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The Intangible Economy

Radek Šauer

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Non-Technical Summary

The paper analyzes how changes in foreign corporate-tax policies can affect a small open economy. Central to the analysis is the role of intangible assets such as patents and software. Unlike tangible production factors, intangible assets are characterized by non-rivalry, which makes it possible to use them across several locations simultaneously. Multinational firms often take advantage of this property and decide to place their intangibles in countries with a business-friendly environment.

The analysis is conducted by means of a dynamic macroeconomic model, in which multinational firms engage in tangible as well as intangible FDI. The paper first investigates the impact of a reduction in foreign territorial corporate tax rates. Such a policy shift incentivizes foreign multinationals to reshore their operations, relocating both tangible and intangible activity back to the headquarters. Consequently, the small open economy faces a contraction in R&D imports, a diminishing stock of intangible capital, and a subsequent decline in exports of royalty services. However, the paper identifies a mitigating factor. Domestic firms within the small open economy may expand to satisfy increased export demand from the growing foreign economy. This helps to sustain corporate-tax revenue despite the partial withdrawal of foreign multinationals.

A bigger risk to the public finances of the small open economy arises from foreign worldwide taxation of intangible income. Under such a policy, foreign governments impose a special levy on intangible income that their multinational firms declare in the small open economy. This form of worldwide taxation weakens the incentive for foreign multinationals to locate intangible assets abroad. As a result, the small open economy has to cope with depressed intangible investment and declining corporate-tax receipts. The labor market, by contrast, remains relatively insulated since intangible FDI is not deeply integrated into the local economy.

Finally, the paper presents a novel theoretical finding. Traditional economic theory suggests that corporate-income taxation does not directly impact arm's-length product prices. Nevertheless, as the model analysis demonstrates, corporate taxes directly affect the price setting of multinational firms if one allows for cannibalization effects between export and FDI.

The Intangible Economy*

Radek Šauer†
Central Bank of Ireland‡and CESifo

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Abstract

The paper explores how a small low-tax economy is affected by foreign corporate-tax shocks. To address this question, I develop a dynamic general-equilibrium model, in which multinational firms engage in both tangible and intangible FDI. Intangible assets arise from multinationals' R&D activities. Each multinational decides whether to place its intangibles in the parent firm or in an overseas affiliate. The placement decision shapes the intra-firm trade in royalties and R&D services. The model reveals that corporate taxes can directly impact arm's-length prices of multinational firms. I investigate territorial corporate taxation as well as worldwide taxation of intangible income.

JEL Classification: E22, E62, F23, H25

Keywords: intangible assets, multinational enterprises, corporate taxation, royalties, R&D services, endogenous markups

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†radek.sauer@centralbank.ie

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1 Introduction

When we start thinking about capital, typically buildings or machines come to our mind. Such assets are examples of tangible capital. However, the capital stock of a modern economy also includes intangible assets. The standard examples of intangibles would be patents and software. As is well documented by Haskel and Westlake (2017), Corrado et al. (2022), or Crouzet et al. (2022), intangible capital has become more and more relevant over the recent years. In the context of intangibles, multinational enterprises (MNEs)—notably those operating in IT and pharmaceutical sectors—play a crucial role. A new intangible asset in the economy is often the result of an MNE's research and development (R&D). The key feature of such an intangible is non-rivalry. The MNE can hold the intangible asset in one of its many affiliates, but the asset can be simultaneously used by all affiliates of the MNE. This feature sharply contrasts with the rivalrous character of tangible capital.

Moreover, intangible assets do not merely represent a non-rivalrous production factor. They also offer a means by which multinational firms can shift profits across borders (Grubert, 2003; Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012; Griffith, Miller and O'Connell, 2014; Schwab and Todtenhaupt, 2021; Altshuler et al., 2025).[1] Because multinationals want to maximize shareholder value, they are interested in curbing their global corporate-tax liability. They find it appealing to place a portion of their intangibles in low-tax jurisdictions. Affiliates located in high-tax jurisdictions then have to pay royalty fees for the use of the intangibles that are held in low-tax jurisdictions. The royalties effectively shift profits from high-tax to low-tax countries and so reduce the global corporate-tax bill of MNEs.

The tax-planning practices of multinational firms can markedly affect macroeconomic aggregates of small low-tax countries such as Ireland, Singapore, or Switzerland (Lane, 2017; MTIS, 2022; BFS, 2025).[2] The impact of intangible assets can be primarily seen in GDP, investment, and trade flows (Hebous and Johannesen, 2021; Jenniges et al., 2023). Additionally, intangibles placed in a low-tax jurisdiction frequently exhibit only loose links to the actual local economy (e.g., Damgaard, Elkjaer and Johannesen, 2024).

My paper aims to investigate the macroeconomic effects of corporate taxation from the perspective of a small low-tax economy, which depends considerably on intangible assets due to its attractive taxation. I explore how the small low-tax economy adjusts when the rest of the world decides to change its corporate taxation. Concretely, I analyze two corporate-tax instruments. Both of them can be leveraged by the rest of the world to limit profit shifting toward the small low-tax economy. The rest of the world can motivate its multinational firms by tax changes to keep intangible assets in the rest of the world instead of placing them in the small low-tax economy. The motivation can be either positive or negative. In the case

[1] Profit shifting more generally was studied for instance by Hines and Rice (1994), Desai, Foley and Hines (2006), Dyreng and Hanlon (2021), Guvenen et al. (2022), or Tørsløv, Wier and Zucman (2023).

[2] When discussing the sizable impact of profit-shifting activities on Irish national accounts, popular media (e.g., Reuters, 2016) regularly use the expression "leprechaun economics"—a term coined by Krugman (2016).

of the positive motivation, the rest of the world lowers its territorial corporate tax rate. In the case of the negative motivation, the rest of the world introduces worldwide taxation of intangible income. This form of worldwide taxation targets royalty income that MNEs from the rest of the world generate in the small low-tax economy. In the US, such a worldwide levy on intangible income is known as GILTI (Global Intangible Low-Taxed Income) tax or NCTI (Net Controlled foreign corporation Tested Income) tax.

I conduct the analysis of the corporate-tax instruments in a dynamic general-equilibrium model, which consists of two microfounded countries. I call them home and foreign. The home country represents the small low-tax economy; the foreign country stands for the rest of the world. The firm sector in the model is populated by multinational firms. Capital is firm-specific and comprises rivalrous tangibles as well as non-rivalrous intangibles. While the tangible assets can be purchased on the market, the intangible assets have to be developed in-house. In addition to the usual arm's-length trade, the model features intra-firm trade in R&D and royalty services. Due to its lower corporate tax rate, the home country attracts a substantial amount of intangible assets. The home country thus operates as an export platform for royalty services.

In economic theory, we commonly believe that corporate taxation does not have the potential to distort arm's-length product prices. The usual argumentation goes as follows. A corporate-income tax is imposed on a tax base that is defined as revenue minus input costs. Therefore, a corporate tax can be interpreted as a combination of a revenue tax and an input subsidy. While a revenue tax increases markups, an input subsidy decreases marginal costs. In equilibrium, these two effects cancel out, and the price-setting conditions stay undistorted by corporate taxation. Nonetheless, the model developed here demonstrates that corporate taxation can actually distort the price setting of a multinational firm. One just needs to allow for cannibalization effects between exports and foreign direct investment (FDI). Under cannibalization, product sales through export and FDI become interconnected. This gives rise to endogenous markups, which depend on both the home and foreign corporate tax rate. The impact of corporate taxation on the markup is then not offset by the corporate-tax factor in the marginal cost.

The first instrument of the foreign government that I analyze is the territorial corporate tax. It is a broad levy, which is imposed on all profits declared in the territory of the foreign country. When the foreign government lowers its territorial corporate tax rate, the MNEs headquartered in the foreign country begin to reshore. They relocate their activity back to the headquarters. They reduce both tangible and intangible FDI. By contrast, domestic firms in the small low-tax jurisdiction expand their workforce and raise tangible investment in order to satisfy a higher export demand coming from the foreign country. The decision of the foreign MNEs to cut intangible FDI significantly impacts the macroeconomic aggregates of the small low-tax economy. The economy experiences a drop in the import of R&D services. As a result, the stock of intangible assets decreases over time. The smaller amount of intangibles leads to weaker exports of royalty services, which are then mirrored in declining GDP.

The corporate-tax revenue of the low-tax jurisdiction is negatively affected by the foreign corporate-tax reduction. However, the loss in revenue is limited. It is true that the government collects less taxes from affiliates of the foreign MNEs due to their reshoring. But at the same time the government receives bigger corporate-tax payments from the domestic firms, which generate higher profits due to the stronger export sales.

In comparison to the territorial tax, the tax on overseas intangible income represents a more targeted instrument. The foreign government levies this tax exclusively on the intangible income earned by its MNEs in the low-tax jurisdiction. After the foreign government implements this type of worldwide taxation, the MNEs headquartered in the foreign country become less willing to locate their intangible assets abroad. Instead of exporting intangibles overseas, they raise intangible investment at the headquarters. In turn, the small low-tax economy has to cope with depressed imports of R&D services, falling exports of royalty services, and decreasing GDP. Despite the substantial deterioration in many of the usual macroeconomic aggregates, the labor market of the low-tax jurisdiction stays widely unaffected because the intangible FDI is not deeply rooted in the local economy. The corporate-tax revenue poses a more serious problem. The falling exports of royalty services cause a decline in the aggregate corporate-tax base. The government faces lower corporate-tax receipts and is thus forced to increase other taxes, which ultimately weigh down private consumption.

In my analysis, I purely focus on the form of intangible capital that the system of national accounts records in the usual measures of capital stock and investment. This form of intangible capital is known as intellectual-property products and consists of assets like patents, software, databases, movies, or exploration rights. Because data on intellectual property is available through regular releases of national accounts, it is commonly analyzed and forecasted by policy institutions (Andersson et al., 2024). In addition to the intellectual-property products, there are other forms of intangible capital, which however stay unmeasured in national-accounts statistics. The literature highlights for example the relevance of brand capital (Belo, Lin and Vitorino, 2014), sweat capital (Bhandari and McGrattan, 2021), customer capital (Drozd and Nosal, 2012; Gourio and Rudanko, 2014; Guerrón-Quintana, Mikami and Nosal, 2025), and organization capital (Atkeson and Kehoe, 2005; Burstein and Monge-Naranjo, 2009; Eisfeldt and Papanikolaou, 2013). The possible relation between the unmeasured forms of intangible capital and factorless income is investigated by Karabarbounis and Neiman (2019). Barkai (2020) shows how a broader construct of intangible capital alters profit and capital shares.

Although intangible capital has received a lot of attention in international macroeconomics, the vast majority of the literature abstracts from intra-firm trade in R&D and royalty services (e.g., McGrattan and Prescott, 2009, 2010; Holmes, McGrattan and Prescott, 2015; McGrattan and Waddle, 2020; Quadrini and Ríos-Rull, 2024). The literature does not usually consider that an MNE can export its intangibles into an affiliate located in a low-tax jurisdiction, where it can subsequently collect royalty fees from affiliates operating in high-

tax jurisdictions. Studies by Dyrda, Hong and Steinberg (2024a,b) represent an exception in this respect, since they allow for trade in R&D as well as royalty services. Both studies model MNEs' choice of intangible capital as a static optimization problem. As a result, intangible investment is identical to the stock of intangible capital. The model I develop here, by contrast, distinguishes between stocks and flows of intangibles. This enables me to examine the adjustment dynamics that are induced by a corporate-tax shock.

Sharma, Slemrod and Stimmelmayr (2023) analyze offshore transfers of intellectual property in a static partial-equilibrium model of a multinational firm. How corporate taxes affect the scale and riskiness of multinationals' R&D projects is studied in Albertus, Glover and Levine (2019). A gravity equation explaining trade in royalty services is estimated by Santacreu (2026). Chodorow-Reich et al. (2024) quantify how corporate provisions of the Tax Cuts and Jobs Act have impacted investment behavior of US firms. The impact is assessed through the lens of a global investment model, which builds on the seminal work by Hall and Jorgenson (1967).

Finally, my paper speaks to the literature that studies product cannibalization inside multiproduct firms (i.a., Feenstra and Ma, 2008; Eckel and Neary, 2010; Dhingra, 2013; Hottman, Redding and Weinstein, 2016; Eckel, Flach and Meng, 2023). The existing literature has demonstrated that price markups can become endogenous in a model of multiproduct firms. Which form the endogenous markups exactly take depends on factors like the underlying product demand or the cognitive depth—how much firms internalize the consequences of their decisions. The novelty of my paper lies in figuring out that corporate taxation and overseas production costs can shape the endogenous markups. To the best of my knowledge, this is the first paper that identifies the potential of corporate taxes to distort the price-setting conditions of a multiproduct firm.

The rest of the paper is structured as follows. Section 2 presents the model; its calibration is then discussed in Section 3. Section 4 examines the impact of foreign territorial corporate taxation. In Section 5, I explore the effects triggered by the worldwide taxation of intangible income. Section 6 concludes.

2 Model

I base my analysis on a neoclassical perfect-foresight model, which consists of two microfounded countries: home and foreign. Figure 1 offers a schematic representation of the model. A formal characterization of each economic agent is developed in the below subsections, where subscripts h and f denote variables and parameters that relate to the home and foreign country, respectively. Variables and parameters of MNEs that are headquartered in the home country bear a superscript h; foreign MNEs are distinguished by a superscript f. In what follows, I describe only the home country and home MNEs in detail. The foreign country and foreign MNEs look analogous.

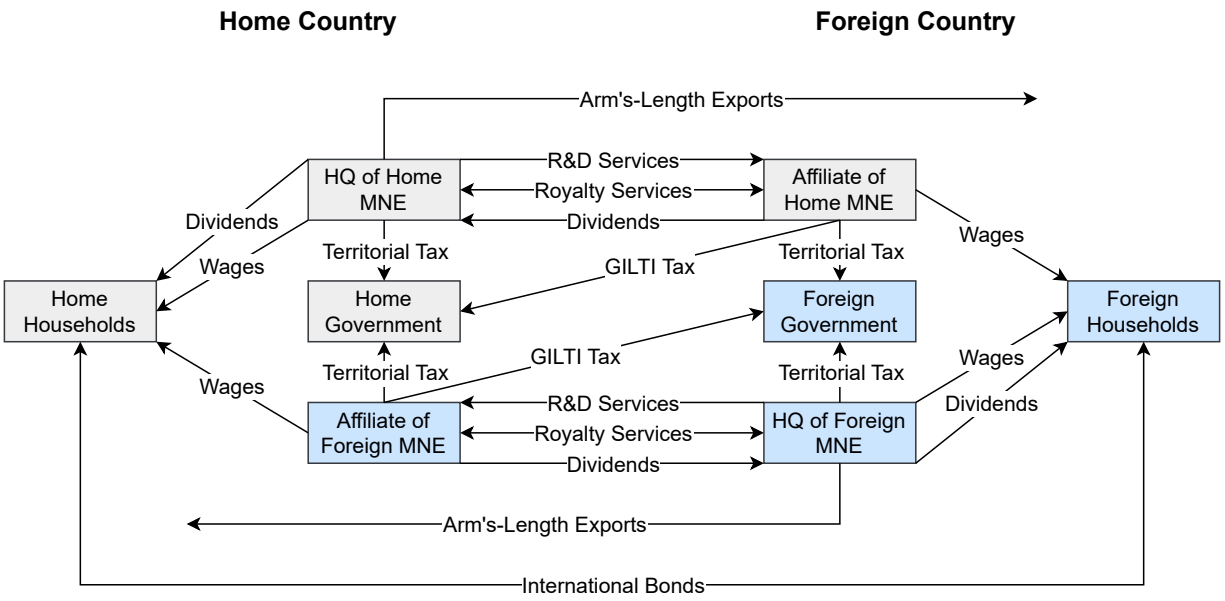

Figure 1: Schematic Representation of the Model. Gray rectangles depict economic agents with a domicile in the home country; blue rectangles represent economic agents with a domicile in the foreign country.

2.1 Households

The home country is populated by a continuum of households $[0; \mathcal{P}_h]$. Each household $\iota \in [0; \mathcal{P}_h]$ maximizes its discounted utility subject to a budget constraint:

$$\max_{\{c_{\iota ht}, l_{\iota ht}, b_{\iota ht}, b^*_{\iota ht}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} (\beta_h)^t \left[\frac{(c_{\iota ht})^{1-\sigma_h} - 1}{1-\sigma_h} - \frac{(l_{\iota ht})^{1+\varphi_h}}{1+\varphi_h} \right]$$

s.t.

$$\begin{aligned} (1+\tau^s_{ht})\, c_{\iota ht} + b_{\iota ht} + \mathcal{E}_t b^*_{\iota ht} + \mathcal{E}_t \frac{\zeta_h}{2} \left(b^*_{\iota ht}\right)^2 + \tau^l_{ht} = (1-\tau^w_{ht})\, w_{ht} l_{\iota ht} + r_{ht-1} b_{\iota ht-1} \\ + \mathcal{E}_t r^*_{t-1} b^*_{\iota ht-1} + \Delta_{ht} + \Gamma_{ht} \end{aligned} \tag{1}$$

The household derives utility from consumption $c_{\iota ht}$ and disutility from labor supply $l_{\iota ht}$. The household can build a portfolio of domestic government bonds $b_{\iota ht}$ and international private bonds $b^*_{\iota ht}$. The bonds yield real gross interest rates r_{ht} and r^*_t. Because the international bonds are denominated in the foreign currency, the household converts them into the home currency by the real exchange rate $\mathcal{E}_t = S_t(P_{ft}/P_{ht})$. When lending or borrowing through the international bonds, the household incurs quadratic portfolio costs. All income generated from the portfolio costs is distributed back to the households in equal lump-sum payments $\Gamma_{ht} = \int_0^{\mathcal{P}_h} \mathcal{E}_t(\zeta_h/2)(b^*_{\iota ht})^2 \, \mathrm{d}\iota/\mathcal{P}_h$. In the labor market, the household earns a real hourly wage $w_{ht} = W_{ht}/P_{ht}$, which is taxed at a rate τ^w_{ht}. The household also faces a sales tax τ^s_{ht} and a lump-sum tax τ^l_{ht}. As regards firm ownership, the home households are the sole share-

holder of MNEs that are headquartered in the home country. The home MNEs pay out their dividends equally to the home households: $\Delta_{ht} = \int_{\Omega_h} d^h_{\omega t}\,\mathrm{d}\omega/\mathcal{P}_h$.[3] Because in equilibrium all home households behave identically, I can drop the household subscript ι for the rest of the paper.

2.2 Final Bundler

The final bundler is a price taker, who maximizes profit subject to a bundling technology:

$$\max_{X_{ht},\, X^h_{\omega ht}\forall\omega\in\Omega_h,\, X^f_{\omega ht}\forall\omega\in\Omega_f} P_{ht}X_{ht} - \int_{\Omega_h} p^h_{\omega ht}X^h_{\omega ht}\,\mathrm{d}\omega - \int_{\Omega_f} p^f_{\omega ht}X^f_{\omega ht}\,\mathrm{d}\omega$$

s.t.

$$X_{ht} = \left[\int_{\Omega_h}\left(\frac{1}{|\Omega|}\right)^{\frac{1}{\theta_h}}\left(X^h_{\omega ht}\right)^{\frac{\theta_h-1}{\theta_h}}\mathrm{d}\omega + \int_{\Omega_f}\left(\frac{1}{|\Omega|}\right)^{\frac{1}{\theta_h}}\left(X^f_{\omega ht}\right)^{\frac{\theta_h-1}{\theta_h}}\mathrm{d}\omega\right]^{\frac{\theta_h}{\theta_h-1}}$$

The bundling technology combines products of home MNEs ($\omega \in \Omega_h$) with products of foreign MNEs ($\omega \in \Omega_f$) into a bundle X_{ht}, which is sold at a price P_{ht}. The bundle is used in the home country for consumption and tangible investment. The final bundler buys the products of the domestic MNEs $X^h_{\omega ht}$ directly from their headquarters at a price $p^h_{\omega ht}$. The products of the overseas MNEs $X^f_{\omega ht}$ are sourced indirectly via dedicated intermediate bundlers at a price $p^f_{\omega ht}$. The parameter $|\Omega| = |\Omega_h| + |\Omega_f|$ captures the total number of MNEs.

2.3 Intermediate Bundlers

For each foreign MNE, there is an intermediate bundler in the home country, who acts as a price-taking middleman between the foreign MNE and the final bundler of the home country. The foreign MNE offers its product ω to the intermediate bundler in two variants.[4] The first variant is the FDI variant $\overline{X}^f_{\omega ht}$, which is produced in the MNE's affiliate in the home country and sold at a price $\overline{p}^f_{\omega ht}$. The second variant is the export variant $\widetilde{X}^f_{\omega ht}$, which is produced at the MNE's headquarters and delivered at a price $\widetilde{p}^f_{\omega ht}$.[5] The intermediate bundler puts the two variants together and supplies the resulting package $X^f_{\omega ht}$ to the final bundler

[3] My paper concentrates on the taxation of corporate income and abstracts from a possible dividend tax. A rigorous analysis of dividend taxation would require an explicit modeling of a principal-agent problem, which would unnecessarily complicate my model. Dividend taxation was analyzed, for instance, by Chetty and Saez (2005), Korinek and Stiglitz (2009), Boissel and Matray (2022), or Ghilardi and Zilberman (2024).

[4] The model makes here the usual Armington (1969) assumption, which means that products from different production locations are perceived as distinct variants.

[5] The stylized fact that MNEs ordinarily supply an overseas market simultaneously through export and FDI was stressed, for example, by Yeaple (2023) or Helpman and Niswonger (2023).

at a price $p^f_{\omega ht}$. One can formalize the behavior of the intermediate bundler as follows:

$$\max_{X^f_{\omega ht}, \overline{X}^f_{\omega ht}, \widetilde{X}^f_{\omega ht}} p^f_{\omega ht} X^f_{\omega ht} - \overline{p}^f_{\omega ht} \overline{X}^f_{\omega ht} - \widetilde{p}^f_{\omega ht} \widetilde{X}^f_{\omega ht}$$

s.t.

$$X^f_{\omega ht} = \left[(\xi_h)^{\frac{1}{\nu_h}} \left(\overline{X}^f_{\omega ht} \right)^{\frac{\nu_h - 1}{\nu_h}} + (1 - \xi_h)^{\frac{1}{\nu_h}} \left(\widetilde{X}^f_{\omega ht} \right)^{\frac{\nu_h - 1}{\nu_h}} \right]^{\frac{\nu_h}{\nu_h - 1}}$$

The substitution elasticity of the intermediate bundlers is assumed to be at least as high as the elasticity of the final bundler: $\nu_h \geq \theta_h$. Put differently, it is easier to substitute within a firm than across firms.[6]

2.4 Multinational Enterprises

A home MNE $\omega \in \Omega_h$, which is headquartered in the home country and owned by home households, consists of two entities: a parent firm in the home country and an overseas affiliate in the foreign country. Both entities produce the product of the MNE by a Cobb–Douglas technology[7]:

$$y^h_{\omega ht} = a^h_{ht} \left[\left(k^h_{\omega ht-1} \right)^{\gamma_h} \left(m^h_{\omega t-1} \right)^{1-\gamma_h} \right]^{\alpha_h} \left(n^h_{\omega ht} \right)^{1-\alpha_h},$$
$$y^h_{\omega ft} = a^h_{ft} \left[\left(k^h_{\omega ft-1} \right)^{\gamma_f} \left(m^h_{\omega t-1} \right)^{1-\gamma_f} \right]^{\alpha_f} \left(n^h_{\omega ft} \right)^{1-\alpha_f}.$$

The output of each entity ($y^h_{\omega ht}$, $y^h_{\omega ft}$) depends on local productivity (a^h_{ht}, a^h_{ft}), local workers ($n^h_{\omega ht}$, $n^h_{\omega ft}$), local tangible capital ($k^h_{\omega ht-1}$, $k^h_{\omega ft-1}$), and global know-how ($m^h_{\omega t-1}$).[8] The global know-how represents the overall knowledge of the MNE.[9] Technically speaking, the global know-how is a composite of all intangible assets that the MNE holds in the parent firm ($m^h_{\omega ht}$) and overseas affiliate ($m^h_{\omega ft}$):

$$m^h_{\omega t} = \left[\left(\mu^h \right)^{\frac{1}{\lambda^h}} \left(m^h_{\omega ht} \right)^{\frac{\lambda^h - 1}{\lambda^h}} + \left(1 - \mu^h \right)^{\frac{1}{\lambda^h}} \left(m^h_{\omega ft} \right)^{\frac{\lambda^h - 1}{\lambda^h}} \right]^{\frac{\lambda^h}{\lambda^h - 1}}.$$

The weight μ^h captures non-tax reasons for why the MNE might keep its intangibles primarily in one of the two countries. For instance, the MNE could suffer from a home bias

[6] The subsequent model derivations also hold for the case $\nu_h < \theta_h$. However, empirical estimates (Broda and Weinstein, 2010; Hottman, Redding and Weinstein, 2016; Redding and Weinstein, 2024) suggest that the within-firm elasticity exceeds the cross-firm elasticity. Therefore, I focus entirely on the case $\nu_h \geq \theta_h$.

[7] In a macroeconomic context, it is common to assume a Cobb–Douglas production function when analyzing intangible capital (e.g., Quadrini and Ríos-Rull, 2024).

[8] The model assumes knowledge spreads without friction across borders. There are no spatial knowledge barriers akin to iceberg costs. Potential barriers to transferring knowledge were thematized in Keller and Yeaple (2013).

[9] In the industrial-organization literature, the concept that entities of a firm group are connected by intangible inputs was stressed by Atalay, Hortaçsu and Syverson (2014).

(high μ^h) or may want to place its intangibles close to overseas customers (low μ^h). The elasticity λ^h describes the MNE's love of diversification. When λ^h approaches infinity, the MNE does not diversify its intangible-asset holdings and instead keeps all intangibles in the location with the most attractive tax treatment. When λ^h approaches zero, the MNE becomes unresponsive to tax incentives and allocates its intangibles according to a fixed key: $m^h_{\omega h}/m^h_{\omega f} = \mu^h/(1-\mu^h)$.

The product output of the parent firm is supplied to the domestic final bundler and the dedicated overseas intermediate bundler: $y^h_{\omega ht} = X^h_{\omega ht} + \eta^h_t \widetilde{X}^h_{\omega ft}$. When exporting its product overseas, the MNE encounters iceberg cost η^h_t. The product output of the overseas affiliate is sold locally to the intermediate bundler: $y^h_{\omega ft} = \overline{X}^h_{\omega ft}$.

The MNE accumulates tangible as well as intangible assets in line with the usual law of motion of capital. During the accumulation process, the MNE faces investment-adjustment costs (i.a., Christiano, Eichenbaum and Rebelo, 2011; Basu and Bundick, 2017; McGrattan and Waddle, 2020). The tangible-capital stocks in the parent firm and overseas affiliate experience wear and tear of rate δ_h and δ_f, respectively. The MNE raises its tangible-capital stocks by investing amounts $i^h_{\omega ht}$ at home and $i^h_{\omega ft}$ overseas:

$$k^h_{\omega ht} = (1-\delta_h)\, k^h_{\omega ht-1} + i^h_{\omega ht} - \frac{\Xi_h}{2}\left(\frac{i^h_{\omega ht}}{k^h_{\omega ht-1}} - \delta_h\right)^2 k^h_{\omega ht-1},$$
$$k^h_{\omega ft} = (1-\delta_f)\, k^h_{\omega ft-1} + i^h_{\omega ft} - \frac{\Xi_f}{2}\left(\frac{i^h_{\omega ft}}{k^h_{\omega ft-1}} - \delta_f\right)^2 k^h_{\omega ft-1}.$$

The intangible assets become obsolete over time at rate ρ_h and ρ_f; the corresponding intangible investments are denoted by $z^h_{\omega ht}$ and $z^h_{\omega ft}$:

$$m^h_{\omega ht} = (1-\rho_h)\, m^h_{\omega ht-1} + z^h_{\omega ht} - \frac{\Upsilon_h}{2}\left(\frac{z^h_{\omega ht}}{m^h_{\omega ht-1}} - \rho_h\right)^2 m^h_{\omega ht-1},$$
$$m^h_{\omega ft} = (1-\rho_f)\, m^h_{\omega ft-1} + z^h_{\omega ft} - \frac{\Upsilon_f}{2}\left(\frac{z^h_{\omega ft}}{m^h_{\omega ft-1}} - \rho_f\right)^2 m^h_{\omega ft-1}.$$

The MNE buys the tangible-investment goods $i^h_{\omega ht}$ and $i^h_{\omega ft}$ from final bundlers at prices P_{ht} and P_{ft}. In contrast, the new intangible assets $z^h_{\omega ht}$ and $z^h_{\omega ft}$ are developed by the MNE in-house. I assume the MNE to conduct its R&D activities exclusively in the parent firm and abstract from the possibility of offshore R&D.[10] This assumption reflects the observation that MNEs tend to concentrate their innovation activities more than their production activities (Bilir and Morales, 2020). The parent firm is typically the key locus of R&D. For example, US multinationals performed between 2009 and 2022 83%–86% of their R&D onshore (BEA, 2024). The MNE is assumed to create new intangibles by a linear production function, which combines researchers ($\bar{j}^h_{\omega ht}$, $\widetilde{j}^h_{\omega ht}$) with R&D productivity (e_{ht}): $z^h_{\omega ht} = e_{ht}\bar{j}^h_{\omega ht}$ and

[10] Offshore R&D has been recently studied by Fan (2025) or Gumpert et al. (2025).

$z^h_{\omega ft} = e_{ht}\widetilde{j}^h_{\omega ht}$. While $\overline{j}^h_{\omega ht}$ denotes researchers who develop intangible assets that stay in the parent firm, $\widetilde{j}^h_{\omega ht}$ captures researchers who create intangibles that are exported to the overseas affiliate. The total number of researchers employed by the MNE is then defined as: $j^h_{\omega ht} = \overline{j}^h_{\omega ht} + \widetilde{j}^h_{\omega ht}$.[11]

The decision-making of the MNE is centralized at the headquarters; the affiliate does not act independently. The objective of the MNE is to maximize the discounted stream of dividends $D^h_{\omega t}$:

$$\sum_{t=0}^{\infty} (\beta_h)^t \frac{\Lambda_{ht}}{\Lambda_{h0}} \frac{P_{h0}}{P_{ht}} D^h_{\omega t}.$$

The MNE applies shareholders' discount factor, in which $\Lambda_{ht} = (c_{ht})^{-\sigma_h} / (1 + \tau^s_{ht})$ stands for the shadow price of wealth. The dividend of the MNE can be written as a sum of two dividends: $D^h_{\omega t} = D^h_{\omega ht} + S_t D^h_{\omega ft}$. The parent firm on its own generates the dividend $D^h_{\omega ht}$, and the overseas affiliate is responsible for the dividend $D^h_{\omega ft}$. The dividend of the affiliate is converted into the home currency by the nominal exchange rate S_t.

The dividend of the parent firm $D^h_{\omega ht}$ takes the following form:

$$\begin{aligned} D^h_{\omega ht} = {} & p^h_{\omega ht} X^h_{\omega ht} + S_t \widetilde{p}^h_{\omega ft} \widetilde{X}^h_{\omega ft} + S_t U^h_{\omega ft} z^h_{\omega ft} + S_t V^h_{\omega ht} m^h_{\omega ht-1} \\ & - W_{ht} \left(n^h_{\omega ht} + j^h_{\omega ht} \right) - P_{ht} i^h_{\omega ht} - V^h_{\omega ft} m^h_{\omega ft-1} \\ & - \tau^c_{ht} \Big[p^h_{\omega ht} X^h_{\omega ht} + S_t \widetilde{p}^h_{\omega ft} \widetilde{X}^h_{\omega ft} + S_t U^h_{\omega ft} z^h_{\omega ft} + S_t V^h_{\omega ht} m^h_{\omega ht-1} \\ & - W_{ht} \left(n^h_{\omega ht} + \widetilde{j}^h_{\omega ht} \right) - P_{ht} \delta_h k^h_{\omega ht-1} - U^h_{\omega ht} \psi^{\rho}_{ht} m^h_{\omega ht-1} - V^h_{\omega ft} m^h_{\omega ft-1} \Big]. \end{aligned} \tag{2}$$

The parent has four sources of revenue. The first two sources are the usual ones: domestic product sales $X^h_{\omega ht}$ and export product sales $\widetilde{X}^h_{\omega ft}$. The remaining two sources of revenue have to do with intangible assets. The parent supplies contract R&D services $z^h_{\omega ft}$ to its overseas affiliate. Moreover, the parent firm charges royalty fees to the overseas affiliate for the use of the intangible assets $m^h_{\omega ht-1}$. These intra-firm transactions are valued at transfer prices $U^h_{\omega ft}$ and $V^h_{\omega ht}$, respectively. The transfer prices are computed by tax consultants, who ensure the MNE's compliance with transfer-pricing rules. The MNE takes the resulting transfer prices as given and applies them in its dividend-maximization problem. A similar assumption was made, for example, in Sharma, Slemrod and Stimmelmayr (2023) or Dyrda, Hong and Steinberg (2024a). In Section 2.5, I describe the underlying transfer-pricing rules in detail.

As equation (2) shows, the parent's dividend is diminished by four expenditures. First, the parent firm has to pay wages to its workers $n^h_{\omega ht}$ and researchers $j^h_{\omega ht}$. The second expenditure is the spending on tangible investment $i^h_{\omega ht}$. Third, the parent pays royalty fees to the overseas affiliate for the use of the intangible assets $m^h_{\omega ft-1}$. The intra-firm royalty $V^h_{\omega ft}$ is again regulated by the transfer-pricing rules and taken by the MNE as given. Finally, the

[11] Ding et al. (2022) argue that the rise in US non-manufacturing employment during the last four decades can be partly explained through manufacturing firms, which expanded employment in professional, scientific, and technical services in order to acquire more intangible know-how.

parent firm is liable to the territorial corporate tax of the home country τ^c_{ht}. The corporate-tax base includes all sources of revenue. The parent can lower its tax base by expensing the following costs: the wage bill of workers ($W_{ht}n^h_{\omega ht}$), the wage bill of researchers providing contract R&D services ($W_{ht}\widetilde{j}^h_{\omega ht}$), and the royalties paid ($V^h_{\omega ft}m^h_{\omega ft-1}$). In addition, the parent receives allowances for tangible ($\delta_h k^h_{\omega ht-1}$) as well as intangible capital ($\psi^\rho_{ht}m^h_{\omega ht-1}$).[12] To conform with the real-world tax accounting, the allowances for the intangibles that are developed and kept in the same firm entity are valued at the R&D costs: $U^h_{\omega ht} = W_{ht}/e_{ht}$. The real R&D costs are defined as: $u^h_{\omega ht} = U^h_{\omega ht}/P_{ht}$.

Now let me specify the dividend of the overseas affiliate:

$$
\begin{aligned}
D^h_{\omega ft} = {} & \overline{p}^h_{\omega ft}\overline{X}^h_{\omega ft} + \frac{1}{S_t}V^h_{\omega ft}m^h_{\omega ft-1} - W_{ft}n^h_{\omega ft} - P_{ft}i^h_{\omega ft} - V^h_{\omega ht}m^h_{\omega ht-1} - U^h_{\omega ft}z^h_{\omega ft} \\
& - \tau^c_{ft}\left(\overline{p}^h_{\omega ft}\overline{X}^h_{\omega ft} + \frac{1}{S_t}V^h_{\omega ft}m^h_{\omega ft-1} - W_{ft}n^h_{\omega ft} - P_{ft}\delta_f k^h_{\omega ft-1} - V^h_{\omega ht}m^h_{\omega ht-1} - U^h_{\omega ft}\psi^\rho_{ft}m^h_{\omega ft-1}\right) \\
& - \tau^m_{ht}\frac{1}{S_t}V^h_{\omega ft}m^h_{\omega ft-1}.
\end{aligned}
$$

The affiliate generates revenue from product sales $\overline{X}^h_{\omega ft}$ and from charging intra-firm royalties for its intangibles $m^h_{\omega ft-1}$. The achieved revenue has to cover several expenditures. The affiliate pays its workers $n^h_{\omega ft}$ and buys tangible-investment goods $i^h_{\omega ft}$. Additionally, the affiliate has to make two payments to the parent firm. It has to pay for the R&D services $z^h_{\omega ft}$ and also for the right to use the parent's intangible assets $m^h_{\omega ht-1}$. The government of the foreign country imposes territorial corporate-income tax τ^c_{ft} on the affiliate's profit. The taxable profit depends on the revenue from the product sales and royalty fees, from which the workers' wages and royalties incurred are deducted. Allowances for tangible ($\delta_f k^h_{\omega ft-1}$) and intangible capital ($\psi^\rho_{ft}m^h_{\omega ft-1}$) reduce the tax base further. To be in line with the actual tax accounting, the allowances for the intangibles that were acquired from a related party have to be appraised at the regulated transfer price $U^h_{\omega ft}$. Besides territorial taxation, the affiliate can be subject to worldwide taxation of intangible income. The government of the home country has the possibility to tax the overseas royalty income of the home MNEs at τ^m_{ht}. After specifying the dividends in nominal terms, I can define the corresponding real dividends: $d^h_{\omega t} = D^h_{\omega t}/P_{ht}$, $d^h_{\omega ht} = D^h_{\omega ht}/P_{ht}$, and $d^h_{\omega ft} = D^h_{\omega ft}/P_{ft}$.

The dividend-maximization problem of the MNE ω with all the demand and technology constraints is summarized in Appendix A. The solution to this optimization problem is characterized by the following equilibrium conditions. If one takes derivatives of the MNE's Lagrangian with respect to tangible investment in the parent firm ($i^h_{\omega ht}$) and overseas affiliate

[12] In Ireland, capitalization of intangibles is a common tax practice (Revenue Commissioners, 2025). In the US, imported intangibles have to be capitalized, while intangibles developed domestically can be either capitalized or expensed (IRS, 2025).

($i^h_{\omega ft}$), one obtains marginal Tobin's Qs of tangible capital:

$$Q^h_{\omega ht} = \frac{1}{1 - \Xi_h \left(\frac{i^h_{\omega ht}}{k^h_{\omega ht-1}} - \delta_h \right)},$$

$$Q^h_{\omega ft} = \frac{\mathcal{E}_t}{1 - \Xi_f \left(\frac{i^h_{\omega ft}}{k^h_{\omega ft-1}} - \delta_f \right)}.$$

Similarly, derivatives with respect to intangible investment at home ($z^h_{\omega ht}$) and overseas ($z^h_{\omega ft}$) deliver marginal Tobin's Qs of intangible capital:

$$\mathcal{Q}^h_{\omega ht} = \frac{\frac{w_{ht}}{e_{ht}}}{1 - \Upsilon_h \left(\frac{z^h_{\omega ht}}{m^h_{\omega ht-1}} - \rho_h \right)},$$

$$\mathcal{Q}^h_{\omega ft} = \frac{\left(1 - \tau^c_{ht}\right) \frac{w_{ht}}{e_{ht}} + \tau^c_{ht} \mathcal{E}_t u^h_{\omega ft}}{1 - \Upsilon_f \left(\frac{z^h_{\omega ft}}{m^h_{\omega ft-1}} - \rho_f \right)},$$

where $u^h_{\omega ft} = U^h_{\omega ft}/P_{ft}$ stands for the real transfer price of R&D services. The optimal choices of tangible capital in the parent firm ($k^h_{\omega ht}$) and overseas affiliate ($k^h_{\omega ft}$) are then governed by the following equations:

$$Q^h_{\omega ht} = \beta_h \frac{\Lambda_{ht+1}}{\Lambda_{ht}} \left\{ \frac{\alpha_h \gamma_h}{1 - \alpha_h} \frac{\left(1 - \tau^c_{ht+1}\right) w_{ht+1} n^h_{\omega ht+1}}{k^h_{\omega ht}} + \tau^c_{ht+1} \delta_h \right.$$
$$\left. + Q^h_{\omega ht+1} \left[1 - \delta_h + \Xi_h \left(\frac{i^h_{\omega ht+1}}{k^h_{\omega ht}} - \delta_h \right) \frac{i^h_{\omega ht+1}}{k^h_{\omega ht}} - \frac{\Xi_h}{2} \left(\frac{i^h_{\omega ht+1}}{k^h_{\omega ht}} - \delta_h \right)^2 \right] \right\},$$

$$Q^h_{\omega ft} = \beta_h \frac{\Lambda_{ht+1}}{\Lambda_{ht}} \left\{ \mathcal{E}_{t+1} \frac{\alpha_f \gamma_f}{1 - \alpha_f} \frac{\left(1 - \tau^c_{ft+1}\right) w_{ft+1} n^h_{\omega ft+1}}{k^h_{\omega ft}} + \mathcal{E}_{t+1} \tau^c_{ft+1} \delta_f \right.$$
$$\left. + Q^h_{\omega ft+1} \left[1 - \delta_f + \Xi_f \left(\frac{i^h_{\omega ft+1}}{k^h_{\omega ft}} - \delta_f \right) \frac{i^h_{\omega ft+1}}{k^h_{\omega ft}} - \frac{\Xi_f}{2} \left(\frac{i^h_{\omega ft+1}}{k^h_{\omega ft}} - \delta_f \right)^2 \right] \right\}.$$

The stocks of intangible capital at the headquarters ($m^h_{\omega ht}$) and abroad ($m^h_{\omega ft}$) are determined by:

$$\mathcal{Q}^h_{\omega ht} = \beta_h \frac{\Lambda_{ht+1}}{\Lambda_{ht}} \left\{ \frac{\alpha_h \left(1 - \gamma_h\right)}{1 - \alpha_h} \frac{\left(1 - \tau^c_{ht+1}\right) w_{ht+1} n^h_{\omega ht+1}}{m^h_{\omega t}} \left(\frac{\mu^h m^h_{\omega t}}{m^h_{\omega ht}} \right)^{\frac{1}{\lambda^h}} \right.$$
$$+ \mathcal{E}_{t+1} \frac{\alpha_f \left(1 - \gamma_f\right)}{1 - \alpha_f} \frac{\left(1 - \tau^c_{ft+1}\right) w_{ft+1} n^h_{\omega ft+1}}{m^h_{\omega t}} \left(\frac{\mu^h m^h_{\omega t}}{m^h_{\omega ht}} \right)^{\frac{1}{\lambda^h}}$$
$$+ \tau^c_{ht+1} u^h_{\omega ht+1} \psi^\rho_{ht+1} + \mathcal{E}_{t+1} v^h_{\omega ht+1} \left(\tau^c_{ft+1} - \tau^c_{ht+1} \right)$$
$$\left. + \mathcal{Q}^h_{\omega ht+1} \left[1 - \rho_h + \Upsilon_h \left(\frac{z^h_{\omega ht+1}}{m^h_{\omega ht}} - \rho_h \right) \frac{z^h_{\omega ht+1}}{m^h_{\omega ht}} - \frac{\Upsilon_h}{2} \left(\frac{z^h_{\omega ht+1}}{m^h_{\omega ht}} - \rho_h \right)^2 \right] \right\},$$

$$\mathcal{Q}^h_{\omega ft} = \beta_h \frac{\Lambda_{ht+1}}{\Lambda_{ht}} \left\{ \frac{\alpha_h (1-\gamma_h)}{1-\alpha_h} \frac{\left(1-\tau^c_{ht+1}\right) w_{ht+1} n^h_{\omega ht+1}}{m^h_{\omega t}} \left[\frac{\left(1-\mu^h\right) m^h_{\omega t}}{m^h_{\omega ft}} \right]^{\frac{1}{\lambda^h}} \right.$$
$$+ \mathcal{E}_{t+1} \frac{\alpha_f (1-\gamma_f)}{1-\alpha_f} \frac{\left(1-\tau^c_{ft+1}\right) w_{ft+1} n^h_{\omega ft+1}}{m^h_{\omega t}} \left[\frac{\left(1-\mu^h\right) m^h_{\omega t}}{m^h_{\omega ft}} \right]^{\frac{1}{\lambda^h}}$$
$$+ \mathcal{E}_{t+1} \tau^c_{ft+1} u^h_{\omega ft+1} \psi^{\rho}_{ft+1} + v^h_{\omega ft+1} \left(\tau^c_{ht+1} - \tau^c_{ft+1} - \tau^m_{ht+1}\right)$$
$$\left. + \mathcal{Q}^h_{\omega ft+1} \left[1 - \rho_f + \Upsilon_f \left(\frac{z^h_{\omega ft+1}}{m^h_{\omega ft}} - \rho_f \right) \frac{z^h_{\omega ft+1}}{m^h_{\omega ft}} - \frac{\Upsilon_f}{2} \left(\frac{z^h_{\omega ft+1}}{m^h_{\omega ft}} - \rho_f \right)^2 \right] \right\},$$

where $v^h_{\omega ht+1} = V^h_{\omega ht+1}/P_{ft+1}$ and $v^h_{\omega ft+1} = V^h_{\omega ft+1}/P_{ht+1}$ denote the real values of royalties.

To obtain the optimal product prices, one has to derive the first-order conditions with respect to the domestic price $p^h_{\omega ht}$, export price $\widetilde{p}^h_{\omega ft}$, and FDI price $\overline{p}^h_{\omega ft}$. Each of the optimal prices can then be expressed as an effective marginal cost multiplied by a gross markup:

$$q^h_{\omega ht} = \mathcal{M}^h_{\omega ht} \frac{(1-\tau^c_{ht})\, w_{ht} n^h_{\omega ht}}{(1-\alpha_h)\, y^h_{\omega ht}}, \tag{3}$$

$$\widetilde{q}^h_{\omega ft} q^h_{\omega ft} = \widetilde{\mathcal{M}}^h_{\omega ft} \frac{1}{\mathcal{E}_t} \eta^h_t \frac{(1-\tau^c_{ht})\, w_{ht} n^h_{\omega ht}}{(1-\alpha_h)\, y^h_{\omega ht}}, \tag{4}$$

$$\overline{q}^h_{\omega ft} q^h_{\omega ft} = \overline{\mathcal{M}}^h_{\omega ft} \frac{\left(1-\tau^c_{ft}\right) w_{ft} n^h_{\omega ft}}{(1-\alpha_f)\, y^h_{\omega ft}}. \tag{5}$$

The relative prices are defined as follows: $q^h_{\omega ht} = p^h_{\omega ht}/P_{ht}$, $q^h_{\omega ft} = p^h_{\omega ft}/P_{ft}$, $\widetilde{q}^h_{\omega ft} = \widetilde{p}^h_{\omega ft}/p^h_{\omega ft}$, and $\overline{q}^h_{\omega ft} = \overline{p}^h_{\omega ft}/p^h_{\omega ft}$. Since the capital stocks ($k^h_{\omega ht-1}$, $k^h_{\omega ft-1}$, $m^h_{\omega t-1}$) are predetermined, the only way the MNE can immediately expand its product output ($y^h_{\omega ht}$, $y^h_{\omega ft}$) is by hiring more workers ($n^h_{\omega ht}$, $n^h_{\omega ft}$). Therefore, the marginal costs are purely driven by wages and do not include any costs related to capital. Because the MNE receives a tax deduction for the wage bill of its workers, the effective marginal costs are lowered by the corporate tax rates. The marginal cost of the exported product variant is increased by the iceberg cost η^h_t and converted into the foreign currency by the real exchange rate $1/\mathcal{E}_t$.

The markup on the domestic market takes the usual exogenous form:

$$\mathcal{M}^h_{\omega ht} = \frac{\theta_h}{(\theta_h - 1)\left(1-\tau^c_{ht}\right)}.$$

Besides the elasticity of the final bundler θ_h, the markup hinges on the corporate tax rate τ^c_{ht} because revenue from product sales enters the corporate-tax base. In the price-setting condition (3), the tax factor $(1-\tau^c_{ht})$ in the denominator of the markup is offset by the same tax factor in the numerator of the effective marginal cost. This means that the price on the domestic market is undistorted by corporate taxation.

When deciding on the export and FDI price, the MNE has to take into account possible cannibalization effects between the export and FDI variant of its product. For instance, if

the MNE sets a low price for the export variant, the export variant could then cannibalize the sales of the FDI variant. Technically speaking, the MNE has to internalize that its choices of $\widetilde{p}^h_{\omega ft}$ and $\overline{p}^h_{\omega ft}$ impact the intermediate price $p^h_{\omega ft}$, which in turn affects the demand for the intermediate bundle $X^h_{\omega ft}$. The MNE's internalization of the cannibalistic effects between exports and FDI gives rise to endogenous markups:

$$\widetilde{\mathcal{M}}^h_{\omega ft} = \frac{\nu_f - (\nu_f - \theta_f)\,\widetilde{\kappa}^h_{\omega ft}}{(\nu_f - 1)\,(1-\tau^c_{ht}) - (\nu_f - \theta_f)\left[(1-\tau^c_{ht})\,\widetilde{\kappa}^h_{\omega ft} + \left(1-\tau^c_{ft}\right)\overline{\kappa}^h_{\omega ft} - \frac{\left(1-\tau^c_{ft}\right)w_{ft}n^h_{\omega ft}}{\left(1-\alpha_f\right)q^h_{\omega ft}X^h_{\omega ft}}\right]},$$

$$\overline{\mathcal{M}}^h_{\omega ft} = \frac{\nu_f - (\nu_f - \theta_f)\,\overline{\kappa}^h_{\omega ft}}{(\nu_f - 1)\left(1-\tau^c_{ft}\right) - (\nu_f - \theta_f)\left[(1-\tau^c_{ht})\,\widetilde{\kappa}^h_{\omega ft} + \left(1-\tau^c_{ft}\right)\overline{\kappa}^h_{\omega ft} - \frac{\eta^h_t \widetilde{X}^h_{\omega ft}}{y^h_{\omega ht}}\frac{\left(1-\tau^c_{ht}\right)w_{ht}n^h_{\omega ht}}{(1-\alpha_h)\mathcal{E}_t q^h_{\omega ft}X^h_{\omega ft}}\right]}.$$

The markups are shaped by several elements. First, they depend on the elasticity of the final bundler θ_f and the elasticity of the intermediate bundler ν_f. Second, each of the markups contains the home corporate tax rate τ^c_{ht} as well as the foreign corporate tax rate τ^c_{ft}. The markups are also influenced by the shares $\widetilde{\kappa}^h_{\omega ft} = \widetilde{q}^h_{\omega ft}(\widetilde{X}^h_{\omega ft}/X^h_{\omega ft})$ and $\overline{\kappa}^h_{\omega ft} = \overline{q}^h_{\omega ft}(\overline{X}^h_{\omega ft}/X^h_{\omega ft})$, which gauge how many percent of the overseas product sales the MNE generates through exporting and FDI, respectively. Finally, each of the markups is affected by the production cost of the alternative product variant. The export markup contains the production cost of the FDI variant; the FDI markup depends on the production cost of the export variant.

After learning the structure of the markups, it is straightforward to see from equilibrium conditions (4) and (5) that corporate taxation can distort the price setting of a multinational firm. Under cannibalization ($\nu_f > \theta_f$), the export price as well as the FDI price are distorted by both the home and foreign corporate tax rate. If one shuts down the cannibalization effects ($\nu_f = \theta_f$), the export and FDI markup degenerate into the usual exogenous markups, and the corresponding prices become free from corporate-tax distortions.

2.5 Transfer Pricing

It is an internationally accepted standard that cross-border intra-firm transactions should be priced in line with the arm's-length principle. One should price transactions between related firms as if they happened between unrelated firms. How to satisfy the arm's-length principle in practice is formulated in OECD guidelines, which are transposed into national tax laws. The guidelines prescribe that transactions involving intangibles should be priced, whenever possible and meaningful, according to the so-called comparable-uncontrolled-price method (OECD, 2022, paras. 2.3, 6.145, 6.146). For a controlled transaction between associated firms, one should apply a price that would occur in a comparable uncontrolled transaction between independent firms.

The model considered here assumes that tax consultants obey the OECD guidelines and compute the transfer prices of intangibles according to the comparable-uncontrolled-price

method. In the context of the model, the comparable uncontrolled price corresponds to a competitive-equilibrium price that is increased by an appropriate markup. Thus, the transfer price $u^h_{\omega ft}$, at which the parent firm supplies R&D services to the overseas affiliate, is calculated as the marginal cost of R&D multiplied by a gross markup ψ^u_t:

$$u^h_{\omega ft} = \psi^u_t \frac{1}{\mathcal{E}_t} \frac{w_{ht}}{e_{ht}}.$$

A royalty fee—the rental rate of intangible capital—is determined as the marginal revenue product of intangible assets multiplied by a gross markup ψ^v_t. Concretely, the royalty $v^h_{\omega ht}$, which is paid by the overseas affiliate for the use of the parent's intangibles $m^h_{\omega ht-1}$, is derived as:

$$v^h_{\omega ht} = \psi^v_t \overline{q}^h_{\omega ft} q^h_{\omega ft} \frac{\partial y^h_{\omega ft}}{\partial m^h_{\omega ht-1}} = \psi^v_t \overline{q}^h_{\omega ft} q^h_{\omega ft} \frac{\alpha_f \left(1-\gamma_f\right) y^h_{\omega ft}}{m^h_{\omega t-1}} \left(\frac{\mu^h m^h_{\omega t-1}}{m^h_{\omega ht-1}} \right)^{\frac{1}{\lambda^h}}.$$

The royalty $v^h_{\omega ft}$, which is paid by the parent firm for the use of the affiliate's intangibles $m^h_{\omega ft-1}$, is obtained as:

$$v^h_{\omega ft} = \psi^v_t q^h_{\omega ht} \frac{\partial y^h_{\omega ht}}{\partial m^h_{\omega ft-1}} = \psi^v_t q^h_{\omega ht} \frac{\alpha_h \left(1-\gamma_h\right) y^h_{\omega ht}}{m^h_{\omega t-1}} \left[\frac{\left(1-\mu^h\right) m^h_{\omega t-1}}{m^h_{\omega ft-1}} \right]^{\frac{1}{\lambda^h}}.$$

The size of the appropriate transfer-pricing markups ψ^u_t and ψ^v_t is regulated by tax authorities. For the remainder of the paper, I can drop the MNE subscript ω because in equilibrium all MNEs from the home country act identically.

At this point, let me stress that my paper considers only legal tax-planning practices. It does not have the intention to investigate illegal tax strategies. MNEs in my model maximize the discounted stream of dividends. They are naturally interested in reducing their global corporate-tax liability. Hence, they use intangible assets as an instrument for international profit shifting. All resulting intra-firm transactions are priced correctly in line with the arm's-length principle. In other words, there is no transfer mispricing. Of course, in reality transfer prices can be manipulated. However, the literature on the prevalence of transfer-price manipulations is still not completely settled. For example, Neiman (2010) argues that the behavior of transfer prices is not driven by tax considerations. In contrast, Cristea and Nguyen (2016) and Davies et al. (2018) hint at potential violations of the arm's-length principle.

2.6 Government

The fiscal policy of the home government is constrained by the following equation:

$$T_{ht} + \tau^l_{ht} \mathcal{P}_h + b_{ht} \mathcal{P}_h = G_{ht} + r_{ht-1} b_{ht-1} \mathcal{P}_h. \tag{6}$$

The government raises revenue T_{ht} from distortionary taxes and $\tau^l_{ht} \mathcal{P}_h$ from lump-sum taxes. In addition, the government issues bonds $b_{ht} \mathcal{P}_h$ to domestic households. These resources fi-

nance public consumption G_{ht} and the repayment of outstanding debt $b_{ht-1}\mathcal{P}_h$ with its gross interest rate r_{ht-1}. Distortionary taxes available to the home government are the sales tax τ^s_{ht}, wage tax τ^w_{ht}, territorial corporate-income tax τ^c_{ht}, and the tax on the overseas intangible income of home MNEs τ^m_{ht}. The overall revenue from distortionary taxation can be written as the following sum:

$$T_{ht} = \tau^s_{ht} c_{ht} \mathcal{P}_h + \tau^w_{ht} w_{ht} l_{ht} \mathcal{P}_h + T^c_{ht} + T^m_{ht},$$

where T^c_{ht} and T^m_{ht} denote the tax collection from τ^c_{ht} and τ^m_{ht}, respectively. The territorial corporate-income tax of the home government is imposed on profits realized in the territory of the home country, which means that the tax is collected from parent firms of home MNEs and from affiliates of foreign MNEs:

$$\begin{aligned} T^c_{ht} = \tau^c_{ht} \Big[& q^h_{ht} X^h_{ht} + \mathcal{E}_t \widetilde{q}^h_{ft} q^h_{ft} \widetilde{X}^h_{ft} + \mathcal{E}_t u^h_{ft} z^h_{ft} + \mathcal{E}_t v^h_{ht} m^h_{ht-1} - w_{ht} \left(n^h_{ht} + \widetilde{j}^h_{ht} \right) - \delta_h k^h_{ht-1} \\ & - u^h_{ht} \psi^\rho_{ht} m^h_{ht-1} - v^h_{ft} m^h_{ft-1} \Big] |\Omega_h| \\ & + \tau^c_{ht} \left(\overline{q}^f_{ht} q^f_{ht} \overline{X}^f_{ht} + \mathcal{E}_t v^f_{ht} m^f_{ht-1} - w_{ht} n^f_{ht} - \delta_h k^f_{ht-1} - v^f_{ft} m^f_{ft-1} - u^f_{ht} \psi^\rho_{ht} m^f_{ht-1} \right) |\Omega_f|. \end{aligned} \tag{7}$$

The worldwide taxation through τ^m_{ht} targets royalty income that home MNEs declare in the foreign country:

$$T^m_{ht} = \tau^m_{ht} v^h_{ft} m^h_{ft-1} |\Omega_h|.$$

2.7 Market Clearing, National Accounts, and the Balance of Payments

In equilibrium, the following market-clearing conditions hold. Households' labor supply $l_{ht}\mathcal{P}_h$ equals firms' labor demand:

$$l_{ht} \mathcal{P}_h = \left(n^h_{ht} + j^h_{ht} \right) |\Omega_h| + n^f_{ht} |\Omega_f|.$$

Parent firms of home MNEs demand workers n^h_{ht} and researchers j^h_{ht}; affiliates of foreign MNEs hire workers n^f_{ht}. International bonds, which home and foreign households trade across the border, satisfy the zero-net-supply condition:

$$b^*_{ht} \mathcal{P}_h + b^*_{ft} \mathcal{P}_f = 0.$$

The market for the final bundle X_{ht} clears as well:

$$X_{ht} = c_{ht} \mathcal{P}_h + G_{ht} + i^h_{ht} |\Omega_h| + i^f_{ht} |\Omega_f|.$$

The final bundle is demanded by households for private consumption c_{ht}, by the government for public consumption G_{ht}, by parent firms of home MNEs for tangible investment i^h_{ht}, and

by affiliates of foreign MNEs for tangible investment i^f_{ht}.

Now let's define a series of variables that measure the aggregate performance of the home economy. I follow the standards of national accounting and introduce the usual macroeconomic aggregates. As discussed earlier, whenever my paper mentions intangibles, it strictly means intellectual-property products (e.g., patents, software, databases). Intellectual property represents the only form of intangibles that the system of national accounts includes in its investment and capital-stock data.[13] Therefore, I define aggregate investment $\mathcal{I}_{ht}$ as the sum of tangible (i^h_{ht}, i^f_{ht}) and intangible (z^h_{ht}, z^f_{ht}) investment, which parents of home MNEs and affiliates of foreign MNEs carry out:

$$\mathcal{I}_{ht} = \left(i^h_{ht} + u^h_{ht} z^h_{ht}\right) |\Omega_h| + \left(i^f_{ht} + u^f_{ht} z^f_{ht}\right) |\Omega_f|.$$

The aggregate investment as well as all subsequent macroeconomic aggregates are deflated by the price of the final bundle P_{ht}.

The export EX_{ht} captures the total value of goods and services that home and foreign MNEs supply from the home country to the foreign country:

$$EX_{ht} = \mathcal{E}_t \left[\left(\widetilde{q}^h_{ft} q^h_{ft} \widetilde{X}^h_{ft} + u^h_{ft} z^h_{ft} + v^h_{ht} m^h_{ht-1} \right) |\Omega_h| + v^f_{ht} m^f_{ht-1} |\Omega_f| \right].$$

As described in Section 2.4, the parent firm of a home MNE engages in arm's-length exporting $\widetilde{X}^h_{ft}$. The parent is also the entity inside of the multinational which is responsible for the conduct of R&D. When a home MNE decides to place some intangibles in its overseas affiliate, the national accounts record an export of R&D services z^h_{ft} from the home country to the foreign country. Intangible assets that home and foreign MNEs keep in the home country (m^h_{ht-1}, m^f_{ht-1}) generate cross-border royalty income. The parent of a home MNE receives from its foreign affiliate a royalty v^h_{ht}; the home affiliate of a foreign MNE obtains from its parent a royalty v^f_{ht}. The national accounts report this royalty income as export of royalty services from the home country to the foreign country. After specifying exports, it is now straightforward to define imports and net exports. The import of the home country corresponds with the export of the foreign country: $IM_{ht} = \mathcal{E}_t EX_{ft}$. The net exports equal the difference between exports and imports: $NX_{ht} = EX_{ht} - IM_{ht}$.

The overall gross value added of the home country GVA_{ht} can be decomposed into two variables:

$$GVA_{ht} = GVA^h_{ht} + GVA^f_{ht}. \tag{8}$$

While the first variable GVA^h_{ht} measures the gross value added by parent firms of home MNEs, the second variable GVA^f_{ht} gauges the gross value added by affiliates of foreign MNEs. When formalizing the behavior of these variables, one has to bear in mind that gross value added is defined as the difference between gross output and intermediate consumption.

[13] To learn more how national-accounts data treats intangible assets, I refer the reader to UN (2009), Avdjiev et al. (2018), Koh, Santaeulàlia-Llopis and Zheng (2020), Atkeson (2020), Barro (2021), or Andersson et al. (2024).

The gross value added by parents of home MNEs hence takes the following form:

$$GVA_{ht}^{h} = \left(q_{ht}^{h} X_{ht}^{h} + \mathcal{E}_t \widetilde{q}_{ft}^{h} q_{ft}^{h} \widetilde{X}_{ft}^{h} + u_{ht}^{h} z_{ht}^{h} + \mathcal{E}_t u_{ft}^{h} z_{ft}^{h} + \mathcal{E}_t v_{ht}^{h} m_{ht-1}^{h} - v_{ft}^{h} m_{ft-1}^{h}\right) |\Omega_h|. \quad (9)$$

The parent of a home MNE creates products for the domestic and export market (X_{ht}^{h}, $\widetilde{X}_{ft}^{h}$). It also creates new intangible assets, which are partly kept at home (z_{ht}^{h}) and partly exported, as R&D services, to the foreign affiliate (z_{ft}^{h}). Moreover, the parent produces royalty services for its foreign affiliate ($v_{ht}^{h} m_{ht-1}^{h}$). Imported royalty services from the affiliate represent intermediate consumption of the parent ($v_{ft}^{h} m_{ft-1}^{h}$).

The gross value added by affiliates of foreign MNEs reflects the two dimensions of FDI:

$$GVA_{ht}^{f} = \left(\overline{q}_{ht}^{f} q_{ht}^{f} \overline{X}_{ht}^{f} + \mathcal{E}_t v_{ht}^{f} m_{ht-1}^{f} - v_{ft}^{f} m_{ft-1}^{f}\right) |\Omega_f|. \quad (10)$$

The horizontal dimension of FDI leads to the creation of products $\overline{X}_{ht}^{f}$, which are intended for the local market. The vertical dimension of FDI results in the production of royalty services $v_{ht}^{f} m_{ht-1}^{f}$, which are exported to the parent firm. Imported royalty services from the parent $v_{ft}^{f} m_{ft-1}^{f}$ are classified as intermediate consumption of the affiliate.

After pinning down the gross value added of the home country, one can easily obtain the corresponding gross domestic product GDP_{ht}. In the system of national accounts, GDP equals to: gross value added plus net indirect taxes. Because the model equivalent to the concept of net indirect taxes is the sales tax paid by households, one can express GDP as: $GDP_{ht} = GVA_{ht} + \tau_{ht}^{s} c_{ht} \mathcal{P}_h$.

Let me now derive how much of the gross value added GVA_{ht} is distributed to capital in gross and net terms. To compute the gross operating surplus GOS_{ht}, I have to subtract compensation of employees from the gross value added:

$$GOS_{ht} = GVA_{ht} - w_{ht} l_{ht} \mathcal{P}_h. \quad (11)$$

The net operating surplus NOS_{ht} is equal to the gross operating surplus less depreciation:

$$NOS_{ht} = GOS_{ht} - \left(\delta_h k_{ht-1}^{h} + u_{ht}^{h} \rho_h m_{ht-1}^{h}\right) |\Omega_h| - \left(\delta_h k_{ht-1}^{f} + u_{ht}^{f} \rho_h m_{ht-1}^{f}\right) |\Omega_f|. \quad (12)$$

The depreciation in the home country is incurred by parent firms of home MNEs and affiliates of foreign MNEs. Tangibles depreciate at the rate δ_h, intangibles at the rate ρ_h.

I can leverage the definitions of the operating surplus and gross value added (8)–(12) to rewrite the corporate-tax revenue of the home government (7) into a more compact form:

$$T_{ht}^{c} = \tau_{ht}^{c} NOS_{ht} + \tau_{ht}^{c} \left(\rho_h - \psi_{ht}^{\rho}\right) \left(u_{ht}^{h} m_{ht-1}^{h} |\Omega_h| + u_{ht}^{f} m_{ht-1}^{f} |\Omega_f|\right). \quad (13)$$

The rewritten equation expresses the revenue T_{ht}^{c} from the territorial corporate tax as a function of the net operating surplus NOS_{ht}—a national-accounts measure of territorial

profit. The additional term in the equation corrects for the potential discrepancy between how national accounting and tax accounting deal with the depreciation of intangible assets.[14] The national accounts apply the actual depreciation rate ρ_h when calculating the net operating surplus. In contrast, the tax liability of corporations depends on the capital allowance ψ^{ρ}_{ht}, which comprises a compensation for depreciation and other possible deductions related to intangibles. The correction term multiplies the discrepancy between ρ_h and ψ^{ρ}_{ht} by the value of the territorial intangible capital stock.

If one combines the budget constraint of households (1) with the fiscal constraint (6), one derives the following balance-of-payments condition:

$$0 = NX_{ht} + \mathcal{E}_t \left(r^*_{t-1} b^*_{ht-1} - b^*_{ht} \right) \mathcal{P}_h + \mathcal{E}_t d^h_{ft} |\Omega_h| - d^f_{ht} |\Omega_f| + T^m_{ht} - \mathcal{E}_t T^m_{ft},$$

which states that the components of the balance of payments have to sum to zero. The condition requires net exports to be in line with the net flows of international bonds, cross-border dividends, and GILTI-tax payments.

3 Calibration

I summarize the calibration of the model in Table 1. The values of the model parameters are chosen such that the home country represents Ireland, which is a standard example of a small open economy with a sizable amount of intangible inward FDI. The foreign country in the model consequently captures the key trading and investment partners of the Irish economy. The home and foreign country differ markedly in their population sizes and fiscal policies. The population of the home country is normalized to one; the population of the foreign country equals the relative size of the aggregate comprising the US, UK, and the EU without Ireland. The home country is a low-tax jurisdiction, which taxes corporate income at 12.5% and spends only 13% of its GDP on government consumption. By contrast, the foreign country is a high-tax jurisdiction with a corporate tax rate of 25% and government consumption reaching 20% of GDP. Unless otherwise stated, the remaining model parameters are calibrated identically across the two countries and take values that are common in the literature.

Because the time periods in the model should be interpreted as years, I set the households' discount factor to 0.98. In the steady state, such a calibration results in an annual real interest rate of two percent. The utility function is logarithmic in consumption and features a Frisch elasticity of 0.5 (e.g., Gross, Klein and Makris, 2022). The parameter of the annual portfolio costs is calibrated to 0.01 (Ghironi and Melitz, 2005; Barattieri, Cacciatore and Ghironi, 2021).

The bundlers' price elasticities are set to the median estimates of Hottman, Redding and

[14] The model assumes the tax allowance for tangible capital to equal the actual depreciation δ_h. Therefore, no correction term for tangibles shows up in (13).

Group	Symbol	Description	Value
Households	$\mathcal{P}_h$	home population	1
	$\mathcal{P}_f$	foreign population	177
	β_h, β_f	discount factor	0.98
	σ_h, σ_f	relative risk aversion	1
	φ_h, φ_f	inverse of Frisch elasticity	2
	ζ_h, ζ_f	portfolio costs	0.01
Bundlers	θ_h, θ_f	price elasticity of final bundler	3.9
	ν_h, ν_f	price elasticity of intermediate bundlers	6.9
	ξ_h, ξ_f	weight of FDI in intermediate bundles	0.5
Firms	$\lvert\Omega_h\rvert$	number of home MNEs	$\mathcal{P}_h$
	$\lvert\Omega_f\rvert$	number of foreign MNEs	$\mathcal{P}_f$
	α_h, α_f	weight of capital	0.4
	γ_h, γ_f	weight of tangible capital	0.756
	λ^h, λ^f	elasticity of intangibles	6
	μ^h	home MNEs' weight of intangibles at headquarters	$\mathcal{P}_h/(\mathcal{P}_h + \mathcal{P}_f)$
	μ^f	foreign MNEs' weight of intangibles at headquarters	$\mathcal{P}_f/(\mathcal{P}_h + \mathcal{P}_f)$
	Ξ_h, Ξ_f	adjustment costs of tangible investment	1
	Υ_h, Υ_f	adjustment costs of intangible investment	1
	δ_h, δ_f	depreciation of tangible capital	0.07
	ρ_h, ρ_f	depreciation of intangible capital	0.21
	η^h, η^f	iceberg cost	1.45
	e_h, e_f	productivity in R&D	1
	a_h^h, a_f^f	productivity at headquarters	1
	a_f^h, a_h^f	productivity overseas	0.38
Transfer Prices	ψ^u	markup of transferred intangibles	$\theta/(\theta-1)$
	ψ^v	markup of royalties	$\theta/(\theta-1)$
Government	τ_h^c	home corporate-income tax rate	0.125
	τ_f^c	foreign corporate-income tax rate	0.25
	ψ_h^ρ, ψ_f^ρ	allowance for intangible capital	ρ
	τ_h^m, τ_f^m	tax rate on overseas intangible income	0
	τ_h^s, τ_f^s	sales tax rate	0.135
	τ_h^w, τ_f^w	wage tax rate	0.2
	G_h/GDP_h	home government consumption to GDP	0.13
	G_f/GDP_f	foreign government consumption to GDP	0.2

Table 1: Benchmark Calibration

Weinstein (2016). The cross-firm elasticity of the final bundlers and the within-firm elasticity of the intermediate bundlers are hence calibrated to 3.9 and 6.9, respectively. As in McGrattan and Waddle (2020), the intermediate bundlers give equal weight to the export and FDI variant of an MNE's product.

The number of MNEs headquartered in a country is identical to the population size of that country (i.a., Tintelnot, 2017). The weight of total capital in the production function is calibrated to 0.4 (Cooley and Prescott, 1995; Quadrini and Ríos-Rull, 2024). As described in

Appendix B, the weight of tangible capital in the production function can be determined by a steady-state relation, which depends on a handful of empirically observable great ratios. The weights of intangible assets in the MNEs' global know-how correspond to the population shares: $\mu^h = \mathcal{P}_h/(\mathcal{P}_h+\mathcal{P}_f)$ and $\mu^f = \mathcal{P}_f/(\mathcal{P}_h+\mathcal{P}_f)$. This calibration means that in a world without tax distortions an MNE would allocate its intangibles across countries according to countries' shares in the global economy. In other words, an MNE would tend to hold intangible assets close to its customers. The elasticity of intangibles in the global know-how ensures that the steady-state royalty exports of the home country approximately equal 20% of GDP. The depreciation rates of capital can be obtained from national-accounts data. While tangible capital annually depreciates by seven percent, intangible assets experience a much higher depreciation rate of 21%. Following McGrattan and Waddle (2020), firms encounter investment-adjustment costs of size one. Iceberg costs introduce a wedge of 45% between production and realized export sales (Atkeson and Burstein, 2008; Alessandria and Choi, 2014). The productivity of MNEs in their parent firms is normalized to one. The productivity in the overseas affiliates—the multinational-production friction—is set to the average estimate of Alviarez (2019).

The transfer prices of intra-firm trade have to satisfy the arm's-length principle. To mimic the conditions of an uncontrolled transaction between unrelated parties, the markups of intra-firm trade are required to equal the exogenous markup that is implied by the cross-firm elasticity. The governments tax labor income at 20% and private consumption at 13.5%. Under the benchmark calibration, allowances for intangible capital track exactly the actual depreciation of intangibles, and the governments do not impose any GILTI-like tax on the overseas intangible income of their MNEs. In Table 2, I show how the steady-state great ratios of the model economy look like under the selected calibration.

Group	Great Ratio in %	Home Country	Foreign Country
Expenditures of GDP	private consumption/GDP	46.5	60.4
	government consumption/GDP	13.0	20.0
	tangible investment/GDP	14.0	14.1
	intangible investment/GDP	13.7	5.6
	net exports/GDP	12.7	–0.1
	import of investment and final consumption/GDP	35.2	0.2
Distribution of GVA	compensation of labor/GVA	41.8	48.0
	gross operating surplus/GVA	58.2	52.0
Capital Stocks	tangible capital/GDP	200.5	201.8
	intangible capital/GDP	65.3	26.6
Current Account	export of R&D/GDP	3.1	0.1
	import of R&D/GDP	13.7	0.0
	export of royalty services/GDP	19.3	0.1
	import of royalty services/GDP	10.8	0.1
	net dividend inflow/GDP	–12.7	0.1
Affiliates of MNEs	GVA of affiliates of overseas MNEs/GVA	61.9	0.0
	tangible investment of affiliates of overseas MNEs/GDP	7.7	0.0

Table 2: Great Ratios of the Model Economy at the Benchmark Calibration

4 Territorial Corporate Tax

In this section, I analyze the first way how the rest of the world can motivate its MNEs to keep intangible assets at the headquarters instead of placing them in the small low-tax jurisdiction. My analysis of the lower territorial tax is based on the following simulation. Let's imagine that in the first year of the simulation the foreign country permanently cuts its territorial corporate-income tax rate τ^c_{ft} from 25% to 20%. As is common in the literature (i.a., Mankiw and Weinzierl, 2006; Jaimovich and Rebelo, 2017; Spencer, 2022), I assume both countries satisfy their fiscal-budget constraints by adjusting government debt (b_{ht}, b_{ft}) and lump-sum taxes (τ^l_{ht}, τ^l_{ft}). Due to Ricardian equivalence, the exact combination of debt and lump-sum taxes does not matter for the equilibrium outcome. All remaining fiscal instruments are kept constant. I show the simulation results in Figures 2–5.

The cut in the foreign corporate tax rate incentivizes foreign MNEs to reduce their tangible as well as intangible FDI. In other words, the foreign MNEs start the process of reshoring. They decide to relocate production from overseas affiliates (y^f_{ht}) to the headquarters (y^f_{ft}). In the overseas affiliates, the reshoring inevitably comes along with layoffs (n^f_{ht}) and lower tangible investment (i^f_{ht}). At the headquarters, the foreign MNEs invest more in tangible capital (i^f_{ft}) and are so able to satiate the increased demand for their products on the domestic market (X^f_{ft}). The narrower tax differential between the home and foreign country ($\tau^c_{ft} - \tau^c_{ht}$) weakens the incentive to hold intangible assets in the small low-tax jurisdiction. The foreign MNEs hence place less intangibles overseas (z^f_{ht}) and rather keep them at the headquarters (z^f_{ft}).

The same considerations on the allocation of intangibles across the two jurisdictions are shared by the home MNEs. As in the case of the foreign MNEs, the cut in the corporate tax rate τ^c_{ft} encourages the home MNEs to decrease their holdings of intangibles in the low-tax jurisdiction (z^h_{ht}) and to simultaneously increase the amount of intangibles held in the high-tax jurisdiction (z^h_{ft}). Due to the foreign tax cut, the home MNEs conduct more tangible FDI (i^h_{ft}) and also increase their overseas workforce (n^h_{ft}). Not only do the home MNEs intensify production in their overseas affiliates (y^h_{ft}), but they additionally raise output at the headquarters (y^h_{ht}) because they are confronted with a stronger export demand ($\widetilde{X}^h_{ft}$). The increased product output at the headquarters has to be accompanied by a corresponding rise in factor inputs. The home MNEs have to carry out more tangible investment (i^h_{ht}) and employ more workers (n^h_{ht}) in the home country.

When it comes to product pricing, let me note that the export markup of the home MNEs $\widetilde{\mathcal{M}}^h_{ft}$ as well as the FDI markup of the foreign MNEs $\overline{\mathcal{M}}^f_{ht}$ increase slightly. This happens because the MNEs internalize cannibalization effects between export and FDI. If the MNEs ignored cannibalization, the markups $\widetilde{\mathcal{M}}^h_{ft}$ and $\overline{\mathcal{M}}^f_{ht}$ would not respond at all to the foreign corporate-tax cut. The two markups would depend only on the elasticity of the intermediate bundler and the corporate tax rate of the home country.

After describing the firms' reaction, let me discuss the response of macroeconomic ag-

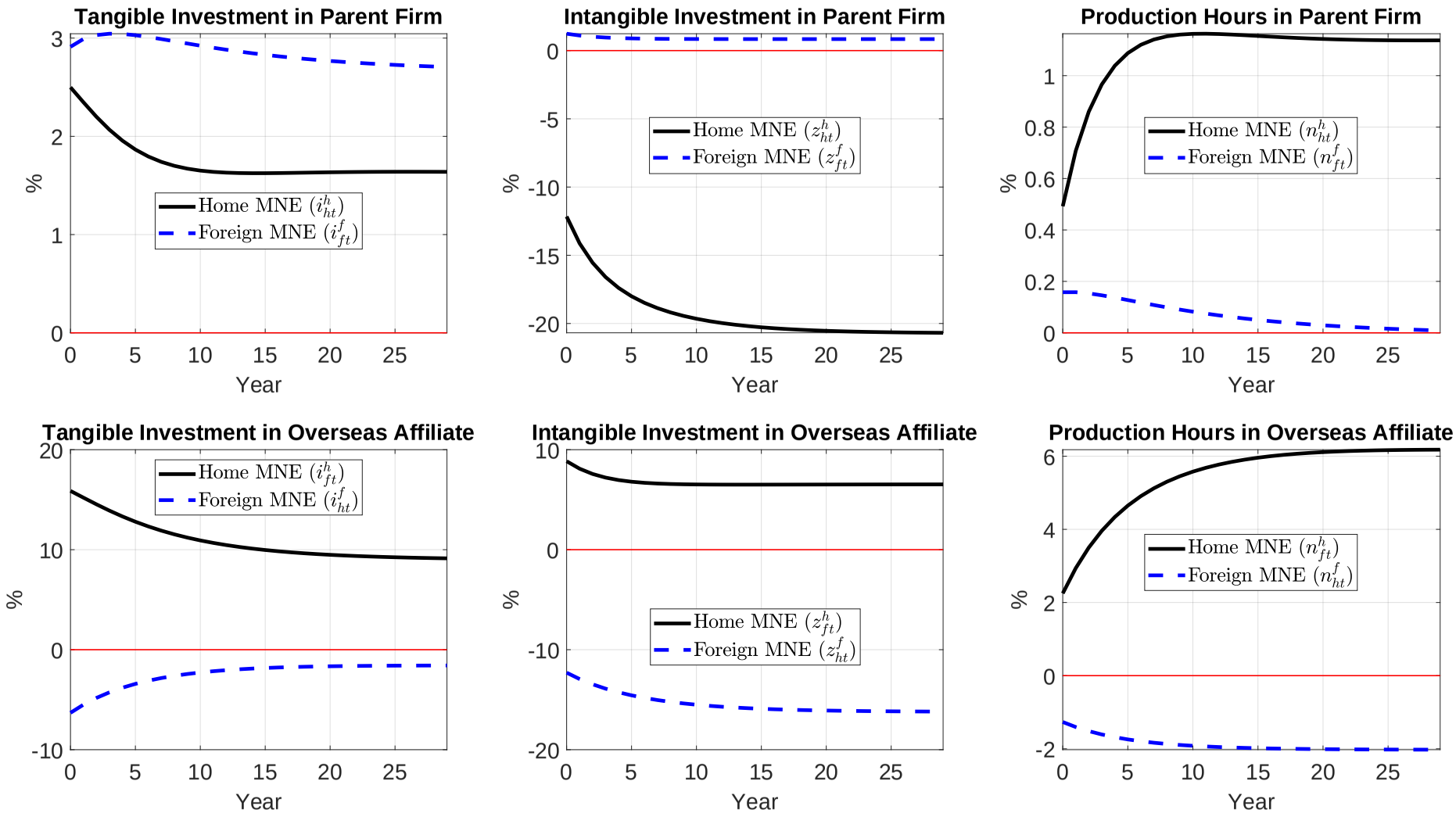

Figure 2: Permanent Cut in Foreign Territorial Corporate Tax Rate. Foreign country cuts its territorial corporate-income tax rate τ^c_{ft} from 25% to 20% in year $t = 0$. Variables are presented as deviations from initial steady state.

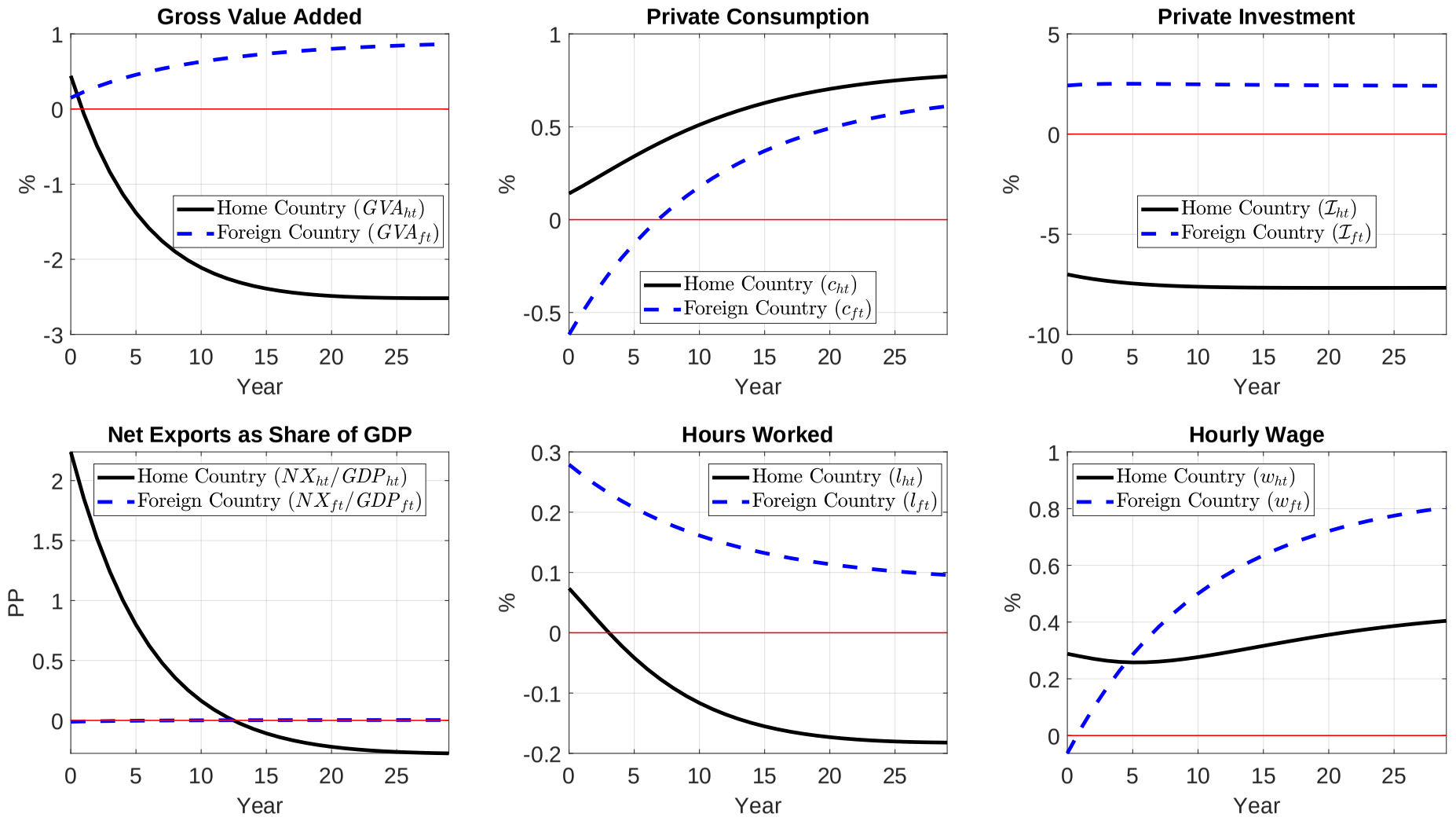

Figure 3: Permanent Cut in Foreign Territorial Corporate Tax Rate. Foreign country cuts its territorial corporate-income tax rate τ^c_{ft} from 25% to 20% in year $t = 0$. Variables are presented as deviations from initial steady state.

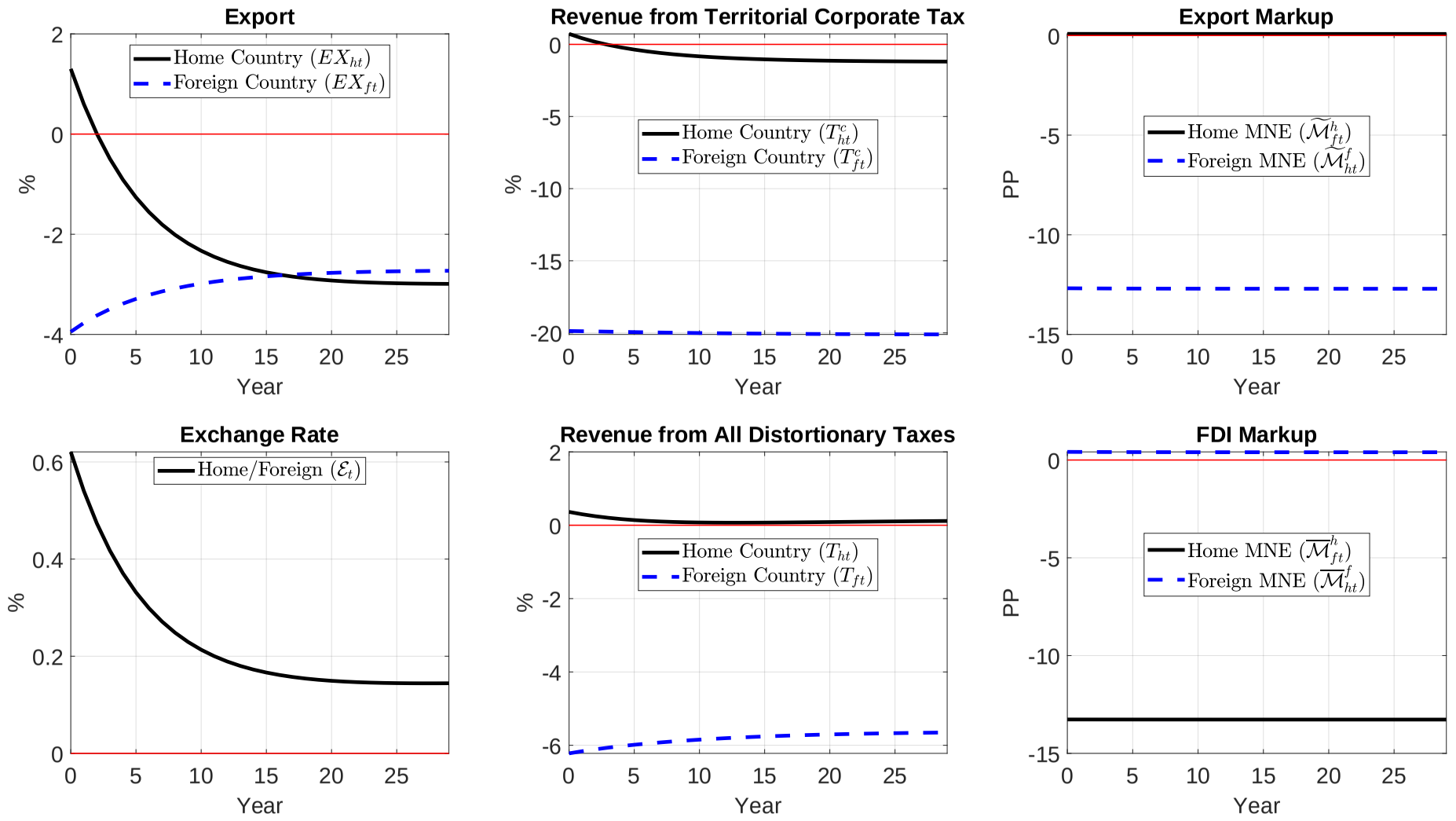

Figure 4: Permanent Cut in Foreign Territorial Corporate Tax Rate. Foreign country cuts its territorial corporate-income tax rate τ^c_{ft} from 25% to 20% in year $t = 0$. Variables are presented as deviations from initial steady state.

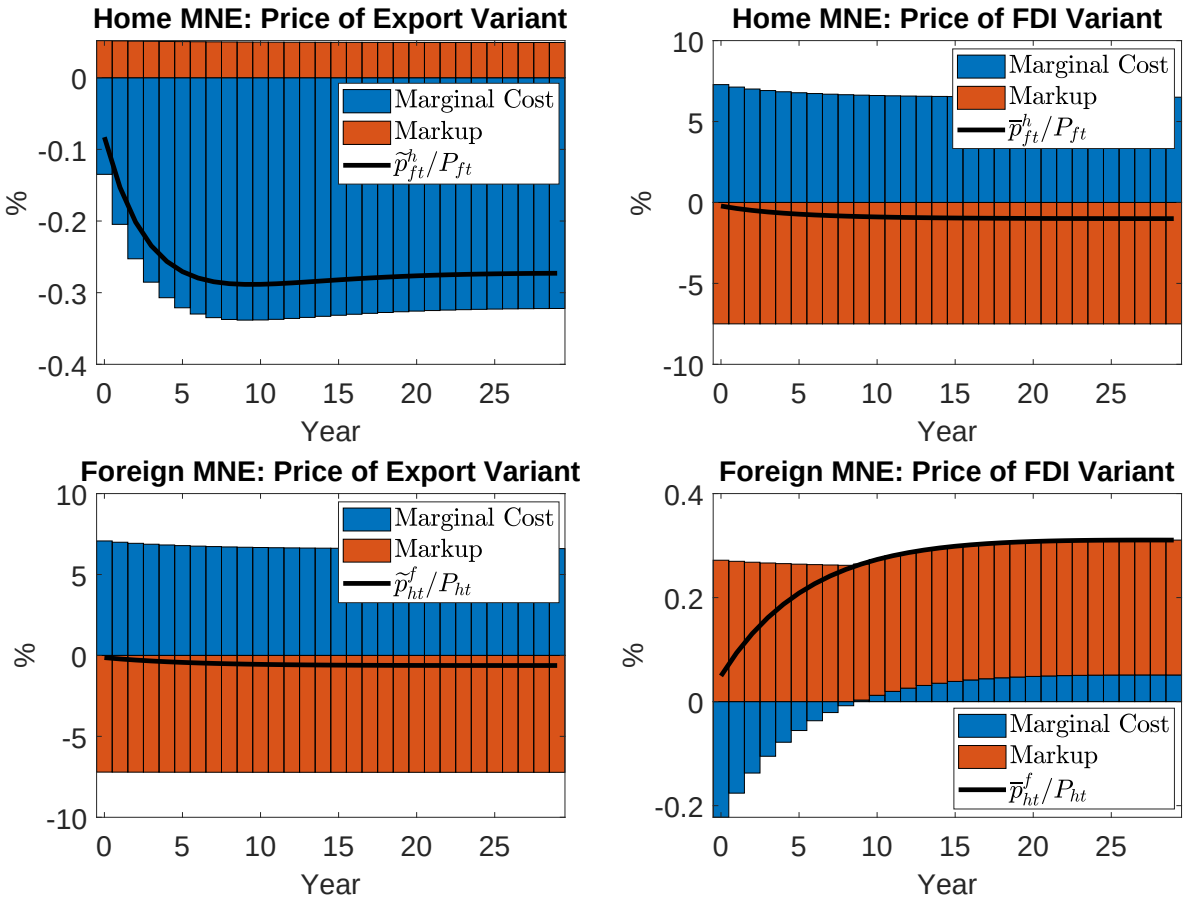

Figure 5: Permanent Cut in Foreign Territorial Corporate Tax Rate. Foreign country cuts its territorial corporate-income tax rate τ^c_{ft} from 25% to 20% in year $t = 0$. Variables are presented as deviations from initial steady state. The response of each relative price (black solid line) is decomposed into the contribution of the effective marginal cost (blue bars) and the contribution of the endogenous markup (red bars).

gregates. Let's begin with the aggregates of the foreign country, where the simulated tax shock originates. The lower corporate tax rate leads to a boost in gross value added (GVA_{ft}), which can be primarily attributed to the aforementioned higher tangible investment of domestic MNEs. The economic expansion is associated with a solid labor demand (l_{ft}) and consequently with a more generous hourly wage (w_{ft}). During the first few years of the simulation, an elevated real interest rate (r_{ft}) depresses private consumption (c_{ft}). However, in the long run, as the real interest rate eases, private consumption expands in line with higher dividends (d^f_t) and higher labor earnings. All firm entities in the foreign country decide to spend more on tangible as well as intangible capital. This generates a rise in the aggregate measure of investment ($\mathcal{I}_{ft}$). Total exports of the foreign country (EX_{ft}) drop immediately at the beginning of the simulation. The drop is driven by weaker exports of R&D services. The foreign MNEs start to place less intangible assets in the overseas affiliates (z^f_{ht}), which is recorded in the national-accounts statistics as a weaker cross-border supply of R&D services.

Next, let's investigate how the foreign tax shock affects the aggregate behavior of the home country. The smaller willingness of the foreign MNEs to locate their intangibles in the

overseas affiliates (z^f_{ht}) causes a fall in the headline investment of the home country ($\mathcal{I}_{ht}$). The stock of the intangibles that the foreign MNEs hold in the overseas affiliates (m^f_{ht}) descends to a lower steady-state level. In consequence, the parent firms of the foreign multinationals pay less royalty fees for the use of the intangibles that are kept in the overseas affiliates ($v^f_{ht} m^f_{ht-1}$). The national accounts book these lower royalty payments as a weaker export of royalty services from the home to the foreign country. The weakness in royalties explains why the total export of the home country (EX_{ht}) decreases over time. The pattern of exports is then mirrored in the declining trajectory of gross value added (GVA_{ht}). Households benefit from an increased hourly wage (w_{ht}), which more than compensates for a small reduction in the total hours worked (l_{ht}). In addition to the higher labor income, the households receive larger dividends (d^h_t) and can hence afford to spend more on consumption (c_{ht}). Furthermore, the foreign tax cut negatively impacts the corporate-tax revenue of the home government (T^c_{ht}). The loss in the corporate-tax revenue is nevertheless limited because the relevant aggregate tax base—the net operating surplus (NOS_{ht})—diminishes only slightly. The tax base of the foreign MNEs' affiliates shrinks as these entities reduce their intangible-asset holdings (m^f_{ht}). But at the same time, the tax base of the home MNEs' parents expands due to the stronger export sales ($\widetilde{X}^h_{ft}$).

5 Tax on Overseas Intangible Income

The second instrument by which the foreign government can motivate its MNEs to keep intangible assets at the headquarters is the worldwide taxation of intangible income. The foreign government can impose a tax on the royalty income that the foreign MNEs generate in the small low-tax jurisdiction. In comparison to the territorial tax τ^c_{ft}, the tax on the overseas royalty income τ^m_{ft} is more targeted. Only the foreign MNEs are directly affected; the home MNEs are impacted solely through general-equilibrium effects. In Figures 6–8, I present how the MNEs and the macroeconomic aggregates respond to the introduction of τ^m_{ft}. The simulated scenario assumes that the new tax, which is set to five percent, is introduced immediately at the beginning of the simulation. The fiscal constraints of the home and foreign country are again fulfilled by adjusting government bonds (b_{ht}, b_{ft}) and lump-sum taxes (τ^l_{ht}, τ^l_{ft}).

The tax on the overseas royalty income discourages the foreign MNEs from locating intangible assets in the small low-tax jurisdiction.[15] The foreign MNEs hence cut their intangible investment in the overseas affiliates (z^f_{ht}). They instead prefer to raise intangible investment at the headquarters (z^f_{ft}). The decision of the foreign MNEs to change the allocation of their intangible assets influences dramatically the macroeconomic aggregates of the small low-tax jurisdiction. The headline investment of the home country ($\mathcal{I}_{ht}$) drops massively. Hand in hand with investment, total imports (IM_{ht}) fall, reflecting the depressed im-

[15] The model analysis abstracts from the possibility of corporate inversions. In practice, corporate inversions face substantial regulation, which often makes them impossible (Gravelle and Marples, 2021).

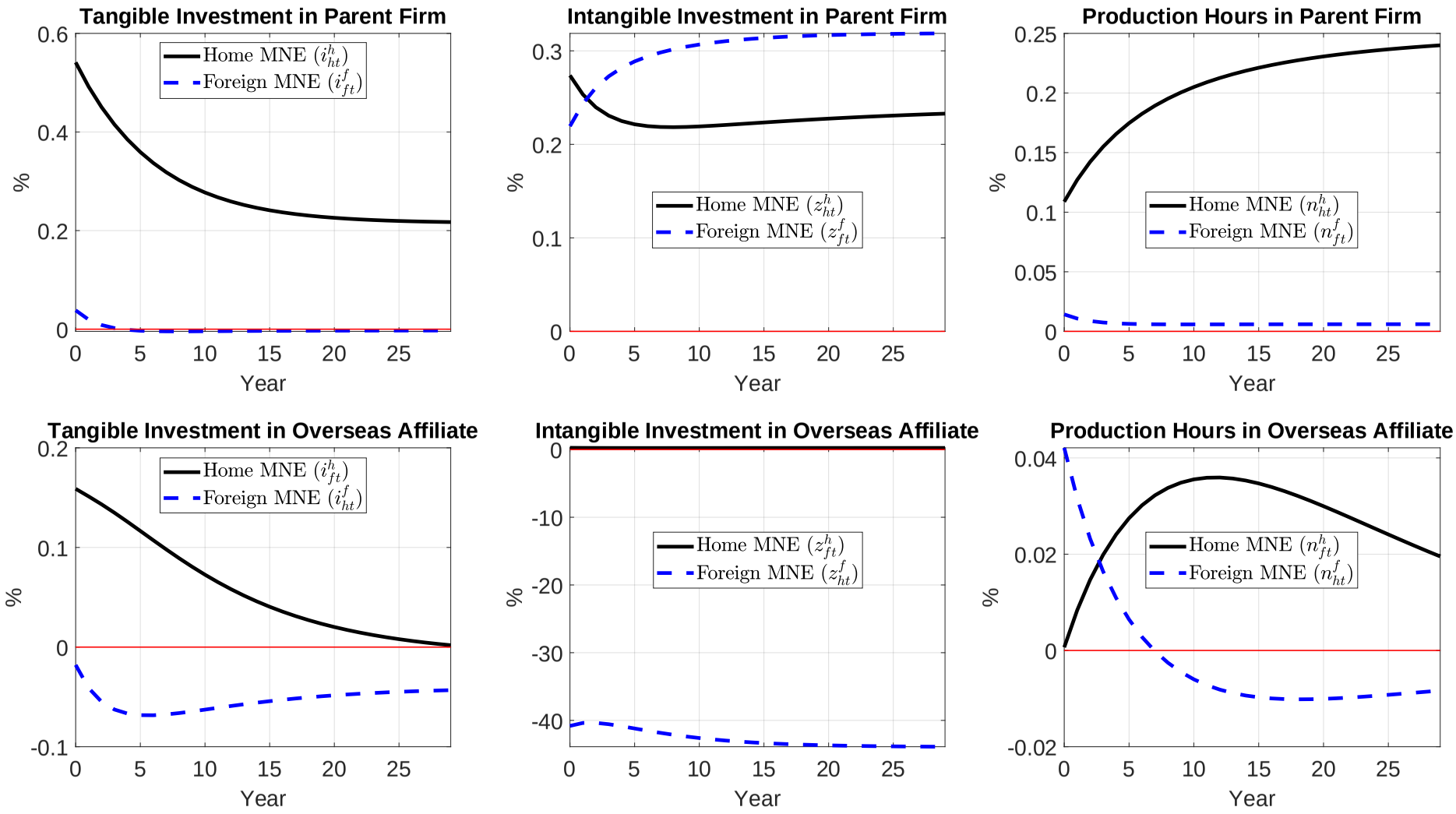

Figure 6: Permanent Hike in Foreign GILTI Tax Rate. Foreign country hikes its tax rate τ^m_{ft}, which is imposed on intangible income that foreign MNEs report in their overseas affiliates. The tax rate increases from 0% to 5% in year $t = 0$. Variables are presented as deviations from initial steady state.

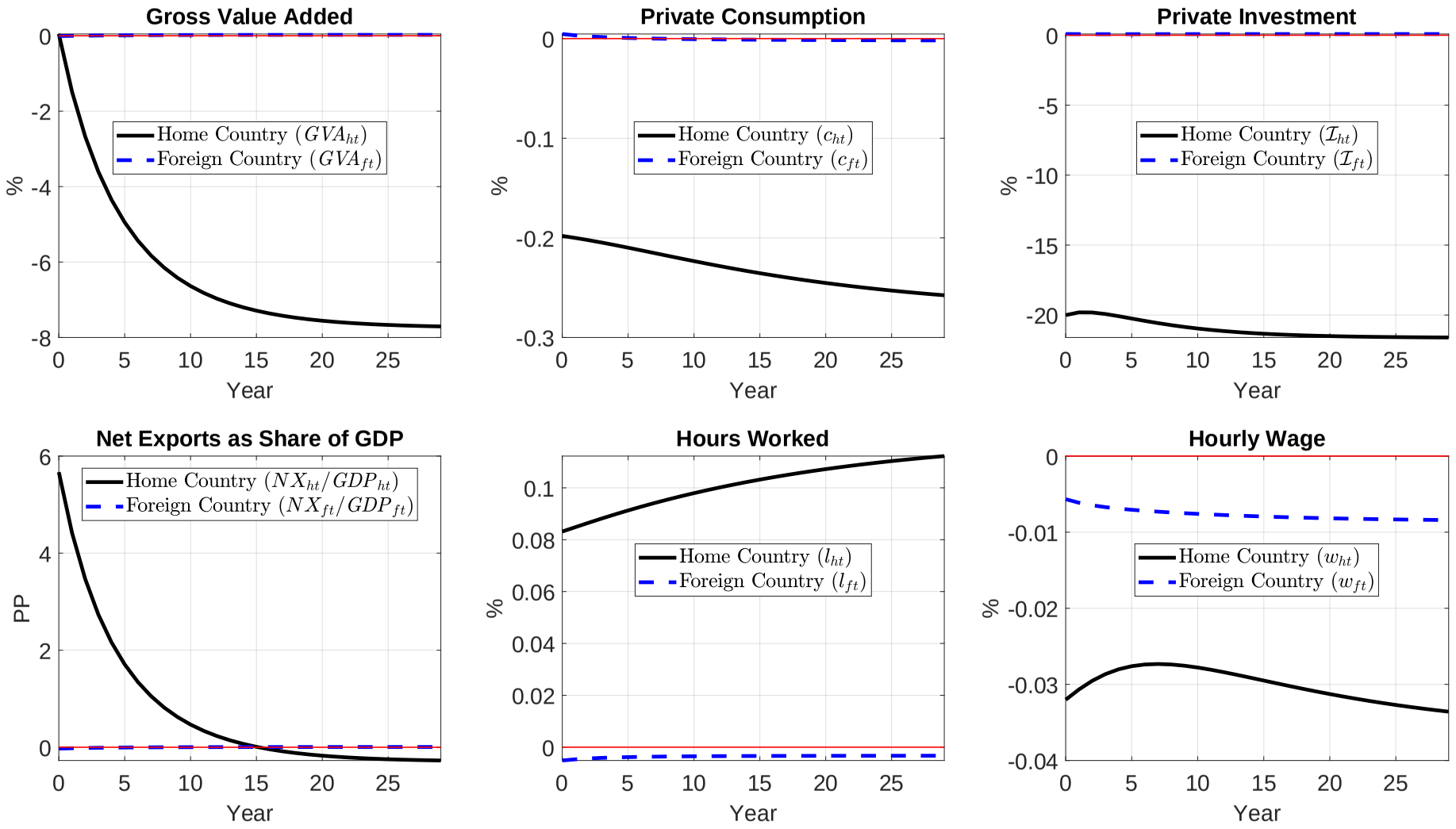

Figure 7: Permanent Hike in Foreign GILTI Tax Rate. Foreign country hikes its tax rate τ_{ft}^{m}, which is imposed on intangible income that foreign MNEs report in their overseas affiliates. The tax rate increases from 0% to 5% in year $t = 0$. Variables are presented as deviations from initial steady state.

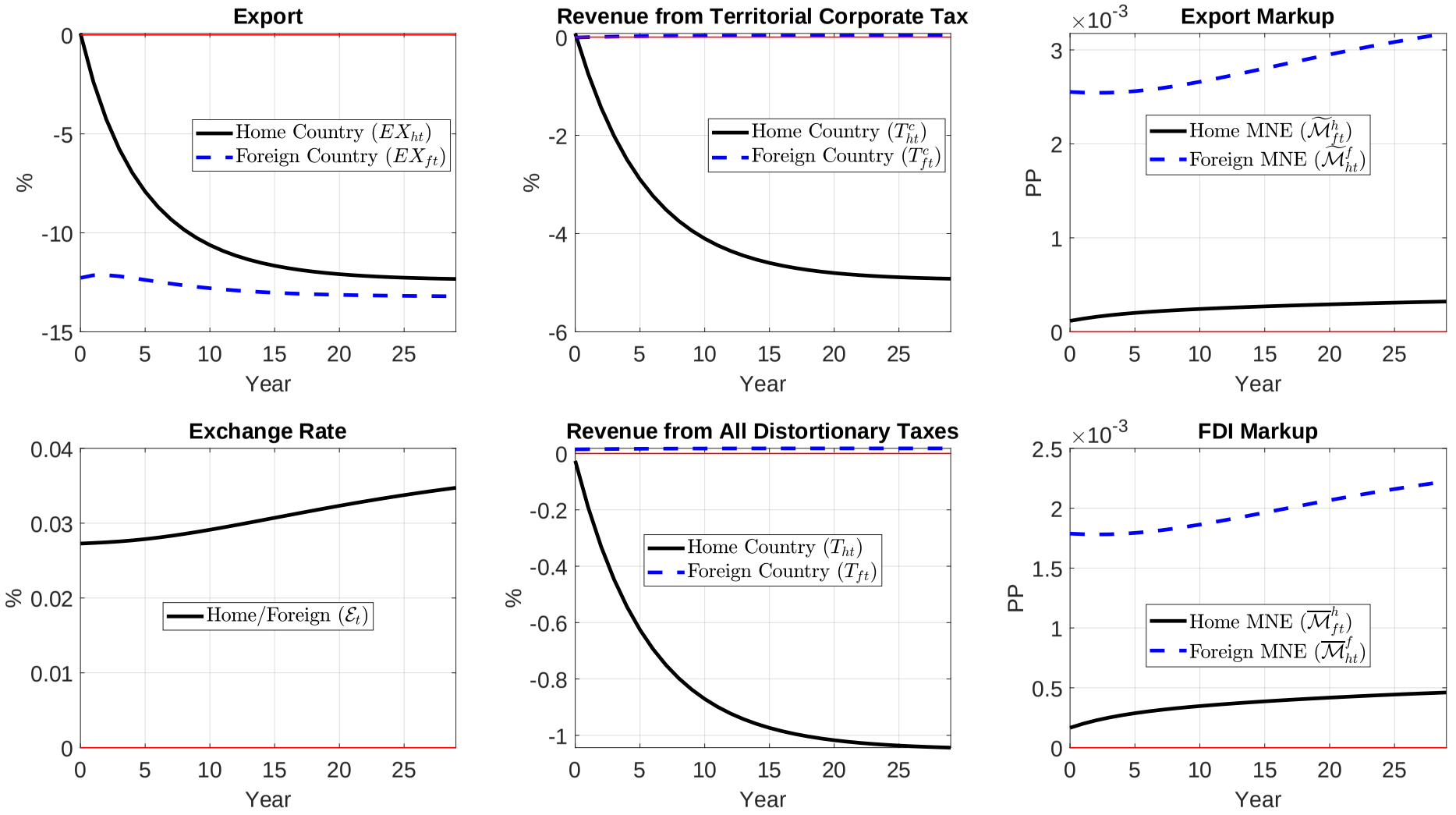

Figure 8: Permanent Hike in Foreign GILTI Tax Rate. Foreign country hikes its tax rate τ^m_{ft}, which is imposed on intangible income that foreign MNEs report in their overseas affiliates. The tax rate increases from 0% to 5% in year $t = 0$. Variables are presented as deviations from initial steady state.

port of R&D services (z^f_{ht}). The reduced intangible investment of the foreign MNEs in the small low-tax jurisdiction leads to a decline in the corresponding stock of intangible capital (m^f_{ht}). Consequently, the parent firms of the foreign MNEs pay less royalty charges to the overseas affiliates ($v^f_{ht} m^f_{ht-1}$). The smaller royalty payments are booked in the system of national accounts as a weaker export of royalty services from the home to the foreign country. The royalties drive the total exports of the home country (EX_{ht}) downward and also cause a decline in gross value added (GVA_{ht}).

Moreover, the decision of the foreign country to introduce worldwide taxation of intangible income has negative consequences for the corporate-tax revenue of the home government (T^c_{ht}). The falling exports of royalty services ($v^f_{ht} m^f_{ht-1}$) decrease the tax base of the foreign MNEs' affiliates. The home government therefore collects less revenue from its territorial corporate tax τ^c_{ht}. In order to satisfy the fiscal-budget constraint, the home government has to impose higher lump-sum taxation on households. The households react by restricting their consumption (c_{ht}). Despite the large adjustments in many of the macroeconomic aggregates, the labor market of the home country does not experience any major changes. This is due to the fact that the intangible FDI of the foreign MNEs (m^f_{ht}) does not exhibit any tight links to the host economy. Also the endogenous product markups of both the home and foreign MNEs stay widely unaffected. Production costs as well as the shares of product sales generated via export and FDI, which together determine the endogenous markups, barely react to the introduction of τ^m_{ft}.

6 Conclusion

The paper investigated how a small low-tax economy adjusts to foreign corporate-tax shocks. Concretely, I analyzed two corporate-tax instruments. The first instrument was the territorial corporate-income tax; the second was the worldwide taxation of intangible income. The analysis was conducted by means of a dynamic macroeconomic model, in which multinational firms undertake tangible as well as intangible FDI. The paper also showed that corporate taxes distort the price setting of a multinational if one allows for cannibalization effects between exports and FDI. More generally, the model developed here could be potentially useful when assessing the impact of other geo-economic risks on a small open economy.

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A Dividend Maximization of a Home MNE

A home MNE $\omega \in \Omega_h$ maximizes the discounted stream of its dividends by controlling the following variables:

$$\left\{p^h_{\omega ht}, \widetilde{p}^h_{\omega ft}, \overline{p}^h_{\omega ft}, n^h_{\omega ht}, n^h_{\omega ft}, \overline{j}^h_{\omega ht}, \widetilde{j}^h_{\omega ht}, i^h_{\omega ht}, i^h_{\omega ft}, z^h_{\omega ht}, z^h_{\omega ft}, k^h_{\omega ht}, k^h_{\omega ft}, m^h_{\omega ht}, m^h_{\omega ft}, m^h_{\omega t}, y^h_{\omega ht}, y^h_{\omega ft}\right\}_{t=0}^{\infty}$$

The MNE chooses product prices ($p^h_{\omega ht}$, $\widetilde{p}^h_{\omega ft}$, $\overline{p}^h_{\omega ft}$), hours spent in production ($n^h_{\omega ht}$, $n^h_{\omega ft}$), hours spent in R&D ($\overline{j}^h_{\omega ht}$, $\widetilde{j}^h_{\omega ht}$), tangible investment ($i^h_{\omega ht}$, $i^h_{\omega ft}$), intangible investment ($z^h_{\omega ht}$, $z^h_{\omega ft}$), tangible-capital stocks ($k^h_{\omega ht}$, $k^h_{\omega ft}$), intangible-capital stocks ($m^h_{\omega ht}$, $m^h_{\omega ft}$), global know-how ($m^h_{\omega t}$), and product output ($y^h_{\omega ht}$, $y^h_{\omega ft}$). The optimization problem of the MNE is constrained by product demand, production technology, and the law of motion of capital. For-

mally, one can express the dividend-maximization problem as follows:

$$\max \sum_{t=0}^{\infty} (\beta_h)^t \frac{\Lambda_{ht}}{\Lambda_{h0}} \frac{P_{h0}}{P_{ht}} \Bigg[(1-\tau^c_{ht}) \left(p^h_{\omega ht} X^h_{\omega ht} + S_t \widetilde{p}^h_{\omega ft} \widetilde{X}^h_{\omega ft} - W_{ht} n^h_{\omega ht} - W_{ht} \widetilde{j}^h_{\omega ht} \right)$$
$$+ S_t \left(1-\tau^c_{ft}\right) \left(\overline{p}^h_{\omega ft} \overline{X}^h_{\omega ft} - W_{ft} n^h_{\omega ft} \right)$$
$$- P_{ht} \left(i^h_{\omega ht} - \tau^c_{ht} \delta_h k^h_{\omega ht-1} \right) - S_t P_{ft} \left(i^h_{\omega ft} - \tau^c_{ft} \delta_f k^h_{\omega ft-1} \right)$$
$$- \left(W_{ht} \overline{j}^h_{\omega ht} - \tau^c_{ht} U^h_{\omega ht} \psi^\rho_{ht} m^h_{\omega ht-1} \right) - \tau^c_{ht} S_t U^h_{\omega ft} z^h_{\omega ft} + S_t \tau^c_{ft} U^h_{\omega ft} \psi^\rho_{ft} m^h_{\omega ft-1}$$
$$+ S_t V^h_{\omega ht} m^h_{\omega ht-1} \left(\tau^c_{ft} - \tau^c_{ht} \right) + V^h_{\omega ft} m^h_{\omega ft-1} \left(\tau^c_{ht} - \tau^c_{ft} - \tau^m_{ht} \right) \Bigg]$$

s.t.

$$y^h_{\omega ht} = a^h_{ht} \left[\left(k^h_{\omega ht-1} \right)^{\gamma_h} \left(m^h_{\omega t-1} \right)^{1-\gamma_h} \right]^{\alpha_h} \left(n^h_{\omega ht} \right)^{1-\alpha_h}$$
$$y^h_{\omega ft} = a^h_{ft} \left[\left(k^h_{\omega ft-1} \right)^{\gamma_f} \left(m^h_{\omega t-1} \right)^{1-\gamma_f} \right]^{\alpha_f} \left(n^h_{\omega ft} \right)^{1-\alpha_f}$$
$$m^h_{\omega t} = \left[\left(\mu^h \right)^{\frac{1}{\lambda^h}} \left(m^h_{\omega ht} \right)^{\frac{\lambda^h-1}{\lambda^h}} + \left(1-\mu^h \right)^{\frac{1}{\lambda^h}} \left(m^h_{\omega ft} \right)^{\frac{\lambda^h-1}{\lambda^h}} \right]^{\frac{\lambda^h}{\lambda^h-1}}$$
$$k^h_{\omega ht} = \left(1-\delta_h\right) k^h_{\omega ht-1} + i^h_{\omega ht} - \frac{\Xi_h}{2} \left(\frac{i^h_{\omega ht}}{k^h_{\omega ht-1}} - \delta_h \right)^2 k^h_{\omega ht-1}$$
$$k^h_{\omega ft} = \left(1-\delta_f\right) k^h_{\omega ft-1} + i^h_{\omega ft} - \frac{\Xi_f}{2} \left(\frac{i^h_{\omega ft}}{k^h_{\omega ft-1}} - \delta_f \right)^2 k^h_{\omega ft-1}$$
$$m^h_{\omega ht} = \left(1-\rho_h\right) m^h_{\omega ht-1} + z^h_{\omega ht} - \frac{\Upsilon_h}{2} \left(\frac{z^h_{\omega ht}}{m^h_{\omega ht-1}} - \rho_h \right)^2 m^h_{\omega ht-1}$$
$$m^h_{\omega ft} = \left(1-\rho_f\right) m^h_{\omega ft-1} + z^h_{\omega ft} - \frac{\Upsilon_f}{2} \left(\frac{z^h_{\omega ft}}{m^h_{\omega ft-1}} - \rho_f \right)^2 m^h_{\omega ft-1}$$
$$z^h_{\omega ht} = e_{ht} \overline{j}^h_{\omega ht}$$
$$z^h_{\omega ft} = e_{ht} \widetilde{j}^h_{\omega ht}$$
$$X^h_{\omega ht} = \frac{1}{|\Omega|} \left(\frac{p^h_{\omega ht}}{P_{ht}} \right)^{-\theta_h} X_{ht}$$
$$\widetilde{X}^h_{\omega ft} = \frac{1-\xi_f}{|\Omega|} \left(\widetilde{p}^h_{\omega ft} \right)^{-\nu_f} \left[\xi_f \left(\overline{p}^h_{\omega ft} \right)^{1-\nu_f} + \left(1-\xi_f\right) \left(\widetilde{p}^h_{\omega ft} \right)^{1-\nu_f} \right]^{\frac{\nu_f-\theta_f}{1-\nu_f}} \left(P_{ft} \right)^{\theta_f} X_{ft}$$
$$\overline{X}^h_{\omega ft} = \frac{\xi_f}{|\Omega|} \left(\overline{p}^h_{\omega ft} \right)^{-\nu_f} \left[\xi_f \left(\overline{p}^h_{\omega ft} \right)^{1-\nu_f} + \left(1-\xi_f\right) \left(\widetilde{p}^h_{\omega ft} \right)^{1-\nu_f} \right]^{\frac{\nu_f-\theta_f}{1-\nu_f}} \left(P_{ft} \right)^{\theta_f} X_{ft}$$
$$y^h_{\omega ht} = X^h_{\omega ht} + \eta^h_t \widetilde{X}^h_{\omega ft}$$
$$y^h_{\omega ft} = \overline{X}^h_{\omega ft}$$

B Parameters Calibrated by Steady-State Relations

I can rewrite steady-state relations of the model in a way that enables me to pin down the calibration of the following three parameters. The below equations deliver parameter values on the basis of steady-state great ratios, which can be observed empirically. To compute the depreciation rate of tangible capital, I divide the great ratio of tangible investment to GDP by the great ratio of tangible capital to GDP:

$$\delta_h = \frac{\frac{i_h^h|\Omega_h| + i_h^f|\Omega_f|}{GDP_h}}{\frac{k_h^h|\Omega_h| + k_h^f|\Omega_f|}{GDP_h}}.$$

Similarly, if one divides the ratio between intangible investment and GDP by the ratio between intangible capital and GDP, one obtains the depreciation rate of intangible capital:

$$\rho_h = \frac{\frac{u_h^h z_h^h|\Omega_h| + u_h^f z_h^f|\Omega_f|}{GDP_h}}{\frac{u_h^h m_h^h|\Omega_h| + u_h^f m_h^f|\Omega_f|}{GDP_h}}.$$

Under the assumption that households' discount factors are identical across countries ($\beta_h = \beta_f = \beta$), the weight of tangible capital in the production function can be pinned down by the relation:

$$\gamma_h = \frac{(1-\alpha_h)\left[\frac{1}{\beta} - 1 + (1-\tau_h^c)\,\delta_h\right]}{\alpha_h\,(1-\tau_h^c)} \frac{k_h^h|\Omega_h| + k_h^f|\Omega_f|}{GDP_h} \left[\frac{w_h l_h \mathcal{P}_h}{GVA_h}\left(1 - \frac{\tau_h^s c_h \mathcal{P}_h}{GDP_h}\right) - \frac{u_h^h z_h^h|\Omega_h| + u_h^f z_h^f|\Omega_f|}{GDP_h} + \frac{u_h^f z_h^f|\Omega_f|}{GDP_h} - \frac{1}{\psi^u}\frac{\mathcal{E} u_f^h z_f^h|\Omega_h|}{GDP_h}\right]^{-1},$$

which contains the following great ratios: tangible capital to GDP, compensation of labor to gross value added, sales-tax revenue to GDP, intangible investment to GDP, import of R&D services to GDP, and export of R&D services to GDP.

T: +353 (0)1 224 6000
www.centralbank.ie
publications@centralbank.ie

Bosca PO 559, Baile Átha Cliath 1, Éire
PO Box 559, Dublin 1, Ireland