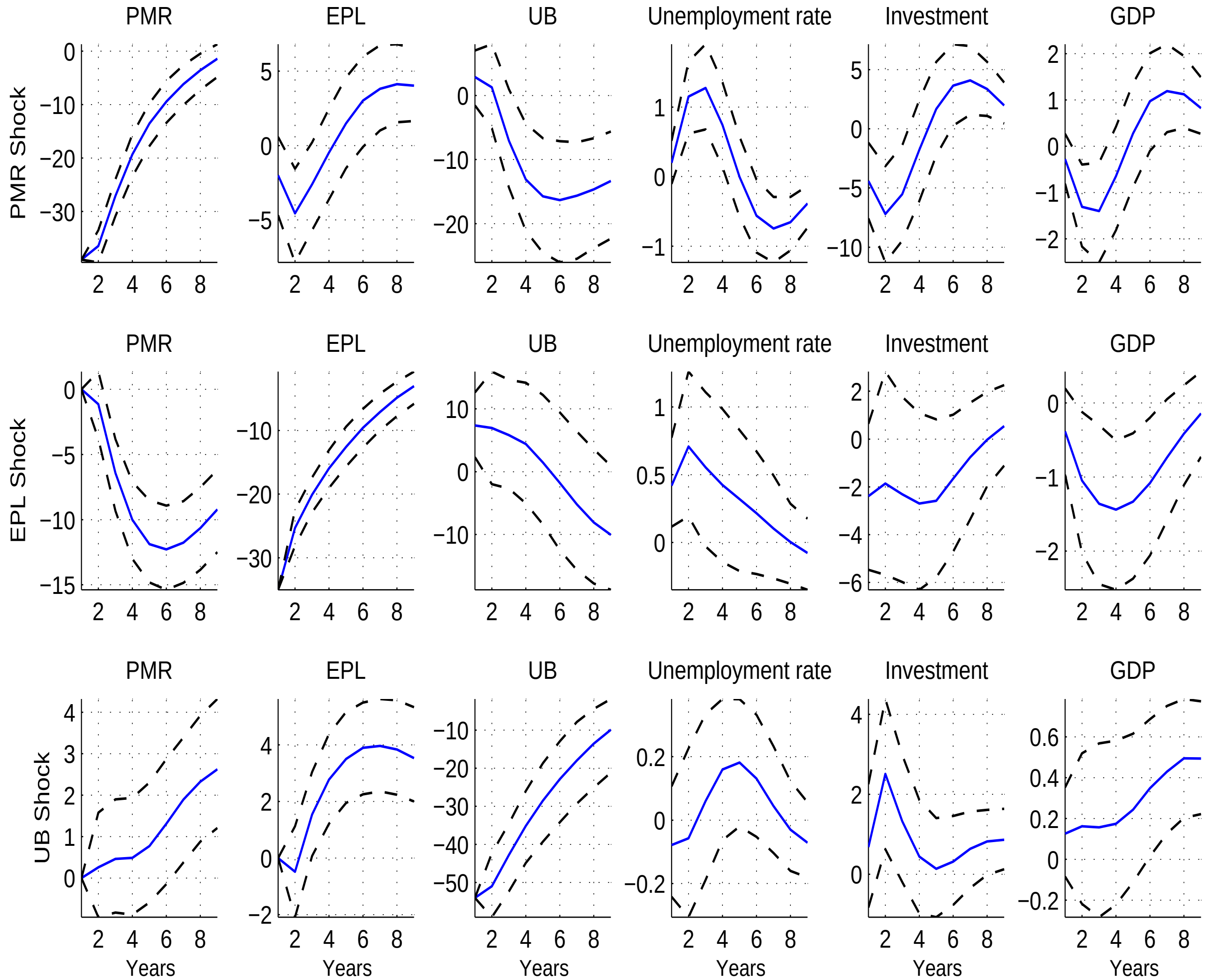


Figure A-3. Augmented Panel VAR with recursive ordering, impulse responses to regulation shocks. GDP and Investment are in percent from baseline; Unemployment rate is in deviations from baseline. *PMR*: index of product market regulation; *EPL*: index of employment protection legislation; *UB*: benefit replacement rate.

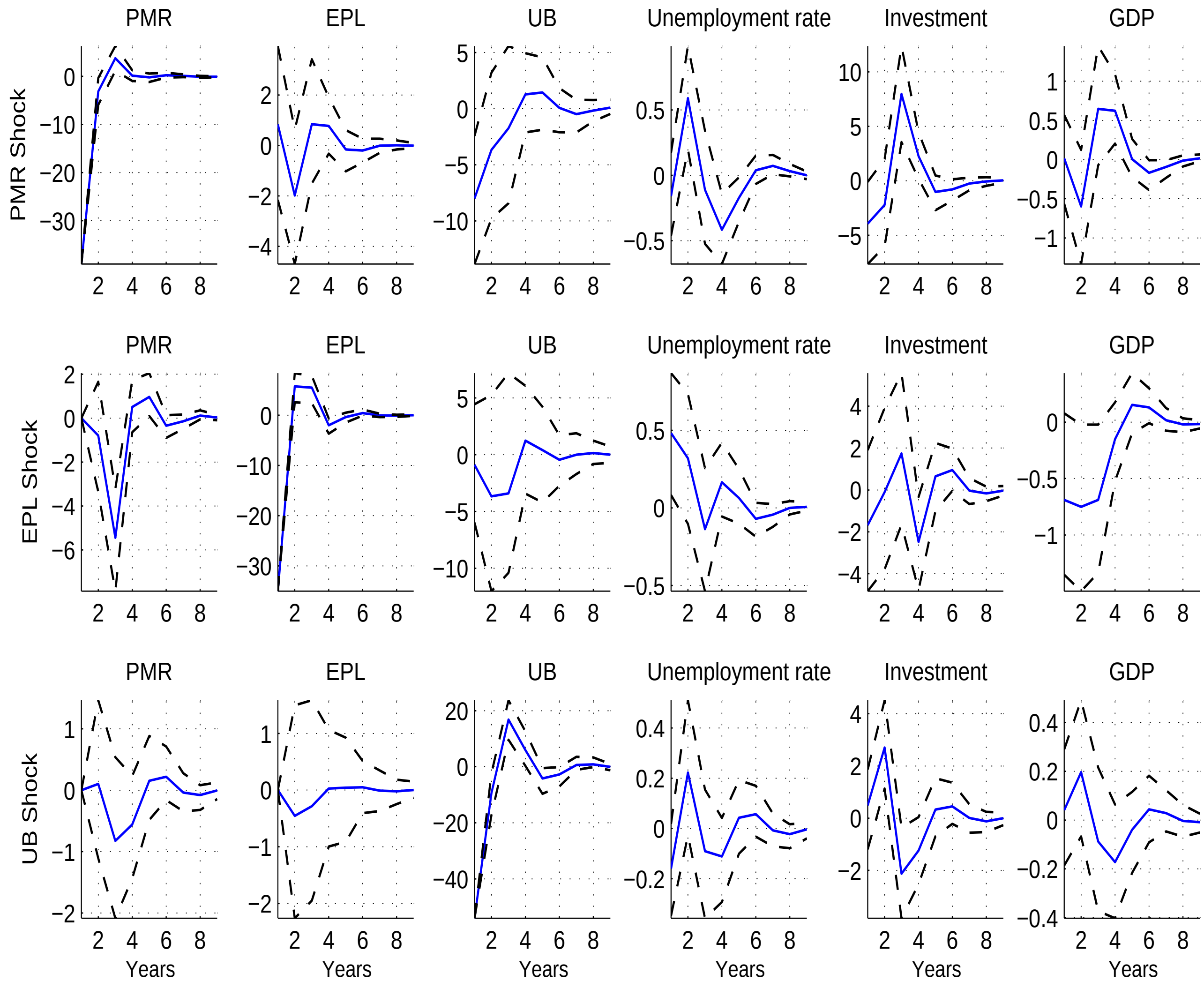


Figure A-4. Panel VAR with variables in first difference, recursive ordering, impulse responses to regulation shocks. GDP and Investment are in percent from baseline; Unemployment rate is in deviations from baseline. *PMR*: index of product market regulation; *EPL*: index of employment protection legislation; *UB*: benefit replacement rate.

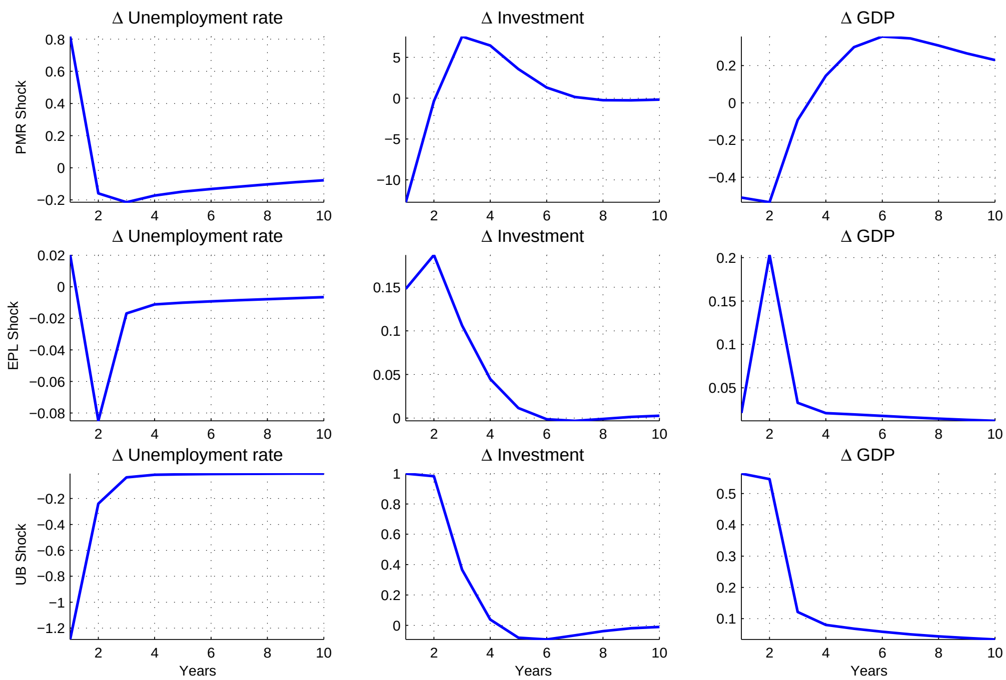


Figure A-5. Model-implied impulse responses to regulation shocks. $\Delta \equiv$ Growth Rate. *PMR*: index of product market regulation; *EPL*: index of employment protection legislation; *UB*: benefit replacement rate.