Market Deregulation and Optimal Monetary Policy in a Monetary Union: Appendix

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A. Wage Determination

Let J_t be the real value of an existing, productive match for a producer, determined by:

$$J_t = \varphi_t Z_t h_t - \frac{w_t}{P_t} h_t - \frac{\vartheta}{2}\pi_{w,t}^2 + E_t \beta_{t,t+1}(1-\lambda)J_{t+1}. \tag{1}$$

Intuitively, J_t is the per-period marginal value product of the match, $\varphi_t Z_t h_t$, net of the wage bill and costs incurred to adjust wages, plus the expected discounted continuation value of the match in the future.[1]

Next, denote with W_t the worker's asset value of being matched, and with $U_{u,t}$ the value of being unemployed. The value of being employed at time t is given by the real wage bill the worker receives plus the expected future value of being matched to the firm. With probability $1-\lambda$ the match will survive, while with probability λ the worker will be unemployed. As a result:

$$W_t = \frac{w_t}{P_t} h_t + E_t \left\{ \beta_{t,t+1} \left[(1-\lambda) W_{t+1} + \lambda U_{u,t+1} \right] \right\}. \tag{2}$$

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[1] Note that equation (1) in the main text and equation (1) above together imply that there is a difference between the value of an existing match to the producer and the vacancy creation cost per match today (which becomes productive tomorrow), reflecting the expected discounted change in the per-period profitability of the match between today and tomorrow. If matches were productive immediately, it would be $J_t = \kappa/q_t$.

The value of unemployment is given by:

$$U_{u,t} = \frac{v(h_t)}{u_{C,t}} + b + E_t \left\{ \beta_{t,t+1} [\iota_t W_{t+1} + (1 - \iota_t) U_{u,t+1}] \right\}. \tag{3}$$

In this expression, $v(h_t)/u_{C,t}$ is the utility gain from leisure in terms of consumption, b is an unemployment benefit from the government (financed with lump sum taxes), and ι_t is the probability of becoming employed at time t, equal to the ratio between the total number of matches and the total number of workers searching for jobs at time t: $\iota_t \equiv M_t/U_t$.

Equations (2) and (3) imply that the worker's surplus $H_t \equiv W_t - U_{u,t}$ is determined by:

$$H_t = \frac{w_t}{P_t} h_t - \left(\frac{v(h_t)}{u_{C,t}} + b \right) + (1 - \lambda - \iota_t) E_t \left(\beta_{t,t+1} H_{t+1} \right). \tag{4}$$

Nash bargaining maximizes the joint surplus $J_t^{\eta} H_t^{1-\eta}$ with respect to w_t, where $\eta \in (0,1)$ is the firm's bargaining power. The first-order condition implies:

$$\eta H_t \frac{\partial J_t}{\partial w_t} + (1 - \eta) J_t \frac{\partial H_t}{\partial w_t} = 0, \tag{5}$$

where:

$$\frac{\partial J_t}{\partial w_t} = -\frac{h_t}{P_t} - \vartheta \frac{\pi_{w,t}}{w_{t-1}} + (1 - \lambda) \vartheta E_t \left[\beta_{t,t+1} (1 + \pi_{w,t+1}) \frac{\pi_{w,t+1}}{w_t} \right], \tag{6}$$

and:

$$\frac{\partial H_t}{\partial w_t} = \frac{h_t}{P_t}. \tag{7}$$

The sharing rule can then be rewritten as:

$$\eta_{w,t} H_t = (1 - \eta_{w,t}) J_t, \tag{8}$$

where:

$$\eta_{w,t} = \frac{\eta}{\eta - (1 - \eta) \left(\frac{\partial H_t}{\partial w_t} / \frac{\partial J_t}{\partial w_t} \right)}. \tag{9}$$

Equation (8) shows that, as in Gertler and Trigari (2009), bargaining shares are time-varying due to the presence of wage adjustment costs. Absent wage adjustment costs, we would have $\partial J_t/\partial w_t = -\partial H_t/\partial w_t$ and a time-invariant bargaining share $\eta_{w,t} = \eta$.

Equation (2) in the main text for the bargained wage implies that the value of a match to a producer can be rewritten as:

$$J_t = \eta_{w,t}\left[\varphi_t Z_t h_t - \frac{\vartheta}{2}\pi_{w,t}^2 - \left(\frac{v(h_t)}{u_{C,t}} + b\right)\right] + E_t\left\{\beta_{t,t+1}J_{t+1}\left[(1-\lambda)\eta_{w,t} + (1-\lambda-\iota_t)(1-\eta_{w,t+1})\frac{\eta_{w,t}}{\eta_{w,t+1}}\right]\right\}. \tag{10}$$

The second term in the right-hand side of this equation reduces to $[1-\lambda-(1-\eta)\,\iota_t]\,E_t\left(\beta_{t,t+1}J_{t+1}\right)$ when wages are flexible. The firm's equilibrium surplus is the share η of the marginal revenue product generated by the worker, net of wage adjustment costs and the worker's outside option, plus the expected discounted future surplus, adjusted for the probability of continuation, $1-\lambda$, and the portion appropriated by the worker, $(1-\eta)\,\iota_t$. Sticky wages again introduce an effect of expected changes in the endogenous bargaining shares.

B. Firm Demand and Optimal Price Setting

The producer of final good ω at Home faces the following domestic and Foreign demands for its output:

$$y_{d,t}(\omega) = (1-\alpha)\sigma\ln\left(\frac{\bar{p}_{d,t}}{p_{d,t}(\omega)}\right)\frac{P_{d,t}}{p_{d,t}(\omega)}\left(\frac{P_{d,t}}{P_t}\right)^{-\phi}Y_t^C, \tag{11}$$

$$y_{x,t}(\omega) = \alpha\sigma\ln\left(\frac{\bar{p}_{x,t}}{p_{x,t}(\omega)}\right)\frac{P_{x,t}}{p_{x,t}(\omega)}\left(\frac{P_{x,t}}{P_t^*}\right)^{-\phi}Y_t^{C*}, \tag{12}$$

where Y_t^C and Y_t^{C*} denote aggregate demand of the final consumption basket at Home and abroad, and

$$\ln\bar{p}_{d,t} = \frac{1}{\sigma N_t} + \frac{1}{N_t}\int_{\omega\in\Omega_{d,t}}\ln p_{d,t}(\omega)d\omega \quad \text{and} \quad \ln\bar{p}_{x,t} = \frac{1}{\sigma N_t} + \frac{1}{N_t}\int_{\omega\in\Omega_{x,t}}\ln p_{x,t}(\omega)d\omega$$

are the maximum prices that a domestic producer can charge in the Home and Foreign markets while still having a positive market share.

Focus first on the case of flexible prices. A Home firm selling at Home chooses $p_{d,t}(\omega)$ to maximize:

$$E_t\sum_{s=t}^{\infty}[\beta(1-\delta)]^{s-t}\frac{u_{C,s}}{u_{C,t}}\left(\frac{p_{d,s}(\omega)}{P_s} - \varphi_s\right)y_{d,s}(\omega),$$

subject to (11). The optimal price of domestic sales is determined by:

$$\frac{p_{d,t}(\omega)}{P_t} = \left[1 + \ln\left(\frac{\bar{p}_{d,t}}{p_{d,t}(\omega)}\right)\right]\varphi_t. \tag{13}$$

When selling abroad, the firm chooses $p_{x,t}(\omega)$ to maximize:

$$E_t \sum_{s=t}^{\infty} [\beta(1-\delta)]^{s-t} \frac{u_{C,s}}{u_{C,t}} \left(Q_s \frac{p_{x,s}(\omega)}{P_s^*} - \varphi_s \right) y_{x,s}(\omega),$$

subject to (12). The optimal export price is determined by:

$$\frac{p_{x,t}(\omega)}{P_t} = \left[1 + \ln \left(\frac{\bar{p}_{x,t}}{p_{x,t}(\omega)} \right) \right] \varphi_t. \tag{14}$$

Pricing-to-market arises if $p_{d,t}(\omega) \neq p_{x,t}(\omega)$ in equilibrium, but the Armington form of the consumption aggregator implies that this never happens. To see this, recall first the definition of the reservation prices (the maximum prices that can be charged while still having positive market share):

$$\begin{aligned}
\ln \bar{p}_{d,t} &= \frac{1}{\sigma N_t} + \frac{1}{N_t} \int\limits_{\omega \in \Omega_{d,t}} \ln p_{d,t}(\omega) d\omega, \\
\ln \bar{p}_{x,t} &= \frac{1}{\sigma N_t} + \frac{1}{N_t} \int\limits_{\omega \in \Omega_{x,t}} \ln p_{x,t}(\omega) d\omega.
\end{aligned}$$

In the symmetric equilibrium, all firms that serve the Home market are also exporters. It follows that:

$$\ln \bar{p}_{d,t} = \frac{1}{\sigma N_t} + \ln p_{d,t}, \quad \text{and} \quad \ln \bar{p}_{x,t} = \frac{1}{\sigma N_t} + \ln p_{x,t}.$$

As a result:

$$\ln \left(\frac{\bar{p}_{d,t}}{p_{d,t}} \right) = \frac{1}{\sigma N_t} = \ln \left(\frac{\bar{p}_{x,t}}{p_{x,t}} \right).$$

Substituting this into the optimal price equations (13) and (14), we have:

$$\frac{p_{d,t}}{P_t} = \left(1 + \frac{1}{\sigma N_t} \right) \varphi_t = \frac{p_{x,t}}{P_t}.$$

Thus, there is no pricing-to-market under flexible prices. This happens because the Armington aggregator implies that the ratios of reservation prices to optimal prices for Home producers in the Home and Foreign markets depend only on the identical number of Home firms that serve domestic and export markets.

The extension to the sticky-price case is straightforward under the assumption that prices are sticky in the currency of producers, an assumption that is always satisfied in a monetary union.

C. Symmetric Equilibrium

The aggregate stock of employed labor in the Home economy in period t is determined by $l_t = (1-\lambda)l_{t-1} + q_{t-1}V_{t-1}$. Furthermore, symmetry across final producers implies that $\theta_t(\omega) = \theta_t = 1 + \sigma N_t$. Hence, $\rho_{d,t}(\omega) = \rho_{d,t}$ and $\rho_{x,t}(\omega) = \rho_{x,t}$.[2] Wage inflation and consumer price inflation are tied by $1+\pi_{w,t} = \left(w_t^r / w_{t-1}^r\right)(1+\pi_{C,t})$, where w_t^r denotes the real wage, w_t/P_t, at time t. Producer price inflation and consumer price inflation are such that $1+\pi_{d,t} = \left(\rho_{d,t}/\rho_{d,t-1}\right)(1+\pi_{C,t})$. Home and Foreign consumer price inflation are such that $1+\pi_{C,t} = (Q_{t-1}/Q_t)\left(1+\pi_{C,t}^*\right)$.

The equilibrium price index satisfies:

$$1 = (1-\alpha)\left[\rho_{d,t}\exp\left(\frac{\tilde{N}-N_t}{2\sigma\tilde{N}N_t}\right)\right]^{1-\phi} + \alpha\left[\rho_{x,t}^*\exp\left(\frac{\tilde{N}^*-N_t^*}{2\sigma\tilde{N}^*N_t^*}\right)\right]^{1-\phi},$$

where $\exp(X)$ denotes the exponential of X.

Labor market clearing requires:

$$l_t = \frac{N_{E,t}f_{E,t}}{Z_t h_t} + \frac{N_t(y_{d,t}+y_{x,t})}{Z_t h_t}.$$

Aggregate demand of the consumption basket must be equal to the sum of consumption, the costs of posting vacancies, and the costs of adjusting wages and prices:

$$Y_t^C = C_t + \kappa V_t + \frac{\vartheta}{2}\pi_{w,t}^2 l_t + \frac{\nu}{2}\pi_{d,t}^2\rho_{d,t}(y_{d,t}+y_{x,t})N_t.$$

Finally, in equilibrium the lump-sum transfers (taxes) are given by:

$$T_t = -P_t b(1-l_t) + P_t\frac{\tau}{2}\left(\frac{A_{t+1}}{P_t}\right)^2 + P_t\left(\varphi_t Z_t l_t h_t - \frac{w_t}{P_t}l_t h_t - \kappa V_t - \frac{\vartheta}{2}\pi_{w,t}^2 l_t\right).$$

We define GDP, denoted with Y_t, as total income: the sum of labor income, dividend income from final producers, and profit income from intermediate producers. Formally: $Y_t \equiv (w_t/P_t)\, l_t h_t + N_t d_t + T_t^i$, where $T_t^i \equiv \varphi_t Z_t l_t h_t - \frac{w_t}{P_t} l_t h_t - \kappa V_t - \frac{\vartheta}{2}\pi_{w,t}^2 l_t$.

[2] The (flexible-price) price elasticity does not depend on N_t^* because of the assumption of an Armington aggregator of Home and Foreign sub-bundles. This same assumption implies that the price elasticity facing a Foreign producer in both markets depends on N_t^*, but not N_t.

D. The Law of Motion for Net Foreign Assets

Recall the representative household's budget constraint:

$$A_{t+1}+P_t\frac{\tau}{2}\left(\frac{A_{t+1}}{P_t}\right)^2+P_tC_t+x_{t+1}\left(N_t+N_{E,t}\right)P_te_t= \tag{15}$$

$$(1+i_t)A_t+x_tP_tN_t(d_t+e_t)+w_tl_th_t+P_tb(1-l_t)+T_t^G+T_t^F+T_t^I.$$

In equilibrium, $x_t=x_{t+1}=1$ for all t. The budget constraint of the government implies:

$$T_t^G=-P_tb(1-l_t).$$

Moreover,

$$T_t^F=P_t\frac{\tau}{2}\left(\frac{A_{t+1}}{P_t}\right)^2,$$

and:

$$T_t^I=P_t\left(\varphi_tZ_tl_th_t-\frac{w_t}{P_t}l_th_t-\kappa V_t-\frac{\vartheta}{2}\pi_{w,t}^2l_t\right).$$

Therefore:

$$A_{t+1}+P_tC_t+N_{E,t}e_t=(1+i_t)A_t+P_tN_t(d_t+e_t)+P_t\varphi_tZ_tl_th_t-P_t\kappa V_t-P_t\frac{\vartheta}{2}\pi_{w,t}^2l_t. \tag{16}$$

It is possible to simplify the consolidated budget constraint of the economy further. To begin, notice that:

$$d_t=\left(\rho_{d,t}-\varphi_t\right)\left(y_{d,t}+y_{x,t}\right)-\frac{\nu}{2}\pi_{d,t}^2\left(y_{d,t}+y_{x,t}\right)\rho_{d,t}.$$

It follows that, after substituting and rearranging, equation (16) can be rewritten in real terms as:

$$a_{t+1}=\frac{1+i_t}{1+\pi_{C,t}}a_t+N_t\left(\rho_{d,t}-\varphi_t\right)\left(y_{d,t}+y_{x,t}\right)+\varphi_tZ_tl_th_t-\left[\begin{array}{c}C_t+N_{E,t}e_t+\kappa V_t+\frac{\vartheta}{2}\pi_{w,t}^2l_t\\+\frac{\nu}{2}\pi_{d,t}^2\left(y_{d,t}+y_{x,t}\right)\rho_{d,t}N_t\end{array}\right]. \tag{17}$$

Next, recall the expression for Home's aggregate demand of the consumption basket:

$$Y_t^C=C_t+\kappa V_t+\frac{\vartheta}{2}\pi_{w,t}^2l_t+\frac{\nu}{2}\pi_{d,t}^2\rho_{d,t}(y_{d,t}+y_{x,t})N_t.$$

Then, equation (17) becomes:

$$a_{t+1} = \frac{1+i_t}{1+\pi_{C,t}} a_t + N_t \left(\rho_{d,t} - \varphi_t\right) \left(y_{d,t} + y_{x,t}\right) + \varphi_t Z_t l_t h_t - \left(Y_t^C + N_{E,t} e_t\right).$$

Finally, recall that free entry implies $e_t = \varphi_t f_{E,t}$, and labor market clearing requires $N_t \varphi_t \left(y_{d,t} + y_{x,t}\right) + N_{E,t} \varphi_t f_{E,t} = \varphi_t Z_t l_t h_t$. It follows that home's net foreign assets entering period $t+1$ are determined by the gross interest income on the asset position entering period t plus the difference between home's total production and total demand (or absorption) of consumption:

$$a_{t+1} = \frac{1+i_t}{1+\pi_{C,t}} a_t + N_t \rho_{d,t} \left(y_{d,t} + y_{x,t}\right) - Y_t^C. \tag{18}$$

A similar equation holds in Foreign:

$$a_{t+1}^* = \frac{1+i_t}{1+\pi_{C,t}^*} a_t^* + N_t^* \rho_{d,t}^* \left(y_{d,t}^* + y_{x,t}^*\right) - Y_t^{C*}. \tag{19}$$

Now, multiply equation (19) by Q_t and subtract the resulting equation from (18). Recall that $1 + \pi_{C,t} = (Q_{t-1}/Q_t)\left(1 + \pi_{C,t}^*\right)$ and use the bond market clearing condition $a_{t+1} + Q_t a_{t+1}^* = 0$ in all periods. It follows that:

$$a_{t+1} = \frac{1+i_t}{1+\pi_{C,t}} a_t + \frac{1}{2}\left[N_t \rho_{d,t} \left(y_{d,t} + y_{x,t}\right) - N_t^* Q_t \rho_{d,t}^* \left(y_{d,t}^* + y_{x,t}^*\right)\right] - \frac{1}{2}\left(Y_t^C - Q_t Y_t^{C*}\right). \tag{20}$$

This is the familiar result that net foreign assets depend positively on the cross-country differential in production of final consumption output and negatively on relative absorption.

Notice next that home absorption of consumption must equal absorption of consumption output from home firms and output from foreign firms:

$$Y_t^C = N_t \rho_{d,t} y_{d,t} + N_t^* \rho_{x,t}^* y_{x,t}^* = N_t \rho_{d,t} y_{d,t} + N_t^* Q_t \rho_{d,t}^* y_{x,t}^*,$$

where we used the fact that $\rho_{x,t}^* = Q_t \rho_{d,t}^*$. Similarly,

$$Y_t^{C*} = N_t^* \rho_{d,t}^* y_{d,t}^* + N_t \rho_{x,t} y_{x,t} = N_t^* \rho_{d,t}^* y_{d,t}^* + N_t \frac{\rho_{d,t}}{Q_t} y_{x,t},$$

where we used $\rho_{x,t} = \rho_{d,t}/Q_t$. Substituting these results into equation (20) yields net foreign assets as a function of interest income on the initial asset position and the trade balance:

$$a_{t+1} = \frac{1+i_t}{1+\pi_{C,t}} a_t + N_t \rho_{d,t} y_{x,t} - N_t^* Q_t \rho_{d,t}^* y_{x,t}^*.$$

E. Data-Consistent Variables

We follow Ghironi and Melitz (2005) and BGM, and we construct an average price index $\tilde{P}_t$ as:

$$\tilde{P}_t = \Omega_t^{\frac{1}{\phi-1}} P_t,$$

where P_t is the welfare-based price index:

$$P_t = \left\{ (1-\alpha) \left[p_{d,t} \exp\left(\frac{\tilde{N} - N_t}{2\sigma \tilde{N} N_t} \right) \right]^{1-\phi} + \alpha \left[p_{x,t}^* \exp\left(\frac{\tilde{N}^* - N_t^*}{2\sigma \tilde{N}^* N_t^*} \right) \right]^{1-\phi} \right\}^{\frac{1}{1-\phi}},$$

and Ω_t is the variety effect:

$$\Omega_t \equiv (1-\alpha) \exp\left(\frac{\tilde{N} - N_t}{2\sigma \tilde{N} N_t} \right) + \alpha \exp\left(\frac{\tilde{N}^* - N_t^*}{2\sigma \tilde{N}^* N_t^*} \right).$$

The average price index $\tilde{P}_t$ is closer to the actual CPI data constructed by statistical agencies than the welfare-based index P_t, and, therefore, it is the data-consistent CPI implied by the model. In turn, given any variable X_t in units of consumption, its data-consistent counterpart is:

$$X_{R,t} \equiv \frac{X_t P_t}{\tilde{P}_t} = \frac{X_t}{\Omega_t^{\frac{1}{\phi-1}}}.$$

F. Social Planner Allocation

The benevolent social planner chooses $\{C_t, C_t, l_t, l_t^*, V_t, V_t^*, h_t, h_t^*, Y_{d,t}, Y_{d,t}^*, Y_{x,t}, Y_{x,t}^*, N_{t+1}, N_{t+1}^*\}_{t=0}^{\infty}$ to maximize the welfare criterion (6) in the main text subject to six constraints (three for each economy). In the list of variables chosen by the planner, $Y_{d,t}, Y_{d,t}^*, Y_{x,t}$, and $Y_{x,t}^*$ denote the sub-bundles of country-specific final goods that enter the Armington aggregator for total absorption of consumption output (Y_t^C and Y_t^{C*}) in each country. As usual, we present relevant equations for the Home economy, with the understanding that analogous equations hold in Foreign.

The first constraint is that intermediate inputs are used to produce final goods and create new product lines:

$$Z_t l_t h_t = \exp\left(\frac{\tilde{N} - N_t}{2\sigma\tilde{N}N_t}\right)(Y_{d,t} + Y_{x,t}) + \left(\frac{N_{t+1}}{1-\delta} - N_t\right) f_{T,t}, \tag{21}$$

where the exponential term converts units of consumption sub-bundles into units of intermediate inputs. Note that the only entry cost that is relevant to the social planner is the technological component of the overall entry cost $f_{E,t}$ facing firms in the decentralized economy. We denote the Lagrange multiplier associated to the constraint (21) with ϖ_t, which corresponds to the social marginal cost of producing an extra unit of intermediate output.

The second constraint is that total output can be used for consumption and vacancy creation:

$$C_t + \kappa V_t = \left[(1-\alpha)^{\frac{1}{\phi}} Y_{d,t}^{\frac{\phi-1}{\phi}} + \alpha^{\frac{1}{\phi}} Y_{x,t}^{*\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}. \tag{22}$$

The Lagrange multiplier associated to this constraint, ξ_t, represents the social marginal utility of consumption resources. In the social planner's environment, $Y_t^C = C_t + \kappa V_t$. Note that, as for the technological cost of product creation $f_{T,t}$, we assume that the cost of vacancy posting κV_t is a feature of technology—the technology for job creation—that characterizes also the planner's environment. (This is a standard assumption in the literature on the DMP model.)

Finally, the third constraint is that the stock of labor in the current period is equal to the number of workers that were not exogenously separated plus previous period matches that become productive in the current period:

$$l_t = (1-\lambda)l_{t-1} + \chi(1-l_{t-1})^{1-\varepsilon} V_{t-1}^{\varepsilon}. \tag{23}$$

The Lagrange multiplier associated to this constraint, ζ_t, denotes the real marginal value of a match to society.

The first-order condition for consumption implies that $\xi_t = u_{C,t}$. The demand schedules for Home output are obtained by combining the first-order conditions with respect to $Y_{d,t}$, $Y_{x,t}$, $Y_{d,t}^*$ and $Y_{x,t}^*$:

$$Y_{d,t} = (1-\alpha)\left[\frac{\varpi_t}{\xi_t}\exp\left(\frac{\tilde{N} - N_t}{2\sigma\tilde{N}N_t}\right)\right]^{-\phi} Y_t^C, \qquad Y_{x,t} = \alpha\left[\frac{\varpi_t}{\xi_t^*}\exp\left(\frac{\tilde{N} - N_t}{2\sigma\tilde{N}N_t}\right)\right]^{-\phi} Y_t^{C*}. \tag{24}$$

Using the results in (24) and the analogs for Foreign output, it is possible to re-write equation (22) as:

$$1 = (1-\alpha)\left[\frac{\varpi_t}{\xi_t}\exp\left(\frac{\tilde{N}-N_t}{2\sigma\tilde{N}N_t}\right)\right]^{1-\phi} + \alpha\left[\frac{\varpi_t^*}{\xi_t}\exp\left(\frac{\tilde{N}^*-N_t^*}{2\sigma\tilde{N}^*N_t^*}\right)\right]^{1-\phi}$$

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

$$f_{T,t}\varpi_t = \beta(1-\delta)E_t\left\{\varpi_{t+1}\left[f_{T,t+1} + \exp\left(\frac{\tilde{N}-N_{t+1}}{2\sigma\tilde{N}N_{t+1}}\right)\frac{1}{2\sigma N_{t+1}}\left(\frac{Y_{d,t+1}+Y_{x,t+1}}{N_{t+1}}\right)\right]\right\}. \tag{25}$$

The first-order conditions for vacancies and employment yield:

$$\frac{\kappa}{q_t} = \beta E_t\left\{\frac{\xi_{t+1}}{\xi_t}\left[\varepsilon\left(\frac{\varpi_{t+1}}{\xi_{t+1}}Z_{t+1}h_{t+1} - \frac{v\left(h_{t+1}\right)}{\xi_{t+1}}\right) + \left[1-\lambda-(1-\varepsilon)\,\iota_{t+1}\right]\frac{\kappa}{q_{t+1}}\right]\right\}, \tag{26}$$

where $q_t \equiv M_t/V_t = \chi\left[(1-l_t)/V_t\right]^{1-\varepsilon}$ is the probability of filling a vacancy implied by the matching function $M_t = \chi\left(1-l_t\right)^{1-\varepsilon}V_t^{\varepsilon}$, and $\iota_t \equiv M_t/\left(1-l_t\right) = \chi\left[V_t/(1-l_t)\right]^{\varepsilon}$ is the probability for a worker to find a job. Equation (26) 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 value of output produced by one worker net of the disutility of labor, augmented by the continuation value of the match.

Finally, the first-order condition for hours implies $v_{h,t} = \varpi_t Z_t$.

Table 2 summarizes the equilibrium conditions for the planned economy. To facilitate the comparison between planned and market economy, we define the following relative prices for the planner's equilibrium: $\rho_{d,t} \equiv \varpi_t/\xi_t$, $\rho_{d,t}^* \equiv \varpi_t^*/\xi_t^*$, $\rho_{x,t} \equiv \varpi_t/\xi_t^*$, and $\rho_{x,t}^* \equiv \varpi_t^*/\xi_t$. Defining the social real exchange rate as $Q_t \equiv \xi_t^*/\xi_t$, the planner's outcome is characterized by optimal risk sharing: $Q_t = u_{C^*,t}/u_{C,t}$. Moreover, the law of one price holds also in the planned economy $\rho_{x,t} = \rho_{d,t}/Q_t$ and $\rho_{x,t}^* = Q_t\rho_{d,t}^*$. Finally, recall that $Y_{d,t}$ represents the aggregate demand for Home goods at Home. The amount of output produced by each Home firm for the Home market is given by $y_{d,t} = \exp\left(\frac{\tilde{N}-N_t}{2\sigma\tilde{N}N_t}\right)Y_{d,t}/N_t$. Analogously, the amount of output produced by each Home firm for the export market is $y_{x,t} = \exp\left(\frac{\tilde{N}-N_t}{2\sigma\tilde{N}N_t}\right)Y_{x,t}/N_t$.

G. Inefficiency Wedges

Comparing the equilibrium conditions in the decentralized economy (Table 1) to those for the planned economy (Table 2) allows us to identify the distortions at work in our model and define inefficiency wedges relative to the efficient allocation. Table 3 summarizes the distortions that characterize the decentralized economy.

- Product creation margin: Comparing the term in square brackets in equation (7) in Table 1 to the term in square brackets in equation (7) in Table 2 implicitly defines the inefficiency wedge along the market economy's product creation margin. Specifically, the product creation wedge is defined as:

$$\Sigma_{PC,t} \equiv \left\{ (1-\delta)\,\beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma_C} \frac{\rho_{d,t+1}}{\rho_{d,t}} \left[\frac{f_{T,t+1}}{f_{T,t}} + \frac{1}{2\sigma N_{t+1} f_{T,t}} \left(y_{d,t+1} + y_{x,t+1} \right) \right] \right\}^{-1},$$

  where all variables are evaluated at the decentralized allocations under Ramsey-optimal policy and historical policy. When $\Upsilon_{\mu,t} = \Upsilon_{N,t} = \Upsilon_{R,t} = 0$, the product creation wedge $\Sigma_{PC,t}$ is equal to 1.

- Job creation margin: Comparing the term in square brackets in equation (9) in Table 1 to the term in square brackets in equation (9) in Table 2 implicitly defines the inefficiency wedge along the market economy's job creation margin:

$$\Sigma_{JC,t} \equiv \left\{ \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma_C} \left[\varepsilon \frac{q_t}{\kappa} \left(\rho_{d,t+1} Z_{t+1} h_{t+1} - \frac{h_{t+1}^{1+\gamma_h} / (1+\gamma_h)}{(C_{t+1})^{-\gamma_C}} \right) + \left[1 - \lambda - (1-\varepsilon)\, \iota_{t+1} \right] \frac{q_t}{q_{t+1}} \right] \right\}^{-1},$$

  where all variables are evaluated at the decentralized allocations under Ramsey-optimal policy and historical policy. When $\Upsilon_{\mu,t} = \Upsilon_{N,t} = \Upsilon_{R,t} = 0$), the real wage is determined by

$$\frac{w_t}{P_t} h_t = \varepsilon \frac{v(h_t)}{u_{C,t}} + (1-\varepsilon)\rho_{d,t} Z_t h_t + \kappa \left(1-\varepsilon\right) \iota_t / q_t,$$

  and the job creation wedge $\Sigma_{JC,t}$ is equal to 1.

- Labor supply margin: Following established practice, we define the associated wedge as the reciprocal of the markup: $\Sigma_{h,t} \equiv 1/\mu_t$. Efficiency along this margin requires $\Sigma_{h,t} = 1$ (or $\Upsilon_{\varphi,t} = 0$).

- Cross-country risk sharing margin: We summarize the combined effect of incomplete markets and the costs of adjusting bond holdings with the financial inefficiency wedge $\Sigma_{RS,t} \equiv \left(u_{C^*,t} / u_{C,t} \right) / Q_t$. Efficiency along this margin requires $\Sigma_{RS,t} = 1$.

- Consumption resource constraint: The resource-constraint wedge is $\Sigma_{Y^C,t} \equiv \Upsilon_{\pi_w,t} + \Upsilon_{\pi_d,t} +$

$\Upsilon_{R,t} N_{E,t}$, which is zero under flexible wages and prices, and without "red tape" in product creation.

H. Calibration

Table A.1 summarizes the calibration, which is assumed symmetric across countries. (Variables without time indexes denote steady-state levels. Following standard practice, we set parameter values so that the model replicates long-run features of the data in the zero-inflation steady state. We set the discount factor β to 0.99, implying an annual real interest rate of 4 percent. The period utility function is given by $u_t = C_t^{1-\gamma_C}/(1-\gamma_C) - l_t h_t^{1+\gamma_h}/(1+\gamma_h)$. The risk aversion coefficient γ_C is equal to 1, while the Frisch elasticity of labor supply $1/\gamma_h$ is set to 0.2, a value consistent with empirical micro estimates.[3] To calibrate the translog parameter, σ, we proceed as follows. In Ghironi and Melitz's (2005) model with Dixit-Stiglitz (1977) preferences, the elasticity of substitution across product varieties is set to 3.8 following Bernard, Eaton, Jensen, and Kortum (2003). We set σ so that our model with translog preferences implies the same steady-state markup as Ghironi and Melitz's calibration.[4] As Ghironi and Melitz, we set substitutability between Home and Foreign goods in the consumption aggregator, ϕ, to 3.8.[5] The degree of home bias $1-\alpha$ is set to 0.8, a conventional value in the literature. To ensure steady-state determinacy and stationarity of net foreign assets, we set the bond adjustment cost τ to 0.0025 as in Ghironi and Melitz (2005).

The scale parameter for the cost of adjusting prices, ν, is equal to 80, as in Bilbiie, Ghironi, and Melitz (2008a). We choose ϑ, the scale parameter of nominal wage adjustment costs, so that the model reproduces the volatility of unemployment relative to GDP observed in the data. This implies $\vartheta = 160$.

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. As a proxy for goods market regulation in the Euro Area, we consider a weighted average of regulation costs across member countries, with weights equal to the contributions of individual

[3] The value of this elasticity has been a source of controversy in the literature. Students of the business cycle tend to work with elasticities that are higher than microeconomic estimates, typically unity and above. Most microeconomic studies, however, estimate this elasticity to be much smaller, between 0.1 and 0.6. For a survey of the literature, see Card (1994). Our results are not affected significantly if we hold hours constant at the optimally determined steady-state level.

[4] This implies a 36 percent markup of price over marginal cost. It may be argued that this is too high. However, in our model, free entry ensures that firms earn zero profit net of entry cost. This means that firms price at average cost (inclusive of the entry cost). Thus, although our calibration implies a fairly high markup over marginal cost, it delivers plausible results with respect to pricing and average cost.

[5] The conventional choice of 1.5 for this Armington elasticity does not alter any of our main results significantly.

countries' GDPs to Euro Area total GDP. To calibrate the initial value of entry costs related to regulation, f_R, we use Pissarides's (2003) index of entry delay, which computes the number of business days that it takes (on average) to fulfill entry requirements. Following Ebell and Haefke (2009), we convert this index in months of lost output. The implied cost of regulation is 69 percent of quarterly steady-state output.

We set unemployment benefits, b, so that the model reproduces the average replacement rate, $b/(wh)$, for the Euro Area reported by OECD (2004). The elasticity of the matching function, ε, is equal to 0.6, as estimated by Blanchard and Diamond (1989) and used in much subsequent literature. The flexible-wage bargaining share of firms, η, is equal to ε, so that the Hosios condition holds in a steady state with zero wage inflation. The exogenous separation rate between firms and workers, λ, is 6 percent, as reported in Campolmi and Faia (2011). To pin down exogenous producer exit, δ, we target the portion of worker separation due to plant exit. This number ranges between 25 and 55 percent in EMU members (see Haltiwanger, Scarpetta, and Schweiger, 2008). We choose a midpoint of these estimates so that the exit of plants accounts for 40 percent of overall job destruction. This yields a value for δ (0.026) that is very close to the calibration in BGM (0.025).

Two labor market parameters are left for calibration: the scale parameter for the cost of vacancy posting, κ, and the matching efficiency parameter, $\varkappa$. As common practice in the literature, we calibrate these parameters to match the steady-state average job finding probability and the probability of filling a vacancy across EMU countries. The former is 25 percent (Hobijn and Şahin, 2009), while the latter is 70 percent, in line with estimates reported by ECB (2002) and Weber (2000).

For the bivariate productivity process, we set persistence and spillover parameters consistent with Baxter (1995) and Baxter and Farr (2005), implying zero spillovers across countries and persistence equal to 0.999. We refer to this as Baxter calibration below. We perform sensitivity analysis by considering also values in Backus, Kehoe, and Kydland (1992, 1994), with lower persistence at 0.906 and positive spillovers at 0.088 (BKK calibration below). We set the standard deviation of productivity innovations at 0.008 to match the absolute volatility of Euro Area GDP, but leave the covariance of innovations at the standard 0.19 percent of Baxter (1995) and Backus, Kehoe, and Kydland (1992, 1994).[6]

[6] Using the 0.73 percent standard deviation of innovations in Baxter (1995) and Backus, Kehoe, and Kydland (1992, 1994) does not alter any of our main results. Only the absolute volatility of GDP is affected and, as a consequence, the absolute magnitude of welfare costs of business cycles (for given regulation level). We also experimented with

Finally, the parameter values in the historical rule for the ECB's interest rate setting are those estimated by Gerdesmeier and Roffia (2003). The inflation and GDP gap weights are 1.93 and 0.075, respectively, while the smoothing parameter is 0.87.

Concerning market deregulation, we assume that the policy parameters f_R, b, and $1-\eta$ are permanently lowered to the corresponding U.S. levels, a standard benchmark for flexible markets. Pissarides (2003) reports that it takes (on average) 9 days to fulfill entry requirements in the U.S. The implied value of f_R is 0.16. Unemployment benefits, b, are tied to the average replacement rate $b/(wh)$. The U.S. replacement rate documented by OECD (2004) is 0.56. To pin down the change in workers' bargaining power $1-\eta$, we use the fact that U.S. employment protection legislation indexes reported by OECD (2004), adjusted for worker coverage by our own calculations, are approximately one third of those for European countries. The implied value of $1-\eta$ is 0.48, not far from the estimates in Flinn (2006).

I. Model Properties

Impulse Responses

Figure A.1 (solid lines) shows impulse responses to a one-percent innovation to Home productivity under the historical rule for ECB interest rate setting.[7] Focus on the Home country first. Unemployment (U_t) does not respond on impact, but it falls in the periods after the shock. The higher expected return of a match induces domestic intermediate input producers to post more vacancies on impact, which results in higher employment in the following period. Firms and workers (costly) renegotiate nominal wages because of the higher surplus generated by existing matches, and wage inflation ($\pi_{w,t}$) increases. Wage adjustment costs make the effective firm's bargaining power procyclical, i.e., $\eta_{w,t}$ rises. To understand why this happens, recall equations (6), (7), and (9). Notice that $\partial J_t/\partial w_t$ is the change in firm surplus due to a change in nominal wages. The first term in the expression (6) for $\partial J_t/\partial w_t$ reflects the fact that, when the nominal wage increases by

the bivariate productivity process for the Euro Area in Canzoneri, Cumby, Diba, and Mykhaylova (2006), which is roughly similar to that estimated for France and Germany by Collard and Dellas (2002). The key difference is that this process features less persistent productivity (0.76). While the performance of the model remains quite good, this parametrization results in excessively smooth consumption relative to the data and a less satisfactory match of international correlations. Our own estimation of bivariate productivity processes for Germany versus different combinations of France, Italy, and Spain yielded results in between the Baxter and BKK calibrations. We settled on the Baxter calibration as benchmark given the stronger consensus for very persistent productivity processes in the literature on quantitative international business cycle models.

[7] Dashed lines show responses under the Ramsey-optimal policy (discussed below). For comparability, all responses in the figure are computed around the Ramsey-optimal steady state.

one dollar, the nominal surplus is reduced by the same amount (times the number of worked hours); the second term is the wage adjustment cost paid by the firm; and the last term represents the expected savings on future wage adjustments if wages are renegotiated today. When the first two effects are larger than the third one, the firm's bargaining share rises. Intuitively, $\eta_{w,t}$ shifts upward to ensure optimal sharing of the cost of adjusting wages between firms and workers. Other things equal, the increase in $\eta_{w,t}$ dampens the response of the renegotiated equilibrium wage, amplifying the response of job creation to the shock.

Employment and labor income rise in the more productive economy, boosting aggregate demand for final goods and household consumption (C_t). The larger present discounted value of future profits generates higher expected return to product creation, stimulating producer entry ($N_{E,t}$) and investment ($I_t \equiv N_{E,t}e_t$) at Home. Price stickiness and increased substitutability across a larger number of available domestic varieties result in mildly countercyclical final producer markups (μ_t).

Product creation falls temporarily in the Foreign country as resources are shifted to Home to finance increased entry in the more productive economy. Accordingly, Home runs a current account deficit in response to the shock (CA_t falls on impact), as Home households borrow from abroad to finance higher investment in new products. Although Foreign households cannot hold shares in the mutual portfolio of Home firms (since only bonds are traded across countries), the return on bond holdings is tied to the return on share holdings in Home firms by no-arbitrage between bonds and shares within each country. Therefore, Foreign households share the benefit of higher Home productivity by shifting resources to Home via lending. Moreover, Home's terms of trade ($TOT_t \equiv p_{x,t}/p^*_{x,t}$) depreciate, i.e., Home goods become relatively cheaper. This shifts world demand toward Home goods (expenditure switching), but also generates a positive wealth effect for Foreign households, whose consumption rises. In contrast to the results of standard international real business cycle (IRBC) models, the combination of expenditure switching and resource shifting is not sufficient to imply negative comovement of GDP (Y_t) and employment across countries. The increase in aggregate demand at Home (which falls on both domestic and imported goods) is strong enough to ensure that trade linkages generate positive comovement of GDP and labor market variables. Interestingly, the adjustment in the Foreign economy takes place mostly along the intensive margin, as the reduction in Foreign product creation is short-lived and followed by a very mild increase as demand stimulates some entry in the Foreign final sector.

The historical policy rule yields muted responses of Home and Foreign producer price inflation ($\pi_{d,t}$ and $\pi^*_{d,t}$) to the shock. In fact, the adjustment of the economy closely mimics that under a policy of zero deviations of area-wide producer price inflation from its long-run target.[8]

Second Moments

Table A.2 presents model-implied, HP-filtered second moments under the Baxter calibration of the bivariate productivity process (normal fonts) and the alternative BKK calibration (italics). Bold fonts denote data moments. Area-wide moments are computed from the AWM database; cross-country correlations are averages of bilateral correlations between the four largest Euro Area economies.

The model correctly reproduces the volatility of area-wide consumption, investment, and real wages relative to GDP and generates first-order autocorrelations in line with the data. It also correctly captures the cyclicality of employment and is not far from its persistence.[9] This successful performance is a result of the model's strong propagation mechanism. Investment volatility is lowered relative to the excessive volatility generated by a standard IRBC framework because product creation requires hiring new workers. This process is time consuming due to search and matching frictions in the labor market, dampening investment dynamics. In contrast, consumption is more volatile than in traditional models as shocks induce larger and longer-lasting income effects.

With respect to the international dimension of the business cycle, the model successfully reproduces a ranking of cross-country correlations that is a challenge for standard IRBC models: Although lower than in the data, GDP correlation is larger than consumption correlation. This result depends both on model features and the parametrization of technology shocks. As shown in 1, an increase in Home productivity generates Foreign expansion through trade linkages, as demand-side complementarities more than offset the effect of resource shifting to the more productive economy. Moreover, absent technology spillovers, Foreign consumers have weaker incentives to increase consumption on impact, which reduces cross-country consumption correlation.

As shown in Table A.2, results are largely unaffected under the BKK calibration of exogenous shocks. The only exception is the magnitude and ranking of cross-country GDP and consumption correlations: The correlation of consumption is now higher than that of GDP. This result is explained by the Foreign permanent income effect of productivity spillovers, which induces Foreign households to increase consumption on impact in anticipation of future higher domestic productiv-

[8] Impulse responses for a policy of strict producer price stability are available upon request.

[9] The absolute volatility of GDP and unemployment is matched by construction. The close match between data- and model-implied real wage moments provides indirect support for our calibration of the nominal wage adjustment cost.

ity.[10]

J. Welfare Computations

Long-Run Policy

We compare welfare under the continuation of historical policy from $t = 0$ on (which implies continuation of the historical steady state) to welfare under the optimal long-run policy from $t = 0$ on (which implies a transition between the initial implementation at $t = 0$ and the Ramsey steady state). We measure the long-run welfare gains of the Ramsey policy in the two countries (which are equal by symmetry) by computing the percentage increase Δ in consumption that would leave the household indifferent between policy regimes. In other words, Δ solves:

$$\sum_{t=0}^{\infty} \beta^t u\left(C_t^{Ramsey}, h_t^{Ramsey} l_t^{Ramsey}\right) = \frac{u\left[\left(1 + \frac{\Delta}{100}\right) C^{Hist}, h^{Hist} l^{Hist})\right]}{1-\beta}.$$

To compute this welfare gain avoiding spurious welfare reversals, we assume identical initial conditions across different monetary policy regimes and include transition dynamics in the computation. Specifically, we assume that all the state variables are set at their steady-state levels under the historical policy at time $t = -1$, regardless of the monetary regime from $t = 0$ on.

Policy over the Cycle

As for the long-run optimal policy, we compare policy regimes by computing the welfare gains for the two countries from optimal policy in the monetary union over the cycle. Specifically, we compute the percentage Δ of steady-state consumption that would make households indifferent between living in a world with uncertainty under monetary policy m, where $m = Ramsey$ or $Hist$, and living in a deterministic Ramsey world:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(C_t^m, h_t^m l_t^m) = \frac{u\left[\left(1 + \frac{\Delta}{100}\right) C^{Ramsey}, h^{Ramsey} l^{Ramsey})\right]}{1-\beta}.$$

First-order approximation methods are not appropriate to compute the welfare associated with each monetary policy arrangement. The solution of the model implies that the expected value of each variable coincides with its non-stochastic steady state. However, in an economy with

[10] Importantly, however, the model generates positive and sizable GDP comovement regardless of the productivity parametrization. Standard IRBC models predict negative or negligible cross-country GDP correlation under the BKK calibration. Resource-shifting and the permanent income hypothesis dominate dynamics in those models.

a distorted steady state, volatility affects both first and second moments of the variables that determine welfare. Hence, we compute welfare by resorting to a second-order approximation of the policy functions.

Deregulation and Welfare in the Long Run

To measure the desirability of reform we compute the percentage increase Δ in steady-state consumption relative to the status quo (no deregulation *and* historical policy) that leaves households indifferent between implementing the reform or not:

$$\sum_{t=0}^{\infty} \beta^t u(C_t^m, l_t^m, h_t^m) = \frac{u\left[\left(1+\frac{\Delta}{100}\right) C^{SQ}, h^{SQ} l^{SQ})\right]}{1-\beta},$$

where SQ stands for status quo and m denotes the monetary regime ($m = Ramsey$ or $Hist$).

K. Price and Wage Indexation

Price Indexation

Following Bilbiie, Fujiwara, and Ghironi (2014), we introduce price indexation by assuming that final producers index price changes to past changes in average product-level prices, so that price adjustment costs take the form:

$$\Gamma_{d,t}(\omega) \equiv \frac{\nu}{2}\left[\frac{p_{d,t}(\omega)}{p_{d,t-1}(\omega)}\left(\frac{p_{d,t-1}}{p_{d,t-2}}\right)^{-\iota_p} - 1\right]^2 p_{d,t}(\omega)\left[y_{d,t}(\omega) + y_{x,t}(\omega)\right],$$

where $\iota_p \in [0,1]$ is the indexation parameter. Note that this nests the no-indexation case when $\iota_p = 0$ and the full-indexation case when $\iota_p = 1$. Let

$$\Gamma_{\iota,d,t}(\omega) \equiv \frac{p_{d,t}(\omega)}{p_{d,t-1}(\omega)}\left(\frac{p_{d,t-1}}{p_{d,t-2}}\right)^{-\iota_p} - 1.$$

Firms maximize the expected present discounted value of the stream of current and future real profits:

$$E_t \sum_{s=t}^{\infty} \beta_{t,s+t}(1-\delta)^{s-t}\left\{\left[\frac{p_{d,t}(\omega)}{P_t}\left(1-\frac{\nu}{2}\Gamma^2_{\iota,d,t}(\omega)\right) - \varphi_t\right]\left[y_{d,t}(\omega) + y_{x,t}(\omega)\right]\right\},$$

where $\beta_{t,t+s} \equiv \beta\left(u_{C,t+s}/u_{C,t}\right)$ and, as in the main text, firm's aggregate demand is given by:

$$y_{d,t}(\omega) + y_{x,t}(\omega) = \sigma \ln\left(\frac{\bar{p}_{d,t}}{p_{d,t}(\omega)}\right)\frac{P_{d,t}}{p_{d,t}(\omega)}\left(\frac{P_{d,t}}{P_t}\right)^{-\phi}\left[(1-\alpha)Y_t^C + \alpha Q_t^{\phi} Y_t^{C*}\right].$$

The first-order condition for $p_{d,t}(\omega)$ yields

$$\rho_{d,t}(\omega) = \mu_t(\omega)\varphi_t,$$

where

$$\mu_t(\omega) \equiv \frac{\theta_t(\omega)}{\left(\theta_t(\omega)-1\right)\Xi_t}$$

and:

$$\begin{aligned}\Xi_t &= \left[1 - \frac{\nu}{2}\Gamma^2_{\iota,d,t}(\omega)\right] + \frac{\nu}{\theta_t(\omega)-1}\Gamma_{\iota,d,t}(\omega)\left(1+\pi_t(\omega)\right)\pi_{t-1}^{-\iota_p}(\omega) \\ &\quad - \frac{\nu(1-\delta)}{\theta_t(\omega)-1}E_t\left\{\beta_{t,t+1}\Gamma_{\iota,d,t+1}(\omega)\left[\frac{\left(1+\pi_{t+1}(\omega)\right)^2}{1+\pi_{C,t+1}}\right]\pi_t^{-\iota_p}(\omega)\frac{y_{d,t+1}(\omega)+y_{x,t+1}(\omega)}{y_{d,t}(\omega)+y_{x,t}(\omega)}\right\}. \quad (27)\end{aligned}$$

As argued by Bilbiie, Fujiwara, and Ghironi (2014), empirically plausible degrees of indexation are between 0.25 and 0.5.

Wage Indexation

Following Arsenau and Chugh (2008), we introduce wage indexation by assuming that the real cost of changing nominal wages between period t and $t-1$ is given by

$$\frac{\vartheta}{2}\left[\frac{w_t}{w_{t-1}}\left(1+\bar{\pi}_t\right)^{-\iota_w} - 1\right]^2,$$

where $\iota_w \in [0,1]$ measures the degree to which nominal wage adjustment is indexed to contemporaneous price inflation, $\bar{\pi}_t$. We allow $\bar{\pi}_t$ to be equal to welfare-consistent CPI inflation ($\bar{\pi}_t = \pi_t^C$) or, alternatively, to its data-consistent counterpart ($\bar{\pi}_t = \tilde{\pi}_t^C$).[11]

The value of a match is now given by:

$$J_t = \varphi_t Z_t h_t - \frac{w_t}{P_t}h_t - \frac{\vartheta}{2}\Gamma^2_{\iota,w,t} + E_t\beta_{t,t+1}(1-\lambda)J_{t+1},$$

[11] The results presented in the main text refer to the case of indexation to welfare-consistent CPI inflation. The results are essentially unchanged with indexation to data-consistent CPI inflation. Details are available on request.

where

$$\Gamma_{\iota,w,t} = \frac{w_t}{w_{t-1}} \left(1+\bar{\pi}_t\right)^{-\iota_w} - 1.$$

The worker asset value of a match and the value of unemployment are unchanged. The Nash bargaining first-order condition implies:

$$\eta H_t \frac{\partial J_t}{\partial w_t} + (1-\eta) J_t \frac{\partial H_t}{\partial w_t} = 0,$$

where:

$$\frac{\partial J_t}{\partial w_t} = -\frac{h_t}{P_t} - \vartheta \Gamma_{\iota,w,t} \frac{\left(1+\bar{\pi}_t\right)^{-\iota_w}}{w_{t-1}} + (1-\lambda)\vartheta E_t \left[\beta_{t,t+1} \Gamma_{\iota,w,t+1} \frac{\left(1+\pi_{w,t+1}\right)\left(1+\bar{\pi}_{t+1}\right)^{-\iota_w}}{w_t}\right].$$

Finally, notice that the above expression can be written as:

$$\frac{\partial J_t}{\partial w_t} P_t = -h_t - \vartheta \frac{\Gamma_{\iota,w,t}}{(w_{t-1}/P_{t-1})} \bar{\pi}_t^{-\iota_w} \left(1+\pi_{C,t}\right) + (1-\lambda)\vartheta E_t \left[\beta_{t,t+1} \frac{\Gamma_{\iota,w,t+1}}{(w_t/P_t)} \left(1+\pi_{w,t+1}\right) \bar{\pi}_{t+1}^{-\iota_w}\right].$$

When $\iota_w = 0$, there is no wage indexation, which corresponds to the benchmark version of the model. When $\iota_w = 1$ (full indexation), the real cost of changing nominal wages is zero in steady state, since, by definition, $\pi_w = \pi^C = \tilde{\pi}^C$. In the latter case, steady-state inflation no longer affects job creation, since the firm bargaining power is equal to the exogenous weight of firm surplus in the Nash bargaining problem.

The empirical evidence concerning the degree of wage indexation has not converged to a punctual indication yet. For the U.S. economy, the estimation of medium-scale DSGE models typically yields values that lie between 0.1 and 0.5. The estimates in Ascari, Branzoli, and Castelnuovo (2011), obtained using micro-level data, suggest an average approximately equal to 0.5.

L. Flexible Exchange Rate and Optimal Cooperative Monetary Policy

We now relax the assumption of a monetary union between Home and Foreign and present the details of the Ramsey-optimal cooperative policy in the absence of monetary union. Relative to the benchmark model, there are three main differences. First, the nominal exchange rate is flexible. Second, there is no longer equalization of interest rates in Home and Foreign, and each country pursues its own monetary policy. Third, the representative household can now invest in two non-contingent nominal bonds that are traded internationally: Home bonds, issued by Home households and denominated in Home currency, and Foreign bonds, issued by Foreign households and denominated in Foreign currency.[12] Let A_{t+1} and $A_{*,t+1}$ denote, respectively, nominal holdings of Home and Foreign bonds at Home.[13] To induce steady-state determinacy and stationary responses to temporary shocks in the model, we continue to assume a quadratic cost of adjusting bond holdings. The cost of adjusting Home bond holdings is $\psi \left(A_{t+1}/P_t\right)^2/2$, while the cost of adjusting Foreign bond holdings is $\psi \left(A_{*,t+1}/P_t^*\right)^2/2$. As in the benchmark model, these costs are paid to financial intermediaries whose only function is to collect these transaction fees and rebate the revenue to households in lump-sum fashion in equilibrium.

The Home household's period budget constraint is:

$$A_{t+1} + S_t A_{*,t+1} + \frac{\psi}{2} P_t \left(\frac{A_{t+1}}{P_t}\right)^2 + \frac{\psi}{2} S_t P_t^* \left(\frac{A_{*,t+1}}{P_t^*}\right)^2 + P_t C_t + x_{t+1}\left(N_t + N_{E,t}\right) P_t e_t =$$
$$(1+i_t)A_t + (1+i_t^*)A_{*,t}S_t + x_t P_t N_t \left(d_t + e_t\right) + w_t l_t h_t + P_t b\left(1 - l_t\right) + T_t^G + T_t^F + T_t^I,$$

where S_t denotes the nominal exchange rate. The Euler equations for bond holdings are:

$$(1+\psi a_{t+1}) = (1+i_{t+1})\, E_t\left[\frac{\beta_{t,t+1}}{1+\pi_{C,t+1}}\right], \tag{28}$$

$$(1+\psi a_{*t+1}) = \left(1+i_{t+1}^*\right) E_t\left[\beta_{t,t+1}\frac{Q_{t+1}}{Q_t\left(1+\pi_{C,t+1}^*\right)}\right],$$

where now the real exchange rate is defined by $Q_t \equiv S_t P_t^*/P_t$. Market clearing implies $a_{t+1}+a_{t+1}^* = 0 = a_{*,t+1}^* + a_{*,t+1}$ in all periods. Therefore, The Euler equation for Home holdings of Foreign bonds can be written as follows:

$$\left(1-\psi a_{*t+1}^*\right) = \left(1+i_{t+1}^*\right) E_t\left[\beta_{t,t+1}\frac{Q_{t+1}}{Q_t\left(1+\pi_{C,t+1}^*\right)}\right]. \tag{29}$$

Home net foreign assets are now determined by:

$$a_{t+1} + Q_t a_{*,t+1} = \frac{1+i_t}{1+\pi_{C,t}} a_t + Q_t \frac{1+i_t^*}{1+\pi_{C,t}^*} a_{*,t} + N_t \rho_{d,t} y_{x,t} - N_t^* Q_t \rho_{d,t}^* y_{x,t}^*. \tag{30}$$

[12] The international asset market in the currency union features a single nominal bond that is traded internationally. With a flexible exchange rate, we introduce Home and Foreign nominal bonds in order to preserve symmetry in the asset market structure.

[13] Foreig nominal holdings of Home bonds are denoted with A_t^*, while Foreign nominal holdings of Foreign bonds are denoted by $A_{*,t}^*$.

We maintain the assumption that export prices are sticky in the currency of producers. As discussed above, this ensures that there is no pricing-to-market, as in the monetary-union scenario. As a result pricing and markup equations are unaffected.

To summarize, all the equations in Table 1 continue to hold with the following exceptions: equations (18) and (19) are replaced by equations (28) and (29) above, and their Foreign counterparts; equations (17) and (20) are replaced by interest rate rules for the Home and Foreign central banks that take a similar form to equation (17), with the interest rate in each country responding to the country's own data-consistent CPI inflation rate and GDP gap; equation (21) is replaced by equation (30) above. The model now features 23 endogenous variables.

Under the optimal, cooperative monetary policy, the central banks of the two countries act together as a single Ramsey authority (however, now choosing two monetary policy instruments) to maximize aggregate welfare under the constraints of the competitive economy. Let $\Lambda_{1,t}, ..., \Lambda_{21,t}$ be the Lagrange multipliers associated to the equilibrium conditions (excluding the two interest rate rules). The Ramsey problem consists of choosing the sequence of multipliers $\{\Lambda_{1,t}, ..., \Lambda_{21,t}\}_{t=0}^{\infty}$ and

$$\{\pi_{C,t}, \pi^*_{C,t}, \pi_{w,t}, \pi^*_{w,t}, C_t, C^*_t, l_t, l^*_t, V_t, V^*_t, J_t, J^*_t, h_t, h^*_t, \rho_{d,t}, \rho^*_{d,t}, N_{t+1}, N^*_{t+1}, Q_t, i_{t+1}, i^*_{t+1,} a_{t+1}, a^*_{*t+1}\}_{t=0}^{\infty},$$

to maximize:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{2} \left(u\left(C_t\right) - l_t v\left(h_t\right) \right) + \frac{1}{2} \left(u\left(C^*_t\right) - l^*_t v\left(h^*_t\right) \right) \right] \right\} \tag{31}$$

subject to the constraints of the market economy (excluding the interest rate rules).

M. Transition Dynamics Following Symmetric Market Deregulation

See Figure A.2.

N. The Business Cycle Effects of Market Reform

See Tables A.3-A.6.

O. Individual Product or Labor Market Deregulation

Transition Dynamics and Long-run Effects

Figures A.3 and A.4 present transition dynamics following separate product and labor market deregulations. For most variables, the dynamics are qualitatively similar to those after joint deregulation of both markets, under both historical and optimal policy. The adjustment under the Ramsey-optimal policy implies smaller markups and higher employment along the transition. This results in a smaller wedge in job creation margin, with a temporary increase in the product creation wedge, both at Home and Foreign. The intuition mirrors that for joint deregulation in goods and labor markets. Regardless of the nature of deregulation, the Ramsey authority ensures that inflationary pressure stimulates job creation and reduces markups along the first part of the transition, before the positive effects of deregulation are fully materialized. The effects of Ramsey policy in the Foreign economy are large and positive during the transition, since consumption and employment comove positively with Home.

As for joint deregulation of product and labor markets, the discrepancies between Ramsey and historical allocations vanish in the long run. As time passes, the need to stimulate vacancy posting and reduce markups is reduced since deregulation per se reduces inefficiency wedges. Table A.7 shows that the optimal level of long-run inflation falls in response to both product and labor market deregulation. Table A.8 shows that the welfare gain from implementing the optimal monetary policy in response to the labor market deregulation is not large for the reforming economy. The positive effects of smaller long-run distortions dominate results, narrowing the welfare gap between historical and Ramsey policy at Home. The Ramsey policy instead remains relatively more desirable in the Foreign country.

To conclude, we note two main differences between product market deregulation and labor market deregulation. First, labor market reform immediately boosts aggregate consumption, since households immediately increase demand in anticipation of higher future income. Different from product market reform, producer entry drops in the aftermath of labor market deregulation. As vacancy posting increases, the expected cost of filling a vacancy rises, pushing up the equilibrium price of intermediate inputs. This makes producer entry more costly. In a sense, incumbent firms have a competitive advantage relative to potential entrants since they do not have to incur the sunk cost to benefit from the labor market reform.

Second, the international adjustment to an asymmetric labor market reform also does not involve costs for the non-reforming trading partner. A larger increase in Home's aggregate demand generates positive spillovers for Foreign consumption and employment. These positive effects are short-lived, however. As time passes, falling wages in the flexible economy lower marginal costs, and terms of trade depreciation induces expenditure switching toward Home goods. Current account deficit in the first part of the transition allows Home households to sustain higher consumption in anticipation of the long-run increase in income.

Business Cycle

Table A.8 shows that both individual reforms narrow the welfare gap between historical and Ramsey-optimal policy at Home as deregulation reduces the need for policy activism. As for the case of joint deregulation, the welfare gain from Ramsey policy increases slightly in the country that remains rigid. The effects are somewhat stronger for a labor market reform: Under the historical policy rule, the welfare cost of business cycles falls by almost 50 percent. The rigid country (Foreign) benefits slightly more from optimal policy following deregulation, while the gain from optimal policy becomes significantly smaller for Home.

P. Anticipated Reforms in a Monetary Union

Figure A.5 considers the consequences of a credible, time-0 announcement of Home market deregulation that will be implemented after six quarters. We maintain the assumption that the initial steady state is rigid and symmetric. (As for the case of unanticipated reforms, we obtain virtually identical results if we consider the alternative scenario in which Home deregulates its market when Foreign already has flexible market regulation.)

Under historical policy (continuous line), households increase consumption and postpone investment when the reform is announced. This result depends on two forces: First, Home households anticipate that income will be permanently higher in the long run, which, other things equal, immediately boosts current consumption. Second, households have an incentive to postpone investment in producer entry, since it will be cheaper to create new products in the future (when barriers to entry are reduced). The net effect is lower demand for the intermediate input.

The marginal cost of production in the downstream sector (the price of the intermediate input) falls. Price rigidity, together with lower substitutability due to declining producer entry, results in higher markups, lower aggregate demand and higher unemployment. In turn, the decline in Home prices leads to a depreciation of Home terms of trade. Expenditure switching toward Home goods has a negative effect on Foreign employment and consumption.

When the reform is finally implemented, the dynamics are very similar to those observed following unanticipated deregulation: Lower barriers to entry increase Home product creation. Consumption temporarily falls as households increase savings to finance product creation. With an open capital account, increased entry is partly financed by borrowing from abroad. As a result, the deregulating economy runs a current account deficit in the aftermath of the market deregulation. As Foreign consumers invest at Home, Foreign consumption falls, and unemployment rises.

Consider now the Ramsey-optimal policy (dashed lines). As shown in Figure A.5, the optimal policy continues to front-load the long-run positive effects of Home market deregulation by immediately generating lower markups, higher consumption, and lower unemployment (at the time of the reform announcement). Relative to historical policy, the Ramsey allocation initially induces a larger fall in product creation by increasing inflation, i.e., reducing the real present discounted value of entry. The Foreign economy is favorably affected by the Ramsey policy on impact due to the larger demand for both Home and Foreign goods in the deregulating economy. Over time the differences between historical and Ramsey policies vanish as the economies converge to the new long-run equilibrium.

Q. Price Stability

See Table A.9.

R. Sensitivity Analysis

We perform sensitivity analysis by considering alternative values for the parameters whose calibration is relatively controversial in the literature. For household preferences, we investigate the role of a unitary intertemporal elasticity of substitutions ($\gamma = 1$), a lower elasticity of substitution between Home and Foreign goods ($\phi = 1.5$), absence of home bias ($\alpha = 0.5$), and a higher Frisch elasticity ($1/\gamma_h = 4$, as typically assumed in the business cycle literature). Finally, we consider an alternative value for the elasticity of the matching function ($\varepsilon = 0.4$, a mid-point of the estimates reported by Petrongolo and Pissarides, 2006). We consider the effect of changing one parameter value at a time relative to the benchmark calibration.

The main results of the paper are extremely robust to the alternative parameter values we consider.[14] The parameter value that affects our results most significantly is the elasticity of the matching function, ε. Specifically, for any given level of market regulation, a lower value of ε reduces the gap between Ramsey-optimal policy and historical policy both in the long run and over the business cycle (the differences between the two policy regimes, however, remain sizable in absolute terms). In the long run, a smaller value of ε lowers the optimal long-run inflation target. Intuitively, when the elasticity of the matching function is below the bargaining power of firms ($\varepsilon < \eta$), there is a stronger tension between using positive long-run inflation to increase the bargaining power of firms (which stimulates job creation) and the cost of this policy (which widens the departure from the Hosios condition introduced by setting $\varepsilon < \eta$). Over the business cycle, instead, the historical policy of (near) price stability is less costly because unemployment is less volatile when ε is smaller, i.e., the need to use inflation to stabilize unemployment is mitigated, and the Ramsey-optimal policy implies less volatile inflation for any level of regulation.

[14] Tables and figures are available on request.

TABLE A.1: CALIBRATION

	Parameter	Value
Risk Aversion	$\gamma_C \quad =$	2
Frisch Elasticity	$1/\gamma_h \ =$	0.2
Discount Factor	$\beta \quad =$	0.99
Elasticity Matching Function	$\varepsilon \quad =$	0.6
Flexible-Wage Firm Bargaining Power	$\eta \quad =$	0.6
Unemployment Benefit	$b \quad =$	0.41
Exogenous Worker Separation	$\lambda \ =$	0.036
Vacancy Cost	$k =$	0.20
Matching Efficiency	$\chi =$	0.38
Home and Foreign Goods Substitutability	$\phi =$	3.8
Home Bias	$\alpha \quad =$	0.2
Translog Substitutability Parameter	$\sigma \quad =$	0.43
Producer Exit	$\delta \quad =$	0.026
Producer Entry Cost, Technology	$f_T \ =$	0.20
Producer Entry Cost, Regulation	$f_R =$	0.80
Price Adjustment Cost	$\nu \ =$	80
Wage Adjustment Cost	$\vartheta =$	160
Historical Policy, Interest Rate Smoothing	$\varrho_i =$	0.87
Historical Policy, Inflation Response	$\varrho_\pi =$	1.93
Historical Policy, GDP Gap Response	$\varrho_Y =$	0.075
Bond Adjustment Cost	$\tau \ =$	0.0025
Productivity Persistence	$\Phi_{11} = \Phi_{22} =$	0.999
Productivity Spillover	$\Phi_{12} = \Phi_{21} =$	0
Productivity Innovations, Standard Deviation		0.009
Productivity Innovations, Correlation		0.253

TABLE A.2: BUSINESS CYCLE STATISTICS

Variable	$\sigma_{X_R^U}$			$\sigma_{X_R^U}/\sigma_{Y_R^U}$			1st Autocorr			$corr(X_{R,t}^U, Y_{R,t}^U)$		
Y_R^U	**1.50**	1.50	*1.44*	**1**	1	*1*	**0.87**	0.83	*0.81*	**1**	1	*1*
C_R^U	**0.63**	1.22	*0.94*	**0.42**	0.80	*0.65*	**0.78**	0.72	*0.72*	**0.87**	0.97	*0.89*
I_R^U	**3.06**	4.05	*5.06*	**2.04**	2.70	*3.51*	**0.90**	0.81	*0.76*	**0.92**	0.62	*0.68*
l^U	**0.68**	0.68	*0.60*	**0.45**	0.45	*0.42*	**0.81**	0.89	*0.88*	**0.64**	0.82	*0.78*
w_R^{Ur}	**0.50**	0.50	*0.44*	**0.33**	0.33	*0.31*	**0.85**	0.94	*0.92*	**0.19**	0.50	*0.62*
$corr(C_{R,t}, C_{R,t}^*)$	**0.55**	0.33	*0.99*									
$corr(Y_{R,t}, Y_{R,t}^*)$	**0.86**	0.39	*0.48*									

Bold fonts denote data moments, normal fonts denote moments for the Baxter calibration of productivity, and italics denote the BKK calibration.

TABLE A.3: VOLATILITY

	Historical Policy						
	Status Quo	Asymmetric PMR	Asymmetric LMR	Asymmetric JOINT	Symmetric PMR	Symmetric LMR	Symmetric JOINT
Y_R	1.50	1.46	1.39	1.38	1.45	1.39	1.37
C_R	1.22	1.17	1.10	1.09	1.17	1.10	1.09
I_R	4.05	4.24	3.41	3.69	4.23	3.41	3.69
l	0.68	0.60	0.47	0.45	0.61	0.47	0.46
Y_R^*	1.50	1.50	1.50	1.50	1.45	1.39	1.37
C_R^*	1.22	1.22	1.22	1.22	1.17	1.10	1.09
I_R^*	4.05	4.04	4.05	4.05	4.23	3.41	3.69
l^*	0.68	0.68	0.68	0.68	0.61	0.47	0.47
	Ramsey Policy						
	Status Quo	Asymmetric PMR	Asymmetric LMR	Asymmetric JOINT	Symmetric PMR	Symmetric LMR	Symmetric JOINT
Y_R	1.18	1.19	1.18	1.19	1.17	1.14	1.15
C_R	0.96	0.94	0.91	0.91	0.93	0.88	0.88
I_R	3.57	3.86	3.42	3.66	3.90	3.42	3.71
l	0.39	0.38	0.33	0.32	0.35	0.28	0.27
Y_R^*	1.18	1.16	1.13	1.12	1.17	1.14	1.15
C_R^*	0.96	0.95	0.94	0.94	0.93	0.88	0.88
I_R^*	3.57	3.61	3.51	3.58	3.90	3.42	3.71
l^*	0.39	0.36	0.32	0.31	0.35	0.28	0.27

TABLE A.4: PERSISTENCE

	Historical Policy						
	Status Quo	Asymmetric PMR	Asymmetric LMR	Asymmetric JOINT	Symmetric PMR	Symmetric LMR	Symmetric JOINT
Y_R	0.83	0.83	0.81	0.81	0.83	0.81	0.81
C_R	0.72	0.72	0.71	0.71	0.72	0.71	0.71
I_R	0.81	0.80	0.81	0.79	0.80	0.82	0.80
l	0.89	0.88	0.87	0.87	0.88	0.87	0.87
Y_R^*	0.83	0.83	0.84	0.84	0.83	0.81	0.81
C_R^*	0.72	0.72	0.72	0.72	0.72	0.71	0.71
I_R^*	0.81	0.81	0.81	0.82	0.80	0.82	0.80
l^*	0.89	0.89	0.89	0.89	0.88	0.87	0.87
	Ramsey Policy						
	Status Quo	Asymmetric PMR	Asymmetric LMR	Asymmetric JOINT	Symmetric PMR	Symmetric LMR	Symmetric JOINT
Y_R	0.73	0.75	0.75	0.75	0.74	0.74	0.75
C_R	0.60	0.63	0.67	0.68	0.62	0.65	0.66
I_R	0.88	0.88	0.88	0.88	0.88	0.88	0.88
l	0.88	0.88	0.87	0.87	0.87	0.86	0.86
Y_R^*	0.73	0.73	0.72	0.72	0.74	0.74	0.75
C_R^*	0.60	0.59	0.58	0.57	0.62	0.65	0.66
I_R^*	0.88	0.88	0.88	0.88	0.88	0.88	0.88
l^*	0.88	0.88	0.87	0.86	0.87	0.86	0.86

TABLE A.5: CROSS-COUNTRY CORRELATIONS

	Historical Policy						
	Status Quo	Asymmetric PMR	Asymmetric LMR	Asymmetric JOINT	Symmetric PMR	Symmetric LMR	Symmetric JOINT
$corr(C_{R,t}, C^*_{R,t})$	0.33	0.33	0.32	0.32	0.33	0.32	0.32
$corr(Y_{R,t}, Y^*_{R,t})$	0.39	0.39	0.39	0.38	0.38	0.39	0.38
	Ramsey Policy						
$corr(C_{R,t}, C^*_{R,t})$	0.01	0.03	0.06	0.08	0.05	0.09	0.11
$corr(Y_{R,t}, Y^*_{R,t})$	-0.08	-0.06	-0.06	-0.04	-0.05	-0.08	-0.05

Table A.6: PRICE AND WAGE INDEXATION, WELFARE COST OF BUSINESS CYCLES

Market Reform	Welfare Cost of Business Cycles					
	Hist		*Ramsey MU*		*Ramsey Coop*	
$\iota_p = \iota_w = 0.5$	Home	Foreign	Home	Foreign	Home	Foreign
Status Quo	0.93	0.93	0.78	0.78	0.74	0.74
Asymmetric	0.61	0.92	0.55	0.75	0.50	0.72
Symmetric	0.61	0.61	0.52	0.52	0.50	0.50
$\iota_p = 1, \iota_w = 0$	Home	Foreign	Home	Foreign	Home	Foreign
Status Quo	0.94	0.94	0.76	0.76	0.71	0.71
Asymmetric	0.62	0.93	0.53	0.73	0.47	0.70
Symmetric	0.62	0.62	0.50	0.50	0.47	0.47
$\iota_p = 0, \iota_w = 1$	Home	Foreign	Home	Foreign	Home	Foreign
Status Quo	0.98	0.98	0.90	0.90	0.89	0.89
Asymmetric	0.64	0.96	0.62	0.87	0.61	0.87
Symmetric	0.63	0.63	0.60	0.60	0.60	0.60

Note: Hist $\equiv$ Historical Monetary Policy;

Ramsey MU $\equiv$ Ramsey-Optimal Policy in the Monetary Union;

Ramsey Coop $\equiv$ Ramsey-Optimal Cooperative Policy With Flexible Exchange Rate;

Asymmetric $\equiv$ Home Country Product and Labor Market Reform;

Symmetric $\equiv$ Home and Foreign Country Product and Labor Market Reform;

ΔWelfare $\equiv$ Welfare change.

Table A.7: INDIVIDUAL REFORMS, OPTIMAL LONG-RUN INFLATION

	Trend Inflation							
	Asymmetric				*Symmetric*			
	PMR		*LMR*		*PMR*		*LMR*	
	Home	Foreign	Home	Foreign	Home	Foreign	Home	Foreign
No Indexation								
Ramsey MU	1.09	1.09	1.00	1.00	1.02	1.02	0.82	0.82
Ramsey Coop	1.03	1.14	0.83	1.14	1.02	1.02	0.82	0.82
Price Indexation ($\iota_p = 1$)								
Ramsey MU	1.14	1.14	0.98	0.98	1.08	1.08	0.76	0.76
Ramsey Coop	1.09	1.18	0.76	1.18	1.08	1.08	0.76	0.76
Wage Indexation ($\iota_w = 1$)								
Ramsey MU	1.02	1.02	1.08	1.08	0.92	0.92	1.06	1.06
Ramsey Coop	0.93	1.10	1.07	1.10	0.92	0.92	1.06	1.06
Price and Wage Indexation								
($\iota_p = \iota_w = 0.5$)								
Ramsey MU	2.19	2.19	2.00	2.00	2.05	2.05	1.66	1.66
Ramsey Coop	2.07	2.30	1.67	2.30	2.05	2.05	1.66	1.66

Note: Ramsey MU ≡ Optimal Policy in the Monetary Union;

Ramsey Coop ≡ Optimal Cooperative Policy With A Flexible Exchange Rate;

Asymmetric ≡ Home Country Reform;

Symmetric ≡ Home and Foreign Country Reform.

Table A.8: WELFARE EFFECTS OF INDIVIDUAL REFORMS

Market Reform	ΔWelfare					
	Hist		*Ramsey MU*		*Ramsey Coop*	
	Home	Foreign	Home	Foreign	Home	Foreign
Asymmetric PMR	5.30	0.28	5.41	0.56	5.44	0.58
Asymmetric LMR	3.20	0.23	3.41	0.54	3.42	0.54
Symmetric PMR	5.55	5.55	5.65	5.65	5.65	5.65
Symmetric LMR	3.41	3.41	3.60	3.60	3.60	3.60
	Welfare Cost of Business Cycles					
	Hist		*Ramsey MU*		*Ramsey Coop*	
	Home	Foreign	Home	Foreign	Home	Foreign
Asymmetric PMR	0.77	0.93	0.65	0.75	0.60	0.72
Asymmetric LMR	0.65	0.93	0.56	0.75	0.52	0.72
Symmetric PMR	0.77	0.77	0.63	0.63	0.59	0.59
Symmetric LMR	0.65	0.65	0.54	0.54	0.51	0.51

Note: Hist ≡ Historical Monetary Policy;

Ramsey MU ≡ Ramsey-Optimal Policy in the Monetary Union;

Ramsey Coop ≡ Ramsey-Optimal Cooperative Policy With Flexible Exchange Rate;

Asymmetric PMR≡ Home Country Product Market Reform;

Asymmetric LMR≡ Home Country Labor Market Reform;

Symmetric ≡ Home and Foreign Country Reform;

ΔWelfare ≡ Welfare change.

Table A.9: WELFARE EFFECTS OF REFORMS, STRICT PRICE STABILITY

Market Reform	ΔWelfare					
	Price Stability		*Ramsey MU*		*Ramsey Coop*	
	Home	Foreign	Home	Foreign	Home	Foreign
Status Quo			0.35	0.35	0.35	0.35
Asymmetric	7.33	0.27	7.45	0.70	7.49	0.72
Symmetric	7.62	7.62	7.83	7.83	7.83	7.83
	Welfare Cost of Business Cycles					
	Price Stability		*Ramsey MU*		*Ramsey Coop*	
	Home	Foreign	Home	Foreign	Home	Foreign
Status Quo	0.90	0.90	0.77	0.77	0.72	0.72
Asymmetric	0.60	0.88	0.54	0.74	0.49	0.71
Symmetric	0.59	0.59	0.52	0.52	0.49	0.49

Note: Hist ≡ Historical Monetary Policy;

Ramsey MU ≡ Ramsey-Optimal Policy in the Monetary Union;

Ramsey Coop ≡ Ramsey-Optimal Cooperative Policy With Flexible Exchange Rate;

Asymmetric ≡ Home Country Product and Labor Market Reform;

Symmetric ≡ Home and Foreign Country Product and Labor Market Reform;

ΔWelfare ≡ Welfare change.

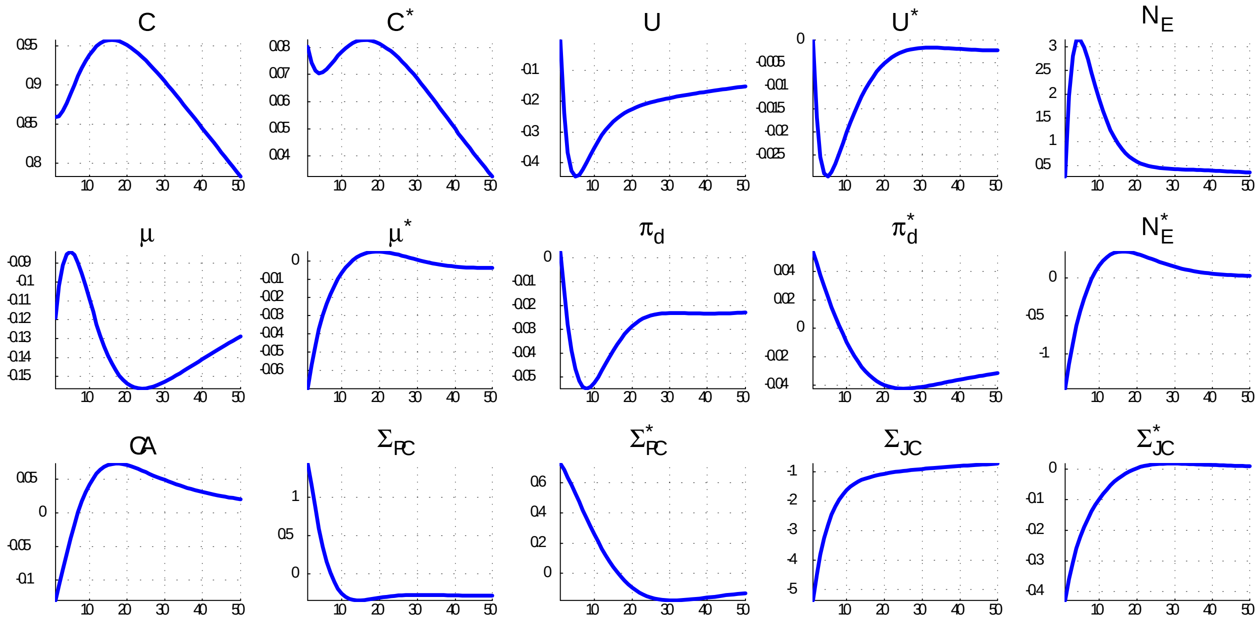

Figure A.1. Home productivity shock with high regulation, historical policy. Responses show percentage deviations from the steady state. Unemployment and inflation are in deviations from the steady state.

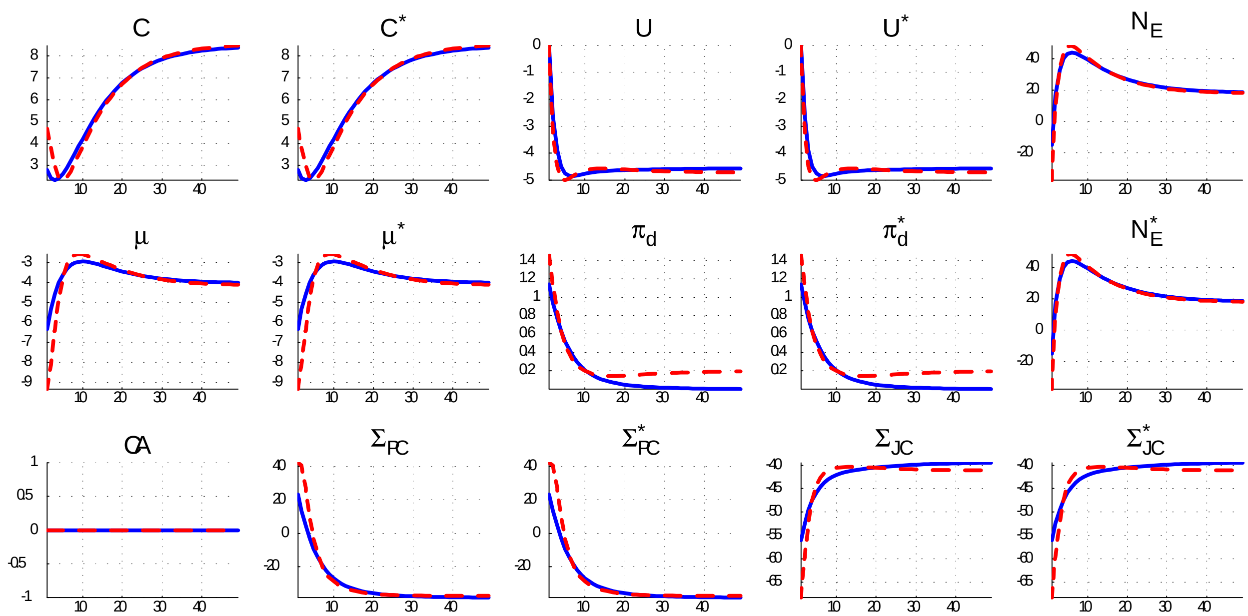

Figure A.2: Home and Foreign product and labor market reform, historical policy (continuous lines) versus Ramsey-optimal policy (dashed lines). Responses show percentage deviations from the high-regulation steady state under historical policy (zero steady-state inflation). Unemployment and inflation are in deviations from the steady state.

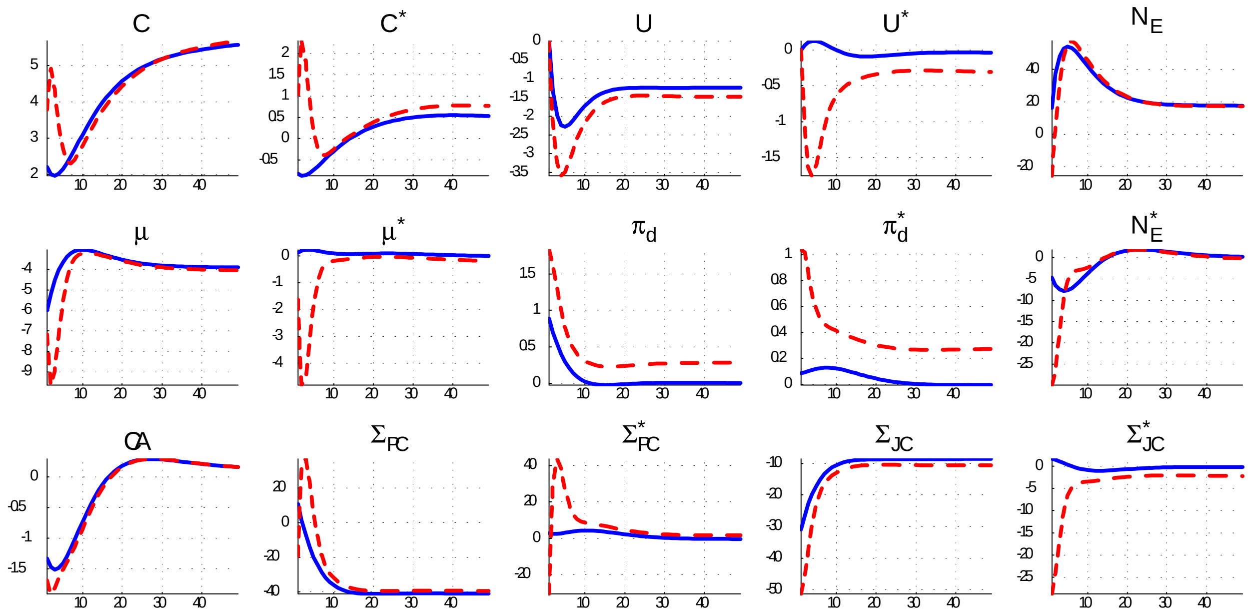

Figure A.3: Home product market reform, historical policy (continuous lines) versus Ramsey-optimal policy (dashed lines). Responses show percentage deviations from the high-regulation steady state under historical policy (zero steady-state inflation). Unemployment and inflation are in deviations from the steady state.

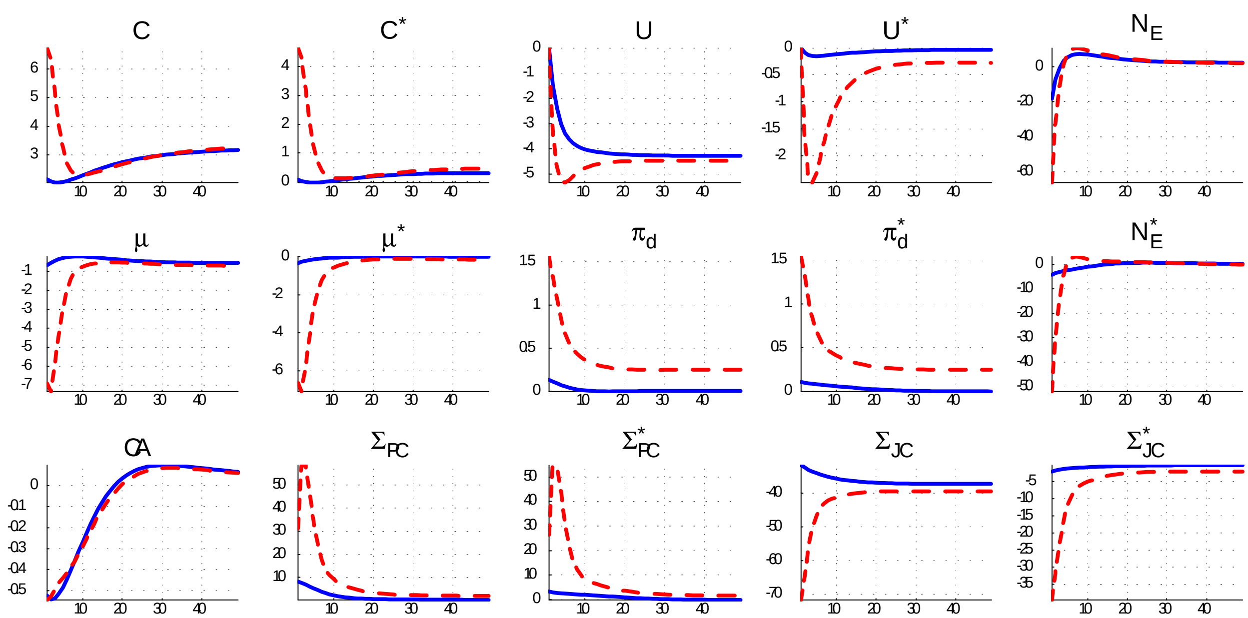

Figure A.4: Home labor market reform, historical policy (continuous lines) versus Ramsey-optimal policy (dashed lines). Responses show percentage deviations from the high-regulation steady state under historical policy (zero steady-state inflation). Unemployment and inflation are in deviations from the steady state.

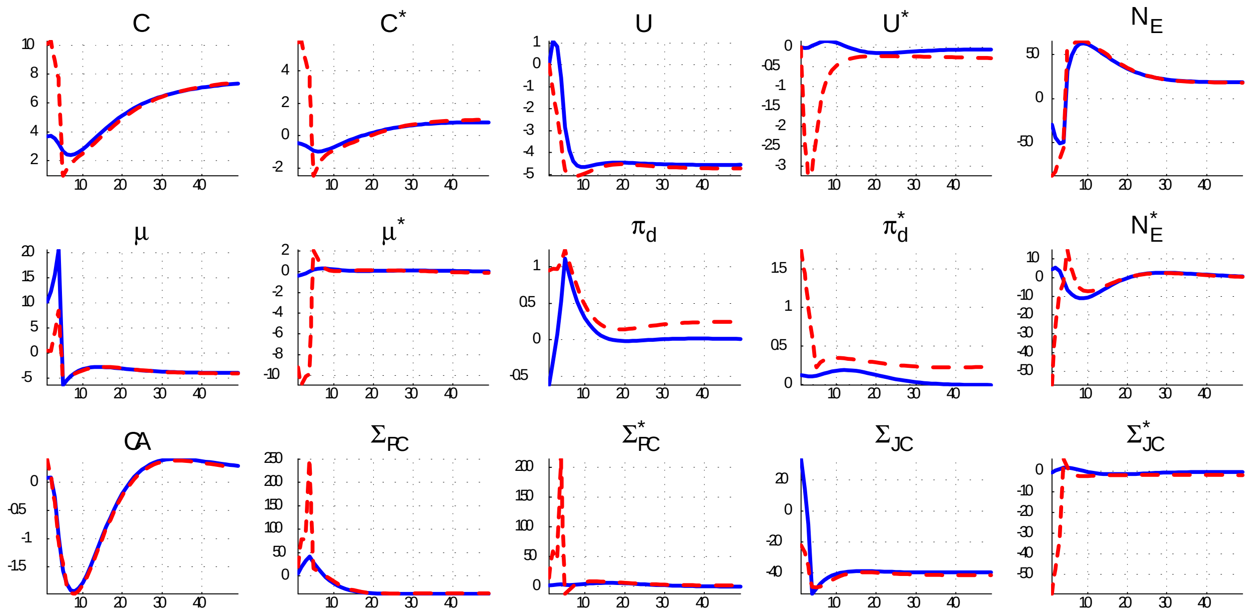

Figure A.5: Anticipated Home product and labor market reform, historical policy (continuous lines) versus Ramsey-optimal policy (dashed lines). Responses show percentage deviations from the high-regulation steady state under historical policy (zero steady-state inflation). Unemployment and inflation are in deviations from the steady state.