DEUTSCHE
BUNDESBANK
EUROSYSTEM

Discussion Paper

Deutsche Bundesbank
No 40/2026

Tariffs, cohort redistribution, and the world real interest rate

Anne Ernst
Matthias Schön
Nikolai Stähler

Discussion Papers represent the authors' personal opinions and do not necessarily reflect the views of the Deutsche Bundesbank or the Eurosystem.

Editorial Board: Daniel Foos
Stephan Jank
Thomas Kick
Martin Kliem
Malte Knüppel
Christoph Memmel
Hannah Paule-Paludkiewicz

Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0

Please address all orders in writing to: Deutsche Bundesbank, Press and Public Relations Division, at the above address or via email: www.bundesbank.de/contact

Internet http://www.bundesbank.de

Reproduction permitted only if source is stated.

DOI https://doi.org/10.71734/DP-2026-40
ISBN 978-3-98848-099-6
ISSN 2941-7503

Tariffs, Cohort Redistribution, and the World Real Interest Rate*

Anne Ernst
Deutsche Bundesbank

Matthias Schön
Deutsche Bundesbank

Nikolai Stähler
Deutsche Bundesbank

Abstract

This paper studies how tariffs affect the world real interest rate when tariff revenue is redistributed across households with different saving propensities. We build a three-region Blanchard–Yaari OLG model with differentiated-goods trade, endogenous net foreign assets, and a world interest rate pinned down by global asset-market clearing. Tariffs distort trade and investment prices, but they also generate fiscal revenue and shift resources across working-age and retired households. This fiscal incidence is central because cohorts differ in their saving behavior. In permanent-tariff experiments, recycling revenue to retirees lowers global saving and raises r^*; recycling it to workers supports saving and can lower r^*. These interest-rate movements feed back into investment, output, consumption, and external positions. Retaliation magnifies output losses and erodes the unilateral consumption gain of the tariff-imposing region. The results show that the macroeconomic effects of protectionism depend not only on trade elasticities and terms of trade, but also on how tariff revenues are distributed across cohorts and how global asset markets clear. The fiscal use of tariff revenue is therefore a first-order determinant of the aggregate and international transmission of trade policy.

Keywords: tariffs, trade conflict, protectionism, international trade, world real interest rate, net foreign assets, overlapping generations, pay-as-you-go pensions

JEL codes: F12, F13, F40, D57, E27

*Contact address: Deutsche Bundesbank, Mainzer Landstraße, 60325 Frankfurt, Germany. E-mail: anne.ernst@bundesbank.de, matthias.schoen1@bundesbank.de, nikolai.staehler@bundesbank.de.
The views expressed in this paper are those of the author(s) and do not necessarily coincide with the views of the Deutsche Bundesbank or the Eurosystem. We would like to thank participants of Bundesbank DSGE group and the Applied Economics Meeting for helpful comments.

1 Introduction

Trade policy has moved from the technocratic margins to the center of contemporary political economy. Across advanced and emerging economies, governments use tariffs and the threat of retaliation not only as instruments of commercial policy, but also as tools of geopolitical bargaining, industrial strategy, and domestic coalition-building. Yet the macroeconomic implications of this shift remain incompletely understood. Tariffs are typically studied through their effects on trade flows, terms of trade, and production distortions. But tariffs also raise government revenue and change the distribution of resources. When households differ in saving behavior, the fiscal incidence of this revenue can alter aggregate saving. In an integrated world economy, these saving responses need not remain domestic: they change external positions and the equilibrium return that clears global asset markets.

This paper studies this channel in a three-region overlapping-generations (OLG) model with differentiated-goods trade, endogenous net foreign asset positions, and a world real interest rate r^* determined by global asset-market clearing. Tariffs affect the economy through three linked margins: they change relative prices, generate fiscal revenue, and alter desired saving by shifting resources between working-age and retired households. The resulting change in saving is transmitted internationally through net foreign asset accumulation and the world interest rate. The contribution is to show how the change in saving interacts with terms-of-trade movements, international wealth redistribution, and endogenous external adjustment. This interaction shapes the effects of protectionism on investment, consumption, output, and r^*.

Two features of the model are central for the mechanism. First, overlapping generations make the fiscal incidence of tariff revenue relevant for aggregate saving. Transfers to working-age households and transfers to retirees have different effects because the two groups differ in their horizons, income profiles, and asset positions. Second, endogenous net foreign asset positions allow these saving responses to translate into international adjustment. A tariff-induced shift in desired saving changes bond accumulation, trade balances, and the world interest rate rather than being absorbed by an exogenously imposed external position. This distinguishes our environment from standard open-economy DSGE models in which stationarity is often obtained by tying net foreign assets to an exogenous reference level through a financial friction.[1]

The paper is best read as a mechanism paper with disciplined quantitative illustration. It is not our goal to provide a full empirical assessment of any particular tariff episode. Nor do we aim to match current global imbalances one-for-one in the initial steady state. Instead, we use a parsimoniously calibrated quantitative model to trace how tariffs reallocate income across households, how these reallocations affect desired saving and net foreign asset positions, and how the resulting general-equilibrium forces shape r^*. Domestic fiscal recycling is implemented through a stylized pay-as-you-go (PAYG) pension

[1] In standard open-economy DSGE models (Obstfeld and Rogoff, 1995), stationarity is often obtained by introducing a financial-market friction that becomes active when net foreign assets deviate from an exogenously fixed reference level; see Schmitt-Grohe and Uribe (2003), Lubik (2007), and Benigno (2009). This approach makes the long-run net foreign asset position largely independent of structural policy changes. In our framework, by contrast, net foreign asset positions are equilibrium outcomes of global asset-market clearing; see also Bodenstein (2011).

block, which provides a transparent institutional device for mapping tariff revenue into income shifts toward working-age households, retired households, or both. The PAYG structure is therefore not the main focus of the paper, but helps make the redistribution channel transparent.

We study permanent 25 percent ad valorem tariffs on consumption and investment imports between regions a and b. In the main text, we consider two tariff scenarios. The first is a unilateral tariff imposed by one region on another. The second is a symmetric retaliation scenario in which the targeted region responds in kind. Across both scenarios, we compare alternative tariff-revenue recycling rules. In the baseline, tariff revenue is recycled through a combination of lower payroll contributions and higher pension benefits. We then consider two polar alternatives in which tariff revenue is used exclusively either to lower payroll contributions or to raise pension benefits. This comparison isolates the role of domestic fiscal incidence in the transmission from tariffs to saving, external positions, and r^*. The analysis further distinguishes conceptually between the direct tariff distortion, the fiscal redistribution across cohorts, and the endogenous interest-rate feedback generated by global asset-market clearing.

Our results can be summarized in three main findings. First, under benchmark recycling, a unilateral tariff lowers output in both the targeted region and the tariff-imposing region, but raises aggregate consumption in the tariff-imposing region. Relative-price movements and domestic fiscal recycling redistribute real resources toward the tariff-imposing region even though domestic production contracts. Second, retaliation eliminates the long-run consumption gain in the tariff-imposing region and deepens the contraction in the regions engaged in the trade conflict. Once both regions impose tariffs, relative-price movements no longer redistribute resources in one direction only, and the unilateral consumption gain disappears. Third, the domestic cohort incidence of tariff-revenue recycling is central for the long-run response of r^*. Recycling tariff revenue primarily toward retired households lowers aggregate saving and raises r^*. Recycling it primarily toward working-age households attenuates this effect and can reverse it if the induced rise in saving is sufficiently strong. These results show how a standard OLG saving channel interacts with tariff-induced relative-price movements, external adjustment, and global asset-market clearing.

The paper relates to three strands of the literature. A first strand studies the macroeconomic effects of tariffs in quantitative trade and production-network environments. Recent contributions include Baqaee and Farhi (2024), Ernst, Hinterlang, Jäger, and Stähler (2026), and Auray, Devereux, and Eyquem (2025). These papers emphasize distortions in trade flows and production, both with and without retaliation. Our focus instead is on how tariffs reallocate income across households and regions with heterogeneous saving behavior, and how this redistribution feeds back into equilibrium external positions and the world real interest rate. A second strand studies tariffs in environments with intergenerational heterogeneity. Our closest reference is Bettendorf and Heijdra (2001), who analyze tariff shocks in a dynamic overlapping-generations model and highlight intergenerational distribution effects. Our paper differs by embedding this channel in a multi-region setting with endogenous net foreign asset positions and an endogenous world real interest rate. A third strand examines the relationship between tariffs, saving, external balances, and interest rates. Mehrotra and Waugh (2025) analyze tariffs and the interest-rate response in a heterogeneous-agent trade model. Alessandria, Ding, Khan, and Mix (2025) study

how alternative uses of tariff revenue shape macroeconomic outcomes. Our contribution to this literature is to show that the cohort incidence of tariff-revenue recycling is central for the long-run response of the equilibrium world real interest rate.

More broadly, the paper identifies a macro-financial transmission channel of trade policy that operates through saving reallocation. In our framework, tariffs and retaliation do not only distort trade flows and production. They also redistribute income across cohorts and regions with heterogeneous saving behavior. This redistribution changes global desired saving, shifts net foreign asset positions, and alters the equilibrium world real interest rate. The paper therefore complements standard tariff analyses by focusing on the interaction between trade policy, fiscal incidence, and global asset-market clearing.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 describes the calibration. Section 4 reports the quantitative results for unilateral tariffs, retaliation, and alternative revenue-recycling rules. Section 5 concludes.

2 The model

We study a three-region overlapping-generations world economy with trade in differentiated goods, tariff policy, international asset trade, and region-specific PAYG pension systems. Regions are indexed by $i \in \mathcal{I} \equiv \{a, b, c\}$, where a denotes the United States, b Europe, and c the Rest of the World. Time is annual. Unless stated otherwise, all real variables for region i are measured in units of the region-i consumption basket, so that $CPI_t^i \equiv 1$ is the local numeraire. Uppercase variables denote aggregates per working-age agent in region i, consistent with the demographic normalization introduced below. For bilateral objects, we use an origin–destination convention: $x_t^{j,i}$ denotes a quantity, price, or policy wedge associated with a good produced in j and absorbed in i. A globally traded one-period real bond yields gross return R_t. The world real interest rate is not imposed exogenously; it is the return that clears the global bond market jointly across all regions. This global closure lets net foreign asset positions adjust endogenously without imposing a region-specific external-debt target. Tariff-induced redistribution across regions and cohorts therefore affects desired saving, net foreign asset positions, and, in equilibrium, the world real interest rate. The remainder of this section presents demographics, household behavior, aggregation, production, financial intermediation, fiscal policy, international trade, and the competitive equilibrium.

2.1 Demographics

Following Gertler (1999), we divide the population in each region i into working-age agents, $N_t^{w,i}$, and retired agents, $N_t^{r,i}$. A working-age agent remains working-age with probability $\omega^i \in (0, 1)$ and retires with probability $1 - \omega^i$. A retired agent survives to the next period with probability $\gamma^i \in (0, 1)$. These transition probabilities are constant within each life-cycle state and deliver tractable aggregation (Blanchard, 1985; Weil, 1989).

In the benchmark specification, we normalize the measure of working-age agents to be constant in each region. Specifically, in every period an inflow of new working-age agents of measure $(1 - \omega^i)N_t^{w,i}$ exactly offsets transitions from working age into retirement, so that

$$N_{t+1}^{w,i} = N_t^{w,i} \equiv N^{w,i} \qquad \forall t.$$

The measure of retired agents then evolves according to

$$N_{t+1}^{r,i} = (1-\omega^i)N^{w,i} + \gamma^i N_t^{r,i}.$$

In steady state,

$$N^{r,i} = \frac{1-\omega^i}{1-\gamma^i} N^{w,i},$$

and

$$\Psi^i \equiv \frac{N^{r,i}}{N^{w,i}} = \frac{1-\omega^i}{1-\gamma^i}, \tag{1}$$

where Ψ^i denotes the retiree dependency ratio.

Relative region size and normalization. Let $N^w \equiv \sum_{k\in\mathcal{I}} N^{w,k}$ denote the world measure of working-age agents. Define the relative size of region i as

$$s_i \equiv \frac{N^{w,i}}{N^w}, \qquad \sum_{i\in\mathcal{I}} s_i = 1. \tag{2}$$

These size shares enter goods-market clearing and external accounts through the ratios s_k/s_i.

We express all region-level aggregates in per-working-age units. Henceforth, uppercase variables denote aggregates per working-age agent in region i. This includes economy-wide aggregates such as C_t^i, Y_t^i, A_t^i, and I_t^i, as well as group-specific aggregates such as $C_t^{w,i}$ and $C_t^{r,i}$. Lowercase variables such as $c_t^{w,i}$ and $c_t^{r,i}$ denote per-person quantities for the corresponding group. Because $N^{w,i}$ is constant, this is only a normalization. Its advantage is that size adjustments in goods-market clearing and external accounts are transparent through the ratios s_k/s_i.

2.2 Households

Households are indexed by region i and life-cycle state $z \in \{w, r\}$. Consumption is measured in units of the region-i final consumption composite defined in Subsection 2.7. Let $a_t^{z,i}$ denote end-of-period asset holdings of a type-(z,i) agent, measured in units of the region-i consumption basket and carried into $t+1$. Let R_t denote the gross world real return between t and $t+1$.

Preferences. Let $V_t^{z,i}$ denote the value function of a type-(z,i) household. Following Gertler (1999) and subsequent applications (Ferrero, 2010; Carvalho, Ferrero, and Nechio, 2016), we adopt a recursive specification that is certainty-equivalent with respect to life-

cycle transition risk.[2] Utility is defined recursively by

$$
\begin{aligned}
V_t^{z,i} &= \left\{ \left(c_t^{z,i}\right)^{1-\frac{1}{\sigma}} + \beta^{z,i} \left(\mathbb{E}_t \left[V_{t+1}^{z',i} \mid z \right] \right)^{1-\frac{1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}}, \qquad (3) \\
\beta^{w,i} &= \beta, \qquad \beta^{r,i} = \beta\gamma^i, \\
\mathbb{E}_t \left[V_{t+1}^{z',i} \mid w \right] &= \omega^i V_{t+1}^{w,i} + (1-\omega^i) V_{t+1}^{r,i}, \\
\mathbb{E}_t \left[V_{t+1}^{z',i} \mid r \right] &= V_{t+1}^{r,i}.
\end{aligned}
$$

The parameter σ governs intertemporal substitution. For retired agents, survival is absorbed into effective discounting. Continuation utility is therefore weighted by $\beta\gamma^i$ rather than β, because a retired agent survives to $t+1$ only with probability γ^i.

Tariff wedges on absorption. Let $\tau_t^{C,i}$ denote the destination-i consumption tariff wedge, defined as the proportional increase in the unit-expenditure function induced by the bilateral consumption tariff rates $\{\mathcal{T}_t^{C,j,i}\}_{j\in\mathcal{I}}$. Let $\tau_t^{I,i}$ denote the analogous wedge for investment. These wedges are defined formally in Subsection 2.7. Consuming $c_t^{z,i}$ units of the final consumption composite therefore requires $(1+\tau_t^{C,i})c_t^{z,i}$ units of the region-i consumption numeraire.

Retired agents. Retired agents do not supply labor. They have access to a competitive annuity market within their home region. Annuity funds are segmented by region and operate only domestically.[3] For a retired agent who survives from $t-1$ to t, annuitization implies that assets carried into period t yield a gross payoff of $(R_{t-1}/\gamma^i)a_{t-1}^{r,i}$ (Yaari, 1965; Blanchard, 1985).

A retired agent in region i chooses consumption $c_t^{r,i}$ and end-of-period asset holdings $a_t^{r,i}$ to maximize (3) subject to

$$
\left(1+\tau_t^{C,i}\right) c_t^{r,i} + a_t^{r,i} = \frac{R_{t-1}}{\gamma^i}\, a_{t-1}^{r,i} + b_t^i,
$$

where b_t^i denotes the pension benefit paid by the regional PAYG system. The corresponding Euler equation is

$$
c_{t+1}^{r,i} = \left[\beta^{r,i} \frac{1+\tau_t^{C,i}}{1+\tau_{t+1}^{C,i}} \frac{R_t}{\gamma^i} \right]^{\sigma} c_t^{r,i}.
$$

Using $\beta^{r,i} = \beta\gamma^i$, the survival term cancels, so the intertemporal condition depends on βR_t.

Define the human wealth of a retired agent as the present value of expected future

[2] In particular, we abstract from additional curvature with respect to uncertainty beyond the intertemporal-substitution margin.

[3] Absent segmentation, cross-region pooling of longevity risk would attenuate the quantitative implications of cross-region differences in γ^i; see Ferrero (2010).

pension benefits, adjusted for survival risk:

$$h_t^{r,i} = b_t^i + \frac{\gamma^i}{R_t} h_{t+1}^{r,i}. \tag{4}$$

The retired agent's consumption function can then be written as

$$(1 + \tau_t^{C,i})\, c_t^{r,i} = \zeta_t^{r,i} \left(\frac{R_{t-1}}{\gamma^i} a_{t-1}^{r,i} + h_t^{r,i} \right), \tag{5}$$

where $\zeta_t^{r,i} \in (0,1)$ is the marginal propensity to consume out of beginning-of-period resources.[4] Analogously, let $\zeta_t^{w,i} \in (0,1)$ denote the marginal propensity to consume of a working-age agent out of beginning-of-period resources, defined formally in (9). Its law of motion is

$$\zeta_t^{r,i} = 1 - \left[\beta \frac{1 + \tau_t^{C,i}}{1 + \tau_{t+1}^{C,i}} \right]^{\sigma} (R_t)^{\sigma-1} \gamma^i \frac{\zeta_t^{r,i}}{\zeta_{t+1}^{r,i}}. \tag{6}$$

Working-age agents. Working-age agents supply one unit of inelastic labor. They do not have access to annuity markets, so assets carried into period t earn the market return R_{t-1}. Each working-age agent pays payroll contributions to the regional PAYG system at rate $\tau_t^{N,i}$. A working-age agent in region i chooses $\{c_t^{w,i}, a_t^{w,i}\}$ to maximize (3) subject to

$$(1 + \tau_t^{C,i})\, c_t^{w,i} + a_t^{w,i} = R_{t-1}\, a_{t-1}^{w,i} + (1 - \tau_t^{N,i})\, w_t^i,$$

where w_t^i denotes the real wage.

Let Φ_{t+1}^i denote the effective discount wedge induced by the possibility of transitioning into retirement:

$$\Phi_{t+1}^i = \omega^i + (1 - \omega^i) \left(\frac{\zeta_{t+1}^{r,i}}{\zeta_{t+1}^{w,i}} \right)^{\frac{1}{1-\sigma}}. \tag{7}$$

The working-age agent's maximization problem yields

$$\omega^i c_{t+1}^{w,i} + (1 - \omega^i) \left(\frac{\zeta_{t+1}^{r,i}}{\zeta_{t+1}^{w,i}} \right)^{\frac{\sigma}{1-\sigma}} c_{t+1}^{r,i} = \left[\beta \frac{1 + \tau_t^{C,i}}{1 + \tau_{t+1}^{C,i}} R_t \Phi_{t+1}^i \right]^{\sigma} c_t^{w,i},$$

where $\Phi_{t+1}^i > 1$ because $\zeta_{t+1}^{r,i} > \zeta_{t+1}^{w,i}$, that is, because retired agents have a higher marginal propensity to consume.[5]

Define the human wealth of a working-age agent as the present value of expected future after-contribution labor income:

$$h_t^{w,i} = (1 - \tau_t^{N,i})\, w_t^i + \frac{\omega^i}{\Phi_{t+1}^i} \frac{h_{t+1}^{w,i}}{R_t} + \left(1 - \frac{\omega^i}{\Phi_{t+1}^i} \right) \frac{h_{t+1}^{r,i}}{R_t}. \tag{8}$$

[4] For the formal derivation, see the technical appendix in Schön and Stähler (2020).

[5] Intuitively, the possibility of transitioning into retirement implies that working-age agents discount future resources at an effective gross rate $R_t \Phi_{t+1}^i$ that exceeds the market gross return R_t; see, among others, Gertler (1999) and Kara and von Thadden (2016).

The working-age agent's consumption function is

$$(1+\tau_t^{C,i})\, c_t^{w,i} = \zeta_t^{w,i} \left(R_{t-1}\, a_{t-1}^{w,i} + h_t^{w,i} \right), \tag{9}$$

and the marginal propensity to consume evolves according to

$$\zeta_t^{w,i} = 1 - \left[\beta \frac{1+\tau_t^{C,i}}{1+\tau_{t+1}^{C,i}} \right]^{\sigma} \left[R_t \Phi_{t+1}^i \right]^{\sigma-1} \frac{\zeta_t^{w,i}}{\zeta_{t+1}^{w,i}}. \tag{10}$$

2.3 Aggregation

We now aggregate within each region. Consistent with the normalization in Subsection 2.1, all region-level objects are expressed per working-age agent.

Labor. Each working-age agent supplies one unit of inelastic labor. Per-working-age labor input is therefore

$$L_t^i \equiv 1. \tag{11}$$

Consumption and wealth. Let A_t^i denote end-of-period financial wealth per working-age agent in region i, measured in units of the region-i consumption basket. Equivalently, A_t^i is the stock of household deposits, that is, claims on the regional investment fund, carried into $t+1$. Beginning-of-period wealth available for consumption decisions in period t is therefore $R_{t-1}A_{t-1}^i$. Let $\lambda_t^i \in [0,1]$ denote the retired-household wealth share at the end of period t, so that $\lambda_t^i A_t^i$ is end-of-period wealth held by retired agents per working-age agent and $(1-\lambda_t^i)A_t^i$ is the corresponding wealth held by working-age agents.

Define per-working-age group consumption by

$$C_t^{w,i} \equiv c_t^{w,i}, \qquad C_t^{r,i} \equiv \Psi^i c_t^{r,i},$$

so that total per-working-age consumption is $C_t^i = C_t^{w,i} + C_t^{r,i}$. Using the individual consumption functions, group consumption satisfies

$$(1+\tau_t^{C,i})\, C_t^{w,i} = \zeta_t^{w,i} \left[R_{t-1}(1-\lambda_{t-1}^i) A_{t-1}^i + h_t^{w,i} \right], \tag{12}$$

$$(1+\tau_t^{C,i})\, C_t^{r,i} = \zeta_t^{r,i} \left[R_{t-1}\lambda_{t-1}^i A_{t-1}^i + \Psi^i\, h_t^{r,i} \right]. \tag{13}$$

The second expression uses that annuitization raises the payoff received by each surviving retiree to R_{t-1}/γ^i, while only a fraction γ^i survives. The survival adjustment therefore cancels in the aggregate.

Aggregating the human-wealth objects gives

$$h_t^{r,i} = b_t^i + \frac{\gamma^i}{R_t}\, h_{t+1}^{r,i},$$

$$h_t^{w,i} = (1-\tau_t^{N,i})\, w_t^i + \frac{\omega^i}{\Phi_{t+1}^i} \frac{h_{t+1}^{w,i}}{R_t} + \left(1 - \frac{\omega^i}{\Phi_{t+1}^i} \right) \frac{h_{t+1}^{r,i}}{R_t}.$$

It remains to characterize the law of motion for the retired-household wealth share λ_t^i. By definition, per-working-age financial wealth held by retired agents equals $\lambda_t^i A_t^i$,

whereas wealth held by working-age agents equals $(1-\lambda_t^i)A_t^i$. New working-age entrants enter with zero assets.

End-of-period wealth held by working-age agents equals the saving of those who remain working-age:

$$(1-\lambda_t^i)A_t^i = \omega^i\Big[R_{t-1}(1-\lambda_{t-1}^i)A_{t-1}^i + (1-\tau_t^{N,i})\,w_t^i - (1+\tau_t^{C,i})\,C_t^{w,i}\Big].$$

End-of-period wealth held by retired agents equals the saving of continuing retirees plus the saving of working-age agents who transition into retirement:

$$\begin{aligned}\lambda_t^i A_t^i = {} & R_{t-1}\lambda_{t-1}^i A_{t-1}^i + b_t^i - (1+\tau_t^{C,i})\,C_t^{r,i} \\ & + (1-\omega^i)\Big[R_{t-1}(1-\lambda_{t-1}^i)A_{t-1}^i + (1-\tau_t^{N,i})\,w_t^i - (1+\tau_t^{C,i})\,C_t^{w,i}\Big].\end{aligned}$$

Using (12) and (13), this can be rewritten as

$$\lambda_t^i\,A_t^i = \omega^i\left[\left(1-\zeta_t^{r,i}\right)\left(R_{t-1}\lambda_{t-1}^i A_{t-1}^i + h_t^{r,i}\right) - \left(h_t^{r,i} - b_t^i\right)\right] + (1-\omega^i)A_t^i. \tag{14}$$

2.4 Production

A representative firm in region i produces a region-specific tradable good using Cobb–Douglas technology:

$$Y_t^i = \varepsilon_{i,t}\,(L_t^i)^{\alpha}\,(\bar{K}_t^i)^{1-\alpha}, \tag{15}$$

where $\varepsilon_{i,t}$ is total factor productivity, $\bar{K}_t^i$ is the predetermined physical capital stock at the beginning of period t, and $\alpha \in (0,1)$ is the labor share.

Let w_t^i denote the real wage in units of the region-i consumption basket, and let $r_t^{K,i}$ denote the real rental rate paid in period t per unit of physical capital. Under perfect competition, factor prices satisfy

$$w_t^i = \alpha\,\mathrm{MC}_t^i\,\frac{Y_t^i}{L_t^i}, \tag{16}$$

$$r_t^{K,i} = (1-\alpha)\,\mathrm{MC}_t^i\,\frac{Y_t^i}{\bar{K}_t^i}, \tag{17}$$

where MC_t^i denotes real marginal cost.

Let $P_t^{i,i}$ denote the producer price of the region-i good in units of the region-i consumption basket, that is, deflated by CPI_t^i. Hence, $P_t^{i,i}$ is the local CPI-deflated producer price which, under flexible prices and perfect competition, equals real marginal cost:

$$P_t^{i,i} = \mathrm{MC}_t^i. \tag{18}$$

For notational convenience, we occasionally refer to the corresponding nominal factory-gate price PPI_t^i, related by $P_t^{i,i} \equiv PPI_t^i/CPI_t^i$. Bilateral prices in the trade block are defined analogously as $P_t^{j,i} \equiv PPI_t^j/CPI_t^i$.

2.5 Investment funds and financial market clearing

Following Fujiwara and Teranishi (2008), a competitive investment fund in each region i intermediates household saving. Let A_t^i denote household deposits outstanding at the end of period t, measured in units of the region-i consumption basket. These deposits are claims on the fund and are carried into $t+1$. Accordingly, deposits carried into period t provide beginning-of-period resources $R_{t-1}A_{t-1}^i$ to the fund. The fund allocates its portfolio between installed domestic capital and net foreign assets, that is, the international bond position.

Let $P_t^{K,i}$ denote the pre-tariff investment-goods price index in region i, measured in units of the region-i consumption basket. Define the gross investment absorption price by

$$\widetilde{P}_t^{K,i} \equiv (1+\tau_t^{I,i})P_t^{K,i}.$$

Purchasing one unit of physical capital at time t therefore costs $\widetilde{P}_t^{K,i}$.

The physical capital stock $\bar{K}_t^i$ used in production in period t is predetermined at the beginning of the period. The tariff-inclusive investment price $\widetilde{P}_t^{K,i}$ determines the marginal cost of acquiring capital during period t and the prospective return on capital from period t onward. Beginning-of-period household financial wealth A_{t-1}^i is also predetermined and provides the payoff $R_{t-1}A_{t-1}^i$. The model does not include an additional surprise-return term that revalues this inherited wealth when an unanticipated tariff shock occurs. Thus, tariff-induced changes in investment prices affect current investment and prospective capital returns, but they do not generate a one-time capital gain or loss for households holding assets before the shock.

The prospective gross payoff from acquiring one unit of installed capital in period t and holding it until period $t+1$ equals the rental payment $r_{t+1}^{K,i}$ plus the continuation value of the undepreciated capital stock, $(1-\delta)\widetilde{P}_{t+1}^{K,i}$. Hence the gross return on capital is

$$R_t^{K,i} \equiv \frac{r_{t+1}^{K,i} + (1-\delta)\widetilde{P}_{t+1}^{K,i}}{\widetilde{P}_t^{K,i}}. \tag{19}$$

Free entry implies zero profits and enforces no arbitrage between domestic capital and the international bond:

$$R_t = R_t^{K,i} \qquad \forall i \in \mathcal{I}.$$

Accordingly, assets carried into period t earn R_{t-1}.

Physical capital accumulates according to

$$\bar{K}_{t+1}^i = (1-\delta)\,\bar{K}_t^i + I_t^i, \tag{20}$$

where $\delta \in (0,1)$ is the depreciation rate and I_t^i denotes gross investment undertaken in period t, which becomes productive in $t+1$.

At the end of period t, the fund allocates household saving between capital that becomes productive in period $t+1$ and the international bond. Its balance sheet is

$$A_t^i = P_t^{K,i}\bar{K}_{t+1}^i + D_t^i. \tag{21}$$

In the implemented savings–assets identity, the end-of-period capital position is valued at

the pre-tariff investment-goods price $P_t^{K,i}$. The tariff-inclusive price $\widetilde{P}_t^{K,i}$ instead enters the marginal cost of new investment and the prospective capital-return condition. This accounting convention implies that changes in the tariff-inclusive investment price do not revalue household wealth inherited from the previous period.

International bond-market clearing. Net foreign assets D_t^i denote the fund's end-of-period international bond position chosen in period t and carried into period $t+1$, measured in units of the region-i consumption basket. Using the relative size parameters s_i from (2) and the real exchange rates $\mathrm{RER}_t^{i,a}$ defined below, bond-market clearing requires world net foreign assets to sum to zero in a common numeraire. Expressing all positions in units of region a consumption yields

$$s_a D_t^a \;+\; \frac{s_b}{\mathrm{RER}_t^{b,a}} D_t^b \;+\; \frac{s_c}{\mathrm{RER}_t^{c,a}} D_t^c \;=\; 0. \tag{22}$$

International financial trade is restricted to one-period real bonds, and the model does not include cross-border ownership of installed capital. The net foreign asset law of motion contains the return on the inherited bond position and the contemporaneous trade balance, but no separate valuation term. Consequently, the model does not generate direct cross-border wealth transfers through the revaluation of installed capital or foreign equity. International wealth effects instead operate through relative prices, interest income, trade balances, and the subsequent accumulation of net foreign assets.

The world real interest rate adjusts so that this global bond-market-clearing condition holds jointly with regional goods-market clearing and the fund balance sheets. Hence the model does not require an exogenous long-run net-foreign-asset target to close the open economy.

2.6 Fiscal policy

The government in region i operates a balanced-budget PAYG pension system. Working-age households pay payroll contributions at rate $\tau_t^{N,i}$ on labor income. Retired households receive pension benefits b_t^i. In addition, the government collects tariff revenue on consumption and investment imports.

Let

$$\mathcal{R}_t^i \equiv \tau_t^{C,i}\, C_t^i + \tau_t^{I,i}\, P_t^{K,i}\, I_t^i \tag{23}$$

denote tariff revenue in region i, expressed per working-age agent and in CPI-deflated real terms.

The consolidated PAYG budget constraint is

$$\tau_t^{N,i}\, w_t^i + \mathcal{R}_t^i = \Psi^i b_t^i. \tag{24}$$

To characterize the fiscal incidence of tariff revenue, we introduce a baseline pension replacement rate $\rho^i \in (0,1)$ and a recycling parameter $\chi^i \in [0,1]$. Absent tariffs, the regional PAYG system satisfies

$$b_t^i = \rho^i w_t^i, \qquad \tau_t^{N,i} = \Psi^i \rho^i.$$

With tariff revenue, we let a fraction χ^i lower payroll contributions and the remaining fraction $1-\chi^i$ raise pension benefits:

$$b_t^i = \rho^i w_t^i + \frac{1-\chi^i}{\Psi^i}\,\mathcal{R}_t^i, \tag{25}$$

$$\tau_t^{N,i} = \Psi^i \rho^i - \chi^i \frac{\mathcal{R}_t^i}{w_t^i}. \tag{26}$$

This formulation nests the alternative recycling rules studied below. When $\chi^i = 1$, all tariff revenue is recycled through lower payroll contributions. When $\chi^i = 0$, all tariff revenue is recycled through higher pension benefits. Intermediate values of χ^i imply joint recycling through both margins. We abstract from other sources of public revenue and from government purchases.

2.7 Trade, price indices, and goods-market clearing

Households in destination region i form CES composites over goods produced in each origin region $j \in \mathcal{I} \equiv \{a, b, c\}$, separately for consumption and investment. We maintain origin-first notation throughout. Thus, $C_t^{j,i}$ denotes consumption absorption in destination i of goods produced in origin j, and $I_t^{j,i}$ denotes investment absorption defined analogously.

Relative prices and real exchange rates. As mentioned above, $P_t^{j,i}$ denotes the origin-j factory-gate price expressed in units of the destination-i consumption basket:

$$P_t^{j,i} \equiv \frac{PPI_t^j}{CPI_t^i}, \tag{27}$$

which guarantees that all region-i real objects are measured in units of CPI_t^i. To relate bilateral prices across destinations, define the consumption-based real exchange rate relative to region a as

$$\mathrm{RER}_t^{i,a} \equiv \frac{CPI_t^a}{CPI_t^i}, \qquad \mathrm{RER}_t^{a,a} \equiv 1. \tag{28}$$

By construction,

$$P_t^{j,i} = P_t^{j,j} \cdot \frac{\mathrm{RER}_t^{i,a}}{\mathrm{RER}_t^{j,a}} \qquad \forall\, i, j \in \mathcal{I}. \tag{29}$$

Tariffs as ad valorem price wedges. Let $\mathcal{T}_t^{C,j,i}$ and $\mathcal{T}_t^{I,j,i}$ denote ad valorem tariff rates on consumption and investment absorption of origin-j goods in destination i. The corresponding gross-of-tariff absorption prices are

$$\widetilde{P}_t^{C,j,i} \equiv P_t^{j,i}(1+\mathcal{T}_t^{C,j,i}), \qquad \widetilde{P}_t^{I,j,i} \equiv P_t^{j,i}(1+\mathcal{T}_t^{I,j,i}).$$

Consumption: demand system, CPI normalization, and tariff wedge. Destination-i consumption is a CES aggregate:

$$C_t^i = \left[\sum_{j\in\mathcal{I}} \vartheta^{C,j,i} \left(C_t^{j,i}\right)^{\eta}\right]^{\frac{1}{\eta}},$$

where $\eta \in (-\infty, 1)$ implies an elasticity of substitution equal to $1/(1-\eta)$ and $\sum_{j\in\mathcal{I}} \vartheta^{C,j,i} = 1$. Working in units of the destination-i consumption basket, the unit-expenditure function evaluated at pre-tariff prices satisfies

$$1 = \left[\sum_{j\in\mathcal{I}} \vartheta^{C,j,i} \left(P_t^{j,i}\right)^{-\eta/(1-\eta)}\right]^{-(1-\eta)/\eta}. \tag{30}$$

Define the consumption tariff wedge $\tau_t^{C,i}$ by evaluating the same unit-expenditure function at gross absorption prices:

$$1 + \tau_t^{C,i} = \left[\sum_{j\in\mathcal{I}} \vartheta^{C,j,i} \left(\widetilde{P}_t^{C,j,i}\right)^{-\eta/(1-\eta)}\right]^{-(1-\eta)/\eta}. \tag{31}$$

Expenditure minimization implies destination-i demand for origin-j goods:

$$C_t^{j,i} = \vartheta^{C,j,i} \left(\frac{\widetilde{P}_t^{C,j,i}}{1+\tau_t^{C,i}}\right)^{-\frac{1}{1-\eta}} C_t^i. \tag{32}$$

Investment: demand system, price index, and tariff wedge. Investment absorption in destination i is defined analogously as a CES aggregate over origins, with the same η. The pre-tariff investment price index $P_t^{K,i}$ is

$$P_t^{K,i} = \left[\sum_{j\in\mathcal{I}} \vartheta^{I,j,i} \left(P_t^{j,i}\right)^{-\eta/(1-\eta)}\right]^{-(1-\eta)/\eta}, \tag{33}$$

where $\sum_{j\in\mathcal{I}} \vartheta^{I,j,i} = 1$. Define the investment tariff wedge $\tau_t^{I,i}$ by evaluating the corresponding unit-expenditure function at gross absorption prices:

$$\left(1+\tau_t^{I,i}\right) P_t^{K,i} = \left[\sum_{j\in\mathcal{I}} \vartheta^{I,j,i} \left(\widetilde{P}_t^{I,j,i}\right)^{-\eta/(1-\eta)}\right]^{-(1-\eta)/\eta}. \tag{34}$$

Cost minimization implies

$$I_t^{j,i} = \vartheta^{I,j,i} \left(\frac{\widetilde{P}_t^{I,j,i}}{(1+\tau_t^{I,i})P_t^{K,i}}\right)^{-\frac{1}{1-\eta}} I_t^i. \tag{35}$$

International linkages: exports, imports, and net foreign assets (size-adjusted). Using the relative size parameters s_i from (2), define destination-i imports and origin-i exports as values measured in units of the region-i consumption basket. We measure trade values at pre-tariff factory-gate prices, while tariff revenues are accounted for separately through the absorption wedges. Imports weight absorbed foreign quantities by the corresponding bilateral relative prices $P_t^{j,i}$. Exports value foreign absorption of the region-i good at the home producer price $P_t^{i,i}$, which equals MC_t^i under flexible prices by (18). The size ratios convert foreign absorption from destination-level per-working-age units into origin-i per-working-age units:

$$\mathrm{IMP}_t^i = \sum_{j \neq i} P_t^{j,i} \big(C_t^{j,i} + I_t^{j,i} \big), \tag{36}$$

$$\mathrm{EXP}_t^i = P_t^{i,i} \sum_{k \neq i} \frac{s_k}{s_i} \big(C_t^{i,k} + I_t^{i,k} \big), \tag{37}$$

Net exports are defined by $\mathrm{NX}_t^i \equiv \mathrm{EXP}_t^i - \mathrm{IMP}_t^i$, and net foreign assets evolve according to

$$D_{t+1}^i = R_t \, D_t^i + \mathrm{NX}_t^i. \tag{38}$$

Goods-market clearing (size-adjusted). Output produced in origin i is absorbed domestically and abroad in quantity terms:

$$Y_t^i = C_t^{i,i} + I_t^{i,i} + \sum_{k \neq i} \frac{s_k}{s_i} \big(C_t^{i,k} + I_t^{i,k} \big), \tag{39}$$

where the size ratios convert absorption defined per working-age agent in the destination into origin-i per-working-age units.

2.8 Competitive equilibrium

Given initial asset positions, installed capital stocks, and tariff policies, a competitive equilibrium is a sequence of quantities, prices, portfolio positions, and fiscal variables such that the following conditions hold in every period:

1. Households solve their consumption-saving problems given prices, returns, wages, payroll contributions, and pension benefits.

2. Firms choose labor and capital services optimally, and producer prices satisfy marginal-cost pricing.

3. Regional investment funds satisfy zero profit, no-arbitrage between capital and the international bond, and the balance-sheet identity.

4. Governments operate PAYG pension systems, set payroll contributions and pension benefits according to the recycling rule, and satisfy the consolidated budget constraint.

5. Goods markets clear in each region.

6. The international bond market clears globally.

7. The world real interest rate adjusts to satisfy global asset-market clearing.

3 Calibration

We calibrate the model at annual frequency for three regions $i \in \mathcal{I} \equiv \{a, b, c\}$. Region a corresponds to the United States (US). Region b aggregates the EU27, Norway, Switzerland, and the United Kingdom (Europe). Region c is the residual block comprising the remaining economies (Rest of the World, RoW). This partition closely follows Ernst, Hinterlang, Mahle, and Stähler (2023).

Demographics and normalization. Agents enter economic life at age 20. A working-age agent in region i remains in the labor force with probability ω^i, so that expected working life equals $1/(1-\omega^i)$. A retired agent survives into the next period with probability γ^i, implying an expected retirement duration of $1/(1-\gamma^i)$. We choose ω^i to match an expected retirement age of 65. We discipline the steady-state retiree dependency ratio, $\Psi^i \equiv N^{r,i}/N^{w,i}$, using OECD population projections (OECD, 2017). Combining the normalization $N^{w,i}_{t+1} = N^{w,i}_t$ with the law of motion for retired agents, $N^{r,i}_{t+1} = (1-\omega^i)N^{w,i} + \gamma^i N^{r,i}_t$, implies the steady-state survival probability

$$\gamma^i = \frac{\Psi^i - 1 + \omega^i}{\Psi^i}. \tag{40}$$

Throughout, region-level aggregates are expressed in per-working-age units, consistent with Subsection 2.1. When a target is stated in per-capita terms, including retirees, we convert it into the model's per-working-age normalization using

$$y^{pc,i} = \frac{Y^i}{1+\Psi^i} \qquad \Longleftrightarrow \qquad Y^i = (1+\Psi^i)y^{pc,i}. \tag{41}$$

Relative region size is captured by the working-age population share $s_i \equiv N^{w,i}/\sum_k N^{w,k}$; cf. (2). These shares scale the goods-market-clearing and external-account identities. Table 1 reports the resulting demographic parameters and size shares.

Table 1: Steady-state demographics and relative size

	US (a)	Europe (b)	RoW (c)
Working-age-to-retirement transition prob. $1-\omega^i$	0.0222	0.0222	0.0200
Retiree dependency ratio Ψ^i	0.3000^T	0.3500^T	0.1900^T
Retired-agent survival prob. γ^i	0.9259^e	0.9365^e	0.8947^e
Working-age population share s_i	0.1464^T	0.1099^T	0.7437^T

Source: OECD (2017). Superscripts T and e denote calibration targets and steady-state implied objects, respectively.

Preferences, technology, and pension systems. Unless stated otherwise, we adopt standard annual parameter values from the business-cycle literature, following Ferrero (2010) and Cooley and Prescott (1995). We target a steady-state world gross real interest rate of $R = 1.04$, which pins down the common discount factor β. Capital depreciates at rate $\delta = 0.10$. Output is produced with a Cobb–Douglas technology with labor share $\alpha = 2/3$, equivalently a capital share of $1-\alpha = 1/3$. We set the elasticity of intertemporal substitution to $\sigma = 0.5$, a conventional value in quantitative OLG applications since Auerbach and Kotlikoff (1987).

To discipline the regional PAYG systems introduced in Section 2.6, we calibrate region-specific pension replacement rates ρ^i. Consistent with OECD (2025) and the institutional interpretation of the three regions, we assume that Europe has the highest steady-state replacement rate, the Rest of the World the second-highest replacement rate, and the United States the lowest replacement rate. Thus, we impose

$$\rho^b > \rho^c > \rho^a.$$

Specifically, we set

$$\rho^a = 0.50, \qquad \rho^b = 0.67, \qquad \rho^c = 0.61.$$

In the initial steady state, bilateral tariff rates are zero, so tariff revenue satisfies $\mathcal{R}^i = 0$. From (24)–(26), steady-state pension benefits and payroll contribution rates are therefore given by

$$b^i = \rho^i w^i, \qquad \tau^{N,i} = \Psi^i \rho^i. \tag{42}$$

Cross-region differences in ρ^i therefore translate directly into different steady-state payroll contribution rates. Table 2 summarizes the structural parameters and reports the implied payroll contribution rates.

Trade structure and output targets. The Armington elasticity across origin varieties is set to $1/(1-\eta) = 1.5$, that is, $\eta = 1/3$, consistent with commonly used values in quantitative international macroeconomics. Following the paper-wide notation, superscripts are ordered by origin and destination, so that $x^{j,i}$ denotes an object associated with an origin-j variety absorbed in destination i. The CES weights $\vartheta^{C,j,i}$ and $\vartheta^{I,j,i}$ govern steady-state expenditure shares across origins in consumption and investment; see Section 2.7. Given these weights and the remaining steady-state restrictions, the model endogenously implies a configuration of net foreign asset positions; see Schön and Stähler (2020) and Ruppert and Stähler (2022) for the external-accounting system in this class of models.

We calibrate the bilateral trade weights as follows. For consumption, we impose a home share of 80 percent in both the US and Europe and allocate the remaining 20 percent symmetrically across the two foreign regions, that is, 10 percent each. For investment, consistent with the stronger home bias typically observed in capital-goods absorption (Ernst et al., 2023), we set a home share of 90 percent and assign 5 percent to each foreign region. We then choose the RoW weights to satisfy the steady-state external-accounting restrictions implied by the model. Table 3 summarizes the resulting final-demand weights.

Finally, we target relative per-capita output levels $y^{pc,i}$ of 1.000 for the US, 0.9855 for Europe, and 0.3885 for the RoW, following Ernst et al. (2023). We select region-

specific productivity levels $\bar{\varepsilon}^i$ to match these targets using the per-capita/per-working-age mapping in (41). We interpret $\bar{\varepsilon}^i$ as the deterministic steady-state component of regional productivity, so that $\varepsilon_{i,t} = \bar{\varepsilon}^i$ in steady state. Table 2 reports the resulting structural parameters.

Table 2: Structural parameters and implied steady-state pension objects

	US (a)	Europe (b)	RoW (c)
Discount factor β	0.92^e (implied by $R = 1.04$)		
IES σ	0.5	0.5	0.5
Depreciation δ	0.1	0.1	0.1
Labor share α	2/3	2/3	2/3
Pension replacement rate ρ^i	0.50	0.67	0.61
Payroll contribution rate $\tau^{N,i} = \Psi^i \rho^i$	0.1500^e	0.2345^e	0.1159^e
TFP level $\bar{\varepsilon}^i$	0.6202^e	0.6311^e	0.3593^e
Armington elas. $1/(1-\eta)$	1.5	1.5	1.5

Notes: Superscript e denotes a steady-state implied object.

Table 3: Trade weights in final demand

Origin	US ($j = a$)	Europe ($j = b$)	RoW ($j = c$)
Panel A. Consumption weights $\vartheta^{C,j,i}$			
Destination US ($i = a$)	0.8000	0.1000	0.1000
Destination Europe ($i = b$)	0.1000	0.8000	0.1000
Destination RoW ($i = c$)	0.0206^e	0.0505^e	0.9289^e
Panel B. Investment weights $\vartheta^{I,j,i}$			
Destination US ($i = a$)	0.9000	0.0500	0.0500
Destination Europe ($i = b$)	0.0500	0.9000	0.0500
Destination RoW ($i = c$)	0.0206^e	0.0505^e	0.9289^e

Notes: Columns report the origin $j \in \{a, b, c\}$, and rows report the destination $i \in \{a, b, c\}$. Superscript e denotes steady-state implied objects.

Initial tariff configuration and fiscal interpretation. In the initial steady state, bilateral tariff rates satisfy

$$\mathcal{T}^{C,j,i} = \mathcal{T}^{I,j,i} = 0,$$

which implies

$$\tau^{C,i} = \tau^{I,i} = 0.$$

The initial steady state is therefore characterized by standard PAYG financing without tariff revenue. The tariff shocks studied below affect the economy not only through trade prices and expenditure switching, but also through the way newly generated tariff revenue is recycled within the regional PAYG systems.

The calibration is intentionally parsimonious. Demographic structure and relative region size are disciplined by external data. The trade weights for the US and Europe are stylized benchmark values chosen to capture substantial home bias in final demand. The RoW weights and productivity levels are then selected so that the model is internally consistent and matches the targeted cross-region output configuration. The pension block is likewise intended as a transparent institutional closure rather than as a full empirical representation of regional pension systems. Accordingly, the calibration should be interpreted as a transparent benchmark rather than as a full empirical fit to bilateral trade, financial stocks, and pension institutions.

In the appendix, we also report results for a symmetric benchmark calibration in which all region-specific parameters are set equal to the values of region a. This exercise abstracts from cross-region heterogeneity in demographics, pension parameters, and other region-specific primitives. It shows that the qualitative mechanisms emphasized in the paper do not rely exclusively on the asymmetric benchmark calibration.

4 Quantitative results

This section reports the quantitative implications of permanent tariff changes for output, consumption, saving, external positions, and the equilibrium world real interest rate r^*. The central question is whether tariff-induced redistribution across regions and cohorts changes global desired saving and thereby the equilibrium world real interest rate. The analysis therefore treats the familiar OLG link between fiscal redistribution and saving as one component of a broader open-economy tariff mechanism. We proceed in three steps. We first study a unilateral tariff under benchmark PAYG recycling. We then compare this benchmark with retaliation. Finally, we examine how alternative tariff-revenue recycling rules inside the PAYG system reshape saving, external adjustment, and the long-run behavior of r^*.

4.1 Simulation design

We consider permanent, unanticipated tariff shocks implemented as bilateral ad valorem tariffs. Whenever a tariff is activated, the corresponding bilateral tariff rate is set to 0.25 from $t = 0$ onward and remains at that level thereafter. Tariffs apply symmetrically to consumption and investment imports. Specifically, for the relevant origin–destination pair (j, i), we set

$$\mathcal{T}_t^{C,j,i} = \mathcal{T}_t^{I,j,i} = 0.25 \qquad \text{for all } t \geq 0, \tag{43}$$

while all other bilateral tariff rates remain at zero. We then compute perfect-foresight transition paths from the initial steady state to the new steady state. The experiments are MIT-shock-type transition exercises. The tariff change is unanticipated before period $t = 0$. Once it occurs, households, firms, investment funds, and governments perfectly foresee the subsequent transition to the new steady state. Because all three regions are modeled jointly and the world real interest rate is determined by global asset-market clearing, the transition does not require an exogenous NFA target or a small-open-economy stationarity device. Beginning-of-period household financial wealth and the capital stock used in current production are predetermined when the tariff shock occurs. The simulations

abstract from surprise valuation gains or losses on inherited capital; changes in investment prices affect new investment and prospective returns from the impact period onward.

The main text focuses on two tariff scenarios. In the unilateral-tariff scenario, region a imposes a 25 percent tariff on imports from region b, so that $\mathcal{T}_t^{C,b,a} = \mathcal{T}_t^{I,b,a} = 0.25$ for all $t \geq 0$, while all other bilateral tariff rates remain at zero. In the retaliation scenario, region b responds by imposing the symmetric 25 percent tariff on imports from region a, so that $\mathcal{T}_t^{C,a,b} = \mathcal{T}_t^{I,a,b} = 0.25$ for all $t \geq 0$ as well.

A central object for the transmission mechanism is the fiscal incidence of tariff revenue inside the regional PAYG systems. In each destination region i, tariff revenue enters the consolidated pension budget, and the government budget constraint holds period by period:

$$\tau_t^{N,i} w_t^i + \tau_t^{C,i} C_t^i + \tau_t^{I,i} P_t^{K,i} I_t^i = \Psi^i b_t^i. \tag{44}$$

We distinguish three recycling rules. Under benchmark PAYG recycling, tariff revenue is split evenly between lower payroll contributions and higher pension benefits, that is, $\chi^i = 0.5$ in each tariff-collecting region. We then consider two polar benchmark cases. Under payroll-tax recycling, $\chi^i = 1$, so all tariff revenue is used to lower payroll contributions. Under pension-benefit recycling, $\chi^i = 0$, so all tariff revenue is used to raise pension benefits. These two polar cases are intended to isolate the role of fiscal incidence as transparently as possible. They should be interpreted as mechanism-revealing benchmark exercises rather than as realistic policy packages.

For each tariff scenario, general equilibrium jointly determines quantities, net foreign asset positions, and the equilibrium world real interest rate $r^* \equiv R - 1$, where R is the asset-market-clearing gross world return implied by global bond-market clearing.

4.2 Long-run effects

Table 4 reports the new steady state relative to the initial steady state. For transparency, the table reports long-run quantity effects under benchmark PAYG recycling. For r^*, it additionally reports the steady-state outcomes under the two cohort-targeted recycling rules, holding the tariff scenario fixed. The table therefore summarizes both the long-run allocation across regions and the sensitivity of the interest-rate response to fiscal incidence.

Table 4: Long-run effects

	Unilateral tariff	Retaliation
Output in a	-0.29	-0.61
Aggregate consumption in a	0.25	-0.74
Output in b	-0.47	-0.88
Aggregate consumption in b	-1.97	-2.29
Output in c	0.00	-0.05
Aggregate consumption in c	0.25	0.53
World interest rate r^* (payroll-tax recycling)	-1.18	-1.27

continued on next page

continued from previous page

	Unilateral tariff	Retaliation
World interest rate r^* (benchmark PAYG recycling)	0.39	1.07
World interest rate r^* (pension-benefit recycling)	1.86	3.29

Notes: Quantity entries are percent deviations from the initial steady state under benchmark PAYG recycling. Entries for r^* report long-run changes, in percentage points, relative to the initial steady state under the indicated recycling rule.

Three results stand out. First, under benchmark PAYG recycling, a unilateral tariff lowers output in both the targeted region and the tariff-imposing region, but aggregate consumption in region a rises in the new steady state. Second, retaliation removes this consumption gain and deepens the output contraction in the tariff-warring regions. Third, the long-run response of r^* depends strongly on how tariff revenue is recycled inside the PAYG system. Under payroll-tax recycling, r^* falls below its initial steady state. Under benchmark PAYG recycling, it rises moderately. Under pension-benefit recycling, it rises sharply. The steady-state comparison therefore points to fiscal incidence within the PAYG system as the key driver of the saving channel we emphasize in the paper. This saving channel is a standard OLG force, but here it operates jointly with tariff-induced relative-price changes, external adjustment, and global asset-market clearing.

4.3 Tariff scenarios: unilateral policy versus retaliation

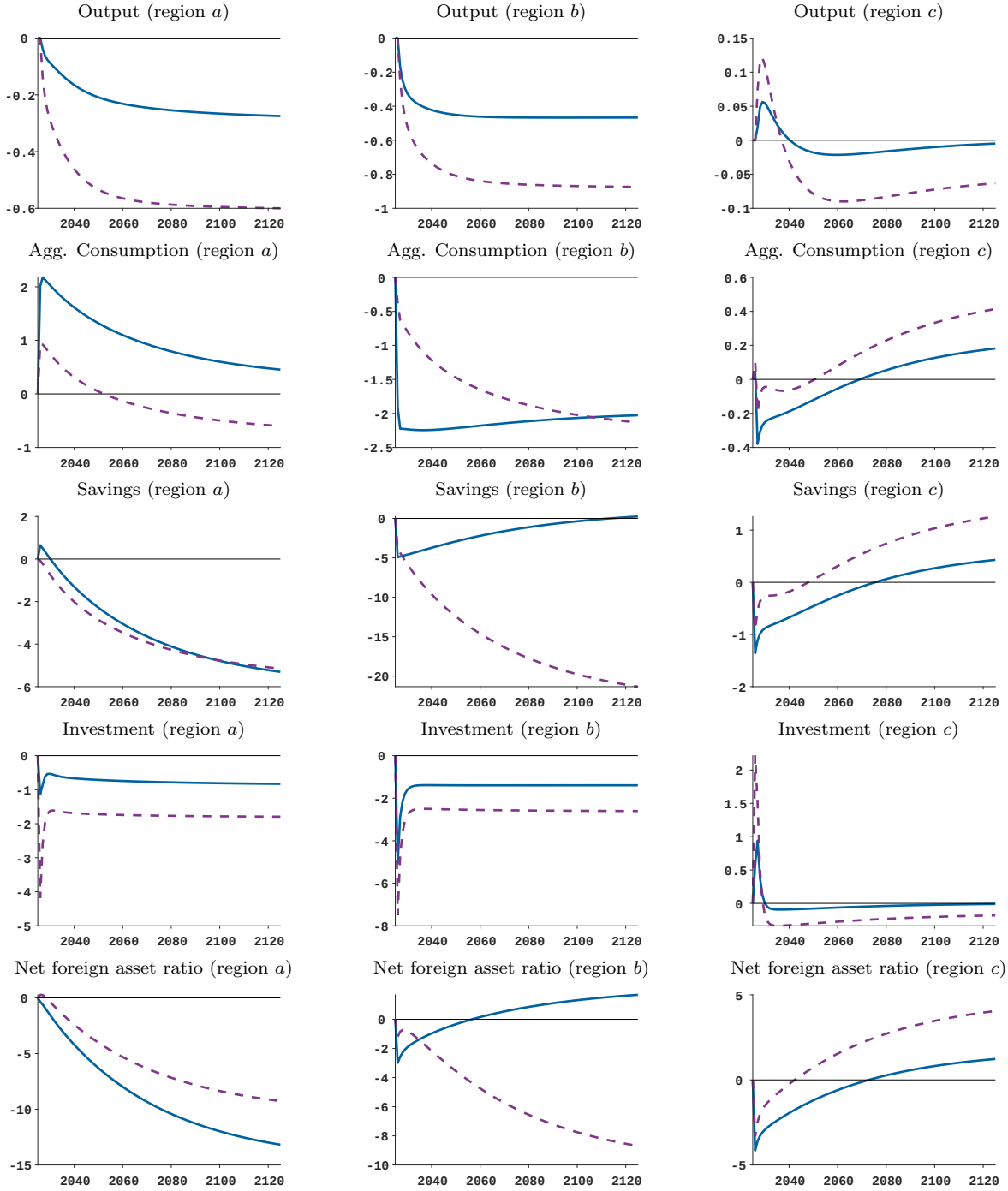
Figure 1 reports perfect-foresight transition paths under a common recycling rule, namely benchmark PAYG recycling. The figure compares the unilateral tariff with retaliation. Figure 2 complements this comparison by reporting the corresponding path of the world real interest rate r^* under benchmark PAYG recycling (it also reports the paths under different recycling rules, which we will discuss later). We begin with the unilateral case because it isolates the redistribution mechanism most clearly. We then show how retaliation modifies this mechanism once tariff wedges operate in both directions.

Unilateral tariff. Under unilateral policy, three results emerge. First, output falls in both the targeted region and the tariff-imposing region. Second, aggregate consumption in the tariff-imposing region can nevertheless rise. Third, the path of r^* reflects the joint adjustment of saving and investment induced by the tariff shock.

Rows 1 and 2 of Figure 1 summarize the regional output and consumption responses. Output falls in the targeted region because the tariff raises the relative price of its varieties in the destination market and thereby compresses export demand. Output also falls in the tariff-imposing region because the tariff applies to investment imports and raises the effective user cost of capital. Region c exhibits short-run trade diversion, as its goods become relatively cheaper than those of the targeted region, but this effect fades over time and output in region c moves slightly below its initial steady state.

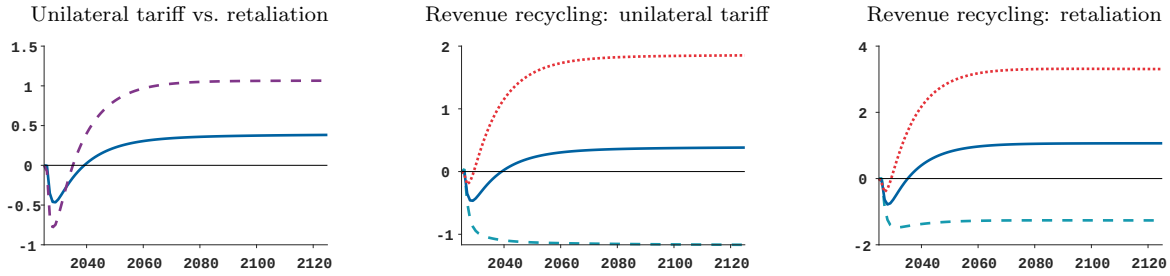
Aggregate consumption behaves differently from output. Despite lower output, aggregate consumption in region a rises under unilateral policy. The mechanism is a redistribution of disposable income generated by relative-price movements and by the way tariff revenue enters the PAYG system. Lower demand in a reduces the effective export

Figure 1: Tariff scenarios - benchmark PAYG recycling: unilateral policy vs retaliation



Notes: The figure reports perfect-foresight transition paths as deviations from the initial steady state. The horizontal axis reports calendar years. Lines compare alternative tariff scenarios under a common tariff-revenue recycling rule, namely benchmark PAYG recycling. The solid line corresponds to the unilateral tariff scenario. The dashed line corresponds to retaliation.

Figure 2: World real interest rate: tariff scenarios and PAYG recycling



Notes: The figure reports perfect-foresight transition paths of the world real interest rate r^* as deviations from the initial steady state. The horizontal axis reports calendar years. The left panel compares the unilateral tariff scenario with retaliation under benchmark PAYG recycling. In the left panel, the solid line corresponds to the unilateral tariff scenario and the dashed line corresponds to retaliation. The middle panel compares alternative tariff-revenue recycling rules under unilateral tariffs. The right panel compares alternative tariff-revenue recycling rules under retaliation. In the middle and right panels, the solid line shows benchmark PAYG recycling, the dashed line shows payroll-tax recycling, and the dotted line shows pension-benefit recycling. The payroll-tax and pension-benefit cases are polar benchmark schemes used to isolate the role of fiscal incidence.

price received by region b and generates a negative wealth effect abroad. Domestically, by contrast, tariff revenue relaxes the PAYG budget in region a and supports household disposable income through lower payroll contributions and higher pension benefits. As a result, aggregate consumption can rise in region a even though domestic production contracts. Aggregate consumption falls in region b, while the response in region c is initially weak and turns positive only gradually.

The tariff on investment imports is immediately visible in the investment panels. Investment contracts in both a and b, reflecting higher effective capital costs in a and weaker export demand and income in b. Region c displays a short-run investment boom as demand is diverted toward its varieties, but this effect fades quickly. Saving falls persistently in region a. In region b, saving also falls on impact, but then gradually recovers. In region c, saving declines initially and then turns positive over time. These responses are reflected in external positions. The NFA ratio of region a deteriorates persistently. In region b, the NFA ratio falls on impact but then improves gradually over the transition. Region c accumulates external assets over time, mirroring its stronger saving response relative to the tariff-imposing region.

Figure 2 shows that the world real interest rate falls on impact because investment demand contracts sharply. Over time, however, r^* rises relative to its impact response and settles above its initial steady state in the long run under benchmark PAYG recycling. The endogenous interest-rate response also feeds back into the real allocation. On impact, the fall in r^* partly cushions the investment contraction by lowering the required return on capital. As r^* subsequently rises, the higher required return dampens capital accumulation and future output, while the higher asset return supports the income of net creditors. The NFA dynamics therefore reflect both the direct trade and income effects of the tariff and the subsequent general-equilibrium feedback from the world real interest rate.

Retaliation. Retaliation strengthens the contractionary forces already visible under unilateral policy. Output losses deepen in both region a and region b, and the consumption gain in region a is largely removed. Region c benefits more strongly in the short run through trade diversion, and its aggregate consumption rises more strongly over time than under unilateral policy. The underlying intuition is that the redistribution generated

by relative-price movements no longer operates in one direction only once both regions impose tariffs. Instead, tariff wedges now operate bilaterally, so that the unilateral redistribution toward a is weakened. This is also visible in saving and external positions. Under retaliation, saving declines more strongly in both a and b, and both regions experience a persistent deterioration in their NFA ratios, while region c accumulates external assets more strongly. Consistent with these stronger general-equilibrium effects, Figure 2 shows that retaliation produces a larger long-run increase in r^* than the unilateral tariff. This larger increase in r^* reinforces the medium-run investment decline in the tariff-warring regions and strengthens the asset-income channel for regions that accumulate external assets.

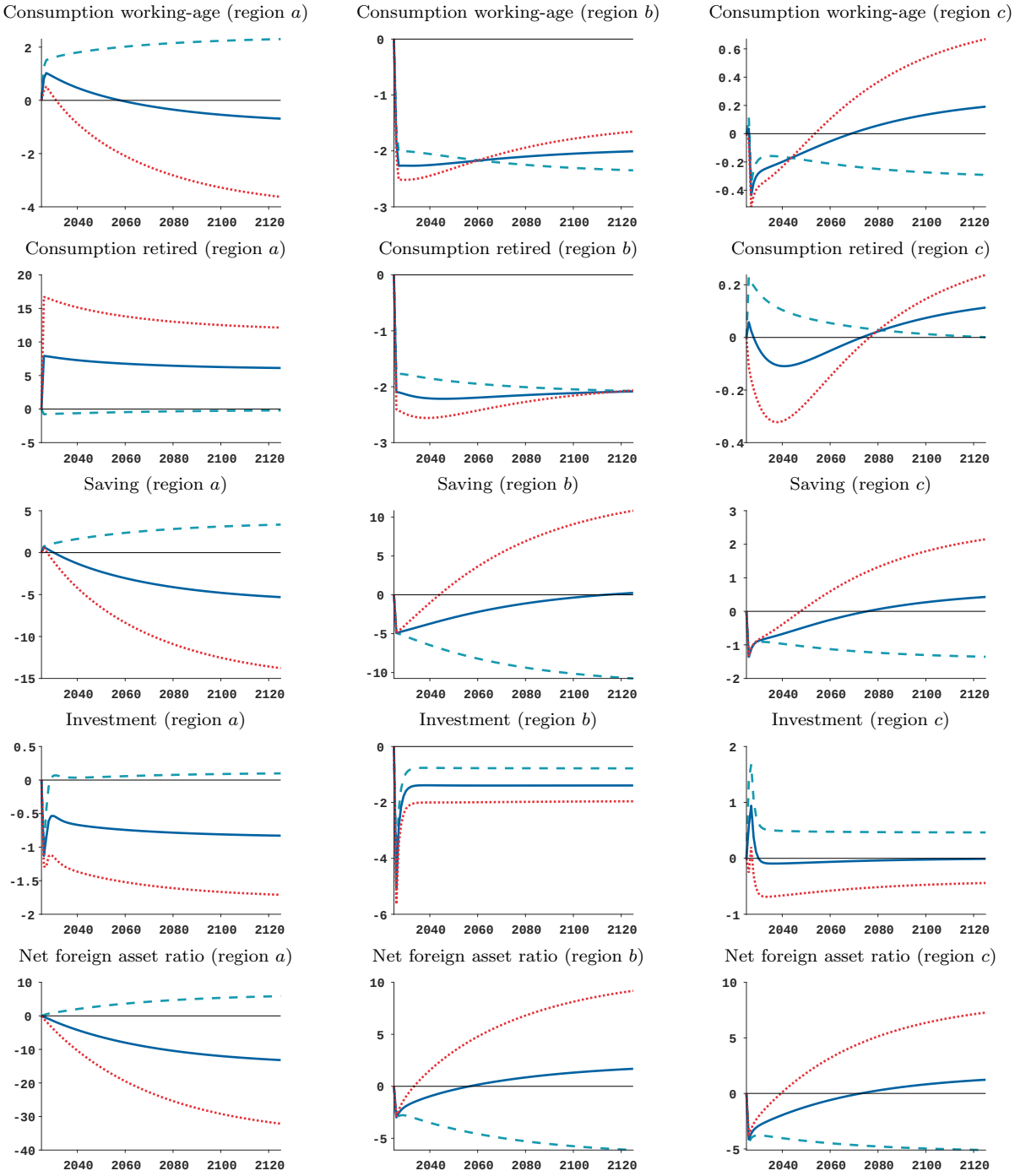
4.4 Revenue recycling and the interest-rate channel

Figures 3 and 4 compare transition paths under alternative tariff-revenue recycling rules. We focus first on the unilateral tariff because it isolates most clearly how fiscal incidence reshapes saving and the equilibrium world real interest rate. Figure 2 complements Figures 3 and 4 by reporting the corresponding paths of r^* under the alternative recycling rules. The retaliation case then shows how the same mechanism operates when tariff wedges are imposed bilaterally.

The figures compare three recycling rules. The first is benchmark PAYG recycling, $\chi^i = 0.5$, under which tariff revenue supports both working-age and retired households through the pension system. The second directs tariff revenue only toward lower payroll contributions, $\chi^i = 1$. The third directs tariff revenue only toward higher pension benefits, $\chi^i = 0$. The latter two are polar benchmark cases designed to isolate the transmission mechanism rather than to approximate realistic policy packages. It is useful to distinguish three components of the transmission mechanism. First, the tariff directly distorts absorption choices by changing the relative prices of imported consumption and investment goods. Second, tariff revenue changes the fiscal incidence of the PAYG system and redistributes resources between working-age and retired households. Third, the induced change in desired saving moves the asset-market-clearing world real interest rate, which then feeds back into investment, output, consumption, and external positions. Through the no-arbitrage condition in (19), a higher r^* raises the required return on installed capital and depresses investment and future capital accumulation. Through the household consumption functions, it also changes the present value of future labor and pension income and raises asset income for net creditors. Revenue recycling through lower payroll contributions directly supports the disposable income of working-age households. Revenue recycling through higher pension benefits directly supports the income of retired households. Therefore, the aggregate response depends not only on the direct trade distortion, but also on the institutional mechanism through which the government redistributes tariff revenue and on the endogenous interest-rate feedback that follows from global asset-market clearing.

Under benchmark PAYG recycling and unilateral tariffs, the cohort-level dynamics are consistent with the aggregate patterns discussed above. In region a, both working-age and retired households initially raise consumption, with a much stronger response among retired households. Over the transition, working-age consumption declines as the initial support to disposable income is offset by lower capital accumulation, weaker productivity,

Figure 3: Unilateral tariff: comparing revenue recycling variants



Notes: The figure reports transition paths under unilateral tariffs imposed by region a on region b. The horizontal axis reports calendar years. Lines compare alternative revenue-recycling rules inside the PAYG system. The solid line shows benchmark PAYG recycling. The dashed line shows payroll-tax recycling. The dotted line shows pension-benefit recycling. The payroll-tax and pension-benefit cases are polar benchmark schemes used to isolate the role of fiscal incidence.

and lower labor income. In region b, consumption declines for both cohorts. Region c is only weakly affected on impact, but consumption rises gradually over time, especially for working-age households. These dynamics are associated with lower saving in region a, an initial decline and subsequent recovery of saving in region b, and a gradual increase in saving in region c. Consistent with these patterns, Figure 2 shows a gradual long-run increase in r^* under benchmark PAYG recycling.

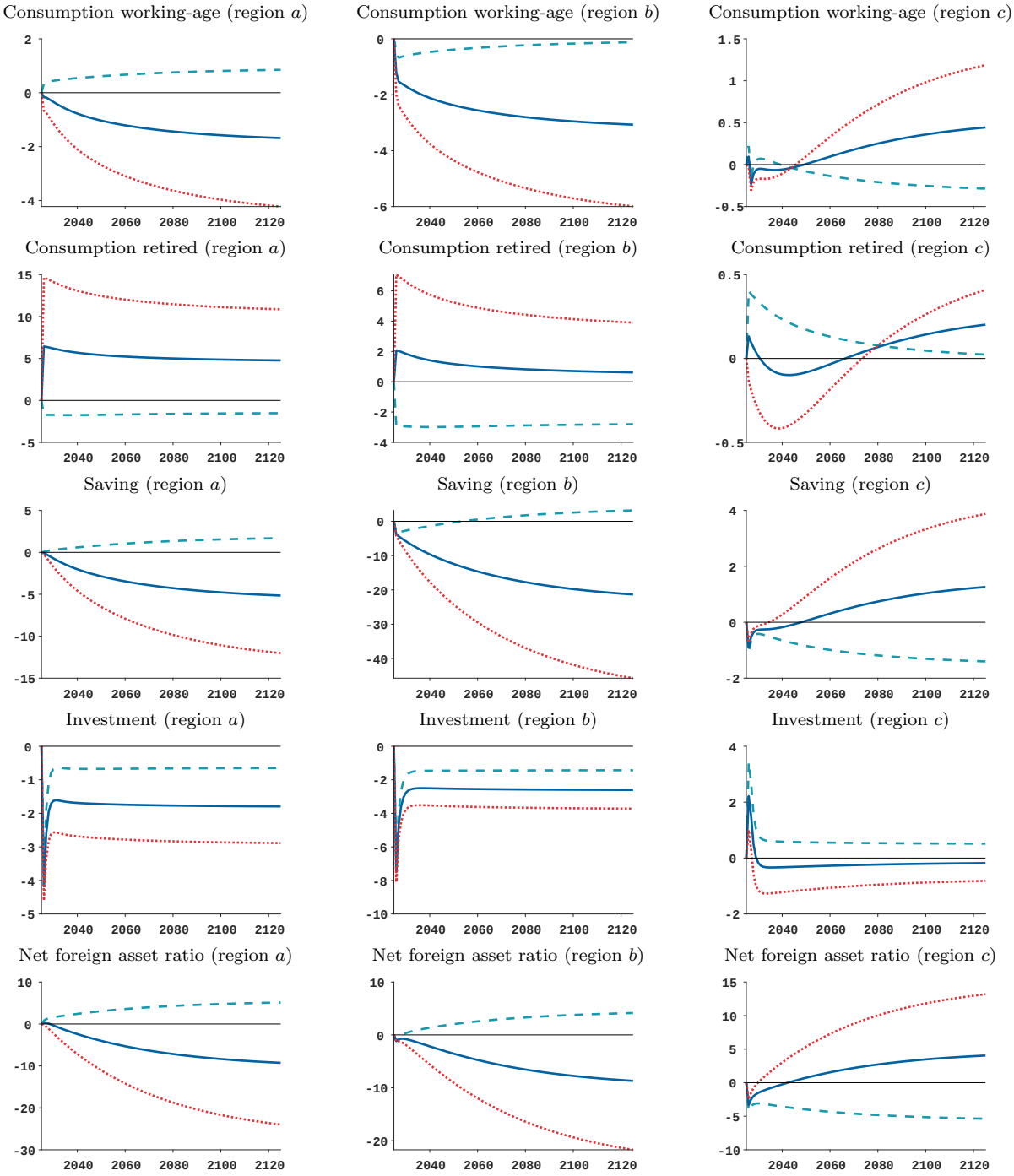
When recycling in region a is shifted toward payroll-tax reductions, the within-region distributional effects change immediately. The first row shows that working-age consumption in region a rises more strongly, while the second row shows that retired-household consumption in region a is much weaker than under benchmark PAYG recycling. From a general-equilibrium perspective, the key implication is visible in the saving and NFA panels. Saving in region a rises above its initial steady state, while the NFA position of region a improves persistently. At the same time, regions b and c move toward weaker saving and weaker external positions than under benchmark PAYG recycling. Accordingly, Figure 2 shows that r^* falls below its initial steady state in the long run under payroll-tax recycling.

When tariff revenue in region a is recycled through higher pension benefits, the incidence shifts toward households with a higher propensity to consume. Working-age agents in region a no longer receive the payroll-contribution reduction that partly offsets higher consumption costs and weaker labor income, so their consumption declines persistently. At the same time, the transfer toward retired households reduces aggregate saving more strongly. The saving panels show the resulting macro adjustment. Saving in region a falls much more sharply, while regions b and especially c increase saving over time. This shift is mirrored in net foreign asset dynamics, with region a's NFA position deteriorating markedly while regions b and especially c accumulate external assets. Consistent with these patterns, Figure 2 shows that pension-benefit recycling generates the strongest rise in r^*.

Because higher values of r^* raise the return on accumulated assets, the increase in asset income also affects cohort consumption outside region a. This is especially visible in region c, where retired-household consumption improves markedly over time under pension-benefit recycling. In region b, retired-household consumption also improves relative to its initial decline, although under unilateral tariffs it remains below its initial steady state. Tariff policy therefore affects the equilibrium world real interest rate not only through trade distortions, but also through the cohort incidence of fiscal recycling and the resulting reallocation of saving across regions.

Finally, Figure 4 shows that these forces are not specific to the unilateral environment. Retaliation deepens the aggregate contraction, but the qualitative ranking across recycling rules remains the same. Payroll-tax recycling supports working-age consumption more strongly. In addition, it leads to the strongest initial drop and a negative long-run response of r^* in Figure 2. Pension-benefit recycling generates the strongest rise in retired-household consumption in the tariff-collecting regions, the sharpest decline in saving in regions a and b, and the strongest rise in r^*. Benchmark PAYG recycling lies between these two polar cases. The figure therefore confirms that the fiscal incidence of tariff revenue remains central even when the tariff conflict is bilateral rather than unilateral.

Figure 4: Retaliation: comparing revenue recycling variants



Notes: The figure reports transition paths under retaliation tariffs imposed by regions a and b. The horizontal axis reports calendar years. Lines compare alternative revenue-recycling rules inside the PAYG system. The solid line shows benchmark PAYG recycling. The dashed line shows payroll-tax recycling. The dotted line shows pension-benefit recycling. The payroll-tax and pension-benefit cases are polar benchmark schemes used to isolate the role of fiscal incidence.

5 Conclusion

This paper analyzes tariff policy in a three-region overlapping-generations model with endogenous net foreign asset positions and a world real interest rate determined by global asset-market clearing. Tariffs affect not only trade flows and production, but also saving, external positions, and r^* through the cohort incidence of tariff revenue. The intergenerational saving response to fiscal redistribution is a standard force in OLG models. The contribution of the paper is to show how this force operates when the fiscal redistribution is generated by tariff policy and interacts with international relative-price movements, endogenous external adjustment, and global asset-market clearing.

Three findings emerge. First, under benchmark PAYG recycling, a unilateral tariff lowers output in both the targeted region and the tariff-imposing region, but it raises aggregate consumption in the tariff-imposing region. Second, retaliation largely removes this consumption gain and deepens the contraction in the regions engaged in the trade conflict. Third, the long-run response of r^* depends critically on how tariff revenue is recycled across domestic cohorts through the pension system. When tariff revenue is recycled primarily through pension benefits, aggregate saving falls and r^* rises. When tariff revenue is recycled through payroll-tax reductions, saving is supported and r^* falls below its initial steady-state level. These results reflect the interaction of three channels: the direct tariff distortion, the fiscal redistribution of tariff revenue across domestic cohorts, and the endogenous interest-rate feedback that affects investment, asset income, and external positions.

In our framework, tariffs and retaliation redistribute income across agents with heterogeneous saving behavior through the fiscal structure of the domestic pension system. This redistribution shifts external positions, changes global desired saving, and can materially alter the equilibrium world real interest rate. The resulting movement in r^* then feeds back into the real allocation by changing investment incentives, future output, household wealth, and the income consequences of creditor and debtor positions.

More broadly, the analysis shows that the effect of tariffs on the world real interest rate is not determined by trade distortions alone. It also depends on the domestic fiscal incidence of tariff revenue and the resulting distribution of income across households with different saving behavior. The PAYG structure in the model is a transparent way to make this mechanism visible. Accordingly, the paper's main message is not tied to pension institutions as such, but to the broader point that tariff policy can affect global financial equilibrium through the way tariff revenue is redistributed within economies. The quantitative exercises should be interpreted as mechanism-oriented steady-state and transition experiments rather than as a direct empirical mapping to current global imbalances. A natural direction for future work is to combine the mechanism emphasized here with richer empirical heterogeneity in external positions, valuation effects, and country-specific fiscal institutions.

References

Alessandria, G. A., J. Ding, S. Y. Khan, and C. B. Mix (2025, May). The tariff tax cut: Tariffs as revenue. Working Paper 33784, National Bureau of Economic Research.

Auerbach, A. J. and L. J. Kotlikoff (1987). Evaluating fiscal policy with a dynamic simulation model. *The American Economic Review 77*(2), 49–55.

Auray, S., M. B. Devereux, and A. Eyquem (2025, May). Tariffs and retaliation: A brief macroeconomic analysis. Working Paper 33739, National Bureau of Economic Research.

Baqaee, D. and E. Farhi (2024). Networks, Barriers, and Trade. *Econometrica 92*(2), 505–541.

Benigno, P. (2009). Price Stability with Imperfect Financial Integration. *Journal of Money, Credit and Banking 41*(s1), 121–149.

Bettendorf, L. J. H. and B. J. Heijdra (2001). Intergenerational welfare effects of a tariff under monopolistic competition. *Journal of Economics 73*(3), 313–346.

Blanchard, O. J. (1985). Debt, Deficits, and Finite Horizons. *Journal of Political Economy 93*(2), 223–247.

Bodenstein, M. (2011). Closing large open economy models. *Journal of International Economics 84*(2), 160–177.

Carvalho, C., A. Ferrero, and F. Nechio (2016). Demographics and Real Interest Rates: Inspecting the Mechanism. *European Economic Review 88*(C), 208–226.

Cooley, T. and E. Prescott (1995). Economic Growth and Business Cycles. In T. Cooley (Ed.), *Frontiers in Business Cycle Research*, pp. 1–38. Princeton University Press, Princeton University, NJ.

Ernst, A., N. Hinterlang, M. Jäger, and N. Stähler (2026). America First? The Macroeconomic Implications of Punitive Tariffs in a Production Network Model. *International Tax and Public Finance forthcoming*(103772).

Ernst, A., N. Hinterlang, A. Mahle, and N. Stähler (2023). Carbon Pricing, Border Adjustment and Climate Clubs: Options for International Cooperation. *Journal of International Economics 144*(103772).

Ferrero, A. (2010). A structural decomposition of the U.S. trade balance: Productivity, demographics and fiscal policy. *Journal of Monetary Economics 57*(4), 478–490.

Fujiwara, I. and Y. Teranishi (2008). A dynamic new Keynesian life-cycle model: Societal aging, demographics, and monetary policy. *Journal of Economic Dynamics and Control 32*(8), 2398–2427.

Gertler, M. (1999). Government debt and social security in a life-cycle economy. *Carnegie-Rochester Conference Series on Public Policy 50*(1), 61–110.

Kara, E. and L. von Thadden (2016). Interest rate effects of demographic changes in a new keynesian life-cycle framework. *Macroeconomic Dynamics 20*(1), 120–164.

Lubik, T. A. (2007). Non-stationarity and instability in small open-economy models even when they are 'closed'. *Economic Quarterly 93*(4), 393–412.

Mehrotra, N. and M. Waugh (2025, September). Tariffs, trade wars, and the natural rate of interest. Working Paper 34206, National Bureau of Economic Research.

Obstfeld, M. and K. Rogoff (1995). The intertemporal approach to the current account. In G. M. Grossman and K. Rogoff (Eds.), *Handbook of International Economics* (1 ed.), Volume 3, Chapter 34, pp. 1731–1799. Elsevier.

OECD (2017). *Pensions at a Glance 2017*.

OECD (2025). *Pensions at a Glance 2025: OECD and G20 Indicators*. OECD Publishing, Paris.

Ruppert, K. and N. Stähler (2022). What Drives the German Current Account? Household Savings, Capital Investments and Public Policies. *Economic Modelling 108*, 105769.

Schmitt-Grohe, S. and M. Uribe (2003). Closing small open economy models. *Journal of International Economics 61*(1), 163–185.

Schön, M. and N. Stähler (2020). When Old Meets Young? Germany's Population Ageing and the Current Account. *Economic Modelling 89*, 315–336.

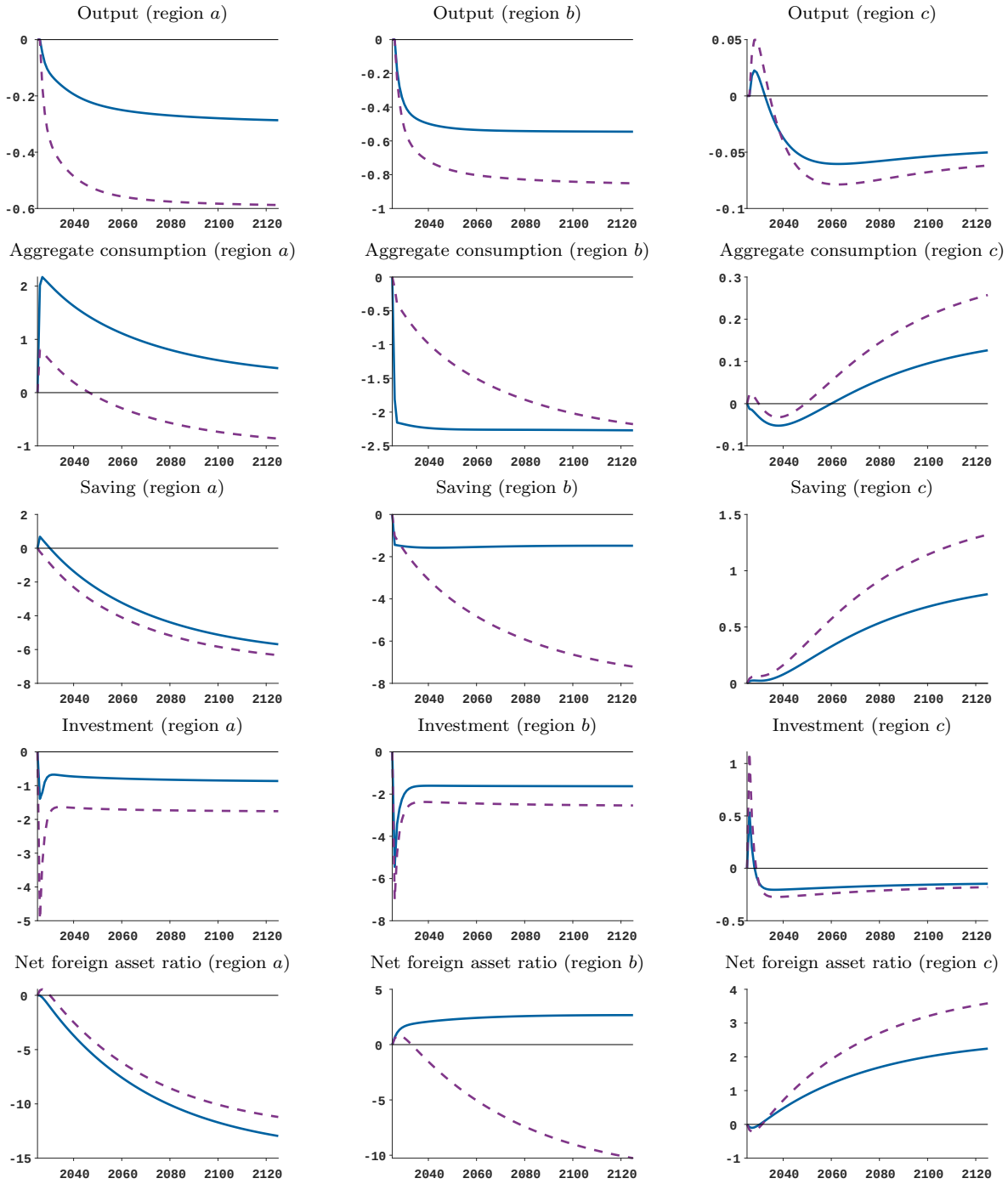
Weil, P. (1989). Overlapping families of infinitely-lived agents. *Journal of Public Economics 38*(2), 183–198.

Yaari, M. E. (1965). Uncertain Lifetime, Life Insurance, and the Theory of the Consumer. *Review of Economic Studies 32*(2), 137–150.

A Results for symmetric regions

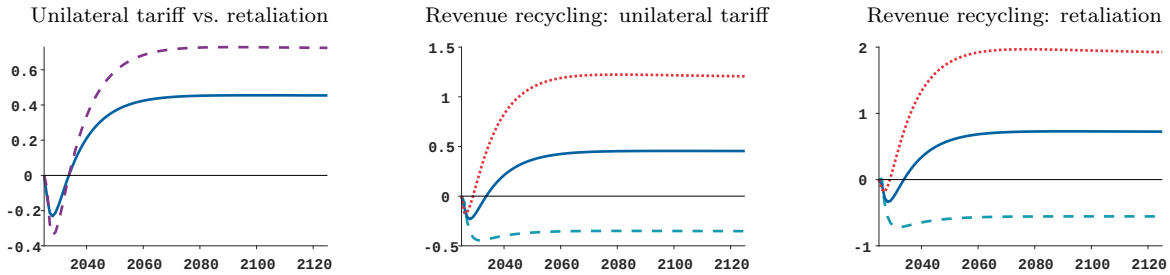
This appendix reports robustness results for a symmetric calibration in which all region-specific parameters are set equal to the values of region a. The exercise abstracts from cross-region heterogeneity in demographics, pension parameters, and other regional primitives, and isolates the role of tariff policy and tariff-revenue recycling in a more symmetric environment.

Figure A.1: Symmetric calibration: unilateral tariff versus retaliation



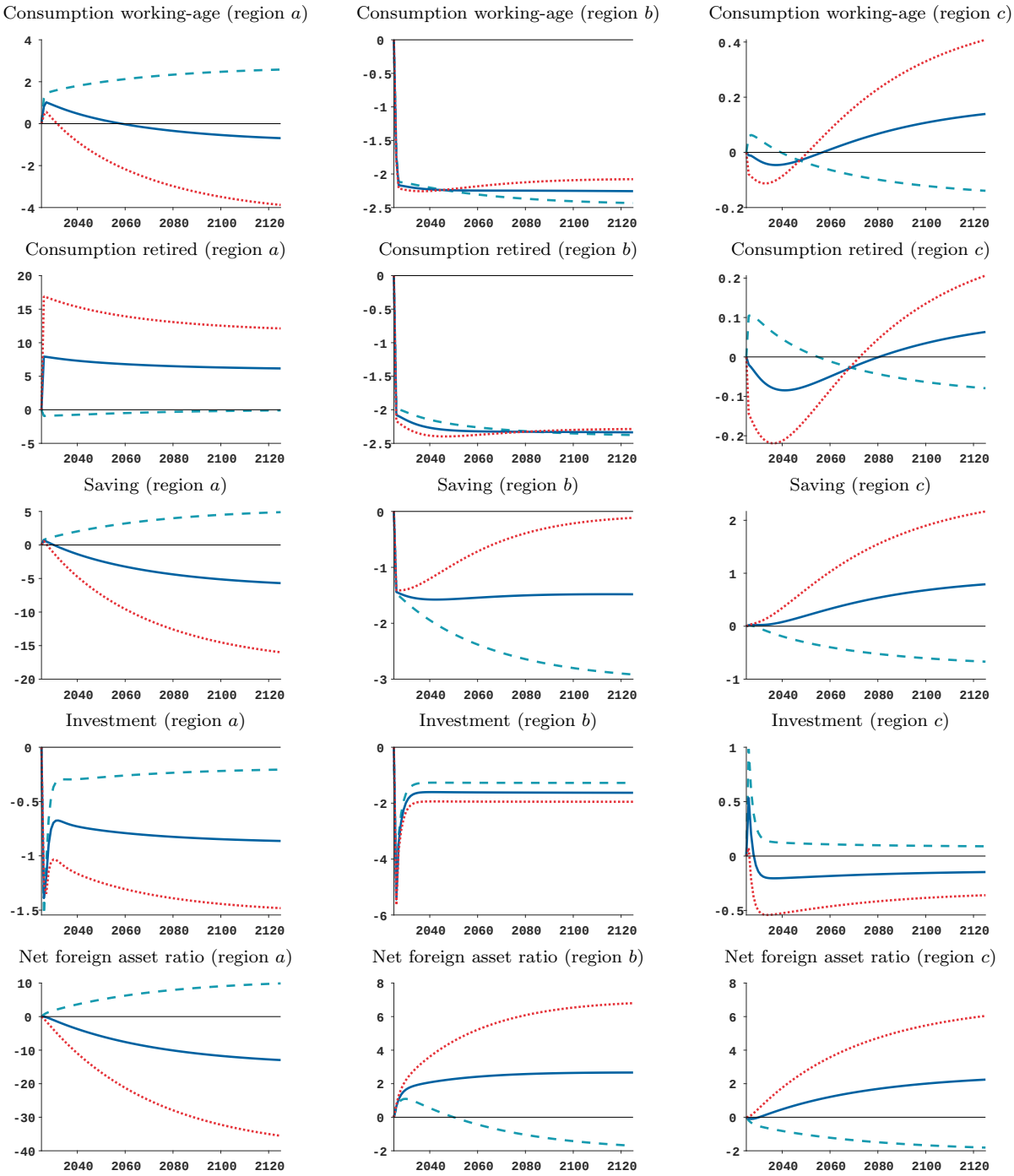
Notes: The figure reports perfect-foresight transition paths as deviations from the initial steady state under the symmetric calibration. The horizontal axis reports calendar years. The solid line corresponds to the unilateral tariff scenario. The dashed line corresponds to retaliation. Both lines use benchmark PAYG recycling.

Figure A.2: Symmetric calibration: world real interest rate, tariff scenarios, and PAYG recycling



Notes: The figure reports perfect-foresight transition paths of the world real interest rate r^* as deviations from the initial steady state. The horizontal axis reports calendar years. The left panel compares the unilateral tariff scenario with retaliation under benchmark PAYG recycling. In the left panel, the solid line corresponds to the unilateral tariff scenario and the dashed line corresponds to retaliation. The middle panel compares alternative tariff-revenue recycling rules under unilateral tariffs. The right panel compares alternative tariff-revenue recycling rules under retaliation. In the middle and right panels, the solid line shows benchmark PAYG recycling, the dashed line shows payroll-tax recycling, and the dotted line shows pension-benefit recycling. The payroll-tax and pension-benefit cases are polar benchmark schemes used to isolate the role of fiscal incidence.

Figure A.3: Symmetric calibration: alternative revenue-recycling rules under unilateral tariffs



Notes: The figure reports perfect-foresight transition paths under a unilateral tariff imposed by region a on region b in the symmetric calibration. The horizontal axis reports calendar years. The solid line shows benchmark PAYG recycling. The dashed line shows payroll-tax recycling. The dotted line shows pension-benefit recycling. The payroll-tax and pension-benefit cases are polar benchmark schemes used to isolate the role of fiscal incidence.