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Corporate Taxation in Open Economies

Abstract

This paper analyzes the macroeconomic impact of corporate taxation. The analysis is conducted in a quantitative two-country model. In the first step, the paper describes the long-run effects of corporate taxation. A reduction in the corporate-income tax rate increases GDP, wages, consumption, investment, and business density. The trade balance is at the same time negatively affected. Firms headquartered in a country which lowers its corporate tax become internationally less active and instead focus more on their domestic market. In the second step, the paper presents adjustment dynamics that are induced by a corporate-tax reform. The dynamic response of the economy can substantially differ when comparing shorter and longer time horizons.

JEL-Codes: E620, F420, H250.

Keywords: corporate taxation, macroeconomy, heterogeneous firms, multinationals, international spillovers.

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1 Introduction

Corporate taxation belongs to the economic topics that receive a lot of attention not only among economists but also among politicians and the general public. Proposals to change the corporate tax, typically either to increase or to decrease the corporate-income tax rate, occur on a regular basis. Recent examples of implemented corporate-tax reforms are the U.S. Tax Cuts and Jobs Act of 2017 or the French gradual decrease in the corporate tax rate between 2020 and 2022. From a policy perspective, it is crucial to understand which effects arise from such corporate-tax cuts. Policy makers want to take the various effects into account when preparing their forecasts and decisions. This paper aims to provide an analysis of the effects that corporate taxation has on the macroeconomy. The paper analyzes how a change in the corporate tax rate affects the domestic economy as well as which international spillover effects are triggered.

I carry out the analysis of corporate taxation in a dynamic macroeconomic model, which consists of two microfounded countries. The modeling of the corporate sector is inspired by Helpman, Melitz and Yeaple (2004). The key feature of this modeling framework is that firms differ in their productivities. A newly founded firm draws its productivity from a Pareto distribution. On the basis of its idiosyncratic productivity, each firm decides how many markets it wants to serve. A firm can supply its good domestically and also internationally. If a firm makes the decision to be internationally active, it can either export or produce abroad in a subsidiary. To ensure the model allows me to draw quantitative conclusions about the effects of corporate taxation, the model contains a wide range of frictions like search and matching, nominal-wage stickiness, habit formation, investment-adjustment costs, and liquidity-constrained households. Section 2 describes the model in detail. Section 3 calibrates the model parameters such that the two modeled countries—home and foreign—correspond to large advanced economies.

In the first step, I use the model to analyze the long-run effects of corporate taxation. I study in Section 4 how a change in the home corporate tax rate affects the long runs of the home and the foreign economy. A reduction in the home corporate tax causes a rise in home macroeconomic aggregates like GDP, private consumption, or private investment. It additionally stimulates firm creation in the home country, increases business density, and positively impacts the labor market by raising wages and lowering unemployment. As the home corporate tax rate reduces, the home country appreciates in real terms, and its trade balance worsens. Firms headquartered in the home country start focusing more on the domestic market. They become reluctant to engage in any type of international activity. In the foreign economy, a cut in the home corporate tax invokes a small increase in GDP and tax revenue. Firms headquartered in the foreign country start perceiving the market of the home country as more attractive. They increasingly decide to export or to open an affiliate in the home country.

In addition to the long-run analysis, the paper offers a dynamic perspective on corporate taxation. Section 5 presents which adjustment dynamics a change in the corporate tax rate induces. The dynamic analysis demonstrates that a corporate-tax reform can temporarily move some variables into an opposite direction than one could conclude from the long-run analysis. For instance, households do not immediately benefit from a corporate-tax cut. Their consumption and real wages initially decrease before they start approaching a new higher steady-state level. Faster inflation together with an elevated real interest rate are responsible for this discrepancy between the short-run and the long-run effect. The simulations in Section 5 also show how a cut in the corporate tax rate causes bigger losses of tax revenue at shorter than at longer time horizons. The self-financing needs time to arise. The expansion of the economy only gradually translates into a broader tax base. Furthermore, the dynamic analysis enables me to investigate the differences between a permanent and a temporary corporate-tax reduction. The model predicts that a temporary cut generates a smaller increase in GDP than a permanent cut. Because economic agents are able to anticipate the reversal of a temporary corporate-tax reduction, the creation of new firms stays relatively subdued. The total number of firms in the economy does not rise substantially, and so GDP expands, in comparison with a permanent cut, only slightly.

This paper broadens the macroeconomic perspective on corporate taxation. The empirical macro literature that studies the effects of corporate-income tax shocks abstracts from open-economy issues (Mertens and Ravn, 2013). It does not quantify how corporate taxation affects the trade balance or the international operations of firms; it does not investigate the cross-border spillover and feedback effects. In comparison, the analysis I conduct here addresses such open-economy aspects of corporate taxation. My paper deals exclusively with territorial taxation, which represents the most common tax regime among OECD countries. Worldwide taxation and the related topic of repatriation taxes are treated by Gu (2017), Curtis, Garín and Mehkari (2020), or Spencer (2022). I introduce the corporate-income tax into the model as a profit tax. A tax on the return of households' capital stock, which the literature sometimes freely interprets as a corporate tax, is assessed by Mankiw and Weinzierl (2006), Trabandt and Uhlig (2011), or Gross, Klein and Makris (2022).

2 Model

The model economy consists of two countries: home and foreign. Variables and parameters of the home country are denoted by the subscript h. Similarly, the subscript f denotes the symbols that correspond to the foreign country. International variables and parameters are denoted by an asterisk. I describe only the home country in detail; the foreign country behaves analogously. I present the list of all equilibrium conditions in Appendix A.

2.1 Households

The home country is populated by a continuum of households $[0; \mathcal{P}_h]$. Each household is constituted by a continuum of members $[0; 1]$, who inelasticly supply their labor. The households are either savers or non-savers. The share of the non-savers is captured by the parameter μ_h.

2.1.1 Non-Savers

A non-saver household $j \in [0; \mu_h \mathcal{P}_h]$ consumes its after-tax income completely:

$$c_{ht}^{ns}(j) = \frac{1}{1 + \tau_{ht}^{va}} \left[\int_{\vartheta \in \Theta_{ht}^{ns}(j)} (1 - \tau_{ht}^{w}) \, v_{ht}^{ns}(\vartheta, j) \, \mathrm{d}\vartheta + \tau_{ht}^{ub} u_{ht}^{ns}(j) - \tau_{ht}^{ls,ns} \right].$$

An employed household member $\vartheta \in \Theta_{ht}^{ns}(j)$ earns a real wage $v_{ht}^{ns}(\vartheta, j)$, which is taxed by τ_{ht}^{w}. Unemployed household members $u_{ht}^{ns}(j)$ receive real unemployment benefits τ_{ht}^{ub}. Each non-saver household has to pay a real lump-sum tax $\tau_{ht}^{ls,ns}$. The value-added tax τ_{ht}^{va} distorts the consumption of the non-saver $c_{ht}^{ns}(j)$.

2.1.2 Savers

A saver household $j \in (\mu_h \mathcal{P}_h; \mathcal{P}_h]$ maximizes its expected utility, which is hit by the discount-factor shock ϵ_{ht}^{β}, with respect to a budget and a capital-accumulation constraint.

$$\max_{c_{ht}^s(j),\, b_{ht}^s(j),\, b_{ht}^{*s}(j),\, i_{ht}^s(j),\, k_{ht}^s(j)} E_t \sum_{z=t}^{\infty} (\beta_h)^{z-t} \frac{\left[c_{hz}^s(j) - \chi_h c_{hz-1}^s(j)\right]^{1-\sigma_h} - 1}{1-\sigma_h} \exp\left(\epsilon_{hz}^{\beta}\right)$$

s.t.

$$k_{hz}^s(j) = \left(1-\delta_h^k\right) k_{hz-1}^s(j) + i_{hz}^s(j) \left[1 - \frac{\Upsilon_h}{2}\left(\frac{i_{hz}^s(j)}{i_{hz-1}^s(j)} - 1\right)^2\right] \exp\left(\epsilon_{hz}^i\right)$$

$$\begin{aligned}
(1+\tau_{hz}^{va})\, c_{hz}^s(j) + i_{hz}^s(j) + b_{hz}^s(j) + \mathcal{E}_z b_{hz}^{*s}(j) + \Gamma_{hz}^s + \tau_{hz}^{ls,s} = & \int_{\vartheta \in \Theta_{hz}^s(j)} (1-\tau_{hz}^w)\, v_{hz}^s(\vartheta, j)\, \mathrm{d}\vartheta \\
& + \tau_{hz}^{ub} u_{hz}^s(j) \\
& + r_{hz}^k k_{hz-1}^s(j) \\
& - \tau_{hz}^k \left[r_{hz}^k k_{hz-1}^s(j) - \delta_h^k k_{hz-1}^s(j)\right] \\
& + \frac{R_{hz-1}}{\Pi_{hz}} b_{hz-1}^s(j) + \mathcal{E}_z \frac{R_{z-1}^*}{\Pi_{fz}} b_{hz-1}^{*s}(j) \\
& + d_{hz}^s
\end{aligned}$$

As in the case of the non-savers, a saver household obtains after-tax labor income and unemployment benefits. Apart from consumption $c_{ht}^s(j)$, a saver decides how much to invest into domestic government bonds $b_{ht}^s(j)$, international private bonds $b_{ht}^{*s}(j)$, and physical capital $k_{ht}^s(j)$. The bonds yield in real home terms R_{ht-1}/Π_{ht} and $\mathcal{E}_t(R_{t-1}^*/\Pi_{ft})$, respectively. How successfully physical investment $i_{ht}^s(j)$ is installed depends on the investment shock ϵ_{ht}^i. The resulting capital stock brings the real return $r_{ht}^k = R_{ht}^k/P_{ht}$, which is taxed by τ_{ht}^k. Each saver household has to pay a real lump-sum tax $\tau_{ht}^{ls,s}$. In addition, each home saver finances the creation of new home firms by Γ_{ht}^s. The variable d_{ht}^s sums the dividend income and the income that the saver household generates from advertising vacancies and advising firms on profit shifting.

2.2 Labor Market

A continuum of home labor-service providers $[0; \mathcal{P}_h]$ hires home household members to supply firms that produce in the home country with labor services. A labor-service provider $s \in [0; \mathcal{P}_h]$ employs $e_{ht}(s)$ workers for a real wage $v_{ht}(s) = V_{ht}(s)/P_{ht}$ and supplies labor services $l_{ht}(s)$ for a real price $w_{ht} = W_{ht}/P_{ht}$. In order to maximize its expected profit, the labor-service provider controls the number of posted vacancies $pv_{ht}(s)$. The vacancies are associated with quadratic costs, which are paid to saver households, who spread information about the new job postings.

$$\max_{pv_{ht}(s),\, e_{ht}(s),\, l_{ht}(s)} E_t \sum_{z=t}^{\infty} (\beta_h)^{z-t} \frac{\iota_{hz}^{c,s}}{\iota_{ht}^{c,s}} \left\{ w_{hz} l_{hz}(s) - \upsilon_{hz}(s) e_{hz}(s) - \frac{\Phi_h}{2} \left[pv_{hz}(s) \right]^2 \right\}$$

$$\text{s.t.}$$

$$l_{hz}(s) = e_{hz}(s)$$

$$e_{hz}(s) = \left(1 - \delta_h^e\right) e_{hz-1}(s) + \frac{M_{hz}}{PV_{hz}} pv_{hz}(s)$$

The saver households own the labor-service providers. Therefore, each labor-service provider applies the savers' stochastic discount factor. Employees leave their jobs at an exogenous separation rate δ_h^e. The posted vacancies are filled at a rate M_{ht}/PV_{ht}, where $PV_{ht} = \int_0^{\mathcal{P}_h} pv_{ht}(s)\, \mathrm{d}s$. The total number of matches M_{ht} comes from an aggregate matching function:

$$M_{ht} = A_{ht}^M \left(\mathcal{P}_h - \int_0^{\mathcal{P}_h} e_{ht-1}(s)\, \mathrm{d}s + \int_0^{\mathcal{P}_h} \delta_h^e e_{ht-1}(s)\, \mathrm{d}s \right)^{\alpha_h^M} (PV_{ht})^{1-\alpha_h^M},$$

in which individuals who enter the quarter as unemployed meet the posted vacancies. After the hiring process is finished, the unemployment rate reads:

$$u_{ht} = \frac{\mathcal{P}_h - \int_0^{\mathcal{P}_h} e_{ht}(s)\, \mathrm{d}s}{\mathcal{P}_h}.$$

Nominal wages of the labor-service providers exhibit stickiness. With probability ξ_h, the labor-service provider indexes its nominal wage to past and trend inflation: $V_{ht}(s) = V_{ht-1}(s) \left(\Pi_{ht-1}\right)^{\varphi_h} \left(\Pi_h\right)^{1-\varphi_h}$. With probability $1 - \xi_h$, the labor-service provider pays the newly bargained wage: $V_{ht}(s) = V_{ht}^*$. Each firm-worker pair that negotiates the nominal wage faces the following Nash bargaining:

$$\max_{V_{ht}^*} \left[VW_{ht}\left(V_{ht}^*\right) - VU_{ht} \right]^{\iota_{ht}} \left[VF_{ht}\left(V_{ht}^*\right) \right]^{1-\iota_{ht}},$$

in which the joint surplus of the worker and the labor-service provider is maximized. The worker surplus equals the difference between the value from employment $VW_{ht}\left(V_{ht}^*\right)$ and the value from unemployment VU_{ht}:

$$
\begin{aligned}
VW_{ht}\left(V_{ht}^{*}\right) = {} & \left(1-\tau_{ht}^{w}\right)\frac{V_{ht}^{*}}{P_{ht}} \\
& + E_t \beta_h \frac{\iota_{ht+1}^{c,s}}{\iota_{ht}^{c,s}} \left\{ \delta_h^e \left[\frac{M_{ht+1}}{\mathcal{P}_h - \int_0^{\mathcal{P}_h} e_{ht}(s)\,\mathrm{d}s + \int_0^{\mathcal{P}_h} \delta_h^e e_{ht}(s)\,\mathrm{d}s} \int_0^{\mathcal{P}_h} VW_{ht+1}\left(V_{ht+1}(s)\right) \frac{M_{ht+1}(s)}{M_{ht+1}}\,\mathrm{d}s \right.\right. \\
& \left. + \left(1 - \frac{M_{ht+1}}{\mathcal{P}_h - \int_0^{\mathcal{P}_h} e_{ht}(s)\,\mathrm{d}s + \int_0^{\mathcal{P}_h} \delta_h^e e_{ht}(s)\,\mathrm{d}s}\right) VU_{ht+1} \right] \\
& \left. + \left(1-\delta_h^e\right)\left[\xi_h VW_{ht+1}\left(V_{ht}^{*}\left(\Pi_{ht}\right)^{\varphi_h}\left(\Pi_h\right)^{1-\varphi_h}\right) + \left(1-\xi_h\right) VW_{ht+1}\left(V_{ht+1}^{*}\right)\right] \right\},
\end{aligned}
$$

$$
\begin{aligned}
VU_{ht} = {} & \tau_{ht}^{ub} \\
& + E_t \beta_h \frac{\iota_{ht+1}^{c,s}}{\iota_{ht}^{c,s}} \left\{ \frac{M_{ht+1}}{\mathcal{P}_h - \int_0^{\mathcal{P}_h} e_{ht}(s)\,\mathrm{d}s + \int_0^{\mathcal{P}_h} \delta_h^e e_{ht}(s)\,\mathrm{d}s} \int_0^{\mathcal{P}_h} VW_{ht+1}\left(V_{ht+1}(s)\right) \frac{M_{ht+1}(s)}{M_{ht+1}}\,\mathrm{d}s \right. \\
& \left. + \left(1 - \frac{M_{ht+1}}{\mathcal{P}_h - \int_0^{\mathcal{P}_h} e_{ht}(s)\,\mathrm{d}s + \int_0^{\mathcal{P}_h} \delta_h^e e_{ht}(s)\,\mathrm{d}s}\right) VU_{ht+1} \right\}.
\end{aligned}
$$

The firm surplus is identical to the value $VF_{ht}\left(V_{ht}^{*}\right)$, which the labor-service provider receives from the match:

$$
\begin{aligned}
VF_{ht}\left(V_{ht}^{*}\right) = {} & w_{ht} - \frac{V_{ht}^{*}}{P_{ht}} \\
& + E_t\left(1-\delta_h^e\right)\beta_h \frac{\iota_{ht+1}^{c,s}}{\iota_{ht}^{c,s}} \left\{\xi_h VF_{ht+1}\left(V_{ht}^{*}\left(\Pi_{ht}\right)^{\varphi_h}\left(\Pi_h\right)^{1-\varphi_h}\right) + \left(1-\xi_h\right) VF_{ht+1}\left(V_{ht+1}^{*}\right)\right\}.
\end{aligned}
$$

2.3 Bundler

A representative bundler maximizes its after-tax profit.

$$
\begin{aligned}
\max_{X_{ht},\, X_{ht}(\omega)\forall\omega\in\Omega_{ht}} \; & P_{ht}X_{ht} - \int_{\omega\in\Omega_{ht}} p_{ht}(\omega)X_{ht}(\omega)\,\mathrm{d}\omega \\
& - \tau_{ht}^{c}\left(P_{ht}X_{ht} - \int_{\omega\in\Omega_{ht}} p_{ht}(\omega)X_{ht}(\omega)\,\mathrm{d}\omega + \mathbb{1}_{ht}\int_{\omega\in\Omega_{ht}^{f,f}} p_{ht}(\omega)X_{ht}(\omega)\,\mathrm{d}\omega\right)
\end{aligned}
$$

s.t.

$$
X_{ht} = \left[\int_{\omega\in\Omega_{ht}} \left(X_{ht}(\omega)\right)^{\frac{\theta_{ht}-1}{\theta_{ht}}}\,\mathrm{d}\omega\right]^{\frac{\theta_{ht}}{\theta_{ht}-1}}
$$

A set of goods Ω_{ht} is available in the home country. The bundler decides how much of each good $\omega \in \Omega_{ht}$ to buy for a given price $p_{ht}(\omega)$. The goods $X_{ht}(\omega)$ are bundled by a Dixit–

Stiglitz aggregator into a final good X_{ht}, which is sold at P_{ht}. The bundler faces a corporate-income tax rate τ^c_{ht}. If the home government introduces border-adjustment taxation ($\mathbb{1}_{ht} = 1$), the bundler is not allowed to deduct expenses for imported goods $\Omega^{f,f}_{ht} \subset \Omega_{ht}$ from the tax base.

2.4 Firms

The saver households act in the model as venture capitalists. The home savers finance the creation of firms that are headquartered in the home country. An initial investment $\kappa^{\mathcal{N}}_{ht}$, which is expressed in terms of the final good, is needed to create a single-product firm ω that has headquarters in the home country. The savers pay for the initial investment and are, in exchange, rewarded by future dividends. After the payment of the initial investment, the newly founded firm draws its idiosyncratic productivity $a(\omega)$ from a Pareto distribution. A scale parameter $\bar{a}^{min}_h$ together with a shape parameter ζ_h characterizes the underlying probability-density function $g_h(a)$. The newly founded firm becomes active one quarter after the draw of its idiosyncratic productivity. The firm offers its good ω in the home country and potentially also in the foreign country till it experiences an exogenous death shock. The exit occurs with a probability δ_h.

The free-entry condition $\kappa^{\mathcal{N}}_{ht} = D_{ht}$ determines the number of the newly founded firms $\mathcal{N}_{ht}$. In equilibrium, the initial investment $\kappa^{\mathcal{N}}_{ht}$ has to equal the entrant's expected discounted stream of real after-tax profits D_{ht}:

$$D_{ht} = E_t \sum_{z=t+1}^{\infty} (1-\delta_h)^{z-t} (\beta_h)^{z-t} \frac{\iota^{c,s}_{hz}}{\iota^{c,s}_{ht}} \tilde{d}_{hz}.$$

The symbol $\tilde{d}_{ht}$ denotes the average real after-tax profit of firms that are headquartered in the home country:

$$\tilde{d}_{ht} = \int_{\bar{a}^{min}_h}^{\infty} d_{ht}(a) g_h(a) \, \mathrm{d}a.$$

The number of active firms that are headquartered in the home country N^h_{ht} depends on the number of active home firms in the past quarter as well as on the number of home entrants:

$$N^h_{ht} = (1-\delta_h) \left(N^h_{ht-1} + \mathcal{N}_{ht} \right).$$

In every quarter, an active firm decides whether to operate purely domestically or to operate internationally. If the firm decides for international operations, it has to specify the form how to serve the market abroad. The firm can supply the foreign market either by exporting or by producing abroad. Effectively, the firm chooses among three different strategies: the domestic strategy, the export strategy, and the FDI strategy.

2.4.1 Domestic Strategy

The domestic strategy represents the simplest mode of operation a firm can select. For a firm ω that is headquartered in the home country, the domestic strategy means producing and supplying its good only in the home country. Under the domestic strategy, the home firm ω maximizes its after-tax profit with respect to the home production function and the demand of the home bundler.

$$\max_{p_{ht}(\omega),\, k_{ht}(\omega),\, l_{ht}(\omega),\, y_{ht}(\omega)} \left(1-\tau^c_{ht}\right)\left[p_{ht}(\omega)X_{ht}(\omega) - R^k_{ht}k_{ht}(\omega) - \left(1+\tau^p_{ht}\right)W_{ht}l_{ht}(\omega)\right]$$

$$\text{s.t.}$$

$$X_{ht}(\omega) = \left(\frac{p_{ht}(\omega)}{P_{ht}}\right)^{-\theta_{ht}} X_{ht}$$

$$y_{ht}(\omega) = a_{ht}\left(gk_{ht}\right)^{\gamma_h} a(\omega)\left(k_{ht}(\omega)\right)^{\alpha_h}\left(l_{ht}(\omega)\right)^{1-\alpha_h}$$

$$X_{ht}(\omega) = y_{ht}(\omega)$$

The firm sets its price $p_{ht}(\omega)$. The output $y_{ht}(\omega)$, which arises from an optimal input mix of capital $k_{ht}(\omega)$ and labor services $l_{ht}(\omega)$, satisfies the demand of the bundler $X_{ht}(\omega)$. Apart from the factor inputs and the firm-specific productivity, the output depends on the aggregate productivity a_{ht} and the government capital gk_{ht}. The home government collects a payroll tax τ^p_{ht} and a corporate-income tax τ^c_{ht}.

The domestic strategy is optimal for firms with low idiosyncratic productivity: $a(\omega) \in [\bar{a}^{min}_h; \bar{a}^{ex}_{ht}]$. The cutoff $\bar{a}^{ex}_{ht}$ denotes the idiosyncratic productivity at which home firms are indifferent between the domestic and the export strategy. The variable $N^{h,dom}_{ht}$ captures the number of home firms that play the domestic strategy.

2.4.2 Export Strategy

Let us focus again on a firm ω that is headquartered in the home country. If such a firm chooses the export strategy, it serves the home as well as the foreign market from a home plant. During the maximization of its after-tax profit, the firm ω takes into account the demand of the home and the foreign bundler as well as the home production function.

$$\max_{p_{ht}(\omega),\, p_{ft}(\omega),\, k_{ht}(\omega),\, l_{ht}(\omega),\, y_{ht}(\omega)} \left(1-\tau^c_{ht}\right)\left[p_{ht}(\omega)X_{ht}(\omega)+S_t p_{ft}(\omega)X_{ft}(\omega)-R^k_{ht}k_{ht}(\omega)\right.$$
$$\left.-\left(1+\tau^p_{ht}\right)W_{ht}l_{ht}(\omega)-P_{ht}\kappa^{ex}_{ht}\right]+\mathbb{1}_{ht}\tau^c_{ht}S_t p_{ft}(\omega)X_{ft}(\omega)$$
$$\text{s.t.}$$
$$X_{ht}(\omega)=\left(\frac{p_{ht}(\omega)}{P_{ht}}\right)^{-\theta_{ht}}X_{ht}$$
$$X_{ft}(\omega)=\left[\frac{p_{ft}(\omega)}{P_{ft}}\left(1+\mathbb{1}_{ft}\frac{\tau^c_{ft}}{1-\tau^c_{ft}}\right)\right]^{-\theta_{ft}}X_{ft}$$
$$y_{ht}(\omega)=a_{ht}\left(gk_{ht}\right)^{\gamma_h}a(\omega)\left(k_{ht}(\omega)\right)^{\alpha_h}\left(l_{ht}(\omega)\right)^{1-\alpha_h}$$
$$X_{ht}(\omega)+\eta_{ht}X_{ft}(\omega)=y_{ht}(\omega)$$

The export strategy entails iceberg costs η_{ht} and a fixed cost κ^{ex}_{ht}. Similarly to Ghironi and Melitz (2005), firms incur the period fixed cost of exporting in the country in which they are headquartered. The firm ω observes the nominal exchange rate S_t and prices to market accordingly by controlling $p_{ht}(\omega)$ and $p_{ft}(\omega)$. If the home government introduces border-adjustment taxation ($\mathbb{1}_{ht}=1$), the export revenue becomes exempt from the corporate-income tax.

In equilibrium, firms with medium idiosyncratic productivity $a(\omega)\in(\bar{a}^{ex}_{ht};\bar{a}^{fdi}_{ht}]$ play the export strategy. The cutoff $\bar{a}^{fdi}_{ht}$ captures the idiosyncratic productivity of home firms at which the export strategy yields the same after-tax profit as the FDI strategy. The number of home firms that select the export strategy equals $N^{h,ex}_{ht}$.

2.4.3 FDI Strategy

The FDI strategy represents the most sophisticated mode of operation a firm can select. If a firm chooses the FDI strategy, it serves the home market from a home plant and the foreign market from a foreign plant. The optimization problem of a firm ω that is headquartered in the home country and decides to play the FDI strategy has the following form.

$$\max_{\substack{p_{ht}(\omega),k_{ht}(\omega),l_{ht}(\omega),y_{ht}(\omega),\\ p_{ft}(\omega),k_{ft}(\omega),l_{ft}(\omega),y_{ft}(\omega),\\ \Lambda_t(\omega)}} \left(1-\tau^c_{ht}\right)\Bigg[p_{ht}(\omega)X_{ht}(\omega) - R^k_{ht}k_{ht}(\omega) - \left(1+\tau^p_{ht}\right)W_{ht}l_{ht}(\omega) - P_{ht}\kappa^{fdi}_{ht}$$
$$- \Lambda_t(\omega) - P_{ht}\frac{\Xi_h}{2}\left(\frac{\Lambda_t(\omega)}{P_{ht}}\right)^2\Bigg]$$
$$+ S_t\left(1-\tau^c_{ft}\right)\left[p_{ft}(\omega)X_{ft}(\omega) - R^k_{ft}k_{ft}(\omega) - \left(1+\tau^p_{ft}\right)W_{ft}l_{ft}(\omega) + \frac{1}{S_t}\Lambda_t(\omega)\right]$$
$$+ \Lambda_t(\omega)\left(\tau^c_{ft}\mathbb{1}_{ft} - \tau^c_{ht}\mathbb{1}_{ht}\right)$$

s.t.

$$X_{ht}(\omega) = \left(\frac{p_{ht}(\omega)}{P_{ht}}\right)^{-\theta_{ht}} X_{ht}$$
$$X_{ft}(\omega) = \left(\frac{p_{ft}(\omega)}{P_{ft}}\right)^{-\theta_{ft}} X_{ft}$$
$$y_{ht}(\omega) = a_{ht}\left(gk_{ht}\right)^{\gamma_h} a(\omega)\left(k_{ht}(\omega)\right)^{\alpha_h}\left(l_{ht}(\omega)\right)^{1-\alpha_h}$$
$$y_{ft}(\omega) = a_{ft}\left(gk_{ft}\right)^{\gamma_f} a(\omega)\left(k_{ft}(\omega)\right)^{\alpha_f}\left(l_{ft}(\omega)\right)^{1-\alpha_f}$$
$$X_{ht}(\omega) = y_{ht}(\omega)$$
$$X_{ft}(\omega) = y_{ft}(\omega)$$

The firm maximizes its worldwide after-tax profit with respect to the home and foreign demand as well as the home and foreign production function. Similarly to the export strategy, the firm encounters a period fixed cost κ^{fdi}_{ht}, which is expressed in terms of the home final good. The FDI strategy offers the possibility to shift profits between tax jurisdictions. The firm needs expert advice on the details of profit shifting. It therefore contacts home savers, who advise firms that are headquartered in the home country on the issue of profit shifting. The price for the advisory services is quadratic in real shifted profits $\lambda_t(\omega) = \Lambda_t(\omega)/P_{ht}$.

Only firms with the highest idiosyncratic productivity $a(\omega) \in (\bar{a}^{fdi}_{ht};\infty)$ find the FDI strategy optimal. The number of home firms that select the FDI strategy is denoted by $N^{h,fdi}_{ht}$.

2.5 Fiscal Policy

The government balances the fiscal-budget constraint:

$$GC_{ht} + GI_{ht} + \tau^{ub}_{ht}u_{ht}\mathcal{P}_h + \frac{R_{ht-1}}{\Pi_{ht}}b_{ht-1} = \tau^{ls,ns}_{ht}\mu_h\mathcal{P}_h + \tau^{ls,s}_{ht}\left(1-\mu_h\right)\mathcal{P}_h + TR_{ht} + b_{ht}.$$

While the government spends money on government consumption GC_{ht}, government investment GI_{ht}, unemployment benefits, and debt repayment, it generates revenue from lump-sum taxes, non-lump-sum taxes TR_{ht}, and bond issuance b_{ht}. The group of the non-lump-sum taxes consists of the wage, capital, payroll, value-added, and corporate-income tax:

$$TR_{ht} = \tau^{w}_{ht} v_{ht} L_{ht} + \tau^{k}_{ht} \left(r^{k}_{ht} - \delta^{k}_{h} \right) K_{ht-1} + \tau^{p}_{ht} w_{ht} L_{ht} + \tau^{va}_{ht} C_{ht} + TR^{c}_{ht}.$$

The model abstracts from the possibility of pass-through taxation. All firms in the model have to pay the corporate-income tax. They are not allowed to pass their profits into the tax base of the personal-income tax. Like the majority of OECD countries, the model features territorial taxation. Profits that multinational firms earn abroad face no repatriation taxes. The government can augment the tax system by border adjustment, under which exports and imports do not enter the tax base of the corporate-income tax. The real revenue from the corporate-income tax consequently reads:

$$\begin{aligned}
TR^{c}_{ht} = {} & \mathbb{1}_{ht} \frac{\tau^{c}_{ht}}{1-\tau^{c}_{ht}} \left(1 + \mathbb{1}_{ht} \frac{\tau^{c}_{ht}}{1-\tau^{c}_{ht}} \right)^{-\theta_{ht}} X_{ht} N^{f,ex}_{ft} \left(\tilde{q}^{f,f}_{ht} \right)^{1-\theta_{ht}} + \tau^{c}_{ht} \frac{1}{\theta_{ht}} X_{ht} N^{h}_{ht-1} \left(\tilde{q}^{h}_{ht} \right)^{1-\theta_{ht}} \\
& + \tau^{c}_{ht} \mathcal{E}_t \left(1 + \mathbb{1}_{ft} \frac{\tau^{c}_{ft}}{1-\tau^{c}_{ft}} \right)^{-\theta_{ft}} X_{ft} \frac{1 - \tau^{c}_{ht} \left(1 - \mathbb{1}_{ht} \right) - \mathbb{1}_{ht} \theta_{ft}}{\theta_{ft} \left(1 - \tau^{c}_{ht} \right)} N^{h,ex}_{ht} \left(\tilde{q}^{h,h}_{ft} \right)^{1-\theta_{ft}} \\
& + \tau^{c}_{ht} X_{ht} \frac{1}{\theta_{ht}} N^{f,fdi}_{ft} \left(\tilde{q}^{f,h}_{ht} \right)^{1-\theta_{ht}} - \tau^{c}_{ht} \kappa^{ex}_{ht} N^{h,ex}_{ht} - \tau^{c}_{ht} \kappa^{fdi}_{ht} N^{h,fdi}_{ht} - \tau^{c}_{ht} \frac{\Xi_h}{2} \left(\lambda_{ht} \right)^2 N^{h,fdi}_{ht} \\
& - \tau^{c}_{ht} \left(1 - \mathbb{1}_{ht} \right) \lambda_{ht} N^{h,fdi}_{ht} + \tau^{c}_{ht} \mathcal{E}_t \lambda_{ft} \left(1 - \mathbb{1}_{ht} \right) N^{f,fdi}_{ft}.
\end{aligned}$$

Government capital GK_{ht} accumulates in line with the usual rule:

$$GK_{ht} = \left(1 - \delta^{GK}_{h} \right) GK_{ht-1} + GI_{ht}.$$

The productivity of a firm that produces in the home country depends on the government capital per active firm gk_{ht}:

$$gk_{ht} = \frac{GK_{ht-1}}{N^{h}_{ht-1} + N^{f,fdi}_{ft}}.$$

2.6 Monetary Policy

The central bank conducts its monetary policy by an interest-rate rule:

$$\frac{R_{ht}}{R_h} = \left(\frac{R_{ht-1}}{R_h} \right)^{\phi^{R}_{h}} \left[\left(\frac{\Pi_{ht}}{\Pi_h} \right)^{\phi^{\Pi}_{h}} \left(\frac{Y_{ht}}{Y_{ht-1}} \right)^{\phi^{Y}_{h}} \right]^{1-\phi^{R}_{h}} \exp\left(\epsilon^{R}_{ht} \right).$$

The nominal interest rate R_{ht} responds to inflation $\Pi_{ht} = P_{ht}/P_{ht-1}$ and output growth Y_{ht}/Y_{ht-1}. The monetary shock ϵ_{ht}^{R} allows for deviations from the strict rule.

2.7 International Linkages

The gross growth rate of the nominal exchange rate ΔS_t can be expressed in terms of the growth rate of the real exchange rate $\mathcal{E}_t/\mathcal{E}_{t-1}$ and the inflation differential Π_{ht}/Π_{ft}:

$$\Delta S_t = \frac{S_t}{S_{t-1}} = \frac{\mathcal{E}_t}{\mathcal{E}_{t-1}} \frac{\Pi_{ht}}{\Pi_{ft}}.$$

The international nominal interest rate R_t^* features a risk premium, which depends on the amount of international bonds b_t^*:

$$R_t^* = R_{ft} \exp\left(-\phi^* \frac{\mathcal{E}_t b_t^*}{Y_{ht}}\right).$$

Under a positive value of b_t^*, the home country is a lender; under a negative value of b_t^*, the home country is a borrower. If one combines the budget constraints of the home and the foreign country, one obtains the following international relation:

$$\begin{aligned}
&\frac{1}{2}\left(Y_{ht} - \mathcal{E}_t Y_{ft}\right) + \frac{1}{2}\Bigg[\mathbb{1}_{ht} \frac{\tau_{ht}^c}{1-\tau_{ht}^c}\left(1 + \mathbb{1}_{ht}\frac{\tau_{ht}^c}{1-\tau_{ht}^c}\right)^{-\theta_{ht}} \left(\tilde{q}_{ht}^{f,f}\right)^{1-\theta_{ht}} X_{ht} N_{ft}^{f,ex} \\
&-\mathcal{E}_t \mathbb{1}_{ft} \frac{\tau_{ft}^c}{1-\tau_{ft}^c}\left(1 + \mathbb{1}_{ft}\frac{\tau_{ft}^c}{1-\tau_{ft}^c}\right)^{-\theta_{ft}} \left(\tilde{q}_{ft}^{h,h}\right)^{1-\theta_{ft}} X_{ft} N_{ht}^{h,ex}\Bigg] = \frac{1}{2}\left(X_{ht} - \mathcal{E}_t X_{ft}\right) + \mathcal{E}_t b_t^* - \mathcal{E}_t \frac{R_{t-1}^*}{\Pi_{ft}} b_{t-1}^* \\
&+ \frac{1-\tau_{ht}^c}{\theta_{ht}}\left(\tilde{q}_{ht}^{f,h}\right)^{1-\theta_{ht}} X_{ht} N_{ft}^{f,fdi} - \mathcal{E}_t \frac{1-\tau_{ft}^c}{\theta_{ft}}\left(\tilde{q}_{ft}^{h,f}\right)^{1-\theta_{ft}} X_{ft} N_{ht}^{h,fdi} + \left(1 - \mathbb{1}_{ft}\right)\tau_{ft}^c PS_{ht} \\
&- \mathcal{E}_t\left(1 - \mathbb{1}_{ht}\right)\tau_{ht}^c PS_{ft},
\end{aligned}$$

where PS_{ht} and PS_{ft} represent the real aggregate profit shifting of home and foreign firms. A cross-country difference in production leads either to an adjustment of the international bonds or to cross-country differences in domestic demand, repatriated profits, and tax liability caused by profit shifting.

3 Calibration

Table 1 presents the benchmark calibration of the model. I symmetrically calibrate the parameters of the home and the foreign country to values that are common in the literature.

The number of households is normalized to one; a fourth of them behaves as non-savers. Because the time periods in the model represent quarters, I set the discount factor to 0.99. The saver households possess a logarithmic utility function with an internal habit of 0.5. While the private capital depreciates at a rate of 2.5%, the installation of new capital suffers from investment-adjustment costs of size four. The risk premium of international bonds features a sensitivity to outstanding debt of 0.1. The net-foreign-asset position between the home and the foreign country is balanced in the steady state.

A nominal-wage contract exhibits on average a duration of one year. If the wage contract is not renegotiated, the nominal wage is equally indexed to past and trend inflation. Employers and employees have the same bargaining power in the steady state. The average employer-employee match lasts for two and a half years. The aggregate matching function puts identical weights on the unemployed and the posted vacancies. I calibrate the vacancy costs and the steady-state matching efficiency such that the steady-state unemployment rate and the steady-state vacancy-filling rate equal 6% and 70%, respectively.

In the steady state, firms encounter a price elasticity of 6. A scale parameter of one and a shape parameter of 6.5 characterize the Pareto distribution of the firm-specific productivities. On average, a firm experiences a death shock after ten years of existence. The benchmark calibration does not allow the government capital to affect the productivity of firms. The weight of private capital in the production function ensures that the steady-state ratio of the total private investment to GDP equals roughly 18%. Export firms have to overcome iceberg costs, which in the steady state cause a wedge of 20% between export sales and production. The initial investment that is required during firm creation is in the steady state normalized to one. The steady-state fixed cost of the export strategy implies a steady-state ratio between exports and GDP of 13%. The steady-state fixed cost of the multinational strategy is calibrated such that foreign affiliates of multinational firms are in the steady state responsible for 20% of the total national production. The benchmark calibration rules out the possibility that firms shift profits across countries.

The home and the foreign government tax the corporate income at 25% in the steady state, and they refrain from border-adjustment taxation. The governments set the employer tax as well as the consumption tax to 10%, the employee tax to 15%, and the capital tax to 25%. The non-saver households neither receive lump-sum benefits nor have to pay lump-sum taxes. The steady-state unemployment benefits replace 50% of the after-tax labor income ($\tau_h^{ub} = \psi_h^{ub} v_h$). The home and the foreign government do not issue bonds in the steady state. I calibrate the steady-state ratio between government consumption and GDP to 20% and the ratio between government investment and GDP to three percent. The government capital depreciates at the same pace as the private capital.

Group	Symbol	Description	Value
Households	$\mathcal{P}_h$, $\mathcal{P}_f$	population size	1
	μ_h, μ_f	fraction of non-savers	0.25
	β_h, β_f	discount factor	0.99
	σ_h, σ_f	relative risk aversion	1
	χ_h, χ_f	habit formation	0.5
	δ_h^k, δ_f^k	depreciation of private capital	0.025
	Υ_h, Υ_f	investment-adjustment costs	4
	ϕ^*	sensitivity of risk premium	0.1
	b^*	steady-state international bonds	0
Labor Market	ξ_h, ξ_f	nominal-wage stickiness	0.75
	φ_h, φ_f	weight of past inflation in wage indexation	0.5
	ι_h, ι_f	steady-state bargaining power of labor	0.5
	δ_h^e, δ_f^e	separation rate	0.1
	α_h^M, α_f^M	weight of the unemployed in the matching function	0.5
	Φ_h, Φ_f	vacancy costs	8.1
	A_h^M, A_f^M	steady-state matching efficiency	0.654
Firms	θ_h, θ_f	steady-state price elasticity	6
	$\bar{a}_h^{min}$, $\bar{a}_f^{min}$	scale parameter of Pareto distribution	1
	ζ_h, ζ_f	shape parameter of Pareto distribution	6.5
	δ_h, δ_f	exit rate	0.025
	γ_h, γ_f	weight of government capital in production function	0
	α_h, α_f	weight of private capital in production function	0.16
	η_h, η_f	steady-state iceberg costs	1.2
	$\kappa_h^{\mathcal{N}}$, $\kappa_f^{\mathcal{N}}$	steady-state initial investment	1
	κ_h^{ex}, κ_f^{ex}	steady-state fixed cost of export strategy	0.008
	κ_h^{mn}, κ_f^{mn}	steady-state fixed cost of multinational strategy	0.3
	Ξ_h, Ξ_f	costs of profit shifting	∞
Fiscal Policy	τ_h^c, τ_f^c	steady-state corporate-income tax rate	0.25
	$\mathbb{1}_h$, $\mathbb{1}_f$	border-adjustment taxation in steady state	0
	τ_h^p, τ_f^p	steady-state employer tax rate	0.1
	τ_h^{va}, τ_f^{va}	steady-state consumption tax rate	0.1
	τ_h^w, τ_f^w	steady-state employee tax rate	0.15
	τ_h^k, τ_f^k	steady-state capital tax rate	0.25
	$\tau_h^{ls,ns}$, $\tau_f^{ls,ns}$	steady-state lump-sum tax on non-savers	0
	ψ_h^{ub}, ψ_f^{ub}	replacement rate of unemployment benefits	0.425
	b_h, b_f	steady-state government bonds	0
	GC_h/Y_h, GC_f/Y_f	government consumption to output in steady state	0.2
	GI_h/Y_h, GI_f/Y_f	government investment to output in steady state	0.03
	δ_h^{GK}, δ_f^{GK}	depreciation of government capital	0.025
Monetary Policy	Π_h, Π_f	steady-state inflation	1.005
	ϕ_h^R, ϕ_f^R	interest-rate smoothing	0.75
	ϕ_h^Π, ϕ_f^Π	reaction to inflation	1.5
	ϕ_h^Y, ϕ_f^Y	reaction to output growth	0.2

Table 1: Benchmark Calibration

Monetary policy in both countries targets annual inflation of two percent. Due to the smoothing parameter of 0.75, the central banks sluggishly adjust their nominal interest rates. The reactions of the central banks to inflation and GDP growth equal 1.5 and 0.2.

Table 2 lists the steady-state great ratios of the model at the benchmark calibration. As the table shows, the model is able to replicate the empirical great ratios of large developed economies.

	U.S.	Japan	Germany	U.K.	France	Model
Private Consumption/GDP	67.8	56.2	53.4	64.5	54.4	58.8
Private Investment/GDP	16.6	20.7	18.1	14.1	18.6	18.2
Government Consumption/GDP	14.8	19.7	19.7	19.7	23.7	20.0
Government Investment/GDP	3.4	3.8	2.3	2.7	3.7	3.0
Export/GDP	12.7	16.4	45.9	29.4	29.9	12.8
Import/GDP	15.8	16.9	39.7	30.8	30.9	12.8
Production of Foreign-Owned Firms/Total Production	–	–	26.2	34.1	18.7	19.7
Revenue from the Corporate-Income Tax/GDP	1.8	3.6	1.8	2.5	2.3	3.9
Revenue from the Employer Tax/GDP	3.1	5.5	6.5	3.6	11.1	6.4
Revenue from the Consumption Tax/GDP	2.0	3.4	7.0	6.8	7.7	5.9
Revenue from the Employee Tax/GDP	9.1	5.5	9.7	8.6	8.4	8.8
Revenue from the Capital Tax/GDP	3.1	2.5	1.0	4.0	3.9	1.2
Expenditure on Unemployment Benefits/GDP	0.4	0.2	1.0	0.3	1.6	1.6

Table 2: Great Ratios in Percent. The table confronts the steady-state great ratios of the model at the benchmark calibration with the empirical great ratios that can be observed in large advanced economies. The great ratios of the GDP components are based on the OECD ANA database (averages over 2010–2019). Data on the production of foreign-owned firms comes from the OECD AMNE database (averages over 2011–2016). Data on the tax revenue is retrieved from the OECD TAX database (averages over 2010–2019), and data on unemployment benefits is obtained from the OECD SOCX database (averages over 2010–2017). The stylized tax system of the model has the following empirical counterparts in the OECD TAX database: taxes on income, profits, and capital gains of corporates (corporate-income tax); employers' social-security contributions (employer tax); general taxes on goods and services (consumption tax); taxes on income and profits of individuals (employee tax); taxes on property (capital tax).

4 The Long-Run Effects of Corporate Taxation

This section studies how corporate taxation affects the long run of the economy. I analyze how the steady state of the model alters when the corporate-income tax rate changes. I vary the home corporate tax rate τ_h^c between 0% and 50% while the foreign corporate tax rate τ_f^c stays unchanged at the benchmark value of 25%. To ensure that the fiscal-budget constraints in the home and the foreign country are satisfied, the lump-sum transfers to saver households

$\tau_h^{ls,s}$ and $\tau_f^{ls,s}$ endogenously adjust. The remaining fiscal instruments are held constant at values that Table 1 presents. Figures 1–3 show the resulting steady states of home and foreign variables at the different calibrations of the home corporate tax rate. The long run of the home variables is depicted by black solid lines, the long run of the foreign variables by blue dashed lines.

A lower home corporate tax triggers more intensive firm creation in the home country $\mathcal{N}_h$, which translates into a larger number of home firms N_h^h. The larger number of home firms raises the home output Y_h. The expansion of output leads to a stronger demand for capital K_h and labor services L_h. Saver households respond to the stronger demand for capital by expanding their investment I_h. Due to the expanded capital investment and the intensive firm creation, the broad definition of private investment $\mathcal{I}_h$ rises as well. A lower unemployment rate u_h together with a more generous wage v_h support the private consumption C_h.

The size of the corporate-tax distortion also influences which strategy firms decide to play. The prevalence of the domestic, export, and multinational strategy among the home firms is determined by the corresponding productivity cutoffs $\bar{a}_h^{ex}$ and $\bar{a}_h^{mn}$. Both cutoffs increase as the home corporate tax decreases. The increasing pattern of the export cutoff $\bar{a}_h^{ex}$ is caused by the rising wage v_h. A higher real wage discourages firms that feature a medium idiosyncratic productivity from exporting and instead prompts them to focus entirely on the domestic market. Therefore, the fraction of domestically oriented firms $N_h^{h,dom}/N_h^h$ increases with a lower corporate tax τ_h^c. For high-productivity home firms, which contemplate serving the foreign market either by exporting or multinational activity, the export strategy becomes through a home corporate-tax cut more appealing. As a result, the fraction of multinational firms $N_h^{h,mn}/N_h^h$ declines with a lower corporate tax τ_h^c. The fraction of export firms $N_h^{h,ex}/N_h^h$ decreases as well because the number of firms that switch from the multinational strategy to the export strategy does not compensate for the firms that switch from the export strategy to the domestic strategy.

At lower levels of the home corporate tax, the smaller prevalence of the export strategy among the home firms is reflected in the weaker home export EX_h. The home export additionally suffers from a real appreciation of the home economy. By contrast, the home import IM_h strengthens with a lower home corporate tax. The import is propelled by a stronger home demand X_h as well as by the real appreciation of the home economy. The export and the import jointly imply that the home net exports NX_h worsen as the home corporate tax reduces. The home country experiences a trade surplus if the tax rate τ_h^c lies above 25% and a trade deficit if the tax rate τ_h^c lies below 25%. Under the symmetrical calibration, when both countries tax the corporate income by 25%, the international trade is balanced.

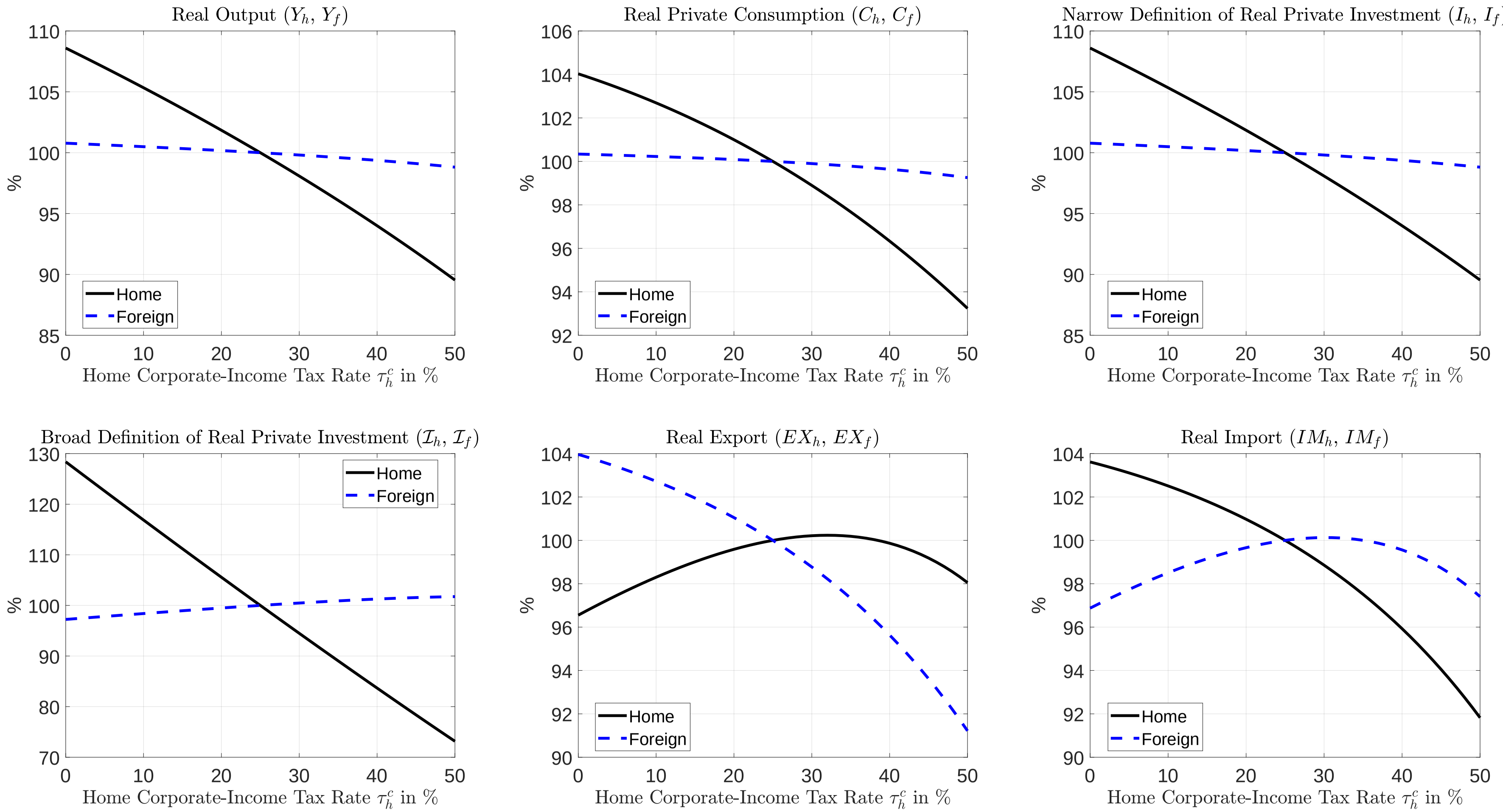

Figure 1: The Long-Run Effect of Corporate Taxation on GDP and Its Components. The corporate-income tax rate in the home country τ_h^c is set to values between 0% and 50%. All remaining parameters keep their benchmark values. Variables are normalized to 100% at $\tau_h^c = 25\%$.

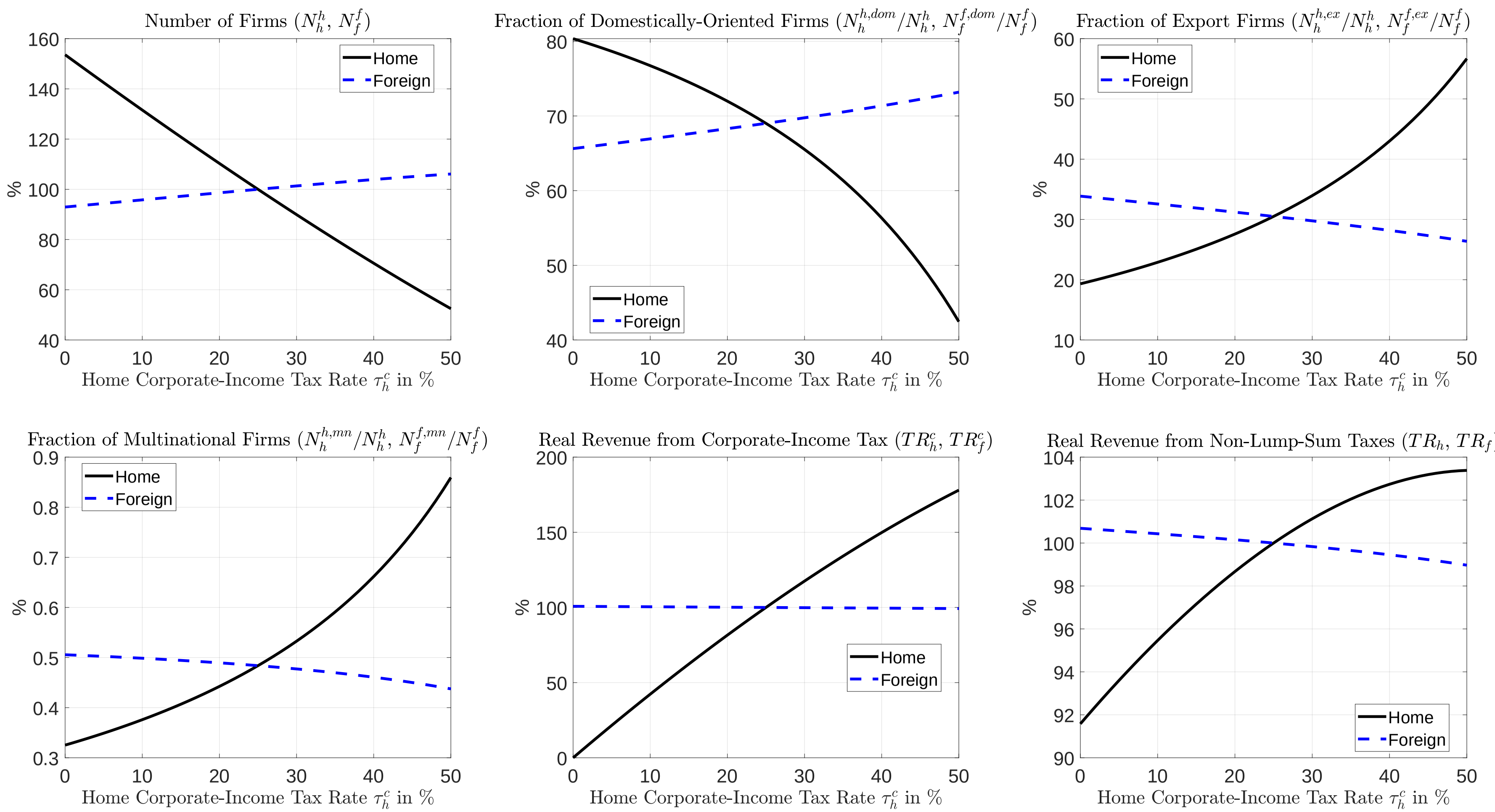

Figure 2: The Long-Run Effect of Corporate Taxation on the Number of Firms and the Tax Revenue. The corporate-income tax rate in the home country τ_h^c is set to values between 0% and 50%. All remaining parameters keep their benchmark values. The total number of firms and the tax revenue are normalized to 100% at $\tau_h^c = 25\%$.

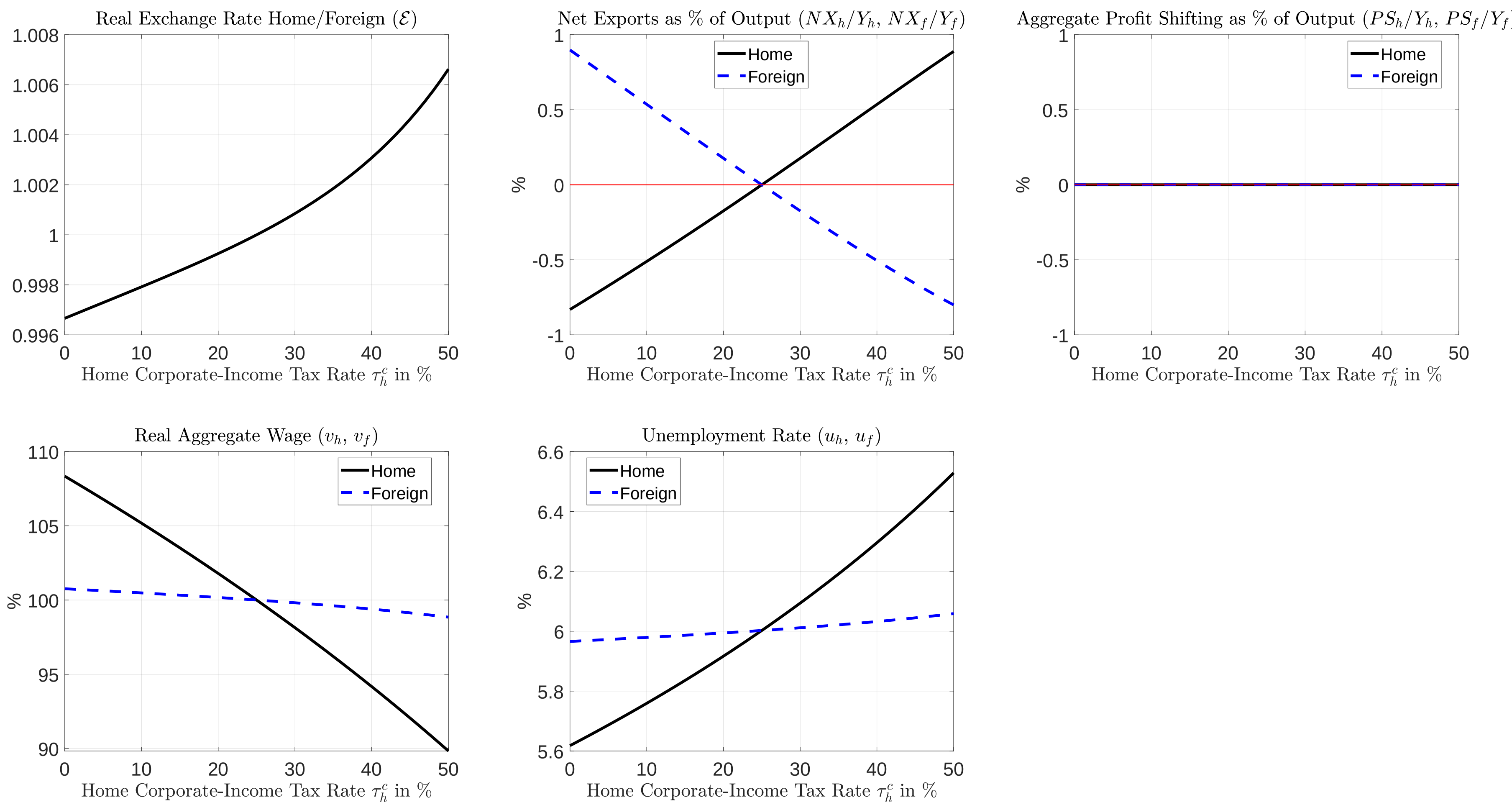

Figure 3: The Long-Run Effect of Corporate Taxation on the International Trade and the Labor Market. The corporate-income tax rate in the home country τ_h^c is set to values between 0% and 50%. All remaining parameters keep their benchmark values. The real aggregate wage is normalized to 100% at $\tau_h^c = 25\%$.

The model analysis demonstrates that a change in the home corporate tax invokes several spillover effects on the foreign economy. A reduction in the home corporate tax has a small positive impact on foreign variables like output Y_f, real wage v_f, private consumption C_f, and tax revenue TR_f. Moreover, if one cuts the home corporate tax rate, the home market becomes more attractive for foreign firms. Technically speaking, the stronger home demand X_h and the lower taxation τ_h^c decrease the productivity cutoffs of foreign firms $\bar{a}_f^{ex}$ and $\bar{a}_f^{mn}$. The fraction of export firms $N_f^{f,ex}/N_f^f$ as well as the fraction of multinational firms $N_f^{f,mn}/N_f^f$ rise with a lower home corporate tax.

5 Adjustment Dynamics Induced by a Corporate-Tax Reform

While Section 4 presents how a change in the corporate tax rate affects the long run of the economy, Section 5 describes how the long run is reached. I investigate here which adjustment dynamics a corporate-tax reform induces before the economy stabilizes at a steady state. Concretely, I simulate three different scenarios, in which the home government always lowers the corporate-income tax rate from 25% to 20%. The first scenario represents a permanent tax cut, which the home government announces and implements at the beginning of the simulation. The second scenario considers a temporary tax cut. The home government lowers the corporate tax rate at the beginning of the simulation and promises to keep it at 20% for the next five years. After the five years pass, the tax rate returns back to 25% as promised by the government. In the third scenario, the home government announces and starts to implement the same temporary tax cut as in the second scenario. However, the government does not now deliver on its promise to reverse the tax cut. The government instead surprises economic agents in quarter 21 by making the cut permanent. In all three scenarios, the tax reforms are financed in a non-distortionary fashion by lower lump-sum transfers to saver households.

Figures 4–10 show how home and foreign variables adjust during the three simulated scenarios. The first scenario is depicted by black solid lines, the second scenario by blue dashed lines, and the third scenario by green dotted lines. The permanent corporate-tax cuts in the first and the third scenario prompt the economy to move from the original steady state toward a new long run. In contrast, the temporary corporate-tax cut in the second scenario induces only a transitory deviation from the original steady state.

The two simulations of a permanent tax reform—scenario 1 and 3—share the same path of the corporate-income tax. In both scenarios, the home corporate tax drops in the first

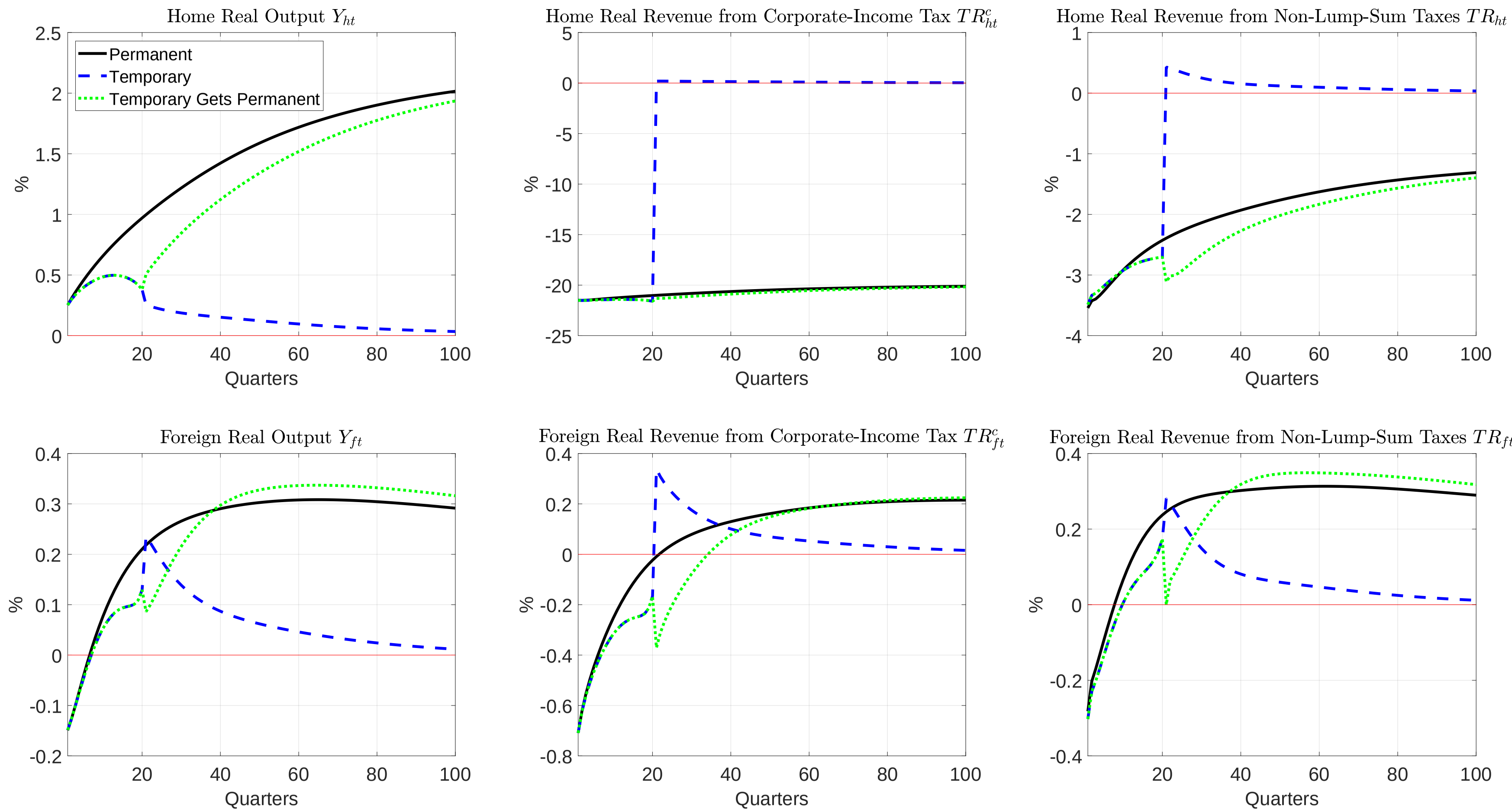

Figure 4: A Permanent versus a Temporary Corporate-Tax Cut in the Home Country from $\tau^c_{h0} = 25\%$ to $\tau^c_{h1} = 20\%$. The black solid lines depict the adjustment dynamics that are induced by a permanent corporate-tax cut. The home government announces and implements the permanent cut in quarter 1. The blue dashed lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut. The home government announces and implements the temporary cut in quarter 1 and reverses the cut, as promised, in quarter 21. The green dotted lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut which becomes permanent. The home government lowers the corporate tax in quarter 1, promises to reverse the tax cut in quarter 21 but surprises the market in quarter 21 by making the tax cut permanent.

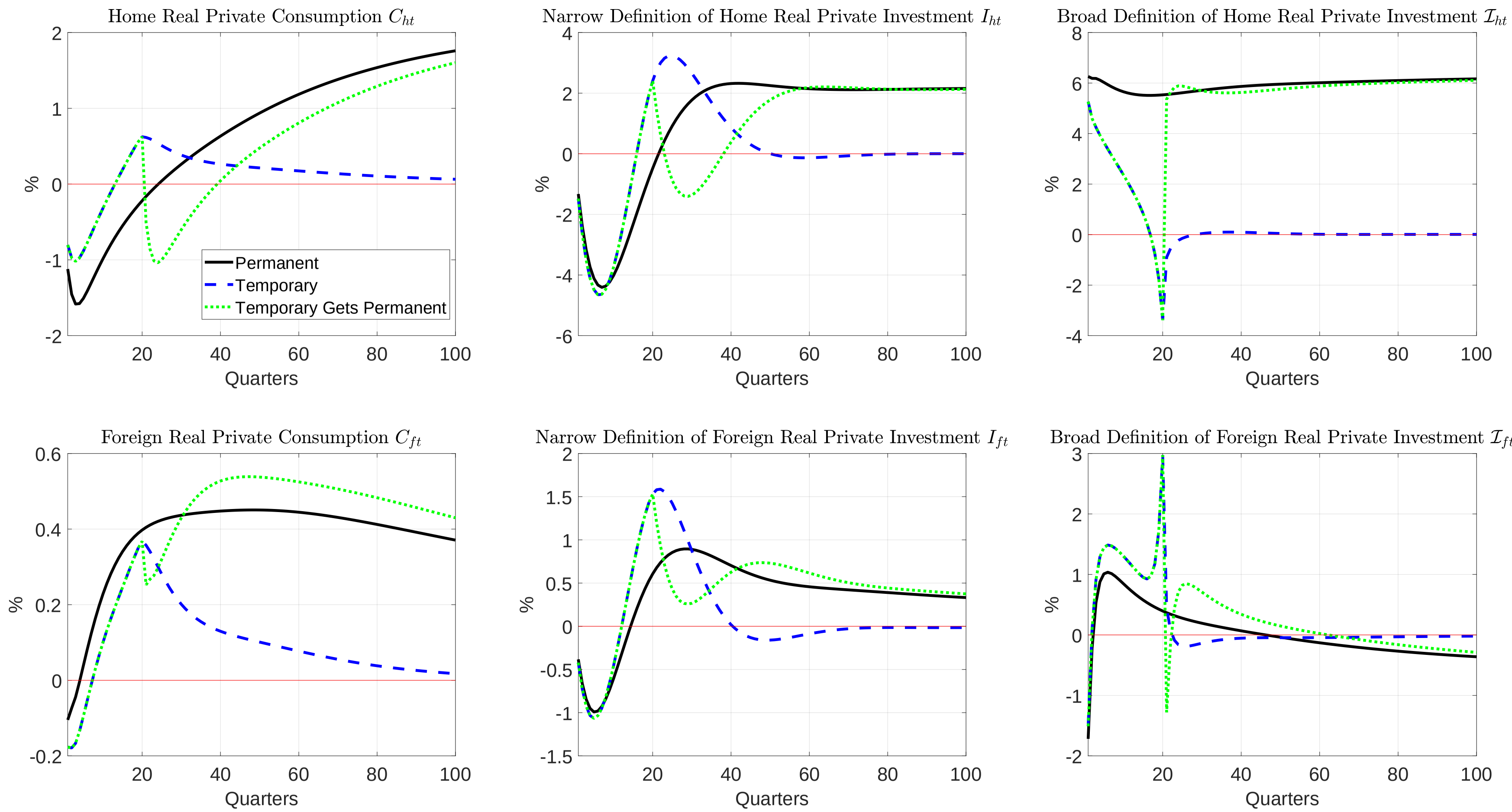

Figure 5: A Permanent versus a Temporary Corporate-Tax Cut in the Home Country from $\tau^c_{h0} = 25\%$ to $\tau^c_{h1} = 20\%$. The black solid lines depict the adjustment dynamics that are induced by a permanent corporate-tax cut. The home government announces and implements the permanent cut in quarter 1. The blue dashed lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut. The home government announces and implements the temporary cut in quarter 1 and reverses the cut, as promised, in quarter 21. The green dotted lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut which becomes permanent. The home government lowers the corporate tax in quarter 1, promises to reverse the tax cut in quarter 21 but surprises the market in quarter 21 by making the tax cut permanent.

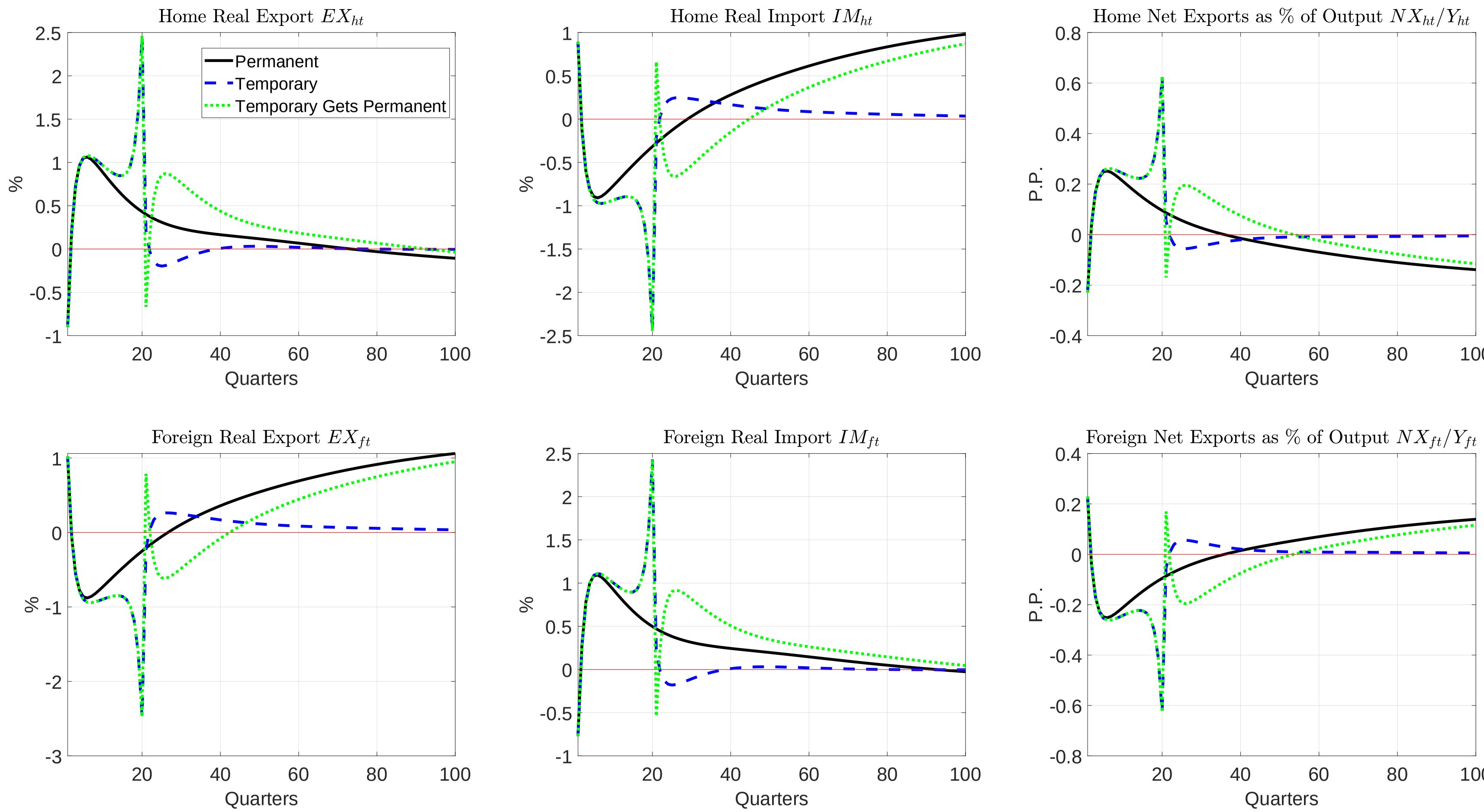

Figure 6: A Permanent versus a Temporary Corporate-Tax Cut in the Home Country from $\tau^c_{h0} = 25\%$ to $\tau^c_{h1} = 20\%$. The black solid lines depict the adjustment dynamics that are induced by a permanent corporate-tax cut. The home government announces and implements the permanent cut in quarter 1. The blue dashed lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut. The home government announces and implements the temporary cut in quarter 1 and reverses the cut, as promised, in quarter 21. The green dotted lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut which becomes permanent. The home government lowers the corporate tax in quarter 1, promises to reverse the tax cut in quarter 21 but surprises the market in quarter 21 by making the tax cut permanent.

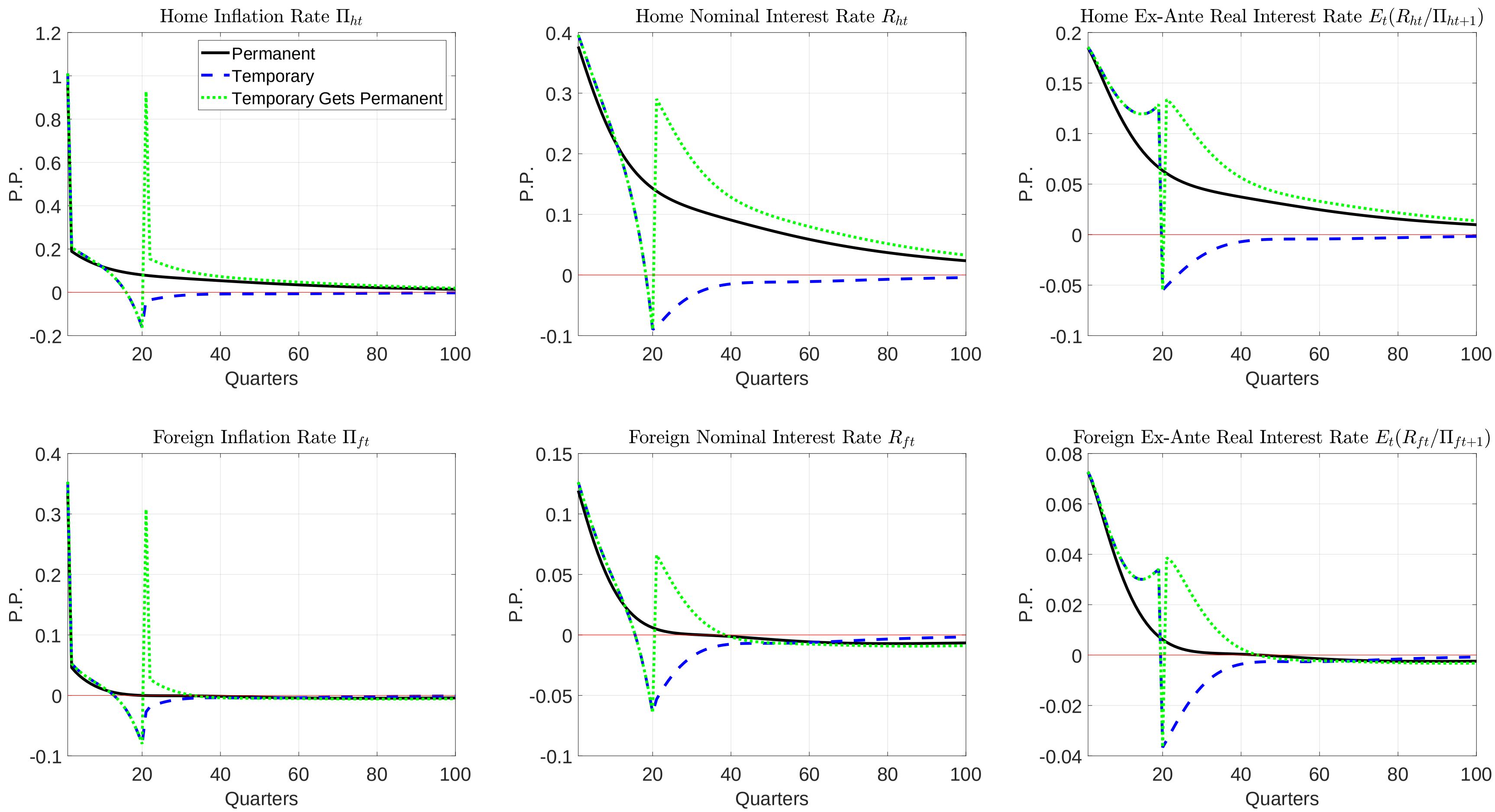

Figure 7: A Permanent versus a Temporary Corporate-Tax Cut in the Home Country from $\tau^c_{h0} = 25\%$ to $\tau^c_{h1} = 20\%$. The black solid lines depict the adjustment dynamics that are induced by a permanent corporate-tax cut. The home government announces and implements the permanent cut in quarter 1. The blue dashed lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut. The home government announces and implements the temporary cut in quarter 1 and reverses the cut, as promised, in quarter 21. The green dotted lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut which becomes permanent. The home government lowers the corporate tax in quarter 1, promises to reverse the tax cut in quarter 21 but surprises the market in quarter 21 by making the tax cut permanent.

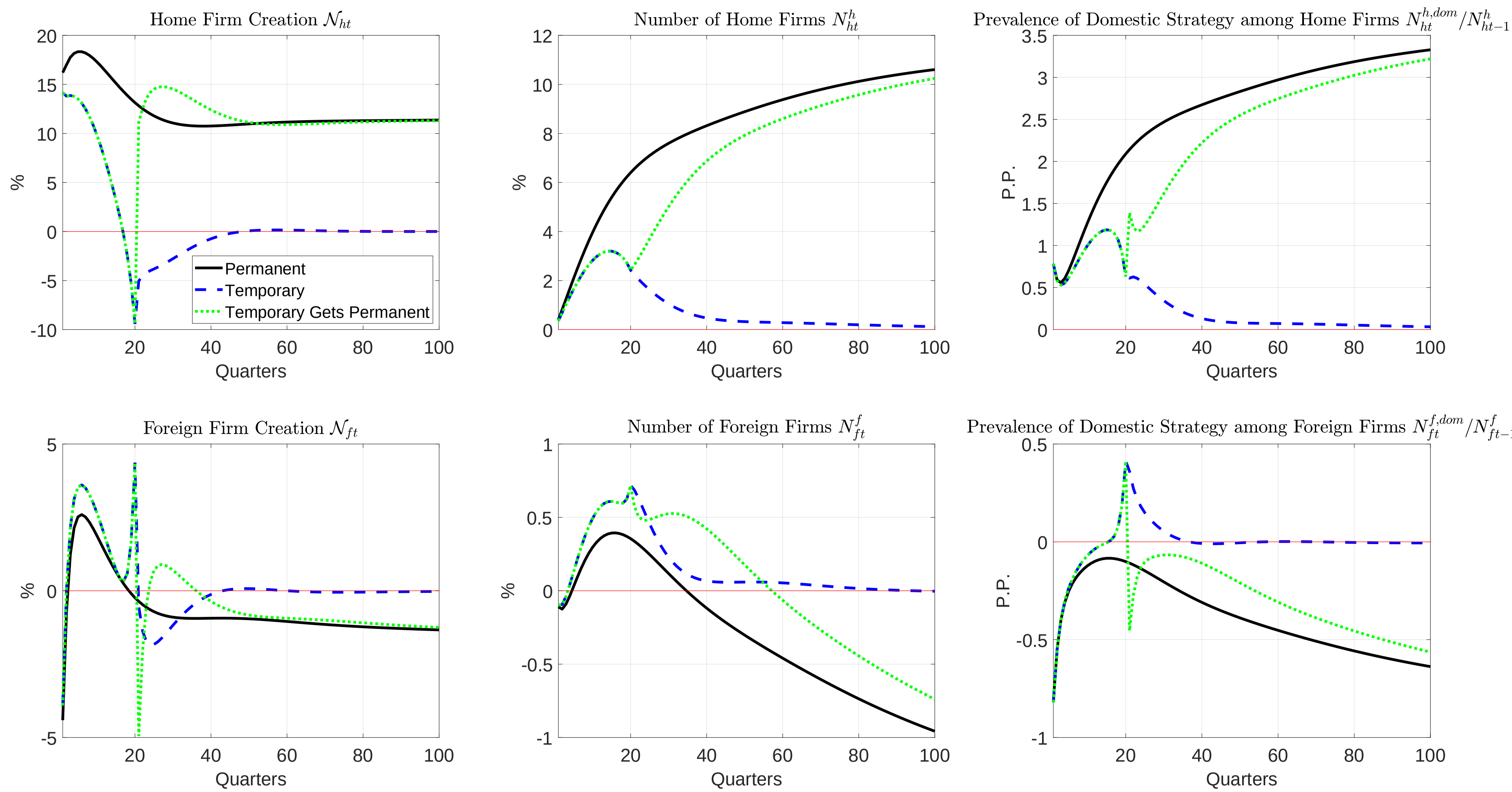

Figure 8: A Permanent versus a Temporary Corporate-Tax Cut in the Home Country from $\tau_{h0}^{c} = 25\%$ to $\tau_{h1}^{c} = 20\%$. The black solid lines depict the adjustment dynamics that are induced by a permanent corporate-tax cut. The home government announces and implements the permanent cut in quarter 1. The blue dashed lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut. The home government announces and implements the temporary cut in quarter 1 and reverses the cut, as promised, in quarter 21. The green dotted lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut which becomes permanent. The home government lowers the corporate tax in quarter 1, promises to reverse the tax cut in quarter 21 but surprises the market in quarter 21 by making the tax cut permanent.

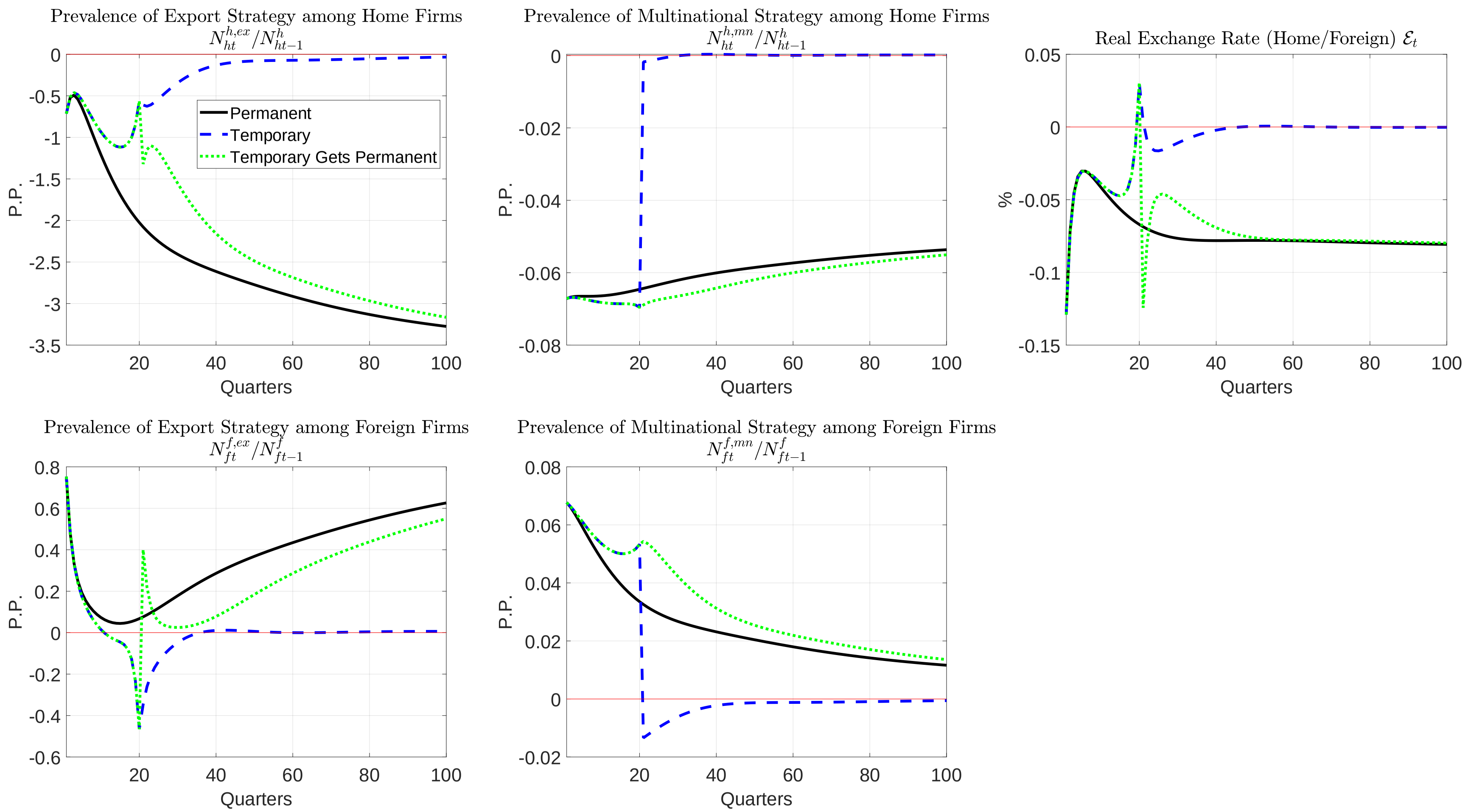

Figure 9: A Permanent versus a Temporary Corporate-Tax Cut in the Home Country from $\tau^c_{h0} = 25\%$ to $\tau^c_{h1} = 20\%$. The black solid lines depict the adjustment dynamics that are induced by a permanent corporate-tax cut. The home government announces and implements the permanent cut in quarter 1. The blue dashed lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut. The home government announces and implements the temporary cut in quarter 1 and reverses the cut, as promised, in quarter 21. The green dotted lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut which becomes permanent. The home government lowers the corporate tax in quarter 1, promises to reverse the tax cut in quarter 21 but surprises the market in quarter 21 by making the tax cut permanent.

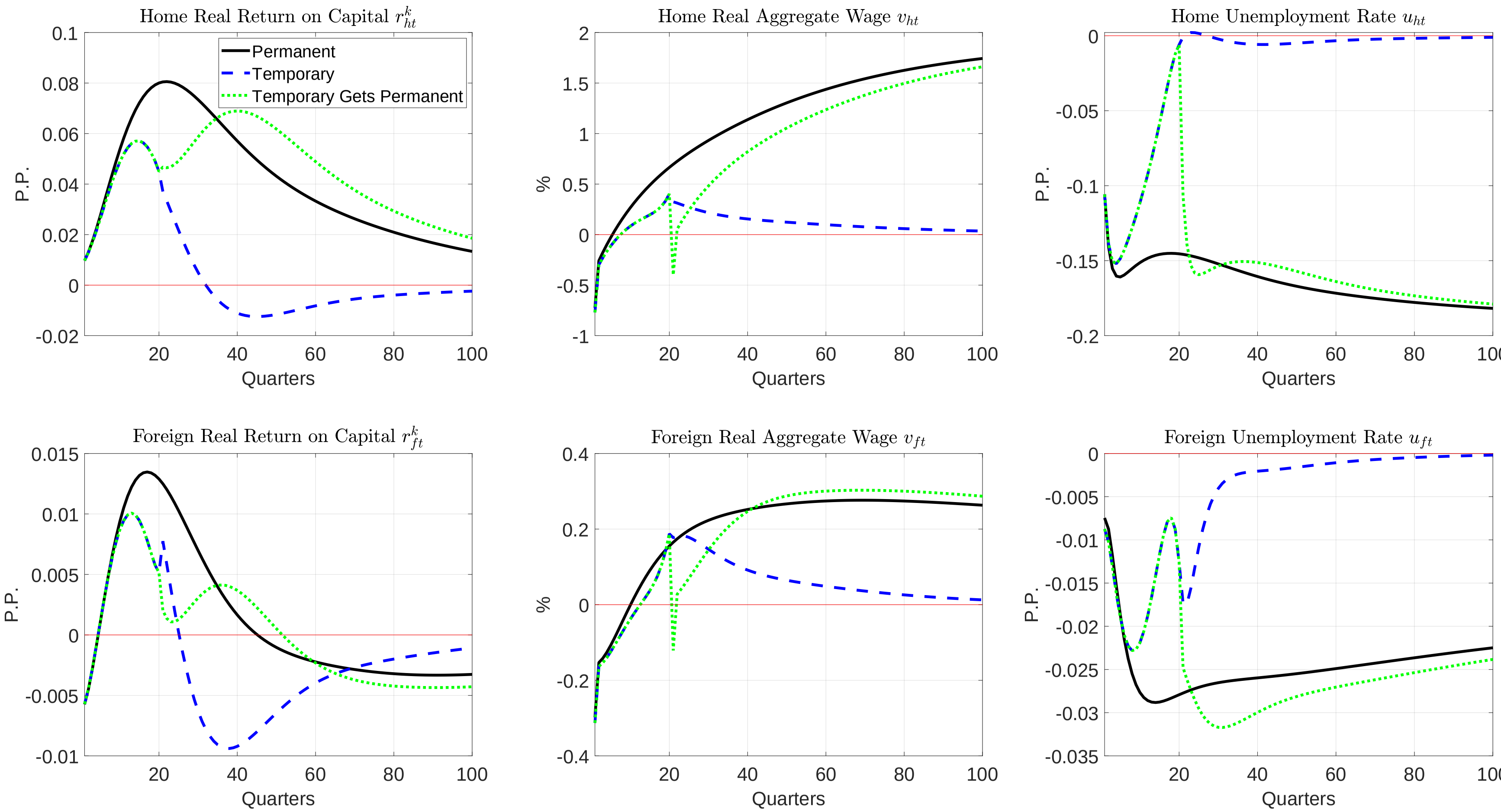

Figure 10: A Permanent versus a Temporary Corporate-Tax Cut in the Home Country from $\tau^c_{h0} = 25\%$ to $\tau^c_{h1} = 20\%$. The black solid lines depict the adjustment dynamics that are induced by a permanent corporate-tax cut. The home government announces and implements the permanent cut in quarter 1. The blue dashed lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut. The home government announces and implements the temporary cut in quarter 1 and reverses the cut, as promised, in quarter 21. The green dotted lines depict the adjustment dynamics that are induced by a temporary corporate-tax cut which becomes permanent. The home government lowers the corporate tax in quarter 1, promises to reverse the tax cut in quarter 21 but surprises the market in quarter 21 by making the tax cut permanent.

quarter from 25% to 20% and stays reduced for the rest of the simulation. Therefore, the differences in the adjustment dynamics between the first and the third scenario arise purely due to the differences in the fiscal communication. Because the first scenario reveals the permanent character of the tax cut already at the beginning of the simulation, the economy immediately starts converging toward the new steady state. In the third scenario, economic agents at first perceive, in line with the government's communication, the tax cut as temporary. The adjustment dynamics under the third scenario are hence during the first five years identical to the dynamics under the second scenario. In quarter 21, when the home government communicates that the corporate-tax cut becomes permanent, economic agents update their beliefs about the nature of the tax reform. The economy leaves the trajectory of the temporary reform and begins approaching the new long run.

One of the key predictions of the dynamic model is that output responds more strongly to a permanent than to a temporary corporate-tax cut. This result closely relates to the different firm dynamics under the permanent and the temporary scenario. Under the permanent cut, the expectation that the corporate tax rate stays reduced not only in the near but also in the distant future triggers massive firm creation $\mathcal{N}_{ht}$, which leads to a substantial increase in the number of home firms N_{ht}^{h}. The substantially increased number of home firms translates into a sizable expansion of the home output Y_{ht}. Under the temporary scenario, economic agents anticipate the reversal of the tax cut. The rise in firm creation is therefore smaller and short-lived. The number of new firms falls below the steady state already before the corporate-income tax rate returns back to 25%. In consequence, the number of home firms and so the home output expand only modestly.

Furthermore, the simulations point out that it takes several quarters for households to benefit from a corporate-tax cut in form of higher real wages and higher consumption. The delayed increase in the real wage v_{ht} and private consumption C_{ht} can be observed under the permanent as well as the temporary scenario. The reduction in the corporate-income tax initiates a stronger demand for labor services L_{ht}. Labor-service providers react by posting more vacancies PV_{ht}. As the labor-service providers intensify their hiring activity, their vacancy costs increase. The rise in the vacancy costs feeds into higher marginal costs and consequently into faster inflation Π_{ht}. Because wages feature nominal stickiness, the real aggregate wage declines before increasing in line with the overall economic expansion. During the first quarters after the corporate-tax cut, households respond to the declined real wage and the elevated real interest rate $E_t(R_{ht}/\Pi_{ht+1})$ by restricting their consumption. Later on, when the real wage climbs up and the real interest rate eases, the households decide to consume more.

The dynamics of the real wage and private consumption are mirrored in the behavior of the net exports NX_{ht}. A robust demand in the foreign country X_{ft} supports the home export EX_{ht}. Nevertheless, the increasing real wage, through which the home economy loses its competitiveness, curbs the export in later quarters. The import IM_{ht} closely follows the path of consumption. It weakens during the first quarters and strengthens afterward. All in all, the home net exports improve at shorter and worsen at longer time horizons.

Finally, the simulated permanent cut in the corporate tax rate reveals that the induced loss of tax revenue markedly differs across time. The revenue from non-lump-sum taxes TR_{ht} is much more depressed at shorter horizons than in the long run. As the economy adjusts to the corporate-tax cut, all tax bases start enlarging. The partial self-financing of the reform becomes gradually more visible.

6 Conclusion

The paper explored the effects of corporate taxation from a macroeconomic standpoint. The presented model enabled me to analyze the corporate tax in an open-economy setting. I examined how a change in the corporate tax rate affects the economy at home and abroad across different time horizons. Not only did the paper describe the reaction of the usual macroeconomic aggregates like GDP or investment, but it also showed, for instance, how international operations of firms respond to changes in corporate taxation. Moreover, I investigated the differences in the propagation of temporary and permanent corporate-income tax shocks. The paper expanded the macro perspective on corporate taxation; its findings could be useful for the assessment of future corporate-tax reforms.

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A Equilibrium Conditions

A.1 Home Country

The consumption of non-savers:

$$c_{ht}^{ns} = \frac{1}{1+\tau_{ht}^{va}} \left[\left(1-\tau_{ht}^{w}\right) v_{ht} \left(1-u_{ht}\right) + \tau_{ht}^{ub} u_{ht} - \tau_{ht}^{ls,ns} \right]$$

The shadow price of wealth:

$$\iota_{ht}^{c,s} = \frac{1}{1+\tau_{ht}^{va}} \left(c_{ht}^{s} - \chi_h c_{ht-1}^{s}\right)^{-\sigma_h} \exp\left(\epsilon_{ht}^{\beta}\right) - \frac{\beta_h \chi_h}{1+\tau_{ht}^{va}} E_t \left(c_{ht+1}^{s} - \chi_h c_{ht}^{s}\right)^{-\sigma_h} \exp\left(\epsilon_{ht+1}^{\beta}\right)$$

Euler equation for domestic bonds:

$$\iota_{ht}^{c,s} = \beta_h E_t \iota_{ht+1}^{c,s} \frac{R_{ht}}{\Pi_{ht+1}}$$

Euler equation for international bonds:

$$\iota_{ht}^{c,s} = \beta_h E_t \iota_{ht+1}^{c,s} \frac{R_t^*}{\Pi_{ft+1}} \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}$$

Household's decision on investment:

$$1=\frac{\iota_{ht}^{ks}}{\iota_{ht}^{cs}}\left[1-\frac{\Upsilon_h}{2}\left(\frac{i_{ht}^s}{i_{ht-1}^s}-1\right)^2-\Upsilon_h\left(\frac{i_{ht}^s}{i_{ht-1}^s}-1\right)\frac{i_{ht}^s}{i_{ht-1}^s}\right]\exp\left(\epsilon_{ht}^i\right)$$
$$+\beta_h\Upsilon_h E_t\frac{\iota_{ht+1}^{cs}}{\iota_{ht}^{cs}}\frac{\iota_{ht+1}^{ks}}{\iota_{ht+1}^{cs}}\left(\frac{i_{ht+1}^s}{i_{ht}^s}-1\right)\left(\frac{i_{ht+1}^s}{i_{ht}^s}\right)^2\exp\left(\epsilon_{ht+1}^i\right)$$

Household's decision on capital:

$$\frac{\iota_{ht}^{k,s}}{\iota_{ht}^{c,s}}=\beta_h E_t\frac{\iota_{ht+1}^{c,s}}{\iota_{ht}^{c,s}}\left[\left(1-\delta_h^k\right)\frac{\iota_{ht+1}^{k,s}}{\iota_{ht+1}^{c,s}}+r_{ht+1}^k-\tau_{ht+1}^k\left(r_{ht+1}^k-\delta_h^k\right)\right]$$

The accumulation of private capital:

$$k_{ht}^s=\left(1-\delta_h^k\right)k_{ht-1}^s+i_{ht}^s\left[1-\frac{\Upsilon_h}{2}\left(\frac{i_{ht}^s}{i_{ht-1}^s}-1\right)^2\right]\exp\left(\epsilon_{ht}^i\right)$$

Aggregate private consumption:

$$C_{ht}=\mu_h\mathcal{P}_h c_{ht}^{ns}+\left(1-\mu_h\right)\mathcal{P}_h c_{ht}^s$$

Aggregate households' investment:

$$I_{ht}=\left(1-\mu_h\right)\mathcal{P}_h i_{ht}^s$$

Aggregate private capital:

$$K_{ht}=\left(1-\mu_h\right)\mathcal{P}_h k_{ht}^s$$

Posted vacancies:

$$\left(PV_{ht}\right)^2=M_{ht}\frac{\mathcal{P}_h}{\Phi_h}\left(w_{ht}-\tilde{v}_{ht}\right)+\left(1-\delta_h^e\right)\beta_h E_t\frac{\iota_{ht+1}^{c,s}}{\iota_{ht}^{c,s}}\frac{M_{ht}}{M_{ht+1}}\left(PV_{ht+1}\right)^2$$

Matching function:

$$M_{ht}=A_{ht}^M\left(u_{ht-1}\mathcal{P}_h+\delta_h^e L_{ht-1}\right)^{\alpha_h^M}\left(PV_{ht}\right)^{1-\alpha_h^M}$$

Employment dynamics:

$$L_{ht}=\left(1-\delta_h^e\right)L_{ht-1}+M_{ht}$$

Unemployment rate:

$$u_{ht} = \frac{\mathcal{P}_h - L_{ht}}{\mathcal{P}_h}$$

Average wage:

$$\tilde{v}_{ht} = \xi_h \frac{(\Pi_{ht-1})^{\varphi_h} (\Pi_h)^{1-\varphi_h}}{\Pi_{ht}} \tilde{v}_{ht-1} + (1-\xi_h) v^*_{ht}$$

Average squared wage:

$$\tilde{v}^{sq}_{ht} = \xi_h \left[\frac{(\Pi_{ht-1})^{\varphi_h} (\Pi_h)^{1-\varphi_h}}{\Pi_{ht}} \right]^2 \tilde{v}^{sq}_{ht-1} + (1-\xi_h) (v^*_{ht})^2$$

Discounted sum of inflation rates:

$$DS^{\Pi}_{ht} = 1 + E_t (1-\delta^e_h) \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \xi_h \frac{(\Pi_{ht})^{\varphi_h} (\Pi_h)^{1-\varphi_h}}{\Pi_{ht+1}} DS^{\Pi}_{ht+1}$$

Discounted sum of inflation rates and wage taxes:

$$DS^{\Pi,\tau}_{ht} = 1 - \tau^w_{ht} + E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} (1-\delta^e_h) \xi_h \frac{(\Pi_{ht})^{\varphi_h} (\Pi_h)^{1-\varphi_h}}{\Pi_{ht+1}} DS^{\Pi,\tau}_{ht+1}$$

Discounted sum of prices for labor services:

$$DS^w_{ht} = w_{ht} + E_t (1-\delta^e_h) \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} DS^w_{ht+1}$$

Discounted sum of optimal wages:

$$DS^{v^*}_{ht} = E_t (1-\delta^e_h) \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} DS^{\Pi}_{ht+1} v^*_{ht+1} + E_t (1-\delta^e_h) \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} DS^{v^*}_{ht+1}$$

Aggregate wage:

$$\begin{aligned} v_{ht} L_{ht} = & \left[\xi_h \frac{(\Pi_{ht-1})^{\varphi_h} (\Pi_h)^{1-\varphi_h}}{\Pi_{ht}} v_{ht-1} + (1-\xi_h) v^*_{ht} \right] (1-\delta^e_h) L_{ht-1} \\ & + \left\{ \left[DS^w_{ht} - (1-\xi_h) DS^{v^*}_{ht} \right] \tilde{v}_{ht} - DS^{\Pi}_{ht} \tilde{v}^{sq}_{ht} \right\} \frac{\mathcal{P}_h}{\Phi_h} \left(\frac{M_{ht}}{PV_{ht}} \right)^2 \end{aligned}$$

The average wage of new matches:

$$\tilde{v}^M_{ht} = \left\{ \left[DS^w_{ht} - (1-\xi_h) DS^{v^*}_{ht} \right] \tilde{v}_{ht} - DS^{\Pi}_{ht} \tilde{v}^{sq}_{ht} \right\} \frac{\mathcal{P}_h}{\Phi_h} \frac{M_{ht}}{(PV_{ht})^2}$$

The average value of a worker at a new match:

$$
\begin{aligned}
VW^M_{ht} &= \tilde{v}^M_{ht} DS^{\Pi,\tau}_{ht} - E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \left(1-\delta^e_h\right) \xi_h \tilde{v}^M_{ht+1} DS^{\Pi,\tau}_{ht+1} \\
&+ E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \delta^e_h \left(1 - \frac{M_{ht+1}}{u_{ht}\mathcal{P}_h + \delta^e_h L_{ht}}\right) VU_{ht+1} + E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \left(1-\delta^e_h\right)\left(1-\xi_h\right) VW^*_{ht+1} \\
&+ E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \left[\delta^e_h \frac{M_{ht+1}}{u_{ht}\mathcal{P}_h + \delta^e_h L_{ht}} + \left(1-\delta^e_h\right)\xi_h\right] VW^M_{ht+1}
\end{aligned}
$$

The value of an unemployed:

$$
VU_{ht} = \tau^{ub}_{ht} + E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \left[\frac{M_{ht+1}}{u_{ht}\mathcal{P}_h + \delta^e_h L_{ht}} VW^M_{ht+1} + \left(1 - \frac{M_{ht+1}}{u_{ht}\mathcal{P}_h + \delta^e_h L_{ht}}\right) VU_{ht+1}\right]
$$

The value of a worker at the newly bargained wage:

$$
\begin{aligned}
VW^*_{ht} &= v^*_{ht} DS^{\Pi,\tau}_{ht} - E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \left(1-\delta^e_h\right) \xi_h v^*_{ht+1} DS^{\Pi,\tau}_{ht+1} + E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \left(1-\delta^e_h\right) VW^*_{ht+1} \\
&+ E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \delta^e_h \frac{M_{ht+1}}{u_{ht}\mathcal{P}_h + \delta^e_h L_{ht}} VW^M_{ht+1} + E_t \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} \delta^e_h \left(1 - \frac{M_{ht+1}}{u_{ht}\mathcal{P}_h + \delta^e_h L_{ht}}\right) VU_{ht+1}
\end{aligned}
$$

The value of a labor-service provider at the newly bargained wage:

$$
VF^*_{ht} = w_{ht} - v^*_{ht} DS^{\Pi}_{ht} + E_t \left(1-\delta^e_h\right) \xi_h \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} v^*_{ht+1} DS^{\Pi}_{ht+1} + E_t \left(1-\delta^e_h\right) \beta_h \frac{\iota^{c,s}_{ht+1}}{\iota^{c,s}_{ht}} VF^*_{ht+1}
$$

Nash bargaining:

$$
\iota_{ht} DS^{\Pi,\tau}_{ht} VF^*_{ht} = \left(1-\iota_{ht}\right) DS^{\Pi}_{ht} \left(VW^*_{ht} - VU_{ht}\right)
$$

Export cutoff:

$$
\begin{aligned}
\bar{a}^{ex}_{ht} = &\left[\frac{1-\tau^c_{ft}\left(1-\mathbb{1}_{ft}\right)}{1-\tau^c_{ft}} \frac{1-\tau^c_{ht}}{1-\tau^c_{ht}\left(1-\mathbb{1}_{ht}\right)} \frac{\theta_{ft}}{\mathcal{E}_t}\right]^{\frac{\theta_{ft}}{\theta_{ft}-1}} \left(\frac{\kappa^{ex}_{ht}}{X_{ft}}\right)^{\frac{1}{\theta_{ft}-1}} \frac{\eta_{ht}}{\theta_{ft}-1} \\
&\times \frac{\left(r^k_{ht}\right)^{\alpha_h} \left[\left(1+\tau^p_{ht}\right) w_{ht}\right]^{1-\alpha_h}}{\alpha_h^{\alpha_h} \left(1-\alpha_h\right)^{1-\alpha_h} a_{ht} \left(gk_{ht}\right)^{\gamma_h}}
\end{aligned}
$$

FDI cutoff:

$$
\begin{aligned}
\bar{a}_{ht}^{fdi} = & \left\{ \left(1-\tau_{ht}^{c}\right)\left(\kappa_{ht}^{fdi}-\kappa_{ht}^{ex}\right) - \frac{\left[\tau_{ht}^{c}\left(1-\mathbb{1}_{ht}\right)-\tau_{ft}^{c}\left(1-\mathbb{1}_{ft}\right)\right]^{2}}{2\left(1-\tau_{ht}^{c}\right)\Xi_{h}} \right\}^{\frac{1}{\theta_{ft}-1}} \\
& \times \left\{ \left(1-\tau_{ft}^{c}\right)\left\{\frac{\left(r_{ft}^{k}\right)^{\alpha_f}\left[\left(1+\tau_{ft}^{p}\right)w_{ft}\right]^{1-\alpha_f}}{\alpha_f^{\alpha_f}\left(1-\alpha_f\right)^{1-\alpha_f}a_{ft}\left(gk_{ft}\right)^{\gamma_f}}\right\}^{1-\theta_{ft}} \right. \\
& - \left(1-\tau_{ht}^{c}\right)\left[\frac{1-\tau_{ht}^{c}\left(1-\mathbb{1}_{ht}\right)}{1-\tau_{ht}^{c}}\frac{1-\tau_{ft}^{c}}{1-\tau_{ft}^{c}\left(1-\mathbb{1}_{ft}\right)}\right]^{\theta_{ft}} \\
& \left. \times \left\{\frac{\eta_{ht}}{\mathcal{E}_t}\frac{\left(r_{ht}^{k}\right)^{\alpha_h}\left[\left(1+\tau_{ht}^{p}\right)w_{ht}\right]^{1-\alpha_h}}{\alpha_h^{\alpha_h}\left(1-\alpha_h\right)^{1-\alpha_h}a_{ht}\left(gk_{ht}\right)^{\gamma_h}}\right\}^{1-\theta_{ft}} \right\}^{\frac{1}{1-\theta_{ft}}} \frac{\theta_{ft}}{\theta_{ft}-1}\left(\frac{\theta_{ft}}{\mathcal{E}_t X_{ft}}\right)^{\frac{1}{\theta_{ft}-1}}
\end{aligned}
$$

The number of home firms:

$$N_{ht}^{h} = \left(1-\delta_h\right)\left(N_{ht-1}^{h}+\mathcal{N}_{ht}\right)$$

The number of home firms that play the domestic strategy:

$$N_{ht}^{h,dom} = N_{ht-1}^{h}\left[1-\left(\frac{\bar{a}_{h}^{min}}{\bar{a}_{ht}^{ex}}\right)^{\zeta_h}\right]$$

The number of home firms that play the export strategy:

$$N_{ht}^{h,ex} = N_{ht-1}^{h}\left[\left(\frac{\bar{a}_{h}^{min}}{\bar{a}_{ht}^{ex}}\right)^{\zeta_h}-\left(\frac{\bar{a}_{h}^{min}}{\bar{a}_{ht}^{fdi}}\right)^{\zeta_h}\right]$$

The number of home firms that play the FDI strategy:

$$N_{ht}^{h,fdi} = N_{ht-1}^{h}\left(\frac{\bar{a}_{h}^{min}}{\bar{a}_{ht}^{fdi}}\right)^{\zeta_h}$$

The average productivity of home firms that serve the home country:

$$\tilde{a}_{ht}^{h} = \left(\frac{\zeta_h}{1+\zeta_h-\theta_{ht}}\right)^{\frac{1}{\theta_{ht}-1}}\bar{a}_{h}^{min}$$

The relative price of home firms that serve the home country:

$$\tilde{q}_{ht}^{h}=\frac{\theta_{ht}}{\theta_{ht}-1}\frac{\left(r_{ht}^{k}\right)^{\alpha_h}\left[\left(1+\tau_{ht}^{p}\right)w_{ht}\right]^{1-\alpha_h}}{\alpha_h^{\alpha_h}\left(1-\alpha_h\right)^{1-\alpha_h}a_{ht}\left(gk_{ht}\right)^{\gamma_h}\tilde{a}_{ht}^{h}}$$

The average productivity of foreign firms that serve the home country by the export strategy:

$$\tilde{a}_{ht}^{f,f}=\left[\frac{\zeta_f}{1+\zeta_f-\theta_{ht}}\frac{\left(\bar{a}_{ft}^{ex}\right)^{\theta_{ht}-\zeta_f-1}-\left(\bar{a}_{ft}^{fdi}\right)^{\theta_{ht}-\zeta_f-1}}{\left(\bar{a}_{ft}^{ex}\right)^{-\zeta_f}-\left(\bar{a}_{ft}^{fdi}\right)^{-\zeta_f}}\right]^{\frac{1}{\theta_{ht}-1}}$$

The relative price of foreign firms that serve the home country by the export strategy:

$$\tilde{q}_{ht}^{f,f}=\mathcal{E}_t\frac{1-\tau_{ft}^{c}}{1-\tau_{ft}^{c}\left(1-\mathbb{1}_{ft}\right)}\frac{\theta_{ht}}{\theta_{ht}-1}\eta_{ft}\frac{\left(r_{ft}^{k}\right)^{\alpha_f}\left[\left(1+\tau_{ft}^{p}\right)w_{ft}\right]^{1-\alpha_f}}{\alpha_f^{\alpha_f}\left(1-\alpha_f\right)^{1-\alpha_f}a_{ft}\left(gk_{ft}\right)^{\gamma_f}\tilde{a}_{ht}^{f,f}}$$

The average productivity of foreign firms that serve the home country by the FDI strategy:

$$\tilde{a}_{ht}^{f,h}=\left(\frac{\zeta_f}{1+\zeta_f-\theta_{ht}}\right)^{\frac{1}{\theta_{ht}-1}}\bar{a}_{ft}^{fdi}$$

The relative price of foreign firms that serve the home country by the FDI strategy:

$$\tilde{q}_{ht}^{f,h}=\frac{\theta_{ht}}{\theta_{ht}-1}\frac{\left(r_{ht}^{k}\right)^{\alpha_h}\left[\left(1+\tau_{ht}^{p}\right)w_{ht}\right]^{1-\alpha_h}}{\alpha_h^{\alpha_h}\left(1-\alpha_h\right)^{1-\alpha_h}a_{ht}\left(gk_{ht}\right)^{\gamma_h}\tilde{a}_{ht}^{f,h}}$$

Aggregate price level:

$$1=N_{ht-1}^{h}\left(\tilde{q}_{ht}^{h}\right)^{1-\theta_{ht}}+N_{ft}^{f,ex}\left[\left(1+\mathbb{1}_{ht}\frac{\tau_{ht}^{c}}{1-\tau_{ht}^{c}}\right)\tilde{q}_{ht}^{f,f}\right]^{1-\theta_{ht}}+N_{ft}^{f,fdi}\left(\tilde{q}_{ht}^{f,h}\right)^{1-\theta_{ht}}$$

Profit shifting of an FDI firm:

$$\lambda_{ht}=\frac{\tau_{ht}^{c}\left(1-\mathbb{1}_{ht}\right)-\tau_{ft}^{c}\left(1-\mathbb{1}_{ft}\right)}{\left(1-\tau_{ht}^{c}\right)\Xi_h}$$

The average after-tax profit of home firms from serving the domestic market:

$$\tilde{\Delta}_{ht}^{dom}=\frac{1-\tau_{ht}^{c}}{\theta_{ht}}\left(\tilde{q}_{ht}^{h}\right)^{1-\theta_{ht}}X_{ht}$$

The average after-tax profit of home firms from the export activity:

$$\tilde{\Delta}_{ht}^{ex} = \mathcal{E}_t \frac{1 - \tau_{ht}^c (1 - \mathbb{1}_{ht})}{\theta_{ft}} \left[\frac{1 - \tau_{ft}^c (1 - \mathbb{1}_{ft})}{1 - \tau_{ft}^c} \right]^{-\theta_{ft}} \left(\tilde{q}_{ft}^{h,h} \right)^{1-\theta_{ft}} X_{ft} - (1 - \tau_{ht}^c) \kappa_{ht}^{ex}$$

The average after-tax profit of home firms from the FDI activity:

$$\tilde{\Delta}_{ht}^{fdi} = \mathcal{E}_t \frac{1 - \tau_{ft}^c}{\theta_{ft}} \left(\tilde{q}_{ft}^{h,f} \right)^{1-\theta_{ft}} X_{ft} - (1 - \tau_{ht}^c) \kappa_{ht}^{fdi} + \frac{\left[\tau_{ht}^c (1 - \mathbb{1}_{ht}) - \tau_{ft}^c (1 - \mathbb{1}_{ft}) \right]^2}{2 (1 - \tau_{ht}^c) \Xi_h}$$

The average after-tax profit of home firms:

$$\tilde{d}_{ht} = \tilde{\Delta}_{ht}^{dom} + \left[\left(\frac{\bar{a}_h^{min}}{\bar{a}_{ht}^{ex}} \right)^{\zeta_h} - \left(\frac{\bar{a}_h^{min}}{\bar{a}_{ht}^{fdi}} \right)^{\zeta_h} \right] \tilde{\Delta}_{ht}^{ex} + \left(\frac{\bar{a}_h^{min}}{\bar{a}_{ht}^{fdi}} \right)^{\zeta_h} \tilde{\Delta}_{ht}^{fdi}$$

Expected after-tax profits of a potential entrant:

$$D_{ht} = E_t (1 - \delta_h) \beta_h \frac{\iota_{ht+1}^{c,s}}{\iota_{ht}^{c,s}} \left(\tilde{d}_{ht+1} + D_{ht+1} \right)$$

Free-entry condition:

$$\kappa_{ht}^{\mathcal{N}} = D_{ht}$$

Capital demand:

$$\begin{aligned} K_{ht-1} = \frac{\alpha_h}{r_{ht}^k} \Bigg\{ & \frac{\theta_{ht} - 1}{\theta_{ht}} X_{ht} \left[N_{ht-1}^h \left(\tilde{q}_{ht}^h \right)^{1-\theta_{ht}} + N_{ft}^{f,fdi} \left(\tilde{q}_{ht}^{f,h} \right)^{1-\theta_{ht}} \right] \\ & + \mathcal{E}_t \frac{\theta_{ft} - 1}{\theta_{ft}} X_{ft} \frac{1 - \tau_{ht}^c (1 - \mathbb{1}_{ht})}{1 - \tau_{ht}^c} \left(1 + \mathbb{1}_{ft} \frac{\tau_{ft}^c}{1 - \tau_{ft}^c} \right)^{-\theta_{ft}} N_{ht}^{h,ex} \left(\tilde{q}_{ft}^{h,h} \right)^{1-\theta_{ft}} \Bigg\} \end{aligned}$$

Demand for labor services:

$$\begin{aligned} L_{ht} = \frac{1 - \alpha_h}{(1 + \tau_{ht}^p) w_{ht}} \Bigg\{ & \frac{\theta_{ht} - 1}{\theta_{ht}} X_{ht} \left[N_{ht-1}^h \left(\tilde{q}_{ht}^h \right)^{1-\theta_{ht}} + N_{ft}^{f,fdi} \left(\tilde{q}_{ht}^{f,h} \right)^{1-\theta_{ht}} \right] \\ & + \mathcal{E}_t \frac{\theta_{ft} - 1}{\theta_{ft}} X_{ft} \frac{1 - \tau_{ht}^c (1 - \mathbb{1}_{ht})}{1 - \tau_{ht}^c} \left(1 + \mathbb{1}_{ft} \frac{\tau_{ft}^c}{1 - \tau_{ft}^c} \right)^{-\theta_{ft}} N_{ht}^{h,ex} \left(\tilde{q}_{ft}^{h,h} \right)^{1-\theta_{ft}} \Bigg\} \end{aligned}$$

Market clearing by the bundler:

$$X_{ht} = C_{ht} + I_{ht} + \kappa_{ht}^{\mathcal{N}} \mathcal{N}_{ht} + \kappa_{ht}^{ex} N_{ht}^{h,ex} + \kappa_{ht}^{fdi} N_{ht}^{h,fdi} + GC_{ht} + GI_{ht}$$

Government capital:

$$GK_{ht} = \left(1 - \delta_h^{GK}\right) GK_{ht-1} + GI_{ht}$$

Government capital per firm:

$$gk_{ht} = \frac{GK_{ht-1}}{N_{ht-1}^h + N_{ft}^{f,fdi}}$$

Revenue from the corporate-income tax:

$$\begin{aligned}
TR_{ht}^c = {} & \mathbb{1}_{ht}\frac{\tau_{ht}^c}{1-\tau_{ht}^c}\left(1 + \mathbb{1}_{ht}\frac{\tau_{ht}^c}{1-\tau_{ht}^c}\right)^{-\theta_{ht}} X_{ht} N_{ft}^{f,ex}\left(\tilde{q}_{ht}^{f,f}\right)^{1-\theta_{ht}} + \tau_{ht}^c \frac{1}{\theta_{ht}} X_{ht} N_{ht-1}^h \left(\tilde{q}_{ht}^h\right)^{1-\theta_{ht}} \\
& + \tau_{ht}^c \mathcal{E}_t \left(1 + \mathbb{1}_{ft}\frac{\tau_{ft}^c}{1-\tau_{ft}^c}\right)^{-\theta_{ft}} X_{ft} \frac{1 - \tau_{ht}^c\left(1 - \mathbb{1}_{ht}\right) - \mathbb{1}_{ht}\theta_{ft}}{\theta_{ft}\left(1-\tau_{ht}^c\right)} N_{ht}^{h,ex}\left(\tilde{q}_{ft}^{h,h}\right)^{1-\theta_{ft}} \\
& + \tau_{ht}^c X_{ht}\frac{1}{\theta_{ht}} N_{ft}^{f,fdi}\left(\tilde{q}_{ht}^{f,h}\right)^{1-\theta_{ht}} - \tau_{ht}^c \kappa_{ht}^{ex} N_{ht}^{h,ex} - \tau_{ht}^c \kappa_{ht}^{fdi} N_{ht}^{h,fdi} - \tau_{ht}^c \frac{\Xi_h}{2}\left(\lambda_{ht}\right)^2 N_{ht}^{h,fdi} \\
& - \tau_{ht}^c\left(1 - \mathbb{1}_{ht}\right)\lambda_{ht} N_{ht}^{h,fdi} + \tau_{ht}^c \mathcal{E}_t \lambda_{ft}\left(1 - \mathbb{1}_{ht}\right) N_{ft}^{f,fdi}
\end{aligned}$$

Revenue from non-lump-sum taxes:

$$TR_{ht} = \tau_{ht}^{va} C_{ht} + \tau_{ht}^w v_{ht} L_{ht} + \tau_{ht}^k \left(r_{ht}^k - \delta_h^k\right) K_{ht-1} + \tau_{ht}^p w_{ht} L_{ht} + TR_{ht}^c$$

Fiscal budget:

$$GC_{ht} + GI_{ht} + \tau_{ht}^{ub} u_{ht} \mathcal{P}_h = TR_{ht} + \tau_{ht}^{ls,ns}\mu_h \mathcal{P}_h + \tau_{ht}^{ls,s}\left(1-\mu_h\right)\mathcal{P}_h + b_{ht} - \frac{R_{ht-1}}{\Pi_{ht}} b_{ht-1}$$

Monetary policy:

$$\frac{R_{ht}}{R_h} = \left(\frac{R_{ht-1}}{R_h}\right)^{\phi_h^R}\left[\left(\frac{\Pi_{ht}}{\Pi_h}\right)^{\phi_h^\Pi}\left(\frac{Y_{ht}}{Y_{ht-1}}\right)^{\phi_h^Y}\right]^{1-\phi_h^R} \exp\left(\epsilon_{ht}^R\right)$$

Output:

$$Y_{ht} = \left[N_{ht-1}^h\left(\tilde{q}_{ht}^h\right)^{1-\theta_{ht}} + N_{ft}^{f,fdi}\left(\tilde{q}_{ht}^{f,h}\right)^{1-\theta_{ht}}\right] X_{ht} + \mathcal{E}_t\left(1 + \mathbb{1}_{ft}\frac{\tau_{ft}^c}{1-\tau_{ft}^c}\right)^{-\theta_{ft}} N_{ht}^{h,ex}\left(\tilde{q}_{ft}^{h,h}\right)^{1-\theta_{ft}} X_{ft}$$

The broad definition of private investment:

$$\mathcal{I}_{ht} = I_{ht} + \kappa_{ht}^{\mathcal{N}}\mathcal{N}_{ht} + \kappa_{ht}^{ex} N_{ht}^{h,ex} + \kappa_{ht}^{fdi} N_{ht}^{h,fdi}$$

Export:

$$EX_{ht} = \mathcal{E}_t \left(1 + \mathbb{1}_{ft} \frac{\tau^c_{ft}}{1 - \tau^c_{ft}}\right)^{-\theta_{ft}} \left(\tilde{q}^{h,h}_{ft}\right)^{1-\theta_{ft}} N^{h,ex}_{ht} X_{ft}$$

Import:

$$IM_{ht} = \mathcal{E}_t EX_{ft}$$

Net exports:

$$NX_{ht} = EX_{ht} - IM_{ht}$$

Aggregate profit shifting:

$$PS_{ht} = \lambda_{ht} N^{h,fdi}_{ht}$$

A.2 Foreign Country

The consumption of non-savers:

$$c^{ns}_{ft} = \frac{1}{1 + \tau^{va}_{ft}} \left[\left(1 - \tau^w_{ft}\right) v_{ft} \left(1 - u_{ft}\right) + \tau^{ub}_{ft} u_{ft} - \tau^{ls,ns}_{ft}\right]$$

The shadow price of wealth:

$$\iota^{c,s}_{ft} = \frac{1}{1 + \tau^{va}_{ft}} \left(c^s_{ft} - \chi_f c^s_{ft-1}\right)^{-\sigma_f} \exp\left(\epsilon^\beta_{ft}\right) - \frac{\beta_f \chi_f}{1 + \tau^{va}_{ft}} E_t \left(c^s_{ft+1} - \chi_f c^s_{ft}\right)^{-\sigma_f} \exp\left(\epsilon^\beta_{ft+1}\right)$$

Euler equation for domestic bonds:

$$\iota^{c,s}_{ft} = \beta_f E_t \iota^{c,s}_{ft+1} \frac{R_{ft}}{\Pi_{ft+1}}$$

Household's decision on investment:

$$\begin{aligned} 1 = {} & \frac{\iota^{ks}_{ft}}{\iota^{cs}_{ft}} \left[1 - \frac{\Upsilon_f}{2} \left(\frac{i^s_{ft}}{i^s_{ft-1}} - 1\right)^2 - \Upsilon_f \left(\frac{i^s_{ft}}{i^s_{ft-1}} - 1\right) \frac{i^s_{ft}}{i^s_{ft-1}}\right] \exp\left(\epsilon^i_{ft}\right) \\ & + \beta_f \Upsilon_f E_t \frac{\iota^{cs}_{ft+1}}{\iota^{cs}_{ft}} \frac{\iota^{ks}_{ft+1}}{\iota^{cs}_{ft+1}} \left(\frac{i^s_{ft+1}}{i^s_{ft}} - 1\right) \left(\frac{i^s_{ft+1}}{i^s_{ft}}\right)^2 \exp\left(\epsilon^i_{ft+1}\right) \end{aligned}$$

Household's decision on capital:

$$\frac{\iota^{k,s}_{ft}}{\iota^{c,s}_{ft}} = \beta_f E_t \frac{\iota^{c,s}_{ft+1}}{\iota^{c,s}_{ft}} \left[\left(1 - \delta^k_f\right) \frac{\iota^{k,s}_{ft+1}}{\iota^{c,s}_{ft+1}} + r^k_{ft+1} - \tau^k_{ft+1} \left(r^k_{ft+1} - \delta^k_f\right)\right]$$

The accumulation of private capital:

$$k_{ft}^{s} = \left(1 - \delta_{f}^{k}\right) k_{ft-1}^{s} + i_{ft}^{s} \left[1 - \frac{\Upsilon_{f}}{2}\left(\frac{i_{ft}^{s}}{i_{ft-1}^{s}} - 1\right)^{2}\right] \exp\left(\epsilon_{ft}^{i}\right)$$

Aggregate private consumption:

$$C_{ft} = \mu_{f}\mathcal{P}_{f}c_{ft}^{ns} + (1 - \mu_{f})\,\mathcal{P}_{f}c_{ft}^{s}$$

Aggregate households' investment:

$$I_{ft} = (1 - \mu_{f})\,\mathcal{P}_{f}i_{ft}^{s}$$

Aggregate private capital:

$$K_{ft} = (1 - \mu_{f})\,\mathcal{P}_{f}k_{ft}^{s}$$

Posted vacancies:

$$(PV_{ft})^{2} = M_{ft}\frac{\mathcal{P}_{f}}{\Phi_{f}}\left(w_{ft} - \tilde{v}_{ft}\right) + \left(1 - \delta_{f}^{e}\right)\beta_{f}E_{t}\frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}}\frac{M_{ft}}{M_{ft+1}}\left(PV_{ft+1}\right)^{2}$$

Matching function:

$$M_{ft} = A_{ft}^{M}\left(u_{ft-1}\mathcal{P}_{f} + \delta_{f}^{e}L_{ft-1}\right)^{\alpha_{f}^{M}}\left(PV_{ft}\right)^{1-\alpha_{f}^{M}}$$

Employment dynamics:

$$L_{ft} = \left(1 - \delta_{f}^{e}\right)L_{ft-1} + M_{ft}$$

Unemployment rate:

$$u_{ft} = \frac{\mathcal{P}_{f} - L_{ft}}{\mathcal{P}_{f}}$$

Average wage:

$$\tilde{v}_{ft} = \xi_{f}\frac{\left(\Pi_{ft-1}\right)^{\varphi_{f}}\left(\Pi_{f}\right)^{1-\varphi_{f}}}{\Pi_{ft}}\tilde{v}_{ft-1} + (1 - \xi_{f})\,v_{ft}^{*}$$

Average squared wage:

$$\tilde{v}_{ft}^{sq} = \xi_{f}\left[\frac{\left(\Pi_{ft-1}\right)^{\varphi_{f}}\left(\Pi_{f}\right)^{1-\varphi_{f}}}{\Pi_{ft}}\right]^{2}\tilde{v}_{ft-1}^{sq} + (1 - \xi_{f})\left(v_{ft}^{*}\right)^{2}$$

Discounted sum of inflation rates:

$$DS_{ft}^{\Pi} = 1 + E_t \left(1 - \delta_f^e\right) \beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \xi_f \frac{\left(\Pi_{ft}\right)^{\varphi_f} \left(\Pi_f\right)^{1-\varphi_f}}{\Pi_{ft+1}} DS_{ft+1}^{\Pi}$$

Discounted sum of inflation rates and wage taxes:

$$DS_{ft}^{\Pi,\tau} = 1 - \tau_{ft}^w + E_t \beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \left(1 - \delta_f^e\right) \xi_f \frac{\left(\Pi_{ft}\right)^{\varphi_f} \left(\Pi_f\right)^{1-\varphi_f}}{\Pi_{ft+1}} DS_{ft+1}^{\Pi,\tau}$$

Discounted sum of prices for labor services:

$$DS_{ft}^{w} = w_{ft} + E_t \left(1 - \delta_f^e\right) \beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} DS_{ft+1}^{w}$$

Discounted sum of optimal wages:

$$DS_{ft}^{v^*} = E_t \left(1 - \delta_f^e\right) \beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} DS_{ft+1}^{\Pi} v_{ft+1}^* + E_t \left(1 - \delta_f^e\right) \beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} DS_{ft+1}^{v^*}$$

Aggregate wage:

$$\begin{aligned} v_{ft} L_{ft} = {} & \left[\xi_f \frac{\left(\Pi_{ft-1}\right)^{\varphi_f} \left(\Pi_f\right)^{1-\varphi_f}}{\Pi_{ft}} v_{ft-1} + \left(1 - \xi_f\right) v_{ft}^* \right] \left(1 - \delta_f^e\right) L_{ft-1} \\ & + \left\{ \left[DS_{ft}^{w} - \left(1 - \xi_f\right) DS_{ft}^{v^*} \right] \tilde{v}_{ft} - DS_{ft}^{\Pi} \tilde{v}_{ft}^{sq} \right\} \frac{\mathcal{P}_f}{\Phi_f} \left(\frac{M_{ft}}{PV_{ft}} \right)^2 \end{aligned}$$

The average wage of new matches:

$$\tilde{v}_{ft}^{M} = \left\{ \left[DS_{ft}^{w} - \left(1 - \xi_f\right) DS_{ft}^{v^*} \right] \tilde{v}_{ft} - DS_{ft}^{\Pi} \tilde{v}_{ft}^{sq} \right\} \frac{\mathcal{P}_f}{\Phi_f} \frac{M_{ft}}{\left(PV_{ft}\right)^2}$$

The average value of a worker at a new match:

$$\begin{aligned} VW_{ft}^{M} = {} & \tilde{v}_{ft}^{M} DS_{ft}^{\Pi,\tau} - E_t \beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \left(1 - \delta_f^e\right) \xi_f \tilde{v}_{ft+1}^{M} DS_{ft+1}^{\Pi,\tau} \\ & + E_t \beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \delta_f^e \left(1 - \frac{M_{ft+1}}{u_{ft} \mathcal{P}_f + \delta_f^e L_{ft}} \right) VU_{ft+1} + E_t \beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \left(1 - \delta_f^e\right) \left(1 - \xi_f\right) VW_{ft+1}^* \\ & + E_t \beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \left[\delta_f^e \frac{M_{ft+1}}{u_{ft} \mathcal{P}_f + \delta_f^e L_{ft}} + \left(1 - \delta_f^e\right) \xi_f \right] VW_{ft+1}^{M} \end{aligned}$$

The value of an unemployed:

$$VU_{ft} = \tau_{ft}^{ub} + E_t\beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \left[\frac{M_{ft+1}}{u_{ft}\mathcal{P}_f + \delta_f^e L_{ft}} VW_{ft+1}^M + \left(1 - \frac{M_{ft+1}}{u_{ft}\mathcal{P}_f + \delta_f^e L_{ft}}\right) VU_{ft+1}\right]$$

The value of a worker at the newly bargained wage:

$$\begin{aligned} VW_{ft}^* = {} & v_{ft}^* DS_{ft}^{\Pi,\tau} - E_t\beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \left(1-\delta_f^e\right) \xi_f v_{ft+1}^* DS_{ft+1}^{\Pi,\tau} + E_t\beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \left(1-\delta_f^e\right) VW_{ft+1}^* \\ & + E_t\beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \delta_f^e \frac{M_{ft+1}}{u_{ft}\mathcal{P}_f + \delta_f^e L_{ft}} VW_{ft+1}^M + E_t\beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} \delta_f^e \left(1 - \frac{M_{ft+1}}{u_{ft}\mathcal{P}_f + \delta_f^e L_{ft}}\right) VU_{ft+1} \end{aligned}$$

The value of a labor-service provider at the newly bargained wage:

$$VF_{ft}^* = w_{ft} - v_{ft}^* DS_{ft}^{\Pi} + E_t\left(1-\delta_f^e\right)\xi_f\beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} v_{ft+1}^* DS_{ft+1}^{\Pi} + E_t\left(1-\delta_f^e\right)\beta_f \frac{\iota_{ft+1}^{c,s}}{\iota_{ft}^{c,s}} VF_{ft+1}^*$$

Nash bargaining:

$$\iota_{ft} DS_{ft}^{\Pi,\tau} VF_{ft}^* = \left(1-\iota_{ft}\right) DS_{ft}^{\Pi} \left(VW_{ft}^* - VU_{ft}\right)$$

Export cutoff:

$$\begin{aligned} \bar{a}_{ft}^{ex} = {} & \left[\frac{1-\tau_{ht}^c\left(1-\mathbb{1}_{ht}\right)}{1-\tau_{ht}^c} \frac{1-\tau_{ft}^c}{1-\tau_{ft}^c\left(1-\mathbb{1}_{ft}\right)} \theta_{ht}\mathcal{E}_t\right]^{\frac{\theta_{ht}}{\theta_{ht}-1}} \left(\frac{\kappa_{ft}^{ex}}{X_{ht}}\right)^{\frac{1}{\theta_{ht}-1}} \frac{\eta_{ft}}{\theta_{ht}-1} \\ & \times \frac{\left(r_{ft}^k\right)^{\alpha_f}\left[\left(1+\tau_{ft}^p\right)w_{ft}\right]^{1-\alpha_f}}{\alpha_f^{\alpha_f}\left(1-\alpha_f\right)^{1-\alpha_f} a_{ft}\left(gk_{ft}\right)^{\gamma_f}} \end{aligned}$$

FDI cutoff:

$$\begin{aligned} \bar{a}_{ft}^{fdi} = {} & \left\{\left(1-\tau_{ft}^c\right)\left(\kappa_{ft}^{fdi} - \kappa_{ft}^{ex}\right) - \frac{\left[\tau_{ft}^c\left(1-\mathbb{1}_{ft}\right) - \tau_{ht}^c\left(1-\mathbb{1}_{ht}\right)\right]^2}{2\left(1-\tau_{ft}^c\right)\Xi_f}\right\}^{\frac{1}{\theta_{ht}-1}} \\ & \times \left\{\left(1-\tau_{ht}^c\right)\left\{\frac{\left(r_{ht}^k\right)^{\alpha_h}\left[\left(1+\tau_{ht}^p\right)w_{ht}\right]^{1-\alpha_h}}{\alpha_h^{\alpha_h}\left(1-\alpha_h\right)^{1-\alpha_h} a_{ht}\left(gk_{ht}\right)^{\gamma_h}}\right\}^{1-\theta_{ht}}\right. \\ & - \left(1-\tau_{ft}^c\right)\left[\frac{1-\tau_{ft}^c\left(1-\mathbb{1}_{ft}\right)}{1-\tau_{ft}^c} \frac{1-\tau_{ht}^c}{1-\tau_{ht}^c\left(1-\mathbb{1}_{ht}\right)}\right]^{\theta_{ht}} \\ & \left.\times\left\{\mathcal{E}_t\eta_{ft} \frac{\left(r_{ft}^k\right)^{\alpha_f}\left[\left(1+\tau_{ft}^p\right)w_{ft}\right]^{1-\alpha_f}}{\alpha_f^{\alpha_f}\left(1-\alpha_f\right)^{1-\alpha_f} a_{ft}\left(gk_{ft}\right)^{\gamma_f}}\right\}^{1-\theta_{ht}}\right\}^{\frac{1}{1-\theta_{ht}}} \frac{\theta_{ht}}{\theta_{ht}-1}\left(\mathcal{E}_t\frac{\theta_{ht}}{X_{ht}}\right)^{\frac{1}{\theta_{ht}-1}} \end{aligned}$$

The number of foreign firms:

$$N_{ft}^{f} = (1 - \delta_f)\left(N_{ft-1}^{f} + \mathcal{N}_{ft}\right)$$

The number of foreign firms that play the domestic strategy:

$$N_{ft}^{f,dom} = N_{ft-1}^{f}\left[1 - \left(\frac{\bar{a}_f^{min}}{\bar{a}_{ft}^{ex}}\right)^{\zeta_f}\right]$$

The number of foreign firms that play the export strategy:

$$N_{ft}^{f,ex} = N_{ft-1}^{f}\left[\left(\frac{\bar{a}_f^{min}}{\bar{a}_{ft}^{ex}}\right)^{\zeta_f} - \left(\frac{\bar{a}_f^{min}}{\bar{a}_{ft}^{fdi}}\right)^{\zeta_f}\right]$$

The number of foreign firms that play the FDI strategy:

$$N_{ft}^{f,fdi} = N_{ft-1}^{f}\left(\frac{\bar{a}_f^{min}}{\bar{a}_{ft}^{fdi}}\right)^{\zeta_f}$$

The average productivity of foreign firms that serve the foreign country:

$$\tilde{a}_{ft}^{f} = \left(\frac{\zeta_f}{1 + \zeta_f - \theta_{ft}}\right)^{\frac{1}{\theta_{ft} - 1}} \bar{a}_f^{min}$$

The relative price of foreign firms that serve the foreign country:

$$\tilde{q}_{ft}^{f} = \frac{\theta_{ft}}{\theta_{ft} - 1}\frac{\left(r_{ft}^{k}\right)^{\alpha_f}\left[\left(1 + \tau_{ft}^{p}\right) w_{ft}\right]^{1-\alpha_f}}{\alpha_f^{\alpha_f}\left(1 - \alpha_f\right)^{1-\alpha_f} a_{ft}\left(gk_{ft}\right)^{\gamma_f}\tilde{a}_{ft}^{f}}$$

The average productivity of home firms that serve the foreign country by the export strategy:

$$\tilde{a}_{ft}^{h,h} = \left[\frac{\zeta_h}{1 + \zeta_h - \theta_{ft}}\frac{\left(\bar{a}_{ht}^{ex}\right)^{\theta_{ft}-\zeta_h-1} - \left(\bar{a}_{ht}^{fdi}\right)^{\theta_{ft}-\zeta_h-1}}{\left(\bar{a}_{ht}^{ex}\right)^{-\zeta_h} - \left(\bar{a}_{ht}^{fdi}\right)^{-\zeta_h}}\right]^{\frac{1}{\theta_{ft}-1}}$$

The relative price of home firms that serve the foreign country by the export strategy:

$$\tilde{q}_{ft}^{h,h} = \frac{1}{\mathcal{E}_t}\frac{1 - \tau_{ht}^{c}}{1 - \tau_{ht}^{c}\left(1 - \mathbb{1}_{ht}\right)}\frac{\theta_{ft}}{\theta_{ft} - 1}\eta_{ht}\frac{\left(r_{ht}^{k}\right)^{\alpha_h}\left[\left(1 + \tau_{ht}^{p}\right) w_{ht}\right]^{1-\alpha_h}}{\alpha_h^{\alpha_h}\left(1 - \alpha_h\right)^{1-\alpha_h} a_{ht}\left(gk_{ht}\right)^{\gamma_h}\tilde{a}_{ft}^{h,h}}$$

The average productivity of home firms that serve the foreign country by the FDI strategy:

$$\tilde{a}_{ft}^{h,f} = \left(\frac{\zeta_h}{1+\zeta_h-\theta_{ft}}\right)^{\frac{1}{\theta_{ft}-1}} \bar{a}_{ht}^{fdi}$$

The relative price of home firms that serve the foreign country by the FDI strategy:

$$\tilde{q}_{ft}^{h,f} = \frac{\theta_{ft}}{\theta_{ft}-1} \frac{\left(r_{ft}^{k}\right)^{\alpha_f}\left[\left(1+\tau_{ft}^{p}\right)w_{ft}\right]^{1-\alpha_f}}{\alpha_f^{\alpha_f}\left(1-\alpha_f\right)^{1-\alpha_f} a_{ft}\left(gk_{ft}\right)^{\gamma_f}\tilde{a}_{ft}^{h,f}}$$

Aggregate price level:

$$1 = N_{ft-1}^{f}\left(\tilde{q}_{ft}^{f}\right)^{1-\theta_{ft}} + N_{ht}^{h,ex}\left[\left(1+\mathbb{1}_{ft}\frac{\tau_{ft}^{c}}{1-\tau_{ft}^{c}}\right)\tilde{q}_{ft}^{h,h}\right]^{1-\theta_{ft}} + N_{ht}^{h,fdi}\left(\tilde{q}_{ft}^{h,f}\right)^{1-\theta_{ft}}$$

Profit shifting of an FDI firm:

$$\lambda_{ft} = \frac{\tau_{ft}^{c}\left(1-\mathbb{1}_{ft}\right)-\tau_{ht}^{c}\left(1-\mathbb{1}_{ht}\right)}{\left(1-\tau_{ft}^{c}\right)\Xi_f}$$

The average after-tax profit of foreign firms from serving the domestic market:

$$\tilde{\Delta}_{ft}^{dom} = \frac{1-\tau_{ft}^{c}}{\theta_{ft}}\left(\tilde{q}_{ft}^{f}\right)^{1-\theta_{ft}} X_{ft}$$

The average after-tax profit of foreign firms from the export activity:

$$\tilde{\Delta}_{ft}^{ex} = \frac{1}{\mathcal{E}_t}\frac{1-\tau_{ft}^{c}\left(1-\mathbb{1}_{ft}\right)}{\theta_{ht}}\left[\frac{1-\tau_{ht}^{c}\left(1-\mathbb{1}_{ht}\right)}{1-\tau_{ht}^{c}}\right]^{-\theta_{ht}}\left(\tilde{q}_{ht}^{f,f}\right)^{1-\theta_{ht}} X_{ht} - \left(1-\tau_{ft}^{c}\right)\kappa_{ft}^{ex}$$

The average after-tax profit of foreign firms from the FDI activity:

$$\tilde{\Delta}_{ft}^{fdi} = \frac{1}{\mathcal{E}_t}\frac{1-\tau_{ht}^{c}}{\theta_{ht}}\left(\tilde{q}_{ht}^{f,h}\right)^{1-\theta_{ht}} X_{ht} - \left(1-\tau_{ft}^{c}\right)\kappa_{ft}^{fdi} + \frac{\left[\tau_{ft}^{c}\left(1-\mathbb{1}_{ft}\right)-\tau_{ht}^{c}\left(1-\mathbb{1}_{ht}\right)\right]^2}{2\left(1-\tau_{ft}^{c}\right)\Xi_f}$$

The average after-tax profit of foreign firms:

$$\tilde{d}_{ft} = \tilde{\Delta}_{ft}^{dom} + \left[\left(\frac{\bar{a}_{f}^{min}}{\bar{a}_{ft}^{ex}}\right)^{\zeta_f} - \left(\frac{\bar{a}_{f}^{min}}{\bar{a}_{ft}^{fdi}}\right)^{\zeta_f}\right]\tilde{\Delta}_{ft}^{ex} + \left(\frac{\bar{a}_{f}^{min}}{\bar{a}_{ft}^{fdi}}\right)^{\zeta_f}\tilde{\Delta}_{ft}^{fdi}$$

Expected after-tax profits of a potential entrant:

$$D_{ft} = E_t \left(1 - \delta_f\right) \beta_f \frac{\iota^{c,s}_{ft+1}}{\iota^{c,s}_{ft}} \left(\tilde{d}_{ft+1} + D_{ft+1}\right)$$

Free-entry condition:

$$\kappa^{\mathcal{N}}_{ft} = D_{ft}$$

Capital demand:

$$\begin{aligned}K_{ft-1} = \frac{\alpha_f}{r^k_{ft}} &\left\{ \frac{\theta_{ft}-1}{\theta_{ft}} X_{ft} \left[N^f_{ft-1} \left(\tilde{q}^f_{ft}\right)^{1-\theta_{ft}} + N^{h,fdi}_{ht} \left(\tilde{q}^{h,f}_{ft}\right)^{1-\theta_{ft}} \right] \right. \\ &\left. + \frac{1}{\mathcal{E}_t} \frac{\theta_{ht}-1}{\theta_{ht}} X_{ht} \frac{1-\tau^c_{ft}\left(1-\mathbb{1}_{ft}\right)}{1-\tau^c_{ft}} \left(1 + \mathbb{1}_{ht} \frac{\tau^c_{ht}}{1-\tau^c_{ht}}\right)^{-\theta_{ht}} N^{f,ex}_{ft} \left(\tilde{q}^{f,f}_{ht}\right)^{1-\theta_{ht}} \right\}\end{aligned}$$

Demand for labor services:

$$\begin{aligned}L_{ft} = \frac{1-\alpha_f}{\left(1+\tau^p_{ft}\right) w_{ft}} &\left\{ \frac{\theta_{ft}-1}{\theta_{ft}} X_{ft} \left[N^f_{ft-1} \left(\tilde{q}^f_{ft}\right)^{1-\theta_{ft}} + N^{h,fdi}_{ht} \left(\tilde{q}^{h,f}_{ft}\right)^{1-\theta_{ft}} \right] \right. \\ &\left. + \frac{1}{\mathcal{E}_t} \frac{\theta_{ht}-1}{\theta_{ht}} X_{ht} \frac{1-\tau^c_{ft}\left(1-\mathbb{1}_{ft}\right)}{1-\tau^c_{ft}} \left(1 + \mathbb{1}_{ht} \frac{\tau^c_{ht}}{1-\tau^c_{ht}}\right)^{-\theta_{ht}} N^{f,ex}_{ft} \left(\tilde{q}^{f,f}_{ht}\right)^{1-\theta_{ht}} \right\}\end{aligned}$$

Market clearing by the bundler:

$$X_{ft} = C_{ft} + I_{ft} + \kappa^{\mathcal{N}}_{ft} \mathcal{N}_{ft} + \kappa^{ex}_{ft} N^{f,ex}_{ft} + \kappa^{fdi}_{ft} N^{f,fdi}_{ft} + GC_{ft} + GI_{ft}$$

Government capital:

$$GK_{ft} = \left(1 - \delta^{GK}_f\right) GK_{ft-1} + GI_{ft}$$

Government capital per firm:

$$gk_{ft} = \frac{GK_{ft-1}}{N^f_{ft-1} + N^{h,fdi}_{ht}}$$

Revenue from the corporate-income tax:

$$
\begin{aligned}
TR^c_{ft} = {} & \mathbb{1}_{ft}\frac{\tau^c_{ft}}{1-\tau^c_{ft}}\left(1+\mathbb{1}_{ft}\frac{\tau^c_{ft}}{1-\tau^c_{ft}}\right)^{-\theta_{ft}} X_{ft}N^{h,ex}_{ht}\left(\tilde{q}^{h,h}_{ft}\right)^{1-\theta_{ft}} + \tau^c_{ft}\frac{1}{\theta_{ft}}X_{ft}N^f_{ft-1}\left(\tilde{q}^f_{ft}\right)^{1-\theta_{ft}} \\
& + \tau^c_{ft}\frac{1}{\mathcal{E}_t}\left(1+\mathbb{1}_{ht}\frac{\tau^c_{ht}}{1-\tau^c_{ht}}\right)^{-\theta_{ht}} X_{ht}\frac{1-\tau^c_{ft}\left(1-\mathbb{1}_{ft}\right)-\mathbb{1}_{ft}\theta_{ht}}{\theta_{ht}\left(1-\tau^c_{ft}\right)}N^{f,ex}_{ft}\left(\tilde{q}^{f,f}_{ht}\right)^{1-\theta_{ht}} \\
& + \tau^c_{ft}X_{ft}\frac{1}{\theta_{ft}}N^{h,fdi}_{ht}\left(\tilde{q}^{h,f}_{ft}\right)^{1-\theta_{ft}} - \tau^c_{ft}\kappa^{ex}_{ft}N^{f,ex}_{ft} - \tau^c_{ft}\kappa^{fdi}_{ft}N^{f,fdi}_{ft} - \tau^c_{ft}\frac{\Xi_f}{2}\left(\lambda_{ft}\right)^2 N^{f,fdi}_{ft} \\
& - \tau^c_{ft}\left(1-\mathbb{1}_{ft}\right)\lambda_{ft}N^{f,fdi}_{ft} + \tau^c_{ft}\frac{1}{\mathcal{E}_t}\lambda_{ht}\left(1-\mathbb{1}_{ft}\right)N^{h,fdi}_{ht}
\end{aligned}
$$

Revenue from non-lump-sum taxes:

$$
TR_{ft} = \tau^{va}_{ft}C_{ft} + \tau^w_{ft}v_{ft}L_{ft} + \tau^k_{ft}\left(r^k_{ft}-\delta^k_f\right)K_{ft-1} + \tau^p_{ft}w_{ft}L_{ft} + TR^c_{ft}
$$

Fiscal budget:

$$
GC_{ft} + GI_{ft} + \tau^{ub}_{ft}u_{ft}\mathcal{P}_f = TR_{ft} + \tau^{ls,ns}_{ft}\mu_f\mathcal{P}_f + \tau^{ls,s}_{ft}\left(1-\mu_f\right)\mathcal{P}_f + b_{ft} - \frac{R_{ft-1}}{\Pi_{ft}}b_{ft-1}
$$

Monetary policy:

$$
\frac{R_{ft}}{R_f} = \left(\frac{R_{ft-1}}{R_f}\right)^{\phi^R_f}\left[\left(\frac{\Pi_{ft}}{\Pi_f}\right)^{\phi^\Pi_f}\left(\frac{Y_{ft}}{Y_{ft-1}}\right)^{\phi^Y_f}\right]^{1-\phi^R_f}\exp\left(\epsilon^R_{ft}\right)
$$

Output:

$$
Y_{ft} = \left[N^f_{ft-1}\left(\tilde{q}^f_{ft}\right)^{1-\theta_{ft}} + N^{h,fdi}_{ht}\left(\tilde{q}^{h,f}_{ft}\right)^{1-\theta_{ft}}\right]X_{ft} + \frac{1}{\mathcal{E}_t}\left(1+\mathbb{1}_{ht}\frac{\tau^c_{ht}}{1-\tau^c_{ht}}\right)^{-\theta_{ht}}N^{f,ex}_{ft}\left(\tilde{q}^{f,f}_{ht}\right)^{1-\theta_{ht}}X_{ht}
$$

The broad definition of private investment:

$$
\mathcal{I}_{ft} = I_{ft} + \kappa^{\mathcal{N}}_{ft}\mathcal{N}_{ft} + \kappa^{ex}_{ft}N^{f,ex}_{ft} + \kappa^{fdi}_{ft}N^{f,fdi}_{ft}
$$

Export:

$$
EX_{ft} = \frac{1}{\mathcal{E}_t}\left(1+\mathbb{1}_{ht}\frac{\tau^c_{ht}}{1-\tau^c_{ht}}\right)^{-\theta_{ht}}\left(\tilde{q}^{f,f}_{ht}\right)^{1-\theta_{ht}}N^{f,ex}_{ft}X_{ht}
$$

Import:

$$
IM_{ft} = \frac{1}{\mathcal{E}_t}EX_{ht}
$$

Net exports:

$$NX_{ft} = EX_{ft} - IM_{ft}$$

Aggregate profit shifting:

$$PS_{ft} = \lambda_{ft} N_{ft}^{f,fdi}$$

A.3 International Linkages

Nominal exchange rate:

$$\Delta S_t = \frac{\mathcal{E}_t}{\mathcal{E}_{t-1}} \frac{\Pi_{ht}}{\Pi_{ft}}$$

Risk premium:

$$R_t^* = R_{ft} \exp\left(-\phi^* \frac{\mathcal{E}_t b_t^*}{Y_{ht}}\right)$$

International bonds:

$$\frac{1}{2}\left(Y_{ht} - \mathcal{E}_t Y_{ft}\right) + \frac{1}{2}\left[\mathbb{1}_{ht} \frac{\tau_{ht}^c}{1-\tau_{ht}^c}\left(1 + \mathbb{1}_{ht}\frac{\tau_{ht}^c}{1-\tau_{ht}^c}\right)^{-\theta_{ht}} \left(\tilde{q}_{ht}^{f,f}\right)^{1-\theta_{ht}} X_{ht} N_{ft}^{f,ex}\right.$$
$$\left. -\mathcal{E}_t \mathbb{1}_{ft} \frac{\tau_{ft}^c}{1-\tau_{ft}^c}\left(1 + \mathbb{1}_{ft}\frac{\tau_{ft}^c}{1-\tau_{ft}^c}\right)^{-\theta_{ft}} \left(\tilde{q}_{ft}^{h,h}\right)^{1-\theta_{ft}} X_{ft} N_{ht}^{h,ex}\right] = \frac{1}{2}\left(X_{ht} - \mathcal{E}_t X_{ft}\right) + \mathcal{E}_t b_t^* - \mathcal{E}_t \frac{R_{t-1}^*}{\Pi_{ft}} b_{t-1}^*$$
$$+ \frac{1-\tau_{ht}^c}{\theta_{ht}}\left(\tilde{q}_{ht}^{f,h}\right)^{1-\theta_{ht}} X_{ht} N_{ft}^{f,fdi} - \mathcal{E}_t \frac{1-\tau_{ft}^c}{\theta_{ft}}\left(\tilde{q}_{ft}^{h,f}\right)^{1-\theta_{ft}} X_{ft} N_{ht}^{h,fdi} + \left(1 - \mathbb{1}_{ft}\right)\tau_{ft}^c PS_{ht}$$
$$- \mathcal{E}_t\left(1 - \mathbb{1}_{ht}\right)\tau_{ht}^c PS_{ft}$$