Importing Aggregate Demand*

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Abstract

How exposed are open economies to global demand shocks? In equilibrium, foreign booms can be absorbed either by domestic consumption ("quantities") or by real exchange rate appreciation ("prices"). We show that failures of Ricardian equivalence and global financial market imperfections, two frictions popular in much recent work, have opposite effects on the split: while elevated marginal propensities to consume push towards quantities, financial frictions instead increase price adjustment. As the flexible-price equilibrium generally features a mix of quantity and price responses, policy needs to be contractionary to achieve flexible-price outcomes if the spending effect dominates, and *vice-versa* if financial frictions are severe. In our quantitative explorations the spending effect tends to win the race, necessitating aggressive domestic policy action.

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1 Introduction

Open economies are continually exposed to shifts in global demand. Large fiscal deficits and stock market booms in the United States, weak demand in China, public spending expansions in Europe, and commodity booms will all have effects that are likely to extend well beyond the countries in which they originate. To what extent do those shocks then get imported by the domestic economy? Do they mainly expand the export sector, or will they also stimulate local spending? How much pressure will they exert on domestic inflation? And how should domestic monetary and fiscal policy react?

We take up these questions in a textbook open-economy environment with nominal rigidities, augmented with two frictions popular in recent work: failures of Ricardian equivalence and global financial market imperfections. Our main result is that a "race" between the two frictions governs the exposure of the domestic economy to demand abroad. In equilibrium, any increase in foreign demand has to be accommodated domestically either through an increase in consumption and thus imports ("quantities"), or absorbed by movements in the real exchange rate ("prices"). We show that greater marginal propensities to consume (MPCs) push the adjustment to come through quantities, and *vice-versa* for financial imperfections. Intuitively, if MPCs are small, then domestic consumption does not follow the foreign spending burst, international financial flows need to be large, and so the real exchange rate must adjust. Conversely, if MPCs are high, the foreign boom passes through quickly to domestic consumption and thus imports, so both cross-border financial flows and real exchange rate adjustment are moderate. At standard parameterizations, this race is won by non-Ricardian consumption behavior, implying large exposure of domestic activity to the conditions abroad.

Turning to policy, the prices-quantities race has immediate implications for how policy can insulate the domestic economy from demand pressures abroad. Attaining flexible-price outcomes — which feature a mix of quantity and price responses — requires contractionary policy if, as in our quantitative analysis, MPCs win the race, as opposed to expansionary policy if, counterfactually, MPCs were small. In the remainder of the introduction we elaborate on all the steps of these arguments, as well as on our approach to quantification.

Environment. For our main analysis we consider the canonical small open economy New Keynesian framework of Galí and Monacelli (2005), but with two twists. First, following Angeletos, Lian, and Wolf (2024a) and Aguiar, Amador, and Arellano (2024), we replace the representative household with a unit continuum of overlapping generations of perpetual-youth consumers (Blanchard 1985), with survival probability $\omega \in (0, 1]$. The endpoint $\omega = 1$ nests the textbook representative-agent case, as in Woodford (2003) and Galí (2008). When $\omega < 1$, households are non-Ricardian, their MPCs are elevated, and the consumption block tractably emulates key predictions of quantitative heterogeneous-agent (HANK) models (Kaplan, Moll, and Violante 2018, Auclert, Rognlie, and Straub 2024). Second, international financial markets are segmented (as in Gabaix and Maggiori 2015, Itskhoki and Mukhin 2021): households only trade in local bonds, with international capital flows intermediated by arbitrageurs with limited funds and risk-bearing capacity. Importantly, these limits to arbitrage lead to equilibrium departures from uncovered interest rate parity (UIP). The supply side instead is unchanged, reducing to a New Keynesian Phillips curve (NKPC). Finally, the policymaker sets the path of (nominal) interest rates, government debt, and foreign exchange interventions (FXI).

We now subject this economy to an exogenous increase in foreign demand, driven, for example, by a foreign fiscal expansion or by booming consumer spending. In equilibrium, the country-level intertemporal budget constraint, or equivalently intertemporal balanced trade, implies that, in present value terms, the increase in foreign demand is necessarily absorbed by either an increase in domestic aggregate consumption ("quantities"), movements in the real exchange rate ("prices"), or a combination of the two. We ask how different assumptions on the environment and on the domestic policy reaction shape this split.

Direct exposure. As a useful benchmark, we begin by asking how the foreign demand impulse shapes the domestic economy if the domestic policy reaction is "neutral," in the sense that the central bank maintains an unchanged path for the real rate of interest (as in Woodford 2011), FXI, and government debt. Intuitively, this experiment captures the domestic economy's *direct* exposure, keeping other determinants of domestic demand fixed. We later ask how alternative assumptions on the policy reaction move us away from this benchmark.

Our first headline result characterizes the pass-through of the foreign demand burst to (the present value of) domestic consumption (and hence GDP), and to the real exchange rate. The expression reveals a "race" between our two key frictions: elevated MPCs and frictions in financial intermediation. To see the intuition for this race, suppose momentarily that the real exchange rate did not move in equilibrium. In the absence of any expenditure switching, a textbook Keynesian cross logic would suggest that domestic consumption c is then

$$c = \frac{\gamma \text{MPC}}{1 - \text{MPC}(1-\gamma)} \times \text{foreign demand}, \tag{1}$$

where $1 - \gamma \in (0, 1)$ is the degree of home bias. Foreign demand first increases production of the home good by γ. Households then spend a fraction (equal to the MPC) of that income, further increasing domestic activity; another fraction $(1-\gamma) \times$ MPC of the resulting income is spent at home; and so on. For an MPC of 1, this gives one-to-one pass-through of foreign demand to domestic consumption and activity — a modern version of the classic Harrod (1933) foreign trade multiplier.

The pure demand logic of (1) is, however, incomplete, as it ignores possible price feedback. If consumer MPCs are already close to unity over short horizons, then the pass-through from foreign demand to domestic production and consumption happens quickly, with consumption at home following demand abroad not just in present value terms, but also date-by-date. If that is the case, then there is no need for any international financial flows, confirming that indeed the real exchange rate need not move. If, instead, short-run MPCs are small, then the pass-through of (1) would only happen over long horizons, the consumption paths are not aligned, and thus large cross-border financial flows would be needed, in turn triggering real exchange rate adjustment. This feedback always moderates, and in the limit of Ricardian consumption behavior fully crowds out, the response of domestic consumption. This is our "race": domestic spending pushes towards one-to-one quantity exposure, but if the spending response is slow, the price movements it induces undo it, and fully so if households are Ricardian.

The race between the two frictions similarly shapes implications for domestic inflation. If adjustment is chiefly through quantities, then *cumulative* domestic consumption and activity equal the foreign demand increase; however, unless domestic consumers are literally hand-to-mouth, the resulting domestic boom tends to trail the foreign boom. As long as price-setting is at least partially forward-looking, this backloading of the domestic boom implies that the cumulative price increase at home necessarily exceeds the inflationary burst abroad. This second result completes the sense in which open economies with meaningful departures from Ricardian equivalence can be very heavily exposed to booming aggregate demand abroad: in the absence of an aggressive domestic policy reaction, economic activity gets imported one-to-one, and inflation even overshoots.

Policy implications. The prices-quantities race at the heart of our results also has important implications for how domestic policy can insulate the economy from aggregate demand pressures abroad. We have already seen that, under a "neutral" monetary policy reaction, models with small and large MPCs (i.e., "RANK" vs. "HANK") give diametrically opposed answers to how foreign increases in demand are accommodated in equilibrium: purely through the real exchange rate in the former, and (almost) purely through consumption and production in the latter. This contrasts with flexible-price outcomes: there the split between prices and quantities is intermediate, determined by static goods and labor market equilibrium conditions and, as a result, *independent* of the strength of both MPCs and financial frictions.

Putting the flexible-price results together with our characterization of direct exposure, it follows that the domestic policy reaction that replicates the flexible-price outcomes is decisively shaped by the relative strength of the two frictions: policy needs to be contractionary if MPCs are elevated ("HANK"), and expansionary if the financial friction dominates ("RANK").[1] We finally discuss how the same degree of insulation of the domestic economy can equiva-

[1]Following Auclert, Rognlie, Souchier, and Straub (2021), we furthermore show that any given monetary policy reaction (i.e., any given path of the real rate) is, if anything, less effective as a means to stabilize the economy when MPCs are high. This further reinforces our lesson: monetary policy in HANK needs to be *particularly* contractionary to tilt adjustment from quantities to prices.

lently be achieved through suitable mixes of fiscal and foreign exchange policy, generalizing prior work on policy instrument equivalence to the open economy (Wolf 2025). Interestingly we find that, when households are decidedly non-Ricardian and MPCs are high, relatively large joint movements in fiscal and FXI policy are needed to replicate the flexible-price allocation, making those instruments less well-suited to replicate monetary policy than perhaps expected in light of the closed-economy literature.

Quantitative analysis. The preceding qualitative analysis leaves a quantitative question: which friction is likely to win the "race," and thus determine the relative importance of quantity and price adjustment, in empirically relevant models? In our baseline environment the direct exposure quantity pass-through share is given as a function of just three "sufficient statistics": the MPC, the feedback ϕ from net foreign asset positions to the real exchange rate (i.e., the financial friction), and the Marshall-Lerner trade elasticity ϑ. At conventional values for those three objects, the quantity share is robustly large — a first back-of-the-envelope answer to the question of how the prices-quantities race is likely to turn out in practice.

We next confirm these calculations in a richer quantitative model. In our analytical baseline setting, the *level* of the contemporaneous MPC also simultaneously pins down the *speed* at which consumers spend their income over time; importantly, when matching the level of the MPC to empirical evidence, that intertemporal spending speed is too large relative to the data, thus biasing our conclusions towards quantity over price adjustment. We thus generalize the consumer block to feature multiple household types, arriving at a model that is consistent with the entire time path of household intertemporal MPCs. Next, for the severity of financial frictions (parameterized by ϕ), we follow Itskhoki and Mukhin (2021) to ensure that our model predicts a persistence of the real exchange rate that is in line with the data.[2] The resulting ϕ is small, making our quantitative exercise most informative for relatively advanced economies. We finally ensure consistency with evidence on the Marshall-Lerner elasticity ϑ, and further extend our model to also feature richer fiscal feedback rules, dominant currency pricing, and a range of alternative assumptions on the monetary policy reaction. Even with all of these additions, the messages of our theoretical analysis extend: the foreign aggregate demand shock is absorbed by a mix of quantities and prices; in the absence of an aggressive domestic monetary policy reaction, the shock is chiefly absorbed through domestic consumption; this goes hand-in-hand with a large domestic price spike; and so an aggressive policy reaction is needed to insulate the domestic economy.

Related literature. The international transmission of foreign shocks is a longstanding problem in macroeconomics. While recent work has greatly advanced our understanding of the

[2] As a further over-identification test of this part of our model calibration, we have also verified that FXI policy has effects on the real exchange rate in line with empirical evidence, following Beltran and He (2025).

expenditure-switching channel (Friedman 1953, Gopinath 2015) and the financial channel (Rey 2015), our paper instead focuses on a more traditional aggregate-demand channel. The latter is central to the transmission of terms-of-trade shocks (Mendoza 1995, Drechsel and Tenreyro 2018, Ayres, Hevia, and Nicolini 2020) and fiscal stimulus (Corsetti, Meier, and Müller 2010, 2012), and is also relevant for other fiscal, trade and monetary shocks (Bernanke 2017, Farhi, Gopinath, and Itskhoki 2014, Kalemli-Özcan 2019, Miranda-Agrippino and Rey 2020).

Our findings are closely related to two classical results. The first is the foreign trade multiplier of Harrod (1933), according to which a country fully imports foreign economic booms. The second comes from the "Australian model" of Salter (1959), Swan (1960) and Corden (1960) and clarifies that an overheating of the domestic economy can be avoided if the exchange rate appreciates sufficiently to absorb the shock.[3] These classical models are static and largely treat aggregate absorption and the exchange rate as policy instruments that can be chosen directly by the government. Our analysis is instead at a more primitive level, asking how deviations from Ricardian equivalence and imperfections in international financial markets shape shock transmission given domestic policy, and thus how they determine the endogenous reaction of policy required to insulate the domestic economy.

Our theory combines three standard ingredients from modern macroeconomics: nominal rigidities, segmented financial markets with limits to arbitrage, plus deviations from Ricardian equivalence.[4] Our analysis is thus closely related to the recent open-economy HANK models of Auclert, Rognlie, Souchier, and Straub (2021), Auclert, Monnery, Rognlie, and Straub (2023), Aggarwal, Auclert, Rognlie, and Straub (2023), Sundram (2025) and Druedahl, Ravn, Sunder-Plassmann, Sundram, and Waldstrøm (2026). We depart from this literature in two key ways. First, unlike most of those studies, we focus on the transmission of foreign demand shocks, rather than on domestic monetary or fiscal disturbances or exchange rate movements themselves. Second, we show that the propagation of these shocks depends crucially on financial frictions in currency markets — a mechanism and conclusion absent from the existing models.

Outline. Section 2 introduces the model. Section 3 then presents our main analytical results on the direct exposure of the domestic economy to foreign demand shocks. Policy implications are discussed in Section 4, and our quantitative analysis follows in Section 5. Section 6 concludes, and the appendix contains proofs as well as various additional results.

[3]See also Harberger (1950), Alexander (1952), as well as Meade (1956). Schmitt-Grohé and Uribe (2021) provide a modern treatment of the Salter-Swan framework.

[4]Nominal rigidities in open-economy models are, among many others, considered by Galí and Monacelli (2005), Devereux and Engel (2003), Benigno and Benigno (2003), Corsetti and Pesenti (2005), Engel (2011), Farhi and Werning (2012), Egorov and Mukhin (2023). Segmented international financial markets are highly popular in the exchange rate literature, e.g., Jeanne and Rose (2002), Gabaix and Maggiori (2015), Itskhoki and Mukhin (2021, 2025, 2023), Gourinchas, Ray, and Vayanos (2025). Finally, a fast-growing literature considers departures from Ricardian equivalence, in both closed and open economies (Kaplan, Moll, and Violante 2018, Auclert, Rognlie, and Straub 2024, Angeletos, Lian, and Wolf 2024a, de Ferra, Mitman, and Romei 2020, Guo, Ottonello, and Perez 2023, Oskolkov 2023, Acharya and Challe 2025, in addition to the papers discussed further above).

2 Environment

This section introduces our baseline small open economy (SOE) model. We augment the classical New Keynesian framework of Galí and Monacelli (2005) with two additional ingredients — segmented international asset markets and a failure of Ricardian equivalence, here modeled through a perpetual-youth, overlapping-generations (OLG) consumer block. Similar to Itskhoki and Mukhin (2021), households can only trade local currency bonds and so all international capital flows have to be intermediated by financial arbitrageurs, who have limited risk-bearing capacity and are subject to financial constraints. Following Angeletos, Lian, and Wolf (2024a), we introduce mortality risk as a convenient proxy for liquidity frictions, breaking Ricardian equivalence and delivering elevated consumer MPCs.

Throughout the paper, we work with the (log-)linearized relations around a steady state in which inflation is zero and real allocations are given by their flexible-price counterparts; we directly present linearized relations whenever possible, with the detailed microfoundations and linearization steps relegated to Appendix B.1. Time is discrete and indexed by $t \in \{0, 1, \dots\}$, uppercase variables denote levels, and an overbar denotes a steady-state value. Lowercase variables denote log-deviations from the steady state, except for asset positions, net exports, and fiscal variables. To accommodate steady states in which these objects may be zero, household asset positions, net foreign asset positions, net exports, and fiscal variables such as tax payments and public debt are measured as absolute deviations from steady state, scaled by steady-state output. As is common in the open-economy literature, stars are used to indicate foreign variables.

2.1 Private sector

The private sector of the economy consists of three key blocks: consumer demand, production and pricing, and the financial sector.

Aggregate demand. The small open home economy is populated by a unit mass of households indexed by i. Households face perpetual-youth mortality risk: each household survives to the next period with probability $\omega \in (0, 1]$ and, upon death, is replaced by a newborn. Preferences are standard, with isolelastic utility over the consumption basket and disutility from labor, so the utility of any household i alive at period t is

$$\mathbb{E}_t \left[\sum_{k=0}^{\infty} (\beta\omega)^k \left(\frac{C_{i,t+k}^{1-\sigma} - 1}{1-\sigma} - \frac{L_{i,t+k}^{1+\varphi}}{1+\varphi} \right) \right],$$

where $\beta \in (0, 1)$ is the household discount factor, and $\sigma > 0$ and $\varphi > 0$ are the inverses of the elasticity of intertemporal substitution (EIS) and the Frisch elasticity, respectively. The consumption basket aggregates over both domestic and foreign goods, to be specified later. In addition to labor income, households also receive firm profits and pay taxes, and can save and borrow through an actuarially fair, risk-free, nominal annuity backed by local currency bonds. Overall, the date-t budget constraint of household i is given as

$$\frac{\omega A^{\mathrm{n}}_{i,t+1}}{\mathcal{I}_t} = A^{\mathrm{n}}_{i,t} + P_t \left(W_t L_{i,t} + \Pi^{\mathrm{pr}}_{i,t} - T_{i,t} - C_{i,t} + S_{i,t} \right),$$

where $A^{\mathrm{n}}_{i,t}$ is household nominal net wealth at the beginning of period t (so $A_{i,t} \equiv A^{\mathrm{n}}_{i,t}/P_t$ is real net wealth), $\mathcal{I}_t$ is the gross nominal interest rate on those bonds, P_t is the consumer price index, W_t is the real wage, $\Pi^{\mathrm{pr}}_{i,t}$ denotes household i's receipt of real firm profits, and $T_{i,t}$ denotes i's real tax payment. The final term, $S_{i,t}$, denotes transfers from old to newborn households, chosen as in Angeletos, Lian, and Wolf (2024a) to facilitate aggregation and allow a simple analytical approximation to consumer spending behavior in full-fledged HANK models.[5] We also assume that household labor supply is intermediated by a labor union that assigns identical hours to all households, i.e., $L_{i,t} = L_t$.[6] Firm profits are rebated equally across households, $\Pi^{\mathrm{pr}}_{i,t} = \Pi^{\mathrm{pr}}_t$, and taxes are identical across households, $T_{i,t} = T_t$. Together, these assumptions imply that post-tax income $W_t L_{i,t} + \Pi^{\mathrm{pr}}_{i,t} - T_{i,t}$ is the same across households.

Aggregating consumer spending across all households i, we obtain two equivalent ways of representing private demand. The first one is an aggregate, log-linearized consumption function, linking date-t spending to wealth, current and future income, and interest rates:

$$c_t = (1-\beta\omega)\left(a_t + \mathbb{E}_t\left[\sum_{k=0}^{\infty} (\beta\omega)^k (gdp_{t+k} - t_{t+k}) \right] \right) - \beta \left(\frac{\omega}{\sigma} - (1-\beta\omega)\frac{\bar{A}}{\bar{Y}} \right) \mathbb{E}_t\left[\sum_{k=0}^{\infty} (\beta\omega)^k r_{t+k} \right], \tag{2}$$

where $a_{i,t}$ is household i's real net wealth at the beginning of period t, $a_t \equiv \int a_{i,t} \mathrm{d}i$ is its aggregate counterpart, gdp_t is total real gross household income measured in units of the domestic consumption basket, $T_t \equiv \int T_{i,t} \mathrm{d}i$ is aggregate real tax revenue, t_t denotes real tax payments, and $r_t \equiv i_t - \mathbb{E}_t[\pi_{t+1}]$ is the (expected) real interest rate.[7] The coefficient on the interest rate term combines intertemporal substitution with the wealth effects associated with changes in real interest rates. As discussed in detail in Angeletos, Lian, and Wolf (2024a), equation (2) provides a tractable approximation to aggregate consumption-spending behavior in HANK-type environments when $\omega < 1$, while the case $\omega = 1$ recovers the textbook representative-agent

[5] Specifically, $S_{i,t} = S^{\text{new}} = \bar{A}$ for newborns and $S_{i,t} = S^{\text{old}} = -\frac{1-\omega}{\omega}\bar{A}$ for old households, which guarantees $(1-\omega)S^{\text{new}} + \omega S^{\text{old}} = 0$. These transfers are chosen so that newborns enter with the same steady-state wealth, and hence the same steady-state consumption, as surviving households.

[6] This assumption prevents consumption and wealth heterogeneity from generating household-specific labor income, and lets the aggregate labor supply relation coincide with the textbook New Keynesian one.

[7] Formally, $a_{i,t} \equiv (A_{i,t} - \bar{A})/\bar{Y}$, so a_t is aggregate real net wealth as a deviation from steady state, normalized by steady-state output and $t_t \equiv (T_t - \bar{T})/\bar{Y}$ records aggregate real tax payments as a deviation from steady state, normalized by steady-state output.

New Keynesian (RANK) consumption block of Woodford (2003) and Galí (2008). In particular, for $\omega < 1$, the MPC $1 - \beta\omega$ is elevated, resulting in transitory fluctuations in income being spent quickly, a model property that looms large in our upcoming analysis.[8]

The second, equivalent, representation of consumer demand comes in the form of an augmented Euler equation,

$$\mathbb{E}_t[\Delta c_{t+1}] = \frac{1}{\sigma} r_t - \alpha a_{t+1}, \tag{3}$$

where $\alpha \equiv \frac{(1-\omega)(1-\beta\omega)}{\omega}$ parameterizes the deviation from the permanent-income model, with $\alpha = 0$ (i.e., $\omega = 1$) corresponding to the familiar representative-agent case. Intuitively, greater wealth $a_{t+1} > 0$ raises c_t above the Ricardian benchmark when $\omega < 1$ (Barro 1974).

Goods market, production, and pricing. The goods market block of the economy is standard, following the open-economy model of Galí and Monacelli (2005). The domestic consumption bundle is an aggregate of home and foreign goods,

$$C_t = \left[(1-\gamma)^{\frac{1}{\theta}} C_{H,t}^{\frac{\theta-1}{\theta}} + \gamma^{\frac{1}{\theta}} C_{F,t}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}.$$

Here $\gamma \in (0, 1)$ indexes openness and $\theta > 0$ is the elasticity of substitution between home and foreign goods. Foreign demand for the home good is given as

$$C_{H,t}^* = \gamma \left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\theta} C_t^*,$$

where C_t^* is the global aggregate consumption demand, P_t^* denotes the foreign consumption-basket price, and $P_{H,t}^*$ is the price of the home good in foreign currency. We can then as usual define the real exchange rate $\mathcal{Q}_t$ and the terms of trade $\mathcal{S}_t$ as

$$\mathcal{Q}_t \equiv \frac{\mathcal{E}_t P_t^*}{P_t} \qquad \text{and} \qquad \mathcal{S}_t \equiv \frac{P_{F,t}}{\mathcal{E}_t P_{H,t}^*},$$

where $P_{F,t}$ is the home-currency price of the foreign good and $\mathcal{E}_t$ is the nominal exchange rate in units of home currency per unit of foreign currency. Thus, an increase in $\mathcal{E}_t$ and $\mathcal{Q}_t$ corresponds to nominal and real depreciations, respectively, while an increase in $\mathcal{S}_t$ corresponds to foreign goods becoming more expensive relative to home goods.

The home good is produced by a unit continuum of monopolistically competitive firms with a linear labor-only production technology, and prices adjust subject to a Calvo (1983)-style friction. For tractability reasons, our main analysis assumes producer currency pricing (PCP), with the alternative case of dollar pricing covered in Appendix B.7 and in our upcoming

[8] The second effect of $\omega < 1$ is that future income streams are discounted more heavily. This property is less essential to our upcoming results, though of course in our OLG economy elevated, front-loaded MPCs and discounting of future income are two sides of the same coin.

quantitative analysis in Section 5. Given the law of one price, the first-order approximation to the real exchange rate and the terms of trade implies that

$$q_t = (1-\gamma)s_t. \tag{4}$$

The same accounting links CPI inflation and home-good (PPI) inflation as

$$\pi_t = \pi_{H,t} + \frac{\gamma}{1-\gamma}\Delta q_t. \tag{5}$$

Firm price-setting together with optimal household labor supply furthermore delivers the following NKPC as our economy's key aggregate supply relation:

$$\pi_{H,t} = \kappa\left(\sigma c_t + \varphi y_t + \frac{\gamma}{1-\gamma}q_t\right) + \beta\mathbb{E}_t[\pi_{H,t+1}], \tag{6}$$

where $\kappa \equiv \frac{(1-\lambda)(1-\beta\lambda)}{\lambda}$ depends on the frequency of price adjustment $1-\lambda$, and y_t denotes physical production of the home good. The term in parentheses is the product real wage, and thus real marginal cost under linear production: $\sigma c_t + \varphi y_t$ is the CPI real wage implied by household labor supply, while $\frac{\gamma}{1-\gamma}q_t$ converts it into units of the home good.

Finally, equating total domestic production with local and foreign demand gives the market-clearing condition for the home good:

$$y_t = (1-\gamma)c_t + \gamma c_t^* + \gamma\theta(q_t + s_t), \tag{7}$$

where the term $q_t + s_t$ summarizes the relative-price effects in the domestic and foreign markets for the home good, and thus determines the expenditure-switching effect of changes in exchange rates. Given this market-clearing condition, total (real) household income is

$$gdp_t = y_t - \gamma s_t, \tag{8}$$

i.e., it equals domestic production adjusted for movements in the terms of trade.

Financial sector. Financial markets are segmented, with households only holding local currency bonds, and all international capital flows intermediated by specialized arbitrageurs. At date t, arbitrageurs choose gross nominal positions H^{n}_{t+1} and $H^{*,\mathrm{n}}_{t+1}$ in home and foreign bonds. These variables denote nominal payoffs at the beginning of period $t+1$, so the date-t amounts invested are discounted by the gross nominal returns. The zero-capital carry-trade constraint is therefore that

$$\frac{H^{\mathrm{n}}_{t+1}}{\mathcal{I}_t} + \frac{\mathcal{E}_t H^{*,\mathrm{n}}_{t+1}}{\mathcal{I}^*_t} = 0,$$

where $\mathcal{I}_t^*$ denotes the gross nominal return on the foreign bond and starred nominal positions are denominated in foreign currency. Next period, arbitrageurs collect the net nominal payoff $H_{t+1}^{\mathrm{n}} + \mathcal{E}_{t+1} H_{t+1}^{*,\mathrm{n}}$ and transfer it lump-sum to households. Financial constraints on the carry trade create limits to arbitrage, so that in equilibrium we have

$$\phi h_{t+1}^* = r_t^* - r_t + \mathbb{E}_t[\Delta q_{t+1}],$$

where h_{t+1}^* denotes the normalized deviation of the foreign-bond position carried by the arbitrageurs, and r_t^* is the foreign real return, defined analogously to r_t.[9] The right-hand side is the expected excess return on the carry trade. The parameter $\phi \geq 0$ governs the severity of financial frictions, and the standard UIP emerges if $\phi = 0$.

Overall, market-clearing in the home- and foreign-currency bond markets requires that

$$A_{t+1}^{\mathrm{n}} + H_{t+1}^{\mathrm{n}} + F_{t+1}^{\mathrm{n}} = D_{t+1}^{\mathrm{n}} \qquad \text{and} \qquad B_{t+1}^{*,\mathrm{n}} = H_{t+1}^{*,\mathrm{n}} + F_{t+1}^{*,\mathrm{n}},$$

where $A_{t+1}^{\mathrm{n}} \equiv \int A_{i,t+1}^{\mathrm{n}} \mathrm{d}i$ is aggregate household nominal net wealth, D_{t+1}^{n} is nominal government debt outstanding, F_{t+1}^{n} and $F_{t+1}^{*,\mathrm{n}}$ are central bank nominal positions in home and foreign bonds, and $B_{t+1}^{*,\mathrm{n}}$ is the domestic economy's nominal net foreign asset position in foreign-currency units; we postpone a discussion of domestic fiscal and monetary policy to Section 2.2. Note that, since households hold only home-currency bonds, the foreign-currency position $B_{t+1}^{*,\mathrm{n}}$ is absorbed by arbitrageurs and the central bank.

To first order, foreign-currency bond market clearing then gives $h_{t+1}^* = b_{t+1}^* - f_{t+1}^*$, where b_{t+1}^* and f_{t+1}^* are the domestic economy's and the domestic central bank's normalized real net foreign asset positions.[10] Substituting this condition into the portfolio choice of arbitrageurs, we get a modified uncovered interest parity (UIP) condition:

$$\mathbb{E}_t[\Delta q_{t+1}] = r_t - r_t^* + \phi\big(b_{t+1}^* - f_{t+1}^*\big). \tag{9}$$

A high b_{t+1}^* means the economy is saving in foreign bonds; absent matching official holdings f_{t+1}^*, arbitrageurs must go long foreign bonds and short home bonds. Because this position exposes them to future exchange-rate risk, they require a higher expected excess return on foreign bonds. This no-arbitrage condition nests the standard UIP with $\phi \to 0$ when arbitrageurs are risk neutral and unconstrained, as well as the stationary version of the canonical incomplete-markets SOE in Schmitt-Grohé and Uribe (2003), with $\phi > 0$ and $f_t^* = 0$.

[9] To define h^*, let $H_t^* \equiv H_t^{*,\mathrm{n}}/P_t^*$ denote the arbitrageur's real foreign bond position in units of the foreign consumption basket. Then, given zero steady-state foreign positions, define the real position scaled by steady-state output as $h_t^* \equiv H_t^*/\bar{Y}$.

[10] Define real foreign positions in units of foreign consumption as $B_t^* \equiv B_t^{*,\mathrm{n}}/P_t^*$ and $F_t^* \equiv F_t^{*,\mathrm{n}}/P_t^*$, and normalized deviations entering the linearized system as $b_t^* \equiv (B_t^* - \bar{B}^*)/\bar{Y}$ and $f_t^* \equiv (F_t^* - \bar{F}^*)/\bar{Y}$.

2.2 Government

We next describe the policy block, focusing on monetary policy, foreign exchange interventions (FXI), and fiscal policy.

Conventional monetary policy. The domestic central bank sets the nominal return on domestic bonds i_t. Since private demand and the UIP condition depend on this instrument through the expected real return r_t, we describe monetary policy directly as a path $\{r_t\}_{t=0}^{\infty}$. Equivalently, given any path of expected inflation, a desired real-rate path can be implemented by choosing nominal rates according to $i_t = r_t + \mathbb{E}_t[\pi_{t+1}]$. Following Woodford (2011), Auclert, Rognlie, and Straub (2024), and Angeletos, Lian, and Wolf (2024a), we specify monetary policy in terms of real-rate paths rather than endogenous (e.g., Taylor-type) feedback rules. This keeps the analysis transparent, allowing us to study first what happens *given* monetary policy and then how the stance of monetary policy needs to adjust. We study extensions to Taylor-type feedback rules in Section 5.

Foreign exchange interventions. The central bank can use sterilized interventions to change the composition of total government debt between home bonds F_t^{n} and foreign bonds $F_t^{*,\mathrm{n}}$. Sterilization means that these positions form a zero-cost swap,

$$\frac{F_{t+1}^{\mathrm{n}}}{\mathcal{I}_t} + \frac{\mathcal{E}_t F_{t+1}^{*,\mathrm{n}}}{\mathcal{I}_t^*} = 0.$$

We assume that the central bank's nominal balance sheet positions satisfy $\bar{F}^{\mathrm{n}} = \bar{F}^{*,\mathrm{n}} = 0$ in steady state. Return and valuation terms involving these positions are therefore second order in the linearized consolidated government budget constraint. The sole first-order effect of interventions is to show up in the augmented UIP condition (9), as discussed above. Similarly to monetary policy, the FX interventions can be summarized by a path of $\{f_t^*\}_{t=1}^{\infty}$.

Fiscal policy. The fiscal authority issues short-term, nominal local-currency government debt. Given the possibility of central bank FXI, assuming that government debt is denominated in home currency is without loss of generality. The consolidated government budget constraint (in nominal terms) is then

$$\frac{D_{t+1}^{\mathrm{n}} - F_{t+1}^{\mathrm{n}}}{\mathcal{I}_t} - \frac{\mathcal{E}_t F_{t+1}^{*,\mathrm{n}}}{\mathcal{I}_t^*} = D_t^{\mathrm{n}} - F_t^{\mathrm{n}} - \mathcal{E}_t F_t^{*,\mathrm{n}} - P_t T_t,$$

where T_t denotes real taxes and D_t^{n} is nominal debt outstanding at the beginning of period t.

For simplicity, we assume that the government debt is zero in the steady state (i.e., $\bar{D} = 0$) and generalize our results to $\bar{D} > 0$ in the quantitative section. The normalized deviation of real government debt from steady state, $d_t \equiv (D_t^{\mathrm{n}}/P_t - \bar{D})/\bar{Y}$, then evolves according to a linearized version of the government's consolidated budget balance

$$\beta d_{t+1} = d_t - t_t, \tag{10}$$

together with the standard no-Ponzi condition. As with monetary and FX policies, it is convenient to describe fiscal policy as a path of government debt $\{d_t\}_{t=1}^{\infty}$.

2.3 Balance of payments

The real net foreign asset position of the economy, measured in normalized deviations, corresponds to the difference between households' wealth and government debt:

$$b_t^* = a_t - d_t, \tag{11}$$

and we take the steady-state net foreign asset position to be zero, i.e., $\bar{B}^* = 0$, for simplicity.[11]

Aggregating the flow-of-funds constraints for households, firms, and the government, and imposing goods- and asset-market clearing, yields the country-level budget constraint

$$\beta b_{t+1}^* = b_t^* + nx_t, \tag{12}$$

where net exports depend on relative demand shifters $c_t - c_t^*$, expenditure switching through $q_t + s_t$, and the terms of trade s_t:

$$nx_t = \gamma\big[\theta q_t + (\theta - 1)s_t - (c_t - c_t^*)\big]. \tag{13}$$

Using the law of one price (4), the trade balance can be expressed as

$$nx_t = \gamma\left(c_t^* - c_t + \vartheta q_t\right), \qquad \text{where} \quad \vartheta \equiv \frac{(2-\gamma)\theta - 1}{1-\gamma} \tag{14}$$

is the usual trade elasticity. We throughout impose the Marshall-Lerner condition $\vartheta > 0$: a real depreciation improves net exports through import compression and export expansion, while a real appreciation lowers net exports.[12] The balance-of-payments block is completed by the standard no-Ponzi restriction on the foreign net asset position, and we assume a zero initial foreign net asset position, $b_0^* = 0$.

[11] Given $\bar{B}^* = 0$ and $\bar{F}^{*,\mathrm{n}} = 0$, foreign-currency asset-market clearing implies $\bar{H}^{*,\mathrm{n}} = 0$. The zero-capital carry-trade constraint then implies $\bar{H}^{\mathrm{n}} = 0$, and home-currency asset-market clearing with $\bar{F}^{\mathrm{n}} = 0$ gives $\bar{A}^{\mathrm{n}} = \bar{D}^{\mathrm{n}}$, or equivalently $\bar{A} = \bar{D}$ in real terms.

[12] Although empirical evidence suggests that short-run trade elasticities are substantially more muted than medium- or long-run responses (and may even have a negative sign), our quantitative exercise evaluates net present values over a longer horizon. This motivates our use of medium-term elasticities, for which $\vartheta > 0$ is the empirically relevant case.

2.4 Rest of the world

The domestic economy is affected by the rest of the world through two exogenous inputs: total foreign demand c_t^* and the foreign real interest rate r_t^*. We will simply assume that both follow arbitrary bounded, absolutely summable stochastic processes.[13] In keeping with our focus on the propagation of foreign aggregate demand, we will chiefly be concerned with the transmission of c_t^*. As we discuss in greater detail in Section 3.4, these foreign outcomes should be understood as determined in response to a combination of underlying foreign shocks (e.g., to policy, private consumer demand, or productivity).

When comparing domestic to foreign outcomes, we will also pay attention to inflationary pressures at home and abroad. For that comparison, and again in keeping with our focus on the transmission of demand, we assume that foreign inflation is pinned down by the path of foreign demand c_t^* through the following global NKPC:

$$\pi_t^* = \kappa(\sigma + \varphi)c_t^* + \beta\mathbb{E}_t[\pi_{t+1}^*]. \tag{15}$$

Equation (15) is the large-economy counterpart of the domestic NKPC: because the home economy is small, the domestic terms of trade, s_t, have no effect on foreign marginal costs, and the rest of the world satisfies $y_t^* = c_t^*$ in equilibrium.

2.5 Equilibrium

The exogenous inputs to the domestic economy are foreign demand and the foreign real interest rate. We also assume that the three domestic policy instruments follow bounded, absolutely summable stochastic processes. Given these two sets of processes, a standard equilibrium definition combines optimality for all domestic agents with market-clearing.

Definition 1. *Given foreign shocks* $\{c_t^*, r_t^*\}_{t\geq 0}$ *and domestic policies* $\{r_t, d_{t+1}, f_{t+1}^*\}_{t\geq 0}$*, an equilibrium is a bounded stochastic path for* $\{c_t, y_t, q_t, s_t, \pi_{H,t}, \pi_t, a_t, t_t, b_t^*, nx_t, \pi_t^*, gdp_t\}_{t\geq 0}$ *that satisfies* (3)-(15)*, together with the initial conditions and no-Ponzi restrictions, and ensures that domestic (PPI) inflation converges to zero,* $\lim_{k\to\infty} \mathbb{E}_t[\pi_{H,t+k}] = 0$.

Since we specify policy directly in terms of paths for policy instruments (rather than feedback rules), our model inherits the familiar long-run indeterminacy of the textbook New Keynesian model. Just as in Woodford (2011), we resolve this indeterminacy by assuming that domestic PPI inflation converges to zero, as in the flexible-price allocation, in the long run.[14] As discussed above, this formulation is attractive because it allows us to study how foreign demand propagates *given* domestic policy; in particular, fixing monetary policy as a path of real

[13] A process x is bounded if there exists $M > 0$ such that $|x_t| < M$ for all dates t and all realizations of uncertainty. Here and throughout, a process x is absolutely summable if $\sum_{j=0}^{\infty} \mathbb{E}_t[|x_{t+j}|] < \infty$ for every date t.

[14] In our analysis, this is equivalent to selecting equilibria in which domestic CPI inflation π_t converges to zero.

interest rates allows us to ask how an impulse to foreign demand propagates given the (real) stance of domestic monetary policy. This approach is in keeping with much recent analytical work on demand-determined economies, including for example Auclert, Rognlie, and Straub (2024) and Angeletos, Lian, and Wolf (2024a).

Lemma 1. *Assume $\alpha + \phi > 0$. There exists a unique equilibrium.*

Note that Lemma 1 rules out the case in which households are Ricardian ($\omega = 1$, so $\alpha = 0$) and there are no currency market financial frictions ($\phi = 0$). Briefly, because of the resulting non-stationarity (Schmitt-Grohé and Uribe 2003), this case requires special treatment and is discussed separately below. With uniqueness in hand, we study the properties of this equilibrium. To simplify notation, we drop expectations and work with perfect-foresight transition paths. At the beginning of $t = 0$, the exogenous foreign shock paths $\{c_t^*, r_t^*\}_{t=0}^{\infty}$ and the policy paths $\{r_t, d_{t+1}, f_{t+1}^*\}_{t=0}^{\infty}$, both absolutely summable, are revealed to private agents, who have perfect foresight thereafter. The resulting transition paths correspond to impulse responses in the stochastic economy.

3 Direct exposure

This section presents our main result on how shocks to foreign aggregate demand pass through to the domestic economy. We begin in Section 3.1 by establishing that any foreign disturbance, and given any possible policy response, is absorbed by either quantities — domestic production and consumption — or prices — the real exchange rate. This decomposition will guide much of the analysis in the remainder of the paper. Sections 3.2 and 3.3 then study the split between prices and quantities in the special case of a neutral domestic policy response, i.e., what we refer to as the "direct exposure." This analysis allows us to cleanly establish our headline result on how a race between MPCs and financial frictions shapes the economy's exposure.

3.1 Prices vs. quantities

Consider an arbitrary foreign demand path c_t^*. It is straightforward to see from the intertemporal version of the country budget constraint (12) - (13) that, in equilibrium, this demand must translate into either domestic consumption c_t or movements in the real exchange rate q_t. To characterize the relation between these three objects, we iterate the country budget forward over time, thus allowing statements about net present values, defined as

$$\text{NPV}(x_t) \equiv \sum_{t=0}^{\infty} \beta^t x_t$$

for any variable x_t. We arrive at the following result.

Lemma 2. *In any equilibrium, foreign demand c_t^* is absorbed by either domestic consumption or the real exchange rate, with*

$$\text{NPV}(c_t^*) = \underbrace{\text{NPV}(c_t)}_{\textit{quantities}} - \vartheta \underbrace{\text{NPV}(q_t)}_{\textit{prices}}. \tag{16}$$

Lemma 2 follows from intertemporal balanced trade, $\text{NPV}(nx_t) = 0$, obtained by iterating the country budget constraint (12) forward, together with the no-Ponzi restriction on the net foreign asset position. The lemma shows that foreign aggregate demand c_t^* must be accommodated in one of two ways: either domestic aggregate demand $c_t > 0$ rises, increasing demand for imported goods, or the real exchange rate $q_t < 0$ appreciates, inducing expenditure switching toward foreign goods, which raises imports and lowers exports. The relative strength of these quantity and price channels has far-reaching implications for the domestic economy. If the adjustment occurs chiefly through quantities, an increase in aggregate consumption c_t not only boosts imports, but also raises demand for local goods. Through the domestic NKPC (6), this consumption boom then exerts upward pressure on home-good inflation. Conversely, if adjustment occurs through a real exchange rate appreciation, domestic activity is insulated, and CPI prices can instead *decline* through the terms-of-trade component in (5). Importantly, the decomposition in (16) applies regardless of the mix of shocks buffeting the foreign economy, and regardless of the domestic policy response.

In the remainder of this section we seek to isolate what features of the economic environment lead the economy towards price vs. quantity adjustment. A key object of interest for us in this analysis is the *foreign trade multiplier*.

Definition 2. *The foreign trade multiplier is the share of a foreign demand boom absorbed by domestic consumption and thus the gross domestic product:*

$$\varsigma \equiv \frac{\text{NPV}(c_t)}{\text{NPV}(c_t^*)} = \frac{\text{NPV}(gdp_t)}{\text{NPV}(c_t^*)}. \tag{17}$$

A second important dimension of the domestic response to foreign demand is the long-run response of prices, defined as

$$p_\infty \equiv \sum_{t=0}^{\infty} \pi_t. \tag{18}$$

We compare this long-run domestic price response with the long-run foreign response, defined analogously as p_∞^*.

3.2 Importing aggregate demand

We now turn to our main analytical results on the equilibrium split between prices and quantities. To isolate how non-policy features of the environment shape that split, we consider the benchmark of "neutral" policies in both economies: abroad, we set $r_t^* = 0$, so the only foreign shock is the demand path c_t^*; and at home, we set $r_t = d_t = f_t^* = 0$, ruling out domestic real-rate changes, debt deviations, and FX intervention. As discussed previously, such a "neutral" domestic policy is a natural starting point, allowing us to understand how pure foreign demand shocks are absorbed domestically; once that case is understood, we will later ask how domestic policy needs to react to insulate the domestic economy. To summarize, the results below are derived under the following assumption:

Assumption. *The home economy faces a global demand boom, with* $\mathrm{NPV}(c_t^*) > 0$, *accompanied by neutral foreign and local policies,* $r_t^* = r_t = d_t = f_t^* = 0$.

Our main result establishes that the equilibrium price-quantity split is governed by a race between two key frictions in our environment: the departure from Ricardian equivalence ($\omega < 1$, or $\alpha > 0$) and the severity of financial frictions ($\phi > 0$). For brevity, below we use the following terms to refer to four possible combinations of (α, ϕ):

Definition 3. *We refer to models with* $\alpha = 0$ *as RANK, and with* $\alpha > 0$ *as HANK. If* $\phi = 0$, *we add the label UIP, i.e.,* $\alpha = \phi = 0$ *is RANK-UIP and* $\alpha > 0, \phi = 0$ *is HANK-UIP.*

For what follows, the two limiting cases of RANK and HANK-UIP will provide particularly useful benchmarks, as each of them emphasizes just one friction at a time — UIP deviations and non-Ricardian consumption, respectively.[15] Looking ahead to our later quantitative analysis in Section 5, empirically relevant models will feature meaningfully elevated MPCs, consistent with a wealth of existing microeconomic evidence (e.g., see Fagereng, Holm, and Natvik 2021). For financial frictions, most standard calibrations of open-economy models assume small (though non-zero) values of ϕ, consistent with the high persistence of the real exchange rate in the data (Rogoff 1996). It follows that the special case of HANK-UIP should be interpreted as the more relevant approximation to a realistically calibrated version of a quantitative model, at least for relatively advanced open economies. Emerging markets with shallow financial markets, and so higher ϕ, might be further away from this benchmark.

Prices vs. quantities in equilibrium. With these assumptions and definitions at hand, we arrive at our central result:

Theorem 1. *The foreign trade multiplier, i.e., the pass-through from foreign demand to domestic consumption and economic activity, satisfies*

$$\varsigma = \frac{\alpha}{\alpha + \vartheta\phi}. \tag{19}$$

[15] As briefly mentioned in Section 2.5, when we refer to RANK below, we focus on the stationary case of $\alpha = 0$ and $\phi > 0$. We will discuss RANK-UIP separately; specifically, when the relevant limits are taken appropriately, RANK-UIP outcomes are the natural limit of RANK outcomes as the financial friction vanishes.

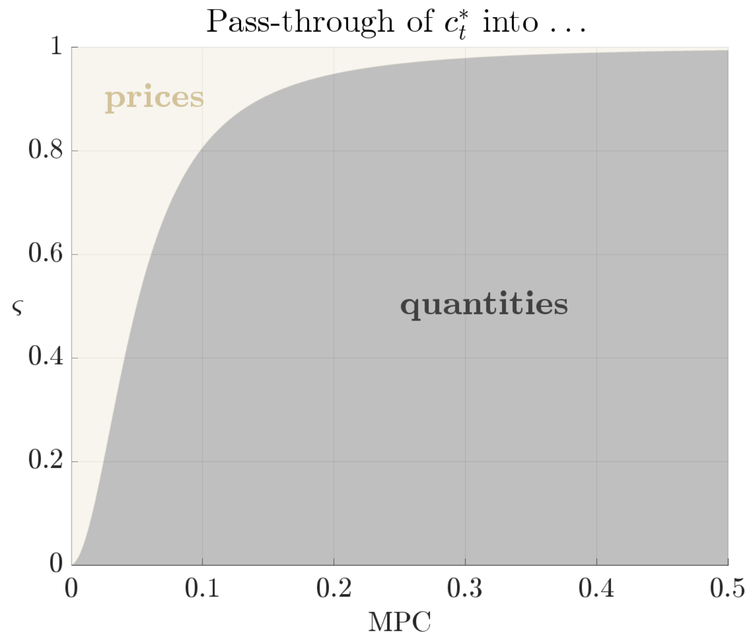

Figure 1: Foreign trade multiplier ς as a function of the MPC $\approx 1-\omega$. The quantity share of the response (ς) is indicated in grey, while the residual price response ($1-\varsigma$) is displayed in beige. Other parameters: $\beta = 0.99^{\frac{1}{4}}$, $\phi = 0.00123$, $\gamma = 0.3$, $\theta = 1.5$.

It is thus increasing in MPCs (i.e., in α) and decreasing in both the severity of the financial frictions (i.e., in ϕ) and the trade elasticity ϑ. In particular:

1. *In RANK, the multiplier is zero, $\varsigma = 0$, so there is complete price adjustment.*

2. *In HANK-UIP, the multiplier is one, $\varsigma = 1$, so there is complete quantity adjustment.*

Theorem 1 sharply characterizes how our two central frictions determine whether foreign demand is absorbed through prices or quantities. The stronger financial frictions, the more prices respond, limiting to full price absorption in RANK; and the stronger the departure from permanent-income consumption, the more the foreign boom is imported through domestic activity, limiting to one-to-one pass-through — that is, $\text{NPV}(c_t) = \text{NPV}(c_t^*)$ — in HANK with $\alpha \gg \phi$. Figure 1 provides an illustration, showing the price-quantity split as a function of the MPC (i.e., $\approx 1-\omega$) for empirically relevant small but non-zero ϕ. We see that quantity pass-through is large already for only moderately elevated MPCs, but then sharply declines as we approach permanent-income consumption, consistent with Theorem 1. The remainder of this section elaborates on the economic mechanism underlying our results, and also further discusses implications for other equilibrium outcomes, in particular including inflation.

Static intuition. To build intuition for Theorem 1 we begin here with a simple static Keynesian cross variant of our infinite-horizon economy.[16] Specifically, domestic consumption is

[16]We study the static, contemporaneous response of the economy to foreign demand. Implicitly, it is assumed that variables in the future adjust to ensure that intertemporal budget constraints are satisfied. Ignoring that

given by a standard Keynesian consumption function,

$$c = \text{MPC} \cdot gdp,$$

where MPC $\in (0,1)$ is the marginal propensity to consume. Total household income is in turn, by market-clearing, given as

$$gdp = c + nx = (1-\gamma)c + \gamma c^* + \gamma\vartheta q,$$

where again c^* is foreign demand and q is the real exchange rate, echoing the market-clearing condition in our full infinite-horizon economy. Combining these two relations yields

$$c = \frac{\gamma \text{MPC}}{1-(1-\gamma)\text{MPC}} \cdot \big(c^* + \vartheta q\big). \tag{20}$$

The term in brackets denotes export revenues, coming either from the exogenous increase in foreign demand c^* or a depreciation of the home currency q. A one percent increase in export revenues increases domestic income by $\gamma \in (0,1)$ (the degree of openness), thus translating to additional domestic spending equal to the MPC. This then sets in motion a standard Keynesian cross: for every unit of further domestic income, a fraction $(1-\gamma)$MPC stays in the domestic economy, further increasing income. This amplification is essentially the Keynesian foreign trade multiplier first derived by Harrod (1933).[17]

Equation (20) is however an incomplete description of outcomes in the domestic economy, as it features two endogenous outcomes: domestic consumption c and the real exchange rate q. A second relation between these two variables is provided by equilibrium in the currency market, requiring that

$$q = -\Phi \cdot nx,$$

and so, via output market-clearing,

$$q = -\frac{\gamma\Phi}{1+\gamma\vartheta\Phi}(c^* - c), \tag{21}$$

with the parameter $\Phi \geq 0$ summarizing, exactly as ϕ in our dynamic model, the severity of the financial frictions. Intuitively, if domestic consumption, and hence import demand, does not rise enough to absorb the additional export revenues, the supply of foreign currency exceeds demand. Intermediaries must absorb this imbalance, putting pressure on the real exchange

future adjustment turns out to be innocuous for the purpose of developing the core intuition.

[17]The original derivations by Harrod rely on the national income identity $Y = C + EX - IM$, balanced trade $IM = EX$, and assume households spend a constant share γ of their income on foreign goods $IM = \gamma C$. It follows that relative prices are irrelevant and $Y = C = EX/\gamma$, i.e. injecting one dollar of extra export revenues boosts domestic output and consumption by $1/\gamma$ dollars.

rate to appreciate ($q < 0$). When arbitrageurs are risk neutral and have deep pockets, $\Phi \approx 0$, they are happy to absorb this imbalance, and so there is little pressure on the exchange rate. By contrast, when financial frictions are severe ($\Phi \to \infty$), then intermediaries are unwilling to take large positions, and so the real exchange rate adjusts, bringing the trade balance and intertemporal borrowing and saving closer to zero ($nx \approx 0$).

The system (20) - (21) shows that the split of the export shock c^* between quantities c and prices q depends crucially on the relative magnitudes of the MPC and of Φ. To see this, consider first the limit MPC $\to 1$, i.e., households are fully hand-to-mouth and consume all the additional income immediately. Furthermore we guess that $q = 0$, i.e., no movement in the real exchange rate. Then (20) delivers $c = \frac{\gamma}{\gamma} c^* = c^*$, i.e., a one-to-one pass-through to domestic consumption, and so indeed from (21) we find that the real exchange rate need not move. Intuitively, when MPC $= 1$, the multiplier in (20) equals 1, and household spending on foreign goods rises one-for-one with export revenues. As a result, trade remains balanced, and equilibrium in the currency market is achieved without any adjustment in the exchange rate. In this case, the foreign trade multiplier operates at full strength. Conversely, if MPC < 1 and $\Phi \to \infty$, then (20) - (21) delivers $c = 0$ and $q = -c^*/\vartheta$, i.e., now domestic consumption does not respond at all, and the real exchange rate appreciates to fully absorb the foreign demand boom. Intuitively, because domestic consumers are more Ricardian, they spend less in the short run (small MPC) and demand fewer imports. It follows that the supply of foreign currency exceeds its demand, necessitating international capital flows, and thus triggering a strong exchange rate response.

Back to the dynamic economy. It turns out that the static analysis of the preceding paragraph captures well the behavior of our actual infinite-horizon economy. We leverage Figure 2, which shows impulse response paths for several variables and several different values of ω (and thus α), to explain this connection. The purpose of this figure is purely illustrative; a quantitative investigation in a more realistic model variant is postponed until Section 5.[18]

The consumption, real exchange rate, and net foreign asset position impulse responses in Figure 2 reflect a "race" between elevated MPCs and financial frictions analogous to the earlier discussion in the static model. Echoing that static analysis, we here begin by guessing, perhaps counterfactually, that the real exchange rate does not move in equilibrium. Since household *lifetime* MPCs necessarily equal one independently of ω, the foreign demand boom passes through one-to-one into domestic consumption in net present value terms. If MPCs are very large ($\omega \to 0$, $\alpha \to \infty$), then domestic consumption will echo foreign demand not just in net present value terms, but date-by-date. As a result, there is no need for any international flows,

[18]As for Figure 1, we set $\beta = 0.99^{\frac{1}{4}}$, $\phi = 0.00123$, $\gamma = 0.3$, $\theta = 1.5$. The other model parameters required for computation of full impulse responses are: $\sigma = 2$, $\varphi = 1$, and $\kappa(\sigma + \varphi) = 0.2$, an illustrative steep slope for the NKPC. Finally c^* follows an AR(1) process with persistence of 0.8.

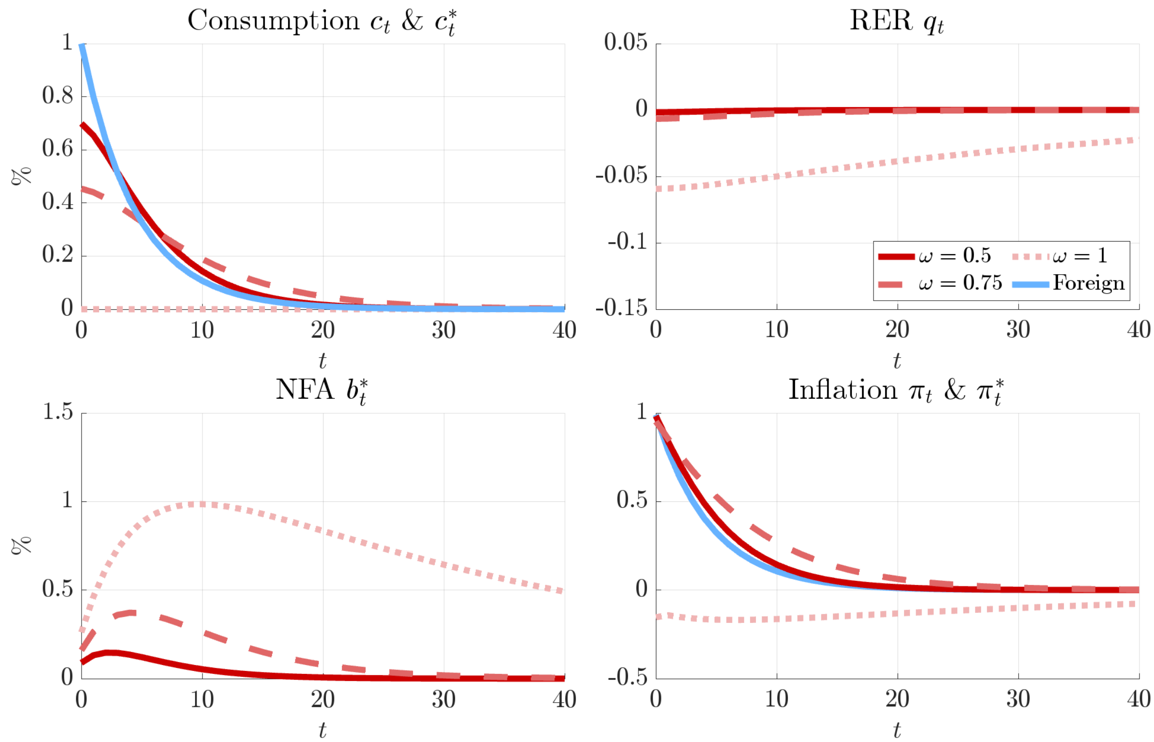

Figure 2: Responses of consumption, the real exchange rate, the net foreign asset position, and inflation to a foreign demand shock c_t^*, with neutral domestic policy and for different ω's (shades of red, solid, dashed, dotted). Foreign consumption and inflation paths in blue.

and so the guess that the real exchange rate need not move is verified. The dark red lines in Figure 2, corresponding to quarterly MPCs of 25 percent and 50 percent, respectively, are close to this limiting case: domestic consumption tracks foreign demand relatively closely date-by-date, so the required net foreign flows are small, and thus the real exchange rate in equilibrium moves little, leading to small crowding-out. If instead consumers are permanent-income, then the increase in domestic spending would be smoothed over time, now instead leading to large and persistent movements in the net foreign asset position, causing a real exchange rate adjustment; and the larger the trade elasticity ϑ, the more potent the effects of this real exchange rate appreciation on domestic activity. This case is depicted as the light dashed red line: with permanent-income households, the real exchange rate responds significantly and persistently, neutralizing the pass-through from foreign demand to domestic consumption.

Zooming out, the key translation between the static and dynamic model is that the single period of the simple static model should be interpreted as the "short run" in the infinite-horizon model. Lifetime cumulative MPCs are always one, but what matters is whether cumulative MPCs are already sufficiently close to one over business-cycle frequencies. If they are, then the foreign boom is imported quickly, and quantities win the race; if they are not, then too much adjustment would need to occur via international flows, so the exchange rate adjusts instead.

In fact, *both* large MPCs and severe financial frictions generate faster mean reversion and thus convergence back to steady state; the race between the two then simply governs the *margin* that ends up doing the adjustment. Our later quantitative analysis in Section 5 disciplines this race through empirical evidence on consumer spending over time and exchange rate dynamics.

Implications for inflation. Relative to the static model, the full infinite-horizon analysis adds one further important wrinkle: it allows us to characterize the *timing* of the imported domestic boom relative to the increase in foreign aggregate demand. Intuitively, with $\phi \to 0$, the foreign boom is imported almost one-to-one in present-value terms. But unless households are exactly hand-to-mouth, they do not spend the additional income immediately — they smooth consumption, so part of the domestic response is shifted toward later dates. This backloading is visible in the top left panel of Figure 2, and formalized in the following lemma.

Lemma 3. *In HANK-UIP, if $c_t^* \geq 0$ for all t, the domestic boom is strictly backloaded relative to the foreign demand boom, in the sense that*

$$\sum_{t=0}^{\infty} NPV_t(c_\tau) \; > \; \sum_{t=0}^{\infty} NPV_t(c_\tau^*), \tag{22}$$

where $NPV_t(x_\tau) \equiv \sum_{\tau=t}^{\infty} \beta^{\tau-t} x_\tau$ computes net present values from date t onwards.

As already discussed above, in HANK-UIP, $\text{NPV}(c_t) = \text{NPV}(c_t^*)$, i.e., the foreign boom passes through one-to-one to domestic consumption. Lemma 3 then reveals that, taking the average across periods, the present value of *future* consumption is higher at home than abroad, i.e., the domestic consumption is backloaded relative to the foreign boom. Intuitively, this reflects (partial) consumption smoothing of households at home, with the domestic consumption boom becoming more and more persistent as $\alpha \to 0$. Importantly, this backloading of demand has implications for price pressures at home.

Proposition 1. *Suppose that $c_t^* \geq 0$ for all t.*

1. *In HANK-UIP, domestic cumulative price pressures exceed those abroad:*

$$\pi_0 = \pi_0^*, \quad p_\infty > p_\infty^*,$$

2. *In RANK, the domestic economy imports deflation:*

$$\pi_0 < 0 < \pi_0^*, \quad p_\infty < 0 < p_\infty^*,$$

Start with the HANK-UIP part of Proposition 1. Since the foreign aggregate demand boom is imported one-to-one into domestic activity in net present value terms, and since the NKPCs

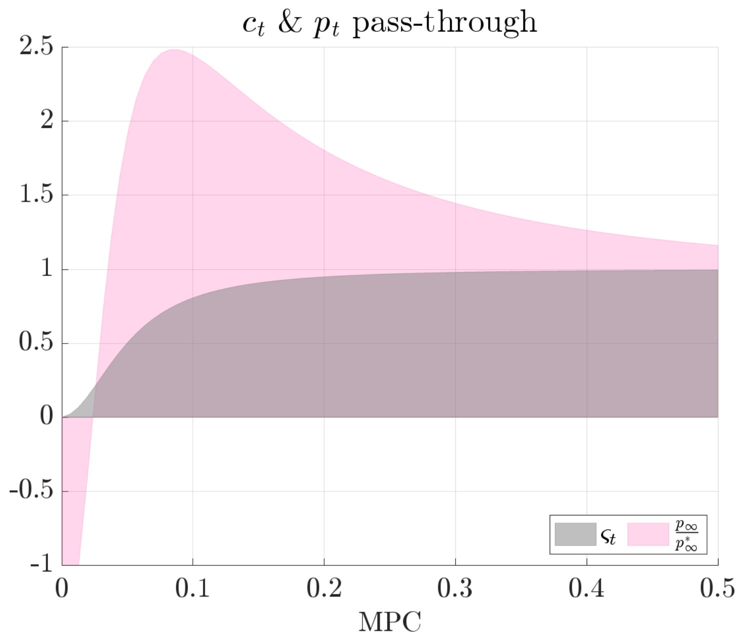

Figure 3: Foreign trade multiplier ς and cumulative inflation ratio as a function of the MPC $\approx 1-\omega$. The quantity share (ς) is indicated in grey, while the relative cumulative price pressure is displayed in pink. All parameters as for Figure 2, see Footnote 18.

(6) and (15) are forward-looking, impact inflation is exactly the same at home and abroad, as visible in the bottom right panel of Figure 2.[19] However, since the domestic boom is relatively more backloaded, and since firm price setting is forward-looking, inflation ends up being more persistent at home, ultimately delivering strictly larger *cumulative* price pressures.[20] In fact, conditional on complete quantity pass-through (as is always the case in HANK-UIP), the inflation gap actually gets *larger* when the MPCs are smaller, because smaller MPCs deliver a more backloaded boom, and so necessarily more inflation. This logic is illustrated further in Figure 3: as long as MPCs are sufficiently elevated to ensure essentially full quantity pass-through (i.e., $\varsigma \approx 1$), the gap between domestic and foreign price pressures gets larger as consumer spending behavior becomes more Ricardian.

As MPCs decline further, however, the pattern changes, with the limit characterized as the second extreme case in Proposition 1. With $\alpha = 0$ and $\phi > 0$ (i.e., the stationary RANK case), all adjustment instead occurs through a real exchange rate appreciation, and so there is

[19]The important implication of this result is that allowing for steady-state gross positions in short-term debt denominated in home and foreign currencies does not change the propagation of foreign demand shocks in HANK-UIP: since $q_0 = 0$ and $\pi_0 = \pi_0^*$, the nominal exchange rate does not move on impact $e_0 = 0$ and the valuation effects are equal zero keeping the decomposition (16) unchanged.

[20]The long-run domestic price level overshoot in the all-quantities limit is not driven by our assumption that price-setting is *purely* forward-looking, but continues to obtain even with empirically relevant hybrid NKPCs. To see why, consider instead the following two alternative extremes. First, if price-setting is fully myopic (i.e., a static NKPC), then $\text{NPV}(\pi_t) = \text{NPV}(\pi_t^*)$, and so $p_\infty \approx p_\infty^*$ with β close to 1. Our conclusions thus re-emerge as soon as price setters are even marginally forward-looking. Second, if price-setting is, because of indexation, fully backward-looking (i.e., a coefficient of β on lagged inflation), then again $\text{NPV}(\pi_t) = \text{NPV}(\pi_t^*)$, and again adding even marginally forward-looking price-setting restores our findings.

deflation both on impact and cumulatively. In Figure 3, this appears as a non-monotonicity of the domestic inflation response in the MPC: as we lower the MPC from a high level, inflation initially increases as the boom becomes more backloaded, but then decreases as progressively less adjustment occurs through quantities.

Aside: RANK-UIP. We close our analysis with a brief discussion of one important special case: the RANK-UIP corner, i.e., both $\alpha = 0$ and $\phi = 0$. We only provide the main takeaways here, with the detailed analysis relegated to Appendix B.2.

The analysis of the RANK-UIP corner is complicated by that model's well-known lack of stationarity (e.g., see Schmitt-Grohé and Uribe 2003), making the analysis exceedingly sensitive to assumptions about boundary conditions. As long as we have either $\alpha > 0$ or $\phi > 0$, our boundary condition — i.e., that $\pi_{H,t} \to 0$ — delivers the same conclusions as requiring any of $c_t, y_t, q_t \to 0$. In RANK-UIP, in contrast, all of those boundary conditions generally give different conclusions, reflecting assumptions at infinity leaking back to the present, as neither $\alpha = 0$ nor $\phi = 0$ give any discounting. One natural criterion for resolving this sensitivity, and for equilibrium selection, is to follow Lubik and Schorfheide (2004) and require continuity in the solution as $\phi \to 0$; with that requirement, all conclusions stated above for RANK apply independently of $\phi \geq 0$, i.e., RANK direct exposure is always all prices.[21]

3.3 The role of openness

A striking feature of Theorem 1 is that the effect of the foreign demand impulse on the home economy actually depends little on the economy's openness. The argument is starkest in the HANK-UIP case, where our results indicate complete pass-through to quantities *independently of the degree of openness* γ.[22] This observation runs against the standard intuition that more open economies should be more exposed to international shocks. It also points to an apparent discontinuity at $\gamma = 0$, since foreign demand shocks have no effect in a closed economy. We resolve this paradox in two steps. We first argue why γ has no first-order effects in a reasonably open economy, and then explain what breaks down in the closed-economy limit $\gamma \to 0$.

Proposition 2. *In HANK-UIP, the role of openness* γ *is summarized by:*

1. *As long as* $\gamma > 0$*, the net present value of the domestic boom is independent of the degree of openness, with the multiplier* $\varsigma = 1$.

[21] Another intermediate case, discussed in detail in Appendix B.3, is a spender-saver model ("TANK"). Along the transition path, the unit MPCs of spenders generate contemporaneous quantity movements, echoing HANK. Owing to the presence of infinitely-lived permanent-income savers, however, there is full price adjustment in a present value sense — stationarity is induced by the financial friction, and so the same conclusions as in pure RANK apply. By the same token, TANK-UIP inherits RANK-UIP's sensitivity to boundary conditions. These insights echo discussions on TANK vs. HANK in closed-economy settings (see Angeletos, Lian, and Wolf 2024a).

[22] Away from this extreme, the degree of openness matters exclusively through the trade elasticity ϑ. If $\theta = 1$, then ϑ is independent of γ, and thus again so is the price-quantity split.

2. *As $\gamma \to 0$, the domestic consumption response becomes flat in the sense that, for each fixed date t, $c_t \to (1-\beta)\,\text{NPV}(c^*_\tau)$, and $p_\infty \to \infty$.*

3. *If PPI inflation is required to return to steady state at and after a fixed finite date $T < \infty$, i.e., $\pi_{H,t} = 0$ for all $t \geq T$, rather than only asymptotically, and if real rates are neutral before that date, i.e., $r_t = r^*_t = 0$ for $t < T$, then the multiplier $\varsigma \to 0$ as $\gamma \to 0$.*

The intuition for the first result is already evident from the simple static example reviewed above. In the limit MPC $\to 1$, local demand converges to

$$c = \frac{\gamma \text{MPC}}{1-(1-\gamma)\text{MPC}} \cdot c^* \to c^*,$$

independently of $\gamma > 0$. Intuitively, a smaller export share dampens the partial equilibrium effect of global demand on local income, but at the same time it reduces leakages from domestic demand to the rest of the world, raising the general equilibrium multiplier. In the limit MPC $\to 1$, these two forces exactly offset each other, rendering the overall effect on the local economy invariant to openness.

Our full dynamic economy adds an important wrinkle to this story, summarized in the second result in Proposition 2. Mathematically, in our characterization of equilibrium dynamics, the persistence of net foreign assets depends on α and γ only through their *product* $\alpha \times \gamma$. A relatively closed economy therefore has transition dynamics similar to those of an economy with low MPCs, which, as discussed above, translates into persistent consumption responses. Economically, with small γ, the propensity to spend on foreign goods is small, demand largely stays in the domestic economy, and the result is a perfectly persistent boom.

Finally, those persistent dynamics help explain the third result in Proposition 2, resolving the apparent discontinuity in γ: since a small γ is associated with a boom of low magnitude but near-unit-root persistence, arresting that boom at some possibly large but finite horizon T breaks the discontinuity, returning us to the intuition that essentially closed economies are also largely insulated from conditions abroad.[23] The practically relevant upshot of those arguments is that the results discussed earlier in this section apply only for relatively open economies; once γ is sufficiently large, however, our exact conclusions are actually not particularly sensitive to its precise value.

The SOE assumption. A related assumption made in our analysis so far is that, under the small-open-economy abstraction, spending that leaks abroad does not feed back into domestic demand. Appendix B.4 shows, however, that none of our results depend on this abstraction.

[23] The same conclusion obtains if the assumption of a fixed path of real rates up to date T is instead replaced by the rule $r_t = \phi_\pi \pi_{H,t}$, with ϕ_π arbitrarily small but strictly positive. In that case again the domestic boom vanishes as $\gamma \to 0$, and for the same reason as in Proposition 2.

There we consider a two-country world economy and establish that Theorem 1 extends essentially without change. The only adjustment is that foreign demand is now not an exogenous primitive, but explicitly tied to primitive shocks, along the lines discussed in the next section.

3.4 Examples of foreign demand shocks

Our preceding analysis characterized the propagation of foreign demand c^* into the domestic economy, and is thus informative about the aggregate effects of *any* primitive foreign shock that, in equilibrium, moves foreign spending. To illustrate the practical relevance of our results, we in this section give several examples of primitive macroeconomic shocks and policies that are likely to primarily propagate through this aggregate demand channel.[24]

Commodity prices and trade policies. Perhaps the most direct source of fluctuations in foreign demand is a commodity price shock. Indeed, Appendix B.5 shows that our main results extend to an environment with a non-tradable sector and two tradable goods (e.g., commodity and manufacturing goods, with the home economy exporting one and importing the other) in which the small open economy takes tradable-goods prices as given. In that setting, the foreign-demand shifter c_t^* summarizes both changes in the physical endowment of the home tradable good as well as changes in the relative price of the two tradable goods. For example, an increase in world commodity prices is isomorphic to a positive foreign demand shock, $c_t^* > 0$, for commodity exporters, and to a negative shock, $c_t^* < 0$, for commodity importers. By Theorem 1, an economy with non-Ricardian consumers is therefore likely to experience a domestic boom in the former case and a recession in the latter, unless domestic monetary or fiscal instruments are used to stabilize aggregate demand (Auclert, Monnery, Rognlie, and Straub 2023). By the same token, such commodity price shocks can also arise from tariffs, sanctions, and other trade policies. Consistent with policymakers' concerns, our analysis implies that such shocks need not remain confined to the export sector: by lowering aggregate demand, they can also generate a contraction in the domestic sector.[25]

Foreign fiscal policy. A second source of fluctuations in foreign aggregate demand, c_t^*, is foreign fiscal policy. It operates through two main channels. First, foreign fiscal policy may directly increase demand for home goods in the form of increased government purchases. Second, expansionary fiscal policy, e.g., deficit-financed stimulus checks, may also indirectly boost foreign consumer spending, and thus yet again demand for the domestic good. Either

[24] In our small open economy setting, *any* possible foreign shock propagates through a mix of the aggregate demand channel, c^*, and the foreign real interest rate, r^*. We here give examples of primitive shocks and policies where the former channel is plausibly dominant.

[25] Our analysis of international spillovers of trade policies is complementary to the large literature on the *domestic* macroeconomic effects of tariffs (e.g., see Krugman 1982, Bergin and Corsetti 2023, Monacelli 2025, Bianchi and Coulibaly 2025, Auclert, Rognlie, and Straub 2025, Werning, Lorenzoni, and Guerrieri 2025).

way, the induced equilibrium change in spending then propagates as characterized in the preceding analysis.[26] In fact, when combined with our findings here, existing closed-economy results on fiscal multipliers and the associated inflationary pressures immediately yield tight *quantitative* predictions on how fiscal stimulus leaks abroad: scaling any fiscal impulse by the associated cumulative multiplier delivers $\text{NPV}(c_t^*)$, and then, in the HANK-UIP all-quantities limit, that exact fiscal multiplier is exported abroad one-to-one, as is the initial price jump π_0. For a concrete example, in the HANK model with short-term nominal debt studied in Angeletos, Lian, and Wolf (2024b), impact inflation following a one per cent, deficit-financed, foreign fiscal expansion (in the form of stimulus checks) satisfies

$$\pi_0^* = \left(\frac{\bar{D}}{\bar{Y}}\right)^{-1},$$

i.e., the classical price jump familiar from the "Fiscal Theory of the Price Level" (see Cochrane 2023), and correspondingly the equilibrium demand increase has to be

$$\text{NPV}(c_t^*) = \frac{1}{\kappa(\sigma + \varphi)} \cdot \left(\frac{\bar{D}}{\bar{Y}}\right)^{-1}.$$

These familiar predictions then get exported one-to-one to the domestic economy.

The preceding discussion evidently relates to several recent episodes. The large fiscal stimulus packages implemented in the U.S. during the Covid-19 pandemic plausibly raised demand not only for U.S.-produced goods and services, but also for imports, thereby exporting demand pressure to the rest of the world. As we discuss further below, stabilizing the economy then requires an aggressive contractionary monetary response, consistent with the policies adopted by many developing countries in the first half of the 2020s (see the discussion in International Monetary Fund 2025). Similarly, the increase in German infrastructure and defense spending since 2024 may generate sizable spillovers to other European economies through both direct procurement and induced private demand. The same logic also runs in reverse: fiscal consolidations in Southern European economies can act as a drag not only on local activity, but also on demand in their trading partners.[27]

Credit shocks. Fluctuations in foreign aggregate demand can also be driven by changes in financial conditions as a textbook example of a "private" demand disturbance. Notably, a

[26] Strictly speaking, our conclusions for inflation in Proposition 1 need to be revised if the foreign stimulus is due to an expansion in government purchases, as those, through the relevant generalization of the foreign NKPC (15), lead to less inflationary pressure.

[27] That said, a nominal peg, as is the case among members of a currency union, dampens the pass-through of the shock into quantities. To see this, consider the HANK-UIP limit and recall from Proposition 1 that, under neutral monetary policy, $q_t = 0$ and the nominal exchange rate moves one-for-one with relative inflation, with $\pi_0 = \pi_0^*$ and $p_\infty > p_\infty^*$. Maintaining the peg is therefore tantamount to a monetary tightening. This lowers aggregate demand and induces the real exchange rate to absorb part of the adjustment.

relaxation or a tightening of credit constraints — potentially due to financial deregulation, or because of a decrease in the value of collateral, such as house prices — will affect foreign activity (e.g., as in Guerrieri and Lorenzoni 2017), thus changing foreign demand for imported goods and spilling over to other economies as described above. Quantitatively, echoing the previous fiscal policy discussion, any such credit-induced foreign booms or busts will, in the HANK-UIP all-quantity limit, get imported one-to-one by the domestic economy. A prime practical example of these forces operating is the Great Recession, with financial disturbances in the U.S. reverberating globally at least in part because of their effects on consumer spending.

Foreign monetary policy. Finally, foreign monetary policy also in part acts through the aggregate demand channel c_t^*, though the foreign real interest rate r_t^* itself is a further, and primary, transmission channel, directly moving the real exchange rate through the modified UIP condition (9). All our previous conclusions thus apply without any change to the *demand channel* of foreign monetary transmission; the expenditure-switching channel related to the induced changes in the real exchange rate is instead not our focus, and so we relegate a more detailed discussion to Appendix B.6.

4 Insulating the domestic economy

We now move beyond the baseline assumption of a neutral domestic policy response, and ask instead how endogenous policy reactions can be used to insulate the domestic economy from demand pressures abroad. In keeping with most prior work, we begin in Sections 4.1 and 4.2 with a focus on conventional monetary policy. Section 4.3 then briefly considers fiscal policy and FXI as alternative, less conventional, policy options.

4.1 The effects of interest rate policy

Our analysis of monetary policy proceeds in two steps. First, in this section, we ask how any given monetary policy reaction, i.e., any given path of real interest rates, propagates and thus alters the conclusions of Section 3. That analysis echoes and somewhat extends results in Auclert, Rognlie, Souchier, and Straub (2021). Second, in the next section, we use those results to study the monetary policy reaction necessary to achieve strict domestic PPI inflation targeting and thus achieve flexible-price outcomes.

The effects of interest rates. Generalizing Section 3, we study the domestic response to bounded, absolutely summable paths for foreign demand and domestic real interest rates. Since the decomposition (16) continues to hold, any foreign-demand disturbance still has to be absorbed through the same two margins: domestic consumption and the real exchange rate.

Lemma 4. *Given arbitrary admissible paths of foreign demand c_t^* and domestic interest rates r_t, holding $r_t^* = d_{t+1} = f_{t+1}^* = 0$, domestic consumption satisfies*

$$\text{NPV}(c_t) = \varsigma\, \text{NPV}(c_t^*) + \varsigma^r\, \text{NPV}(\mathcal{R}_t), \tag{23}$$

where ς is the neutral policy pass-through characterized in Section 3, $\mathcal{R}_t \equiv \sum_{j=0}^{\infty} r_{t+j}$, and ς^r is the pass-through of interest rate policy to domestic consumption.

The first term in (23) is the direct pass-through from foreign demand to domestic consumption. It is exactly the coefficient ς characterized in the preceding section. Lemma 4 shows that allowing interest rates to respond does not change this direct exposure. Instead, the interest-rate response adds a separate channel, summarized by $\varsigma^r\, \text{NPV}(\mathcal{R}_t)$, where $\mathcal{R}_t$ is the cumulative (or long-term) interest rate impulse that enters the consumer Euler equation at date t, and ς^r measures how the present value of this impulse then passes through to the present value of domestic consumption. We characterize ς^r next.

Proposition 3. *The interest rate pass-through coefficient ς^r is given as*

$$\varsigma^r = -\frac{\vartheta(\alpha + \frac{1}{\sigma}\phi)}{\alpha + \vartheta\phi} < 0 \tag{24}$$

In particular:

1. *In the Cole and Obstfeld (1991) special case of log preferences ($\theta = \sigma = 1$), $\varsigma^r = -\vartheta = -1$ for any admissible (α, ϕ).*
2. *Given $\phi > 0$, $|\varsigma^r|$ is decreasing in the non-Ricardian parameter α iff $\vartheta < \frac{1}{\sigma}$.*

Proposition 3 generalizes important results in Auclert, Rognlie, Souchier, and Straub (2021) to our present setting with financial frictions and our tractable approximation of the effects of binding liquidity constraints. The first part of the interest-rate pass-through formula reflects the Cole-Obstfeld cancellation. A higher real rate directly reduces domestic aggregate demand and hence import demand, overall raising net exports by $\frac{1}{\sigma} r_t$. The same rate increase appreciates the real exchange rate, inducing expenditure switching that lowers net exports by ϑr_t. The net effect on the trade balance is therefore governed by the gap between the intertemporal elasticity and the trade elasticity, $\frac{1}{\sigma} - \vartheta$. In the logarithmic case $\theta = \sigma = 1$ (as in Cole and Obstfeld 1991), these elasticities coincide, $nx_t = 0$, and the trade-balance margin is neutralized, with the fall in import demand from weaker domestic spending exactly offset by the expenditure-switching effect of the appreciation. With no change in net exports and no change in the foreign position that arbitrageurs must intermediate, the equilibrium is independent of α and ϕ. Away from this special case, net exports respond to the rate hike. This activates the household income channel through α and the net-foreign-asset valuation channel through ϕ. When $\vartheta < \frac{1}{\sigma}$, an interest rate hike improves the trade balance, and so less Ricardian consumption behavior, i.e., a larger α, dampens monetary transmission as in Auclert, Rognlie, Souchier, and Straub (2021).

Implications for exposure. For our purposes, the relevant object is ς^r, the coefficient that maps the present value of the cumulative-rate impulse in (23) into the present value of domestic consumption. Since $\varsigma^r < 0$, a contractionary domestic monetary policy response to a boom abroad lowers domestic consumption relative to the neutral-policy benchmark, and therefore moves the adjustment from quantities to prices. In the Cole and Obstfeld special case highlighted in the first part of Proposition 3, this interest-rate transmission is independent of (α, ϕ). Our previous race logic then applies unchanged: for any given interest rate response, a larger α relative to ϕ leaves the domestic response more heavily slanted toward quantities.

Away from this special case, the interest-rate component itself also depends on the same race of MPCs vs. financial frictions. When $\vartheta < \frac{1}{\sigma}$, the empirically relevant (short-run) case emphasized by Auclert, Rognlie, Souchier, and Straub, an interest rate hike improves the trade balance because the direct fall in import demand dominates the expenditure-switching loss from the appreciation. With less Ricardian households, the induced income gain is spent more quickly. A larger α (for a given ϕ) therefore reduces $|\varsigma^r|$, and so a given tightening produces a smaller present-value decline in domestic consumption and reinforces the quantity response. Even with an endogenous interest rate response, our previous conclusions for the direct exposure part thus extend with relatively little change: larger departures from Ricardian equivalence increase exposure to aggregate demand abroad, for any given rate response.

4.2 Inflation targeting

While in the previous section we asked how any *given* stance of monetary policy affected the exposure of the domestic economy to foreign demand shocks, we now use those results to instead *characterize* the policy stance that successfully insulates the domestic economy, first in the sense of achieving flexible-price outcomes, then in output stabilization.

The flexible-price target. We begin by characterizing the pass-through of foreign demand to domestic quantities and prices in a flexible-price variant of our economy. That is, we consider the economy of Section 3, but replace the NKPC (6) with the optimal labor supply relation (the $\kappa \to \infty$ limit of the NKPC)

$$\sigma c_t + \varphi y_t = -\frac{\gamma}{1-\gamma} q_t, \tag{25}$$

and then solve the resulting system for equilibrium allocations, with $\pi_{H,t} = 0$ for all t.

Proposition 4. *The foreign trade multiplier in the flexible-price equilibrium, denoted ς^f and defined analogously to Definition 2, satisfies*

$$\varsigma^f = \frac{\gamma(1+\varphi)}{(1-\gamma)\vartheta(\sigma+\varphi)+\gamma(1+\varphi)} \in (0,1), \tag{26}$$

and is independent of (α, ϕ).

The foreign trade multiplier in the flexible-price economy is directly pinned down through three relations: the frictionless labor supply condition (25) (which differs from our main analysis in Section 3) as well as the output market-clearing and intertemporal country budget constraint relations, both identical to above. Combining those three relations, we find a foreign trade multiplier that, *inter alia*, depends on the degree of openness and the trade elasticity ϑ, but is independent of the two key frictions (α, ϕ). Intuitively, these coefficients matter for the speed and shape of transition paths, but not for the overall absorption through higher consumption and production, with these trade-offs governed entirely by optimal labor supply and (intertemporally) balanced trade.

Achieving the target. Combining our earlier results on outcomes given a neutral policy response together with the flexible-price target in Proposition 4, we can finally ask how policy needs to react to implement flexible-price outcomes, and so in particular how that reaction is shaped by the key frictions (α, ϕ).

Corollary 1. *The real interest rate path that implements the flexible-price equilibrium satisfies*

$$\mathrm{NPV}(\mathcal{R}_t) = -\frac{1}{\varsigma^r}\left(\varsigma - \varsigma^f\right) \cdot \mathrm{NPV}(c_t^*). \tag{27}$$

There exists a cutoff

$$\bar{\alpha}(\phi) \equiv \frac{\gamma(1+\varphi)}{(1-\gamma)(\sigma+\varphi)}\phi, \tag{28}$$

strictly increasing in ϕ and strictly positive for $\phi > 0$, such that

$$\mathrm{NPV}(\mathcal{R}_t) > 0 \quad \textit{if and only if} \quad \alpha > \bar{\alpha}(\phi). \tag{29}$$

Corollary 1 puts together the results of the previous sections to arrive at our main implication for policy: to insulate the domestic economy in the sense of replicating the flexible-price outcomes, policy needs to be expansionary if $\alpha = 0$ (RANK), but contractionary if the departure from Ricardian equivalence is large enough ($\alpha > \bar{\alpha}(\phi)$, HANK). That takeaway is an immediate implication of two observations. First, as we saw in Section 3, under "neutral" policy, the foreign demand impulse is absorbed chiefly through prices if α is small, and through quantities if α is large. Second, in the flexible-price equilibrium, the foreign shock passes through partially to quantities, with the share independent of α. Since interest rate hikes are contractionary, this reveals that monetary policy must be more contractionary the larger α, and in fact change sign as α increases.

Other forms of insulation. While the previous discussion focused on flexible-price outcomes (i.e., PPI inflation stabilization) as the implementation target for domestic monetary policy, the same conclusions also extend, and are even easier to characterize, if instead the objective is to insulate domestic consumption and economic activity.

Corollary 2. *Perfect consumption or gross domestic product stabilization requires a real interest rate path with*

$$\text{NPV}(\mathcal{R}_t) = -\frac{\varsigma}{\varsigma^r} \cdot \text{NPV}(c_t^*). \tag{30}$$

In RANK ($\alpha = 0$), domestic activity is already insulated ($\varsigma = 0$), with the foreign boom fully absorbed by prices (i.e., the real exchange rate), and so no further interest rate adjustment is needed (in present value terms). In HANK ($\alpha > 0$), most adjustment in the absence of a policy reaction instead occurs through quantities, so a real rate hike is necessary.

4.3 Other policy options

We conclude with a brief discussion of how the other two available policy levers — fiscal policy and FXI — shape our conclusions on the domestic economy's exposure to and insulation from foreign demand pressures. Echoing the previous two subsections, we proceed in two steps: we first characterize how arbitrary fiscal and FXI policies, parameterized as before as paths $\{d_t, f_t^*\}$, propagate, and then ask how they can be used to insulate the domestic economy.

The effects of fiscal policy and FXI. Analogously to Lemma 4, given arbitrary, absolutely summable paths of monetary, fiscal, and FX policy, domestic consumption satisfies

$$\text{NPV}(c_t) = \varsigma \, \text{NPV}(c_t^*) + \varsigma^r \, \text{NPV}(\mathcal{R}_t) + \varsigma^d \, \text{NPV}(\mathcal{D}_t) + \varsigma^{fx} \, \text{NPV}(\mathcal{F}_t^*), \tag{31}$$

where ς and ς^r are as in the preceding sections, $\mathcal{D}_t \equiv \sum_{j=0}^{\infty} d_{t+1+j}$, $\mathcal{F}_t^* \equiv \sum_{j=0}^{\infty} f_{t+1+j}^*$, and $\varsigma^d, \varsigma^{fx}$ denote the pass-through, respectively, of fiscal and FX policy to domestic consumption. As for interest rate policy, the relevant policy impulse here is the cumulative, long-term change of the fiscal and FX stance. We now obtain the following characterization of the corresponding policy pass-through coefficients:

Proposition 5. *The fiscal and FXI pass-through coefficients $\varsigma^d, \varsigma^{fx}$ are given as*

$$\varsigma^d = \varsigma^{fx} = \frac{\alpha\phi\vartheta}{\alpha + \phi\vartheta} \geq 0, \tag{32}$$

and so are equal to zero in both the RANK and HANK-UIP models.

As expected, increases in government debt and purchases of foreign bonds stimulate domestic activity. Surprisingly, however, both financial frictions $\phi > 0$ and elevated MPCs $\alpha > 0$ are required for either of the two policies to have any effect on $\text{NPV}(c_t)$. To see why, consider first an increase in domestic government debt. As long as households are non-Ricardian ($\alpha > 0$), that increase leads to a short-term aggregate demand boost, offset by a medium-term demand contraction, as taxes are ultimately increased to return government debt to steady state.[28] If $\phi = 0$, then the two effects offset each other and so economic activity actually remains unchanged in present value terms.[29] Instead, when $\phi > 0$, the international borrowing associated with the short-term demand boost puts pressure on the exchange rate and thus leads to a depreciation of the home currency. This depreciation then increases exports and overall more than offsets the future tax-induced contraction, delivering $\text{NPV}(c_t) > 0$. Symmetrically, purchases of foreign bonds depreciate the domestic exchange rate as long as there are financial intermediation frictions ($\phi > 0$), increasing exports; and if households are non-Ricardian ($\alpha > 0$), then this increase in exports also translates to higher domestic consumption.

It follows from the preceding discussion that endogenous fiscal and FX policies are unlikely to materially alter our conclusions on how foreign aggregate demand disturbances c^* get absorbed into domestic prices and quantities. Intuitively, given any (absolutely summable) path of such policies, if ϕ is set to an empirically relevant small value, the quantity share will be close to our benchmark foreign trade multiplier ς characterized in Section 3.

Instrument equivalence and flexible-price outcomes. We finally ask whether fiscal and FX policies can substitute for monetary policy and implement the flexible-price outcomes characterized above. While the answer is "yes," the preceding analysis immediately suggests an important qualifier: if ϕ is small, then the fiscal and FX policies that are required to insulate the domestic economy are large.

Proposition 6. *Suppose that $\alpha, \phi > 0$. Then:*

1. *The flexible-price equilibrium paths $\{c_t, y_t, q_t, s_t, gdp_t\}$ can be implemented using fiscal and FXI policies alone, with $r_t = 0$.*

2. *The fiscal and FXI policy paths that implement the flexible-price equilibrium satisfy*

$$\text{NPV}(\mathcal{D}_t + \mathcal{F}_t^*) = -\frac{1}{\varsigma^d}\left(\varsigma - \varsigma^f\right) \cdot \text{NPV}(c_t^*), \tag{33}$$

[28] Note that, by implicitly considering debt paths with $\lim_{t\to\infty} d_t = 0$ (since $\mathcal{D}_0$ is finite), we are restricting attention to (in present value terms) balanced-budget fiscal policies.

[29] In other words, when $\phi \to 0$, pure domestic fiscal policy is unable to engineer consumption paths with non-zero net present value. This extreme conclusion is driven by the small open economy assumption, which implies that demand leaking abroad never returns to the domestic economy.

and so, for a positive foreign-demand boom and fixed $\alpha > 0$*,*

$$\lim_{\phi \to 0} |\text{NPV}(\mathcal{D}_t + \mathcal{F}_t^*)| = \infty.$$

Proposition 6 extends the closed-economy monetary-fiscal equivalence result of Wolf (2025) to the open-economy context. Intuitively, in an open-economy setting, monetary policy affects the equilibrium allocation through two channels — the aggregate demand condition (3) and expenditure switching induced by the real exchange rate, through the modified UIP condition (9). In contrast, only one channel operates for each of the other two instruments: fiscal policy shifts intertemporal aggregate demand, whereas FX interventions directly affect the exchange rate. As a result, and unlike in the closed economy, two policy instruments are now required to replicate the effects of monetary policy. Furthermore, the second part of the proposition, which follows directly from the preceding discussion, shows that — when financial frictions are moderate (ϕ is small) — large interventions are needed to attain flexible-price outcomes and, hence, fiscal and FX policies actually provide a poor substitute for monetary policy.

5 Quantitative analysis

We now investigate the practical relevance of our theoretical results. Specifically, we study the exposure of open economies to aggregate demand conditions abroad in a rich quantitative model that, crucially, is disciplined with an eye towards evidence on the two key margins of our "race" — consumer spending behavior and financial market imperfections.

5.1 Model and calibration strategy

We consider a variant of the model in Section 2, but with one key addition: we substantially generalize the consumer block to be consistent with empirical evidence on the degree of departure from Ricardian equivalence. The remainder of this section presents calibration details for all model blocks, with a summary provided in Table 1. Further model variants away from this benchmark will be studied in Section 5.3. Throughout we pay most attention to our two key frictions: MPCs and imperfections in international financial intermediation.

Intertemporal MPCs. By our discussion in Section 3.2, a key determinant of the quantities vs. prices split is the *speed* of consumer spending over time, since that speed is what governs the equilibrium alignment (or lack thereof) between c_t and c_t^*, and therefore the need (or not) for large net foreign asset positions. In our benchmark model, this speed of spending was mechanically tied to the level of MPC through the OLG coefficient ω, with the level MPC equal to $1 - \beta\omega$, and then those MPCs decaying dynamically at rate ω. As discussed by both

Parameter	Description	Value	Target
Demand			
χ_i	Population shares	$\{0.55, 0.45\}$	Intertemporal MPCs
ω_i	Survival rates	$\{0.93, 0.65\}$	Intertemporal MPCs
σ	Inverse EIS	2	Standard
β	Discount factor	0.998	Annual real rate
Financial Intermediation			
ϕ	Financial friction	0.00123	RER persistence
International			
θ	Demand elasticity	1.5	Standard
γ	Openness	0.3	Standard
Supply			
$\kappa\left(\sigma+\varphi\right)$	Slope of NKPC	0.0062	Literature
φ	Inverse Frisch elasticity	1	Standard
Policy			
$\bar{D}/\bar{Y}$	Gov't debt level	1.04	Household liq. wealth
τ_d	Tax feedback	1	Benchmark
ϕ_π	Inflation feedback	0	Benchmark

Table 1: Quantitative model, calibration.

Auclert, Rognlie, and Straub (2024) and Angeletos, Lian, and Wolf (2024a), however, empirical evidence on consumer spending is actually inconsistent with this restriction: if we set ω to match the level MPC, then dynamically consumers in the model spend too quickly relative to the data. This is problematic for our purposes here, as such excessively fast spending would bias our conclusions towards quantity over price adjustment.

To deal with this concern, we generalize the consumer block to feature two distinct types of households i with heterogeneous survival probabilities ω_i. As it turns out, this is the minimal structure necessary to allow a tight fit to empirical evidence on consumer-spending behavior over time, e.g., as documented in Fagereng, Holm, and Natvik (2021). Specifically, we choose the population shares and their heterogeneous survival rates to match that paper's empirical evidence on consumer spending over the first five years after income receipt — the relevant business-cycle frequency across which the "race" at the heart of our theory will unfold. Matching this evidence is feasible with just two OLG types, one relatively close to permanent-income spending, and one with a materially elevated MPC.

Financial intermediation. The second key ingredient for our theory is the severity of financial frictions. Following Itskhoki and Mukhin (2021), we set that parameter to ensure that, following persistent financial shocks (i.e., wedges to the modified UIP condition (9)) — which arguably account for most of exchange rate volatility — the induced movements in the real exchange rate have a half life of five years, in line with the literature on the PPP puzzle (Rogoff 1996).[30] This delivers a value of $\phi = 0.00123$, close to standard numbers used in the literature, in particular for more advanced economies with deep international financial markets. In Section 5.3 we investigate how our conclusions change as we move away from this baseline.

More on consumers. The discount factor β is set to target a steady-state real rate of interest of one per cent (annual), and for the inverse of the intertemporal elasticity of substitution we choose $\sigma = 2$, a standard value. Turning to demand for foreign goods, we consider a fairly open economy, setting $\gamma = 0.3$ (e.g., relevant for the UK). Finally, we set the elasticity of substitution between home and foreign goods to $\theta = 1.5$, consistent with standard calibrations and empirical estimates of trade elasticities (e.g., as in Boehm, Levchenko, and Pandalai-Nayar 2023, Feenstra, Luck, Obstfeld, and Russ 2018).

Supply. We set the inverse Frisch elasticity φ to 1 and the slope of the NKPC $\kappa(\sigma + \varphi)$ to 0.0062, both standard values in the New Keynesian literature (e.g., see the textbook treatment in Galí 2008) and consistent, for the NKPC slope, with recent estimates (e.g., Hazell, Herreño, Nakamura, and Steinsson 2022). In keeping with our theoretical analysis we consider producer currency pricing (PCP) as our benchmark, though we also report results from an alternative with dominant currency pricing (DCP).

Policy. In keeping with our theoretical analysis, we begin by considering a "neutral" policy benchmark, to learn about the direct exposure of the domestic economy to foreign demand. First, for monetary policy, we consider a feedback rule of the form

$$i_t = \mathbb{E}_t[\pi_{t+1}] + \phi_\pi \pi_{H,t}.$$

Here, $\phi_\pi = \infty$ would correspond to perfect domestic PPI inflation targeting (and thus implement flexible-price outcomes), though we begin by considering $\phi_\pi = 0$. Second, for fiscal policy, we generalize the model to feature a non-zero amount of steady-state government debt, calibrated to total household liquid wealth holdings, as in Angeletos, Lian, and Wolf (2024a). We then assume that taxes adjust over time according to a standard Leeper (1991)-style fiscal

[30] Specifically, we add an AR(1) disturbance to (9) with quarterly persistence of 0.97, exactly following Itskhoki and Mukhin (2021). We then compute the implied autocorrelation of the real exchange rate.

feedback rule of the form

$$t_t = \tau_d \left\{ d_t + \beta \frac{\bar{D}}{\bar{Y}} \left[r_t + \mathbb{E}_t[\pi_{t+1}] - \pi_{t+1} \right] \right\},$$

with $\tau_d \in (0, 1]$ indicating the speed of fiscal adjustment. We begin by setting $\tau_d = 1$, corresponding to perfect government debt stabilization (exactly as in our preceding theoretical analysis), but then later consider slower fiscal adjustment.

5.2 Importing foreign demand in practice

Figure 4 is the quantitative analogue of the earlier illustrative Figure 2, showing impulse responses (in different shades of red, solid, dashed, and dotted) to the foreign demand path c_t^* displayed in the top left panel (in blue). For reference, the foreign demand impulse is moderately persistent (top left), with most of the aggregate demand movement concentrated within the first two years, broadly consistent with the recent U.S. fiscal stimulus episode; that demand path then induces a similarly persistent path of foreign inflation (bottom right). The domestic impulse responses correspond to results from our baseline quantitative model (medium red, solid) and two model variants (light-dotted and dark-dashed red, respectively).

The headline result is that, exactly as in our earlier illustrative figure, under our benchmark "neutral" policy response, the foreign boom is mostly imported through quantities, and not through prices. For reference, consider first of all the darkest (dashed) red line, which sets $\phi = 0$ and thus necessarily features full quantity pass-through.[31] We see that, exactly analogous to the discussion above, we have $\text{NPV}(c_t) = \text{NPV}(c_t^*)$, $\pi_0 = \pi_0^*$, as well as $p_\infty > p_\infty^*$ – one-to-one quantity pass-through, and more than one-to-one long-term price pass-through. The other panels show the long-term real rate $\mathcal{R}_t$ (by assumption zero here) and the real exchange rate q_t (which does not move, reflecting complete quantity pass-through). Now turn to the medium solid line, our main quantitative model. Since now $\phi > 0$, the real exchange rate appreciates somewhat. Crucially, however, we see that the departure from Ricardian equivalence still rather clearly wins the race: quantity pass-through is meaningful, now around 78 per cent, and both domestic activity and inflation are materially and somewhat persistently elevated. It follows that, in the absence of aggregate policy reaction, our quantitatively disciplined economy is still heavily exposed to aggregate demand abroad.

Finally, for reference, the light dotted red line displays flexible-price outcomes, obtained by setting the monetary policy inflation coefficient ϕ_π to ∞. Relative to the direct exposure, domestic consumption rises by much less (though quite persistently) and domestic PPI inflation is, by construction, perfectly stabilized. CPI inflation can still move through the terms-of-trade

[31] Although Theorem 1 only established complete quantity pass-through under $\phi = 0$ for our baseline OLG demand structure, it is straightforward to see that the proof argument also extends to richer aggregate demand structures, including the multi-type OLG hybrid considered here.

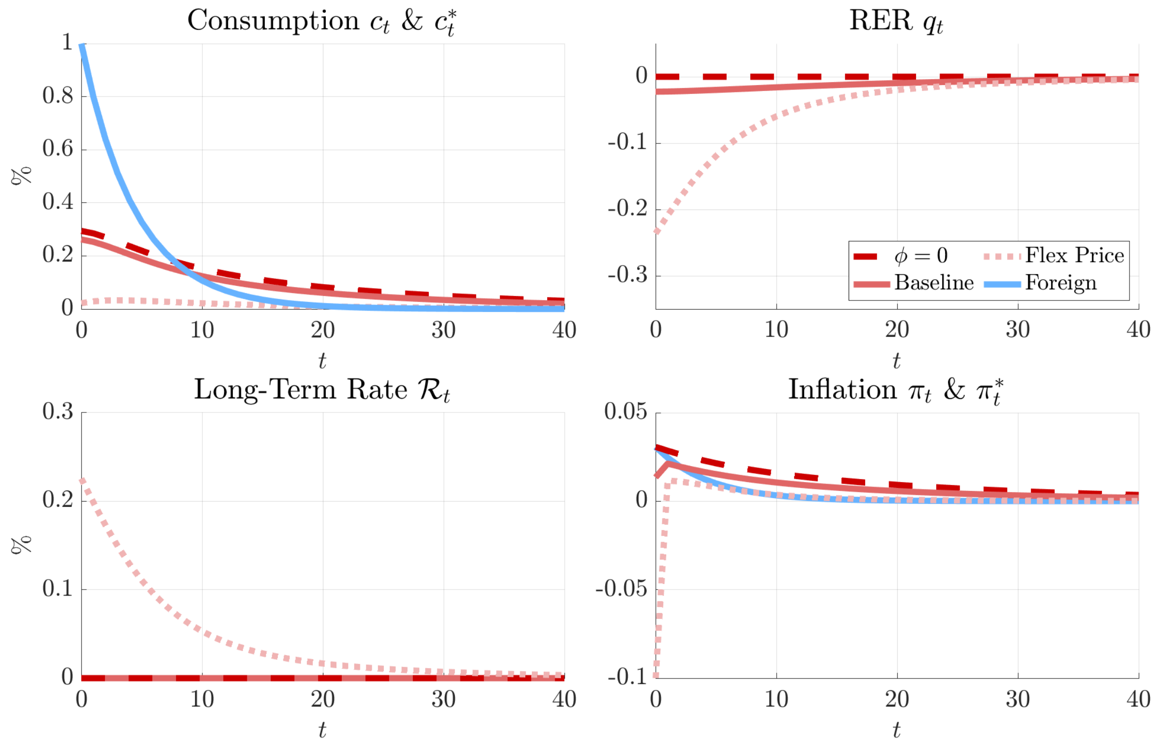

Figure 4: Responses of consumption, the real exchange rate, the cumulative real rate, and inflation to a foreign demand shock c_t^*, with neutral domestic policy and either $\phi = 0$ (dark-dashed red) or the baseline calibration (medium-solid red), and with the baseline calibration and flexible-price outcomes (light-dotted red). Foreign consumption and inflation paths in blue.

component in (5), so the persistent real exchange appreciation generates deflation on impact. Importantly, these paths of output and inflation require a significant and persistent tightening of the monetary stance, as shown in the bottom left panel.

5.3 Prices vs. quantities in further model variants

The main takeaway of the preceding analysis was that, in our quantitative model, the departure from Ricardian equivalence wins the race at the heart of our theory, so quantity exposure is large, and aggressive policy action is needed to insulate the economy. We here show that those same conclusions extend across a range of further model variants. Results are summarized in Figure 5, with the dots indicating the prices-quantity split for several model variants. In the figure dots in the bottom right part mostly feature quantity adjustment, and *vice-versa* in the top left part. Recall that, because of the budget constraint logic of Lemma 2, all dots necessarily lie along the downward-sloping diagonal — the foreign shock is absorbed either through quantities or prices.

- *Consumers.* We alter the consumer block of our quantitative model in three ways. First,

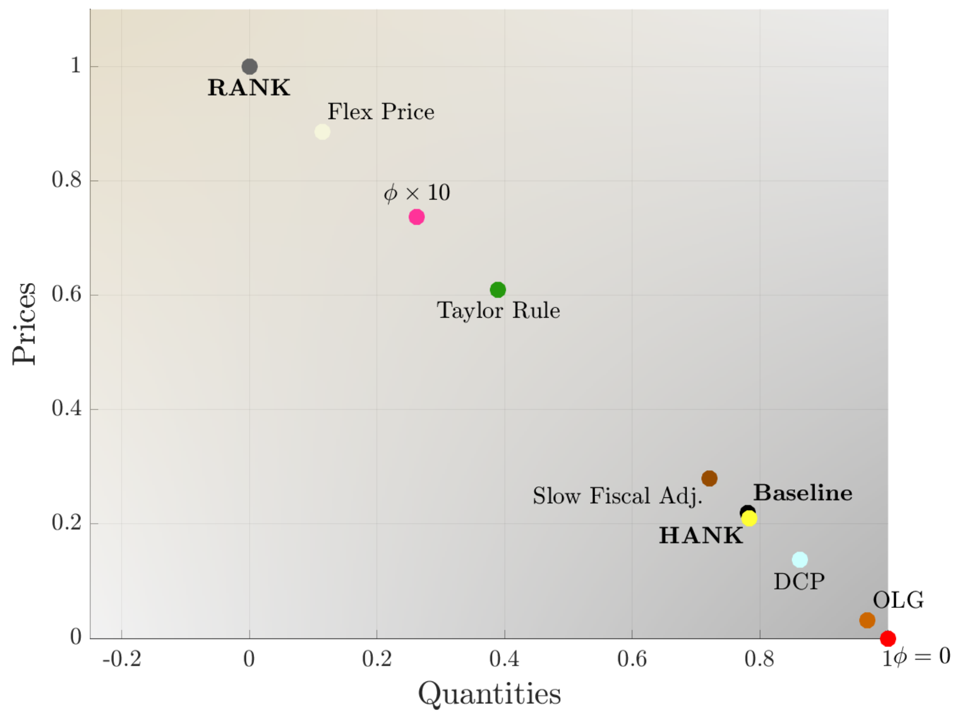

Figure 5: Prices vs. quantity adjustment in several different model variants. The x-axis, "quantities", shows the foreign trade multiplier ς. The y-axis, "prices", then gives the residual price (real exchange rate) adjustment.

we switch to a simple representative-agent structure (i.e., $\omega_i = 1$). Then, as expected given Theorem 1, we see all direct exposure adjustment happening through prices. Second, we switch to a single-type OLG structure, consistent with the same *impact* MPC as the full quantitative model. As discussed in Section 5.1, consumer intertemporal spending is now faster, tilting the "race" towards quantities, with now almost all adjustment occurring through quantities. And third, we replace the consumer block by a full-blown heterogeneous-agent consumer block, described in further detail in Appendix C.2. As expected in light of the results of Auclert, Rognlie, and Straub (2024) and Wolf (2025), since that model's intertemporal MPCs look similar to our benchmark two-type model, we also get a nearly identical price-quantity split.

- *Financial frictions.* We next alter our assumptions on the severity of financial frictions. First, as already discussed in the preceding section, if $\phi = 0$ then all adjustment occurs through quantities. Second, we scale up ϕ by a factor of 10 — a much higher value that reduces the half life of the real exchange rate just below three years, and is arguably relevant for countries with very shallow international financial markets. The associated large deviations from UIP then shift adjustment much more toward prices, as expected.[32]

[32]This large value of ϕ counterfactually implies a very large elasticity of the real exchange rate with respect to

- *DCP.* Switching from PCP to DCP breaks the rigid link (4) between the real exchange rate and the terms of trade, and thus generally also breaks the sharp prices-quantities characterization in Theorem 1. In Figure 5, we see that the switch to DCP even further pushes adjustment to come through quantities. Intuitively, DCP effectively reduces the trade elasticity ϑ, thus weakening the effect of any given real exchange rate movement (and so ϕ) on quantities. That said, the departure is still moderate, and Appendix B.7 provides a more detailed discussion of why; briefly, even with DCP, a variant of Theorem 1 holds in the Cole and Obstfeld special case, and our benchmark calibration is not very far away from that limit.

- *Policy.* We entertain several alternative assumptions on the policy response. First, we switch to much slower fiscal adjustment, setting $\tau_d = 0.01$. Such slow adjustment allows domestic government debt to fall in equilibrium, contracting demand in the short run, delaying the imported boom, and thus pushing the adjustment somewhat towards prices, though not materially so. Second, we change monetary policy to a conventional Taylor rule, setting

$$i_t = \rho_i i_{t-1} + (1 - \rho_i)\phi_\pi \pi_t,$$

  with empirically relevant interest rate smoothing, $\rho_i = 0.95$, and a strong inflation response, $\phi_\pi = 2.15$. Consistent with the analysis in Section 4.1, this policy reaction shifts the adjustment towards prices. Intuitively, since direct exposure is largely on quantities, moving materially towards prices requires a significantly contractionary monetary policy reaction — and the endogenous Taylor rule adjustment provides just such a contractionary response, with the implied real interest rate path reducing consumption by almost 40 per cent of the size of the original foreign demand burst $\text{NPV}(c_t^*)$.

  Finally, we also show the flexible-price outcomes. We can see that attaining those would require an even more meaningful policy contraction, now moving the quantity response to foreign demand from around 78 per cent (direct exposure) to around 11 per cent; for RANK, the required policy response would instead be a mild *expansion*, as expected given the theoretical discussion in Section 4.2.

6 Conclusion

The central result of the present paper is that a race between two frictions popular in prior work — departures from Ricardian equivalence among consumers, vs. departures from UIP due to intermediation frictions — plays a decisive role in shaping the exposure of open economies

FX policy, an order of magnitude above the numbers reported in Beltran and He (2025), and thus again relevant only for very shallow international markets. See Appendix C.1 for further details.

to aggregate demand disturbances abroad. In equilibrium, because of intertemporal trade balance, such foreign demand shocks will either lead to greater domestic production and thus consumption ("quantities") or are moderated through a real exchange rate appreciation ("prices"). Theoretically, we argued that elevated MPCs push adjustment to come through quantities, and *vice-versa* for international intermediation frictions; and in practice, MPCs are likely to win that race, at least for advanced economies, leading to meaningful quantity exposure. The immediate policy implication is that, to insulate the domestic economy from such foreign demand pressures, an aggressive policy reaction is needed.

The obvious limitation of our analysis here is that it is purely positive in nature. An important question for future work is thus whether, and if so how, the race between elevated MPCs and financial frictions shapes how open economies *should* optimally react to conditions abroad, and how policy can attain those outcomes.

A second direction for future work is to connect our results with macroeconomic, time series evidence. Our analysis here was micro-to-macro in nature: we isolated a mechanism present in a large family of popular models, and disciplined it using direct microeconomic evidence on its two key ingredients. An alternative strategy would be to test for aggregate international co-movement following expansions in demand. Some contributions along those lines, including Canova (2005) and Druedahl, Ravn, Sunder-Plassmann, Sundram, and Waldstrøm (2026), also tend to find meaningful quantity pass-through. Additional work that more directly disciplines the calibration of the financial friction parameter ϕ would also be highly valuable, as it would further inform the quantity-price split.

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Supplementary appendix for:
Importing Aggregate Demand

This Appendix contains further material for the article "Importing Aggregate Demand." We provide: (i) proofs of all results; (ii) supplementary details for the theoretical analysis in Sections 2 to 4; and (iii) supplementary details for the quantitative analysis in Section 5.

Any references to equations, figures, tables, assumptions, propositions, lemmas, or sections that are not preceded by "A." — "C." refer to the main article.

A Proofs

A.1 Proof of Lemma 1

The parameter restrictions in Lemma 1 imply $\eta \equiv \alpha + \vartheta\phi > 0$. If $\alpha > 0$, then this is immediate. If $\alpha = 0$, then $\alpha + \phi > 0$ implies $\phi > 0$, and the Marshall-Lerner condition gives $\eta = \vartheta\phi > 0$. Now let

$$\tilde{c}_t \equiv c_t - \vartheta q_t = c_t - (1-\gamma)\vartheta s_t. \tag{A.1}$$

Using (4) in (13), net exports can be written as

$$nx_t = \gamma(c_t^* - \tilde{c}_t). \tag{A.2}$$

Moreover, (11) implies $a_{t+1} = b_{t+1}^* + d_{t+1}$. Combining (3) with (9) gives

$$\mathbb{E}_t[\Delta\tilde{c}_{t+1}] = \left(\frac{1}{\sigma} - \vartheta\right) r_t + \vartheta r_t^* - \alpha d_{t+1} + \vartheta\phi f_{t+1}^* - \eta b_{t+1}^*. \tag{A.3}$$

Together with (12), equations (A.2) and (A.3) form a linear rational expectations system in $(b_t^*, \tilde{c}_t)$, with the matrix mapping $(b_t^*, \tilde{c}_t)$ into $(b_{t+1}^*, \mathbb{E}_t[\tilde{c}_{t+1}])$ given as

$$\begin{pmatrix} \beta^{-1} & -\gamma\beta^{-1} \\ -\eta\beta^{-1} & 1 + \eta\gamma\beta^{-1} \end{pmatrix} \tag{A.4}$$

The characteristic polynomial associated with (A.4) is

$$P(\lambda) = \lambda^2 - \left(1 + \beta^{-1} + \frac{\eta\gamma}{\beta}\right)\lambda + \beta^{-1}. \tag{A.5}$$

Since $\eta > 0$, (A.5) gives $P(0) > 0$, $P(1) < 0$, and a product of roots equal to $\beta^{-1} > 1$. Hence one root lies in $(0,1)$ and the other is larger than one. Since b_0^* is predetermined, the no-Ponzi condition selects a unique bounded process for $(b_t^*, \tilde{c}_t)$.

The preceding argument pins down the process for $(b_t^*, \tilde{c}_t)$, but not yet the level of the terms of trade. Given this process for b_t^*, (9) and (4) give, for the given processes of r_t, r_t^*, and f_{t+1}^*,

$$\mathbb{E}_t[\Delta s_{t+1}] = \frac{r_t - r_t^* + \phi\left(b_{t+1}^* - f_{t+1}^*\right)}{1-\gamma}. \tag{A.6}$$

Hence (A.6) fixes the expected terms-of-trade depreciation. Any remaining non-uniqueness in s_t must therefore be a bounded martingale component. To rule it out, compare two candidate equilibria with the same process for $(b_t^*, \tilde{c}_t)$. For any variable x_t, write $Dx_t \equiv x_t^{(1)} - x_t^{(2)}$ for the difference between the two candidate equilibria. Since the right-hand side of (A.6) is the same in the two candidates,

$$\mathbb{E}_t[Ds_{t+1}] = Ds_t. \tag{A.7}$$

Because $\tilde{c}_t$ in (A.1) is also the same in the two equilibria, $Dc_t - (1-\gamma)\vartheta Ds_t = 0$, so $Dc_t = (1-\gamma)\vartheta Ds_t$.

Substituting these differences into (7) gives $Dy_t = ((1-\gamma)\vartheta+\gamma)Ds_t$, and the difference in real marginal cost is equal to

$$\xi Ds_t, \qquad \text{where} \quad \xi \equiv \sigma(1-\gamma)\vartheta + \varphi((1-\gamma)\vartheta+\gamma)+\gamma. \tag{A.8}$$

Taking differences of (6) at date t, and using (A.8), gives

$$D\pi_{H,t} = \kappa\xi Ds_t + \beta\mathbb{E}_t[D\pi_{H,t+1}].$$

Forward iteration of this difference equation, using the terminal inflation condition in each candidate equilibrium (so $\lim_{k\to\infty}\mathbb{E}_t[D\pi_{H,t+k}] = 0$) and (A.7), gives

$$D\pi_{H,t} = \kappa\xi\sum_{\ell=0}^{\infty}\beta^{\ell}\mathbb{E}_t[Ds_{t+\ell}] = \frac{\kappa\xi Ds_t}{1-\beta}. \tag{A.9}$$

Applying (A.9) at date $t+k$, taking $\mathbb{E}_t[\cdot]$, and using (A.7) gives

$$\mathbb{E}_t[D\pi_{H,t+k}] = \frac{\kappa\xi Ds_t}{1-\beta}.$$

The left-hand side converges to zero as $k\to\infty$. Since $\xi \neq 0$ (which follows from $\vartheta > 0$) $Ds_t = 0$. Thus s_t is unique. Then (4) pins down q_t, (A.1) pins down c_t, and (7) pins down y_t. The remaining variables are pinned down residually by (8), (11), (10), (6), (5), (15), and (13). This constructs the equilibrium and proves uniqueness.

A.2 Proof of Lemma 2

Iterating the country budget constraint (12) gives

$$\sum_{t=0}^{T}\beta^t nx_t = \beta^{T+1}b^*_{T+1} - b^*_0. \tag{A.10}$$

Using $b^*_0 = 0$ and the no-Ponzi condition, and letting $T\to\infty$ in (A.10), we obtain $\mathrm{NPV}(nx_t) = 0$. Next, using (4) in (13),

$$nx_t = \gamma\left[c^*_t - c_t + \theta q_t + (\theta-1)s_t\right] = \gamma\left(c^*_t - c_t + \vartheta q_t\right). \tag{A.11}$$

Taking net present values in (A.11) and using $\mathrm{NPV}(nx_t) = 0$ gives

$$\mathrm{NPV}(c^*_t) = \mathrm{NPV}(c_t) - \vartheta\,\mathrm{NPV}(q_t),$$

which is (16). Since $nx_t = gdp_t - c_t$, the same argument also gives

$$\mathrm{NPV}(gdp_t) = \mathrm{NPV}(c_t). \tag{A.12}$$

A.3 Proof of Theorem 1

Under neutral policies, $r_t^* = r_t = d_t = f_t^* = 0$, and thus $a_t = b_t^*$. The Euler equation and UIP reduce to

$$\Delta c_{t+1} = -\alpha b_{t+1}^*, \qquad \Delta q_{t+1} = \phi b_{t+1}^*. \tag{A.13}$$

The proof of Lemma 1 selects the unique bounded path for $(b_t^*, \tilde{c}_t)$ from the linear system formed by (12), (A.2), and (A.3). Because the foreign-demand input is absolutely summable, the selected stable path for $(b_t^*, \tilde{c}_t)$ is absolutely summable and hence converges to zero. Equation (A.6) then implies that Δs_{t+1} is absolutely summable, so s_t converges to some limit s_∞. Since $\tilde{c}_t \to 0$ and $c_t^* \to 0$, the relations $c_t = \tilde{c}_t + (1-\gamma)\vartheta s_t$ and (7) give $c_t \to (1-\gamma)\vartheta s_\infty$ and $y_t \to ((1-\gamma)\vartheta + \gamma)s_\infty$, so the real marginal cost in (6) converges to ξs_∞. Taking limits in the level NKPC (6) and using $\pi_{H,t} \to 0$ gives $\xi s_\infty = 0$. The proof of Lemma 1 shows that $\xi \neq 0$ under the Marshall-Lerner condition $\vartheta > 0$, so $s_\infty = 0$, and hence $c_t \to 0$ and $q_t \to 0$. Combining the two laws of motion in (A.13) gives

$$\phi(c_{t+1} - c_t) + \alpha(q_{t+1} - q_t) = 0. \tag{A.14}$$

Equation (A.14) implies that $\phi c_t + \alpha q_t$ is constant over time. Since $c_t \to 0$ and $q_t \to 0$, the constant is zero:

$$\phi c_t + \alpha q_t = 0. \tag{A.15}$$

For $\phi > 0$, (A.15) gives

$$\text{NPV}(c_t) = -\frac{\alpha}{\phi}\text{NPV}(q_t). \tag{A.16}$$

Combining (A.16) with the trade-balance relation (16) yields, for HANK ($\alpha > 0, \phi > 0$),

$$\text{NPV}(c_t^*) = \left(1 + \frac{\vartheta\phi}{\alpha}\right)\text{NPV}(c_t). \tag{A.17}$$

Substituting (A.17) into (17) gives (19). In RANK, $\alpha = 0$ and $\phi > 0$. The relation (A.15) then gives $c_t = 0$ for all t, and hence $\varsigma = 0$. In HANK-UIP, $\alpha > 0$ and $\phi = 0$, (9) gives $\Delta q_{t+1} = 0$, so q_t is constant. Since $q_t \to 0$, this constant is zero, and Lemma 2 gives complete quantity pass-through, $\varsigma = 1$.

Under the Marshall-Lerner condition $\vartheta > 0$, (19) is increasing in α and decreasing in both ϕ and ϑ.

A.4 Proof of Lemma 3

For any path x, write

$$\text{NPV}_t(x_\tau) \equiv \sum_{\tau=t}^{\infty} \beta^{\tau-t} x_\tau.$$

In HANK-UIP, $\alpha > 0$ and $\phi = 0$. In this case, the proof of Theorem 1 gives $q_t = 0$ for all t, and hence $s_t = 0$. Thus

$$\beta b_{t+1}^* = b_t^* + \gamma(c_t^* - c_t). \tag{A.18}$$

Forward iteration from date t, using the no-Ponzi condition, gives

$$\mathrm{NPV}_t(c_\tau) - \mathrm{NPV}_t(c^*_\tau) = \frac{b^*_t}{\gamma}. \tag{A.19}$$

Summing across dates,

$$\sum_{t=0}^{\infty} [\mathrm{NPV}_t(c_\tau) - \mathrm{NPV}_t(c^*_\tau)] = \frac{1}{\gamma}\sum_{t=0}^{\infty} b^*_t.$$

The Euler equation under neutral policy is

$$c_{t+1} - c_t = -\alpha b^*_{t+1}. \tag{A.20}$$

Since $b^*_0 = 0$ and the selected stable path satisfies $c_t \to 0$,

$$\sum_{t=0}^{\infty} b^*_t = \frac{1}{\alpha}\sum_{t=1}^{\infty}(c_{t-1} - c_t) = \frac{c_0}{\alpha}. \tag{A.21}$$

It remains to show that $c_0 > 0$. Solving the stable (b^*_t, c_t) subsystem, let $\rho \in (0,1)$ denote the stable root of

$$\beta\rho^2 - (1 + \beta + \alpha\gamma)\rho + 1 = 0.$$

The selected path satisfies

$$c_t = \chi b^*_t + (1 - \beta\rho)\sum_{j=0}^{\infty}(\beta\rho)^j c^*_{t+j}, \qquad \chi \equiv \frac{1 - \beta\rho}{\gamma} > 0. \tag{A.22}$$

Since $b^*_0 = 0$, $c^*_t \geq 0$ for all t, and $c^*_t > 0$ for some t (because by assumption $\mathrm{NPV}(c^*_t) > 0$), (A.22) gives $c_0 > 0$. Therefore

$$\sum_{t=0}^{\infty} [\mathrm{NPV}_t(c_\tau) - \mathrm{NPV}_t(c^*_\tau)] = \frac{c_0}{\alpha\gamma} > 0, \tag{A.23}$$

which proves (22).

A.5 Proof of Proposition 1

First consider HANK-UIP, where $\alpha > 0$ and $\phi = 0$. By (A.15) and (4), $q_t = s_t = 0$, so $\pi_t = \pi_{H,t}$ and $y_t = (1-\gamma)c_t + \gamma c^*_t$. Let $A \equiv \sigma + (1-\gamma)\varphi > 0$. Forward iteration of the domestic and foreign NKPCs gives

$$\pi_t - \pi^*_t = \kappa A\,[\mathrm{NPV}_t(c_\tau) - \mathrm{NPV}_t(c^*_\tau)] = \frac{\kappa A}{\gamma} b^*_t. \tag{A.24}$$

Since $b^*_0 = 0$, $\pi_0 = \pi^*_0$. Summing (A.24) over dates and using (A.23),

$$p_\infty - p^*_\infty = \kappa A \sum_{t=0}^{\infty} [\mathrm{NPV}_t(c_\tau) - \mathrm{NPV}_t(c^*_\tau)] = \frac{\kappa A}{\alpha\gamma} c_0 > 0. \tag{A.25}$$

This proves the HANK-UIP part.

Now consider RANK, with $\alpha = 0$ and $\phi > 0$. By (A.15), $c_t = 0$ for all t, because $\phi > 0$. Thus (A.1) gives

$$\tilde{c}_t = -\vartheta q_t = -(1-\gamma)\vartheta s_t.$$

The country budget and UIP become

$$\beta b^*_{t+1} = b^*_t + \gamma(c^*_t - \tilde{c}_t), \qquad \tilde{c}_{t+1} - \tilde{c}_t = -\vartheta\phi b^*_{t+1}. \tag{A.26}$$

The system (A.26) is (A.18) and (A.20), with $\tilde{c}_t$ replacing c_t and $\vartheta\phi$ replacing α. Since $c^*_t \geq 0$ for all t and $c^*_t > 0$ for some t (because $\text{NPV}(c^*_t) > 0$), (A.22) gives $\tilde{c}_0 > 0$, while (A.19) and (A.21) imply

$$\text{NPV}_t(\tilde{c}_\tau) - \text{NPV}_t(c^*_\tau) = \frac{b^*_t}{\gamma}, \qquad \sum_{t=0}^{\infty} b^*_t = \frac{\tilde{c}_0}{\vartheta\phi} > 0$$

In particular, $\text{NPV}_0(\tilde{c}_\tau) = \text{NPV}_0(c^*_\tau) > 0$. The foreign NKPC gives

$$\pi^*_t = \kappa(\sigma + \varphi)\text{NPV}_t(c^*_\tau),$$

and since $c^*_t \geq 0$ for all t and $c^*_t > 0$ for some t, we have both $\text{NPV}_0(c^*_\tau) > 0$ as well as $\sum_{t=0}^{\infty} \text{NPV}_t(c^*_\tau) > 0$. Thus $\pi^*_0 > 0$ and $p^*_\infty > 0$.

It remains to sign domestic inflation in RANK. Using $c_t = 0$, $s_t = -\tilde{c}_t/((1-\gamma)\vartheta)$, and $\gamma(c^*_t - \tilde{c}_t) = \beta b^*_{t+1} - b^*_t$, domestic real marginal cost can be written as

$$\sigma c_t + \varphi y_t + \gamma s_t = \varphi(\beta b^*_{t+1} - b^*_t) - \frac{\gamma(1+\varphi)}{(1-\gamma)\vartheta}\tilde{c}_t.$$

Forward iteration of the domestic NKPC therefore yields

$$\pi_{H,t} = -\kappa\varphi b^*_t - \frac{\kappa\gamma(1+\varphi)}{(1-\gamma)\vartheta}\text{NPV}_t(\tilde{c}_\tau).$$

Normalizing the pre-shock terms of trade to $s_{-1} = 0$, and using $s_0 = -\tilde{c}_0/((1-\gamma)\vartheta)$, we get

$$\pi_0 = \pi_{H,0} + \gamma s_0 = -\frac{\gamma}{(1-\gamma)\vartheta}\left[\kappa(1+\varphi)\text{NPV}_0(\tilde{c}_\tau) + \tilde{c}_0\right] < 0.$$

Finally, $s_t \to 0$, so the terms-of-trade component in CPI inflation sums to zero. Moreover,

$$\sum_{t=0}^{\infty} \text{NPV}_t(\tilde{c}_\tau) = \sum_{t=0}^{\infty} \text{NPV}_t(c^*_\tau) + \frac{1}{\gamma}\sum_{t=0}^{\infty} b^*_t > 0.$$

The first term is positive since $c^*_t \geq 0$ for all t and $c^*_t > 0$ for some t, and the second is positive because $\tilde{c}_0 > 0$. Therefore

$$p_\infty = \sum_{t=0}^{\infty} \pi_{H,t} = -\kappa\varphi\sum_{t=0}^{\infty} b^*_t - \frac{\kappa\gamma(1+\varphi)}{(1-\gamma)\vartheta}\sum_{t=0}^{\infty} \text{NPV}_t(\tilde{c}_\tau) < 0.$$

A.6 Proof of Proposition 2

Part 1. In HANK-UIP, $\alpha > 0$ and $\phi = 0$. For each fixed $\gamma > 0$, Theorem 1 gives

$$\varsigma = 1.$$

The HANK-UIP argument in the proof of Theorem 1 then gives $q_t = 0$ for all t, and hence $s_t = 0$ by (4). Therefore $\mathrm{NPV}(c_t) = \mathrm{NPV}(c_t^*)$ by (16), independently of the degree of openness $\gamma > 0$.

Part 2. At $\phi = 0$, under the neutral-policy assumptions used in Theorem 1, (12), (13), and (4) with $q_t = s_t = 0$, together with (3) and (11), give the equilibrium dynamics for (b_t^*, c_t):

$$\begin{aligned} \beta b_{t+1}^* &= b_t^* + \gamma(c_t^* - c_t), \\ c_{t+1} - c_t &= -\alpha b_{t+1}^*. \end{aligned} \tag{A.27}$$

Let $\rho_\gamma \in (0,1)$ denote the stable root associated with (A.27),

$$\beta\rho_\gamma^2 - (1 + \beta + \alpha\gamma)\rho_\gamma + 1 = 0.$$

As $\gamma \to 0$, $\rho_\gamma \to 1$. The stable solution from the proof of Lemma 3 is

$$c_t = \chi_\gamma b_t^* + (1 - \beta\rho_\gamma)\sum_{j=0}^{\infty}(\beta\rho_\gamma)^j c_{t+j}^*, \qquad \chi_\gamma = \frac{1 - \beta\rho_\gamma}{\gamma}. \tag{A.28}$$

Since $b_0^* = 0$,

$$c_0(\gamma) = (1 - \beta\rho_\gamma)\sum_{j=0}^{\infty}(\beta\rho_\gamma)^j c_j^* \to (1 - \beta)\,\mathrm{NPV}(c_t^*).$$

For a positive foreign-demand boom, this limit is strictly positive. Now let $\hat{b}_t = b_t^*/\gamma$. Dividing the first equation in (A.27) by γ and substituting (A.28) together with $\gamma\chi_\gamma = 1 - \beta\rho_\gamma$ gives

$$\beta\hat{b}_{t+1} = \beta\rho_\gamma\hat{b}_t + c_t^* - (1 - \beta\rho_\gamma)\sum_{j=0}^{\infty}(\beta\rho_\gamma)^j c_{t+j}^*.$$

Taking limits $\gamma \to 0$ recursively from $\hat{b}_0 = 0$ gives

$$\hat{b}_{t+1} \to \hat{b}_t + \sum_{j=0}^{\infty}\beta^j c_{t+j}^* - \sum_{j=0}^{\infty}\beta^j c_{t+1+j}^*, \qquad \hat{b}_0 = 0.$$

Hence

$$\hat{b}_t \to \sum_{j=0}^{\infty}\beta^j c_j^* - \sum_{j=0}^{\infty}\beta^j c_{t+j}^*.$$

Using (A.28) once more, for every fixed t,

$$c_t \to (1-\beta)\left(\hat{b}_t + \sum_{j=0}^{\infty} \beta^j c^*_{t+j}\right) \to (1-\beta)\sum_{j=0}^{\infty} \beta^j c^*_j. \tag{A.29}$$

Thus, as $\gamma \to 0$, the domestic consumption response becomes flat in the sense of (A.29).

Finally, write $A_\gamma \equiv \sigma + (1-\gamma)\varphi$, the constant denoted A in the HANK-UIP part of the proof of Proposition 1. Equation (A.25) gives

$$p_\infty - p^*_\infty = \frac{\kappa A_\gamma}{\alpha\gamma} c_0(\gamma).$$

Since $A_\gamma \to \sigma + \varphi > 0$, $c_0(\gamma)$ has a strictly positive limit for a positive foreign-demand boom, and p^*_∞ is finite under the maintained summability assumptions, we have $p_\infty \to \infty$, proving the second claim.

Part 3. Continue to consider HANK-UIP, so $\alpha > 0$ and $\phi = 0$, with $d_{t+1} = f^*_{t+1} = 0$ and $r^*_t = 0$. For $t < T$, the domestic real rate is neutral, $r_t = 0$. From date T onward, the domestic real-rate path is chosen to keep PPI inflation at steady state, $\pi_{H,t} = 0$ for all $t \geq T$. Use $\tilde{c}_t$ as defined in (A.1). For $t < T$, the UIP condition (9), together with $\phi = 0$ and $r_t = r^*_t = 0$, implies $q_{t+1} = q_t$. Iterating this restriction up to date T gives $q_t = q_T$ for $0 \leq t \leq T$. The definition in (A.1) then gives $c_t = \tilde{c}_t + \vartheta q_T$. Substituting this expression into (12) after using (13) and (4), and using (11) in the Euler equation (3), we obtain the path before T:

$$\begin{aligned} \beta b^*_{t+1} &= b^*_t + \gamma(c^*_t - \tilde{c}_t), \\ \tilde{c}_{t+1} - \tilde{c}_t &= -\alpha b^*_{t+1}. \end{aligned}$$

Given $\tilde{c}_0$, this gives, for $0 \leq t \leq T$,

$$\begin{pmatrix} b^*_t \\ \tilde{c}_t \end{pmatrix} = \begin{pmatrix} \beta^{-1} & -\gamma\beta^{-1} \\ -\alpha\beta^{-1} & 1+\alpha\gamma\beta^{-1} \end{pmatrix}^t \begin{pmatrix} 0 \\ \tilde{c}_0 \end{pmatrix} + \sum_{j=0}^{t-1} \begin{pmatrix} \beta^{-1} & -\gamma\beta^{-1} \\ -\alpha\beta^{-1} & 1+\alpha\gamma\beta^{-1} \end{pmatrix}^{t-1-j} \begin{pmatrix} \gamma\beta^{-1} \\ -\alpha\gamma\beta^{-1} \end{pmatrix} c^*_j. \tag{A.30}$$

It remains to pin down the scalar $\tilde{c}_0$ using the equilibrium conditions from date T onward.

For $t \geq T$, the requirement $\pi_{H,t} = 0$, together with (6), implies zero real marginal cost. Using (4) and (7), this condition is

$$[\sigma + (1-\gamma)\varphi]\,\tilde{c}_t + \gamma\varphi c^*_t + \xi s_t = 0, \qquad \xi \equiv (1-\gamma)\vartheta(\sigma+\varphi) + \gamma(1+\varphi). \tag{A.31}$$

Equivalently,

$$q_t = -\frac{(1-\gamma)\left([\sigma + (1-\gamma)\varphi]\,\tilde{c}_t + \gamma\varphi c^*_t\right)}{\xi}. \tag{A.32}$$

Combining (A.32) with (9), (3), and (11) gives

$$\left(\tilde{c}_{t+1} + \psi_\gamma c^*_{t+1}\right) - \left(\tilde{c}_t + \psi_\gamma c^*_t\right) = -\frac{\alpha\xi}{D_\gamma} b^*_{t+1},$$

where

$$D_\gamma \equiv \xi + (1-\gamma)\left(\sigma^{-1} - \vartheta\right)\left[\sigma + (1-\gamma)\varphi\right], \qquad \psi_\gamma \equiv \frac{(1-\gamma)\left(\sigma^{-1}-\vartheta\right)\gamma\varphi}{D_\gamma}. \tag{A.33}$$

The denominator is positive, since

$$D_\gamma = \frac{\sigma + \varphi + \gamma(2-\gamma)\varphi(\sigma\theta - 1)}{\sigma} > 0. \tag{A.34}$$

This inequality in turn is true because, if $\sigma\theta \geq 1$, the numerator is above $\sigma + \varphi$; and if $\sigma\theta < 1$, it is above $\sigma + \sigma\theta\varphi$. Together with the country budget constraint (12), using (A.2) and (A.33), the system for $t \geq T$ can be written as

$$\begin{aligned} \beta b^*_{t+1} &= b^*_t + \gamma\left[(1+\psi_\gamma)c^*_t - (\tilde{c}_t + \psi_\gamma c^*_t)\right], \\ (\tilde{c}_{t+1} + \psi_\gamma c^*_{t+1}) - (\tilde{c}_t + \psi_\gamma c^*_t) &= -\frac{\alpha\xi}{D_\gamma} b^*_{t+1}. \end{aligned} \tag{A.35}$$

Now let $\rho^f_\gamma \in (0,1)$ be the stable root associated with (A.35),

$$\beta(\rho^f_\gamma)^2 - \left(1 + \beta + \frac{\alpha\gamma\xi}{D_\gamma}\right)\rho^f_\gamma + 1 = 0. \tag{A.36}$$

The bounded path for $t \geq T$ is therefore

$$\tilde{c}_t + \psi_\gamma c^*_t = \frac{1-\beta\rho^f_\gamma}{\gamma} b^*_t + (1-\beta\rho^f_\gamma)(1+\psi_\gamma)\sum_{j=0}^{\infty}(\beta\rho^f_\gamma)^j c^*_{t+j}, \qquad t \geq T. \tag{A.37}$$

Evaluating (A.37) at $t = T$, and combining it with (A.30) for $(b^*_T, \tilde{c}_T)$, gives the unique $\tilde{c}_0$. Then the full fixed-γ path is obtained from

$$c_t = \tilde{c}_t + \vartheta q_t, \qquad r_t = q_{t+1} - q_t,$$

with $q_t = q_T$ for $t < T$ and q_t given by the zero-marginal-cost formula (A.32) for $t \geq T$.

We now take $\gamma \to 0$. Since $D_\gamma \to (\sigma+\varphi)/\sigma$ by (A.34), $\psi_\gamma \to 0$ by (A.33), and $\rho^f_\gamma \to 1$ by (A.36), the limiting date-T condition reduces to a scalar equation for $\lim_{\gamma\to 0}\tilde{c}_0$. Specifically, the pre-$T$ solution (A.30) implies, for each fixed $t \leq T$,

$$\tilde{c}_t - \tilde{c}_0 \to 0, \qquad \frac{b^*_T}{\gamma} \to \beta^{-T}\sum_{j=0}^{T-1}\beta^j\left(c^*_j - \lim_{\gamma\to 0}\tilde{c}_0\right). \tag{A.38}$$

Taking limits in the date-T condition (A.37) gives

$$\lim_{\gamma\to 0}\tilde{c}_0 = (1-\beta)\left[\beta^{-T}\sum_{j=0}^{T-1}\beta^j\left(c^*_j - \lim_{\gamma\to 0}\tilde{c}_0\right) + \sum_{j=0}^{\infty}\beta^j c^*_{T+j}\right]. \tag{A.39}$$

Solving (A.39) yields

$$\lim_{\gamma\to 0}\tilde{c}_0 = (1-\beta)\left[\sum_{j=0}^{T-1}\beta^j c_j^* + \beta^T \sum_{j=0}^{\infty}\beta^j c_{T+j}^*\right] = (1-\beta)\,\mathrm{NPV}(c_t^*). \tag{A.40}$$

Thus $\tilde{c}_t \to (1-\beta)\,\mathrm{NPV}(c_t^*)$ for every fixed $t \le T$, while

$$\vartheta q_T = -\frac{(1-\gamma)\vartheta\left([\sigma+(1-\gamma)\varphi]\,\tilde{c}_T + \gamma\varphi c_T^*\right)}{\xi} \to -(1-\beta)\,\mathrm{NPV}(c_t^*). \tag{A.41}$$

Since $q_t = q_T$ for $t < T$, and since (A.32) gives the same formula for q_T at date T, (A.40) and (A.41) imply $c_t = \tilde{c}_t + \vartheta q_T \to 0$ for every fixed $t \le T$.

It remains to show that the net-present-value contribution of dates $t \ge T$ to $\mathrm{NPV}(c_t)$ vanishes in the limit. Forward iteration of the country budget (12) from date T, using (A.2), gives

$$\mathrm{NPV}_T(\tilde{c}_\tau) = \mathrm{NPV}_T(c_\tau^*) + \frac{b_T^*}{\gamma}.$$

Taking date-T net present values in the zero-marginal-cost condition (A.31) and using $c_t = \tilde{c}_t + (1-\gamma)\vartheta s_t$ gives

$$\mathrm{NPV}_T(c_\tau) = \frac{\gamma(1+\varphi)}{\xi}\mathrm{NPV}_T(c_\tau^*) + \frac{1+\varphi+(1-\gamma)\vartheta\varphi}{\xi}b_T^*. \tag{A.42}$$

The limit in (A.38) shows $b_T^* = O(\gamma)$, so the right-hand side of (A.42) converges to zero. Therefore

$$\mathrm{NPV}(c_t) = \sum_{t=0}^{T-1}\beta^t c_t + \beta^T \mathrm{NPV}_T(c_\tau) \to 0.$$

Since the foreign-demand boom has $\mathrm{NPV}(c_t^*) > 0$, the definition (17) gives

$$\varsigma = \frac{\mathrm{NPV}(c_t)}{\mathrm{NPV}(c_t^*)} \to 0.$$

This proves the third claim.

A.7 Proof of Lemma 4

In this subsection, the only active domestic policy instrument is the real interest rate, and the foreign real rate is unchanged, i.e., $r_t^* = d_{t+1} = f_{t+1}^* = 0$. Since $a_{t+1} = b_{t+1}^*$, the Euler equation and UIP reduce to

$$c_{t+1} - c_t = \frac{1}{\sigma}r_t - \alpha b_{t+1}^*, \qquad q_{t+1} - q_t = r_t + \phi b_{t+1}^*. \tag{A.43}$$

The same stability and terminal-selection argument as in the proofs of Lemma 1 and Theorem 1 gives $c_t \to 0$ and $q_t \to 0$. Now define

$$\mathcal{B}_t^* \equiv \sum_{j=0}^{\infty} b_{t+1+j}^*, \qquad \mathcal{R}_t \equiv \sum_{j=0}^{\infty} r_{t+j}.$$

The stable path selected by the no-Ponzi condition and the maintained summability restrictions make these objects well defined; they also ensure that $\mathrm{NPV}(\mathcal{R}_t)$ is finite. Forward iteration of the two laws of motion gives

$$c_t = \alpha \mathcal{B}_t^* - \frac{1}{\sigma}\mathcal{R}_t, \qquad q_t = -\phi \mathcal{B}_t^* - \mathcal{R}_t. \tag{A.44}$$

Eliminating $\mathcal{B}_t^*$ from (A.44) yields

$$\phi c_t + \alpha q_t = -\left(\alpha + \frac{\phi}{\sigma}\right)\mathcal{R}_t. \tag{A.45}$$

Taking net present values in (A.45) and using (16),

$$\phi\,\mathrm{NPV}(c_t) + \alpha\,\mathrm{NPV}(q_t) = -\left(\alpha + \frac{\phi}{\sigma}\right)\mathrm{NPV}(\mathcal{R}_t), \qquad \mathrm{NPV}(c_t^*) = \mathrm{NPV}(c_t) - \vartheta\,\mathrm{NPV}(q_t).$$

Substituting the second relation into the first gives

$$\phi\,\mathrm{NPV}(c_t) + \frac{\alpha}{\vartheta}\left[\mathrm{NPV}(c_t) - \mathrm{NPV}(c_t^*)\right] = -\left(\alpha + \frac{\phi}{\sigma}\right)\mathrm{NPV}(\mathcal{R}_t).$$

Therefore

$$\mathrm{NPV}(c_t) = \frac{\alpha}{\alpha + \vartheta\phi}\,\mathrm{NPV}(c_t^*) - \frac{\vartheta\left(\alpha + \frac{\phi}{\sigma}\right)}{\alpha + \vartheta\phi}\,\mathrm{NPV}(\mathcal{R}_t).$$

Using (19), the coefficient on $\mathrm{NPV}(c_t^*)$ is exactly ς. This proves (23), with

$$\varsigma^r = -\frac{\vartheta\left(\alpha + \frac{\phi}{\sigma}\right)}{\alpha + \vartheta\phi}. \tag{A.46}$$

A.8 Proof of Proposition 3

The expression for ς^r follows from (A.46). Under the maintained restrictions, $\alpha + \vartheta\phi > 0$. Moreover, either $\alpha > 0$, or $\alpha = 0$ and $\phi > 0$, then $\alpha + \phi/\sigma > 0$. Since $\vartheta > 0$, this implies $\varsigma^r < 0$.

If preferences are logarithmic and $\theta = 1$, then $\sigma = 1$ and $\vartheta = ((2-\gamma)\theta - 1)/(1-\gamma) = 1$. Hence, for any admissible (α, ϕ),

$$\varsigma^r = -\frac{\alpha + \phi}{\alpha + \phi} = -1 = -\vartheta.$$

For fixed $\phi > 0$,

$$|\varsigma^r| = \frac{\vartheta\left(\alpha + \frac{\phi}{\sigma}\right)}{\alpha + \vartheta\phi},$$

and differentiation gives

$$\frac{\partial|\varsigma^r|}{\partial\alpha} = \frac{\vartheta\phi\left(\vartheta - \frac{1}{\sigma}\right)}{(\alpha + \vartheta\phi)^2}.$$

Thus $|\varsigma^r|$ is decreasing in α if and only if $\vartheta < 1/\sigma$. At the admissible $\phi = 0$ endpoint, where $\alpha > 0$, the formula gives $\varsigma^r = -\vartheta$, and hence $|\varsigma^r|$ is independent of α. This proves the proposition.

A.9 Proof of Proposition 4

Let $\{c_t^f, y_t^f, q_t^f, s_t^f, gdp_t^f\}$ denote the flexible-price equilibrium paths, let $b_{t+1}^{*;f}$ be the associated net foreign asset path, and define

$$\tilde{c}_t^f \equiv c_t^f - \vartheta q_t^f = c_t^f - (1-\gamma)\vartheta s_t^f.$$

Recall from (A.8) that $\xi \equiv \sigma(1-\gamma)\vartheta + \varphi((1-\gamma)\vartheta + \gamma) + \gamma = (1-\gamma)\vartheta(\sigma+\varphi) + \gamma(1+\varphi)$. Using (4) in (7) along these paths,

$$\begin{aligned} y_t^f &= (1-\gamma)c_t^f + \gamma c_t^* + \gamma\theta(q_t^f + s_t^f) \\ &= (1-\gamma)\tilde{c}_t^f + \gamma c_t^* + ((1-\gamma)\vartheta + \gamma)s_t^f. \end{aligned}$$

Substituting this expression and $c_t^f = \tilde{c}_t^f + (1-\gamma)\vartheta s_t^f$ into (25) gives

$$[\sigma + (1-\gamma)\varphi]\,\tilde{c}_t^f + \gamma\varphi c_t^* + \xi s_t^f = 0. \tag{A.47}$$

Taking net present values in (A.47) and applying (A.2) and the country budget constraint to the flexible-price paths, together with the no-Ponzi condition,

$$\text{NPV}(\tilde{c}_t^f) = \text{NPV}(c_t^*),$$

gives

$$(\sigma+\varphi)\,\text{NPV}(c_t^*) + \xi\,\text{NPV}(s_t^f) = 0.$$

Therefore

$$\text{NPV}(c_t^f) = \text{NPV}(\tilde{c}_t^f) + (1-\gamma)\vartheta\,\text{NPV}(s_t^f) = \frac{\gamma(1+\varphi)}{\xi}\,\text{NPV}(c_t^*).$$

The expression contains neither α nor ϕ. Moreover, $\gamma(1+\varphi) > 0$, and by Marshall-Lerner,

$$\xi - \gamma(1+\varphi) = (1-\gamma)\vartheta(\sigma+\varphi) > 0.$$

Hence ς^f is given by (26) and lies in $(0,1)$.

A.10 Proof of Corollary 1

By Lemma 4, implementing the flexible-price allocation requires

$$\varsigma^f\,\text{NPV}(c_t^*) = \varsigma\,\text{NPV}(c_t^*) + \varsigma^r\,\text{NPV}(\mathcal{R}_t),$$

and therefore

$$\text{NPV}(\mathcal{R}_t) = -\frac{1}{\varsigma^r}\left(\varsigma - \varsigma^f\right)\text{NPV}(c_t^*).$$

This proves the first claim. To sign the expression, use (19), (24), and (26) to write

$$\text{NPV}(\mathcal{R}_t) = \frac{(1-\gamma)(\sigma+\varphi)}{\xi\,(\alpha+\phi/\sigma)}\,(\alpha-\bar{\alpha}(\phi))\,\text{NPV}(c_t^*),$$

where

$$\bar{\alpha}(\phi) \equiv \frac{\gamma(1+\varphi)}{(1-\gamma)(\sigma+\varphi)}\phi.$$

The cutoff is strictly increasing in ϕ and strictly positive for $\phi > 0$. Since the remaining coefficient is positive, for a positive foreign-demand boom ($\text{NPV}(c_t^*) > 0$),

$$\text{NPV}(\mathcal{R}_t) > 0 \quad \text{if and only if} \quad \alpha > \bar{\alpha}(\phi).$$

A.11 Proof of Corollary 2

Perfect consumption stabilization implies $\text{NPV}(c_t) = 0$. By (A.12), perfect GDP stabilization imposes the same present-value restriction. Applying Lemma 4 and setting $\text{NPV}(c_t) = 0$ gives

$$0 = \varsigma\,\text{NPV}(c_t^*) + \varsigma^r\,\text{NPV}(\mathcal{R}_t).$$

Therefore any real-rate path that perfectly stabilizes consumption or GDP must satisfy

$$\text{NPV}(\mathcal{R}_t) = -\frac{\varsigma}{\varsigma^r}\,\text{NPV}(c_t^*).$$

A.12 Proof of Proposition 5

Allow all three domestic policy instruments, and keep $r_t^* = 0$. Since $a_{t+1} = b_{t+1}^* + d_{t+1}$, the Euler equation and UIP become

$$c_{t+1} - c_t = \frac{1}{\sigma}r_t - \alpha b_{t+1}^* - \alpha d_{t+1}, \qquad q_{t+1} - q_t = r_t + \phi b_{t+1}^* - \phi f_{t+1}^*. \tag{A.48}$$

The terminal-selection argument used for (A.43) gives $c_t \to 0$ and $q_t \to 0$. Now define

$$\mathcal{B}_t^* \equiv \sum_{j=0}^{\infty} b_{t+1+j}^*, \qquad \mathcal{R}_t \equiv \sum_{j=0}^{\infty} r_{t+j}, \qquad \mathcal{D}_t \equiv \sum_{j=0}^{\infty} d_{t+1+j}, \qquad \mathcal{F}_t^* \equiv \sum_{j=0}^{\infty} f_{t+1+j}^*.$$

Forward iteration of (A.48) gives

$$c_t = \alpha\mathcal{B}_t^* + \alpha\mathcal{D}_t - \frac{1}{\sigma}\mathcal{R}_t, \qquad q_t = -\phi\mathcal{B}_t^* + \phi\mathcal{F}_t^* - \mathcal{R}_t. \tag{A.49}$$

Eliminating $\mathcal{B}_t^*$ from (A.49) yields

$$\phi c_t + \alpha q_t = \alpha\phi(\mathcal{D}_t + \mathcal{F}_t^*) - \left(\alpha + \frac{\phi}{\sigma}\right)\mathcal{R}_t. \tag{A.50}$$

Taking net present values in (A.50) and using (16),

$$\phi\,\text{NPV}(c_t) + \frac{\alpha}{\vartheta}\left[\text{NPV}(c_t) - \text{NPV}(c_t^*)\right] = \alpha\phi\,\text{NPV}(\mathcal{D}_t + \mathcal{F}_t^*) - \left(\alpha + \frac{\phi}{\sigma}\right)\text{NPV}(\mathcal{R}_t).$$

Therefore

$$\text{NPV}(c_t) = \frac{\alpha}{\alpha + \vartheta\phi}\,\text{NPV}(c_t^*) - \frac{\vartheta\left(\alpha + \frac{\phi}{\sigma}\right)}{\alpha + \vartheta\phi}\,\text{NPV}(\mathcal{R}_t) + \frac{\alpha\phi\vartheta}{\alpha + \vartheta\phi}\,\text{NPV}(\mathcal{D}_t + \mathcal{F}_t^*).$$

Using (19) and (24), this proves (31), with

$$\varsigma^d = \varsigma^{fx} = \frac{\alpha\phi\vartheta}{\alpha + \vartheta\phi}.$$

The expression is non-negative. It is furthermore equal to zero in RANK, where $\alpha = 0$ (with $\phi > 0$), and in HANK-UIP, where $\phi = 0$.

A.13 Proof of Proposition 6

Take the flexible-price paths $\{c_t^f, y_t^f, q_t^f, s_t^f, gdp_t^f\}$ and the associated net foreign asset path $b_{t+1}^{*,f}$ from the proof of Proposition 4. It remains to choose fiscal and FXI paths so that the Euler equation and UIP hold with $r_t = 0$. Since $\alpha, \phi > 0$, choose

$$d_{t+1} = -b_{t+1}^{*,f} - \frac{c_{t+1}^f - c_t^f}{\alpha}, \qquad f_{t+1}^* = b_{t+1}^{*,f} - \frac{q_{t+1}^f - q_t^f}{\phi}. \tag{A.51}$$

The two paths in (A.51) are admissible under the same boundedness and summability restrictions maintained above. They imply

$$c_{t+1}^f - c_t^f = -\alpha\left(b_{t+1}^{*,f} + d_{t+1}\right), \qquad q_{t+1}^f - q_t^f = \phi\left(b_{t+1}^{*,f} - f_{t+1}^*\right),$$

so the Euler equation and UIP hold along the flexible-price paths with $r_t = 0$. The remaining allocation conditions are exactly the flexible-price conditions verified in the proof of Proposition 4, and taxes are pinned down residually by the government budget constraint. Hence fiscal and FXI policies alone implement $\{c_t^f, y_t^f, q_t^f, s_t^f, gdp_t^f\}$.

For any such implementation, (31) and (32) imply

$$\varsigma^f\,\text{NPV}(c_t^*) = \varsigma\,\text{NPV}(c_t^*) + \varsigma^d\,\text{NPV}(\mathcal{D}_t + \mathcal{F}_t^*).$$

Thus

$$\text{NPV}(\mathcal{D}_t + \mathcal{F}_t^*) = -\frac{1}{\varsigma^d}\left(\varsigma - \varsigma^f\right)\text{NPV}(c_t^*). \tag{A.52}$$

Consider a positive foreign-demand boom with $\text{NPV}(c_t^*) > 0$. Since (32) gives $\varsigma^d = \alpha\phi\vartheta/(\alpha+\vartheta\phi) \to 0$ as $\phi \to 0$, while $\varsigma \to 1$ for fixed $\alpha > 0$ and $\varsigma^f \in (0, 1)$, (A.52) implies that the absolute size of the required fiscal-FXI impulse diverges as $\phi \to 0$.

B Supplementary details for the theoretical analysis

We first provide detailed derivations for all equations of our baseline model, before then considering several model variants and special cases.

B.1 Environment

This section offers supplementary details for all model blocks, following the structure of Section 2.

Demand. The demand equations (2) and (3) follow from the household problem. Specifically, dividing the household budget constraint in the main text by P_t gives

$$\omega A_{i,t+1}\frac{P_{t+1}}{\mathcal{I}_t P_t} = A_{i,t} + W_t L_t + \Pi_t^{\text{pr}} - T_t - C_{i,t} + S_{i,t}.$$

The annuity is actuarially fair: conditional on survival, one unit saved at date t pays $\mathcal{I}_t P_t/(\omega P_{t+1})$ consumption units at date $t+1$. The survival probability in the household objective therefore cancels the annuity wedge in the intertemporal first-order condition, giving

$$C_{i,t}^{-\sigma} = \beta\,\mathbb{E}_t\left[\frac{\mathcal{I}_t P_t}{P_{t+1}} C_{i,t+1}^{-\sigma}\right].$$

The aggregate consumption function (2) follows from the same household problem in present-value form. Log-linearizing the individual intertemporal budget constraint around the common steady state, and using the fact that all households receive the same non-asset income and pay the same taxes, gives

$$c_{i,t} = (1-\beta\omega)\left(a_{i,t} + \mathbb{E}_t\left[\sum_{k=0}^{\infty}(\beta\omega)^k(gdp_{t+k} - t_{t+k})\right]\right) - \beta\left(\frac{\omega}{\sigma} - (1-\beta\omega)\frac{\bar{A}}{\bar{Y}}\right)\mathbb{E}_t\left[\sum_{k=0}^{\infty}(\beta\omega)^k r_{t+k}\right]. \tag{B.1}$$

The first term is the annuitized value of financial wealth and after-tax labor and dividend income. The second term combines intertemporal substitution with the first-order wealth effect from changing the return on the steady-state asset position. Integrating (B.1) over households replaces $a_{i,t}$ by $a_t \equiv \int a_{i,t}\mathrm{d}i$ and yields (2). To first order, the household Euler equation also implies

$$\mathbb{E}_t[c_{i,t+1} - c_{i,t}] = \frac{1}{\sigma} r_t$$

for every date-t household, conditional on survival. Let $\mathcal{J}_{t+1}$ denote the set of these households that survive to date $t+1$, which has mass ω. Integrating the last equation over the date-t population gives

$$\mathbb{E}_t\left[\frac{1}{\omega}\int_{\mathcal{J}_{t+1}} c_{i,t+1}\mathrm{d}i - c_t\right] = \frac{1}{\sigma} r_t. \tag{B.2}$$

The individual consumption function is affine in beginning-of-period assets with coefficient $1-\beta\omega$, while the remaining terms are common across households. Since newborn households enter with the steady-state asset position, the aggregate asset deviation a_{t+1} is carried by the surviving households.

Hence

$$\frac{1}{\omega}\int_{\mathcal{J}_{t+1}} c_{i,t+1}\mathrm{d}i - c_{t+1} = (1-\beta\omega)\left(\frac{a_{t+1}}{\omega} - a_{t+1}\right) = \frac{(1-\omega)(1-\beta\omega)}{\omega}a_{t+1}. \tag{B.3}$$

Combining (B.3) with (B.2) gives

$$\mathbb{E}_t[\Delta c_{t+1}] = \frac{1}{\sigma}r_t - \frac{(1-\omega)(1-\beta\omega)}{\omega}a_{t+1},$$

which is (3) with $\alpha \equiv (1-\omega)(1-\beta\omega)/\omega$.

Goods market, production, and pricing. The price index dual to the domestic consumption aggregator is

$$P_t = \left[(1-\gamma)P_{H,t}^{1-\theta} + \gamma P_{F,t}^{1-\theta}\right]^{\frac{1}{1-\theta}}.$$

Cost minimization gives domestic demands for the home and foreign goods,

$$C_{H,t} = (1-\gamma)\left(\frac{P_{H,t}}{P_t}\right)^{-\theta} C_t, \qquad C_{F,t} = \gamma\left(\frac{P_{F,t}}{P_t}\right)^{-\theta} C_t.$$

To first order, the domestic CPI satisfies $p_t = (1-\gamma)p_{H,t} + \gamma p_{F,t}$. Under producer currency pricing and the law of one price, $p_{H,t} = e_t + p^*_{H,t}$ and $p_{F,t} = e_t + p^*_t$, so the terms of trade are $s_t = p_{F,t} - p_{H,t}$ and the real exchange rate satisfies

$$q_t = e_t + p^*_t - p_t = (1-\gamma)s_t,$$

which is (4). The same accounting gives $p_t = p_{H,t} + \gamma s_t$, and hence

$$\pi_t = \pi_{H,t} + \gamma\Delta s_t,$$

which is (5).

The implied domestic demand for the home good is $c_{H,t} = c_t + \theta\gamma s_t$. For foreign demand, using $p^*_{H,t} - p^*_t = -q_t - \gamma s_t$ gives $c^*_{H,t} = c^*_t + \theta(q_t + \gamma s_t)$. The steady-state domestic and foreign shares in home output are $1-\gamma$ and γ, respectively. Home-good market clearing therefore implies

$$y_t = (1-\gamma)c_t + \gamma c^*_t + \gamma\theta(q_t + s_t),$$

which is (7). Total household income is the value of home output in units of the domestic consumption basket, $P_{H,t}Y_t/P_t$. Since $p_{H,t} - p_t = -\gamma s_t$, its log-linearized value is

$$gdp_t = y_t - \gamma s_t,$$

as in (8). This also implies $nx_t = gdp_t - c_t$, the expression used in the balance-of-payments block.

On the supply side, each home producer uses a linear labor-only technology, and the labor union assigns the same hours to all households. The household labor-supply condition gives the CPI real wage $w_t = \sigma c_t + \varphi y_t$. Since firms price in units of the home good, real marginal cost is the product real wage,

$$mc_t = w_t + p_t - p_{H,t} = \sigma c_t + \varphi y_t + \gamma s_t. \tag{B.4}$$

With Calvo price adjustment, a fraction $1-\lambda$ of firms can reset prices each period. The standard log-linear Calvo pricing recursion is

$$\pi_{H,t} = \frac{(1-\lambda)(1-\beta\lambda)}{\lambda} mc_t + \beta \mathbb{E}_t[\pi_{H,t+1}].$$

Substituting (B.4) gives (6), with $\kappa \equiv (1-\lambda)(1-\beta\lambda)/\lambda$.

Financial sector. The modified UIP condition (9) follows from the segmented-market environment of Itskhoki and Mukhin (2021), specialized to the case without an exogenous noise-trader demand shock. Households trade only local-currency bonds, and any foreign-currency exposure is absorbed by private arbitrageurs and, when the central bank intervenes, by the central bank. As in the main text, nominal variables dated $t+1$ denote positions carried into the beginning of period $t+1$.

The derivation uses three primitive restrictions. The first is the zero-capital constraint on the private intermediaries' carry trade:

$$\frac{H^{\mathrm{n}}_{t+1}}{\mathcal{I}_t} + \frac{\mathcal{E}_t H^{*,\mathrm{n}}_{t+1}}{\mathcal{I}^*_t} = 0.$$

Here H^{n}_{t+1} and $H^{*,\mathrm{n}}_{t+1}$ are the intermediaries' nominal positions in home and foreign bonds, $\mathcal{I}_t$ and $\mathcal{I}^*_t$ are the corresponding gross nominal returns, and $\mathcal{E}_t$ converts the foreign-currency leg into home currency. The equation says that the date-t values of the two legs sum to zero: a long position in one currency bond is financed by an equal-value short position in the other.

The second is home-currency bond-market clearing:

$$A^{\mathrm{n}}_{t+1} + H^{\mathrm{n}}_{t+1} + F^{\mathrm{n}}_{t+1} = D^{\mathrm{n}}_{t+1}.$$

Households hold A^{n}_{t+1}, arbitrageurs hold H^{n}_{t+1}, and the central bank holds F^{n}_{t+1}; together these positions absorb the nominal government debt D^{n}_{t+1}.

The third is foreign-currency bond-market clearing:

$$B^{*,\mathrm{n}}_{t+1} = H^{*,\mathrm{n}}_{t+1} + F^{*,\mathrm{n}}_{t+1}.$$

As in the main text, $B^{*,\mathrm{n}}_{t+1}$ is the domestic economy's nominal net foreign asset position in foreign-currency units, equal to foreign households' borrowing. This position is allocated between arbitrageurs, $H^{*,\mathrm{n}}_{t+1}$, and the central bank, $F^{*,\mathrm{n}}_{t+1}$. A positive $H^{*,\mathrm{n}}_{t+1}$ is a long foreign-bond position financed by a short home-bond position.

We define real positions in foreign consumption baskets by

$$B^*_{t+1} \equiv \frac{B^{*,\mathrm{n}}_{t+1}}{P^*_{t+1}}, \qquad H^*_{t+1} \equiv \frac{H^{*,\mathrm{n}}_{t+1}}{P^*_{t+1}}, \qquad F^*_{t+1} \equiv \frac{F^{*,\mathrm{n}}_{t+1}}{P^*_{t+1}},$$

with normalized deviations

$$b_{t+1}^* \equiv \frac{B_{t+1}^* - \bar{B}^*}{\bar{Y}}, \qquad h_{t+1}^* \equiv \frac{H_{t+1}^* - \bar{H}^*}{\bar{Y}}, \qquad f_{t+1}^* \equiv \frac{F_{t+1}^* - \bar{F}^*}{\bar{Y}}.$$

In home-consumption units, this real position is $\mathcal{Q}_{t+1} B_{t+1}^*$. Since $\bar{B}^* = 0$ and $\bar{\mathcal{Q}} = 1$, the normalized deviation is also b_{t+1}^*, the time-shifted counterpart of the left-hand side of (11). In the steady state considered here, $\bar{B}^* = \bar{H}^* = \bar{F}^* = 0$. Deflating foreign-currency clearing by P_{t+1}^* and normalizing by $\bar{Y}$ therefore gives

$$h_{t+1}^* = b_{t+1}^* - f_{t+1}^*. \tag{B.5}$$

The return entering the intermediaries' portfolio problem is the carry-trade excess return implied by the zero-capital position. Per unit of date-t home-currency funding, the home-consumption real payoff is

$$\mathcal{I}_t^* \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \frac{P_t}{P_{t+1}} - \mathcal{I}_t \frac{P_t}{P_{t+1}}.$$

For the log-linear system it is convenient to work with the corresponding log excess return,

$$x_{t+1} \equiv \log\left(\frac{\mathcal{I}_t^* \mathcal{E}_{t+1}}{\mathcal{I}_t \mathcal{E}_t}\right) = i_t^* - i_t + \Delta e_{t+1}.$$

Since $q_t = e_t + p_t^* - p_t$, $r_t = i_t - \mathbb{E}_t[\Delta p_{t+1}]$, and $r_t^* = i_t^* - \mathbb{E}_t[\Delta p_{t+1}^*]$, the expected log excess return is

$$\mathbb{E}_t[x_{t+1}] = r_t^* - r_t + \mathbb{E}_t[\Delta q_{t+1}].$$

Assume arbitrageurs have CARA utility over the one-period payoff. Their local mean-variance problem in the normalized position is

$$\max_{h_{t+1}^*} \left\{ h_{t+1}^* \mathbb{E}_t[x_{t+1}] - \frac{\phi}{2}(h_{t+1}^*)^2 \right\}.$$

The first-order condition is

$$\phi h_{t+1}^* = r_t^* - r_t + \mathbb{E}_t[\Delta q_{t+1}]. \tag{B.6}$$

Substituting (B.5) into (B.6) yields

$$r_t^* - r_t + \mathbb{E}_t[\Delta q_{t+1}] = \phi\big(b_{t+1}^* - f_{t+1}^*\big),$$

or, equivalently,

$$\mathbb{E}_t[\Delta q_{t+1}] = r_t - r_t^* + \phi\big(b_{t+1}^* - f_{t+1}^*\big),$$

which is (9). Official foreign-bond holdings reduce the foreign-currency risk left with arbitrageurs, while a larger residual position $b_{t+1}^* - f_{t+1}^*$ raises the expected excess return required to induce intermediation. When $\phi = 0$, the condition collapses to standard UIP.

No-Ponzi conditions. The consolidated government no-Ponzi condition, connected to the linearized government flow budget (10), is

$$\lim_{k\to\infty} \mathbb{E}_t \left[\frac{(D^{\mathrm{n}}_{t+k+1} - F^{\mathrm{n}}_{t+k+1})/P_{t+k+1}}{\prod_{\ell=0}^{k} R_{t+\ell+1}} - \frac{\mathcal{Q}_{t+k+1} F^*_{t+k+1}}{\prod_{\ell=0}^{k} \left(R^*_{t+\ell+1} \mathcal{Q}_{t+\ell+1}/\mathcal{Q}_{t+\ell} \right)} \right] = 0, \tag{B.7}$$

where $R_{s+1} \equiv \mathcal{I}_s/\Pi_{s+1}$, $R^*_{s+1} \equiv \mathcal{I}^*_s/\Pi^*_{s+1}$, $\Pi_{s+1} \equiv P_{s+1}/P_s$, and $\Pi^*_{s+1} \equiv P^*_{s+1}/P^*_s$.

The no-Ponzi restriction on the foreign net asset position, connected to the country flow budget (12), is

$$\lim_{k\to\infty} \mathbb{E}_t \left[\frac{\mathcal{Q}_{t+k+1} B^*_{t+k+1}}{\prod_{\ell=0}^{k} \left(R^*_{t+\ell+1} \mathcal{Q}_{t+\ell+1}/\mathcal{Q}_{t+\ell} \right)} \right] = 0. \tag{B.8}$$

Equations (B.7) and (B.8) are the terminal restrictions used below when iterating (10) and (12), respectively.

B.2 RANK-UIP

This section provides further details on the RANK-UIP special case, i.e., $\alpha = 0$ and $\phi = 0$. As in the main analysis, we continue to focus on the neutral-policy case, with $r_t = r^*_t = d_t = f^*_t = 0$. Along a perfect-foresight path in RANK-UIP, $\alpha = \phi = 0$, so (3) and (9) imply

$$\Delta c_{t+1} = 0, \qquad \Delta q_{t+1} = 0.$$

Thus $c_t = c$ and $q_t = q$ for some constants c and q. Iterating the country budget (12), using net exports from (14) as well as $b^*_0 = 0$, gives

$$\mathrm{NPV}(c^*_t) = \mathrm{NPV}\left(c_t - \vartheta q_t\right) = \frac{c - \vartheta q}{1-\beta},$$

and therefore

$$c - \vartheta q = (1-\beta)\,\mathrm{NPV}(c^*_t).$$

The RANK-UIP block alone pins down this composite, but not the split between consumption and the real exchange rate. To see how different terminal conditions select that split, write

$$\xi \equiv \sigma(1-\gamma)\vartheta + \varphi((1-\gamma)\vartheta + \gamma) + \gamma.$$

Using (7), (4), and the real marginal cost term in the NKPC (6), together with the fact that $c^*_t \to 0$ (from absolute summability), the limits of output and real marginal cost along this one-dimensional family are

$$\begin{aligned} \lim_{t\to\infty} y_t &= (1-\gamma)(1-\beta)\,\mathrm{NPV}(c^*_t) + \frac{(1-\gamma)\vartheta + \gamma}{1-\gamma} q, \\ \lim_{t\to\infty} mc_t &= \left[\sigma + (1-\gamma)\varphi\right](1-\beta)\,\mathrm{NPV}(c^*_t) + \frac{\xi}{1-\gamma} q. \end{aligned}$$

(6) together with the boundary condition $\pi_{H,t} \to 0$ selects one point in this one-dimensional family: limiting marginal cost must be zero. This particular limit delivers a foreign trade multiplier of

$$\varsigma_{\pi_H}^{RANK-UIP} = \frac{\gamma\left[1+\varphi+(1-\gamma)\vartheta\varphi\right]}{\xi}$$

which evidently differs from the limit as $\phi \to 0^+$ (and with $\alpha = 0$) in our main expression in Theorem 1. Importantly, and differently from our main analysis, different terminal conditions now however select different c, q splits. Notably, $c_t \to 0$ delivers a foreign trade multiplier of

$$\varsigma_c^{RANK-UIP} = 0,$$

$y_t \to 0$ delivers

$$\varsigma_y^{RANK-UIP} = \frac{\gamma\left[1+(1-\gamma)\vartheta\right]}{(1-\gamma)\vartheta+\gamma},$$

and $q_t \to 0$ delivers

$$\varsigma_q^{RANK-UIP} = 1.$$

This sensitivity to terminal conditions reflects RANK-UIP's lack of stationarity. Requiring, in the spirit of Lubik and Schorfheide (2004), continuity in ϕ as $\phi \to 0^+$ delivers the boundary selection of $c_t \to 0$.

B.3 TANK model

We present the model outline and key results on the prices-quantities split in TANK economies, supplementing the brief discussion in Footnote 21.

Model equations. Let a measure $\mu \in (0,1)$ of households be hand-to-mouth, denoted by H, and let the remaining measure $1-\mu$ be permanent-income savers, denoted by S. The hand-to-mouth households neither borrow nor save, so the two individual budget constraints are

$$\begin{aligned} C_{i,t}^H &= W_t L_{i,t}^H + \Pi_{i,t}^{\text{pr},H} - T_{i,t}^H + S_{i,t}^H, \\ \frac{A_{i,t+1}^{\text{n},S}}{\mathcal{I}_t} &= A_{i,t}^{\text{n},S} + P_t\left(W_t L_{i,t}^S + \Pi_{i,t}^{\text{pr},S} - T_{i,t}^S - C_{i,t}^S + S_{i,t}^S\right). \end{aligned}$$

As above, unions assign identical hours to both groups, profits and taxes are type independent up to steady-state transfers that equalize steady-state consumption, and only savers hold assets, so $a_t = (1-\mu)a_t^S = b_t^* + d_t$. Around the same zero-debt steady state as in the analytical model above, aggregate TANK demand, which replaces the OLG consumption function (2), is

$$c_t = \underbrace{\mu(gdp_t - t_t)}_{\text{hand-to-mouth}} + \underbrace{(1-\beta)\left(a_t + (1-\mu)\mathbb{E}_t\left[\sum_{k=0}^{\infty}\beta^k(gdp_{t+k} - t_{t+k})\right]\right) - \frac{\beta(1-\mu)}{\sigma}\mathbb{E}_t\left[\sum_{k=0}^{\infty}\beta^k r_{t+k}\right]}_{\text{savers}}. \tag{B.9}$$

This TANK aggregate demand implies the adjusted Euler equation

$$\mathbb{E}_t[\Delta c_{t+1}] = \mu\,\mathbb{E}_t[\Delta(gdp_{t+1} - t_{t+1})] + \frac{1-\mu}{\sigma} r_t. \tag{B.10}$$

Unlike the OLG block in (3), the TANK equation has no $-\alpha a_{t+1}$ term: permanent-income savers pin down the growth of their consumption as a function of only the real rate of interest, while the hand-to-mouth households add the static current income term. As we will see, the lack of the $-\alpha a_{t+1}$ term is why TANK-UIP inherits RANK-UIP's sensitivity to boundary conditions.

Main results. We consider the same neutral-policy experiment as in Theorem 1, and again working along perfect-foresight paths. Since $d_t = 0$, the government budget gives $t_t = 0$, and (B.10) reduces to

$$\Delta c_{t+1} = \mu \Delta gdp_{t+1}. \tag{B.11}$$

Now suppose first that $\phi > 0$. The boundedness requirement in Definition 1 rules out the explosive root of the (b_t^*, q_t) system. Since $c_t^* \to 0$, the selected bounded path has finite limits, and then (9) gives $b_{t+1}^* \to 0$. The country budget therefore gives $nx_t \to 0$, so $gdp_\infty = c_\infty$, while (14) and $c_t^* \to 0$ give $c_\infty = \vartheta q_\infty$. Taking limits in (6), and using (8) as well as (4), the terminal condition in Definition 1, $\pi_{H,t} \to 0$ translates to the requirement that

$$0 = \left((\sigma+\varphi)\vartheta + \frac{\gamma(1+\varphi)}{1-\gamma}\right) q_\infty,$$

and so $q_\infty = c_\infty = gdp_\infty = 0$. Putting this together with (B.11), we see that this implies $c_t - \mu gdp_t$ is constant over time, and that this constant is zero:

$$c_t = \mu gdp_t. \tag{B.12}$$

Using (8), (7), and (4), this condition becomes

$$c_t = \frac{\mu\gamma}{1-\mu(1-\gamma)}\left(c_t^* + \vartheta q_t\right), \tag{B.13}$$

where $\frac{\mu\gamma}{1-\mu(1-\gamma)} \in (0,1)$. In words, whenever the foreign demand impulse is not fully offset by the real exchange rate, hand-to-mouth households generate a contemporaneous movement in domestic consumption, differently from RANK. That said, in present value terms, TANK actually echoes the conclusions of RANK. To see this, combine (B.12) with $nx_t = gdp_t - c_t$ to get

$$nx_t = \frac{1-\mu}{\mu} c_t.$$

Iterating the country budget constraint and using the no-Ponzi condition then implies

$$0 = \text{NPV}(nx_t) = \frac{1-\mu}{\mu}\,\text{NPV}(c_t),$$

so, for $\mu \in (0,1)$,

$$\varsigma^{TANK} \equiv \frac{\text{NPV}(c_t)}{\text{NPV}(c_t^*)} = 0, \qquad \text{NPV}(q_t) = -\frac{1}{\vartheta}\,\text{NPV}(c_t^*). \tag{B.14}$$

Spenders therefore move quantities along the transition path, but the permanent-income savers make those movements wash out in present value.

The preceding conclusions remain true as $\phi \to 0^+$. At $\phi = 0$ exactly, UIP only implies that $q_t = q$ for some constant q, while (B.11) together with goods-market clearing gives $c_t = \frac{\mu\gamma}{1-\mu(1-\gamma)} c_t^* + c$ for some constant c. Intertemporal trade balance imposes only

$$c - \vartheta q = (1-\beta)\frac{1-\mu}{1-\mu(1-\gamma)}\,\text{NPV}(c_t^*), \tag{B.15}$$

leaving the split between c and q to be determined by a boundary condition. TANK-UIP therefore inherits the boundary-condition sensitivity of RANK-UIP, discussed in detail in Appendix B.2.

B.4 A two-economy model

For the analysis in this section we depart from the assumption of a small open economy, and instead consider a world economy consisting of two equally large economies — home and foreign. We assume that, in terms of economic primitives, those two economies are identical, unless otherwise indicated. As in our main analysis, we use stars to indicate variables corresponding to the foreign economy. Differently from the main analysis, however, we now cannot simply specify foreign outcomes as exogenous paths; instead, we will jointly determine domestic and foreign outcomes in response to a foreign shock. In keeping with the discussion in Section 3.4, the specific foreign shock example that we will consider is that of a foreign fiscal expansion; the analysis extends with essentially no change, however, to other shocks (e.g., to foreign consumer demand shocks in the form of Euler equation wedges).

Model equations. We denote the (symmetric) degree of openness in both economies by $\gamma \in (0, \frac{1}{2})$. The Euler equations at home and abroad are identical, and as in our main model. The real exchange rate and the terms of trade are now linked as

$$q_t = (1-2\gamma)s_t, \tag{B.16}$$

with foreign inflation linked to the terms of trade (and other outcomes) via

$$\pi_t^* = \pi_{F,t}^* - \gamma\Delta s_t \tag{B.17}$$

as well as

$$\pi_{F,t}^* = \kappa\big(\sigma c_t^* + \varphi y_t^* - \gamma s_t\big) + \beta\pi_{F,t+1}^*. \tag{B.18}$$

Using each country's demand for their own and the foreign good, output market-clearing for the home and foreign goods requires that

$$y_t = (1-\gamma)c_t + \gamma c_t^* + \frac{2(1-\gamma)\theta\gamma}{1-2\gamma} q_t, \tag{B.19}$$

$$y_t^* = (1-\gamma)c_t^* + \gamma c_t - \frac{2(1-\gamma)\theta\gamma}{1-2\gamma} q_t. \tag{B.20}$$

Our assumptions on international financial markets, and so the adjusted UIP condition, are unchanged. We will furthermore continue to assume that domestic policy is neutral; for foreign policy we will similarly assume that $r_t^* = 0$, but for foreign fiscal policy we obviously need to depart from neutrality, as we wish to consider fiscal shocks. Specifically, the foreign government budget constraint is

$$\beta d_{t+1}^* = d_t^* - t_t^* \tag{B.21}$$

and we assume that foreign taxes evolve according to the feedback rule

$$t_t^* = \tau_y^*(y_t^* + \gamma s_t) + \tau_d^* d_t^* - (1-\tau_d^*)\varepsilon_t^\tau. \tag{B.22}$$

here ε_t^τ is the exogenous fiscal shock, τ_d^* denotes the foreign speed of fiscal adjustment, and τ_y^* is automatic feedback from foreign output to foreign tax revenue, as in Angeletos, Lian, and Wolf (2024a), included for reasons that will become clear momentarily. This completes the sketch of the extended two-country model environment.

Main results. Note that net exports of the domestic economy in the two-country model are given as

$$nx_t = y_t - \gamma s_t - c_t = \gamma\Big(c_t^* - c_t + \underbrace{\frac{2(1-\gamma)\theta - 1}{1-2\gamma}}_{\tilde{\vartheta}} q_t\Big), \tag{B.23}$$

We impose the two-economy Marshall-Lerner condition $\tilde{\vartheta} > 0$. The domestic NFA evolves as

$$\beta(a_{t+1} - d_{t+1}) = (a_t - d_t) + nx_t.$$

Iterating on this expression exactly as in the proof of Lemma 2, we obtain that

$$\text{NPV}(c_t^*) = \text{NPV}(c_t) - \tilde{\vartheta}\,\text{NPV}(q_t). \tag{B.24}$$

That is, exactly as in our main model, foreign demand — which now of course is an endogenous equilibrium outcome — is accommodated in equilibrium through either prices or quantities.

Using the domestic Euler equation and the adjusted UIP relation, we obtain a relationship between consumption and the real exchange rate that allows us, just as in the proof of Theorem 1, to express the pass-through from $\text{NPV}(c_t^*)$ to $\text{NPV}(c_t)$ in terms of primitives:

$$\frac{\text{NPV}(c_t)}{\text{NPV}(c_t^*)} = \frac{\alpha}{\alpha + \tilde{\vartheta}\phi}. \tag{B.25}$$

We thus see that our main result on the prices-quantities split also extends with essentially no change, just now — as stated above — involving an endogenous object, $\text{NPV}(c_t^*)$. Finally, our assumptions on the foreign shock, and in particular the foreign fiscal rule, allow us to straightforwardly characterize that endogenous object in terms of primitives when $\tau_d^* = 0$ and foreign government debt is initially zero, $d_0^* = 0$: in that case we have, echoing the closed-economy "self-financing" results of Angeletos, Lian, and Wolf (2024a),

$$\text{NPV}(c_t^*) = \frac{\text{NPV}(\varepsilon_t^\tau)}{\tau_y^*}.$$

Intuitively, as the foreign fiscal shock is not financed through endogenous tax hikes, financing instead occurs through endogenous equilibrium feedback to the tax base.[33] This discussion reveals how closed-economy self-financing results for fiscal stimulus can extend to open-economy settings.

B.5 Non-tradables

We consider a version of a New Keynesian SOE model with tradables and non-tradables.

Model equations. The domestic economy has an exogenous endowment of tradables $y_{T,t}$, and there is endogenous production of non-tradables $y_{N,t}$ under sticky prices (as, e.g., in Farhi and Werning 2017). We allow the country to export one tradable good (e.g., a commodity) and import another one (e.g., manufacturing goods), with foreign prices p_t^{e*} and p_t^{i*} determined at the global level and taken as given by a small open economy. The home consumption bundle is the usual CES aggregator of non-tradables and imported tradables, with relative weights $1-\gamma$ and γ, and exported tradables account for measure zero of foreign consumption. It follows that the terms of trade $s_t \equiv p_t^{i*} - p_t^{e*}$ are exogenous as well, and the real exchange rate is given by

$$q_t \equiv e_t + p_t^{i*} - p_t = (1-\gamma)\big(e_t + p_t^{i*} - p_{N,t}\big),$$

where e_t is the nominal exchange rate. We will assume the same structure of asset markets as before, with foreign-currency bonds as the only internationally traded asset and zero steady-state cross-border positions. Along the perfect-foresight path, define real rates as $r_t \equiv i_t - \Delta p_{t+1}$ and $r_t^* \equiv i_t^* - \Delta p_{t+1}^{i*}$. The aggregate Euler equation (3) and the modified UIP condition (9) are then the same as in the perfect-foresight version of the baseline model. From household optimal demand and market clearing, we get

$$c_{N,t} = y_{N,t} = c_t + \frac{\gamma}{1-\gamma}\theta q_t \qquad \text{and} \qquad c_{T,t} = c_t - \theta q_t,$$

[33] Note that here all financing occurs through tax base expansion. The analogous expressions for financing that instead occurs through prices were provided in the main text discussion for foreign fiscal shocks, see Section 3.4.

and the country budget constraint can be written as

$$\beta b_{t+1}^* = b_t^* + \gamma\Big[\theta q_t - c_t + (y_{T,t} - s_t)\Big]. \tag{B.26}$$

From the labor supply condition and a linear production function, it follows that

$$w_t - p_{N,t} = \sigma c_t + \varphi l_t + p_t - p_{N,t} = \sigma c_t + \varphi y_{N,t} + \frac{\gamma}{1-\gamma} q_t$$

and hence the NKPC in the non-tradable sector is largely isomorphic to the baseline supply curve (6):

$$\pi_{N,t} = \kappa \left[\sigma c_t + \varphi y_{N,t} + \frac{\gamma}{1-\gamma} q_t\right] + \beta \pi_{N,t+1}. \tag{B.27}$$

This completes the characterization of the equilibrium system.

Main results. Keeping monetary and fiscal policy fixed, the equilibrium dynamics of q_t and c_t are determined by the system (3), (9) and (B.26), which is isomorphic to the one in the baseline model once the foreign demand shock is defined as $c_t^* \equiv y_{T,t} - s_t$ and $\vartheta = \theta$. Foreign demand shocks in this extended model variant thus include changes in energy prices, foreign tariffs, and sanctions: an increase in export prices p_t^{e*} corresponds to $c_t^* > 0$ and an increase in import prices p_t^{i*} results in $c_t^* < 0$. It follows that our main results about the foreign trade multiplier extend to the present setup with tradable and non-tradable goods. The NKPC (B.27) also implies domestic inflation if aggregate consumption absorbs most of the shock, and domestic deflation if the real exchange rate appreciates, again as in our main exercise.

B.6 Effects of r^*

In our environment, foreign monetary policy affects the domestic economy through two channels: the foreign real interest rate r_t^*, and the associated foreign aggregate demand path c_t^*. The analysis in Section 3 fully characterized the effects of the aggregate demand path c_t^*, so here we will begin by first studying the effects of r_t^* in isolation, before then tying the two together.

r^* in isolation. Consider an arbitrary absolutely summable path of foreign real rates r_t^* and define

$$\mathcal{R}_t^* \equiv \sum_{j=0}^{\infty} r_{t+j}^*.$$

Proceeding as in our main analysis, we can iterate forward the domestic Euler equation and adjusted UIP condition to arrive at

$$\phi c_t + \alpha q_t = \alpha \mathcal{R}_t^*.$$

Taking net present values and using the intertemporal trade-balance relation (16) with our temporarily maintained assumption of $c_t^* = 0$ for all t, we get

$$\phi \,\mathrm{NPV}(c_t) + \alpha \,\mathrm{NPV}(q_t) = \alpha \,\mathrm{NPV}(\mathcal{R}_t^*), \qquad 0 = \mathrm{NPV}(c_t) - \vartheta \,\mathrm{NPV}(q_t).$$

Solving this system gives the effects of an arbitrary foreign real rate path in isolation:

$$\mathrm{NPV}(c_t) = \frac{\alpha\vartheta}{\alpha + \vartheta\phi} \mathrm{NPV}(\mathcal{R}_t^*), \qquad \mathrm{NPV}(q_t) = \frac{\alpha}{\alpha + \vartheta\phi} \mathrm{NPV}(\mathcal{R}_t^*).$$

As before it is instructive to consider two limiting cases. First, in RANK $\alpha = 0$, $\phi > 0$, the system is stationary, and the Euler equation implies that $c_t = 0$ in all periods. Combining this with the preceding equation gives

$$\mathrm{NPV}(c_t) = 0, \qquad \mathrm{NPV}(q_t) = 0.$$

Thus, foreign real interest rate paths in isolation have no net present value effect on home consumption. Second, in HANK-UIP $\alpha > 0$, $\phi = 0$, the UIP condition implies $q_t = \mathcal{R}_t^*$, and hence

$$\mathrm{NPV}(c_t) = \vartheta \,\mathrm{NPV}(\mathcal{R}_t^*), \qquad \mathrm{NPV}(q_t) = \mathrm{NPV}(\mathcal{R}_t^*).$$

Here the expenditure-switching channel through a home real appreciation means that a foreign monetary easing, directly through the lower real rate path, contracts the domestic economy.

Tying c_t^* to r_t^*. To tie the foreign real rate path to equilibrium foreign consumption, we need to specify primitives of the foreign economy; we will simply assume that all the economic primitives are identical to our benchmark domestic economy, and so the foreign economy is the closed-economy analogue of that domestic economy. If the foreign monetary policy is combined with "neutral" foreign fiscal policy (i.e., $d_t^* = 0$), then the effect of the foreign interest rate policy on foreign consumption is summarized by the following standard Euler equation:

$$\Delta c_{t+1}^* = \frac{1}{\sigma} r_t^*.$$

The same stability and terminal-selection argument as in the baseline model then implies that

$$c_t^* = -\frac{1}{\sigma}\mathcal{R}_t^*, \qquad \mathrm{NPV}(c_t^*) = -\frac{1}{\sigma}\mathrm{NPV}(\mathcal{R}_t^*).$$

Putting these expressions together with our main analysis in Section 3 as well as the preceding analysis on r_t^*, we obtain that

$$\mathrm{NPV}(c_t) = \frac{\alpha\left(\vartheta - \frac{1}{\sigma}\right)}{\alpha + \vartheta\phi} \mathrm{NPV}(\mathcal{R}_t^*), \qquad \mathrm{NPV}(q_t) = \frac{\alpha + \frac{\phi}{\sigma}}{\alpha + \vartheta\phi} \mathrm{NPV}(\mathcal{R}_t^*).$$

In RANK, we just as before see complete insulation of the domestic economy, with all of the adjustment occurring through prices. In HANK-UIP, on the other hand, there are now two offsetting effects, and so the combined effect on domestic consumption is ambiguous. Although the foreign demand channel raises home consumption when foreign monetary policy stimulates foreign demand, the expenditure-switching channel works in the opposite direction through a home real appreciation, as discussed above. In the Cole-Obstfeld case, $\vartheta = \frac{1}{\sigma}$, these two effects exactly offset each other and $\mathrm{NPV}(c_t) = 0$; and if the expenditure-switching mechanism is weak, $\vartheta < \frac{1}{\sigma}$, then a foreign monetary easing with $\mathrm{NPV}(\mathcal{R}_t^*) < 0$ raises home consumption in net present value terms. Intuitively, elevated MPCs amplify both channels through which foreign monetary policy affects domestic household income: higher c_t^* raises export revenues, while an appreciation of q_t lowers them. Either way, however, the "race" between the two frictions emphasized in our headline analysis operates throughout.

B.7 Dollar currency pricing

Under DCP, both import and export prices are set in the foreign currency, the law of one price does not hold for home goods, and now there are two NKPCs — for local and foreign markets.[34] This breaks the one-to-one mapping (4) between the real exchange rate and the terms of trade, but leaves unchanged equilibrium conditions that use only definitions of s_t and q_t.

Model equations. To derive the NKPCs, consider the inverse markups in the domestic and export sectors and express them using the labor supply condition and the definitions of the price indices:

$$\begin{aligned} w_t^{\text{nom}} - p_{H,t} &= \sigma c_t + \varphi y_t + p_t - p_{H,t} = \sigma c_t + \varphi y_t + p_t - \frac{p_t - \gamma(e_t + p_t^*)}{1-\gamma} = \sigma c_t + \varphi y_t + \frac{\gamma}{1-\gamma} q_t, \\ w_t^{\text{nom}} - e_t - p_{H,t}^* &= \sigma c_t + \varphi y_t + p_t - e_t - p_t^* + p_t^* - p_{H,t}^* = \sigma c_t + \varphi y_t - q_t + s_t, \end{aligned}$$

where the nominal wage and the nominal exchange rate are given by $w_t^{\text{nom}} \equiv w_t + p_t$ and $e_t \equiv p_t + q_t - p_t^*$, respectively. It follows that the home NKPC remains unchanged and is still described by equation (6). In contrast, the export NKPC is

$$\pi_{H,t}^* = \kappa\left(\sigma c_t + \varphi y_t - q_t + s_t\right) + \beta \pi_{H,t+1}^*.$$

Combining this equation with the foreign NKPC (15) gives the law of motion for the terms of trade:

$$\Delta s_t = \kappa\Big[(\sigma + \varphi) c_t^* - \sigma c_t - \varphi y_t + q_t - s_t\Big] + \beta \Delta s_{t+1}. \tag{B.28}$$

In sum, the equilibrium system (3)-(15) remains unchanged except for equation (4) being replaced by the additional NKPC (B.28), and with net exports given by the primitive expression (13) rather than the PCP-reduced expression (14).

[34]This section considers a classical interpretation of DCP in the spirit of Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020). If dollar-invoiced goods have flexible prices and wages are sticky, we get closer to the baseline model and to the model with tradable and non-tradable goods (in which our results hold unchanged, see Appendix B.5 and McLeay and Tenreyro 2026).

Main results. Replacing PCP with DCP can change the pass-through of foreign shocks into domestic consumption. Even if the real exchange rate is constant, the nominal exchange rate moves whenever domestic inflation differs from foreign inflation. This affects exporter markups, induces firms to adjust foreign-currency prices, and eventually moves the terms of trade. That said, there are good reasons to expect this effect on the multiplier to be small and positive. In particular, the terms-of-trade term drops out of net exports when the demand elasticity is one, $\theta = 1$. In this case, the Euler equation (3), modified UIP condition (9), and country budget constraint (12) determine the dynamics of c_t and q_t independently of the currency of invoicing. Our main results about the race between the two frictions in Theorem 1 therefore extend exactly to the DCP case when $\theta = 1$ and approximately when $\theta \approx 1$.[35] When $\theta > 1$, DCP effectively reduces the trade elasticity by dampening expenditure switching in export markets. A lower ϑ then increases the pass-through of foreign demand shocks into local consumption, ς, according to Theorem 1, in line with our simulations in Figure 5.

[35]The same argument also applies to other pricing protocols, including local currency pricing (LCP).

C Supplementary details for the quantitative analysis

We here give further details for our quantitative analysis in Section 5; specifically, we first discuss the model calibration, and then sketch the quantitative HANK-type model.

C.1 Calibration of MPCs and ϕ

In light of our theory, the two most important sets of parameters for our quantitative model are those governing intertemporal MPCs as well as the deviation from UIP. Figure C.1 illustrates our calibration strategy for both.

iMPCs. To pin down the deviation from Ricardian equivalence, we ensure that the aggregate consumption function of our quantitative two-type model features intertemporal MPCs following one-off income gains consistent with the empirical evidence. In the left panel of Figure C.1, the gray area gives our empirical target: 95 per cent confidence intervals for the average household spending response to a one-off lump-sum income gain, as taken from Fagereng, Holm, and Natvik (2021). The black line then shows the model-implied analogue; as claimed in the main text, the two-type model provides a close fit to the empirical targets.

Financial frictions. For the severity of financial frictions ϕ, we follow Itskhoki and Mukhin (2021) and subject our quantitative model to a persistent financial shock, i.e., a persistent wedge ψ_t to the adjusted UIP condition,

$$\mathbb{E}_t[\Delta q_{t+1}] = r_t - r_t^* + \phi\big(b_{t+1}^* - f_{t+1}^*\big) + \psi_t,$$

where ψ_t follows an AR(1) process with persistence 0.97. As in our main exercise we close the model with neutral domestic policy (including in particular monetary policy), and then compute the autocorrelation of the induced real exchange rate process as a function of ϕ. The right panel of Figure C.1 shows the corresponding real exchange rate half-life as a function of ϕ, with the target of five years reached for $\phi = 0.00123$.

For some further supplementary evidence, we also subject the model to an FXI shock f_t^* following the stochastic process

$$f_t^* - f_{t-1}^* = 0.0467\left[f_{t-1}^* - f_{t-2}^*\right] + e_t^f,$$

where e_t^f denotes the FXI shock, and the assumed form of the process follows Beltran and He (2025). Those authors estimate that an FXI shock equal to one per cent of annualized GDP moves exchange rates by 10-30 per cent; in our model, even the upper end of that range requires setting ϕ to an even smaller value than our headline number, with $\phi = 0.0003$. The alternative high-friction coefficient considered in Figure 5 would thus materially overstate that exchange rate response.

C.2 HANK model

This section provides a sketch of the quantitative HANK model that we use for Figure 5. The discussion will be brief because the household block of the model is essentially borrowed from Wolf (2025) and

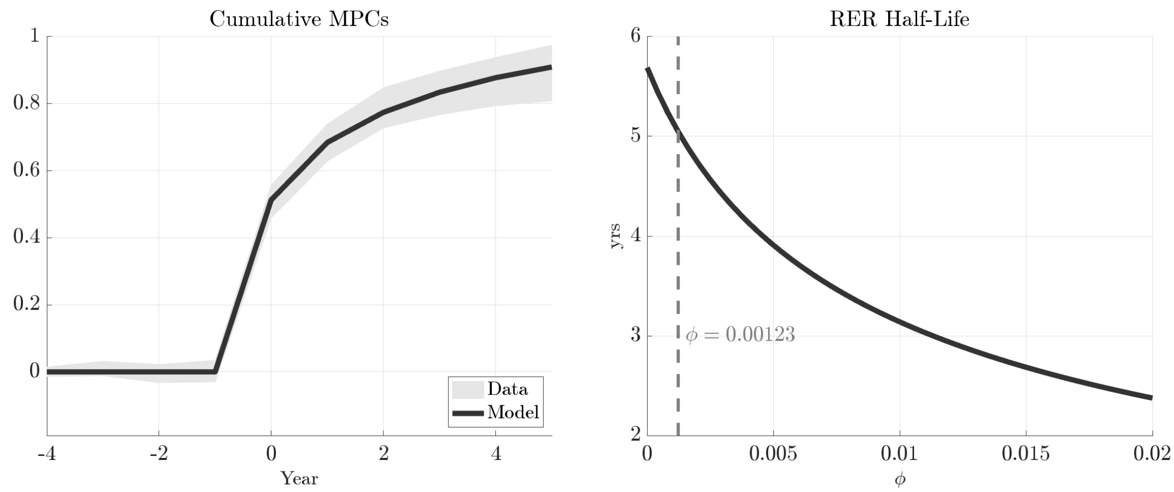

Figure C.1: Left panel: cumulative MPCs in the baseline quantitative model (black) and in the data (gray), with the data targets taken from Figure 2 in Fagereng, Holm, and Natvik (2021), corresponding to 95 per cent confidence intervals. Right panel: real exchange rate half-life following a persistent financial shock, as a function of ϕ.

Angeletos, Lian, and Wolf (2024a).

The model economy is exactly identical to the baseline quantitative model of Section 5, but with one twist: the two-type OLG household block is replaced by a unit continuum of households $i \in [0, 1]$ that face uninsurable income risk. Households have preferences

$$\mathbb{E}_t \left[\sum_{k=0}^{\infty} \beta^k \left(\frac{C_{i,t+k}^{1-\sigma} - 1}{1-\sigma} - \frac{L_{i,t+k}^{1+\varphi}}{1+\varphi} \right) \right].$$

They save and borrow (subject to a constraint) in a nominally risk-free bond, receive labor and dividend income in proportion to their (stochastic) productivity, pay a proportional tax τ_y on that income, and finally pay additional lump-sum uniform taxes $\tilde{T}_t$. We can thus write the household budget constraint in real terms as

$$C_{i,t} + D_{i,t+1} = (1-\tau_y) e_{i,t} GDP_t - \tilde{T}_t + \frac{I_{t-1}}{\Pi_t} D_{i,t}, \quad D_{i,t+1} \geq \underline{D},$$

where $\underline{D}$ is the household borrowing constraint. Whenever possible we set parameters as in our baseline model, with some notable exceptions to be discussed next. The remaining HANK-specific parameters are: the income risk process; the borrowing constraint; and the discount factor and steady-state interest rate. The income risk process is taken from Kaplan, Moll, and Violante (2018), ported to discrete time as in Wolf (2025). The borrowing constraint $\underline{D}$ is set to zero, and the discount factor β is backed out residually to clear the asset market, with an annual real rate of one per cent. For the fiscal tax-and-transfer system, we set steady-state debt (and so household wealth) slightly larger than in our baseline analysis, to $\bar{D}/\bar{Y} = 2$; we furthermore assume that there is a steady-state baseline transfer (i.e., $\bar{\tilde{T}} < 0$) of 5 per cent of GDP, and residually recover τ_y from the government budget. This fiscal tax-and-transfer set-up helps us align MPCs in the HANK model with our baseline analysis.