THE DISPERSION OF MARK-UPS IN AN OPEN ECONOMY

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ABSTRACT

We introduce heterogeneous mark-ups through Bertrand competition in a two-country model with endogenous firms' entry and tradability `a la Ghironi and Melitz (2005). Bertrand competition generates a distribution of mark-ups according to which firms that are larger and more productive charge lower prices, attract larger market shares and extract larger mark-ups. First, we characterize first-best allocations and their implementation. We find that they are inde- pendent from the degree of mark-ups' heterogeneity, suppress the dispersion of mark-ups and imply zero distortions on labor as well as substantial subsidies to preserve firm's incentives to enter. Second, second-best alternative policies with a restricted number of instruments and a balanced budget significantly reduce the potential welfare gains from fiscal policies. Third, the total welfare losses from passive policies are lower under heterogeneous mark-ups than under homogeneous mark-ups: while the dispersion of mark-ups has negative effects on the intensive margin, output per firm, it also raises expected profits for potential entrants and raises the ex- tensive margin, the number of firms in both domestic and export markets, pushing them closer to their efficient levels. Fourth, we also investigate the dynamic properties of allocations under passive and optimal policies considering aggregate productivity shocks and trade liberalization experiments.

KEYWORDS

Heterogeneous firms, Endogenous Entry, Open economy, Strategic pricing. Optimal taxation.

JEL

D4, E20, E32.

The Dispersion of Mark-ups in an Open Economy

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Abstract

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1 Introduction

Mark-ups in the world economy have recently been the object of much attention. While it has been argued that mark-ups have been trending up over the last years (Autor, Dorn, Katz, Patterson, and Reenen (2017), Loecker, Eeckhout, and Unger (2020)) and that large firms account for a growing share of aggregate fluctuations (Gabaix (2011)), the dispersion of mark-ups has also been considered as a potential source of resource misallocation both in closed economies (see Restuccia and Rogerson (2008) or Baqaee and Farhi (2020) among others) and in open economies (see Holmes, Hsu, and Lee (2014) or Edmond, Midrigan, and Xu (2015)) and as a determinant of the granular origins of competitive advantages (see Gaubert and Itskhoki (2020)).

In this paper, we introduce heterogeneous mark-ups by assuming strategic pricing through Bertrand competition in an otherwise standard two-country model with endogenous firms' entry and tradability *à la* Ghironi and Melitz (2005) to investigate the design of optimal fiscal policies. Indeed, a growing literature in international trade stresses the importance of strategic pricing and the resulting dispersion of mark-ups in shaping allocations (Bernard, Eaton, Jensen, and Kortum (2003), Melitz and Ottaviano (2008), Atkeson and Burstein (2008) for instance) and more specifically the welfare gains from trade (Edmond, Midrigan, and Xu (2015)).

First and as expected, when fiscal policy is passive, Bertrand competition generates a distribution of mark-ups according to which larger and more productive firms charge lower prices, attract larger market shares and extract larger mark-ups. In addition, the Melitz (2003) selection mechanism of exporting firms implies that the latter are more productive and hence charge higher mark-ups. These results are both intuitive and match the observed distribution of mark-ups (see Holmes, Hsu, and Lee (2014)).

Second, we derive the first-best allocations and show how they can be implemented. First-best allocations fully correct the pricing distortions, imply a zero dispersion of mark-ups and a very low level of mark-ups, along with generous subsidies to preserve firms' incentive to enter both domestic and export markets. These allocations can be implemented using a combination of firm-specific sales subsidies, a differentiated taxation scheme of corporate profits and labor taxation. In an economy with homogeneous mark-ups, the first-best is identical but, in contrast, it is much easier to implement through a single policy instrument: a uniform, time-varying sales subsidy on all firms. In both cases, the welfare losses from passive fiscal policies are very large compared to the first-best allocations, around 15%. Given the complexity of the implementation scheme under heterogeneous mark-ups, and in light of its cost – implementation requires large amounts of subsidies whether mark-ups are heterogeneous or homogeneous – we consider second-best alternative policies where the number of policy instruments is restricted and government's budget has to be balanced. We find that these restrictions significantly lower the ability of policymakers to reduces the welfare losses associated with the equilibrium under passive policies, as only 1/3 of the total potential welfare gains can be implemented in this case.

Third, while first-best allocations are independent from the degree of mark-ups' homogeneity, we find that the total welfare losses from passive policies are *lower* under heterogeneous mark-ups than under homogeneous mark-ups. Surprising at first glance, the result can be rationalized by considering the effects of the dispersion of mark-ups both on the intensive margin – output per-firm – and on the extensive margin – the number of firms. Indeed, Bertrand competition implies that the dispersion and the average level of mark-ups are positively related. Hence, the dispersion of mark-ups also raises the level of mark-ups with two effects. On the one hand, all else equal, higher mark-ups reduce the quantity of output produced by each firm – the intensive margin – and induce misallocation. On the other hand, higher mark-ups imply higher expected profits for potential entrants, which boosts entry and thus raises the number of existing firms – the extensive margin. We show that the welfare gains associated with the second effect – given that our consumption bundle features love for variety – dominates the welfare losses associated with the first effect in our model. This second-best result thus implies that the dispersion of mark-ups can generate welfare gains when fiscal policy is passive. A restricted version of our model where the number of firms is constrained to remain constant finds, in line with common wisdom, that more dispersed mark-ups and thus higher average mark-ups generate welfare losses through their negative effects on the intensive margin.

Fourth, while the previous results focused mostly on the steady-state implications of our model and the related optimal policies, we also investigate the dynamic properties of the model under passive and optimal fiscal policies. Under passive fiscal policies, when the model is driven by temporary aggregate productivity shocks, the model behaves very much like the Ghironi and Melitz (2005) model. A novel prediction of our model is that average mark-ups are counter-cyclical while export mark-ups are pro-cyclical. Optimal fiscal policies imply adjustments of tax rates that overturn this pattern, align all mark-ups over the business cycle – zero dynamic dispersion – and make all mark-ups pro-cyclical, to implement the efficient dynamics of firm's entry over the business cycle. These results are in line with the findings of contributions focusing on endogenous entry with homogeneous mark-ups in closed economies (Bilbiie, Ghironi, and Melitz (2019)) as well as in open economies (Cacciatore and Ghironi (2020)). Along the business cycle and conditional on aggregate productivity shocks, the dispersion of mark-ups makes little difference quantitatively speaking.

Last, in the spirit of Edmond, Midrigan, and Xu (2015), we run a trade liberalization experiment by which (iceberg) trade costs gradually and permanently fall to almost zero. We find that the long-run welfare gains are much larger under the first-best fiscal policy and that the short-run welfare gains are significantly affected by the dispersion of mark-ups. In particular, the dispersion of mark-ups affects the dynamics of firms' creation resulting from a trade liberalization in a critical manner. As in Edmond, Midrigan, and Xu (2015), the dispersion of mark-ups lowers the long-run welfare gains from trade, but for a different reason: it affects negatively business dynamism and lowers the long-run number of firms. However, since in this case less resources are invested in the short-run to create new firms, consumption increases more at the intensive margin at short to medium horizons – less 9 years. While the long-run welfare gains from trade integration range from 12% to 14.5% depending on calibrations, the short-run welfare gains under dispersed mark-ups can be up to 3% larger than under homogeneous mark-ups.

Our contributions to the literature can be viewed as the following. First, to the best of our knowledge, our paper is the first to introduce strategic pricing decisions in a Ghironi and Melitz (2005) model. The resulting predictions regarding the distribution of mark-ups and the cyclical pattern of average mark-ups are qualitatively consistent with empirical evidence. While related to the recent literature on how strategic pricing affects key results of the literature in international trade, such as the pro-competitive gains from trade (Edmond, Midrigan, and Xu (2015)) or the building of comparative advantages (Gaubert and Itskhoki (2020)), our focus is on the effect of the dispersion of mark-ups on firms' creation and on optimal fiscal policy. Second, the second-best result according to which mark-ups not only generate misallocation but can also affect business dynamism positively is novel. It somehow builds on the Schumpeterian view that market power is not only distortive but also shapes incentives for incumbent firms or innovators to enter markets. Third, our paper contributes to the debate about the optimal taxation of firms in the open economy under strategic pricing, and thus offers an interesting complement to recent contributions on the subject. Etro and Colciago (2010) consider an optimal fiscal policy under strategic pricing both in the steady state and along the business cycle. Bilbiie, Ghironi, and Melitz (2019) investigate the welfare gains from optimal fiscal policies with endogenous entry. However, these two papers consider a closed economy while we consider an open economy. Cacciatore and Ghironi (2020) focus on optimal monetary policy in an open economy model with endogenous entry, matching labor-market frictions. Along the way, they discuss the properties of the first-best equilibrium. However, they do not consider how to implement the first-best using taxes with closed-form formulas, and assume a standard monopolistic competition pricing rule for firms, implying homogeneous mark-ups.

The paper is structured as follows. Section 2 develops a two-country model *à la* Ghironi and Melitz (2005) with strategic pricing. Section 3 discusses the fiscal policy set-ups and presents the baseline numerical values that will be used in the various simulations. Section 4 focuses on the steady-state implications of mark-ups' dispersion on allocations under passive fiscal policies and on the design of optimal or constrained-optimal fiscal policies. Section 5 discusses the dynamic implications of the model and of optimal policies after temporary productivity shocks or permanent trade liberalization experiments. Section 6 offers an insight into our results with a calibration that features more dispersion in mark-ups, and Section 7 concludes.

2 Model

2.1 Households

The economy is made of two countries of equal size. We focus on the Home economy unless specified otherwise, being understood that symmetric conditions hold for the Foreign economy. There is a representative household that maximizes a welfare index:[1]

$$\mathcal{W}_t = \mathsf{E}_t \left\{ \sum_{s=t}^{\infty} \beta^{s-t} \left(\log c_s - \chi \frac{l_s^{1+\psi}}{1+\psi} \right) \right\} \tag{1}$$

subject to the budget constraint:

$$E_t \left\{ \Lambda_{t+1,t} b_{t+1} \right\} + \widetilde{v}_t \left(n_t + n_{e,t} \right) x_t + c_t = b_t + \left(\widetilde{\pi}_t + \widetilde{v}_t \right) n_t x_{t-1} + \left(1 - \tau_{wt} \right) w_t l_t - T_t \tag{2}$$

and to the appropriate transversality conditions on assets. In the above expressions, β is the subjective discount factor, c_t is the aggregate consumption bundle, l_t is the quantity of labor supplied and the elasticity of labor supply with respect to the real wage is ψ^{-1}. Variable w_t denotes the real wage and τ_{wt} is the labor income tax rate. Households have access to two assets: shares of a mutual fund of firms and a portfolio b_t of state-contingent assets, denominated in terms of the Home currency. In period t, the household determines the optimal fraction x_t of the fund to be held, given the average value of firms in period t, $\widetilde{v}_t$, and the average after-tax real amount of operating profits $\widetilde{\pi}_t$, given the dynamics of firms (to be detailed later). Notice that operating profits generated at home and through exports are potentially taxed at different levels. Last, T_t is a lump-sum tax. First order conditions of the household with respect to c_t, ℓ_t, b_t and x_t imply:

$$\beta r_t \mathsf{E}_t \left\{ \frac{c_t}{c_{t+1}} \right\} = 1 \tag{3}$$

$$\beta \left(1 - \delta \right) \mathsf{E}_t \left\{ \frac{c_t}{c_{t+1}} \left(\widetilde{\pi}_{t+1} + \widetilde{v}_{t+1} \right) \right\} = \widetilde{v}_t \tag{4}$$

$$\chi l_t^{\psi} c_t = \left(1 - \tau_{wt} \right) w_t \tag{5}$$

where $r_t = 1/\mathsf{E}_t \left\{ \Lambda_{t+1,t} \right\}$ is the real interest rate of the domestic economy. Given the assumption of complete markets and using the fact that state-contingent assets are denominated in terms of the Home currency, an equation similar to Equation (3) holds in the Foreign economy and implies

$$q_t = \Phi c_t / c_t^* \tag{6}$$

where q_t stands for the real exchange rate – expressed as the relative price of the Foreign consumption good – and where Φ is a parameter that depends on the initial distribution of wealth. The economy is made of sectors s, each of which produces differentiated varieties of goods ω. Aggregate

[1] We do not describe in details relations characterizing the foreign economy. However, similar conditions hold.

consumption is a bundle of the different sectoral goods available in the economy:

$$c_t = \left(\int_0^1 c_t(s)^{\frac{\theta-1}{\theta}} ds \right)^{\frac{\theta}{\theta-1}} \tag{7}$$

where $\theta > 1$ is the elasticity of substitution between different sectoral goods. The corresponding CPI is:

$$p_t = \left(\int_0^1 p_t(s)^{1-\theta} ds \right)^{\frac{1}{1-\theta}} \tag{8}$$

where $p_t(s)$ is the price of sectoral good s. In addition, within each sector s, households have preferences over domestic and foreign varieties of the sectoral good s:

$$c_t(s) = \left(\int_{\omega \in \Omega} c_t(s,\omega)^{\frac{\gamma-1}{\gamma}} d\omega \right)^{\frac{\gamma}{\gamma-1}} \tag{9}$$

where Ω denotes the space of potential varieties of goods that can be produced either at home or abroad and $\gamma > \theta$ the elasticity of substitution among varieties. The corresponding sectoral CPIs write

$$\left(\int_{\omega \in \Omega} p_t(s,\omega)^{1-\gamma} d\omega \right)^{\frac{1}{1-\gamma}} = p_t(s), \ \forall s \tag{10}$$

The individual variety demands are thus

$$c_t(s,\omega) = \rho_t(s)^{-\theta} \rho_t(s,\omega)^{-\gamma} c_t \tag{11}$$

where $\rho_t(s) = p_t(s)/p_t$ denotes the relative sectoral price of goods in sector s and $\rho_t(s,\omega) = p_t(s,\omega)/p_t(s)$ denotes the relative price of variety ω in sector s

2.2 Firms

In each sector and country, there is a continuum of heterogeneous firms producing differentiated varieties.[2] The sector allows for endogenous entry. Over the entire space of varieties, only a subset will actually be created and commercialized. Firms have specific random productivity draws z that remain fixed once firms have been created. Variety creation incurs at once and for all sunk cost f_e, paid in units of the final good, that generates demands as given by Equation (11). At each period t, there are two types of firms: $n_t(s)$ firms that are already productive at the beginning of the period and n_{et} firms that are newly created – but nonproductive yet – within the period. At the end of the period a fraction $\delta \in [0,1]$ of all existing firms is exogenously affected by an exit shock. The total number of varieties thus evolves according to:

$$n_t(s) = (1-\delta)(n_{t-1}(s) + n_{et-1}(s)) \tag{12}$$

[2]We focus on the domestic firms but symmetric conditions hold for foreign producers.

Firm-specific productivity z in sector s has a Pareto distribution with lower bound $z_{\min}(s)$ and shape parameter $\varepsilon > \gamma - 1$. The probability density function of z is $g(z,s) = \varepsilon z_{\min}(s)^{\varepsilon} / z(s)^{\varepsilon+1}$ and the cumulative density function is $G(z,s) = 1 - (z_{\min}(s)/z(s))^{\varepsilon}$. The condition for entry is that the expected value of firms should equate the sunk entry cost f_e. As in Gaubert and Itskhoki (2020), we assume that firms enter markets according to a sequential entry game in which firms with lower productivity draws and therefore lower marginal costs move first. The entry selection game, along with the given exogenous death shock and the Pareto *ex-ante* distribution of firms implies a unique productivity cut-off, and equalizes the expected value of firms with the *ex-post* average value of firms $\widetilde{v}_t$, so that the entry condition writes:

$$\widetilde{v}_t(s) = f_e \tag{13}$$

which, given the Euler equation on shares, gives

$$(1-\delta)\beta \mathsf{E}_t \left\{ \frac{c_t}{c_{t+1}} \left(\widetilde{\pi}_{t+1}(s) + f_e\right) \right\} = f_e \tag{14}$$

where $\widetilde{\pi}_t(s)$ stands for the average profits made by domestic firms in sector s. Firm can address their domestic market as well as the foreign market. However, access to the export market requires the repeated payment of a cost f_x, paid in units of the final good and that generates demands as given by Equation (11). This implies that only $n_{xt}(s) < n_t(s)$ varieties will be available to Foreign consumers while $n^*_{xt}(s) < n^*_t(s)$ Foreign varieties will be available to Home consumers. Let

$$y_t(s,z) = a_t z \ell_t(s,z) \tag{15}$$

be the individual production function of a firm in sector s, where z is an exogenously drawn initial firm-level of productivity, $\ell_t(s,z)$ the amount of labor used in the production of goods and a_t the level of aggregate productivity, evolving as an AR(1) process subject to iid shocks

$$\log(a_t/a) = \rho_a \log(a_{t-1}/a) + \xi_{at} \tag{16}$$

Total operating profits from firm z in sector s are defined as

$$\begin{aligned} \pi_t(s,z) \quad = \quad & (1-\tau_{\pi t})\left(\left(1-\tau_{yt}(s,z)\right)\rho_{ht}(s,z) - \frac{w_t}{z}\right) y_{ht}(s,z) \\ & + \phi_t(s,z)\left(1-\tau^x_{\pi t}\right)\left[\left(\left(1-\tau^x_{yt}(s,z)\right) q_t \rho_{ft}(s,z) - (1+\tau_t)\frac{w_t}{z}\right) y_{ft}(s,z) - f_x\right] \end{aligned} \tag{17}$$

In this equation, $\tau_{yt}(s,z)$ is a firm-specific tax rate on domestic sales and $\tau^x_{yt}(s,z)$ on export sales. In addition, $\rho_{ht}(s,z)$ (resp. $y_{ht}(s,z)$) and $\rho_{ft}(s,z)$ (resp. $y_{ft}(s,z)$) denote the Home and Foreign relative price (resp. quantity) of the variety produced by the firm. Further, $\phi_t(s,z) = \{0,1\}$ is an indicator variable that equates 1 if the firm exports. In this case, the firm has to produce $(1+\tau_t)\, y_{ft}(s,z)$ to sell $y_{ft}(s,z)$. The Foreign price is denominated in units of the Foreign currency and has to be converted using the real exchange rate q_t. Further, τ_t is an exogenous iceberg shipping cost applying to the local exporting firms, evolving as an AR(1) process subject to iid shocks

$$\log\left(\tau_t/\tau\right) = \rho_\tau \log\left(\tau_{t-1}/\tau\right) + \xi_{\tau t} \tag{18}$$

We depart from the assumption of monopolistic competition and assume that firms engage in a strategic pricing game – Bertrand competition – by which they take into account the effect of their pricing decisions on sectoral demands via the sectoral price levels, assuming that each firm z faces a downward slopping demand schedule as described in the household section. Hence, instead of choosing just $p_{ht}(s,z)$ and $p_{ft}(s,z)$, each firm chooses $(p_{ht}(s,z), p_{ft}(s,z), p_t(s), p_t^*(s))$ maximizing profits subject to the variety demand function, and the aggregate price indices. First-order conditions imply

$$\rho_{ht}(s,z) = \mu_{ht}(s,z)\frac{w_t}{a_t z} \text{ and } \rho_{ft}(s,z) = \mu_{ft}(s,z)\frac{w_t}{a_t z}\frac{(1+\tau_t)}{q_t} \tag{19}$$

where

$$\mu_{ht}(s,z) = \frac{\sigma_{ht}(s,z)}{(\sigma_{ht}(s,z)-1)(1-\tau_{yt}(s,z))} \text{ with } \sigma_{ht}(s,z) = \theta\kappa_{ht}(s,z) + \gamma(1-\kappa_{ht}(s,z)) \tag{20}$$

$$\mu_{ft}(s,z) = \frac{\sigma_{ft}(s,z)}{(\sigma_{ft}(s,z)-1)\left(1-\tau_{yt}^x(s,z)\right)} \text{ with } \sigma_{ft}(s,z) = \theta\kappa_{ft}(s,z) + \gamma(1-\kappa_{ft}(s,z)) \tag{21}$$

In these equations, $\kappa_{ht}(s,z) = \rho_{ht}(s,\omega)^{1-\gamma}$ and $\kappa_{ft}(s,z) = \rho_{ft}(s,\omega)^{1-\gamma}$ respectively denote the Home and Foreign market shares of domestic firm z in sector s. These equations show that firms' size affects pricing in the sense that larger firms – the most productive ones who set lower prices and extract larger market shares – can extract larger markups than implied by the sole preferences of households by exploiting their strategic market positions. We consider parameter and productivity spaces that ensure that prices (resp. markups) are strictly decreasing (resp. increasing) in the level of productivity z. The monotonicity of these relations between individual productivity and prices/markups allow for the aggregation procedure described in the next paragraphs. Finally, we assume symmetry across sectors and drop the s index. We then can use the above equations to derive the expression of individual operating profits as

$$\begin{aligned}\pi_t(z) &= (1-\tau_{\pi t})\left(1-\tau_{yt}(z)-\mu_{ht}(z)^{-1}\right)\rho_{ht}(z)^{1-\gamma} y_t \\ &\quad +\phi_t(z)(1-\tau_{\pi t}^x)\left[q_t\left(1-\tau_{yt}^x(z)-\mu_{ft}(z)^{-1}\right)\rho_{ft}(z)^{1-\gamma} y_t^* - f_x\right]\end{aligned} \tag{22}$$

This equation shows that, since sales are taxed at home, the tax rate both alters aggregate and export profits, and is therefore a tool that potentially corrects both internal and external distortions. We are finally able to derive the export threshold z_{xt} for the last firm that is profitable enough to address foreign markets:

$$q_t\left(1-\tau_{yt}^x(z_{xt})-\mu_{ft}(z_{xt})^{-1}\right)\rho_{ft}(z_{xt})^{1-\gamma} y_t^* = f_x \tag{23}$$

2.3 Aggregation

An equilibrium features a mass n_t (n_t^*) of firms – and varieties – in the Home (Foreign) country, among which $n_{xt} = (1 - G(z_{xt}))\, n_t = (z_{\min}/z_{xt})^{\varepsilon}\, n_t$ ($n_{xt}^* = 1 - G(z_{xt}^*) = (z_{\min}/z_{xt}^*)^{\varepsilon}\, n_t^*$) will export. Let us define $\widetilde{z}_t$ ($\widetilde{z}_t^*$) as the average level of productivity of producers addressing the domestic market only – defined such as $\rho_{ht}(\widetilde{z}_t) = \widetilde{\rho}_{ht}$ ($\rho_{ht}^*(\widetilde{z}_t^*) = \widetilde{\rho}_{ht}^*$), and $\widetilde{z}_{xt}$ ($\widetilde{z}_{xt}^*$) as the average level of productivity of firm addressing both markets, defined such as $\rho_{ft}(\widetilde{z}_{xt}) = \widetilde{\rho}_{ft}$ ($\rho_{ft}^*(\widetilde{z}_{xt}^*) = \widetilde{\rho}_{ft}^*$). It can be shown that these averages write

$$\widetilde{z}_t^{-1} = \left(\int_{z_{\min}}^{\infty} \left(z^{-1}\right)^{1-\gamma} dG(z)\right)^{\frac{1}{1-\gamma}} \text{ and } \widetilde{z}_{xt}^{-1} = \left(\frac{1}{1 - G(z_{xt})} \int_{z_{xt}}^{\infty} \left(z^{-1}\right)^{1-\gamma} dG(z)\right)^{\frac{1}{1-\gamma}} \quad (24)$$

for the Home economy and

$$\widetilde{z}_t^{*-1} = \left(\int_{z_{\min}}^{\infty} \left(z^{-1}\right)^{1-\gamma} dG(z)\right)^{\frac{1}{1-\gamma}} \text{ and } \widetilde{z}_{xt}^{*-1} = \left(\frac{1}{1 - G(z_{xt}^*)} \int_{z_{xt}^*}^{\infty} \left(z^{-1}\right)^{1-\gamma} dG(z)\right)^{\frac{1}{1-\gamma}} \quad (25)$$

for the Foreign economy. Average productivity levels are harmonic means of the individual levels of productivity as in Ghironi and Melitz (2005). This average is not affected by the dispersion of mark-ups at the variety level because the average mark-up, that is determined as a function of the average market share and the average price, is also the mark-up of the firm with an average level of productivity $\tilde{z}_t$. The same logic applies to the average export mark-up. However, this does not mean that the dispersion of mark-ups is neutral for the equilibrium, as it affects profits, and therefore the level of entry on domestic and export markets. We are now ready to derive the expression of these average productivity levels based on the imposed Pareto distribution of firms:

$$\widetilde{z}_t = \nabla z_{\min} \text{ and } \widetilde{z}_{xt} = \nabla z_{xt} \quad (26)$$

$$\widetilde{z}_t^* = \nabla z_{\min} \text{ and } \widetilde{z}_{xt}^* = \nabla z_{xt}^* \quad (27)$$

where $\nabla = (\varepsilon / (\varepsilon - (\gamma - 1)))^{\frac{1}{\gamma-1}}$. Once these average levels have been defined, the model aggregates in the following way. Average price levels are given by

$$\widetilde{\rho}_{ht} = \widetilde{\mu}_{ht} w_t / (a_t \widetilde{z}_t) \text{ and } \widetilde{\rho}_{ft} = (1 + \tau_t)\, q_t^{-1} \widetilde{\mu}_{ft} w_t / (a_t \widetilde{z}_{xt}) \quad (28)$$

$$\widetilde{\rho}_{ht}^* = \widetilde{\mu}_{ht}^* w_t^* / (a_t^* \widetilde{z}_t^*) \text{ and } \widetilde{\rho}_{ft}^* = (1 + \tau_t^*)\, q_t \widetilde{\mu}_{ft}^* w_t^* / (a_t^* \widetilde{z}_{xt}^*) \quad (29)$$

variety effects associated with the price indices write

$$n_t \widetilde{\rho}_{ht}^{1-\gamma} + n_{xt}^* \widetilde{\rho}_{ft}^{*1-\gamma} = 1 \text{ and } n_t^* \widetilde{\rho}_{ht}^{*1-\gamma} + n_{xt} \widetilde{\rho}_{ft}^{1-\gamma} = 1 \quad (30)$$

while profits write

$$\widetilde{\pi}_t = (1-\tau_{\pi t})\,\widetilde{\pi}_{ht} + (1-\tau^x_{\pi t})\,\frac{n_{xt}}{n_t}\widetilde{\pi}_{ft} \text{ and } \widetilde{\pi}^*_t = (1-\tau^*_{\pi t})\,\widetilde{\pi}^*_{ht} + (1-\tau^{x*}_{\pi t})\,\frac{n^*_{xt}}{n^*_t}\widetilde{\pi}^*_{ft} \tag{31}$$

where

$$\widetilde{\pi}_{ht} = \left(1-\tau_{yt}\left(\widetilde{z}_t\right)-\widetilde{\mu}^{-1}_{ht}\right)\widetilde{\rho}^{1-\gamma}_{ht}y_t \text{ and } \widetilde{\pi}_{ft} = q_t\left(1-\tau^x_{yt}\left(\widetilde{z}_{xt}\right)-\widetilde{\mu}^{-1}_{ft}\right)\widetilde{\rho}^{1-\gamma}_{ft}y^*_t - f_x \tag{32}$$

$$\widetilde{\pi}^*_{ht} = \left(1-\tau^*_{yt}\left(\widetilde{z}^*_t\right)-\widetilde{\mu}^{*-1}_{ht}\right)\widetilde{\rho}^{*1-\gamma}_{ht}y^*_t \text{ and } \widetilde{\pi}^*_{ft} = q^{-1}_t\left(1-\tau^{x*}_{yt}\left(\widetilde{z}^*_{xt}\right)-\widetilde{\mu}^{*-1}_{ft}\right)\widetilde{\rho}^{*1-\gamma}_{ft}y_t - f_x \tag{33}$$

Equilibrium conditions on the labor markets imply

$$a_t l_t = n_t\widetilde{\rho}^{-\gamma}_{ht}\widetilde{y}_t/\widetilde{z}_t + (1+\tau_t)\,n_{xt}\widetilde{\rho}^{-\gamma}_{ft}\widetilde{y}^*_t/\widetilde{z}_{xt} \tag{34}$$

$$a^*_t l^*_t = n^*_t\widetilde{\rho}^{*-\gamma}_{ht}\widetilde{y}^*_t/\widetilde{z}^*_t + (1+\tau^*_t)\,n^*_{xt}\widetilde{\rho}^{*-\gamma}_{ft}\widetilde{y}_t/\widetilde{z}^*_{xt} \tag{35}$$

and equilibrium conditions on goods markets give

$$y_t = c_t + n_{et}f_e + n_{xt}f_x \tag{36}$$

$$y^*_t = c^*_t + n^*_{et}f_e + n^*_{xt}f_x \tag{37}$$

Finally, given our assumptions on the various tax rates in each economy, the budget constraints of governments are

$$\tau_{wt}w_t l_t + n_t\left(\tau_{\pi t}\widetilde{\pi}_{ht} + \tau_{yt}\left(\widetilde{z}_t\right)\widetilde{\rho}^{1-\gamma}_{ht}y_t\right) + n_{xt}\left(\tau^x_{\pi t}\widetilde{\pi}_{ft} + \tau^x_{yt}\left(\widetilde{z}_{xt}\right)q_t\widetilde{\rho}^{1-\gamma}_{ft}y^*_t\right) + T_t = 0 \tag{38}$$

$$\tau^*_{wt}w^*_t l^*_t + n^*_t\left(\tau^*_{\pi t}\widetilde{\pi}^*_{ht} + \tau^*_{yt}\left(\widetilde{z}^*_t\right)\widetilde{\rho}^{*1-\gamma}_{ht}y^*_t\right) + n^*_{xt}\left(\tau^{x*}_{\pi t}\widetilde{\pi}^*_{ft} + \tau^{x*}_{yt}\left(\widetilde{z}^*_{xt}\right)q^{-1}_t\widetilde{\rho}^{*1-\gamma}_{ft}y_t\right) + T^*_t = 0 \tag{39}$$

and the (residual) dynamics of net foreign assets is

$$b_{t+1} = r_t b_t + q_t n_{xt}\widetilde{\rho}^{1-\gamma}_{ft}y^*_t - n^*_{xt}\widetilde{\rho}^*_{ft}y_t \tag{40}$$

3 Fiscal policy and parameter values

As shown in Appendix A, the formal derivation of optimal tax rates is possible for the first-best equilibrium. However, in more restricted environments, we proceed by solving the dual form of the Ramsey problem, which involves more complex algebra. That is, we consider a benevolent planner that commits to maximize households' lifetime welfare subject to the equations characterizing a competitive equilibrium, potentially along with additional restrictions, such as a balanced-budget constraint or a restricted set of policy instruments. In such cases, we proceed numerically, which requires to give numerical values to model parameters.

3.1 Parameter values

The parametrization is identical in both countries, and targets countries that belong to the Euro Area. The targeted moments are those stemming from the case of passive fiscal policies where all policy instruments are zero, *i.e.* $\tau_{wt} = \tau_{wt}^{*} = \tau_{\pi t} = \tau_{\pi t}^{*} = \tau_{\pi t}^{x} = \tau_{\pi t}^{x*} = \tau_{yt}(z) = \tau_{yt}^{*}(z) = \tau_{yt}^{x}(z) = \tau_{yt}^{x*}(z) = 0$. The model is quarterly. The discount factor is $\beta = 0.99$. We follow the literature and set the Frisch elasticity of labor supply to $\psi^{-1} = 1$. In the production sector, the minimal level of firms' productivity is $z_{\min} = 0.75$.[3] We also adjust the value of $f_e = 3.28345$ to obtain an investment-to-GDP ratio $(n_e f_e + n_x f_x)/y = 0.2$ in the case of passive policies. The value of f_x is determined endogenously to match a target proportion of traded varieties $n_x/n = 0.2$ based on French data (see Berman, Martin, and Mayer (2012)). Considering European data from the SDBS Database, firms' death rate is consistent with $\delta = 0.025$. Further, we follow Cacciatore, Fiori, and Ghironi (2016) and calibrate the elasticity of substitution between varieties at $\gamma = 3.8$ and the Pareto parameter at $\varepsilon = 3.4$.[4] The difference between the elasticity of substitution between sectoral goods θ and γ governs the extent of mark-ups' dispersion. We choose $\theta = 2.5$ and run a sensitivity analysis with respect to this parameter. Finally, we choose the value of the iceberg cost parameter $\tau = 0.3$, which implies a degree of trade openness of 0.2591 in the case of passive fiscal policy, in line with European data about intra-zone trade openness.

3.2 Fiscal policy

We investigate various fiscal policies in our model. Our natural benchmark is the first-best equilibrium (FB: I), described in Appendix A. However, the first-best is arguably complex to implement, in the sense that it requires the planner to have a lot of firm-level information. Further, the first-best implies that the planner can set firm-specific sales tax rates, and tax domestic and export profits differently. Last, the first-best implies the use of lump-sum taxes. Hence, we investigate more realistic (second-best) cases. First, we consider the case of uniform sales taxes on firms along with a balanced-budget requirement (BB+UST: II). We also investigate a more restricted case where sales taxes are null and the taxation of profits uniform (BB+NST+UPT: III). These three cases are compared to a passive equilibrium where all tax rates are zero (passive: IV). The sequential consideration of constraints on the first-best equilibrium allows to gauge the relative importance of each of these restrictions, especially in terms of steady-state welfare. Finally, we contrast the implications of these policies in the baseline model with heterogeneous mark-ups (a) with the implications of the same policies in a model with standard monopolistic competition pricing by annihilating the effects of strategic pricing and imposing $\sigma(z) = \gamma$, which induces constant and homogeneous mark-ups (b).

[3] This value ensures that the relation between price levels, market shares and mark-ups is strictly monotonic.

[4] Incidentally, a value of $\gamma = 3.8$ implies rather high steady state mark-ups over marginal costs. However, given the presence of fixed costs, mark-ups over average costs are in line with values found in the literature (See Bilbiie, Ghironi, and Melitz (2008) for an extensive discussion).

4 Steady state

4.1 Baseline results

Table 1 reports the steady-state tax rates under the alternative policy set-ups along with the allocations they imply, as well as their resulting welfare effects with respect to the first-best equilibrium. The welfare losses are computed against the first-best equilibrium, in terms of Hicksian equivalent decrease in consumption ζ associated with switching from the first-best allocation to the current allocation:

$$\log\left(c^{FB}\left(1-\frac{\zeta}{100}\right)\right)-\chi\frac{l^{FB(1+\psi)}}{1+\psi}=\log c-\chi\frac{l^{1+\psi}}{1+\psi} \tag{41}$$

Since all equilibria are symmetric and both countries have similar size, we report variables without reference to a specific country being understood that they are identical across countries.

Table 1: Steady-state allocations

		Heterogeneous mark-ups				Homogeneous mark-ups			
Variable	Symbol	Ia	IIa	IIIa	IVa	Ib	IIb	IIIb	IVb
Consumption	c	3.588	2.545	2.543	2.459	3.588	2.545	2.542	2.435
Labor	l	1.221	0.978	0.978	1.000	1.221	0.978	0.978	1.003
Varieties	n	13.751	9.848	9.836	6.734	13.751	9.849	9.836	6.297
Exp. varieties	n_x	2.745	1.956	1.422	1.347	2.745	1.944	1.363	1.257
% of exp. varieties	$100 \times n_x/n$	19.963	19.862	14.454	20.000	19.963	19.734	13.854	19.963
Output	y	4.843	3.444	3.425	3.074	4.843	3.444	3.422	3.010
Real wage	w	3.936	3.380	2.547	2.227	3.967	3.512	2.578	2.212
Av. dom. mark-up	$\mu(\widetilde{z})$	1.008	1.040	1.370	1.376	1.000	1.002	1.357	1.357
Av. exp. mark-up	$\mu(\widetilde{z}_x)$	1.008	1.048	1.389	1.392	1.000	1.002	1.357	1.357
Log diff.	$100 \times \log \frac{\mu(\widetilde{z}_x)}{\mu(\widetilde{z})}$	–	0.776	1.321	1.142	–	–	–	–
Av. tax on dom. sales	$\tau_y(\widetilde{z})$	−0.355	−0.318	–	–	−0.357	−0.354	–	–
Av. tax on exp. sales	$\tau_y^x(\widetilde{z}_x)$	−0.363	−0.318	–	–	−0.357	−0.354	–	–
Min. tax on dom. sales	$\tau_y(z_{\min})$	−0.348	−0.318	–	–	−0.357	−0.354	–	–
Min. tax on exp. sales	$\tau_y^x(z_x)$	−0.349	−0.318	–	–	−0.357	−0.354	–	–
Tax on dom. profits	τ_π	0.017	−0.117	−0.323	–	0.000	−0.123	−0.371	–
Tax on exp. profits	τ_π^x	0.045	0.373	−0.323	–	0.000	0.372	−0.371	–
Tax on labor	τ_w	−0.008	0.333	0.116	–	0.000	0.358	0.127	–
Welfare losses (%)	ζ	0.000	9.670	9.766	14.410	0.000	9.672	9.780	15.450

Note: I: First-best, II: Balanced budget + uniform sales taxes, III: Balanced budget + no sales taxes + uniform profits taxes, IV: Passive policy. Welfare losses are computed as the Hicksian equivalent increase in consumption that would make households indifferent between the equilibrium and the first-best allocation.

Starting with the passive allocation under heterogeneous mark-ups, Table 1 (column IVa) shows that, in line with our model's description, mark-ups are larger for more productive and larger firms. More productive firms face lower marginal production costs and attract larger markets shares. Under the strategic pricing rule, they also charge higher mark-ups. As such, the average mark-up of exporting firms is larger than the average mark-up. In the passive equilibrium, the benefits of varieties for the consumers exceeds the levels of mark-ups, leading to an inefficiently low level of entry: the number of varieties is half the first-best level. The total (steady-state) welfare losses associated with a passive fiscal policy is thus equivalent to a 14.4% drop in the first-best level of steady-state consumption.

Comparing this allocation with the same allocation (with zero tax rates) under homogeneous mark-ups in Table 1 (column IVb) reveals an important additional result. Under homogeneous mark-ups, both domestic and export average mark-ups are equal (by definition) and lower than their counterpart under strategic pricing. We could thus expect allocations under homogeneous mark-ups to be welfare improving with respect to allocation under heterogeneous mark-ups. However, this would be neglecting the positive effect of mark-up levels on the total number of varieties. Indeed, the dispersion of mark-ups leads to higher average levels of mark-ups, which raises aggregate expected profits. Given the entry decision rule given by Equation (14), average profits must be equal under all configurations since the value of the entry cost f_e remains identical. A higher level of aggregate profits must thus result in more firms to produce a similar level of average profits. Hence, the dispersion of mark-ups and the resulting higher average level of mark-ups raise profits and allow more firms to enter, which reduces the distance between the level of firms' entry under passive fiscal policies and their efficient level. Further, even though the export cut-off is higher under heterogeneous mark-ups and passive policies, which selects a lower fraction of exporting firms, the total number of exporting firms is larger since the number of firms is larger. The number of exporting firms thus ends-up being higher than under homogeneous mark-ups.

Mark-ups thus affect welfare in two opposite directions: (i) for a given number of firms on a given market, they distort prices in a way that lowers the intensive margin, *i.e.* the quantity of goods produced by each firm, and thus affect welfare negatively but (ii) they induce more entry in domestic markets, which raises the number of domestic and exporting firms, which affect welfare positively. These two effects will be made more transparent in the sensitivity analysis reported in the next subsection. For the baseline calibration, the positive effects dominate and heterogeneous mark-ups welfare-dominate to a situation of homogeneous mark-ups, producing a welfare gain of 1% of first-best consumption equivalent.

As shown in Appendix A, the heterogeneity of mark-ups is fully neutralized in the first-best allocation. Indeed, if the *dispersion* of mark-ups can have positive effects when the *level* of mark-ups is high, the largest welfare gains are achieved by lowering the *level* of mark-ups and compensating firms for the lost profits to maintain the incentive to enter both domestic and export markets. Hence, the previous result about the welfare gains from dispersed mark-ups can be qualified as a "second-best" one. Comparing Column Ia and Ib of Table 1, first-best allocations almost perfectly coincide whether we assume that mark-ups are heterogeneous or homogeneous. The only slight difference is that the level of mark-ups is marginally larger under heterogeneous mark-ups and the level of the real wage slightly lower. However, since households receive firms' profits, this does not affect the level of aggregate consumption. Further, given the slightly different patterns of labor taxation in both cases, this does not affect labor supply either. As a result, allocations coincide in terms of welfare, number of domestic and exporting firms, as well as in terms of output, consumption and labor. However, one should note that first-best allocations are implemented differently in both cases.

With homogeneous mark-ups, Column Ib of Table 1 indicate that the first-best allocation is straightforward to implement, and requires only a single policy instrument: a uniform sales subsidy that entirely offsets mark-ups, $\tau_y = 1/(1-\gamma)$. Other instruments such as the labor income and corporate profit tax rates are simply null. Under heterogeneous mark-ups, Column Ia of Table 1 reveals a more complex implementation of the first-best equilibrium. Appendix A provides closed-form solutions for tax formulas, and shows that the implementation of the first-best implies negative (or null) labor tax rates, since these instruments are used to correct the excess market power of the least productive exporting firm. Under our chosen calibration, the corresponding first-best labor income tax rate is $\tau_w = -0.008$. In addition, corporate profit tax rates are used to address the average excess market power on domestic and export markets. They therefore induce a positive taxation of corporate profits, and larger tax rates on export profits than on domestic profits. The corresponding tax rates are respectively $\tau_\pi = 0.017$ and $\tau_\pi^x = 0.045$. Finally, sales taxes serve two purposes. First, they subsidize all existing firms to lower the average level of mark-ups – tax rates are all in the order of magnitude of $1/(1-\gamma)$ – while compensating firms enough to preserve the expected gains from entry on domestic and export markets. Second, they align mark-ups across firms by providing more (less) generous subsidies to the larger (smaller) firms that extract larger (smaller) mark-ups.

As shown above, the first-best solution under heterogeneous mark-ups has only two slightly positive tax rates (those on export profits) and subsidizes the economy massively to undo the various distortions at play in the model. The first-best solution under homogeneous mark-ups is even more costly to public finance since it consists entirely in subsidies. As such, the steady-state lump-sum tax (T) is positive and large in both cases. As shown in Column IIa and IIb of Table 1, imposing a balanced budget ($T_t = 0$) requires more tax rates to be positive and large, as the planner can not subsidize as much as in the first-best solution. The optimal solution with a uniform sales tax and a balanced budget consists in using sales subsidies, as in the first-best solution. However, export profits and labor income are now taxed heavily, around 30-40%, while domestic profits are mildly subsidized. This pattern holds both under heterogeneous and homogeneous mark-ups, the chief difference being that labor is taxed less and sales subsidized less more under heterogeneous mark-ups. This taxation system is less efficient because subsidizing sales is not enough to implement the efficient levels of entry when taxing labor heavily at the same time. In both cases, the constraints imposed on the budget balance and tax instruments result in large welfare losses compared to the first-best, producing a 9.67% welfare loss of under heterogeneous mark-ups, and a 9.672% loss under homogeneous mark-ups.

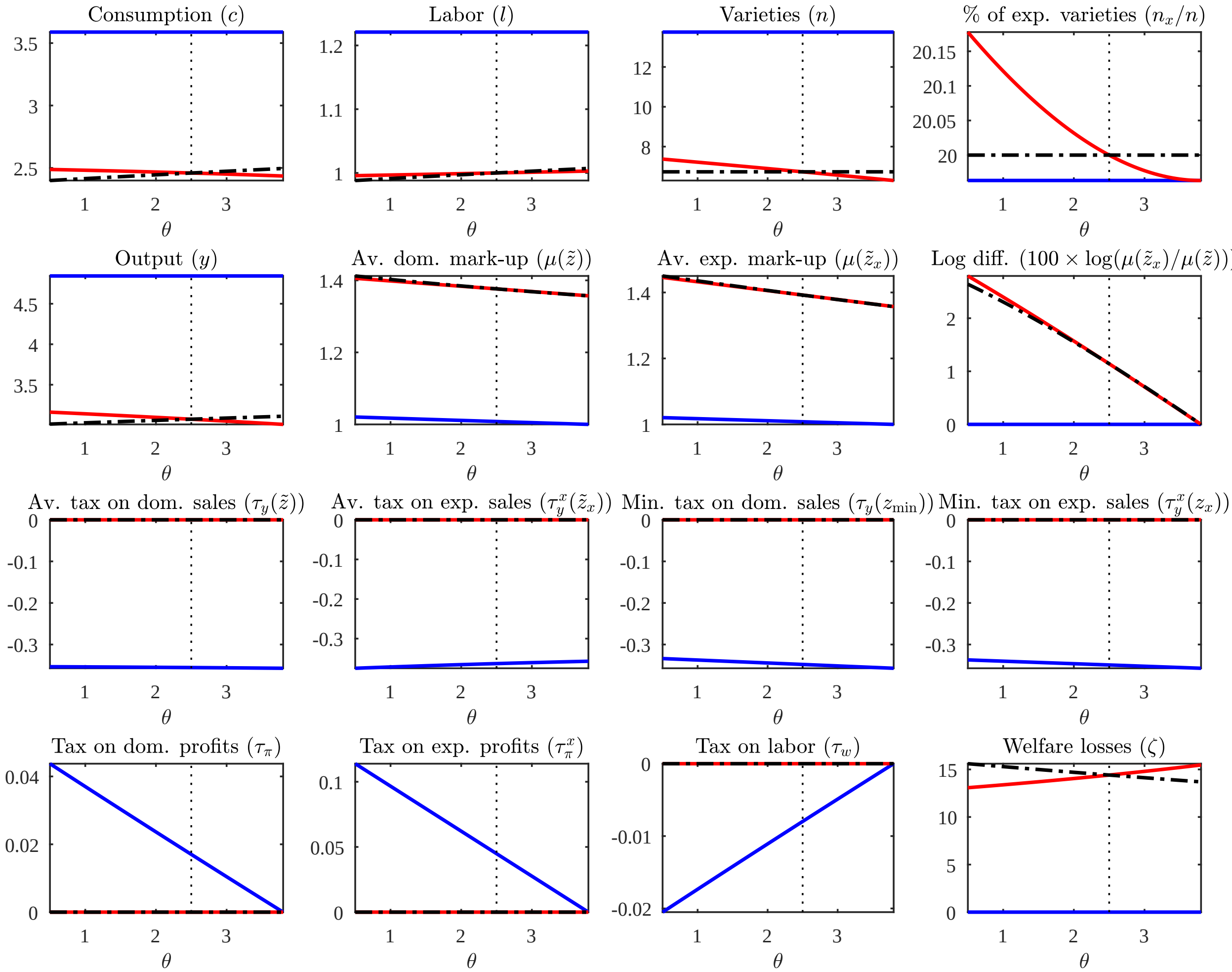
Last, Column IIIa and IIIb of Table 1 provide an additional and important result: the planner can emulate much of the effects of the previous (constrained) tax policy using an even more restricted set of policy instruments, *i.e.* using only the labor income tax rate and a uniform tax rate on profits. In this case, the planner chooses to subsidize heavily corporate profits (around 32% under heterogeneous mark-ups and 35% under homogeneous mark-ups) and finances this policy by taxing labor (at 11.6% under heterogeneous mark-ups and 12.7% under homogeneous mark-ups). This policy produces a roughly similar level of firms' entry compared to the previous policy (with a balanced budget, a uniform subsidy on sales and differentiated tax rates on corporate profits). In addition, labor effort and consumption are broadly equivalent, resulting in similar (although slightly larger) welfare losses. The only noticeable difference is the fraction of exporting firms, that is lower than under the previous policy, which accounts for the slightly lower level of consumption and the small welfare losses with respect to this case.

4.2 Sensitivity

One of the main result from the above analysis is that the dispersion of mark-ups under passive policies increases the average level of mark-ups, and brings the level of firms' entry closer to its first-best level. The result could be sensitive to alternative parameter values, in particular those pertaining to the structure of markets (θ or γ) and their implications for strategic pricing and the dispersion of mark-ups, or the distribution of firms' productivity (ε). A first way of increasing the dispersion of mark-ups is to consider a smaller sectoral elasticity of substitution θ. In the specific case where $\theta = \gamma$, there is no additional market power to be gained by firms using strategic pricing, and mark-ups are homogeneous, constant and equal to $(\gamma - 1)^{-1}$. As soon as θ drops, firms can exploit additional market power and the pricing rules imply that mark-ups are larger than $(\gamma - 1)^{-1}$, and larger for firms with larger market shares. Hence, the smaller θ, the larger the resulting dispersion in mark-ups. As shown by Figure 1 smaller values of θ also raise average mark-ups under passive fiscal policies, which leads to more entry (varieties) and more consumption at the extensive margin. The equilibrium thus gets closer to the first-best levels of consumption and entry, and the associated welfare losses from passive fiscal policies are smaller, although not by much quantitatively speaking. Welfare losses fall from 15.45% in the case of homogeneous mark-ups, to 14.1% in the baseline calibration ($\theta = 2.5$) and 13.3% for the lowest value of θ (0.5) considered in Figure 1. Importantly, these welfare gains are absent when the entry mechanism is shut down and the number of firms on each market restricted to be constant. In this case, the dispersion of mark-ups implied by lower values of θ implies higher average mark-ups that lower the quantity that firms produce of each variety – the intensive margin – and more dispersed mark-ups deliver welfare losses in this case.

An alternative way of varying the dispersion of mark-ups is to consider alternative values of γ, as

Figure 1: Steady-state results for varying levels of the sectoral elasticity of substitution θ.

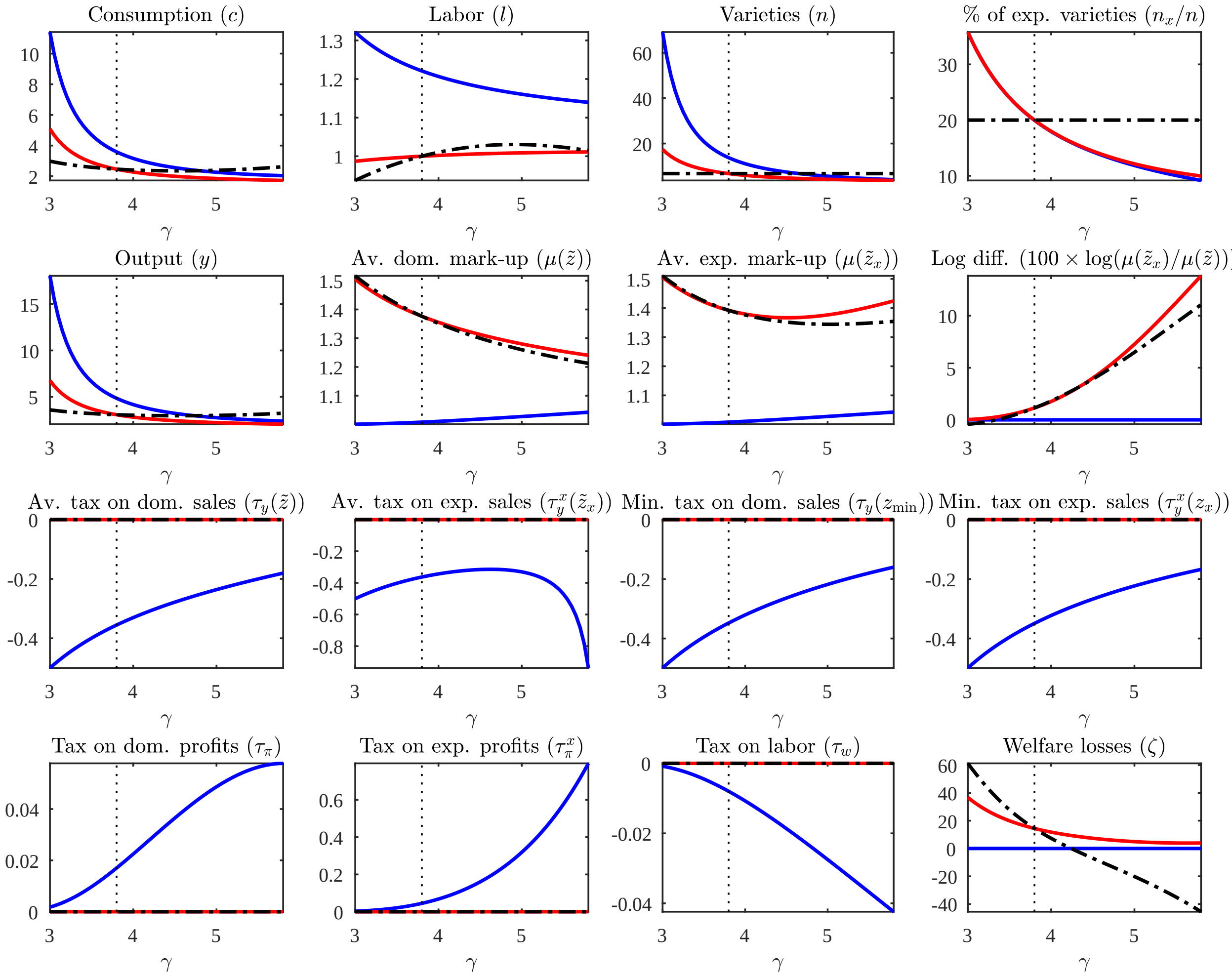


Note: Blue: First-best, Red: Passive fiscal policy, Dash-dotted black: No entry ($n = \overline{n}$ and $n_x = \overline{n}_x$). The vertical line indicates the baseline calibration.

in Figure 2.

On the one hand, lower values of γ imply larger mark-ups with passive fiscal policies and larger optimal subsidies for domestic sales in the first best equilibrium. As such, firms' aggregate profits are larger which raises the level of entry, the extensive margin of consumption and thus consumption. All else equal, this raises the utility of the representative households in both equilibria. On the other hand, the distance between the passive and the first-best equilibrium also increases with lower values of γ. Hence, considering larger values of γ lowers the average levels of mark-ups – which lowers the level of welfare under both equilibria – but raises their dispersion – which brings both equilibria closer together. Figure 2 shows that the welfare losses from passive policies thus range from 36.7% for the lowest value of γ considered ($\gamma = 3$), to less than 4% for the largest value ($\gamma = 6$). The comparison of these results with the steady state obtained when shutting down the entry mechanism on both markets is also interesting. When γ is low, this equilibrium has no other

Figure 2: Steady-state results for varying levels the elasticity of substitution γ.

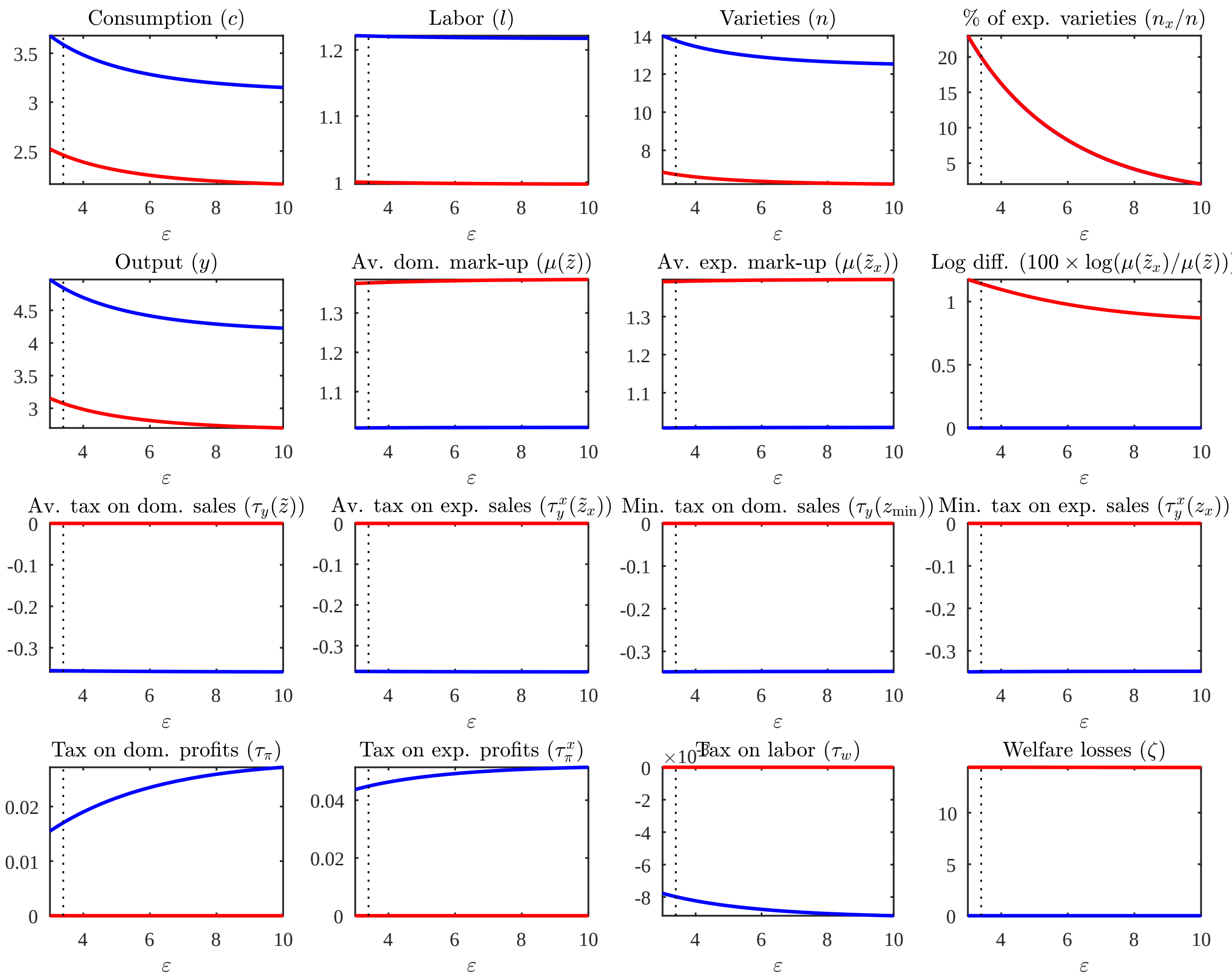


Note: Blue: First-best, Red: Passive fiscal policy, Dash-dotted black: No entry ($n = \overline{n}$ and $n_x = \overline{n}_x$). The vertical line indicates the baseline calibration.

benefit to the households than the reduction in labor effort which slightly raises the real wage and thus the intensive margin of consumption. However, all the potential benefits from additional firm's entry are absent, which generates huge welfare losses compared to the first-best or even the passive equilibrium. When γ is larger though, this equilibrium can results in welfare gains with respect to the first-best with entry, since (i) the number of firms remains constant in this case while it falls along with a dropping level of mark-ups in the first-best equilibrium, and (ii) the distortions resulting from imperfect competition fall, resulting in a less distorted intensive margin.

Finally, given our parametric restrictions according to which $\gamma > \varepsilon - 1$, Figure 3 considers the variables of Table 1 for $\varepsilon \in [3, 10]$. It shows that smaller values of ε, associated with more dispersed productivity levels of firms, induce more firms' entry. Average productivity levels depend positively on ∇, which itself depends negatively on ε. With more productive firms on average, aggregate profits are larger which allows more firms to enter the domestic market, implying more consumption and more output at the extensive margin. However, since first-best and passive equilibria are almost identically affected by changes in ε, the steady-state welfare losses from passive fiscal policies remain basically unchanged.[5]

Figure 3: Steady-state results for varying levels of firms' heterogeneity ε.



Note: Blue: First-best, Red: Passive fiscal policy. The vertical line indicates the baseline calibration.

4.3 Summary

Summing up the above results, we show that, under dispersed mark-ups, the first-best policy aligns all mark-ups to zero and subsidizes firms to preserve incentives to enter both domestic and export markets. The dispersion of mark-ups is thus null in the first-best equilibrium. However, away from the first-best policy, the dispersion of mark-ups can have positive effects on allocations by inducing higher average mark-ups, more entry and thus by bringing the number of firms closer to its efficient level. These positive effects are larger than the usual distortionary effects that reduce the intensive

[5] The case where the entry mechanism is shut down is of negligible interest when varying ε and is therefore not reported, but available upon request.

margin, *i.e.* the quantity of goods produced by each firm. The welfare gains associated to this "second-best" effect of mark-ups' dispersion are however much smaller than the welfare gains from implementing first-best allocations.

5 Dynamics

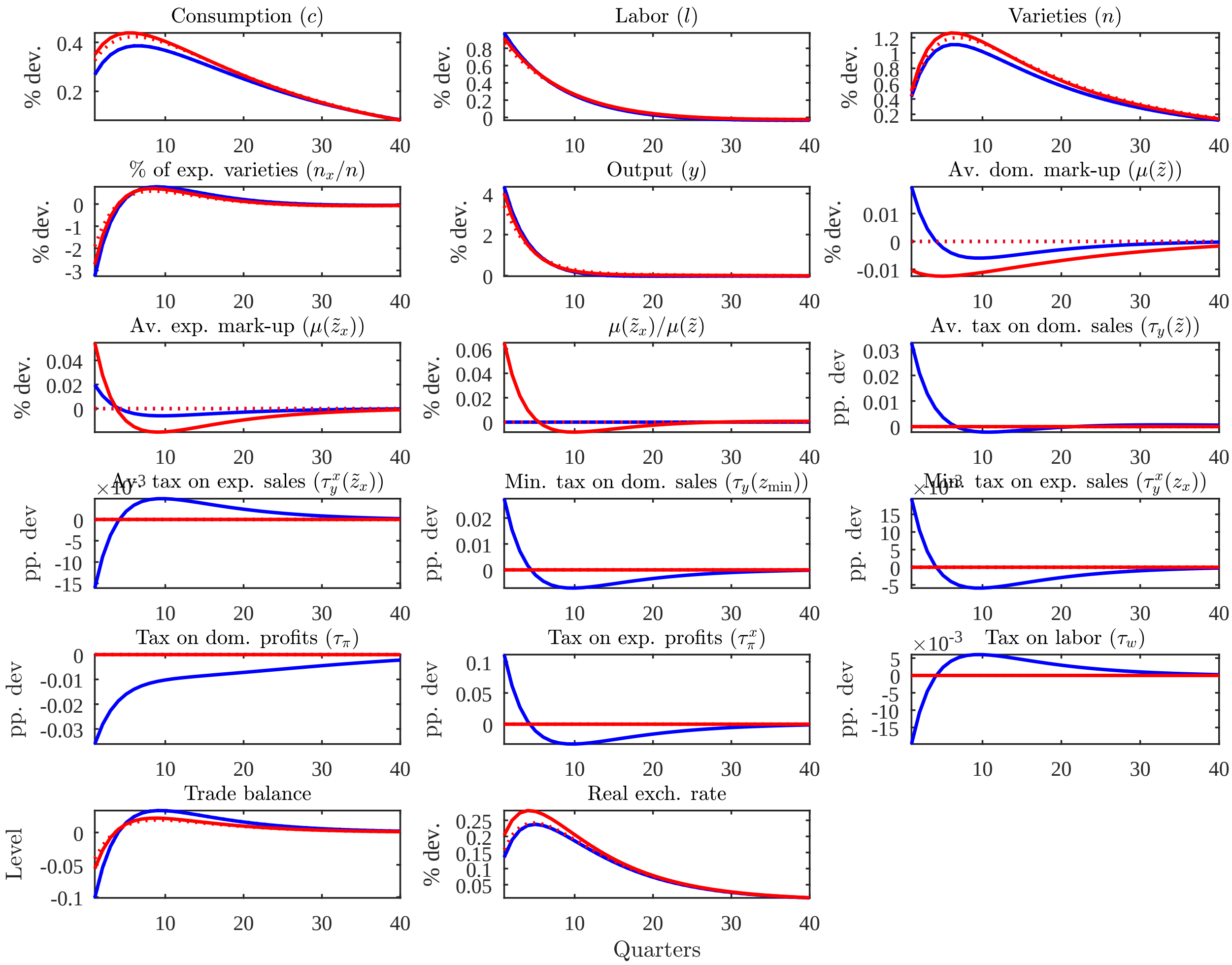
We compare the responses implied by our model under passive fiscal policies and under the first-best policy after productivity and trade shocks. Our first question pertains to the cyclical pattern of mark-ups under passive policies as well as the cyclical pattern of taxes conditional on temporary but persistent productivity shocks. A second question relates to the welfare gains from trade, as we consider the respective predictions of the model under passive fiscal policies and the first best after full trade liberalization that brings trade costs permanently close to zero.

5.1 Productivity shocks

Figure 4 reports the dynamics of variables in the home country to a 1% improvement in its own aggregate productivity a_t. The model is solved up to a second-order approximation using perturbation methods with an AR(1) coefficient of $\rho_a = 0.9$. As shown in Figure 4, the effects of a home productivity shock are very much similar qualitatively to those of the Ghironi and Melitz (2005) model. The rise in home productivity triggers a rise in creation of new firms, and slowly raises the number of varieties available to local consumers. This investment, along with the consumption smoothing behavior of households, leads the country to run a trade deficit for the first 5-6 quarters. The joint rise in investment implied by the creation of new firms and consumption raises the labor cost of production, which initially raises the relative price of local exporting firms. This leads the local export cut-off to rise, inducing a reduction in the proportion of exporting firms, which incidentally contributes to the initially observed trade deficit. After 5-6 quarters, the number of firms has risen enough to raise the number of exporters above its steady-state value, overturning the initial negative effect the shock had on the home proportion of exporting firms. Conditional on productivity shocks, the number of home firms is thus pro-cyclical and the number of home exporting firms is counter-cyclical. While these effects are qualitatively similar whether fiscal policy is passive or set according to the first-best formulas described in Appendix A, the behavior of mark-ups is not.

Under passive fiscal policies, the strategic pricing rule implies that mark-ups vary. In particular, the competitive forces at play under the strategic pricing rule implies that domestic mark-ups are counter-cyclical, since more home firms means more competition on the home market and less ability for incumbent and entering firms to extract large mark-ups. On the contrary, the mark-ups of exporting firms are pro-cyclical, as the shock induces less home exporting firms on impact, less competition on export markets and thus larger mark-ups. As a result, the dispersion of mark-ups is

Figure 4: Impulse responses to a 1% Home productivity shock (a_t) - Home country



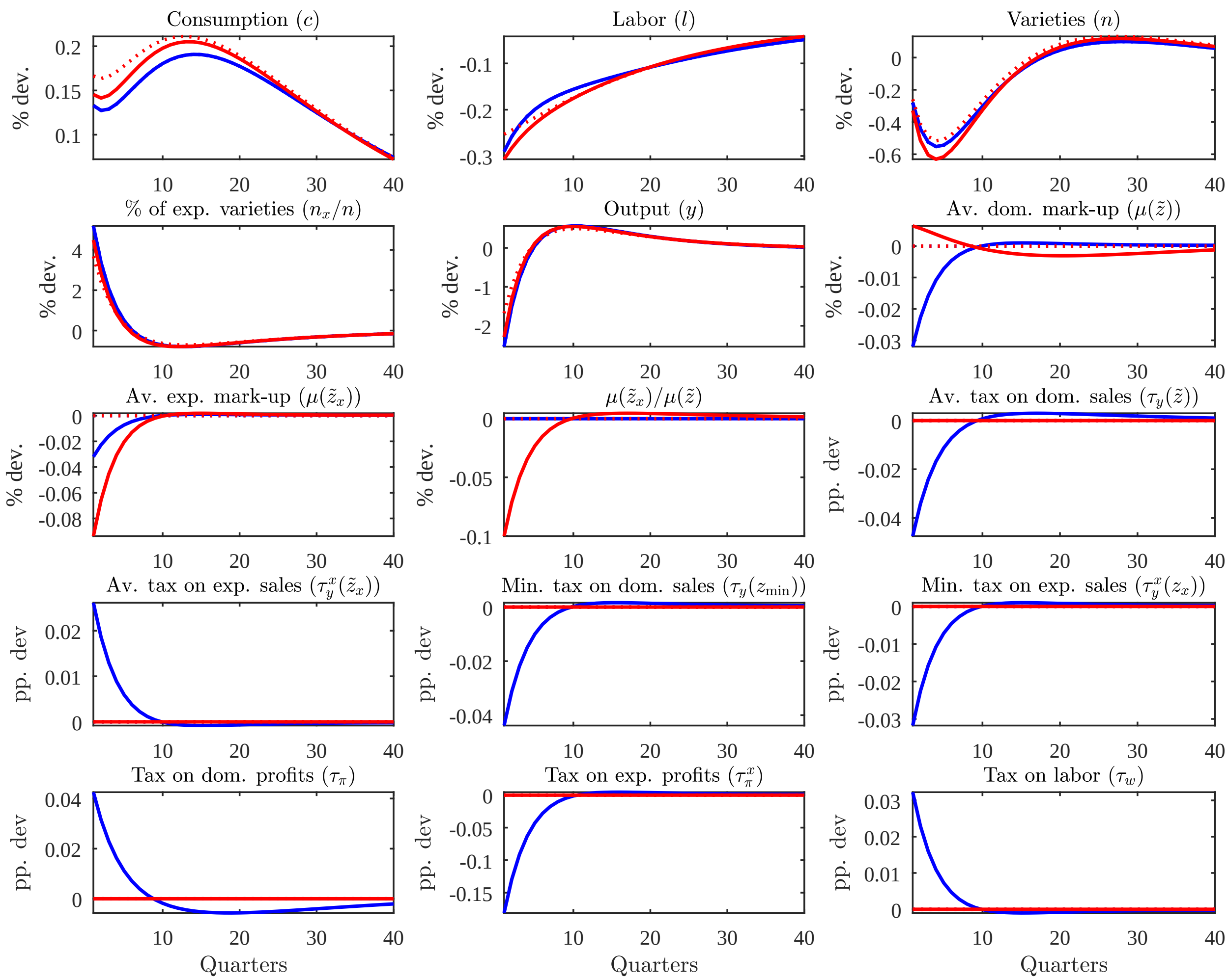
Note: Blue: First-best, Red: Passive fiscal policy. Dotted: Homogeneous mark-ups.
The persistence parameter is $\rho_a = 0.9$.

pro-cyclical in our model under passive fiscal policies. Importantly, it induces firms' entry, varieties and thus consumption to rise above their efficient levels.

The first-best fiscal policy consists in neutralizing the dispersion of mark-ups along the business cycle, as it did in the steady state. Therefore, lower average mark-ups on the domestic home market call for a smaller subsidies – the tax rate increases from negative steady-state values – and larger export mark-ups call for larger subsidies – the tax rate falls from negative values. However, even though mark-ups are aligned over the business cycle under the first-best policy, they are not constant. Indeed, first-best mark-ups are pro-cyclical to implement the first-best level of firms' entry after a productivity shock, a result that is reminiscent of Bilbiie, Ghironi, and Melitz (2019) in a closed economy, or Cacciatore and Ghironi (2020) in the context of an open economy.

What are the effects of the local shock on the foreign economy? Once again, as explained in Ghironi and Melitz (2005) and shown in Figure 5, since the production conditions improve in the home economy, foreign firms shut down and relocate their production units in the home economy. Hence, the number of firms drops in the foreign economy in response to a positive productivity shock in the home economy. The depreciation of the foreign terms of labor triggers a fall in the relative price of foreign exporters and their proportion increases on impact, which raises temporarily the number of exporting firms. The large disinvestment in firms' creation observed in the foreign economy is thus met with a declining level of output, a pro-cyclical number of firms on the foreign market, and a counter-cyclical number of foreign exporters.

Figure 5: Impulse responses to a 1% Home productivity shock (a_t) - Foreign country



Note: Blue: First-best, Red: Passive fiscal policy. Dotted: Homogeneous mark-ups.
The persistence parameter is $\rho_a = 0.9$.

Under passive fiscal policies, a pro-cyclical number of firms in the foreign economy is also associated with a counter-cyclical behavior of average mark-ups, and a counter-cyclical number of exporting firms with a pro-cyclical pattern of these firms' mark-ups. Here too, this cyclical pattern of mark-ups leads to an inefficiently large exit of foreign firms and thus an inefficiently large drop in foreign labor. As in the home economy, the first-best policy aligns mark-ups: the subsidy for foreign firms addressing the foreign market increases – the tax rate falls from negative values – and the average subsidy of foreign exporting firms falls – the tax rate rises from negative values. The first-best policy thus aligns average domestic and exporting firms' mark-ups, and makes them pro-cyclical to help implement the efficient level of foreign firms' exit. Given our baseline calibration, the quantitative importance of mark-ups' dispersion is relatively limited, but an extensive discussion of the role of mark-ups' dispersion is provided in Section 6.

5.2 Trade shocks

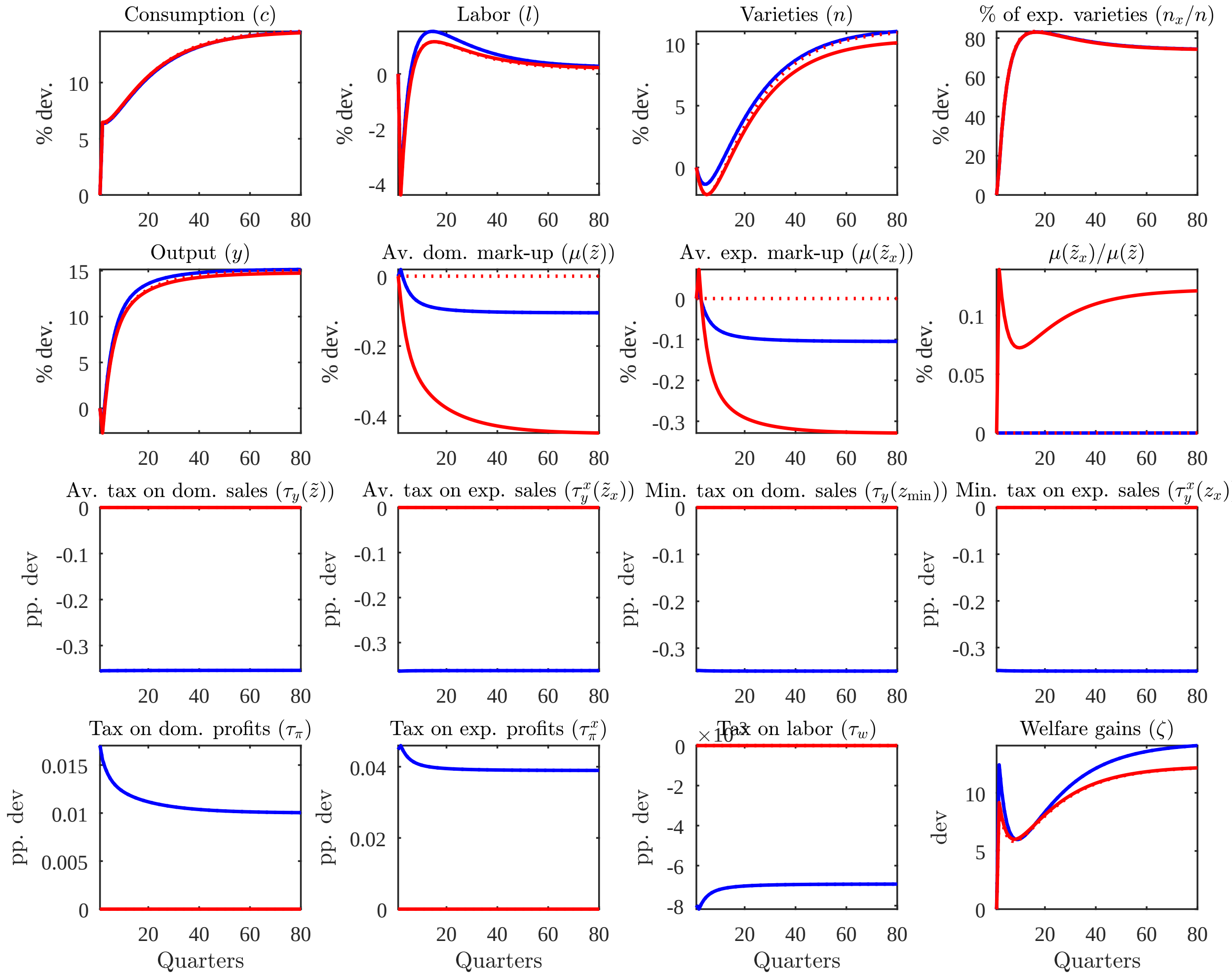
We investigate the predictions of our model regarding the effects of a full liberalization in trade. The latter is modeled as permanent fall in iceberg trade costs to almost zero, *i.e.* from $\tau = 0.3$ to $\tau = 0.01$, in the spirit of Edmond, Midrigan, and Xu (2015). The persistence parameter of the process for trade cost is set to $\rho_\tau = 0.9$ so that the liberalization is achieved after 5 years.[6] The resulting dynamics under alternative policies (passive vs. first-best) as well as under homogeneous mark-ups are depicted in Figure 6. Since the shock is symmetric, we only report the responses of home variables, being understood that foreign variables evolve similarly, and that international variables such as the real exchange rate or the trade balance are unaffected.

A large fall in trade costs first lowers the price of exporting firms, which lowers the export cut-off and fosters the entry of new – less productive – firms in export markets. The rise in the number of exporting firms raises consumption at the extensive margin (of trade) since households now have access to a wider set of imported varieties. While the rise in the production of exported goods raises labor demand and the real wage – that goes along with the rise in consumption also at the intensive margin – it also raises the production cost of other firms, generating a short-lived drop in average profits. The latter implies a similarly short-lived drop in firms' entry and aggregate output. However, the rise in average export profits and the rise in the proportion of exporting firms raises the average profitability of firms, which raises firms' entry and thus the total number of varieties, and further contributes to raise consumption at the extensive margin. In the short run, the response of labor supply is dominated by the wealth effect and drops sharply, before rising slightly in the medium run, when the substitution effect dominates.

Under passive fiscal policies, the rising number of exporting and then domestic firms raises competition on both markets and leads mark-ups to shrink, and more so for average domestic mark-ups. However, they fall too much compared to their efficient level, which results in an inefficiently low level of firms' entry, and thus consumption, which results is smaller welfare gains (12.3%) than under the first best fiscal policy (14.32%). The first-best fiscal policy consists in subsidizing all firms more to help achieve the efficient level of mark-ups implied by the trade liberalization. These

[6] For this experiment, the model is simulated under perfect foresight using the initial steady state as initial conditions. The algorithm used is a two-point boundary problem using a trust region method and implemented through the Dynare set-up for deterministic simulations (see Adjemian, Bastani, Juillard, Karamé, Mihoubi, Perendia, Pfeifer, Ratto, and Villemot (2011)), and accounts for all potential non-linearities.

Figure 6: Impulse responses to a permanent trade liberalization.



Note: Blue: First-best, Red: Passive fiscal policy. Dotted: Homogeneous mark-ups. Welfare gains denote the change in the Hicksian equivalent computed against the first-best steady on the whole transition path.

larger subsidies come on top of the objective of keeping mark-ups aligned. Overall, the quantitative importance of mark-ups heterogeneity in this exercise is also limited.

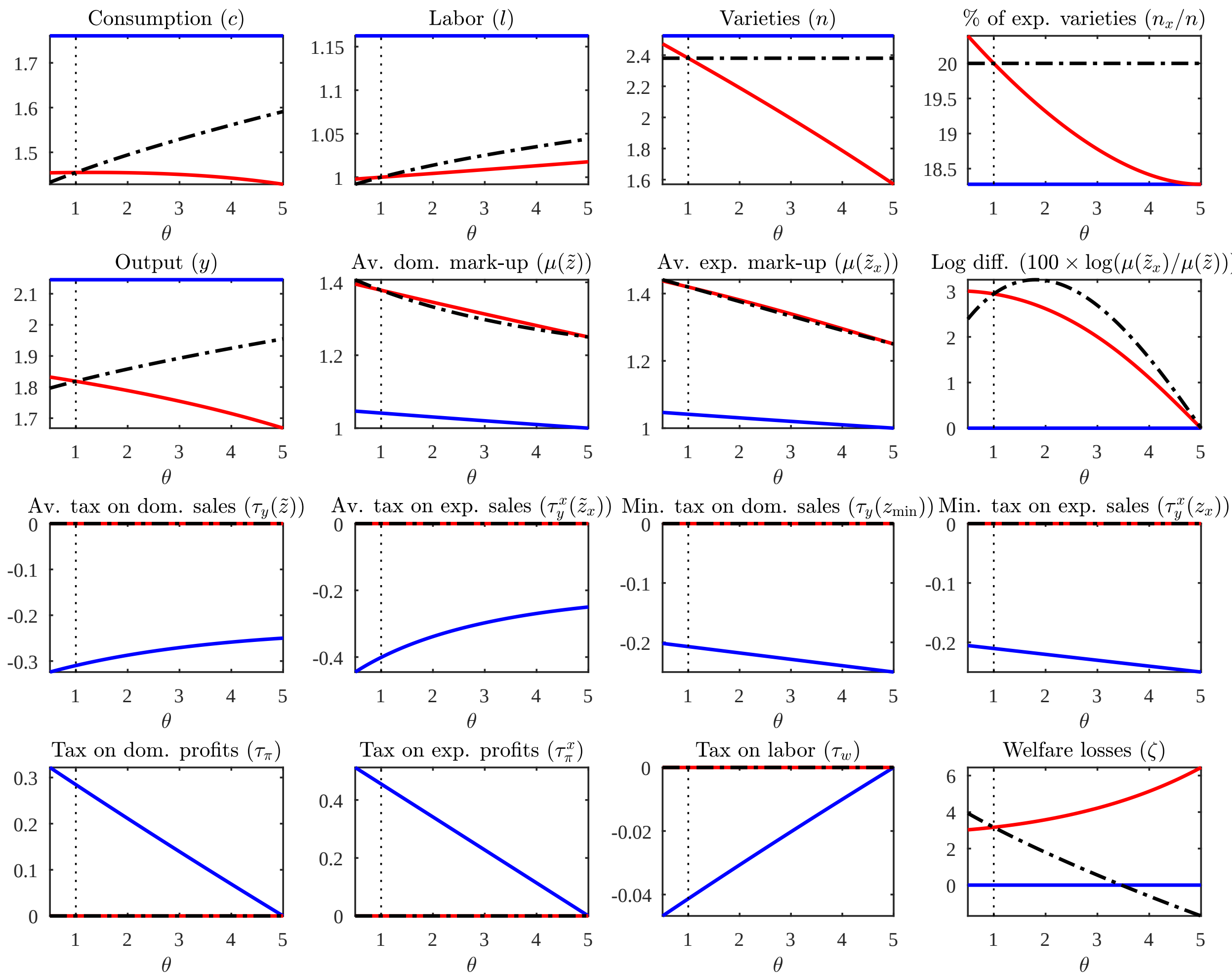
6 Alternative calibration

This section investigates the role of mark-ups' dispersion by using an alternative calibration with higher dispersion. This alternative calibration is one where the difference between the elasticity of substitution between varieties within sectors and the sectoral elasticity of substitution is quantitatively more important, which opens the possibility for firms to exploit more extensively their market power through the strategic pricing rule. We focus on the calibration proposed by Gaubert and Itskhoki (2020) where the sectoral elasticity is unitary $\theta = 1$, larger than our baseline value, and where the elasticity of substitution within sectors is $\gamma = 5$, larger than our baseline value. In addition, Gaubert and Itskhoki (2020) use French data and estimate a Pareto parameter of

$\varepsilon = 4.382$ governing the distribution of firms' productivity, as well as a trade cost parameter of $\tau = 0.342$. We recalibrate our model so as to hit the same targets as in our baseline calibration – a proportion of exporting firms of 20%, an investment-to-GDP ratio of 20% and a labor effort normalized to $l = l^* = 1$ – and adjust f_e, f_x and χ accordingly.

First, we run a sensitivity analysis of the steady-state allocations under passive and first-best fiscal policies with respect to θ, as we did for our baseline calibration, and report the results in Figure 7.

Figure 7: Steady-state results for varying θ – alternative calibration.



Note: Blue: First-best, Red: Passive fiscal policy, Dash-dotted black: No entry ($n = \overline{n}$ and $n_x = \overline{n}_x$). The vertical line indicates Gaubert and Itskhoki (2020)'s calibration.

Under Gaubert and Itskhoki (2020)'s calibration, the model predicts more dispersion in mark-ups, higher average mark-ups and thus more entry, which brings the number of varieties under a passive fiscal policy closer to its first-best level for any value of θ. Hence, the absolute level of welfare losses from passive fiscal policies is smaller in comparison to our baseline result. Those range from 6.4% under homogeneous mark-ups ($\theta = \gamma = 5$) to 3% for the lowest value of θ considered in our sensitivity analysis (0.5). Welfare losses reach 3.2% for the calibration of Gaubert and

Itskhoki (2020). In spite of these large quantitative differences between our baseline and alternative calibrations, a common qualitative pattern characterizes the relation between the dispersion of mark-ups and the welfare losses from a passive fiscal policy: lower values of the sectoral elasticity θ imply more dispersed mark-ups, higher average levels of mark-ups, more entry, more consumption at the extensive margin and thus lower welfare losses from passive fiscal policies. Once again and more clearly than under our baseline calibration, the dispersion of mark-ups induced by lower values of θ generates larger welfare losses when the entry mechanism is shut down, as in this case higher mark-ups affect consumption through their negative effects on the intensive margin, *i.e.* the quantity of each good produced by firms.[7]

Second, we repeat the dynamic experiments of Section 5, and look at the effects of temporary productivity shocks as well as a permanent full trade liberalization under this alternative calibration. Appendix B presents the impulse responses after a temporary productivity shock and shows that our baseline results are qualitatively robust. If anything, the alternative calibration widens the distance between the business cycle components of allocations under passive and first-best policies. The effects of a trade liberalization under the alternative calibration are more interesting, we believe, as shown in Figure 8.[8]

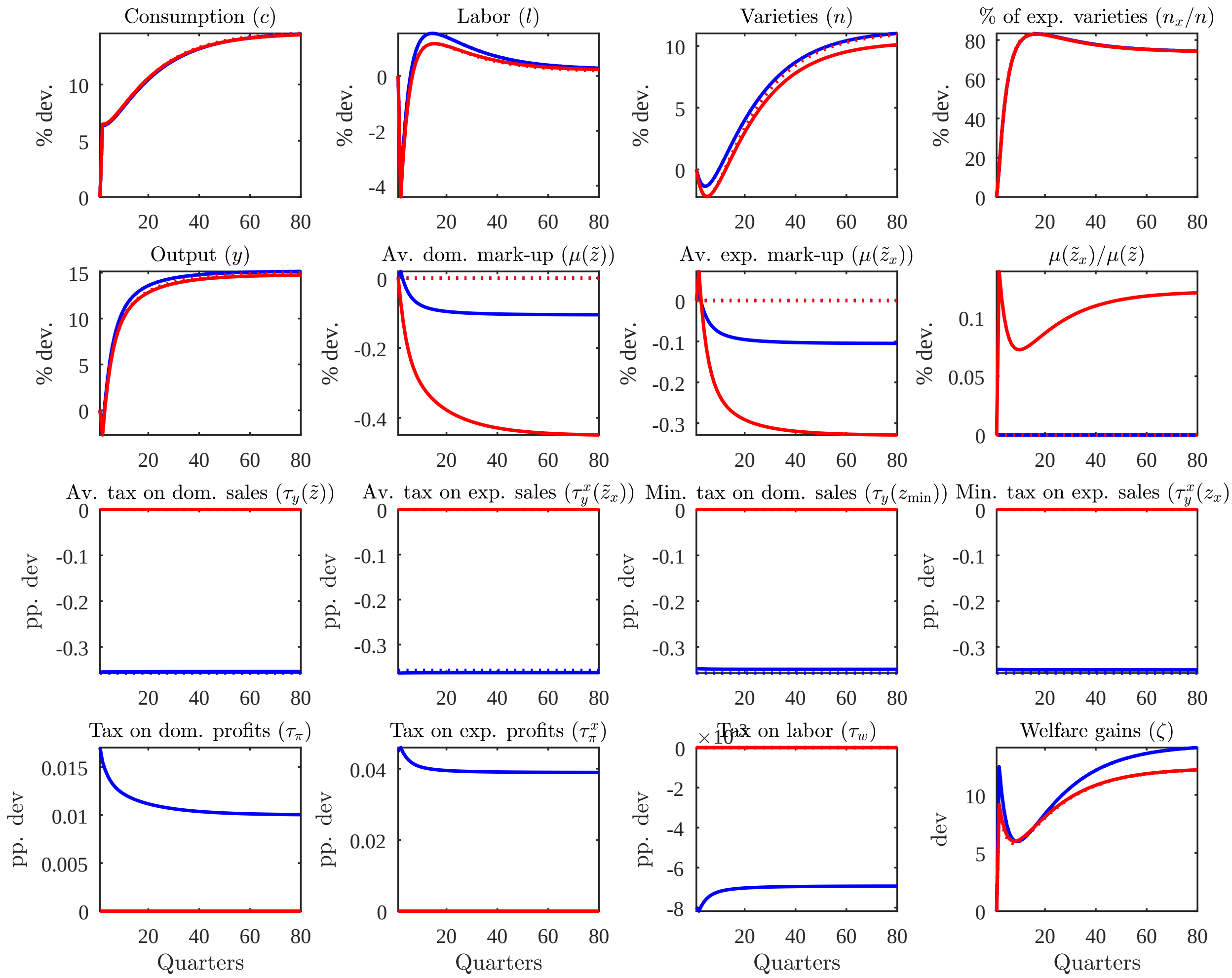
The effects of a full trade liberalization are qualitatively similar under this calibration: the export cut-off falls, more firms become exporters, the number of domestic firms falls initially before rising, consumption and output increase and the trade liberalization generates large welfare gains. The key difference is that, in the model with passive fiscal policies and heterogeneous mark-ups, the rise in competition on export markets translates into a much larger fall in average mark-ups. Hence, the profitability of firms is hit harder in the first quarters which results in more exit and then in a more sluggish rise in entry. This frees up resources for a larger short-run increase in consumption at the intensive margin, generating larger short-run welfare gains in this case compared to the case of homogeneous mark-ups and even compared to first-best equilibrium. In the medium and long run however – after 25 quarters – this results in a lesser rise in varieties, less additional consumption at the extensive margin and thus lower welfare gains in comparison to the case of homogeneous mark-ups and in comparison to the first best.

Figure 9 displays the dynamics of welfare gains from the trade liberalization, and shows that more dispersed mark-ups can matter for the short-run dynamics implied by a full trade liberalization through its effect on firms' entry. The impact gains are slightly above 14% of steady-state first-best consumption both under passive fiscal policies with heterogeneous mark-ups and in the first-best

[7]The level of welfare can be higher without entry than in the first-best with entry because we impose a constant number of domestic but also exporting firms. For large values of θ, the first-best is associated with a decreasing number of exporting firms while their number is constant when we shut down the entry mechanism. The model without entry thus ends-up having more exporting firms and more consumption at the extensive margin than the first best with entry when θ becomes large enough.

[8]For stability reasons, we only impose $\gamma = 4.5$ instead of $\gamma = 5$.

Figure 8: Impulse responses to a permanent trade liberalization - alternative calibration.



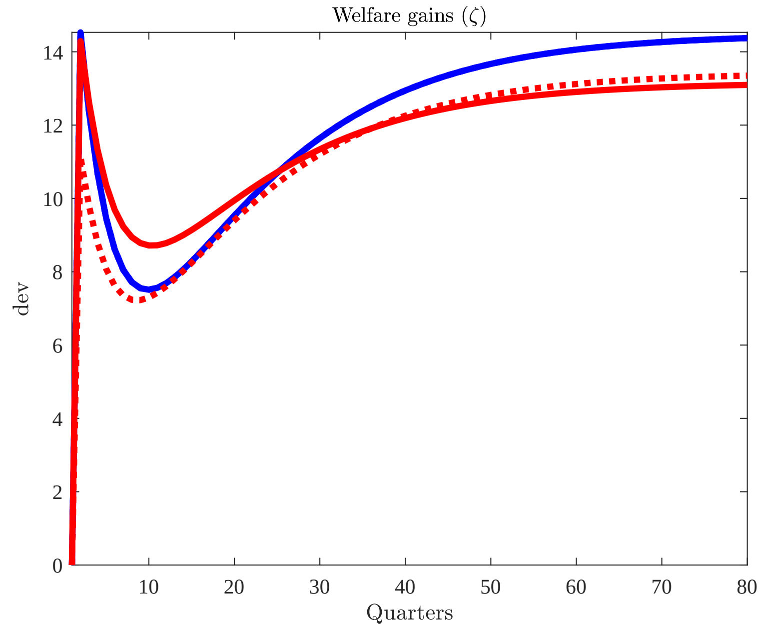
Note: Blue: First-best, Red: Passive fiscal policy. Dotted: Homogeneous mark-ups. Welfare gains denote the change in the Hicksian equivalent computed against the first-best steady on the whole transition path.

equilibrium, while they reach "only" 11% under passive fiscal policies and homogeneous mark-ups. It takes 25 quarters before the first-best equilibrium generates larger welfare gains than the equilibrium under passive policies and heterogeneous mark-ups, and more than 35 quarters before the equilibrium with homogeneous mark-ups produces larger welfare gains. From a lifetime perspective though, the inefficient level of firms' entry induced by the case of passive fiscal policies and heterogeneous mark-ups ends up producing lower gains (13.14%) than the case of homogeneous mark-ups (13.41%) and than the first-best equilibrium (14.45%).

7 Conclusion

In this paper, we introduce heterogeneous mark-ups by assuming strategic pricing through Bertrand competition in a two-country model with endogenous firms' entry and tradability à la Ghironi and Melitz (2005). We show that, under dispersed mark-ups, the first-best policy aligns all mark-ups to

Figure 9: Welfare effects of a permanent trade liberalization - alternative calibration.



Note: Blue: First-best, Red: Passive fiscal policy. Dotted: Homogeneous mark-ups. Welfare gains denote the change in the Hicksian equivalent computed against the first-best steady on the whole transition path.

zero and subsidizes firms to preserve incentives to enter both domestic and export markets. Departing from this first-best policy, the dispersion of mark-ups can have positive effects on allocations by inducing higher average mark-ups, more entry and thus by bringing the number of firms closer to its efficient level. These positive effects are larger than the usual distortionary effects that reduce the intensive margin, *i.e.* the quantity of goods produced by each firm. The welfare gains associated to this second-best effect of mark-ups' dispersion remain however much smaller quantitatively than the welfare gains from implementing first-best allocations. In addition, we compare the responses implied by our model under passive fiscal policies and under the first best policy after temporary productivity and permanent trade shocks. Productivity shocks imply counter-cyclical mark-ups and pro-cyclical export mark-ups under a passive fiscal policy while the first-best policy aligns all mark-ups and makes them pro-cyclical, to implement the efficient level of firm's entry. In addition, the steady-state dispersion of mark-ups does not have large quantitative effects on the business cycle properties of the model under passive fiscal policies. Last, a trade liberalization experiment shows that the welfare gains from trade are larger under an optimal fiscal policy, and that the steady-state dispersion of mark-ups under a passive fiscal policy can have significant effects on the short-run welfare gains from trade, through its effects on business creation.

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A First-best equilibrium

A.1 Characterization

The first-best equilibrium consists in choosing an allocation

$$\{\mathcal{A}\}_{t=0}^{\infty} = \left\{c_t, c_t^*, l_t, l_t^*, y_{ht}(z), y_{ft}(z), y_{ht}^*(z), y_{ft}^*(z), n_t, n_t^*, z_{xt}, z_{xt}^*\right\}_{t=0}^{\infty}$$

that maximizes households' welfare

$$\mathcal{W}_t = \mathsf{E}_t \left\{ \sum_{s=t}^{\infty} \beta^{s-t} \left(\log c_s + \log c_s^* - \chi \frac{l_s^{1+\psi}}{1+\psi} - \chi \frac{l_s^{*1+\psi}}{1+\psi} \right) \right\} \tag{42}$$

subject to the goods and labor markets constraints:

$$l_t = \int_{z_{\min}}^{\infty} \frac{y_{ht}(z)}{a_t z} g(z)\, dz + \int_{z_{xt}}^{\infty} \frac{(1+\tau)\, y_{ft}(z)}{a_t z} g(z)\, dz \tag{43}$$

$$l_t^* = \int_{z_{\min}}^{\infty} \frac{y_{ht}^*(z)}{a_t^* z} g(z)\, dz + \int_{z_{xt}^*}^{\infty} \frac{(1+\tau)\, y_{ft}^*(z)}{a_t^* z} g(z)\, dz \tag{44}$$

$$c_t + \left(\frac{n_{t+1}}{1-\delta} - n_t\right) f_e + \left(\frac{z_{\min}}{z_{xt}}\right)^{\varepsilon} n_t f_x = \left[\int_{z_{\min}}^{\infty} y_{ht}(z)^{\frac{\gamma-1}{\gamma}} g(z)\, dz + \int_{z_{xt}^*}^{\infty} y_{ft}^*(z)^{\frac{\gamma-1}{\gamma}} g(z)\, dz\right]^{\frac{\gamma}{\gamma-1}} = y_t \tag{45}$$

$$c_t^* + \left(\frac{n_{t+1}^*}{1-\delta} - n_t^*\right) f_e + \left(\frac{z_{\min}}{z_{xt}^*}\right)^{\varepsilon} n_t^* f_x = \left[\int_{z_{\min}}^{\infty} y_{ht}^*(z)^{\frac{\gamma-1}{\gamma}} g(z)\, dz + \int_{z_{xt}}^{\infty} y_{ft}(z)^{\frac{\gamma-1}{\gamma}} g(z)\, dz\right]^{\frac{\gamma}{\gamma-1}} = y_t^* \tag{46}$$

where we have used

$$n_{et} = \frac{n_{t+1}}{1-\delta} - n_t \text{ and } n_{et}^* = \frac{n_{t+1}^*}{1-\delta} - n_t^* \tag{47}$$

and the fact that Pareto distributions imply

$$n_{xt} = \left(\frac{z_{\min}}{z_{xt}}\right)^{\varepsilon} n_t \text{ and } n_{xt}^* = \left(\frac{z_{\min}}{z_{xt}^*}\right)^{\varepsilon} n_t^* \tag{48}$$

The FOC wrt c_t, c_t^*, l_t, l_t^* give

$$-1/c_t = \zeta_t \text{ and } -1/c_t^* = \zeta_t^* \tag{49}$$

$$\phi_t = \chi l_t^{\psi} \text{ and } \phi_t^* = \chi l_t^{*\psi} \tag{50}$$

where ϕ_t and ϕ_t^* are the multipliers associated with the labor market clearing conditions and ζ_t and ζ_t^* those associated with the goods clearing conditions. FOC wrt to $y_{ht}(z)$, $y_{ft}(z)$, $y_{ht}^*(z)$ and $y_{ft}^*(z)$ thus give

$$y_{ht}(z) = \varrho_t(z)^{-\gamma} y_t, \text{ and } y_{ft}(z) = \left((1+\tau)\, \varphi_t^{-1} \varrho_t(z)\right)^{-\gamma} y_t^* \tag{51}$$

$$y_{ht}^*(z) = \varrho_t^*(z)^{-\gamma} y_t^*, \text{ and } y_{ft}^*(z) = \left((1+\tau)\, \varphi_t (1+\tau)\, \varrho_t^*(z)\right)^{-\gamma} y_t \tag{52}$$

where $\varphi_t = \zeta_t^*/\zeta_t = c_t/c_t^*$ is the ratio of marginal utilities of consumption, $\varrho_t(z) = \varpi_t/(a_t z)$ and

$\varrho_t^*(z) = \varpi_t^* / (a_t^* z)$ with $\varpi_t = -\phi_t/\zeta_t = \chi l_t^{\psi} c_t$ and $\varpi_t^* = -\phi_t^*/\zeta_t^* = \chi l_t^{*\psi} c_t^*$. Finally, notice that, in the first-best equilibrium

$$\widetilde{z}_t = \nabla z_{\min} \text{ and } \widetilde{z}_{xt} = \nabla z_{xt} \quad (53)$$

$$\widetilde{z}_t^* = \nabla z_{\min} \text{ and } \widetilde{z}_{xt}^* = \nabla z_{xt}^* \quad (54)$$

where $\widetilde{z}_t$ $(\widetilde{z}_t^*)$ and $\widetilde{z}_{xt}$ $(\widetilde{z}_{xt}^*)$ are defined so that

$$\varrho_t(\widetilde{z}_t) = \widetilde{\varrho}_{ht} = \varpi_t / (a_t \widetilde{z}_t), \; \varrho_{ft}(\widetilde{z}_{xt}) = \widetilde{\varrho}_{ft} = (1+\tau)\varphi_t^{-1} \varpi_t / (a_t \widetilde{z}_{xt}) \quad (55)$$

$$\varrho_t^*(\widetilde{z}_t^*) = \widetilde{\varrho}_{ht}^* = \varpi_t^* / (a_t^* \widetilde{z}_t^*), \; \varrho_{ft}^*(\widetilde{z}_{xt}^*) = \widetilde{\varrho}_{ft}^* = (1+\tau)\varphi_t (1+\tau) \varpi_t^* / (a_t^* \widetilde{z}_{xt}^*) \quad (56)$$

Let us use these equations to rewrite the constraints as:

$$a_t l_t = n_t \frac{\widetilde{\varrho}_{ht}^{-\gamma} y_t}{\nabla z_{\min}} + (1+\tau) z_{\min}^{\varepsilon} z_{xt}^{-\varepsilon} n_t \frac{\widetilde{\varrho}_{ft}^{-\gamma} y_t^*}{\nabla z_{xt}} \quad (57)$$

$$a_t^* l_t^* = n_t^* \frac{\widetilde{\varrho}_{ht}^{*-\gamma} y_t^*}{\nabla z_{\min}} + (1+\tau) z_{\min}^{\varepsilon} z_{xt}^{*-\varepsilon} n_t^* \frac{\widetilde{\varrho}_{ft}^{*-\gamma} y_t}{\nabla z_{xt}^*} \quad (58)$$

$$c_t + \left(\frac{n_{t+1}}{1-\delta} - n_t\right) f_e + z_{\min}^{\varepsilon} z_{xt}^{-\varepsilon} n_t f_x = \left[n_t \widetilde{\varrho}_{ht}^{1-\gamma} + z_{\min}^{\varepsilon} z_{xt}^{*-\varepsilon} n_t^* \widetilde{\varrho}_{ft}^{*1-\gamma}\right]^{\frac{\gamma}{\gamma-1}} y_t \quad (59)$$

$$c_t^* + \left(\frac{n_{t+1}^*}{1-\delta} - n_t^*\right) f_e + z_{\min}^{\varepsilon} z_{xt}^{*-\varepsilon} n_t^* f_x = \left[n_t^* \widetilde{\varrho}_{ht}^{*1-\gamma} + z_{\min}^{\varepsilon} z_{xt}^{-\varepsilon} n_t \widetilde{\varrho}_{ft}^{1-\gamma}\right]^{\frac{\gamma}{\gamma-1}} y_t^* \quad (60)$$

before deriving the FOCs on total varieties. Those imply:

$$\beta(1-\delta) \mathsf{E}_t \left\{ \frac{c_t}{c_{t+1}} \left(\widetilde{\Psi}_{t+1} + f_e\right) \right\} = f_e \quad (61)$$

$$\beta(1-\delta) \mathsf{E}_t \left\{ \frac{c_t^*}{c_{t+1}^*} \left(\widetilde{\Psi}_{t+1}^* + f_e\right) \right\} = f_e \quad (62)$$

where $\widetilde{\Psi}_t$ and $\widetilde{\Psi}_t^*$ denote the average first-best Home and Foreign profits, defined as

$$\widetilde{\Psi}_t = \underbrace{\frac{\widetilde{\varrho}_{ht}^{1-\gamma} y_t}{\gamma-1}}_{\text{FB av. domestic Home profits}} + \frac{n_{xt}}{n_t} \underbrace{\left(\frac{\varphi_t \widetilde{\varrho}_{ft}^{1-\gamma} y_t^*}{\gamma-1} - f_x\right)}_{\text{FB av. export Home profits}} \quad (63)$$

$$\widetilde{\Psi}_t^* = \underbrace{\frac{\widetilde{\varrho}_{ht}^{*1-\gamma} y_t^*}{\gamma-1}}_{\text{FB av. domestic Foreign profits}} + \frac{n_{xt}^*}{n_t^*} \underbrace{\left(\frac{\widetilde{\varrho}_{ft}^{*1-\gamma} y_t}{\varphi_t(\gamma-1)} - f_x\right)}_{\text{FB av. Foreign export profits}} \quad (64)$$

Finally, the optimal conditions on export thresholds give:

$$\frac{\varphi_t \varrho_{ft}(z_{xt})^{1-\gamma} y_t^*}{\gamma-1} = f_x \text{ and } \frac{\varrho_{ft}^*(z_{xt}^*)^{1-\gamma} y_t}{\varphi_t(\gamma-1)} = f_x \quad (65)$$

A.2 Implementation

Let us start with the demand functions of the first-best equilibrium

$$y_{ht}(z) = \varrho_t(z)^{-\gamma} y_t, \text{ and } y_{ft}(z) = \left(\frac{(1+\tau)}{\varphi_t}\varrho_t(z)\right)^{-\gamma} y_t^* \quad (66)$$

$$y_{ht}^*(z) = \varrho_t^*(z)^{-\gamma} y_t^*, \text{ and } y_{ft}^*(z) = \left(\varphi_t(1+\tau)\varrho_t^*(z)\right)^{-\gamma} y_t \quad (67)$$

Since our decentralized equilibrium features complete markets, we have $\varphi_t = q_t$. Further, identifying decentralized and first-best labor supply equations implies $\varpi_t = (1-\tau_{wt}) w_t$ and $\varpi_t^* = (1-\tau_{wt}^*) w_t^*$, and therefore $\varrho_t(z) = (1-\tau_{wt}) w_t / (a_t z)$ and $\varrho_t^*(z) = (1-\tau_{wt}^*) w_t^* / (a_t^* z)$. Comparing with the actual demand equations, the implementation of the first-best equilibrium requires:

$$\mu_{ht}(z) = \frac{\sigma_{ht}(z)}{(\sigma_{ht}(z)-1)(1-\tau_{yt}(z))} = 1-\tau_{wt} \text{ and } \mu_{ft}(z) = \frac{\sigma_{ft}(z)}{(\sigma_{ft}(z)-1)\left(1-\tau_{yt}^x(z)\right)} = 1-\tau_{wt} \quad (68)$$

$$\mu_{ht}^*(z) = \frac{\sigma_{ht}^*(z)}{\left(\sigma_{ht}^*(z)-1\right)\left(1-\tau_{yt}^*(z)\right)} = 1-\tau_{wt}^* \text{ and } \mu_{ft}^*(z) = \frac{\sigma_{ft}^*(z)}{\left(\sigma_{ft}^*(z)-1\right)\left(1-\tau_{yt}^{x*}(z)\right)} = 1-\tau_{wt}^* \quad (69)$$

for all z. The first-best implies that all mark-ups should be aligned to the same level. In the decentralized equilibrium, markups are decreasing functions of relative prices – increasing functions of market shares – and more productive firms set lower prices – and higher markups – these formulas imply that firms be taxed/subsidized based on their size/productivity/market power. The average mark-up level can be implemented using the labor income taxes τ_{wt} and τ_{wt}^*, while the firm-specific component can only be implemented using firm-specific sales taxes. Since $\sigma_{ht}(z)$ and $\sigma_{ft}(z)$ differ as long as trade costs are positive, the planner must use *both instruments* $\tau_{yt}(z)$ and $\tau_{yt}^x(z)$, *i.e.* tax local producers and exports differently, which implies

$$\tau_{yt}(z) = 1 - \frac{\sigma_{ht}(z)}{(\sigma_{ht}(z)-1)(1-\tau_{wt})}, \ \forall z \quad (70)$$

$$\tau_{yt}^x(z) = 1 - \frac{\sigma_{ft}(z)}{(\sigma_{ft}(z)-1)(1-\tau_{wt})}, \ \forall z \quad (71)$$

A similar reasoning applies to the Foreign economy and implies

$$\tau_{yt}^*(z) = 1 - \frac{\sigma_{ht}^*(z)}{\left(\sigma_{ht}^*(z)-1\right)(1-\tau_{wt}^*)}, \ \forall z \quad (72)$$

$$\tau_{yt}^{x*}(z) = 1 - \frac{\sigma_{ft}^*(z)}{\left(\sigma_{ft}^*(z)-1\right)(1-\tau_{wt}^*)}, \ \forall z \quad (73)$$

Let us now focus on the total number of varieties created. The Euler equation on firm's equation holds under both the decentralized and first-best equilibrium, and guarantees $\widetilde{\Psi}_t = \widetilde{\pi}_t$ and $\widetilde{\Psi}_t^* = \widetilde{\pi}_t^*$. However, it matters that the composition of domestic and export profits respectively are equalized, for the efficient number of produced and exported varieties to arise in the decentralized equilibrium.

In this respect, the taxation rates of profits are critical and implementing the first best implies

$$\tau_{\pi t} = 1-\frac{(\widetilde{\sigma}_{ht}-1)(1-\tau_{wt})}{\gamma-1} \text{ and } \tau_{\pi t}^{x}=1-\frac{(\widetilde{\sigma}_{ft}-1)(1-\tau_{wt})}{\gamma-1}\Lambda_t \tag{74}$$

$$\tau_{\pi t}^{*} = 1-\frac{(\widetilde{\sigma}_{ht}^{*}-1)(1-\tau_{wt}^{*})}{\gamma-1} \text{ and } \tau_{\pi t}^{x*}=1-\frac{\left(\widetilde{\sigma}_{ft}^{*}-1\right)(1-\tau_{wt}^{*})}{\gamma-1}\Lambda_t^{*} \tag{75}$$

with

$$\Lambda_t = \frac{\widetilde{\rho}_{ft}^{1-\gamma}y_t^{*}-f_x(\gamma-1)}{\widetilde{\rho}_{ft}^{1-\gamma}y_t^{*}-f_x(\widetilde{\sigma}_{ft}-1)(1-\tau_{wt})} \tag{76}$$

$$\Lambda_t = \frac{\widetilde{\rho}_{ft}^{*1-\gamma}y_t-f_x(\gamma-1)}{\widetilde{\rho}_{ft}^{*1-\gamma}y_t-f_x\left(\widetilde{\sigma}_{ft}^{*}-1\right)(1-\tau_{wt})} \tag{77}$$

Basically these conditions imply that average domestic and export profits are aligned with their first-best counterparts, implying that the economy features the first-best number of exported and domestic varieties. Finally, the implementation of the optimal export thresholds uniquely pins down the labor income tax rates τ_{wt} and τ_{wt}^{*} according to

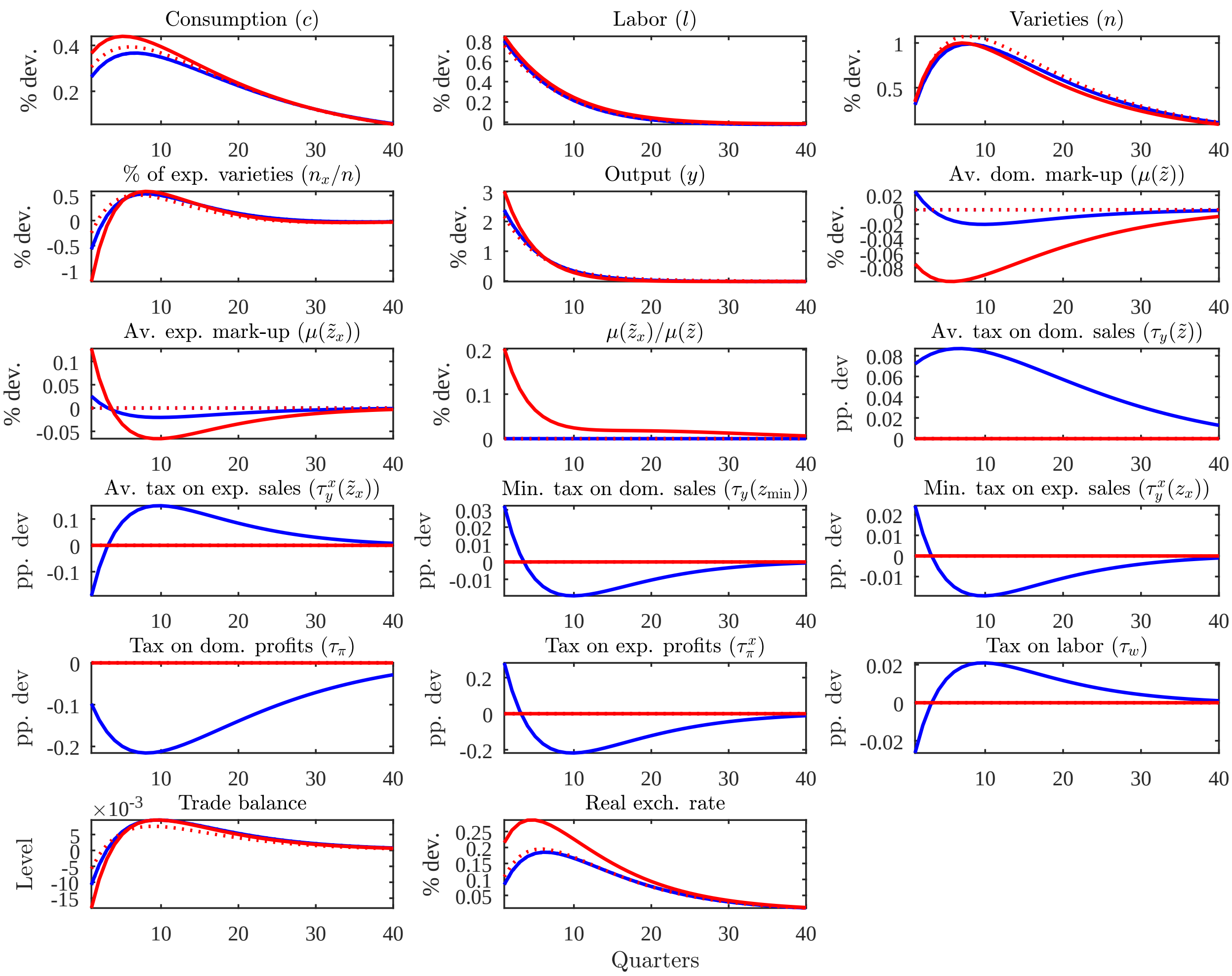
$$\tau_{wt}=\frac{\sigma_{ft}(z_{xt})-\gamma}{\sigma_{ft}(z_{xt})-1} \text{ and } \tau_{wt}^{*}=\frac{\sigma_{ft}^{*}(z_{xt}^{*})-\gamma}{\sigma_{ft}^{*}(z_{xt}^{*})-1} \tag{78}$$

The above tax rates are negative or null, since $\gamma \geq \sigma_{ft}(z_{xt}) \geq \theta$. The labor tax (Equation (78)) is used/specialized to undo the excess market power of the least productive exporting firms. Corporate profit taxes (Equations (74)-(75)) are used/specialized to undo the average excess market power on domestic and export markets. Since $\gamma \geq \sigma_{ft}(z_{xt})$, the average tax rates on corporate profits are positive. In addition, since $\widetilde{\sigma}_{ft} > \widetilde{\sigma}_{ht}$, exporting firms are more productive, attract larger market shares and charge higher excess mark-ups, they should be taxed at a higher rate on their corporate profits. Finally, sales are subsidized: Equations (68)-(69) show that sales taxes are used to align the heterogeneous mark-ups of firms – bring the dispersion of mark-ups to zero – and to bring the level of mark-ups to zero while subsidizing firms enough for them to cover the entry and export fixed costs.

B Additional results

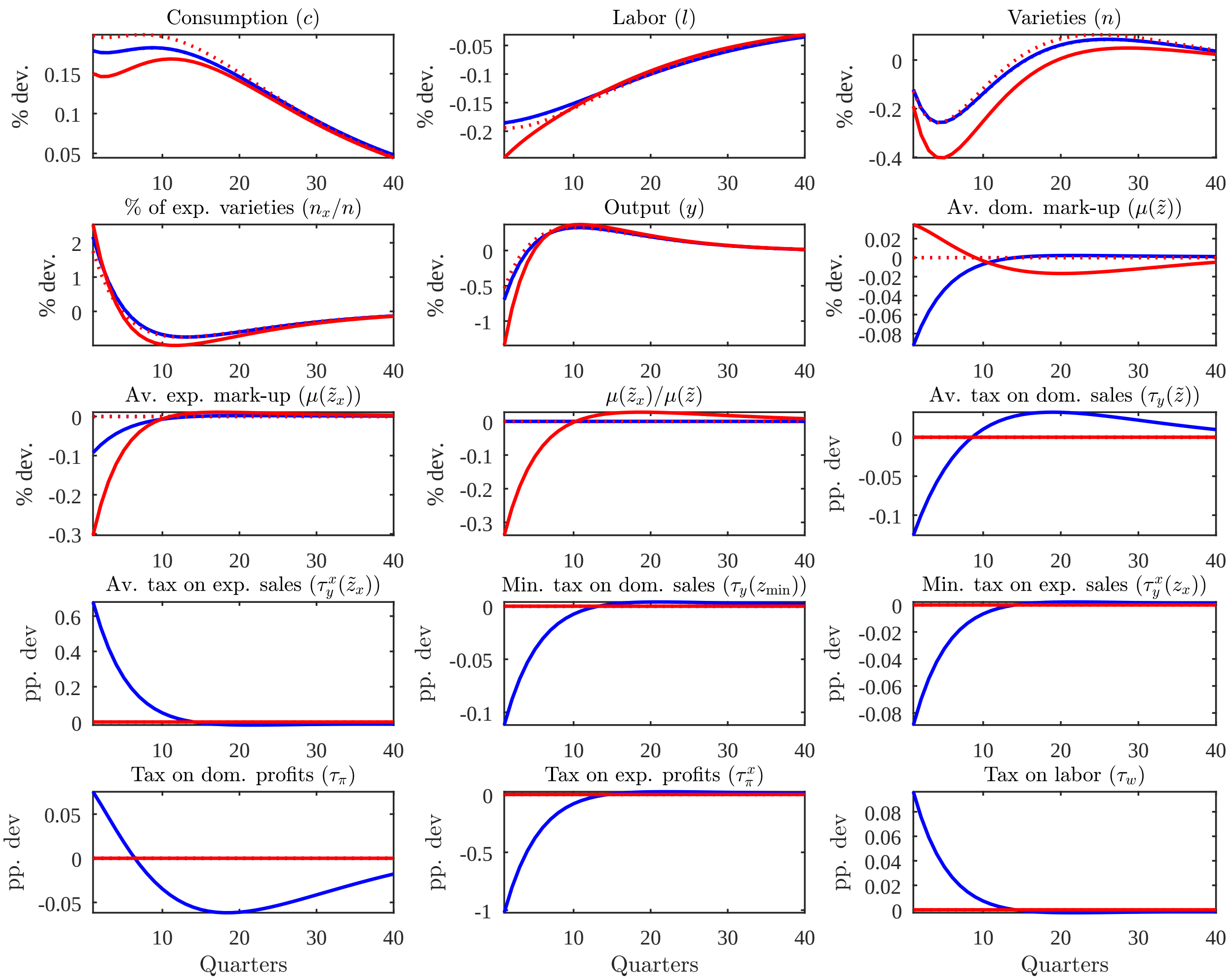
We report the dynamics implied by the model after a home productivity shock under both passive and first-best policies when the calibration follows Gaubert and Itskhoki (2020) closely. This calibration features much more dispersed mark-ups. As shown in Figures 10-11, our results are qualitatively robust to alternative calibrations featuring more dispersion in mark-ups. If anything, this calibration widens the distance between short-run allocation under passive and first-best policies.

Figure 10: Impulse responses to a 1% Home productivity shock (a_t) - Home country



Note: Blue: First-best, Red: Passive fiscal policy. Dotted: Homogeneous mark-ups. The persistence parameter is $\rho_a = 0.9$. Gaubert and Itskhoki (2020)'s calibration.

Figure 11: Impulse responses to a 1% Home productivity shock (a_t) - Foreign country



Note: Blue: First-best, Red: Passive fiscal policy. Dotted: Homogeneous mark-ups. The persistence parameter is $\rho_a = 0.9$. Gaubert and Itskhoki (2020)'s calibration.

ABOUT OFCE

The Paris-based Observatoire français des conjonctures économiques (OFCE), or French Economic Observatory is an independent and publicly-funded centre whose activities focus on economic research, forecasting and the evaluation of public policy.

Its 1981 founding charter established it as part of the French Fondation nationale des sciences politiques (Sciences Po), and gave it the mission is to "ensure that the fruits of scientific rigour and academic independence serve the public debate about the economy". The OFCE fulfils this mission by conducting theoretical and empirical studies, taking part in international scientific networks, and assuring a regular presence in the media through close cooperation with the French and European public authorities. The work of the OFCE covers most fields of economic analysis, from macroeconomics, growth, social welfare programmes, taxation and employment policy to sustainable development, competition, innovation and regulatory affairs.

ABOUT SCIENCES PO

Sciences Po is an institution of higher education and research in the humanities and social sciences. Its work in law, economics, history, political science and sociology is pursued through ten research units and several crosscutting programmes.
Its research community includes over two hundred twenty members and three hundred fifty PhD candidates. Recognized internationally, their work covers a wide range of topics including education, democracies, urban development, globalization and public health.
One of Sciences Po's key objectives is to make a significant contribution to methodological, epistemological and theoretical advances in the humanities and social sciences. Sciences Po's mission is also to share the results of its research with the international research community, students, and more broadly, society as a whole.

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