Decomposing Persistent Trade Imbalances *

David D. Shin

University of Tennessee, Knoxville

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Abstract

This paper develops a quantitative dynamic general equilibrium model to study the drivers of persistent trade imbalances across major advanced and emerging economies from 2000 to 2014. The decomposition analysis shows that persistent trade imbalances reflect different domestic forces across countries: weaker bequest motives in the United States and Mexico, higher public spending in the United Kingdom, and faster productivity growth together with life-cycle investment needs in India. Persistent surpluses in China, Germany, and the Republic of Korea are driven by stronger bequest motives, longer life expectancy, and life-cycle income and investment profiles that support higher saving. A counterfactual analysis shows that China's accession to the World Trade Organization increased China's trade balance by 0.552 percentage points of GDP on average and lowered the U.S. trade balance by 0.054 percentage points.

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*David D. Shin: Department of Economics, University of Tennessee, Knoxville, TN 37919, U.S.A.; dshin5@utk.edu. This paper was previously titled "Understanding Trade Imbalances." I am very grateful to my dissertation advisors, Rafael Dix-Carneiro, Daniel Xu, Laura Castillo-Martinez, and Andrea Lanteri, for their invaluable guidance. I thank Ricardo Reyes-Heroles, Matthias Kehrig, Cosmin Ilut, David Berger, Gregor Jarosch, Chiara Maggi, Alexandre Sollaci, Martin Stuermer, Petia Topalova, Jaewoo Lee, JaeBin Ahn, Ting Lan, Armen Khederlarian, Kerem Cosar, and James Lake for their helpful comments.

1 Introduction

Persistent trade imbalances have been a defining feature of the global economy. In advanced economies, the United States has run persistent deficits since 1976, while Germany has maintained surpluses since 2000. Among emerging economies, China has consistently run surpluses since 1994, whereas India has experienced persistent deficits over the same period.

Given the prevalence of persistent trade imbalances, understanding their drivers is crucial. Without knowing whether imbalances are driven by frictions or by economic fundamentals, policy interventions risk exacerbating distortions rather than improving efficiency and welfare.[1] From a national income accounting perspective, the trade balance equals the difference between national saving and investment. Persistent imbalances therefore arise when saving and investment evolve differently across economies over time.

This paper develops a unified quantitative dynamic general equilibrium framework of the global economy to evaluate how a wide range of economic forces contribute to persistent trade imbalances. The model incorporates demographic factors such as life expectancy and population growth; life-cycle patterns in labor income, investment, and bequest motives; institutional and policy factors such as financial intermediation costs, government spending, public debt, and international trade costs; and macroeconomic forces such as productivity growth and intertemporal distortions.[2] Together, these factors shape saving and borrowing behavior across economies and account for the persistent differences in trade balances observed in the data.

In the model, aggregate saving in each economy depends on public saving by the government and private saving by households. Household saving, in turn, is shaped by paths of income, prices, interest rates, and demographic factors.

First, changes in productivity and in export and import costs affect households'

[1]For instance, policies aimed at reducing deficits driven by distortions may help prevent unsustainable borrowing that raises foreign liabilities and financial instability (Obstfeld, 2012). By contrast, when deficits reflect economic fundamentals, such policies can distort investment and innovation.

[2]Intertemporal distortions capture residual forces influencing saving behavior that account for trade imbalances unexplained by other modeled mechanisms. The term "distortions" is not meant to imply inherently welfare-reducing inefficiencies, though such interpretations may arise. This paper focuses on positive rather than normative analysis, and the welfare implications of intertemporal distortions lie beyond its scope.

real income and purchasing power, generating saving behavior driven by consumption-smoothing motives. Second, differences in investment demand across age groups create variation in saving incentives, as cohorts with greater investment needs borrow to finance capital accumulation. Third, government expenditures influence household saving through taxation, since higher spending financed by taxes reduces disposable income. Fourth, changes in financial intermediation costs alter incentives to save and borrow by changing the relative cost of borrowing. Finally, life expectancy, life-cycle income profiles, and voluntary bequest motives shape saving behavior by influencing how cohorts value future consumption over the life cycle.

Aggregate private saving in an economy reflects the combined choices of cohorts of different sizes and at different stages of the life cycle. The size of the cohort entering the labor market varies over time within each economy. Young households, with upward-sloping income paths and stronger investment motives, tend to borrow to smooth consumption and finance investment, while middle-aged households increase saving for retirement and voluntary bequests, partially offsetting the borrowing of younger generations. The composition of the economy, therefore, influences aggregate saving, expenditure, and trade imbalances.

I calibrate the model using a combination of micro- and macro-level data to represent a world economy comprising eight economies that exhibited persistent trade imbalances between 2000 and 2014: the United States, China, Germany, the United Kingdom, the Republic of Korea, Mexico, India, and the Rest-of-World (ROW) aggregate.[3] Using these datasets, I recover changes in productivity and trade costs using the hat-algebra approach developed in Dekle et al. (2007), and construct financial intermediation costs, demographic objects, fiscal intensities, labor income, and investment profiles, and voluntary bequest motives directly from the data. These objects are treated as exogenous throughout the analysis and are not targeted to match trade imbalances.

Finally, I infer economy-specific intertemporal distortions as residual wedges so that the model exactly matches the observed evolution of trade imbalances in each year.

[3]Data sources include, but are not limited to, the World Input–Output Database (WIOD), the UN World Population Prospects (WPP), the Luxembourg Income Study (LIS), and household-level balance sheet datasets such as the Luxembourg Wealth Study (LWS) and the National Survey of Tax and Benefit (NaSTaB) for the Republic of Korea.

These wedges absorb components of saving behavior not captured by the model's other mechanisms and ensure that the model replicates trade imbalances across all economies over the 2000–2014 period.

Through the lens of the calibrated model, I quantify how economy-specific factors shape trade imbalances. For each of the 96 economy-specific factors considered in the analysis, I conduct a ceteris paribus counterfactual experiment in which the factor for a given economy is replaced by its global average. I then compute the resulting average change in each economy's trade balance, expressed as a share of GDP, over the 2000–2014 period, reflecting the effect of removing economy-specific variation in that factor. This measure indicates whether a factor is surplus- or deficit-inducing and allows direct comparison of its quantitative importance across factors.

The results show that persistent trade imbalances are driven by multiple, primarily domestic forces rather than a single dominant factor. Among deficit-running economies, including the United States, the United Kingdom, Mexico, and India, the dominant deficit-inducing forces differ across countries: weaker bequest motives play a central role in the United States and Mexico, public spending is quantitatively important in the United Kingdom, and faster productivity growth, together with life-cycle investment needs, are the main drivers in India. Lower financial intermediation costs in advanced economies and faster productivity growth in emerging economies further contribute to deficits, but their quantitative importance varies by country.

Among surplus-running economies, stronger bequest motives, longer life expectancy, and life-cycle income and investment profiles that support higher saving contribute to persistent trade surpluses in China, Germany, and the Republic of Korea. Overall, the results highlight that cross-country heterogeneity in life-cycle saving behavior plays a central role in shaping the level and persistence of trade imbalances.

I then evaluate the role of international trade through a counterfactual experiment that removes the China shock, defined as China's accession to the World Trade Organization (WTO) in 2001 and the associated decline in bilateral trade costs. I find that the China shock is surplus-inducing for China, raising China's trade balance by 0.552 percentage points of GDP on average over 2000–2014, while it is deficit-inducing for the United States, lowering the U.S. trade balance by 0.054 percentage points.

Importantly, declines in trade partners' costs of importing from China since 2000 raise the trade balances of both China and the United States, implying that lower import costs from China are surplus-inducing for both economies in general equilibrium. This result illustrates that trade-cost shocks can generate simultaneous deficit or surplus pressures across multiple economies in a multi-economy framework.

Related Literature This paper contributes to the literature on global imbalances by developing a unified quantitative framework that isolates the distinct roles of demographic and life-cycle forces, trade costs, financial frictions, productivity growth, and fiscal policy as drivers of trade imbalances in a dynamic multi-economy general equilibrium setting.

This paper relates to studies that emphasize demographic forces as drivers of global imbalances (Ferrero, 2010; Backus et al., 2014; Sposi, 2021; Auclert et al., 2021; Bárány et al., 2023). I extend this literature by allowing for cross-economy heterogeneity in age-specific labor income profiles, age-specific investment behavior, and voluntary bequest motives. I document substantial cross-country heterogeneity in life-cycle behavior by combining micro-level datasets from multiple sources. Using individual-level income data from the Luxembourg Income Study (LIS) and household-level balance sheet data from the Luxembourg Wealth Study (LWS) covering multiple countries, I show that cross-country differences in life-cycle profiles have quantitatively important implications for trade imbalances.

This paper also contributes to a growing literature linking international trade and trade imbalances (Dekle et al., 2007; Alessandria and Choi, 2021; Dix-Carneiro et al., 2023; Dix-Carneiro and Traiberman, 2023; Cuñat and Zymek, 2024; Mac Mullen and Woo, 2025). Within this literature, Reyes-Heroles (2016) and Alessandria et al. (2024) show that changes in trade costs contributed to the rising dispersion of global imbalances by facilitating intertemporal trade and consumption smoothing. This paper complements this literature by studying the level and persistence of trade imbalances across multiple economies within a unified dynamic general equilibrium framework, and by quantitatively comparing the role of trade costs with other structural forces. A key implication of the multi-economy structure is that trade imbalances cannot be inferred bilaterally: in the presence of bilateral trade costs, a surplus-inducing force in one economy can also be surplus-inducing in other economies.[4]

Another strand of literature argues that financial frictions can raise saving in fast-growing but financially underdeveloped economies by limiting domestic asset storage (Caballero et al., 2008), restricting household and firm borrowing (Song et al., 2011; Coeurdacier et al., 2015; Wang et al., 2017), or impeding insurance against idiosyncratic risks (Mendoza et al., 2009; Angeletos and Panousi, 2011; Coeurdacier et al., 2015). However, most existing models rely on two-country frameworks, which limit their ability to explain why some financially advanced economies, such as Germany, persistently run trade surpluses, while some emerging economies, such as India, sustain persistent trade deficits. I complement this literature by showing that financial frictions matter for persistent trade imbalances, but that their quantitative relevance is concentrated in a subset of advanced economies with low financial intermediation costs, such as the United States, where easier access to external finance facilitates capital inflows and sustains trade deficits.

Lastly, this paper relates to a large body of international macroeconomics literature studying the drivers of current account imbalances, including trade imbalances (Sheffrin and Woo, 1990; Ghosh and Ostry, 1995; Bergin and Sheffrin, 2000; Chinn and Prasad, 2003; Blanchard et al., 2005; Bergin, 2006; Engel and Rogers, 2006; Itskhoki and Mukhin, 2021; Chinn and Ito, 2022; Coutinho et al., 2022). It is closely related to Boer et al. (2025), who emphasize relative demand shocks that alter domestic demand for foreign goods and foreign demand for domestic goods as key drivers of current account dynamics at business cycle frequencies. This paper complements that work by providing microfoundations for relative demand forces operating through income, saving, and investment, and by showing that these forces also shape the level and persistence of trade imbalances across countries.

To keep the analysis tractable, this paper does not explicitly model other potentially important sources of global imbalances, such as cross-country differences in pension systems (Eugeni, 2015; Niemeläinen, 2021), incentives to accumulate foreign reserves (Bacchetta et al., 2013; Alfaro et al., 2014; Benigno et al., 2022), precautionary saving arising from uncertainty (Mendoza et al., 2009; Angeletos and Panousi, 2011; Choi et al., 2017),

[4]For example, the model implies that the import-cost channel of the China shock is surplus-inducing for both China and the United States, in contrast to the predictions of two-country frameworks.

and investment motives unrelated to life-cycle patterns (Anderson et al., 2019; Ravikumar et al., 2019). Nonetheless, these channels are indirectly captured by the intertemporal distortions, which represent the portion of trade imbalances unexplained by the model's structural components. Hence, the relative importance of these omitted factors can be inferred from the estimated contribution of intertemporal distortions.[5]

The paper is structured as follows. Section 2 presents the quantitative dynamic general equilibrium model. Section 3 describes the data sources and calibration procedure. Section 4 conducts quantitative exercises that evaluate how different factors affect trade imbalances. Finally, Section 5 concludes and discusses directions for future work.

2 Model

The model builds on existing quantitative frameworks of international trade and global imbalances. The production and international trade block closely follows Caliendo and Parro (2015). Following Bárány et al. (2023), I incorporate financial frictions, demographic changes, and life expectancy captured by survival probabilities. Relative to their framework, I extend the model to include multiple sectors, asymmetric changes in trade costs across economies, and differences in voluntary bequest motives, life-cycle wage and investment profiles, and government expenditures and debt across economies. Moreover, I capture financial frictions as time-varying borrowing costs instead of credit constraints.[6]

The model features a world economy comprising N economies indexed by $n \in \mathcal{N}$. Within each economy, there are I sectors indexed by $i \in \mathcal{I}$. Time is discrete and is indexed by $t \in \{0, 1, ...\} \equiv \mathcal{T}$. Within each economy, households are classified by age, indexed by $j \in \{0, ..., J\} \equiv \mathcal{J}$. The number of households in economy n at time t and of age j is denoted by $L_{n,j,t}$, while the total population of economy n at time t is given by $L_{n,t} = \sum_{j=0}^{J} L_{n,j,t}$. Labor and capital are fully mobile within an economy but not across economies. There is no aggregate uncertainty, and as a result, all agents possess perfect

[5]Exogenous country-specific intertemporal distortions are widely used in the literature to exactly match the evolution of trade imbalances; see, for example, Stockman and Tesar (1995), Eaton et al. (2016), Reyes-Heroles (2016), Kehoe et al. (2018), and Dix-Carneiro et al. (2023).

[6]Credit constraints impose hard borrowing limits, whereas borrowing costs map more directly to empirical counterparts such as interest rate spreads. They also offer computational convenience. Frictions not captured by spreads are absorbed into intertemporal distortions, defined as residuals at the economy level.

foresight over aggregate variables.

2.1 National Income Identity, Saving, and the Trade Balance

To fix ideas, consider the accounting identities linking output, saving, and the trade balance. Let $GDP_{n,t}$ denote gross domestic product, and let $X^C_{n,t}$, $X^I_{n,t}$, and $X^G_{n,t}$ denote aggregate expenditures on final consumption, investment, and government goods. The trade balance (net exports) is denoted by $TB_{n,t}$. The national income identity is

$$GDP_{n,t} = X^C_{n,t} + X^I_{n,t} + X^G_{n,t} + TB_{n,t}. \tag{1}$$

Define aggregate national saving as $S_{n,t} \equiv GDP_{n,t} - X^C_{n,t} - X^G_{n,t}$. Aggregate saving can be decomposed into private saving, $S^C_{n,t}$, and public saving, $S^G_{n,t}$, so that $S_{n,t} = S^C_{n,t} + S^G_{n,t}$. Substituting into Equation (1) yields

$$\left(S^C_{n,t} - X^I_{n,t}\right) + S^G_{n,t} = TB_{n,t}, \tag{2}$$

which shows that the trade balance equals private net lending, $(S^C_{n,t} - X^I_{n,t})$, plus public saving, $S^G_{n,t}$.

Equation (2) provides the organizing accounting framework for the model. Any factor that affects households' current consumption relative to income shifts private saving $S^C_{n,t}$ and thereby the trade balance, including demographics, preferences, financial frictions, and equilibrium changes in income and prices induced by technology and trade costs. For given income, higher investment $X^I_{n,t}$ lowers $TB_{n,t}$ unless it is offset by higher private or public saving. Fiscal policy affects the trade balance through public saving $S^G_{n,t}$, both via government expenditure $X^G_{n,t}$ and through policies that alter the path of government debt.

2.2 Final Goods

In each economy, households and the government purchase economy-level bundles of goods and services, referred to as final goods. A final good is a bundle of sector-level bundles $\{Y^i_{n,t}\}$, hereafter called sectoral goods. There are three types of final goods: a final consumption good $Y^C_{n,t}$, a final investment good $Y^I_{n,t}$, and a final government good $Y^G_{n,t}$.

This distinction captures differences in the composition of consumption (C), investment (I), and government (G) expenditure baskets within an economy, as well as variation in these compositions across economies.

For each $f \in \{C, I, G\}$, the final good is a Cobb–Douglas aggregate of sectoral goods:

$$Y^f_{n,t} = \prod_{i \in \mathcal{I}} \left(Y^i_{n,t}\right)^{\alpha^{i,f}_n}, \tag{3}$$

where $\alpha^{i,f}_n$ is the expenditure share on sector i in economy n for use f, with $\sum_{i \in \mathcal{I}} \alpha^{i,f}_n = 1$. Equation (3) shows that expenditure shares vary across uses and economies. Given the sectoral prices $\{P^i_{n,t}\}$, the corresponding price index for use f is $P^f_{n,t} = \prod_{i \in \mathcal{I}} \left(\frac{P^i_{n,t}}{\alpha^{i,f}_n}\right)^{\alpha^{i,f}_n}$.

2.3 Sectoral Goods

Sectoral goods are bundles that aggregate sector-specific tradable varieties, which may be produced domestically or imported. These goods are either used to produce final goods or used by variety producers as intermediate inputs for production. Formally, the sectoral good $Y^i_{n,t}$ in sector i of economy n at time t is a Constant Elasticity of Substitution (CES) aggregate of tradable sector-specific varieties $y^i_{n,t}(\omega)$:

$$Y^i_{n,t} = \left(\int_0^1 \left(y^i_{n,t}(\omega)\right)^{\frac{\sigma-1}{\sigma}} d\omega\right)^{\frac{\sigma}{\sigma-1}}, \tag{4}$$

where $\sigma > 1$ dictates the elasticity of substitution across varieties.

The price of the sector-i good, $P^i_{n,t}$, in economy n at time t is given by $P^i_{n,t} = \left(\int_0^1 \left(p^i_{n,t}(\omega)\right)^{1-\sigma} d\omega\right)^{\frac{1}{1-\sigma}}$, where $p^i_{n,t}(\omega)$ represents the price of variety ω in economy n at time t. Since varieties are tradable, the sectoral price index depends on the prices of both domestic and foreign varieties.

2.4 Variety Producers

Perfectly competitive variety producers in sector i produce tradable varieties $y^i_{n,t}(\omega)$ using a Cobb-Douglas production function that depends on the economy-variety-specific productivity $z^i_{n,t}(\omega)$, effective labor input $l^i_{n,t}(\omega)$, capital input $k^i_{n,t}(\omega)$, and intermediate goods $m^i_{n,t}(\omega)$. A producer's profit maximization problem is given by:

$$\max_{l^i_{n,t}(\omega),k^i_{n,t}(\omega),m^i_{n,t}(\omega)} \quad p^i_{n,t}(\omega)\, y^i_{n,t}(\omega) - w_{n,t}\, l^i_{n,t}(\omega) - r^k_{n,t}\, k^i_{n,t}(\omega) - P^{i,M}_{n,t}\, m^i_{n,t}(\omega) \tag{5}$$

$$\text{s.t.} \qquad y^i_{n,t}(\omega) = z^i_{n,t}(\omega)\Big(\big(l^i_{n,t}(\omega)\big)^{\eta^i_n}\big(k^i_{n,t}(\omega)\big)^{1-\eta^i_n}\Big)^{1-\gamma^i_n}\Big(m^i_{n,t}(\omega)\Big)^{\gamma^i_n}, \tag{6}$$

where $p^i_{n,t}(\omega)$ denotes the price of variety ω; $w_{n,t}$ denotes the wage per unit of effective labor in economy n at time t; $r^k_{n,t}$ denotes the rental rate of capital, and $P^{i,M}_{n,t}$ denotes the price of an intermediate good used in sector i of economy n. Parameters $\{\eta^i_n\}$ and $\{\gamma^i_n\}$ respectively govern the shares of total production costs spent on labor inputs and intermediate inputs which vary across sectors and economies.

The intermediate good $m^i_{n,t}(\omega)$ for variety producers is a Cobb-Douglas bundle of sectoral goods $\{m^{i,k}_{n,t}(\omega)\}$: $m^i_{n,t}(\omega) \equiv \prod_{k\in\mathcal{I}}\Big(m^{i,k}_{n,t}(\omega)\Big)^{\gamma^{i,k}_n}$, where $\gamma^{i,k}_n \geq 0$ governs the share of intermediate expenditure of producers in sector i of economy n spent on sector k, with $\sum_{k\in\mathcal{I}} \gamma^{i,k}_n = 1$.[7]

Since the production function exhibits constant returns to scale and markets are perfectly competitive, the price set by a variety-ω producer in sector i with productivity $z^i_{n,t}(\omega)$ equals the unit cost of production, $\frac{mc^i_{n,t}}{z^i_{n,t}(\omega)}$, where $mc^i_{n,t}$ denotes the economy-sector-specific cost of an input bundle given by

$$mc^i_{n,t} \equiv \Upsilon^i_n\Big((w_{n,t})^{\eta^i_n}(r^k_{n,t})^{1-\eta^i_n}\Big)^{1-\gamma^i_n}\left(\prod_{k\in\mathcal{I}}\Big(P^k_{n,t}\Big)^{\gamma^{i,k}_n}\right)^{\gamma^i_n}, \tag{7}$$

where Υ^i_n is a constant specific to sector i of economy n.[8]

Following Eaton and Kortum (2002), I assume that the productivity $z^i_{n,t}(\omega)$ of a producer in economy n producing variety ω in sector i at time t is drawn from a Fréchet distribution with the following cumulative distribution function:

$$F_{n,t}(z^i_{n,t}(\omega)) = e^{-T^i_{n,t}(z^i_{n,t}(\omega))^{-\theta_i}}, \tag{8}$$

[7]The sectoral linkages in production governed by $\gamma^{i,k}_n$ allow for the effects of demand or supply shocks in one sector to propagate to other sectors.

[8]Specifically, $\Upsilon^i_n = (1-\gamma^i_n)^{-(1-\gamma^i_n)}(\eta^i_n)^{-\eta^i_n(1-\gamma^i_n)}(1-\eta^i_n)^{-(1-\eta^i_n)(1-\gamma^i_n)}\Big(\prod_{k\in\mathcal{I}}\Big(\gamma^{i,k}_n\gamma^i_n\Big)^{-\gamma^{i,k}_n\gamma^i_n}\Big)$.

which depends on two parameters: $T^i_{n,t}$ and θ_i. $T^i_{n,t}$ captures the productivity level of sector i in economy n at time t, with higher values implying a greater likelihood of high productivity draws. The parameter θ_i governs productivity dispersion within sector i, with larger values implying more homogeneous productivity across producers. [9]

2.5 International Trade

Shipping goods from sector i of economy m to economy n at time t entails an iceberg shipping cost $d^i_{nm,t} \geq 1$.[10] This assumption implies that producers in economy m need to ship $d^i_{nm,t}$ units of good for one unit of good to arrive in economy n.

Consumers derive the same amount of utility from the same varieties produced in different economies. Hence, consumers shop around the world for producers with the best deals. Then, the price of variety ω in economy n at time t is given by

$$p^i_{n,t}(\omega) = \min_{m \in \mathcal{N}} \left\{ \frac{mc^i_{m,t}}{z^i_{m,t}(\omega)} d^i_{nm,t} \right\}. \tag{9}$$

Equation (9) shows that the producer of variety ω in sector i of economy m who sells to economy n is either a supplier with a low input cost $mc^i_{m,t}$, a supplier with a high productivity draw $z^i_{m,t}(\omega)$, or a supplier who faces a low bilateral iceberg shipping cost $d^i_{nm,t}$.

Under these assumptions, the amount economy n imports from sector i of economy m at time t, $X^i_{nm,t}$, can be expressed as $X^i_{nm,t} = \pi^i_{nm,t} X^i_{n,t}$, where

$$\pi^i_{nm,t} = \frac{T^i_{m,t} \left(mc^i_{m,t} d^i_{nm,t} \right)^{-\theta_i}}{\sum_{k \in \mathcal{N}} T^i_{k,t} \left(mc^i_{k,t} d^i_{nk,t} \right)^{-\theta_i}} \tag{10}$$

denotes the fraction of expenditure of economy n spent on varieties produced by sector i of economy m at time t, and $X^i_{n,t}$ is the aggregate expenditure of economy n spent

[9] The parameter θ_i is crucial, as it is closely linked to Ricardian comparative advantage that promotes international trade between economies. If θ_i is small (i.e., productivity dispersion is large), economies more actively engage in international trade, as all economies have a comparative advantage in producing some varieties despite the differences in aggregate productivity levels.

[10] There is no shipping cost for transactions within economies: $d^i_{nn,t} = 1, \forall n \in \mathcal{N}, i \in \mathcal{I}, t \in \mathcal{T}$. Also, the triangle inequality always holds: $d^i_{nm,t} \leq d^i_{nh,t} d^i_{hm,t}, \forall n, m, h \in \mathcal{N}, i \in \mathcal{I}, t \in \mathcal{T}$.

on sector i at time t. The gravity equation above shows that lower θ_i (i.e., greater productivity dispersion across varieties) and higher $T^i_{m,t}$ (i.e., better average productivity of the exporting economy) promote bilateral trade between economies. By contrast, higher $d^i_{nm,t}$ (i.e., more severe trade barriers) inhibits bilateral trade, as in Eaton and Kortum (2002).

Denote $\Phi^i_{n,t} \equiv \sum_{k\in\mathcal{N}} T^i_{k,t}\left(mc^i_{k,t}d^i_{nk,t}\right)^{-\theta_i}$. $\Phi^i_{n,t}$ is a parameter that captures the distribution of absolute levels of productivity, input costs, and trade barriers of all economies in the world. Assuming $\sigma < 1+\theta_i$, the price index of a sectoral good of sector i of economy n at time t can be expressed as $P^i_{n,t} = \Psi^i\left(\Phi^i_{n,t}\right)^{-\frac{1}{\theta_i}}$ where $\Psi^i \equiv \left[\Gamma\left(\frac{\theta_i+1-\sigma}{\theta_i}\right)\right]^{\frac{1}{1-\sigma}}$ and $\Gamma(\cdot)$ is a Gamma function.[11] The above expression shows that the price of a sectoral good $P^i_{n,t}$ depends on the states of productivity $\{T^i_{n,t}\}$, comparative advantage θ_i, trade costs $\{d^i_{nm,t}\}$, and input costs $\{mc^i_{n,t}\}$.

2.6 International Asset Market and Global Banks

A global market exists for risk-free financial assets, denominated in units of the final consumption good of a base economy $n^\star$ with the price of the consumption good $P^C_{n^\star,t}$.[12] Financial transactions are intermediated by perfectly competitive global banks that search for households willing to lend at the lowest rate. This process determines the world interest rate R_t.

Financial intermediation in lending entails various costs, including assessing household default risk, complying with economy-specific financial regulations, and paying fees to governments and managers. When a household in economy n takes a negative asset position ($b' < 0$), the intermediation cost is $\phi_{n,t}|b'|$, which depends on the economy-specific cost $\phi_{n,t}$ and the asset position b'. Under perfect competition, global banks offer economy-specific interest rates $\kappa_{n,t+1}(b')$ such that they earn zero profits: $\kappa_{n,t+1}(b') = R_{t+1} + \phi_{n,t}\,\mathbb{1}[b' < 0]$. That is, global banks set lending rates to cover both the world interest rate R_t, which reflects the cost of sourcing funds from households, and additional costs of financial intermediation.[13]

[11] Since Ψ^i is time-invariant, it cancels in the analysis of changes over time. Accordingly, σ need not be estimated, as it only enters through Ψ^i.

[12] The United States is used as the base economy in the quantification.

[13] In the quantitative analysis, I estimate $\phi_{n,t}$ as the spread between economy-specific lending rates and

The key feature of the model is that, within each economy, households with negative asset positions (borrowers) and positive asset positions (savers) face different interest rates. Also, households in different economies face different interest rates, reflecting heterogeneity in financial environments across economies. This approach is closely related to the debt-elastic interest rate commonly used in the international macroeconomics literature (Schmitt-Grohé and Uribe, 2003; Uribe and Yue, 2006).

Global banks pay financial intermediation costs in units of the final consumption good of the base economy $n^{\star}$. Hence, their total financial intermediation expenditure in economy n at time t, $X^F_{n,t}$, is given by:

$$X^F_{n,t} = P^C_{n^{\star},t} \sum_{j=0}^{J} \left(\frac{1}{R_{t+1}} - \frac{1}{\kappa_{n,t+1}(b_{n,j+1,t+1})} \right) \cdot \left(-b_{n,j+1,t+1}\right) \cdot \mathbb{1}\left[b_{n,j+1,t+1} < 0\right] \cdot L_{n,j,t} \quad (11)$$

where $b_{n,j+1,t+1}$ is the asset position that a household of age j in economy n chooses at time t to hold at age $j+1$ in period $t+1$. The term $\left(\frac{1}{R_{t+1}} - \frac{1}{\kappa_{n,t+1}(b_{n,j+1,t+1})}\right)$ represents the per-unit, economy-specific intermediation cost, which depends on the household's chosen asset position. The aggregate intermediation costs $X^F_{n,t}$ capture the inefficiencies generated by financial frictions.

2.7 Households

Households, indexed by age j, economy n, and time t, hold a financial asset position $b_{n,j,t}$, productive capital $k_{n,j,t}$, and housing $h_{n,j,t}$. They choose consumption and saving to maximize lifetime utility, subject to exogenous life-cycle investment rules for productive capital and housing. Their decisions depend on the parameters and variables summarized in Table 1.

To ensure that household investment behavior captures the life-cycle patterns observed in the data, while keeping the model tractable, I specify exogenous rules for investment in productive capital and housing. For all non-terminal ages $j < J$, productive capital investment $i^k_{n,j,t}$ and housing investment $i^h_{n,j,t}$ are not choice variables but are instead determined by age-specific profiles, $s^k_{n,j}$ and $s^h_{n,j}$, a common price of investment good

the world interest rate observed in the data. These spreads may capture not only the intermediation costs highlighted in the main text but also potential markups charged by oligopolistic banks.

Table 1: Household Parameters and Variables

Symbol	Definition
Parameters	
β	Discount factor
ν	Inverse of the elasticity of intertemporal substitution (EIS)
τ_n	Economy-specific strength of voluntary bequest motive
$\chi_{n,j+1,t+1}$	Survival probability from age j to $j+1$
$e_{n,j}$	Age-specific supply of effective labor
$s^k_{n,j}$	Age-specific productive capital investment share of wage income
$s^h_{n,j}$	Age-specific housing investment share of wage income
δ_n	Depreciation rate of productive capital and housing
Variables	
$b_{n,j,t}$	Household's financial asset position at age j and time t
$k_{n,j,t}$	Household's productive capital holdings at age j and time t
$h_{n,j,t}$	Household's housing holdings at age j and time t
$c_{n,j,t}$	Household's consumption at age j and time t
$i^k_{n,j,t}$	Household's investment in productive capital at age j and time t
$i^h_{n,j,t}$	Household's investment in housing at age j and time t
$\kappa_{n,t+1}(\cdot)$	Asset-position-specific interest rate function
$\varepsilon_{n,t}$	Intertemporal distortion
$w_{n,t}$	Wage per unit of effective labor
$r^k_{n,t}$	Rental rate of productive capital
$\Omega_{n,j,t}$	Bequest income
$\mathcal{T}_{n,j,t}$	Government transfer
$P^C_{n,t}$	Price of final consumption good
$P^I_{n,t}$	Price of final investment good

$P^I_{n,t}$, and the wage per unit of effective labor in economy n, $w_{n,t}$, which reflects aggregate economic conditions:

$$i^k_{n,j,t} = \frac{s^k_{n,j} w_{n,t}}{P^I_{n,t}}, \qquad i^h_{n,j,t} = \frac{s^h_{n,j} w_{n,t}}{P^I_{n,t}}. \tag{12}$$

This specification allows investment in both productive capital (which is used for production) and residential housing (which is not used for production) to vary systematically over the life cycle and across economies, while responding to time-varying wages and investment prices.[14]

Given these investment rules, the household's optimization problem is to choose consumption, c, and the next period's financial asset position, b', to maximize lifetime utility, $V_{n,j,t}(b,k,h)$, given the current financial asset position, b, productive capital holdings, k, and housing holdings, h. Formally, for ages $j \in \{0,1,\ldots,J-1\}$, the recursive problem is

$$V_{n,j,t}(b,k,h) = \max_{c,\,b'} \left\{ \frac{c^{1-\nu}}{1-\nu} + v(h) + \beta\, e^{\varepsilon_{n,t+1}} \chi_{n,j+1,t+1} V_{n,j+1,t+1}(b',k',h') \right\}. \tag{13}$$

where $v(h)$ captures utility from residential housing.[15] The household is subject to the budget constraint and the laws of motion for productive capital and housing:

$$P^C_{n,t} c + P^I_{n,t} i^k_{n,j,t} + P^I_{n,t} i^h_{n,j,t} + \frac{P^C_{n^\star,t}}{\kappa_{n,t+1}(b')} b' = P^C_{n^\star,t} b + r^k_{n,t} k + w_{n,t} e_{n,j} + \Omega_{n,j,t} + \mathcal{T}_{n,j,t}, \tag{14}$$

$$k' = (1-\delta_n)k + i^k_{n,j,t}, \tag{15}$$

$$h' = (1-\delta_n)h + i^h_{n,j,t}. \tag{16}$$

At the terminal age J, the problem simplifies to choosing consumption c and leaving a voluntary bequest b' to maximize final-period utility:

$$V_{n,J,t}(b,k,h) = \max_{c,\,b'} \left\{ \frac{c^{1-\nu}}{1-\nu} + v(h) + \frac{\tau^\nu_n}{1-\nu} \left(\frac{P^C_{n^\star,t+1}}{P^C_{n,t+1}} b' \right)^{1-\nu} \right\}. \tag{17}$$

where the term $\frac{P^C_{n^\star,t+1}}{P^C_{n,t+1}} b'$ converts the bequest into units of the final consumption good in economy n at time $t+1$.

[14] The age-specific investment profiles reflect predictable life-cycle accumulation patterns, with housing investment concentrated early in life. The functional form also allows investment to co-move with aggregate economic conditions through wages and investment prices, consistent with standard macroeconomic models (Greenwood et al., 1997; King and Rebelo, 1999). For tractability, the model abstracts from endogenous portfolio choice, interest-rate-sensitive investment, and adjustment costs.

[15] Housing provides utility but does not enter production. This specification reflects the residential nature of housing and avoids conflating household housing wealth with productive capital. Since exogenous rules determine housing, I do not specify a functional form for $v(h)$.

To ensure that bequests are made exclusively in financial assets, terminal investment in productive capital and housing satisfies $i^k_{n,J,t} = -(1-\delta_n)k$ and $i^h_{n,J,t} = -(1-\delta_n)h$, which imply that households liquidate all non-financial assets at the end of the life cycle. [16]

The household's saving decision is shaped by three primary economic forces: (i) life-cycle income dynamics, (ii) intertemporal trade-offs, and (iii) bequest motives.

Households supply labor and productive capital inelastically, but their income streams vary significantly over their lives. Labor income is determined by the economy-specific time-varying wage, $w_{n,t}$, and an age-specific supply of effective labor, $e_{n,j}$.[17] Similarly, income from productive capital depends on the economy-specific rental rate, $r^k_{n,t}$, and the household's accumulated capital stock, $k_{n,j,t}$. The evolution of productive capital and housing follows age-specific investment profiles, $s^k_{n,j}$ and $s^h_{n,j}$. These predictable life-cycle patterns in income and investment needs give rise to two key motives: investment financing and consumption smoothing. Young households typically borrow against future income to finance investments and maintain stable consumption, while middle-aged households save mainly for retirement.

The household's saving decision follows an intertemporal optimality condition, balancing the value of consuming today against the value of consuming tomorrow. This trade-off depends on two key elements: the effective rate of return on saving and the household's preferences.

The effective rate of return is a composite measure capturing all factors that shape the benefits of deferring consumption. It depends on the asset-position-specific interest rate determined by $\kappa_{n,t+1}(\cdot)$, survival probabilities $\chi_{n,j+1,t+1}$, and changes in the relative price of consumption $\frac{P^C_{n,t}}{P^C_{n^\star,t}}$, which reflect movements in the real exchange rate. In addition, the model incorporates an economy-specific intertemporal distortion, $\varepsilon_{n,t}$, introduced to capture saving behaviors not accounted for by changes in other model variables. For example, a positive distortion (i.e., $\varepsilon_{n,t+1} > 0$) increases the trade balance by effectively reducing the value of consuming today, thereby encouraging higher saving and lower consumption.

[16]This assumption reflects the real-world practice whereby assets, such as real estate and privately held capital, are typically liquidated so that their value can be transferred to heirs in liquid form.

[17]The age-specific effective labor supply can be interpreted as a result of human capital accumulation, experience, and/or seniority. It can differ across economies due to differences in labor market institutions.

Two fundamental preference parameters govern the household's response to this effective rate of return. The discount factor, β, determines patience, while the elasticity of intertemporal substitution (EIS), $1/\nu$, determines the willingness of households to adjust consumption growth in response to changes in the return on saving. A higher EIS implies a stronger adjustment.

Finally, the model incorporates bequest motives. A voluntary bequest motive, governed by the strength parameter τ_n, determines the utility or emotional rewards households derive from leaving wealth to heirs in economy n.[18] In addition to these intended bequests, the model also features accidental bequests, which arise when households do not survive to the terminal age and their wealth is redistributed to younger generations.

2.8 Bequests

There are two sources of bequests in the model: accidental and voluntary. Accidental bequests arise from mortality risk, captured by the survival probabilities $\{\chi_{n,j,t}\}$, while voluntary bequests are intentional transfers chosen by households. The total value of bequests, $BV_{n,t}$, or the transfers received by surviving households in economy n at time t, is given by

$$BV_{n,t} = \underbrace{\sum_{j=1}^{J} P^C_{n^\star,t} b_{n,j,t} \left(L_{n,j-1,t-1} - L_{n,j,t} \right)}_{\text{Accidental Bequests}} + \underbrace{P^C_{n^\star,t} b_{n,J+1,t} L_{n,J,t-1}}_{\text{Voluntary Bequests}}, \tag{18}$$

where $b_{n,J+1,t}$ is the bequest left by age-J household chosen in time $t-1$ and received in t. The first term on the right-hand side represents accidental bequests, which arise when households of age $j-1$ die between $t-1$ and t, leaving behind their assets $b_{n,j,t}$. The second term represents voluntary bequests, which are intentional transfers made by households at the terminal age J.

[18] I incorporate a voluntary bequest motive to account for the sluggish decumulation of assets after retirement and the substantial asset holdings of older households observed in the data. More broadly, the parameter τ_n can be interpreted as capturing precautionary motives arising from incomplete insurance against late-life risks, dynastic considerations, or institutional and cultural factors that discourage asset decumulation. While it is theoretically possible to also include utility from accidental bequests, doing so would require additional structure and data that are not available.

Given the lack of detailed data on how bequests are redistributed across surviving households, I assume that total bequests are evenly allocated among households aged $J_{\min} \leq j \leq J_{\max}$. Under this assumption, the per-household bequest transfer is

$$\Omega_{n,j,t} = \frac{BV_{n,t}}{\sum_{j=J_{\min}}^{J_{\max}} L_{n,j,t}}. \tag{19}$$

2.9 Government

In each economy n at time t, the government spends $X_{n,t}^G$, collects lump-sum taxes from households, and issues debt to finance any fiscal imbalance. To maintain tractability while allowing for cross-country and time variation in fiscal behavior, government spending and net asset positions are specified exogenously as

$$X_{n,t}^G = \xi_{n,t}^X \sum_{i \in \mathcal{I}} GO_{n,t}^i, \tag{20}$$

$$B_{n,t}^G = -\xi_{n,t}^B \frac{\sum_{i \in \mathcal{I}} GO_{n,t}^i}{P_{n^\star,t}^C}, \tag{21}$$

where $GO_{n,t}^i$ denotes gross output in sector i of economy n, $B_{n,t}^G$ is the government's net asset position, and $\xi_{n,t}^X$ and $\xi_{n,t}^B$ are exogenous, time-varying ratios governing government spending and debt relative to aggregate output.[19]

Governments are assumed to borrow at the world interest rate R_t.[20] Accordingly, the government budget constraint is given by

$$X_{n,t}^G + \frac{P_{n^\star,t}^C}{R_{t+1}} B_{n,t+1}^G = \left(\sum_{j=0}^{\bar{J}} \mathcal{T}_{n,j,t} L_{n,j,t} \right) + P_{n^\star,t}^C B_{n,t}^G, \tag{22}$$

where $\mathcal{T}_{n,j,t}$ denotes lump-sum transfers and $\bar{J}$ is the typical retirement age, so that lump-sum taxes are imposed only on households up to that age and are thus borne entirely by the working-age population. Equation (22) implies that the government finances its expenditure, net of new borrowing, through uniform lump-sum transfers (or taxes when

[19] When $B_{n,t}^G < 0$, $-B_{n,t}^G$ denotes government debt.

[20] This assumption reflects that sovereigns typically face lower borrowing costs than households due to lower credit risk, direct access to capital markets, and the high liquidity of government securities.

negative) levied each period on households of working age ($j \leq \bar{J}$). Hence, the per-capita transfer for working-age households is given by

$$\mathcal{T}_{n,j,t} = -\frac{X^G_{n,t} + \frac{P^C_{n^\star,t}}{R_{t+1}} B^G_{n,t+1} - P^C_{n^\star,t} B^G_{n,t}}{\sum_{j=0}^{\bar{J}} L_{n,j,t}}. \tag{23}$$

2.10 Aggregate Variables

Aggregate final expenditures on consumption and investment are defined as

$$X^C_{n,t} \equiv \sum_{j=0}^{J} P^C_{n,t} c_{n,j,t} L_{n,j,t} + X^F_{n,t}, \tag{24}$$

$$X^I_{n,t} \equiv \sum_{j=0}^{J} P^I_{n,t} \left(i^k_{n,j,t} + i^h_{n,j,t} \right) L_{n,j,t}. \tag{25}$$

Sectoral gross output is given by $GO^i_{n,t} = \sum_{m \in \mathcal{N}} \pi^i_{mn,t} X^i_{m,t}$, and the trade balance (net exports) is

$$TB_{n,t} \equiv \sum_{i \in \mathcal{I}} GO^i_{n,t} - \sum_{i \in \mathcal{I}} X^i_{n,t}. \tag{26}$$

Sectoral expenditure satisfies

$$X^i_{n,t} = \sum_{f \in \{C,I,G\}} \alpha^{i,f}_n X^f_{n,t} + \sum_{k \in \mathcal{I}} \gamma^k_n \gamma^{k,i}_n GO^k_{n,t}. \tag{27}$$

Gross domestic product is defined as value added from labor and productive capital, $GDP_{n,t} = \sum_{j=0}^{J} \left(w_{n,t} e_{n,j} + r^k_{n,t} k_{n,j,t} \right) L_{n,j,t}$. The external asset position of economy n is characterized by its net foreign asset position $NFA_{n,t+1}$, total liabilities $TL_{n,t+1}$, and total assets $TA_{n,t+1}$:

$$NFA_{n,t+1} = B^G_{n,t+1} + \sum_{j=0}^{J} b_{n,j+1,t+1} L_{n,j,t}, \tag{28}$$

$$TL_{n,t+1} = -\Big(B^G_{n,t+1} \mathbb{1}[B^G_{n,t+1} < 0] + \sum_{j=0}^{J} b_{n,j+1,t+1} \mathbb{1}[b_{n,j+1,t+1} < 0] L_{n,j,t} \Big), \tag{29}$$

$$TA_{n,t+1} = B^G_{n,t+1} \mathbb{1}[B^G_{n,t+1} > 0] + \sum_{j=0}^{J} b_{n,j+1,t+1} \mathbb{1}[b_{n,j+1,t+1} > 0] L_{n,j,t}. \tag{30}$$

The population age distribution evolves according to $L_{n,j,t} = \chi_{n,j,t}\, L_{n,j-1,t-1}$, implying total population, $L_{n,t} = L_{n,0,t} + \sum_{j=1}^{J} \chi_{n,j,t}\, L_{n,j-1,t-1}$.

2.11 Sequential Equilibrium

A sequential equilibrium is a set of sequences of prices and interest rates, $\mathbb{P}$, and sequences of decisions by households, producers, and banks, together with government and international trade variables, $\mathbb{Y}$, given governments' initial asset positions and households' initial distributions of financial assets, productive capital, and housing, $\{B^G_{n,0}, b_{n,j,0}, k_{n,j,0}, h_{n,j,0}\}_{n\in\mathcal{N},\, j\in\mathcal{J}}$, and the parameter set Θ, such that the following conditions hold:

1. Households maximize lifetime utility subject to their budget constraints, life-cycle investment rules, and the laws of motion for productive capital and housing.

2. Producers maximize profits given wages, rental rates, and intermediate input costs.

3. Global banks set asset-position-specific interest rates and earn zero profits:

$$\kappa_{n,t+1}(b') = R_{t+1} + \phi_{n,t}\, \mathbb{1}[b' < 0], \quad \forall n \in \mathcal{N},\ t \in \mathcal{T}. \tag{31}$$

4. Labor, capital, and goods markets clear:

$$w_{n,t}\sum_{j=0}^{J} e_{n,j}L_{n,j,t} = \sum_{i\in\mathcal{I}}(1-\gamma_n^i)\eta_n^i GO_{n,t}^i, \quad \forall n\in\mathcal{N},\ t\in\mathcal{T}, \tag{32}$$

$$r_{n,t}^k\sum_{j=0}^{J} k_{n,j,t}L_{n,j,t} = \sum_{i\in\mathcal{I}}(1-\gamma_n^i)(1-\eta_n^i) GO_{n,t}^i, \quad \forall n\in\mathcal{N},\ t\in\mathcal{T}, \tag{33}$$

$$\begin{aligned} X_{n,t}^i &= \sum_{f\in\{C,I,G\}} \alpha_n^{i,f} X_{n,t}^f \\ &\quad + \sum_{k\in\mathcal{I}} \gamma_n^k \gamma_n^{k,i} \sum_{m\in\mathcal{N}} \pi_{mn,t}^k X_{m,t}^k, \quad \forall n\in\mathcal{N},\ i\in\mathcal{I},\ t\in\mathcal{T}. \end{aligned} \tag{34}$$

5. Government budget constraints hold:

$$X_{n,t}^G + \frac{P_{n^\star,t}^C}{R_{t+1}} B_{n,t+1}^G = \sum_{j=0}^{\bar{J}} \mathcal{T}_{n,j,t}L_{n,j,t} + P_{n^\star,t}^C B_{n,t}^G, \quad \forall n\in\mathcal{N},\ t\in\mathcal{T}. \tag{35}$$

6. The international asset market clears:

$$\sum_{n\in\mathcal{N}}\left(B_{n,t+1}^G + \sum_{j=0}^{J} b_{n,j+1,t+1}L_{n,j,t}\right) = 0, \quad \forall t\in\mathcal{T}. \tag{36}$$

For readability, detailed descriptions of the parameter set Θ, prices $\mathbb{P}$, and endogenous variables $\mathbb{Y}$ are provided in Appendix A.1.

In equilibrium, the balance-of-payments condition holds for each economy:

$$\sum_{i\in\mathcal{I}} X_{n,t}^i + NFA_{n,t+1} = R_t NFA_{n,t} + \sum_{i\in\mathcal{I}} GO_{n,t}^i, \quad \forall n\in\mathcal{N},\ t\in\mathcal{T}. \tag{37}$$

Equivalently,

$$TB_{n,t} = \sum_{i\in\mathcal{I}} GO_{n,t}^i - \sum_{i\in\mathcal{I}} X_{n,t}^i = NFA_{n,t+1} - R_t NFA_{n,t}. \tag{38}$$

An increase (decrease) in aggregate saving therefore corresponds to an increase (decrease) in the trade balance through the accumulation (decumulation) of external assets.

3 Quantification

I map the model to eight economies: the United States, China, Germany, the United Kingdom, the Republic of Korea, Mexico, India, and the Rest of World (ROW). These economies display persistent trade imbalances from 2000 to 2014. The United States, the United Kingdom, Mexico, and India run persistent trade deficits, while China, Germany, and the Republic of Korea run persistent trade surpluses. This selection preserves computational tractability while allowing the model to capture heterogeneity across major deficit- and surplus-running economies.

The time frame is restricted to 2000–2014, the period covered by the World Input-Output Database (WIOD) 2016 release, which provides detailed and consistent production, expenditure, and bilateral trade data across 43 countries and 56 industries (Timmer et al., 2015).[21] The industries within each economy are grouped into three sectors: Agriculture/Mining (A), Manufacturing (M), and Services (S).

Table 2 provides a summary of the model's parameters. The parameters are classified into three categories: (1) parameter values borrowed from the literature, (2) parameters calibrated without solving the model, and (3) parameters calibrated using the method of simulated moments (MSM).

Externally Calibrated Parameters Panel A of Table 2 reports parameters set to common values in the literature. The parameter ν is set to 2 so that the elasticity of intertemporal substitution (EIS) equals 0.5.[22] The Fréchet parameters $\{\theta_i\}$, which govern productivity dispersion within each sector, are set following the estimates of Caliendo and Parro (2015) and range from 4.49 to 9.11.[23] Furthermore, I assume that households become economically active at age 20 and can live up to age 80; hence, there are 61 age cohorts in each economy, and the age index j runs from 0 to 60 (i.e., $J = 60$). I define the working-age

[21]When data series extend beyond 2014 (e.g., population and interest rates), I use the longer sample to discipline parameters and projections.

[22]Previous studies provide extensive evidence that the EIS is small (Hall, 1988; Campbell, 1999; Yogo, 2004; Guvenen, 2006). Estimates typically fall below one, with many in the 0–0.5 range, and the meta-analysis by Havránek (2015) finds an average around 0.5.

[23]In particular, the estimates are taken from Table 1 (99% sample) in Caliendo and Parro (2015). The value for Agriculture is 9.11; the value for Manufacturing is 7.10, calculated as an observation-weighted average across manufacturing industries; the value for Services is 4.49 based on the aggregate estimate.

Table 2: Summary of Parameters

Panel A. Externally Calibrated			
Parameter	Value(s)	Description	Source
ν	2	Inverse of EIS	See text
$\{\theta_A, \theta_M, \theta_S\}$	$\{9.11,\ 7.10,\ 4.49\}$	Productivity dispersion	CP
J	60	Terminal age of the life cycle	
$\bar{J}$	45	Max. age of working-age households	
$\{J_{\min}, J_{\max}\}$	$\{30,\ 49\}$	Max. & min. ages of receiving bequests	See text
$n^\star$	USA	Denomination of financial asset	See text
Panel B. Calibrated Without Solving the Model			
Parameter		Description	Source
η_n^i		Labor shares	WIOD
γ_n^i		Intermediate input shares	WIOD
$\gamma_n^{i,k}$		Input–output shares	WIOD
$\{\alpha_n^{i,C}, \alpha_n^{i,I}, \alpha_n^{i,G}\}$		Final expenditure shares	WIOD
$\{\xi_{n,t}^X, \xi_{n,t}^B\}$		Government spending & debt	WIOD, GFS
δ_n		Depreciation rate	PWT
$\chi_{n,j,t}$		Conditional survival probabilities	WPP
$\phi_{n,t}$		Financial intermediation cost	See text
$e_{n,j}$		Effective labor supply by age	LIS
$\{s_{n,j}^k, s_{n,j}^h\}$		Capital & housing investment by age	LWS, NaSTaB
$T_{n,t}^i$		Sector-level productivity	WIOD
$d_{nm,t}^i$		Bilateral trade cost	WIOD
Panel C. Calibrated using the Method of Simulated Moments (MSM)			
Parameter	Value(s)	Description	
β	0.982	Discount factor	
τ_n		Voluntary bequest	

Notes: WIOD = World Input-Output Database 2016 Release, GFS = IMF Government Finance Statistics, WPP = UN World Population Prospects, LIS = Luxembourg Income Study, LWS = Luxembourg Wealth Study, NaSTaB = National Survey of Tax and Benefit, PWT = Penn World Table, CP = Caliendo and Parro (2015).

households to be from age 20 to age 65 and set the parameter $\bar{J}$ to 45. The minimum and maximum ages for receiving bequests, $J_{\min}$ and $J_{\max}$, are set to 30 and 49, reflecting that most inheritances are received when households are in their 50s and 60s.[24] Finally, the base economy in which the financial asset is denominated is expressed in units of the final consumption good of the United States (i.e., $n^\star = \text{USA}$), so that the U.S. consumption

[24]See Zagheni and Wagner (2015), Garbinti and Georges-Kot (2019), Bourquin et al. (2020), and Gropp and de Fontenay (2021) for more details.

good serves as the global numeraire or unit of account for financial transactions.[25]

Production and Expenditure Panel B of Table 2 reports parameters calibrated outside the model. I use the World Input–Output Database (WIOD), November 2016 release, to calibrate production and expenditure parameters. The Socio-Economic Accounts (SEA) of the WIOD provide industry-level information on gross output, value added, employment, capital stock, labor and capital compensation, intermediate input expenditures, and price indices for gross output and value added, and intermediate inputs.

The labor shares $\{\eta_n^i\}$, intermediate input shares $\{\gamma_n^i\}$, input–output shares $\{\gamma_n^{i,k}\}$, and final expenditure shares $\{\alpha_n^{i,C}, \alpha_n^{i,I}, \alpha_n^{i,G}\}$ are computed directly from the dataset. For each parameter, annual values are first calculated and then averaged across the time periods. Government spending intensities $\{\xi_{n,t}^X\}$ are computed as government expenditure relative to economy-level gross output. Government debt intensities $\{\xi_{n,t}^B\}$ are measured as central government gross debt relative to gross output using the IMF Government Finance Statistics (IMF, 2024). Both series are held constant after 2014. Figure A1 and Figure A2 report these series and display substantial heterogeneity across economies.

Capital Depreciation The capital depreciation rates $\{\delta_n\}$ are obtained from the Penn World Table (Feenstra et al., 2015). For each economy, I calculate the GDP-weighted average depreciation rate over 2000–2014. For the Rest of the World (ROW), the depreciation rate is computed based on all countries except the United States, China, Germany, the United Kingdom, the Republic of Korea, Mexico, and India.

Life Expectancy and Population Inflow Conditional survival probabilities, $\{\chi_{n,j,t}\}$, are constructed from age-specific population data, $\{L_{n,j,t}\}$, to capture changes in the age structure of each economy over time. I use data on population by age from the UN World Population Prospects (WPP) for 2000–2021 (United Nations, 2024); the probabilities are computed as $\chi_{n,j,t} = \frac{L_{n,j,t}}{L_{n,j-1,t-1}}, \quad j > 0$.[26] After 2021, both the age-20 population and the conditional probabilities are held constant.

[25]See Gopinath et al. (2020) and Gopinath and Stein (2021) for discussions of the dominant-currency paradigm and the mechanisms underlying the U.S. dollar's global role.

[26]In some cases, the size of an age cohort increases over time, potentially due to immigration. In such cases, the conditional survival probability is set to one.

Figure A3 reports the implied life expectancy for 2000–2014, defined as the probability that a household aged 40 ($j = 20$) in year t survives to the end of the life cycle relative to the probability for a household aged 40 in 2000, $\prod_{h=1}^{J-20} \frac{\chi_{n,20+h,t+h}}{\chi_{n,20+h,2000+h}}$. Figure A4 shows the number of new labor market entrants over the same period, measured as the population of the age-20 cohort relative to its 2000 level, $L_{n,0,t}/L_{n,0,2000}$. Figure A3 presents that the life-expectancy index changes little in the United States and the United Kingdom, rises sharply in Korea in the mid-2000s, and declines significantly in Mexico and India by 2014. Figure A4 shows that the population of the age 20 cohort shrinks sharply in Korea, rises in China until 2010, and then falls, and increases modestly in the United States and the United Kingdom, but by less than the increase in the global average.

Financial Intermediation Cost The financial intermediation costs $\{\phi_{n,t}\}$ from 2000 to 2014 are computed as the percentage point differences between lending interest rates and the world interest rate. I use the mortgage interest rate to proxy the lending interest rate since mortgage borrowing constitutes a large share of household debt. For China and India, where the information on mortgage interest rates is unavailable, I use their benchmark lending rates, which are reference rates used by banks to price loans. The lending interest rate for the Rest of the World (ROW) is calculated as the GDP-weighted average of the other seven economies considered in the analysis. The world nominal interest rate is computed as the minimum of the long-term government bond yields for 11 major countries, to be consistent with the model's assumption that the world interest rate is the lowest interest rate that banks face after searching globally.[27] A detailed description of data sources and the procedure is provided in Appendix A.3.1. After 2014, I assume that financial intermediation costs remain constant.

Figure A5 shows the resulting financial intermediation costs for 2000–2014. The figure indicates that, over 2000–2014, financial intermediation costs in India and Mexico consistently exceeded the global average. In contrast, the financial intermediation costs in the United States, China, the United Kingdom, Germany, and the Republic of Korea remained near or below the global average and trend downward.

[27] In particular, eleven economies are the United States, Germany, the United Kingdom, Canada, France, Italy, Australia, Spain, Switzerland, South Africa, and Japan.

Age-Specific Labor Supply Age-specific labor supply profiles, $\{e_{n,j}\}$, are estimated using the Luxembourg Income Study (LIS), which provides individual-level labor income data for multiple countries and years (LIS, 2026). For the Republic of Korea, I use the data from the Korea Labour and Income Panel Study (KLIPS) from 1999 to 2022 (Jang et al., 2023). For each economy, I normalize the labor supply of 40-year-old individuals to one unit of effective labor and measure the labor supply of each age cohort as its average labor income relative to the average labor income of 40-year-old individuals. This approach assumes that the wage per unit of effective labor is economy-specific, so age-specific effective labor supply can be inferred from relative labor income across cohorts.

Specifically, I estimate $\{e_{n,j}\}$ by regressing labor income on a full set of age fixed effects, controlling for year, gender, marital status, education, and industry affiliation. The effective labor for each age j is then given by the estimated age fixed effect normalized to the estimate for 40-year-old individuals. For the Rest of the World (ROW), I construct the profile as a population-weighted average of the estimated age profiles from Brazil, Canada, France, Italy, and Japan. A detailed description of data sources and the estimation procedure is provided in Appendix A.3.2.

Figure A6 presents the estimated effective labor supply by age for each economy. The figure shows that profiles are hump-shaped in all economies, with effective labor supply rising from age 20 to a peak in the early to mid-50s and then declining. Relative to the global average, China's profile peaks earlier and falls more sharply after the mid-50s.

Age-Specific Investment Age-specific investment profiles, $\{s^k_{n,j}, s^h_{n,j}\}$, are calibrated using household-level cross-sectional data on equity, non-residential, and residential asset holdings from the Luxembourg Wealth Study (LWS) (LWS, 2026). For the Republic of Korea, I use the National Survey of Tax and Benefit (NaSTaB) from 2008 to 2023.

I construct time-invariant life-cycle profiles for productive capital and housing from household-level microdata in LWS and NaSTaB. I first build time-invariant age profiles of net financial assets, productive capital, and housing by collapsing balance-sheet variables to weighted means by age, normalizing all asset positions by average labor income around age 40, and then averaging these normalized age profiles across survey years. Using adjacent ages on the resulting time-invariant capital and housing profiles, $\{\tilde{k}_{n,j}, \tilde{h}_{n,j}\}$, I infer implied investment flows consistent with the laws of motion: $i_{n,j,t}^{k,\text{shape}} = \tilde{k}_{n,j+1} - (1 - \delta_{n,t})\tilde{k}_{n,j}$ and $i_{n,j,t}^{h,\text{shape}} = \tilde{h}_{n,j+1} - (1 - \delta_{n,t})\tilde{h}_{n,j}$, where depreciation rates $\delta_{n,t}$ are sourced from the Penn World Table.[28] For each economy and year from 2000 to 2014, I then scale these implied flows so that investment aggregated across ages matches aggregate capital and housing investment expenditures from the WIOD. Finally, I average the scaled profiles across years to obtain time-invariant investment profiles, $s_{n,j}^{k,\text{Data}}$ and $s_{n,j}^{h,\text{Data}}$. Details are provided in Appendix A.3.3.

Figures A7 and A8 report the calibrated age-specific profiles of capital and housing investment for each economy. Capital investment profiles are hump-shaped, while housing investment profiles are front-loaded over the life cycle, with investment concentrated at younger ages and declining thereafter. Both profiles display substantial cross-country heterogeneity. Relative to the GDP-weighted global average, China features comparatively higher housing investment expenditures, while the United States and the United Kingdom exhibit persistently lower investment over most of the life cycle.

Productivity and Trade Costs Estimating the levels of fundamentals, such as productivity and trade costs across sectors and economies at each point in time, is difficult. To address this, I use the exact hat algebra technique developed by Dekle et al. (2007) and Caliendo et al. (2019). Using this approach, the model can be solved with changes in productivity and trade costs over time, without requiring estimates of their levels in every period, given the initial distribution of observable moments such as bilateral trade shares. Furthermore, these changes in productivity and trade costs can be recovered by inverting the model equations with observed data. To capture the changes in productivity and trade costs, I introduce the hat notation, which denotes proportional deviations of a variable $x_{n,t}$ from its 2000 level (i.e., $\hat{x}_{n,t} \equiv \frac{x_{n,t}}{x_{n,2000}}$).

As derived in Appendix A.6, changes in productivity and trade costs can be recovered given the Frechet parameter θ_i, proportional changes in observed bilateral trade shares

[28]While depreciation is allowed to vary over time in the construction of investment profiles using PWT data, the model uses a time-invariant depreciation rate δ_n, calibrated as the GDP-weighted average over 2000–2014.

$(\hat{\pi}^i_{mn,t})^{Data}$, and the proportional changes in observed sector-level price indices $(\hat{P}^i_{n,t})^{Data}$:

$$\hat{T}^i_{n,t} = (\hat{\pi}^i_{nn,t})^{Data} \left(\frac{(\hat{mc}^i_{n,t})^{Data}}{(\hat{P}^i_{n,t})^{Data}} \right)^{\theta_i}, \tag{39}$$

$$\hat{d}^i_{mn,t} = \left(\frac{(\hat{\pi}^i_{nn,t})^{Data}}{(\hat{\pi}^i_{mn,t})^{Data}} \right)^{\frac{1}{\theta_i}} \left(\frac{(\hat{P}^i_{m,t})^{Data}}{(\hat{P}^i_{n,t})^{Data}} \right). \tag{40}$$

In words, Equation (39) shows that an increase in productivity $T^i_{n,t}$ can be inferred through two distinct channels. On the demand side, if the expenditure share on domestically produced products, $(\hat{\pi}^i_{nn,t})^{Data}$, increases while marginal costs remain unchanged, this implies productivity growth of the domestic sector. On the supply side, if factor payments rise, captured by a higher marginal cost relative to the output price, $\frac{(\hat{mc}^i_{n,t})^{Data}}{(\hat{P}^i_{n,t})^{Data}}$, while the expenditure share on domestically produced products does not change, this likewise implies productivity growth of the domestic sector.

On the other hand, Equation (40) shows that changes in the cost of economy m importing from economy n, $\hat{d}^i_{mn,t}$, can be inferred from shifts in expenditure shares and prices. If importer m shifts expenditure toward goods from exporter n, holding fixed exporter n's home expenditure share, the inferred cost of importing from n to m falls. The trade elasticity θ_i determines the strength of this inference: when trade flows are highly elastic (i.e., θ_i is large), even small changes in trade costs generate large changes in trade shares, so, for a given change in the trade share, the implied change in costs is smaller. Furthermore, if the price index of importer m, $(\hat{P}^i_{m,t})^{Data}$, declines while the price index of exporter n, $(\hat{P}^i_{n,t})^{Data}$, remains unchanged, this also suggests the cost of importing from exporter n has fallen for importer m.[29]

Bilateral trade shares, $\left(\pi^i_{mn,t}\right)^{Data}$, are computed using the World Input–Output Table (WIOT) of the WIOD. Sector-level price indices, $\left(P^i_{n,t}\right)^{Data}$, are computed using the Socio-Economic Accounts (SEA) of the WIOD and the 2023 release of the GGDC Productivity Level Database (PLD). Factor prices used to construct marginal costs of production, $\left(mc^i_{n,t}\right)^{Data}$, are computed from labor and capital compensation together with employment

[29] Changes in trade costs obtained using Equation (40) may reflect any barriers to bilateral trade including but not limited to tariffs, non-tariff barriers, geographical distance, political distance, and exchange rate policies.

and capital stock data in the WIOD SEA. To focus on differential growth across economies, I remove the common global output growth component when constructing these variables. Specifically, I de-trend labor and capital compensation by dividing them by world gross output, and I de-trend sector-level price indices by the GDP-weighted geometric mean of sector-level prices across economies. Additional details on the construction of these variables are provided in Appendix A.3.4.

For periods after 2014, I project productivity and trade costs using AR(1) models of one-period log changes in levels. For productivity, I allow a drift for 20 years and then set it to zero so that growth converges and levels flatten, with the steady state reached in 2183 (i.e., three model life cycles after the base year 2000). For trade costs, I use an AR(1) specification without a constant, assuming that policy shocks and disruptions create temporary fluctuations while long-run costs stabilize. Details of the procedure and parameter estimates are provided in Appendix A.3.4.

Figure A9 reports sector-level productivity measures, $(\hat{T}^i_{n,t})^{1/\theta_i}$, normalized to their 2000 levels. The figure highlights substantial heterogeneity in productivity growth across both economies and sectors. China, Mexico, and India exhibit productivity levels above the value-weighted global average, while the remaining economies lie below the global average.

Figures A10 and A11 report economy-level averages of bilateral trade costs, normalized to their 2000 levels. Figure A10 shows the average cost of exporting to each destination, while Figure A11 shows the average cost of importing from each origin. Both figures indicate a decline in GDP-weighted global average trade costs over time, alongside pronounced heterogeneity across economies and sectors.

Initial Conditions I calibrate the initial age distributions of household financial positions $\{b_{n,j,0}\}$, productive capital holdings $\{k_{n,j,0}\}$, and housing wealth $\{h_{n,j,0}\}$ by combining life-cycle profile shapes from household micro data with economy-level aggregate targets. Age-profile shapes are estimated from the Luxembourg Wealth Study (LWS) and the National Survey of Tax and Benefit (NaSTaB), normalized by labor income at age 40 and imposing $b_{n,0} = k_{n,0} = h_{n,0} = 0$ for each source country n. Productive capital profiles are scaled to match the aggregate capital stock in 2000 using WIOD data. Household financial positions are scaled to jointly match aggregate private debt and the household net asset position implied by the external balance-sheet identity, using net foreign asset positions from Lane and Milesi-Ferretti (2018) and government net assets from IMF (2024).[30] Additional details are provided in Appendix A.3.3. Figures A12, A13, and A14 display the calibrated initial age distributions of household financial positions $\{b_{n,j,0}\}$, productive capital holdings $\{k_{n,j,0}\}$, and housing wealth $\{h_{n,j,0}\}$.

Discount Factor and Voluntary Bequest Panel C of Table 2 reports parameters calibrated using the method of simulated moments (MSM). I estimate these parameters by solving the full dynamic general equilibrium model and choosing values that minimize the distance between model-implied and empirical moments. Additional details are provided in Appendix A.4.

The discount factor β is calibrated to match the average world real interest rate over 2000–2021. World real interest rates are constructed by deflating world nominal interest rates with inflation measured using the U.S. Personal Consumption Expenditures (PCE) price index.[31] This procedure implies a discount factor of $\beta = 0.982$.

The voluntary bequest parameter τ_n governs long-run saving behavior by placing weight on assets held at the terminal stage of the life cycle. Through backward recursion of the household optimality conditions, τ_n shapes the entire late-life asset accumulation profile. Accordingly, I calibrate $\{\tau_n\}$ to match the full age distribution of household financial positions in 2014 for cohorts that were economically active in 2000 (ages 34–80 in 2014). The empirical targets are constructed using household-level age profiles from the Luxembourg Wealth Study (LWS) and the National Survey of Tax and Benefit (NaSTaB), scaled to match aggregate household balance-sheet moments using net foreign asset positions from Lane and Milesi-Ferretti (2018) and government net assets from IMF (2024).

Table 3 reports the calibrated values of τ_n across economies. The estimates reveal substantial cross-country heterogeneity in voluntary bequest motives, with larger values of τ_n implying stronger incentives for middle-aged and older households to accumulate assets in order to leave bequests at the end of the life cycle. In particular, the United States exhibits a relatively weak bequest motive, with $\tau_{\text{USA}} = 13.940$, while China features

[30] Table A4 reports net foreign asset position and total liabilities (relative to GDP) in 2000.
[31] Retrieved from https://fred.stlouisfed.org/series/PCEPI.

Table 3: Calibration of Discount Factor and Voluntary Bequest Parameters

Panel A. Calibrated Parameters		
Parameter	Description	Value
β	Discount factor	0.982
τ_{USA}	Bequest motive, United States	13.940
τ_{CHN}	Bequest motive, China	50.912
τ_{DEU}	Bequest motive, Germany	18.372
τ_{GBR}	Bequest motive, United Kingdom	44.700
τ_{KOR}	Bequest motive, Korea	20.798
τ_{MEX}	Bequest motive, Mexico	12.753
τ_{IND}	Bequest motive, India	48.085
τ_{ROW}	Bequest motive, Rest of World	49.298
Panel B. Targeted Moments		
Moment	Data	Model
World real interest rate (2000–2021)	0.986	0.986
Avg. financial assets, 2014 (USA)	1.862	1.863
Avg. financial assets, 2014 (CHN)	1.307	1.308
Avg. financial assets, 2014 (DEU)	1.931	1.933
Avg. financial assets, 2014 (GBR)	5.478	5.478
Avg. financial assets, 2014 (KOR)	1.072	1.075
Avg. financial assets, 2014 (MEX)	0.470	0.442
Avg. financial assets, 2014 (IND)	0.806	0.802
Avg. financial assets, 2014 (ROW)	3.484	3.484

Notes: The world real interest rate is the average gross real return over 2000–2021, constructed by deflating world nominal interest rates with the U.S. Personal Consumption Expenditures (PCE) price index. Average financial assets in 2014 are computed as the mean net household financial position across cohorts that were alive and economically active in the base year 2000, corresponding to ages 34–80 in 2014. Financial assets are expressed relative to the age-40 wage and exclude equity-like holdings net of debt.
Sources: World Input-Output Database (2016 Release); Luxembourg Wealth Study (LWS); National Survey of Tax and Benefit (NaSTaB); Lane and Milesi-Ferretti (2018).

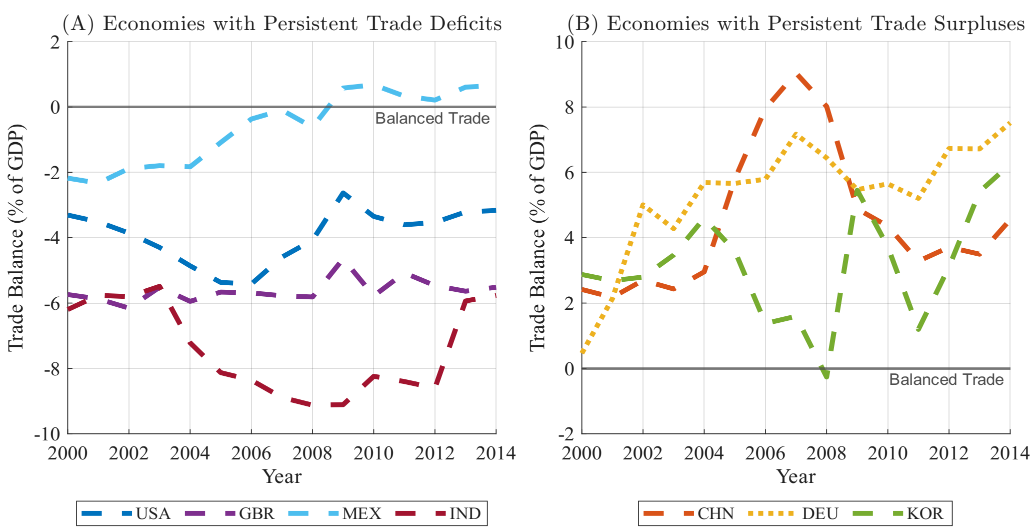
a much stronger bequest motive, with $\tau_{\text{CHN}} = 50.912$, implying substantially greater incentives for late-life asset accumulation in China.

Intertemporal Distortions Intertemporal distortions, $\{\varepsilon_{n,t}\}$, are introduced to absorb the residual trade imbalances from 2000–2014, after accounting for all modeled fundamentals and frictions. Hence, they are calibrated only after calibrating other parameters to capture the unexplained component of trade imbalances. Since global trade imbalances must sum to zero, the number of distortions needed is $|\mathcal{N}| - 1$ each year; therefore, I impose that the intertemporal distortions across economies sum to zero for each year.

In the model, intertemporal distortions $\{\varepsilon_{n,t}\}$ act as economy-specific wedges in households' intertemporal Euler equations. They are introduced as residual factors to absorb the component of trade imbalances not explained by the modeled fundamentals and frictions. For example, a trade surplus in China in year t that cannot be accounted for by other mechanisms can be rationalized by a higher $\varepsilon_{\text{CHN},t+1}$, which tilts choices toward saving and away from current consumption, raising the trade balance. Figure A15 reports the calibrated paths of $\varepsilon_{n,t}$.

4 Quantitative Analysis

Figure 1: Trade balances (% of GDP) of Seven Economies from 2000 to 2014



Notes: Trade balances (% of GDP) of the United States (USA), China (CHN), Germany (DEU), the United Kingdom (GBR), the Republic of Korea (KOR), Mexico (MEX), and India (IND) from 2000 to 2014. Economies that ran persistent trade deficits (surpluses) are shown in Panel A (B). Estimates are computed using the World Input-Output Database (WIOD) 2016 Release.

4.1 Decomposition Analysis

Figure 1 shows that the United States, the United Kingdom, Mexico, and India ran persistent trade deficits from 2000 to 2014, while China, Germany, and the Republic of Korea consistently ran surpluses. Equation (38) implies that the world goods market clearing condition requires trade balances to sum to zero, i.e., $\sum_{n\in\mathcal{N}} TB_{n,t} = 0$. If economies were identical and shared the same time paths of fundamentals and frictions, each would have $TB_{n,t} = 0$; thus, persistent surpluses and deficits reflect heterogeneity across economies.

To quantify how differences across economies contribute to the observed persistent trade imbalances, I conduct a decomposition analysis using the calibrated model. The analysis focuses on a set of economy-specific factors that shape the path of aggregate expenditures, saving, and, consequently, trade balances. Specifically, I consider: (i) demographic factors, including life expectancy $\{\chi_{n,j,t}\}$ and population growth $\{L_{n,0,t}\}$; (ii) life-cycle factors, captured by the effective labor supply profile $\{e_{n,j}\}$, the capital and housing investment profiles $\{s^k_{n,j}, s^h_{n,j}\}$, and the voluntary bequest motive $\{\tau_n\}$; (iii) institutional and policy factors, captured by financial intermediation costs $\{\phi_{n,t}\}$, government spending and debt intensities $\{\xi^X_{n,t}, \xi^B_{n,t}\}$, and bilateral trade costs $\{\hat{d}^i_{nm,t}\}$; and (iv) macroeconomic and residual factors, including sectoral productivity growth $\{\hat{T}^i_{n,t}\}$ and intertemporal distortions $\{\varepsilon_{n,t}\}$. Table A7 lists the factors included in the analysis and summarizes the dominant channels through which each economy-specific factor can influence aggregate saving and the trade balance.[32]

4.1.1 Impact Measure

Given the model's dynamic and non-linear structure, isolating the effect of an economy-specific factor on trade imbalances is challenging. I therefore conduct a ceteris-paribus counterfactual experiment to quantify the impact. In particular, I set the factor of economy n, $\vec{x}_n$, to the global average, $\vec{x}$, while keeping all other factors at their calibrated levels, re-solve the general equilibrium, compute the time-average deviation between the model-generated and observed trade balances, and interpret the resulting change as that factor's impact. Details on the construction of factor-specific global averages are provided in

[32] The decomposition is conducted for the seven selected economies and the Rest of the World (ROW), for a total of eight economies. With 12 factors per economy, this yields 96 factors.

Appendix A.5.

Formally, I define an impact measure $\mathcal{M}_m(\vec{x}_n \to \vec{x})$ as the average change in the trade balance of economy m when factor $\vec{x}_n$ originating from economy n is replaced by its global average $\vec{x}$:

$$\mathcal{M}_m(\vec{x}_n \to \vec{x}) = \frac{1}{15} \sum_{t=2000}^{2014} \left(\frac{TB_{m,t}^{Data}}{GDP_{m,t}^{Data}} - \frac{TB_{m,t}^{Model}(\vec{x}_n \to \vec{x})}{GDP_{m,t}^{Model}(\vec{x}_n \to \vec{x})} \right) \times 100 \tag{41}$$

where $TB_{m,t}^{Model}(\vec{x}_n \to \vec{x})$ and $GDP_{m,t}^{Model}(\vec{x}_n \to \vec{x})$ denote the model-implied trade balance and GDP of economy m at time t after setting $\vec{x}_n$ to $\vec{x}$. $TB_{m,t}^{Data}$ and $GDP_{m,t}^{Data}$ are the trade balance and GDP observed in the data.

The measure $\mathcal{M}_m(\cdot)$ provides a transparent way to assess the contribution of each economy-specific factor to trade imbalances. A positive value of $\mathcal{M}_m(\vec{x}_n \to \vec{x})$ indicates that $\vec{x}_n$ is, on average, a "surplus-inducing" factor for economy m, meaning that the factor in economy n shifts the trade balance of economy m upward, since setting it to the global average reduces the trade balance. Conversely, a negative value indicates that $\vec{x}_n$ is a "deficit-inducing" factor, pulling the trade balance of economy m downward on average.

4.1.2 Deficit-inducing Factors for Deficit-running Economies

Table 4 reports the ten factors with the largest deficit-inducing impacts for economies that maintained persistent trade deficits between 2000 and 2014. As shown in Figure 1, these economies are the United States, the United Kingdom, Mexico, and India.

United States For the United States, the largest deficit-inducing factor is the domestic bequest motive. The U.S.-specific bequest parameter reduces the trade balance by 20.73 percentage points of GDP on average over 2000–2014, reflecting a weaker bequest motive relative to the global benchmark. Lower desired bequests reduce asset accumulation and depress aggregate saving, generating a persistent trade deficit.

Domestic life-cycle income profiles and financial intermediation costs also contribute to U.S. trade deficits. The U.S. income profile lowers the trade balance by 2.24 percentage points of GDP, while lower financial intermediation costs reduce it by an additional 0.84 percentage points. Faster income growth early in the life cycle, combined with easier

Table 4: Major Deficit-Inducing Factors in Deficit-running Economies

United States (USA)			United Kingdom (GBR)		
Origin	Factor	Impact	Origin	Factor	Impact
USA	Bequest	-20.73	GBR	Distortion	-36.55
ROW	Bequest	-6.03	ROW	Bequest	-5.39
USA	Distortion	-2.50	GBR	Public Spending	-3.61
USA	Income Profile	-2.24	USA	Housing Profile	-2.37
ROW	Productivity	-0.97	USA	Productivity	-1.84
ROW	Income Profile	-0.91	USA	Life Expectancy	-1.11
CHN	Bequest	-0.87	ROW	Productivity	-1.03
USA	Financial Cost	-0.84	ROW	Income Profile	-0.92
GBR	Capital Profile	-0.76	CHN	Bequest	-0.66
CHN	Public Spending	-0.63	CHN	Distortion	-0.63
Mexico (MEX)			**India (IND)**		
Origin	Factor	Impact	Origin	Factor	Impact
MEX	Bequest	-19.94	IND	Productivity	-13.60
MEX	Productivity	-13.46	IND	Life Expectancy	-9.25
MEX	Housing Profile	-4.39	IND	Capital Profile	-6.08
ROW	Bequest	-2.60	ROW	Bequest	-5.55
USA	Housing Profile	-1.14	IND	Housing Profile	-5.20
USA	Productivity	-0.85	IND	Trade Cost	-2.64
ROW	Productivity	-0.70	USA	Housing Profile	-2.37
USA	Life Expectancy	-0.67	USA	Productivity	-1.73
USA	Public Debt	-0.56	CHN	Productivity	-1.30
CHN	Distortion	-0.45	USA	Life Expectancy	-1.18

Notes: The table reports the ten largest deficit-inducing factors for each deficit-running economy based on the impact measure $\mathcal{M}(\cdot)$, defined as the time-averaged deviation between observed trade balances relative to GDP and model-implied trade balances relative to GDP under counterfactual factor replacement.

access to borrowing, encourages households to borrow against future income to smooth consumption, lowering aggregate saving and the trade balance.

Foreign factors further contribute to U.S. trade deficits, particularly those originating from China. China's stronger-than-average bequest motive lowers the U.S. trade balance by 0.87 percentage points of GDP, while China's lower public spending lowers it by 0.63 percentage points. Both factors raise aggregate saving in China, reduce the world interest rate, and ease borrowing conditions faced by U.S. households, sustaining higher borrowing and consumption in the United States.

United Kingdom For the United Kingdom, the dominant deficit-inducing factor is the domestic intertemporal distortion. This factor reduces the U.K. trade balance by 36.55 percentage points of GDP on average over 2000–2014. Intertemporal distortions are modeled as a residual, and their large quantitative importance reflects the need to rationalize the United Kingdom's exceptionally large gross international asset positions rather than a single identifiable behavioral margin alone.[33]

Public spending also plays a quantitatively important role in explaining the U.K. trade deficit. The U.K.-specific public spending intensity lowers the trade balance by 3.61 percentage points of GDP, reflecting lower public saving associated with higher government expenditures.

Foreign factors further contribute to the U.K. trade deficit, particularly those originating from the United States. U.S. housing investment profiles lower the U.K. trade balance by 2.37 percentage points of GDP, while U.S. productivity growth and life expectancy lower it by 1.84 and 1.11 percentage points, respectively. Lower U.S. housing investment, slower U.S. productivity growth, and shorter U.S. life expectancy relative to the global benchmark are deficit-inducing for the United Kingdom, as these forces raise U.S. saving, lower the world interest rate, increase borrowing in the United Kingdom, and reduce its trade balance.

Mexico For Mexico, the dominant deficit-inducing force is the domestic bequest motive. Mexico's bequest parameter reduces the trade balance by 19.94 percentage points of GDP on average over 2000–2014, reflecting weaker bequest motives that lower desired asset accumulation and depress aggregate saving.

Domestic productivity is the second key driver. Mexico's productivity path reduces the trade balance by 13.46 percentage points of GDP, consistent with higher expected

[33] As shown in Table A4, the United Kingdom enters the sample period with total external liabilities exceeding 300% of GDP, far larger than in other economies. In the model, such large gross positions require sizable intertemporal wedges to reconcile observed borrowing, lending, and trade balance dynamics with saving behavior. In practice, these distortions may capture institutional and structural features not explicitly modeled, including the role of the United Kingdom as a global financial hub, the scale of its financial sector, cross-border intermediation activity, and balance-sheet expansion associated with international banking and asset management.

lifetime income encouraging stronger consumption smoothing and greater borrowing against future income.

Foreign factors are present but quantitatively smaller. Factors originating from the United States, including housing investment profiles, productivity, life expectancy, and public debt, reduce Mexico's trade balance by smaller amounts through their effects on global saving and the world interest rate, but they remain minor relative to the dominant domestic forces.

India For India, the dominant deficit-inducing force is domestic productivity. India's productivity path reduces the trade balance by 13.60 percentage points of GDP on average over 2000–2014, reflecting faster productivity growth that raises expected lifetime income, strengthens consumption smoothing, and lowers aggregate saving.

Demographic and life-cycle investment factors are also quantitatively important. Lower life expectancy relative to the global benchmark reduces the trade balance by 9.25 percentage points of GDP by weakening retirement-saving incentives. India's capital and housing investment profiles further reduce the trade balance by 6.08 and 5.20 percentage points of GDP, respectively, reflecting higher life-cycle investment needs that increase borrowing over the life cycle.

Foreign factors play a smaller role in generating deficits. Housing investment profiles, life expectancy, and productivity in the United States reduce India's trade balance by modest amounts through their effects on the world interest rate through aggregate saving, as well as through international trade, which affects relative income growth and price paths.

Across all deficit-running economies, domestic factors account for the majority of deficit-inducing forces. In the United States and the United Kingdom, life-cycle and policy-related factors, including income and housing investment profiles, bequest motives, and public spending, play the dominant role. In contrast, in Mexico and India, domestic productivity and life-cycle investment profiles are central, while foreign factors contribute but remain quantitatively modest.

Table 5: Major Surplus-Inducing Factors in Surplus-Running Economies

China (CHN)			Germany (DEU)		
Origin	Factor	Impact	Origin	Factor	Impact
CHN	Bequest	13.22	DEU	Housing Profile	9.49
CHN	Distortion	11.41	USA	Bequest	8.91
USA	Bequest	10.18	DEU	Capital Profile	7.79
CHN	Public Spending	9.19	DEU	Life Expectancy	5.00
CHN	Income Profile	7.14	GBR	Distortion	1.44
CHN	Life Expectancy	2.43	ROW	Housing Profile	1.40
USA	Distortion	1.76	DEU	Productivity	1.32
GBR	Distortion	1.70	USA	Distortion	1.26
ROW	Housing Profile	1.50	USA	Income Profile	1.12
CHN	Financial Cost	1.31	DEU	Income Profile	1.00
Republic of Korea (KOR)					
Origin	Factor	Impact			
USA	Bequest	9.59			
KOR	Life Expectancy	6.92			
KOR	Public Spending	5.56			
KOR	Distortion	4.24			
GBR	Distortion	1.65			
ROW	Housing Profile	1.35			
USA	Income Profile	1.11			
USA	Distortion	0.98			
KOR	Income Profile	0.94			
DEU	Bequest	0.89			

Notes: The ten largest surplus-inducing factors for each surplus running economy based on the impact measure $\mathcal{M}(\cdot)$, defined as the time-averaged deviation between observed trade balances relative to GDP and model-implied trade balances relative to GDP under counterfactual factor replacement.

4.1.3 Surplus-inducing Factors for Surplus-running Economies

Table 5 reports the ten factors with the largest surplus-inducing impacts for economies that maintained persistent trade surpluses between 2000 and 2014. As shown in Figure 1, these economies are China, Germany, and the Republic of Korea.

China For China, the dominant surplus-inducing force is the domestic bequest motive. China's bequest parameter raises the trade balance by 13.22 percentage points of GDP on average over 2000–2014, reflecting strong bequest motives that increase desired asset accumulation and raise aggregate saving.

Fiscal and life-cycle factors are also quantitatively important. Lower public spending relative to the global average raises China's trade balance by 9.19 percentage points of GDP. In addition, relative to the global average, China's income profile exhibits faster income growth early in the life cycle and a sharper decline around middle age, strengthening incentives to save for retirement and for consumption smoothing, which raises the trade balance by 7.14 percentage points of GDP.

Foreign factors have modest effects overall, with one notable exception. Stronger bequest motives in the United States raise China's trade balance by 10.18 percentage points of GDP, while other foreign factors have smaller effects.

Germany For Germany, the dominant surplus-inducing forces are domestic life-cycle and investment profiles. Germany's housing and capital investment profiles raise the trade balance by 9.49 and 7.79 percentage points of GDP, respectively. Germany's housing investment profile lies below the global average, reducing borrowing used to finance investment, while its capital investment profile is lower than the global average after middle age, limiting investment expenditures later in the life cycle. Together, these features raise aggregate saving and sustain persistent trade surpluses.

Demographic factors further contribute to Germany's surplus. Higher life expectancy relative to the global average raises the trade balance by 5.00 percentage points of GDP, reflecting stronger incentives to save for retirement over the life cycle. Lower domestic productivity growth raises the trade balance more modestly, by 1.32 percentage points of GDP, as slower expected income growth dampens consumption smoothing and supports higher saving.

Foreign factors have modest effects overall, with one quantitatively important channel. Weaker bequest motives in the United States raise Germany's trade balance by 8.91 percentage points of GDP by increasing the world interest rate and thereby strengthening saving incentives in Germany, while other foreign factors have smaller effects. Overall, Germany's trade surplus is driven primarily by domestic life-cycle and demographic forces, with foreign saving behavior playing a supporting role.

Republic of Korea For the Republic of Korea, the largest surplus-inducing factor originates from the United States through bequest motives. U.S. bequest motives raise Korea's trade balance by 9.59 percentage points of GDP on average over 2000–2014, indicating that saving behavior in the United States plays an important role in shaping Korea's trade surplus.

Domestic factors are also quantitatively important. Life expectancy growth in Korea exceeds the global average, strengthening incentives to save for retirement and raising the trade balance by 6.92 percentage points of GDP. Lower government spending relative to the global average further raises the trade balance by 5.56 percentage points of GDP through its effects on aggregate saving.

Life-cycle income dynamics reinforce these effects. Relative to the global average, Korea's income profile exhibits slower income growth at younger ages and a slower decline after middle age, reducing incentives to borrow early in life and supporting higher saving later in the life cycle. Together, these domestic life-cycle features and foreign saving behavior account for Korea's persistent trade surplus.

Across all surplus-running economies, domestic life-cycle and institutional factors account for the bulk of persistent trade surpluses. In China, Germany, and the Republic of Korea, bequest motives, life expectancy, and life-cycle income and investment profiles systematically raise aggregate saving and tilt trade balances toward surplus. Foreign factors matter in specific cases, such as U.S. bequest behavior for Germany and Korea, but heterogeneity in domestic life-cycle incentives remains the central force shaping persistent trade surpluses.

4.2 Counterfactual Analysis: China Shock

Policy discussions often focus on whether changes in bilateral trade costs, through tariffs, non-tariff barriers, or other trade policies, can meaningfully affect a country's aggregate trade balance (Navarro and Autry, 2011; Brookings Institution, 2020; Council on Foreign Relations, 2024). In contrast, macroeconomic analyses typically emphasize that aggregate trade imbalances are primarily determined by domestic saving and investment dynamics rather than bilateral trade frictions (Blanchard and Milesi-Ferretti, 2011; Gourinchas et al., 2024).

Motivated by this discussion, I use the calibrated model to assess the role of international trade in shaping aggregate trade imbalances through the China shock, defined as China's accession to the World Trade Organization in 2001. The China shock generated persistent declines in bilateral trade costs faced by China and its trading partners, as shown in Figures A10 and A11. To quantify its impact, I conduct a counterfactual experiment that holds bilateral trade costs between China and other economies fixed at their year-2000 levels.

Table 6: China Shock and Trade Imbalances

Economy	Impact on Trade Imbalance (% of GDP)		
	No China Export Cost Shock	No China Import Cost Shock	No China Trade Cost Shocks
United States	-0.052	0.002	-0.054
China	-0.188	0.832	0.552
Germany	-0.148	-0.109	-0.237
United Kingdom	-0.048	-0.109	-0.147
Republic of Korea	-0.166	-0.063	-0.227
Mexico	-0.022	-0.208	-0.224
India	-0.179	-0.093	-0.220

Notes: Each column reports impact measures from counterfactual simulations that shut down the respective China trade cost shock by fixing bilateral trade costs at their year-2000 levels. Impacts are time-averaged deviations between model-implied and observed trade balances relative to GDP.

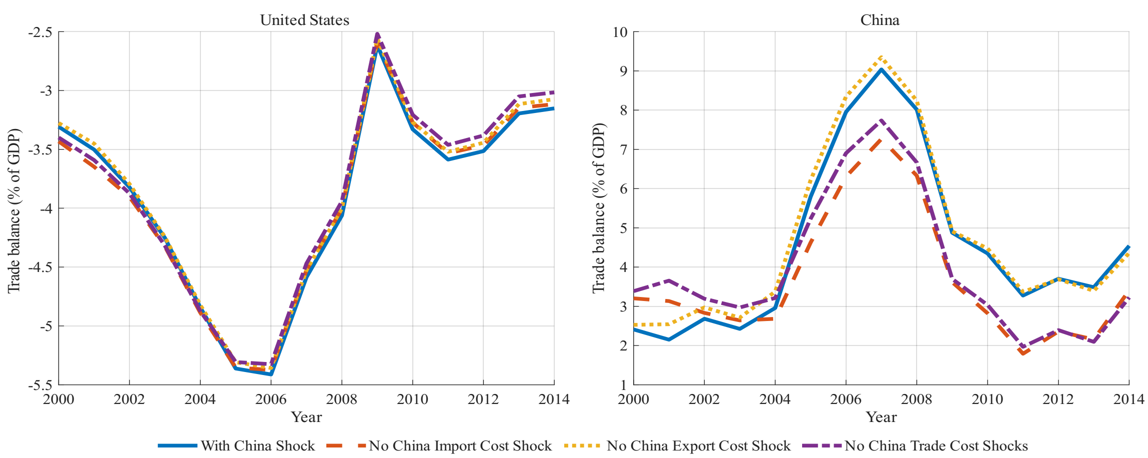
I consider three counterfactual scenarios. First, costs of exporting to China are held fixed at their year-2000 levels for all other economies ("No China Export Cost Shock"). Second, costs of importing from China are held fixed at their year-2000 levels ("No China Import Cost Shock"). Third, both export and import cost changes are shut down simultaneously ("No China Trade Cost Shocks").

Impact measures are defined analogously to $\mathcal{M}_m(\cdot)$: negative (positive) values indicate that shutting down the China shock raises (lowers) the model-implied trade balance (relative to GDP), implying that the China shock itself is deficit-inducing (surplus-inducing). Table 6 reports the resulting impacts on trade balances across seven economies. Figure 2 presents the trade balances of the United States and China from 2000 to 2014 with and without the China shock.

United States For the United States, shutting down the China shock raises the trade balance by 0.054 percentage points of GDP in the "No China Trade Cost Shocks" case, implying that the China shock is deficit-inducing. This effect is driven almost entirely by the export-cost channel: in the "No China Export Cost Shock" case, the trade balance is lower by 0.052 percentage points of GDP, while in the "No China Import Cost Shock" case the trade balance increases slightly by 0.002 percentage points of GDP.

The result for the import-cost channel reflects heterogeneous adjustments across economies driven by asymmetric trade linkages and differences in expenditure and saving patterns. The response of the United States is smaller than in other economies; since trade balances must sum to zero in levels, the import-cost channel generates a positive adjustment to the U.S. trade balance.

Figure 2: The Impact of the China Shock on Trade Balances of the United States and China



Notes: Trade balance (% of GDP) of the United States and China from 2000 to 2014 with and without the China shock.

China For China, shutting down the China shock lowers the model-implied trade balance by 0.552 percentage points of GDP in the “No China Trade Cost Shocks” case, implying that the China shock is surplus-inducing. This outcome is driven by the import-cost channel: the decline in trade partners’ costs of importing from China raises China’s model-implied trade balance by 0.832 percentage points of GDP, while the export-cost channel reduces it by 0.188 percentage points. The export-cost channel lowers the trade balance, reflecting a consumption-smoothing response to declining import costs in China: higher real income induces households to borrow more earlier in the life cycle and accumulate more assets later.

The surplus-inducing effect of the import-cost channel reflects heterogeneous general equilibrium adjustments across economies. Trading partners exhibit larger responses to the same shock, absorbing most of the adjustment through higher imports and larger trade deficits, while China’s response is smaller. As global trade balances must sum to zero, this asymmetry generates a counterpart surplus for China.

Germany and the United Kingdom For Germany, the China shock lowers the trade balance by 0.237 percentage points of GDP in the “No China Trade Cost Shocks” case. Both channels contribute to this outcome: the “No China Export Cost Shock” lowers the trade balance by 0.148 percentage points of GDP, while the “No China Import Cost Shock” lowers it by 0.109 percentage points. Together, the results indicate that the China shock modestly lowers the trade balance of Germany.

For the United Kingdom, the China shock lowers the trade balance by 0.147 percentage points of GDP in the “No China Trade Cost Shocks” case. This response is driven primarily by the import-cost channel, which reduces the trade balance by 0.109 percentage points of GDP, while the export-cost channel contributes a smaller decline of 0.048 percentage points. Overall, the China shock generates a quantitatively small but systematic deficit-inducing effect for the United Kingdom.

Republic of Korea, Mexico, and India For the Republic of Korea, the China shock lowers the trade balance by 0.227 percentage points of GDP in the “No China Trade Cost Shocks” case. Both channels contribute to this outcome: the export-cost channel lowers the trade balance by 0.166 percentage points of GDP, while the import-cost channel lowers it by 0.063 percentage points. Together, the results indicate a modest deficit-inducing effect for Korea.

For Mexico, the China shock lowers the trade balance by 0.224 percentage points of GDP in the "No China Trade Cost Shocks" case. The decline is driven primarily by the import-cost channel, which reduces the trade balance by 0.208 percentage points of GDP, while the export-cost channel contributes a much smaller reduction of 0.022 percentage points. Overall, the China shock generates a moderate deficit-inducing effect for Mexico.

For India, the China shock lowers the trade balance by 0.220 percentage points of GDP in the "No China Trade Cost Shocks" case. Both channels play a role, with the export-cost channel reducing the trade balance by 0.179 percentage points of GDP and the import-cost channel lowering it by 0.093 percentage points. As in the other economies, the China shock produces a quantitatively small but systematic deficit-inducing effect for India.

Discussion Taken together, these results indicate that changes in bilateral trade costs associated with the China shock have measurable but modest effects on aggregate trade balances. For most economies, the quantitative impact is small relative to overall trade imbalances, and the sign of the response varies across countries depending on the strength and direction of their trade links with China.

The dominant adjustment channel differs across economies. For some economies, such as the United States, the response is driven primarily by the export-cost channel, reflecting changes in exports to China and the associated income and expenditure adjustments. For others, including Mexico and the United Kingdom, the import-cost channel accounts for a larger share of the adjustment.

More broadly, the results highlight the importance of a multi-country framework for interpreting trade shocks. The import-cost shock raises the trade balance for both China and the United States, an outcome that cannot arise in a two-country setting. With multiple economies trading with China and responding differently to the same shock, larger deficit adjustments in some economies imply counterpart surplus adjustments in others in general equilibrium.

5 Conclusion

This paper develops a unified dynamic general equilibrium framework to study the forces driving persistent trade imbalances across major advanced and emerging economies from 2000 to 2014. Using a calibrated multi-economy model, I quantify how demographic factors, life-cycle income and investment profiles, bequest motives, productivity growth, fiscal policy, financial intermediation costs, and trade costs jointly shape trade balances over time.

The results show that persistent trade imbalances arise from the interaction of multiple, primarily domestic forces rather than a single dominant mechanism. Among deficit-running economies, the dominant drivers differ across countries: weaker bequest motives play a central role in the United States and Mexico, public spending is quantitatively important in the United Kingdom, and faster productivity growth, together with life-cycle investment needs, are the main deficit-inducing forces in India. In surplus-running economies, including China, Germany, and the Republic of Korea, stronger bequest motives, longer life expectancy, and life-cycle income and investment profiles that support higher saving generate persistent trade surpluses.

The paper also evaluates the role of international trade through a counterfactual analysis of the China shock associated with China's accession to the World Trade Organization in 2001. The results show that the China shock is surplus-inducing for China, while it is modestly deficit-inducing for the United States. More broadly, the China shock generates modest but systematic deficit pressures in other economies. These findings demonstrate that trade-cost shocks can shift trade balances across multiple economies simultaneously.

Taken together, the results underscore the importance of a multi-economy general equilibrium framework for interpreting global imbalances. Future research could build on this framework by endogenizing policy-driven saving mechanisms, such as pension systems or reserve accumulation, and by incorporating uncertainty, policy expectations, and foreign direct investment.

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A Appendix

A.1 Descriptions of Equilibrium Objects

This appendix lists the elements of the price set $\mathbb{P}$, parameter set Θ, and endogenous variable set $\mathbb{Y}$ referenced in Section 2 and in the sequential equilibrium definition.

Table A1: Elements of the Price Set $\mathbb{P}$

Symbol	Definition
$w_{n,t}$	Wage per unit of effective labor in economy n
$r^k_{n,t}$	Rental rate of capital in economy n
R_t	World interest rate (in final consumption units of base economy $n^\star$)
$\kappa_{n,t}(\cdot)$	Asset-position-specific gross interest rate faced by households in economy n
$p^i_{n,t}(\omega)$	Price in economy n of variety ω in sector i
$P^i_{n,t}$	Sector-i price index in economy n
$P^C_{n,t}$	Final consumption price index in economy n
$P^I_{n,t}$	Final investment price index in economy n
$P^G_{n,t}$	Final government price index in economy n
$P^C_{n^\star,t}$	Consumption price index of the base economy $n^\star$
$P^{i,M}_{n,t}$	Price of the intermediate-input bundle used by sector i in economy n

Table A2: Elements of the Parameter Set Θ

Symbol	**Definition**
$N,\ I,\ J$	Numbers of economies, sectors, and life-cycle ages
$n^{\star}$	Base economy index for numeraire consumption units
$\bar{J}$	Working-age cutoff for lump-sum tax incidence
$J_{\min}$, $J_{\max}$	Minimum and maximum ages receiving redistributed bequests
β	Discount factor
ν	Inverse of the elasticity of intertemporal substitution (EIS)
σ	Elasticity of substitution across varieties within a sector
θ_i	Fréchet productivity dispersion parameter
$T^i_{n,t}$	Productivity of sector-i in economy n at time t
$d^i_{mn,t}$	Iceberg trade costs from exporter n to importer m in sector i
$\alpha^{i,C}_n$	Sectoral expenditure shares in final consumption expenditure
$\alpha^{i,I}_n$	Sectoral expenditure shares in final investment expenditure
$\alpha^{i,G}_n$	Sectoral expenditure shares in final government expenditure
η^i_n	Labor cost share in sector i of economy n
γ^i_n	Intermediate-input cost share in sector i of economy n
$\gamma^{i,k}_n$	Input–output shares: sector i intermediates sourced from sector k
τ_n	Strength of voluntary bequest motive in economy n
δ_n	Capital depreciation rate in economy n
$\chi_{n,j,t}$	Survival probabilities from age j to $j+1$
$e_{n,j}$	Age-specific effective labor supply
$s^k_{n,j}$	Age-specific capital investment shares of wage income
$s^h_{n,j}$	Age-specific housing investment shares of wage income
$\phi_{n,t}$	Financial intermediation cost parameter
$\xi^X_{n,t}$	Government spending intensity parameter
$\xi^B_{n,t}$	Government debt intensity parameter
$\varepsilon_{n,t}$	Intertemporal distortion in economy n

Notes: Time-varying sequences (e.g., $T^i_{n,t}$, $d^i_{mn,t}$, $\phi_{n,t}$, $\xi_{n,t}$, $\varepsilon_{n,t}$) are treated as exogenous in the quantification.

Table A3: Elements of the Endogenous Variable Set $\mathbb{Y}$

Symbol	**Definition**
Households and Bequests	
$c_{n,j,t}$, $i^{k}_{n,j,t}$, $i^{h}_{n,j,t}$	Consumption and investment of age-j households
$b_{n,j,t}$, $k_{n,j,t}$, $h_{n,j,t}$	Financial asset, capital, and housing of age-j households
$b_{n,j+1,t+1}$	Next-period financial asset position
$k_{n,j+1,t+1}$, $h_{n,j+1,t+1}$	Next-period capital and housing stocks
$V_{n,j,t}(\cdot)$	Lifetime utility value function
$\Omega_{n,j,t}$	Per-capita bequest transfer received
$BV_{n,t}$	Total bequest value
$\mathcal{T}_{n,j,t}$	Lump-sum government transfer
Production and Sectoral Aggregation	
$l^{i}_{n,t}(\omega)$, $k^{i}_{n,t}(\omega)$, $m^{i}_{n,t}(\omega)$	Labor, capital, intermediate inputs for variety ω in sector i
$m^{i,k}_{n,t}(\omega)$	Material input from sector k used in sector i for variety ω
$y^{i}_{n,t}(\omega)$	Output of variety ω in sector i
$z^{i}_{n,t}(\omega)$	Idiosyncratic productivity draw for variety ω in sector i
$mc^{i}_{n,t}$	Unit cost of the input bundle in sector i
$Y^{i}_{n,t}$	Sectoral good
$Y^{C}_{n,t}$, $Y^{I}_{n,t}$, $Y^{G}_{n,t}$	Final consumption, investment, and government goods
Trade and Price Aggregation	
$\pi^{i}_{nm,t}$	Share of economy n expenditure in sector i on exporter m
$X^{i}_{nm,t}$	Imports of economy n from economy m in sector i
$X^{i}_{n,t}$	Expenditure of economy n on sector i
$X^{F}_{n,t}$	Financial intermediation expenditure
$X^{C}_{n,t}$	Aggregate final consumption expenditure
$X^{I}_{n,t}$	Aggregate final investment expenditure
$X^{G}_{n,t}$	Aggregate final government expenditure
$GO^{i}_{n,t}$	Gross output (revenue) of sector i in economy n
External Accounts and Aggregates	
$TB_{n,t}$	Trade balance (net exports)
$GDP_{n,t}$	Value added (gross domestic product)
$NFA_{n,t+1}$, $TL_{n,t+1}$, $TA_{n,t+1}$	Net foreign assets, total liabilities, total assets
Demography	
$L_{n,0,t}$	Inflow of new labor-market entrants
$L_{n,j,t}$, $L_{n,t}$	Cohort-j population and total population

A.2 Tables and Figures

Table A4: Net Foreign Asset Position (NFA) and Total Liabilities (TL) in 2000

Economy	NFA/GDP	TL/GDP
United States	-0.156	0.892
China	-0.035	0.318
Germany	0.001	1.376
United Kingdom	-0.075	3.030
Republic of Korea	-0.075	0.401
Mexico	0.317	0.507
India	-0.170	0.292

Notes: Net foreign asset position and total liabilities in 2000 (relative to GDP). Estimates are from Lane and Milesi-Ferretti (2018).

Table A5: Productivity Process Parameters used for Projection ($\rho^T_{n,i}$, $\mu^T_{n,i}$)

Economy	Agriculture/Mining		Manufacturing		Services	
	$\rho^T_{n,i}$	$\mu^T_{n,i}$	$\rho^T_{n,i}$	$\mu^T_{n,i}$	$\rho^T_{n,i}$	$\mu^T_{n,i}$
United States	0.472	-0.044	0.118	-0.063	0.109	-0.076
China	0.606	0.107	0.218	0.010	0.483	0.026
Germany	0.042	-0.149	0.436	-0.056	0.435	-0.031
United Kingdom	0.523	-0.032	0.063	-0.086	0.330	-0.034
Republic of Korea	-0.058	-0.143	0.231	-0.043	-0.009	-0.042
Mexico	-0.180	0.037	-0.525	0.156	-0.208	-0.024
India	0.129	0.058	0.131	0.122	0.315	0.034
Rest of World	0.584	-0.050	0.325	-0.034	0.671	-0.023

Notes: Each pair $(\rho^T_{n,i}, \mu^T_{n,i})$ represents the estimated persistence and trend parameters of the sector-specific productivity process for each economy and sector.

Table A6: Trade Cost Process Parameters used for Projection ($\rho^d_{nm,i}$)

	USA	CHN	DEU	GBR	KOR	MEX	IND	ROW
Panel A: Agriculture/Mining								
USA	0.000	-0.620	-0.527	0.067	-0.124	0.241	0.137	-0.000
CHN	0.256	0.000	-0.496	-0.370	-0.030	0.558	0.706	0.349
DEU	-0.660	-0.225	0.000	-0.557	-0.384	0.239	-0.115	-0.075
GBR	-0.367	-0.524	-0.221	0.000	-0.557	-0.190	0.064	0.004
KOR	-0.267	0.081	-0.710	-0.173	0.000	-0.539	-0.438	0.035
MEX	-0.132	-0.190	-0.584	-0.611	-0.017	0.000	-0.198	-0.059
IND	-0.661	-0.535	-0.470	-0.075	-0.644	0.608	0.000	0.210
ROW	-0.174	0.006	-0.600	0.050	0.064	0.150	-0.239	0.000
Panel B: Manufacturing								
USA	0.000	0.854	0.052	-0.055	0.139	-0.099	0.183	-0.272
CHN	0.362	0.000	0.419	-0.249	0.356	0.507	0.258	0.382
DEU	0.001	0.792	0.000	-0.233	-0.269	-0.042	0.001	0.253
GBR	-0.405	0.203	0.403	0.000	-0.710	-0.367	-0.215	-0.018
KOR	0.470	0.252	0.371	0.113	0.000	-0.329	-0.213	0.042
MEX	0.443	0.806	-0.216	0.595	0.175	0.000	0.325	0.487
IND	-0.209	0.797	-0.262	-0.438	0.088	-0.645	0.000	0.026
ROW	0.477	0.825	0.162	0.157	0.159	0.150	0.503	0.000
Panel C: Services								
USA	0.000	0.092	-0.113	0.331	0.192	-0.135	0.285	0.157
CHN	0.074	0.000	0.073	-0.050	0.140	-0.024	-0.148	-0.006
DEU	0.096	0.169	0.000	0.086	0.069	0.022	0.222	0.063
GBR	-0.001	0.075	-0.121	0.000	-0.254	0.143	0.005	-0.217
KOR	0.270	0.157	-0.207	0.032	0.000	-0.042	0.027	0.061
MEX	-0.246	-0.191	0.507	-0.168	0.245	0.000	0.293	0.259
IND	0.156	0.595	0.329	-0.245	0.049	-0.025	0.000	0.222
ROW	-0.171	0.530	0.377	0.537	-0.080	-0.075	0.245	0.000

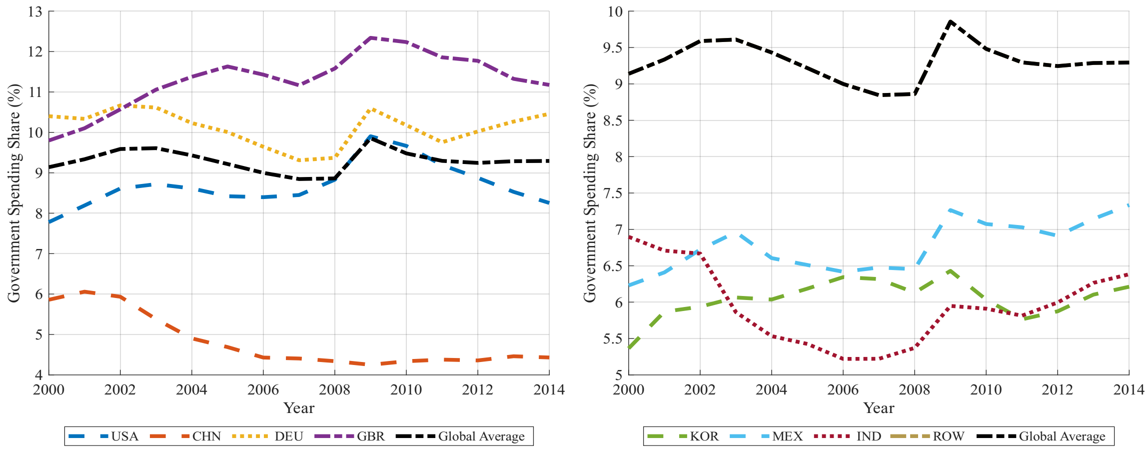
Notes: Each panel reports the estimated persistence parameter $\rho^d_{nm,i}$ for bilateral trade costs between origin n and destination m for a given sector.

Table A7: Factors Considered in the Decomposition Analysis

Factor	**Variable**	**Dominant Channel**
Life Expectancy	$\chi_{n,j,t}$	Longer expected lifespans increase desired retirement saving, tending to raise the trade balance
Population Growth	$L_{n,0,t}$	Larger cohorts of young households raise aggregate borrowing, tending to lower the trade balance
Labor Profile	$e_{n,j}$	Steeper life-cycle income growth induces early-life borrowing for consumption smoothing, tending to lower the trade balance
Capital Profiles	$s^k_{n,j}$	Higher life-cycle investment needs raise demand for borrowing, tending to lower the trade balance
Housing Profiles	$s^h_{n,j}$	Front-loaded housing investment increases early-life borrowing needs, tending to lower the trade balance
Bequest Motive	τ_n	Stronger bequest motives raise desired asset accumulation, tending to raise the trade balance
Financial Cost	$\phi_{n,t}$	Higher intermediation costs restrict borrowing, tending to raise the trade balance
Public Spending	$\xi^X_{n,t}$	Higher spending changes tax burdens on working-age households, affecting aggregate saving and trade balance
Public Debt	$\xi^B_{n,t}$	Higher debt shifts taxes intertemporally, affecting public, private saving, and trade balance
Import Cost	$\hat{d}^i_{nm,t}$	Lower import costs raise real income and borrowing for consumption smoothing, tending to lower the trade balance
Export Cost	$\hat{d}^i_{mn,t}$	Lower export costs raise income and borrowing for consumption smoothing, tending to lower the trade balance
Productivity	$\hat{T}^i_{n,t}$	Faster productivity growth raises expected income and borrowing for consumption smoothing, tending to lower the trade balance
Intertemporal Distortion	$\varepsilon_{n,t}$	Stronger preference for future consumption tilts choices toward saving, tending to raise the trade balance

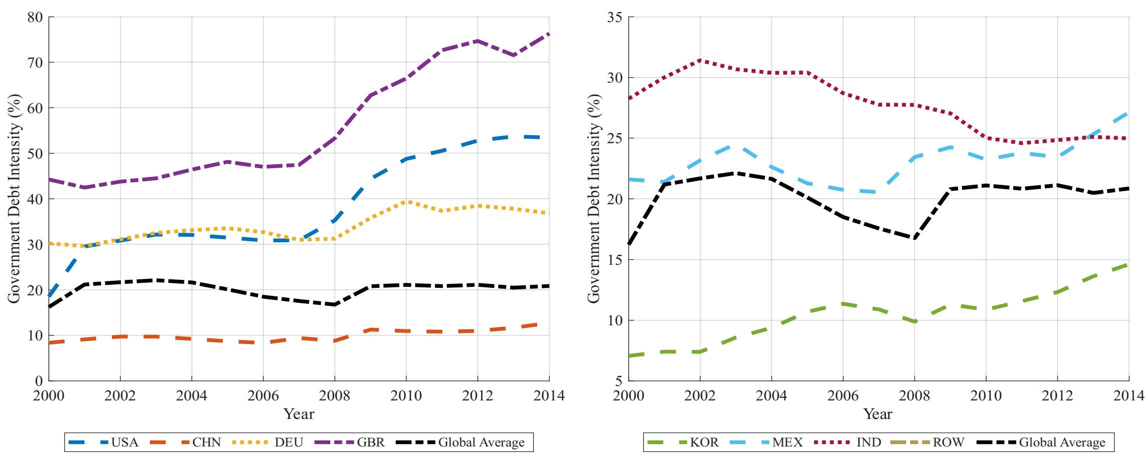
Notes: Economy-specific factors affecting aggregate saving, thereby generating differences in trade balances across economies. Dominant channels describe one possible mechanism; equilibrium effects may differ once general equilibrium interactions are taken into account.

Figure A1: Government Spending Intensity ($\xi^X_{n,t}$) from 2000 to 2014



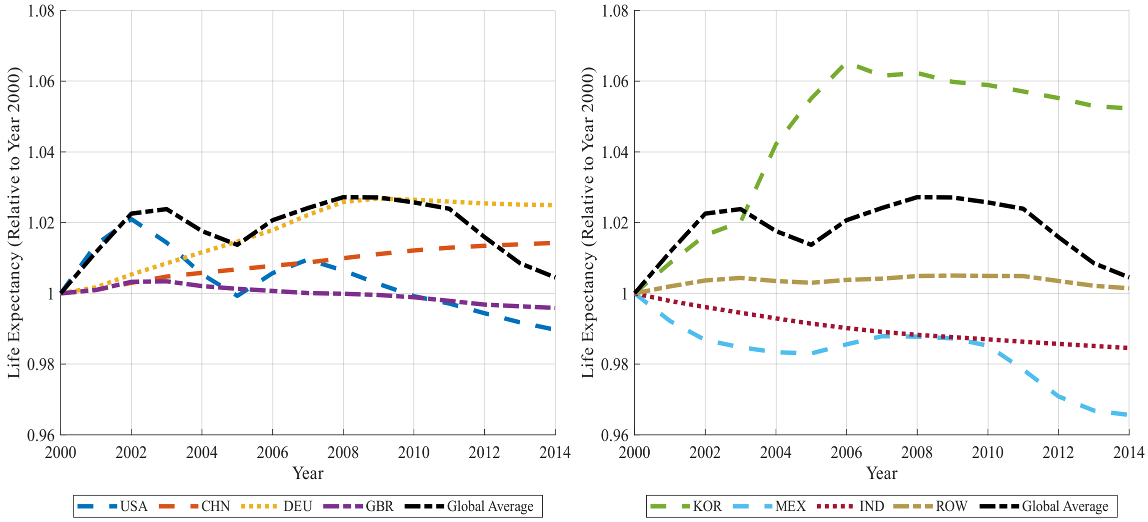
Notes: Government spending intensities $\xi^X_{n,t}$ are measured as central government purchases relative to gross output from 2000 to 2014. The global average is computed as a value-added–weighted arithmetic mean across economies, using time-averaged value-added weights.
Sources: World Input-Output Database (WIOD) 2016 Release.

Figure A2: Government Debt Intensity ($\xi^B_{n,t}$) from 2000 to 2014



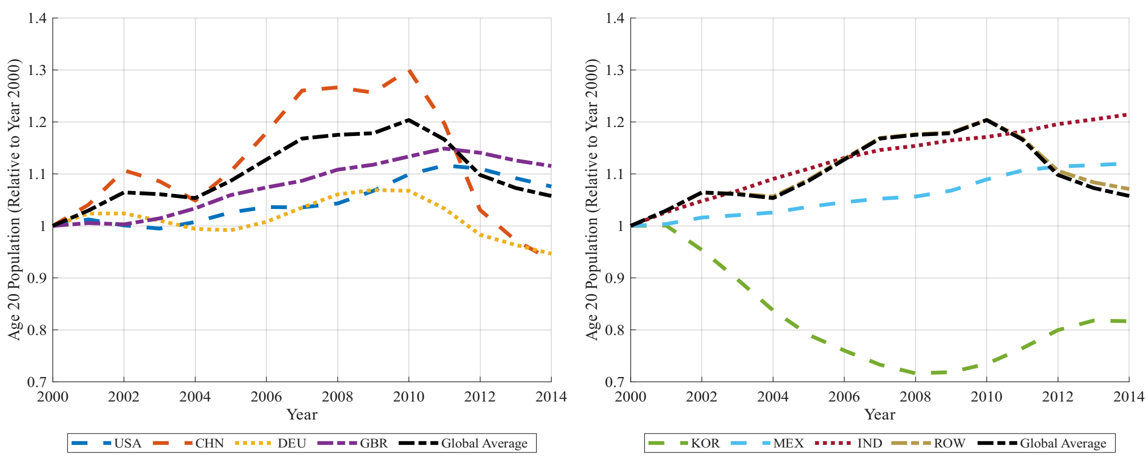
Notes: Government debt intensities $\xi^B_{n,t}$ are measured as central government gross debt relative to gross output from 2000 to 2014. The global average is computed as a value-added–weighted arithmetic mean across economies, using time-averaged value-added weights.
Sources: IMF Government Finance Statistics (GFS).

Figure A3: Life Expectancy Index (Age 40 Cohort, Relative to 2000), 2000–2014



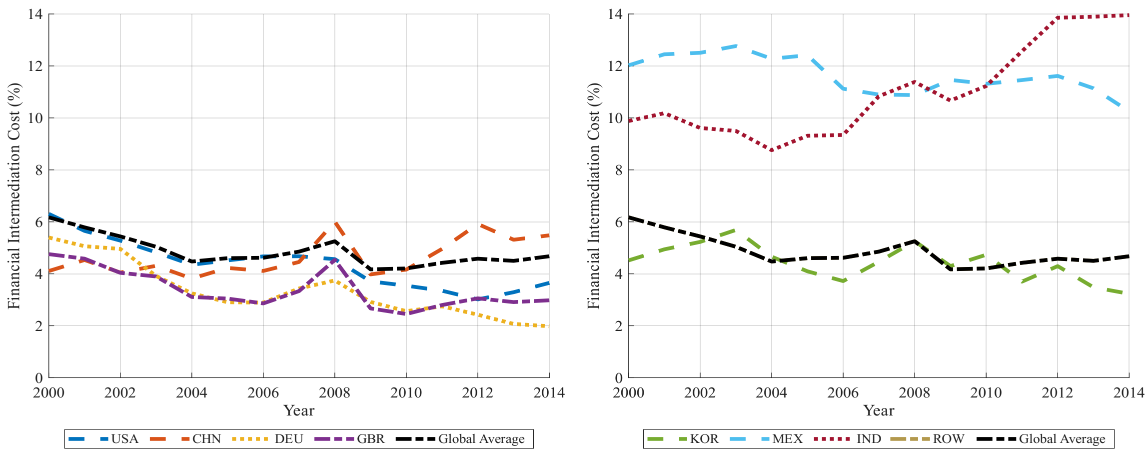
Notes: An index of life expectancy for a household aged 40 in year t, normalized to 1 in 2000. For economy n, the index equals $\prod_{h=1}^{J-20}\left(\chi_{n,20+h,t+h}/\chi_{n,20+h,2000+h}\right)$, i.e., the product of conditional survival probabilities from age 41 to the terminal age in year t relative to the value in 2000. Survival probabilities $\{\chi_{n,j,t}\}$ are constructed from UN World Population Prospects (WPP) age-specific population data. The global average uses population-weighted geometric means of $\chi_{n,j,t}$ (weights proportional to $L_{n,t}$) at each age-year (j,t), then applies the same age-40 product and normalization.

Figure A4: Age 20 Population (Relative to Year 2000) from 2000 to 2014



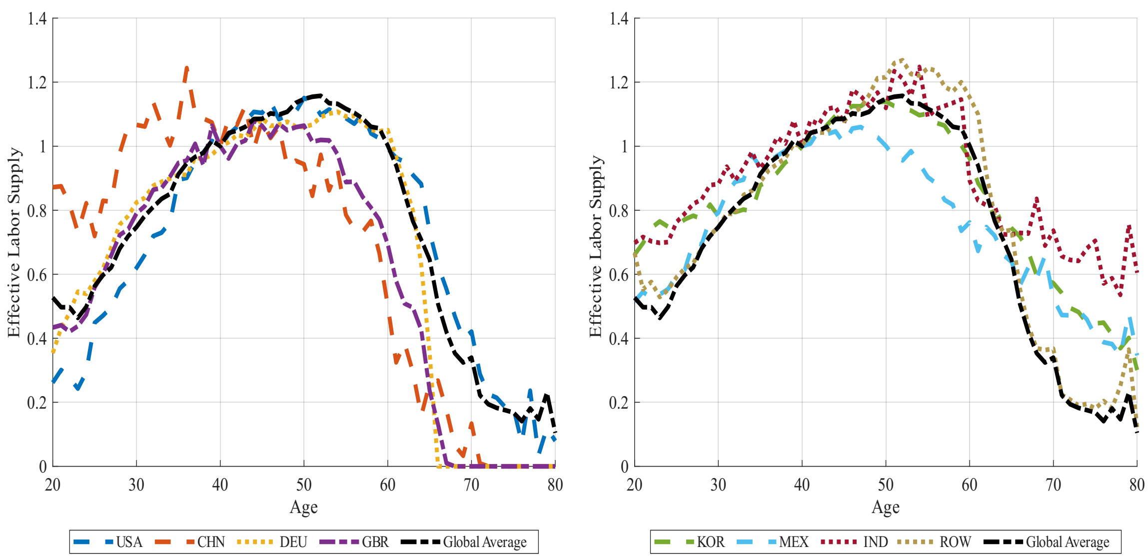
Notes: Age-20 population relative to its 2000 level ($L_{n,0,t}/L_{n,0,2000}$) from 2000 to 2014, constructed using data from UN World Population Prospects (WPP). The global average is computed as a population-weighted geometric mean across economies in each year, with weights proportional to total population $L_{n,t}$, and is normalized to 1 in 2000.

Figure A5: Financial Intermediation Cost ($\phi_{n,t}$) from 2000 to 2014



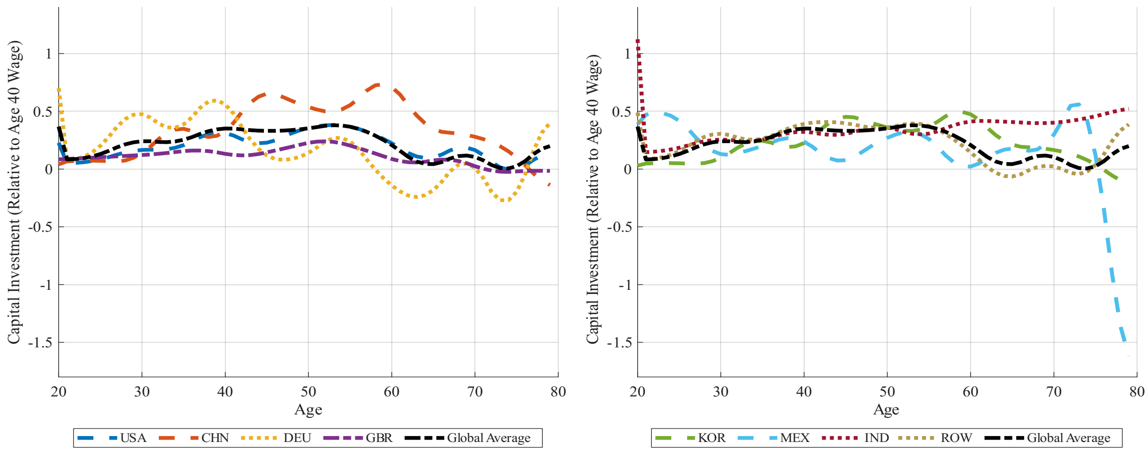
Notes: Financial intermediation costs from 2000 to 2014, computed as the lending-rate spread $\phi_{n,t} = i^L_{n,t} - (R_t - 1)$, where $i^L_{n,t}$ is the lending rate and R_t is the world interest rate (see Section A.3.1). The global average series is computed as a value-added–weighted average across economies.

Figure A6: Effective Labor Supply ($e_{n,j}$) by Age (Share of Age 40 Wage)



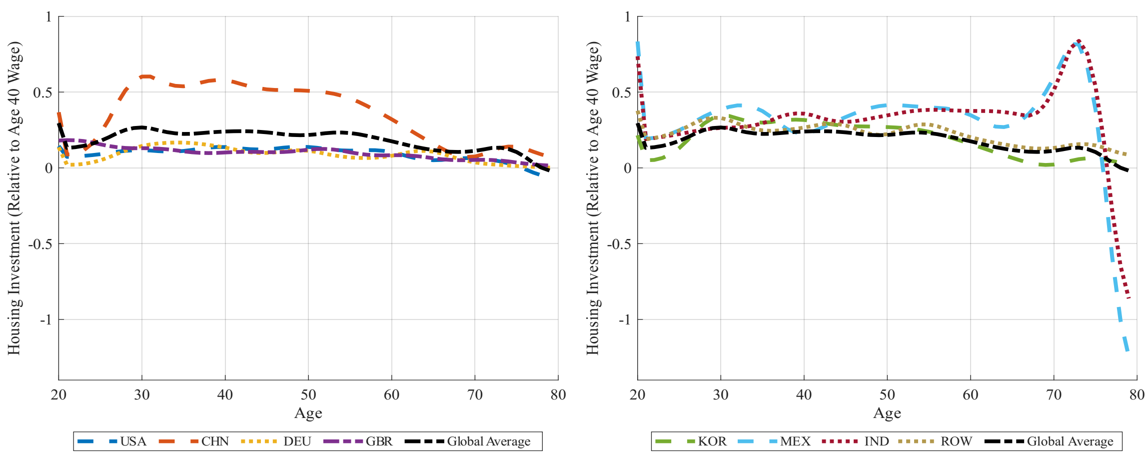
Notes: Effective labor supply by age is measured as income relative to age-40 income, with a household aged 40 supplying one unit of effective labor. Estimates are based on the Luxembourg Income Study (LIS). The global average profile is computed as a value-added–weighted average across economies, using time-averaged value-added weights.

Figure A7: Capital Investment ($s^k_{n,j}$) by Age (Share of Age 40 Wage)



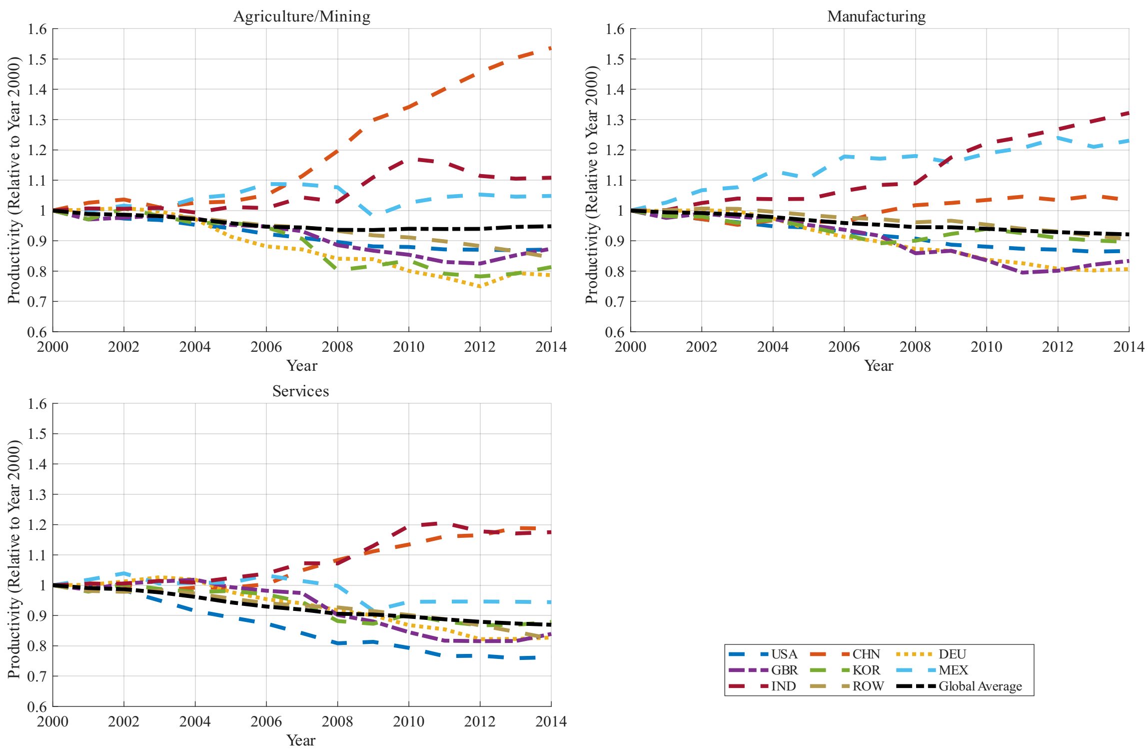
Notes: Capital investment profiles relative to age-40 wages are computed using household equity and non-residential asset positions from the Luxembourg Wealth Study (LWS) and the National Survey of Tax and Benefit (NaSTaB). The global average profile is computed as a value-added weighted average across economies.

Figure A8: Housing Investment ($s^h_{n,j}$) by Age (Share of Age 40 Wage)



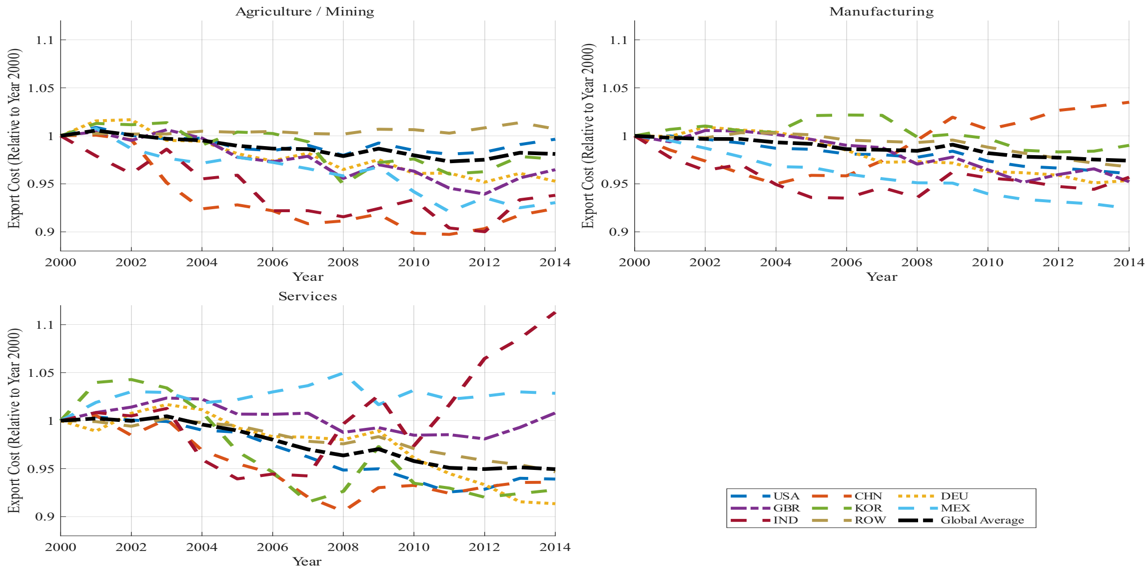
Notes: Housing investment profiles relative to age-40 wages are computed using data from the Luxembourg Wealth Study (LWS) and the National Survey of Tax and Benefit (NaSTaB). The global average profile is computed as a value-added weighted average across economies.

Figure A9: Productivity from 2000 to 2014



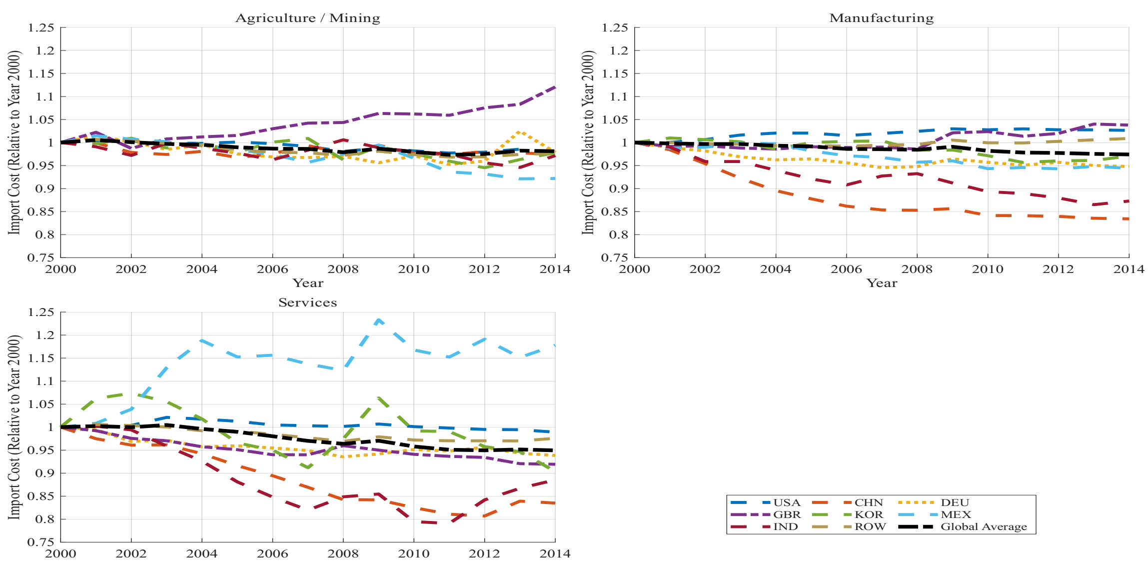
Notes: Sectoral productivity measures $(\hat{T}^i_{n,t})^{1/\theta_i}$ are shown relative to year-2000 levels for 2000–2014, using data from the World Input-Output Database 2016 Release. The global average series is computed as a value-added–weighted geometric mean across economies. Productivity dispersion parameters θ_i equal 9.11 for Agriculture, 7.10 for Manufacturing, and 4.49 for Services.

Figure A10: Average Costs of Exporting to Economies from 2000 to 2014



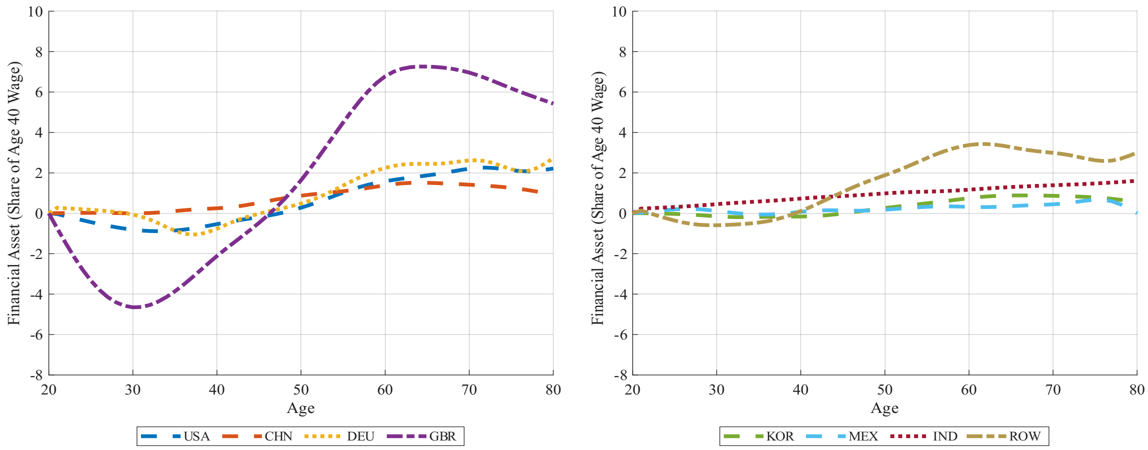
Notes: Average costs of exporting to each economy, shown relative to year-2000 levels for 2000–2014, are computed using data from the World Input-Output Database 2016 Release. The global average series is constructed as a value-added–weighted geometric mean across economies.

Figure A11: Average Costs of Importing from Economies from 2000 to 2014



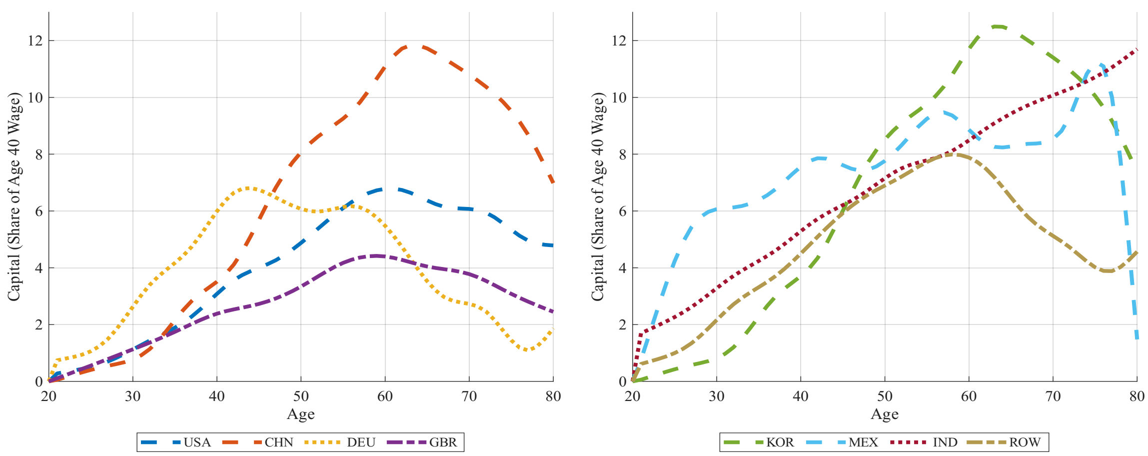
Notes: Average costs of importing from each economy, shown relative to year-2000 levels for 2000–2014, are computed using data from the World Input-Output Database 2016 Release. The global average series is constructed as a value-added–weighted geometric mean across economies.

Figure A12: Financial Asset Position ($b_{n,j,0}$) by Age in 2000 (Share of Age 40 Wage)



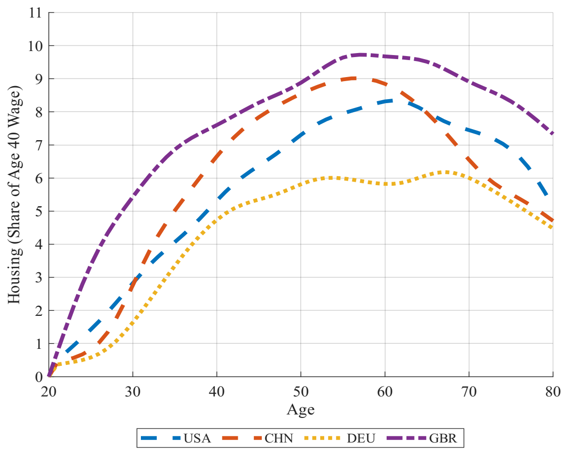
Notes: Financial asset positions by age in the base year 2000, measured as net household financial assets relative to age-40 wages. Age-profile shapes are estimated from household microdata in the Luxembourg Wealth Study (LWS) and the National Survey of Tax and Benefit (NaSTaB), normalized by age-40 income, and scaled to match economy-level aggregate household debt and net foreign asset positions using data from IMF (2024) and Lane and Milesi-Ferretti (2018).

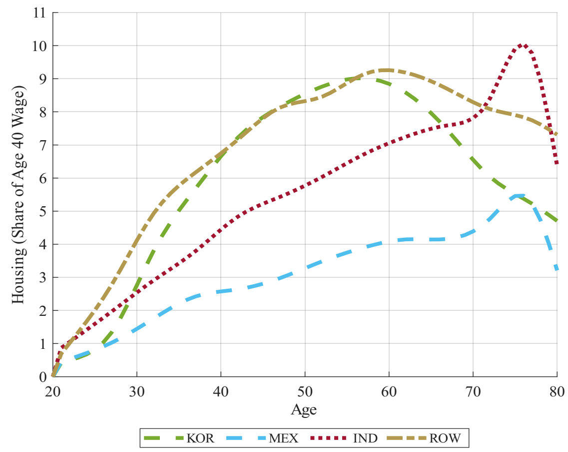
Figure A13: Capital Stock ($k_{n,j,0}$) by Age in 2000 (Share of Age 40 Wage)



Notes: Capital stock by age in the base year 2000, measured relative to age-40 wages. Age-profile shapes are estimated from household micro data in the Luxembourg Wealth Study (LWS) and the National Survey of Tax and Benefit (NaSTaB), normalized by age-40 income, and scaled to match economy-level aggregate capital stocks using data from Timmer et al. (2015).

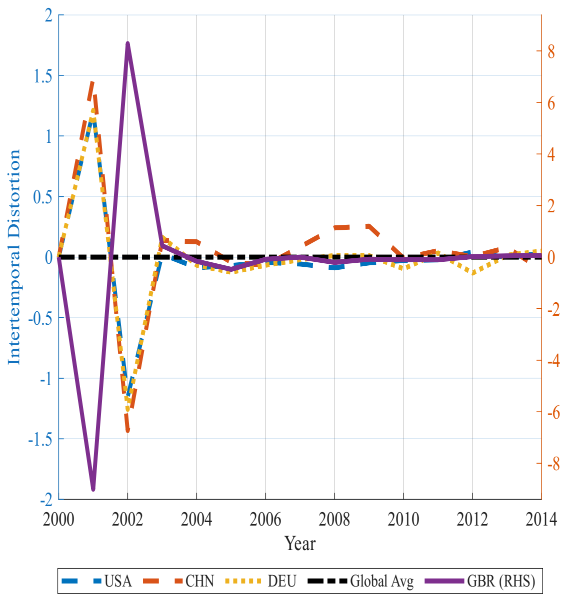
Figure A14: Housing Stock ($h_{n,j,0}$) by Age in 2000 (Share of Age 40 Wage)

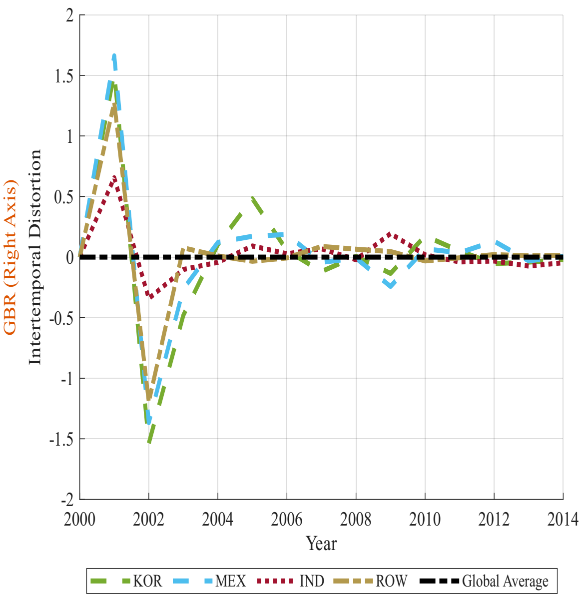




Notes: Housing stock by age in the base year 2000, measured relative to age-40 wages. Age-profile shapes are estimated from household micro data in the Luxembourg Wealth Study (LWS) and the National Survey of Tax and Benefit (NaSTaB), normalized by age-40 income, and scaled to match economy-level aggregate housing stocks using data from Timmer et al. (2015).

Figure A15: Intertemporal Distortions ($\varepsilon_{n,t}$) from 2000 to 2014





Notes: Intertemporal distortion series from 2000 to 2014, capturing economy-specific wedges that rationalize observed trade imbalances not explained by other cross-country differences in the model. By construction, the global average distortion equals zero in each year.

A.3 Detailed Description of Data and Calibration

This section describes the data sources and the procedures used to calibrate model parameters.

A.3.1 Financial Intermediation Costs

Economy-specific lending interest rate I construct economy-specific lending rates using the longest available national mortgage or benchmark lending rate series that are consistently reported over the full sample period. For the United States, I use the 30-year fixed-rate mortgage from Freddie Mac's Primary Mortgage Market Survey, accessed via FRED.[34] For the United Kingdom, I use historical mortgage rate series compiled by Mortgageable and Statista.[35] For Germany, I use mortgage interest rate series reported by Global Property Guide that track annualized agreed rates and narrowly defined effective rates.[36] For Korea, I use mortgage interest rate data compiled by TheGlobalEconomy with the Bank of Korea as the underlying source.[37] For Mexico, I use mortgage interest rate series reported by Global Property Guide.[38] For China, where a consistent national mortgage series is not available for the full period, I use the People's Bank of China benchmark lending rate as compiled by MacroMicro.[39] For India, I use the State Bank of India benchmark prime lending rate as a representative lending rate.[40]

These sources are used because official central-bank lending or mortgage rate series are either unavailable or discontinuous for several economies over the full horizon considered. While the underlying instruments differ across countries (e.g., mortgage rates, benchmark lending rates, or prime lending rates), all series capture the effective cost of household borrowing and are expressed as annualized nominal rates. To ensure comparability, I harmonize the series by focusing on long-term retail borrowing rates and abstracting from short-term policy rates that do not reflect household credit conditions.

[34]Sourced from FRED: MORTGAGE30US.
[35]Sourced from Mortgageable and Statista.
[36]Sourced from Global Property Guide: Germany.
[37]Sourced from TheGlobalEconomy: Korea.
[38]Sourced from Global Property Guide: Mexico.
[39]Sourced from MacroMicro: PBC benchmark lending rate.
[40]Sourced from SBI: Benchmark Prime Lending Rate (historical).

For the Rest of the World, I set the lending rate in each year equal to the value-added-weighted average of the seven economies above.

World interest rate The world interest rate equals the minimum of long-term government bond yields across a fixed set of major countries: the United States, Germany, the United Kingdom, Canada, France, Italy, Australia, Spain, Switzerland, South Africa, and Japan.[41] For each country, I take the long-term government bond yield series, and then take the minimum across the eleven countries for each year. This construction matches the assumption that global banks can search internationally and borrow at the lowest available interest rate.

A.3.2 Age-Specific Labor Supply

I estimate age–specific labor supply profiles using the Luxembourg Income Study (LIS), the largest harmonized income micro–database, which provides 975 datasets from 53 countries and spans five decades (LIS, 2026). LIS include both household– and person–level files. I use the person files for the estimation. The person files include information on labor income, demographics, education, industry, and survey weights. For the Republic of Korea, I use the data from the Korea Labour and Income Panel Study (KLIPS) from 1999 to 2022 (Jang et al., 2023).

I estimate profiles using the following LIS waves: United States (1999–2023); China (2002, 2013, 2018); Germany (1999–2020); United Kingdom (1999–2021); Korea (2006, 2008, 2010, 2012, 2014, 2016–2021); Mexico (1998–2006, excluding 1999, 2001, and 2003; 2008–2022, even years); India (2011); France (1999–2020); Japan (2008–2020); Canada (1999–2021); Italy (1998; 2000–2016 even years; 2020); Brazil (1999; 2001–2009; 2011–2022).

For each country, I stack all LIS person waves used in the estimation and restrict the sample to employed individuals ages 19 to 80. Within each country, I regress labor income on a full set of age fixed effects, controlling for year, sex, marital status, education, and industry, with observations weighted by person–level survey weights. The estimated age effects trace the average labor income profile by age after conditioning on observables.

[41] Sourced from FRED government bond yields.

I convert the estimated profile into an effective labor supply profile by normalizing the age–40 value to one. Once a zero appears at a given age, I set all subsequent ages to zero. For the Rest of the World, I construct the profile as the simple average of the age–specific profiles from Brazil, Canada, France, Italy, and Japan.

A.3.3 Financial Asset, Capital, and Housing Profiles and Age-Specific Investment

I use two household-level cross-sectional datasets, together with the WIOD, to calibrate capital and housing investment profiles $s^k_{n,j}$ and $s^h_{n,j}$: the Luxembourg Wealth Study (LWS) and the National Survey of Tax and Benefit (NaSTaB). The Luxembourg Wealth Study (LWS) is a harmonized, cross-national database of household wealth covering a broad set of advanced and emerging economies, providing household- and person-level information on financial and non-financial assets, liabilities (debt), market and government income, labor market outcomes, demographic characteristics, and survey weights. The National Survey of Tax and Benefit (NaSTaB) is an annual survey of Korean households that includes information on age, labor income (wages), financial assets, non-financial assets, liabilities (debt), and person-level survey weights.

I estimate life-cycle profiles using the following LWS waves: United States (1995–2022, triennial); Germany (2002, 2007, 2012, 2017); United Kingdom (2007–2021, even years); Mexico (2019); France (2009, 2014, 2017, 2020); Australia (2004, 2010, 2014, 2016, 2018, 2020); Norway (2010, 2013, 2016, 2019–2022); South Africa (2015, 2017). The profiles for the Rest of the World (ROW) are computed using data from France, Australia, Norway, and South Africa. I use the National Survey of Tax and Benefit (NaSTaB) waves 2008–2023 and proxy missing age profiles for China by mapping them to the Republic of Korea.

Initial conditions for asset positions I construct initial age profiles of household financial positions $\{b_{n,j,0}\}$, productive capital holdings $\{k_{n,j,0}\}$, and housing wealth $\{h_{n,j,0}\}$ by combining age-profile shapes estimated from the LWS and NaSTaB with economy-level aggregate targets in the base year (2000). The procedure separates the estimation of age profiles from their aggregate scaling.

For each survey wave, I restrict the sample to ages 20–80 and compute survey-weighted mean asset positions by age. All profiles are normalized by average labor income at age 40, and I impose the model normalization $b_{c,0} = k_{c,0} = h_{c,0} = 0$ for each source country c. For Korea, asset objects are constructed using NaSTaB. The financial position $b_{c,j}$ is defined as net financial claims excluding equity-like holdings and net of debt. Productive capital $k_{c,j}$ equals direct non-residential property plus indirect equity-like claims. Housing $h_{c,j}$ equals non-financial assets net of direct non-residential property. I average the resulting normalized profiles across available waves to obtain smooth age-profile shapes $\tilde{b}_{c,j}$, $\tilde{k}_{c,j}$, and $\tilde{h}_{c,j}$.

Given an age-profile shape from source country c, I scale productive capital to match the aggregate capital stock $K_{n,0}$ according to $k_{n,j,0} = \omega^k_{n,0}\tilde{k}_{n,j}$, where $\omega^k_{n,0} = K_{n,0} \Big/ \sum_{j=0}^{J} w_{n,0} L_{n,j,0} \tilde{k}_{n,j}$, $w_{n,0}$ denotes the economy-level wage in year 2000, and $L_{n,j,0}$ is the population-by-age distribution. For housing, I use the normalized age-profile shape $\tilde{h}_{n,j}$ from the micro data in units of the age-40 wage and convert it into levels by multiplying by the economy-level wage: $h_{n,j,0} = w_{n,0} \times \tilde{h}_{n,j}$.

For household financial positions, I construct age-specific profiles that jointly match aggregate private debt and the household net asset position. Let $\tilde{b}_{n,j}$ and $\tilde{k}_{n,j}$ denote the normalized age-profile shapes of financial assets and productive capital obtained from the micro data.

For each economy n and year t, I determine two scale factors. First, I match aggregate private household debt $B^C_{n,t}$ by scaling the negative part of the financial asset profile. Let $WL_{n,j,t} = w_{n,t} L_{n,j,t}$ denote efficiency-unit population weights. The debt scale factor is given by $\omega^b_n = B^C_{n,0} / \sum_{j=0}^{J} WL_{n,j,0} |\tilde{b}_{n,j}| \mathbb{1}\{\tilde{b}_{n,j} < 0\}$.

Second, I match the aggregate household net asset position implied by the external balance-sheet identity, $NFA_{n,t} = B^H_{n,t} + B^G_{n,t}$, where $NFA_{n,t}$ is taken from Lane and Milesi-Ferretti (2018) and $B^G_{n,t}$ denotes government net assets from IMF (2024). Given the debt scaling, the remaining household net position $B^H_{n,t} = NFA_{n,t} - B^G_{n,t}$ is matched by allowing positive household financial positions to load on the productive capital profile. The corresponding scale factor is $\omega^f_n = (B^H_{n,0} - \omega^b_n \sum_{j=0}^{J} WL_{n,j,0} \tilde{b}_{n,j}) / \sum_{j=0}^{J} WL_{n,j,0} \tilde{k}_{n,j}$.

The resulting age-specific household financial position is given by $b_{n,j,0} = \omega^b_n \tilde{b}_{n,j} + \omega^f_n \tilde{k}_{n,j}$. Stocks and similar liquid instruments that are recorded as capital in this calibration procedure can be interpreted as both productive capital and financial assets. Accordingly, in the calibration of household financial positions, I allow $b_{n,j,0}$ to load on both $\tilde{b}_{n,j}$ and

$\tilde{k}_{n,j}$, reflecting the fact that a non-trivial fraction of measured capital holdings consists of liquid financial claims. This construction ensures that aggregate household debt and net household assets exactly match their data counterparts while preserving the life-cycle patterns implied by the micro data.

Age-specific investment profiles I construct age-specific investment profiles for productive capital and housing using household-level cross-sectional data on asset holdings from the LWS and NaSTaB, together with aggregate investment expenditures from the WIOD. Since the underlying surveys are cross-sectional, I infer investment by age from the age-to-age evolution of average asset holdings implied by the law of motion for capital and housing.

For each economy n, I begin with time-invariant age profiles of productive capital and housing, $\{\tilde{k}_{n,j}, \tilde{h}_{n,j}\}$. Given these profiles, I compute implied age-specific investment flows for each year t according to $i^{k,\text{shape}}_{n,j,t} = \tilde{k}_{n,j+1} - (1-\delta_{n,t})\tilde{k}_{n,j}$ and $i^{h,\text{shape}}_{n,j,t} = \tilde{h}_{n,j+1} - (1-\delta_{n,t})\tilde{h}_{n,j}$, where $\delta_{n,t}$ is the economy- and year-specific depreciation rate sourced from the Penn World Table, which is only used to calibrate investment profiles.

For each economy and year from 2000 to 2014, I scale these implied investment flows so that, when aggregated across ages using population weights and efficiency units of labor, they match observed aggregate investment expenditures. Productive capital investment is scaled to match non-housing gross fixed capital formation, defined as total investment net of housing investment. Housing investment is scaled to match construction-related investment, proxied in the WIOD by construction-sector final investment demand. The resulting scale factors vary by economy and year.

Finally, I average the scaled age-specific investment flows across years to obtain time-invariant investment profiles for productive capital and housing, denoted $\{s^k_{n,j}\}$ and $\{s^h_{n,j}\}$. These profiles preserve the life-cycle shape implied by household asset accumulation while exactly matching aggregate investment levels in the data.

A.3.4 Productivity and Trade Costs

For the calibration of productivity and trade costs, I work with proportional changes relative to year 2000, denoted $\hat{x}_{n,t} \equiv x_{n,t}/x_{n,2000}$. I compute proportional changes in bilateral trade shares $(\hat{\pi}^i_{mn,t})^{\text{Data}}$ directly from the WIOD. I obtain proportional changes in marginal costs $(\hat{mc}^i_{n,t})^{\text{Data}}$ using data on labor and capital compensation, employment, capital stocks, and price indices from the WIOD Socio Economic Accounts. To focus on differential growth across economies, I remove the common global component by deflating labor and capital compensation by world gross output and by detrending sectoral prices with the GDP-weighted geometric mean across economies.

Sector level prices I construct proportional changes in sector level price indices $(\hat{P}^i_{n,t})^{\text{Data}}$ using WIOD Socio Economic Accounts and the 2023 GGDC Productivity Level Database (PLD), where hat variables denote proportional changes relative to 2000. First, I anchor sector level price levels in 2005 with the PLD. Then, I build time series using industry-level price changes in the WIOD. Then, within each economy n and sector i, I collapse industry level prices to a sector level index using value added shares as weights.

Denote $\text{PPP}^y_{n,k,2005}$ the output purchasing power parity in PLD for industry k in economy n in 2005 relative to that in the United States. Denote $LP_{n,k,2005}$ the labor productivity in industry k and economy n in 2005 defined as the value added per worker. To reflect cross-industry dispersion, I scale $\text{PPP}^y_{n,k,2005}$ inversely with labor productivity to construct the industry-level price indices:

$$P_{n,k,2005} = \frac{\text{PPP}^y_{n,k,2005}}{LP_{n,k,2005}},$$

where $P_{n,k,2005}$ is the industry k price level for economy n in 2005.

Next, denote $s_{n,k,2005}$ the 2005 value added share of industry k within sector i in economy n and $\mathcal{K}(i)$ the number of industries in sector i. I aggregate industry prices to a sector-level price index using a value added weighted geometric mean:

$$P^i_{n,2005} = \exp\left(\sum_{k\in\mathcal{K}(i)} s_{n,k,2005} \ln P_{n,k,2005}\right),$$

where $P^i_{n,2005}$ is the sector i price level in economy n in 2005.

Exact hat algebra Given observed hat variables and the sector-specific Fréchet parameters θ_i, I recover changes in productivity and bilateral trade costs by inverting the model equations, as in Dekle et al. (2007) and Caliendo et al. (2019):

$$\hat{T}^i_{n,t} = (\hat{\pi}^i_{nn,t})^{\text{Data}} \left(\frac{(\hat{mc}^i_{n,t})^{\text{Data}}}{(\hat{P}^i_{n,t})^{\text{Data}}} \right)^{\theta_i},$$

$$\hat{d}^i_{mn,t} = \left(\frac{(\hat{\pi}^i_{nn,t})^{\text{Data}}}{(\hat{\pi}^i_{mn,t})^{\text{Data}}} \right)^{1/\theta_i} \left(\frac{(\hat{P}^i_{m,t})^{\text{Data}}}{(\hat{P}^i_{n,t})^{\text{Data}}} \right).$$

Projection beyond 2014 for productivity For each economy–sector pair (n, i), I estimate a first-order autoregression, AR(1), on the log growth of productivity over 2000–2014:

$$g^T_{n,i,t} \equiv \log\left(\frac{\hat{T}^i_{n,t}}{\hat{T}^i_{n,t-1}} \right) = \mu^T_{n,i} + \rho^T_{n,i}\, g^T_{n,i,t-1} + \varepsilon^T_{n,i,t}.$$

Estimates of the drift $\mu^T_{n,i}$ and persistence $\rho^T_{n,i}$ are shown in Table A5. I project levels via $\hat{T}^i_{n,t} = \hat{T}^i_{n,t-1} \exp(g^T_{n,i,t})$. For the first twenty years after 2014, I set $\varepsilon^T_{n,i,t} = 0$ and keep the estimated drift $\mu^T_{n,i}$ active. After year twenty, I set the drift to zero so growth converges to zero and levels flatten. This delivers medium-run trend growth and a stationary long run with constant levels.

Projection beyond 2014 for bilateral trade costs For each origin-destination pair (m, n) with $m \neq n$ and sector i, I estimate a first-order autoregression, AR(1), without a constant on the log growth of bilateral trade costs over 2000–2014:

$$g^d_{m,n,i,t} \equiv \log\left(\frac{\hat{d}^i_{mn,t}}{\hat{d}^i_{mn,t-1}} \right) = \rho^d_{m,n,i}\, g^d_{m,n,i,t-1} + \varepsilon^d_{m,n,i,t}.$$

Estimates of the persistence parameters $\rho^d_{m,n,i}$ are shown in Table A6. I project levels by chaining $\hat{d}^i_{mn,t} = \hat{d}^i_{mn,t-1} \exp\big(g^d_{m,n,i,t}\big)$, setting $\varepsilon^d_{m,n,i,t} = 0$, and imposing zero drift by construction. This specification treats trade cost movements as transitory policy and disruption shocks around a stable long-run level.

A.4 Method of Simulated Moments (MSM) Procedure

This section describes the moments targeted and the estimation procedure for parameters calibrated using the method of simulated moments (MSM). The MSM parameter set is $\Theta^{\text{MSM}} = \{\beta, \{\tau_n\}_{n\in\mathcal{N}}\}$, where β is a common discount factor and τ_n governs the strength of the voluntary bequest motive in economy n.

A.4.1 Targeted Moments

The MSM calibration targets (i) the average world real interest rate and (ii) the age distribution of household financial asset positions late in the sample.

A.4.2 Calibration of the Discount Factor

The discount factor β controls the overall strength of intertemporal substitution and therefore shifts the model-implied world real interest rate along the equilibrium transition path. I choose β so that the model matches the average world real interest rate in the data over 2000–2021:

$$\frac{1}{22}\sum_{t=2000}^{2021} R_t^{\text{Model}}(\beta) = \frac{1}{22}\sum_{t=2000}^{2021} R_t^{\text{Data}}.$$

I construct the world real interest rate by deflating the world nominal interest rate series with inflation measured using the U.S. Personal Consumption Expenditures (PCE) price index.[42] Let R_t^{Data} denote the resulting world real interest rate. I choose β so that the model-implied average world real interest rate over 2000–2021 matches its empirical counterpart.[43]

A.4.3 Calibration of Voluntary Bequest Parameters

The voluntary bequest parameter τ_n governs long-run saving behavior by placing weight on assets held at the terminal stage of the life cycle. As a result, τ_n shapes the entire late-life asset accumulation profile rather than a single age-specific moment. To

[42] Retrieved from https://fred.stlouisfed.org/series/PCEPI.

[43] In the data, the average world real interest rate over 2000–2021 is -1.42%.

make this link transparent, define the (real) cash-on-hand of an individual of age $j+h$ in economy n at time $t+h$ as

$$x_{n,j,t}(h) \equiv b_{n,j,t}(h) + y_{n,j+h,t+h} - c_{n,j,t}(h) - \frac{P^I_{n,t+h}}{P^C_{n^\star,t+h}}\left(i^h_{n,j+h,t+h} + i^k_{n,j+h,t+h}\right),$$

where $b_{n,j,t}(h)$ denotes beginning-of-period financial assets in consumption units, $y_{n,j+h,t+h}$ collects non-asset resources in consumption units (labor income and net transfers), and the last term is investment spending in consumption units. Then the one-step intertemporal optimality equation can be written compactly as

$$x_{n,j,t}(h+1) = \kappa_{n,t}(h+1)x_{n,j,t}(h).$$

where $\kappa_{n,t}(h+1)$ denotes the effective rate of return on saving. At the terminal age, the voluntary bequest motive implies a terminal asset condition of the form $b_{n,j,t}(J-j+1) = \tau_n \cdot \Xi_{n,j,t} \cdot x_{n,j,t}(J-j)$, where $\Xi_{n,j,t}$ is a known composite term that depends on prices and the terminal gross return. This condition makes τ_n a direct shifter of terminal asset holdings. Since the dynamic system links terminal assets to earlier saving decisions through backward recursion, τ_n affects the full age distribution of assets observed late in the sample. Accordingly, I target the age distribution of financial positions in 2014 to calibrate τ_n.

For financial asset positions, for each economy n, I target the full age profile of household financial positions in year 2014 for cohorts that were economically active in the base year 2000. Since household asset profiles are constructed for ages 20–80, the economically active cohorts in 2000 correspond to households aged $j \geq 20$ in 2000, i.e., aged $j \geq 34$ in 2014. The empirical moment vector for economy n is therefore given by

$$\mathbb{M}_n^{\tau,\text{Data}} = \left\{b^{\text{Data}}_{n,j,2014}\right\}_{j\in\mathcal{J}_{2014}}, \qquad \mathcal{J}_{2014} = \{34,\ldots,80\}.$$

Financial positions are measured relative to the age-40 wage and correspond to net household financial claims excluding equity-like holdings and net of debt. The construction of these profiles follows exactly the same procedure as for the base-year profiles described in Appendix A.3.3.

A.4.4 MSM Objective Function

Let $\mathbb{M}^{\text{Model}}(\Theta^{\text{MSM}})$ denote the model-implied counterpart of the targeted moments, obtained by solving the full dynamic general equilibrium model under parameters Θ^{MSM}. I choose Θ^{MSM} to minimize $Q(\Theta^{\text{MSM}}) = ||\mathbb{M}^{\text{Data}} - \mathbb{M}^{\text{Model}}||$.

A.4.5 Calibration Algorithm

The MSM calibration proceeds as follows:

1. **Initialization:** Choose initial guesses for Θ^{MSM}.
2. **Model solution:** Solve the dynamic general equilibrium model and simulate the transition path.
3. **Moment construction:** Compute model-implied moments, including the average world real interest rate over 2000–2021 and the 2014 financial asset profile for ages $j \in \mathcal{J}_{2014}$.
4. **Objective evaluation:** Evaluate the MSM criterion function $Q(\Theta^{\text{MSM}})$.
5. **Parameter update:** Update Θ^{MSM} using a numerical minimization routine until convergence.
6. **Sequential step:** After estimating Θ^{MSM}, I pin down intertemporal distortions $\{\varepsilon_{n,t}\}$ so that the model exactly matches observed trade imbalances in each year.

A.5 Construction of Global Averages

This section describes how I construct the global averages used in the decomposition analysis in Section 4.1.1. Global averages define a counterfactual world economy in which demographic objects reflect the global population structure, while economic behavior reflects global production shares. The construction follows factor-specific weighting and aggregation rules that are consistent with the economic nature of each variable.

Weights I use two time-varying weighting schemes. Population weights $\omega_{n,t}^{POP}$ are proportional to total population in economy n in year t. Value-added weights $\omega_{n,t}^{VA}$ are proportional to WIOD value added in economy n over 2000–2014 and are held fixed at their 2014 values thereafter. For objects that use time-invariant weights, I define ω_{n}^{VA} as the arithmetic average of $\omega_{n,t}^{VA}$ over 2000–2014. Arithmetic means are used for level-based objects, while geometric means are used for multiplicative objects such as growth rates and hat variables.

Average life expectancy Let $\chi_{n,j,t}$ denote the conditional survival probability at age j in economy n and year t. I construct the global survival probability as the population-weighted geometric mean, $\bar{\chi}_{j,t} = \exp\left(\sum_{n\in\mathcal{N}} \omega_{n,t}^{POP} \ln \chi_{n,j,t}\right)$. In the decomposition analysis for economy n, I replace $\chi_{n,j,t}$ with $\bar{\chi}_{j,t}$ for all ages and years and reconstruct the population distribution recursively using $L_{n,j,t} = \bar{\chi}_{j,t} L_{n,j-1,t-1}$ for $j, t \geq 2$.

Average population inflow growth Let $L_{n,t}^{\text{in}} = L_{n,20,t}$ denote the inflow of new cohorts. I compute the inflow growth rate $g_{n,t}^{\text{in}} = L_{n,t}^{\text{in}}/L_{n,t-1}^{\text{in}}$ and define the global average as the population-weighted geometric mean, $\bar{g}_{t}^{\text{in}} = \exp\left(\sum_{n\in\mathcal{N}} \omega_{n,t}^{POP} \ln g_{n,t}^{\text{in}}\right)$. For economy n, I impose $L_{n,t}^{\text{in}} = \bar{g}_{t}^{\text{in}} L_{n,t-1}^{\text{in}}$ and reconstruct the full age distribution using $\bar{\chi}_{j,t}$.

Average effective labor by age Let $e_{n,j}$ denote effective labor supply at age j. I compute the global labor profile as a value-added-weighted arithmetic mean, $\bar{e}_j = \sum_{n\in\mathcal{N}} \omega_{n}^{VA} e_{n,j}$. In the decomposition analysis, I replace $e_{n,j}$ with $\bar{e}_j$ for all ages.

Average investment profiles Let $s_{n,j}^{k}$ and $s_{n,j}^{h}$ denote productive-capital and housing investment by age, expressed as shares of the age-40 wage. I compute global investment profiles using value-added-weighted arithmetic means, $\bar{s}_{j}^{k} = \sum_{n\in\mathcal{N}} \omega_{n}^{VA} s_{n,j}^{k}$, and $\bar{s}_{j}^{h} = \sum_{n\in\mathcal{N}} \omega_{n}^{VA} s_{n,j}^{h}$. In the decomposition analysis, I replace economy-specific profiles with these global averages.

Average bequest motive Let τ_n denote the voluntary bequest parameter in economy n. I compute the global bequest motive as the value-added–weighted arithmetic mean across economies, $\bar{\tau} = \sum_{n \in \mathcal{N}} \omega_n^{VA} \tau_n$. This yields a global average bequest motive of $\bar{\tau} = 35.1519$. In the decomposition analysis for economy n, I replace τ_n with $\bar{\tau}$.

Average financial intermediation cost Let $\phi_{n,t}$ denote the financial intermediation cost. I compute the global average as the value-added-weighted arithmetic mean, $\bar{\phi}_t = \sum_{n \in \mathcal{N}} \omega_{n,t}^{VA} \phi_{n,t}$. In the decomposition analysis, I replace $\phi_{n,t}$ with $\bar{\phi}_t$.

Average government expenditure Let $\xi_{n,t}^X$ denote government purchases as a share of gross output. The global average is defined as the value-added-weighted arithmetic mean, $\bar{\xi}_t^X = \sum_{n \in \mathcal{N}} \omega_{n,t}^{VA} \xi_{n,t}^X$. In the decomposition analysis, I replace $\xi_{n,t}^X$ with $\bar{\xi}_t^X$.

Average government debt Let $\xi_{n,t}^B$ denote government debt as a share of gross output. The global average is defined as the value-added-weighted arithmetic mean, $\bar{\xi}_t^B = \sum_{n \in \mathcal{N}} \omega_{n,t}^{VA} \xi_{n,t}^B$. In the decomposition analysis, I replace $\xi_{n,t}^B$ with $\bar{\xi}_t^B$.

Average bilateral trade costs Let $\hat{d}_{nm,t}^i$ denote the iceberg trade cost hat variable for exports from economy m to economy n in sector i. For each destination n, I construct the average export cost as a value-added-weighted geometric mean, $\hat{d}_{n,t,\text{avg,ex}}^i = \exp\left(\sum_{m \in \mathcal{N}} \omega_{m,t}^{VA} \ln \hat{d}_{nm,t}^i \right)$, and analogously define the average import cost. Domestic trade costs are normalized to one, $\hat{d}_{nn,t}^i = 1$. In the decomposition analysis, I replace bilateral costs with these averages to isolate export- or import-side effects.

Average productivity Let $\hat{T}_{n,t}^i$ denote sectoral productivity hat variables. For each sector-year (i, t), I compute the global productivity frontier as a value-added-weighted geometric mean, $\hat{T}_{\text{avg},t}^i = \exp\left(\sum_{n \in \mathcal{N}} \omega_{n,t}^{VA} \ln \hat{T}_{n,t}^i \right)$. In the decomposition analysis, I replace $\hat{T}_{n,t}^i$ with $\hat{T}_{\text{avg},t}^i$.

Average intertemporal distortion Let $\varepsilon_{n,t}$ denote the intertemporal distortion. By construction, its global average equals zero in every year. Accordingly, in the decomposition analysis, I set $\varepsilon_{n,t} = 0$ for all economies and years.

A.6 Derivations

This section derives the exact hat-algebra expressions used to compute changes in bilateral trade costs and productivity. All derivations follow from the standard Eaton–Kortum environment under perfect competition and CES demand.

Bilateral import shares (gravity equation) Let $\pi^i_{nm,t}$ denote the share of economy n's sector-i expenditure allocated to goods from exporter m. Then

$$\pi^i_{nm,t} = \frac{T^i_{m,t}\left(mc^i_{m,t}d^i_{nm,t}\right)^{-\theta_i}}{\sum_{k=1}^{N} T^i_{k,t}\left(mc^i_{k,t}d^i_{nk,t}\right)^{-\theta_i}}.$$

Sectoral price index The corresponding sector-i price index in economy n is

$$P^i_{n,t} = \gamma\left(\sum_{k=1}^{N} T^i_{k,t}\left(mc^i_{k,t}d^i_{nk,t}\right)^{-\theta_i}\right)^{-1/\theta_i} \equiv \gamma\left(\Phi^i_{n,t}\right)^{-1/\theta_i},$$

which implies

$$\gamma^{\theta_i}\left(P^i_{n,t}\right)^{-\theta_i} = \sum_{k=1}^{N} T^i_{k,t}\left(mc^i_{k,t}d^i_{nk,t}\right)^{-\theta_i}.$$

Changes in bilateral trade costs Combine the import share for exporter m with the domestic share ($m = n$):

$$\pi^i_{nm,t} = \frac{T^i_{m,t}\left(mc^i_{m,t}d^i_{nm,t}\right)^{-\theta_i}}{\gamma^{\theta_i}\left(P^i_{n,t}\right)^{-\theta_i}}, \qquad \pi^i_{nn,t} = \frac{T^i_{n,t}\left(mc^i_{n,t}d^i_{nn,t}\right)^{-\theta_i}}{\gamma^{\theta_i}\left(P^i_{n,t}\right)^{-\theta_i}}.$$

Taking the ratio gives

$$\frac{\pi^i_{nm,t}}{\pi^i_{nn,t}} = \frac{T^i_{m,t}\left(mc^i_{m,t}d^i_{nm,t}\right)^{-\theta_i}}{T^i_{n,t}\left(mc^i_{n,t}d^i_{nn,t}\right)^{-\theta_i}}.$$

Using the exporter-m domestic share in economy m,

$$\pi^i_{mm,t} = \frac{T^i_{m,t}\left(mc^i_{m,t}d^i_{mm,t}\right)^{-\theta_i}}{\gamma^{\theta_i}\left(P^i_{m,t}\right)^{-\theta_i}},$$

and the normalization $d^i_{nn,t} = d^i_{mm,t} = 1$, one obtains the exact hat-algebra expression for bilateral trade costs:

$$\hat{d}^i_{nm,t} = \left(\frac{\hat{\pi}^i_{nn,t}}{\hat{\pi}^i_{nm,t}}\right)^{1/\theta_i}\left(\frac{\hat{P}^i_{m,t}}{\hat{P}^i_{n,t}}\right).$$

Changes in productivity From the domestic share,

$$\pi^i_{nn,t} = \frac{T^i_{n,t}\left(mc^i_{n,t}d^i_{nn,t}\right)^{-\theta_i}}{\gamma^{\theta_i}\left(P^i_{n,t}\right)^{-\theta_i}},$$

and using $d^i_{nn,t} = 1$, proportional changes satisfy

$$\hat{T}^i_{n,t} = \hat{\pi}^i_{nn,t}\left(\frac{\hat{mc}^i_{n,t}}{\hat{P}^i_{n,t}}\right)^{\theta_i}.$$

A.7 Solution Algorithm

In this section, I present the algorithm used to solve the model.

1. Compute law of motion for cohort size

$$L_{n,j,t} = \chi_{n,j,t} \, L_{n,j-1,t-1}.$$

2. Compute law of motion for population

$$L_{n,t} = \sum_{j=0}^{J} L_{n,j,t} = L_{n,0,t} + \sum_{j=1}^{J} \chi_{n,j,t} \, L_{n,j-1,t-1}.$$

3. Begin $\boxed{\text{Loop 1}}$ (loop over $\{R_t\}_{t=1}^{T}$)

4. Begin $\boxed{\text{Loop 2}}$ (loop over $\{w_{n,t}, r^k_{n,t}\}_{n\in\mathcal{N}}$)

5. Guess factor prices: $w_{n,t}$, $r^k_{n,t}$.

6. Guess sectoral good prices: $P^i_{n,t}$.

7. Guess sectoral gross output: $GO^i_{n,t}$.

8. Compute time-change (hat) variables

$$\hat{w}_{n,t} = \frac{w_{n,t}}{w_{n,0}},$$
$$\hat{r}^k_{n,t} = \frac{r^k_{n,t}}{r^k_{n,0}},$$
$$\hat{P}^i_{n,t} = \frac{P^i_{n,t}}{P^i_{n,0}}.$$

9. Begin $\boxed{\text{Loop 3}}$ (loop over $\{\hat{P}^i_{n,t}\}_{n,i}$)

10. Compute final consumption good price

$$\hat{P}^C_{n,t} = \prod_{i\in\mathcal{I}} \left(\hat{P}^i_{n,t}\right)^{\alpha^{i,C}_n}.$$

11. Compute investment good price

$$\hat{P}^{I}_{n,t} = \prod_{i \in \mathcal{I}} \left(\hat{P}^{i}_{n,t}\right)^{\alpha_n^{i,I}}.$$

12. Compute intermediate good price

$$\hat{P}^{i,M}_{n,t} = \prod_{k \in \mathcal{I}} \left(\hat{P}^{k}_{n,t}\right)^{\gamma_n^{i,k}}.$$

13. Compute marginal cost of production

$$\hat{mc}^{i}_{n,t} = \left((\hat{w}_{n,t})^{\eta_n^i}(\hat{r}^{k}_{n,t})^{1-\eta_n^i}\right)^{1-\gamma_n^i}\left(\hat{P}^{i,M}_{n,t}\right)^{\gamma_n^i}.$$

14. Compute bilateral trade share

$$\hat{\pi}^{i}_{mn,t} = \left(\frac{\hat{T}^{i}_{n,t}\left(\hat{mc}^{i}_{n,t}\hat{d}^{i}_{mn,t}\right)^{-\theta_i}}{\sum_{k=1}^{N} \pi^{i}_{mk,0}\,\hat{T}^{i}_{k,t}\left(\hat{mc}^{i}_{k,t}\hat{d}^{i}_{mk,t}\right)^{-\theta_i}}\right).$$

15. Compute sectoral good price

$$\begin{aligned}
\hat{\Phi}^{i}_{n,t} &\equiv \sum_{k \in \mathcal{N}} \pi^{i}_{nk,0}\,\hat{T}^{i}_{k,t}\left(\hat{mc}^{i}_{k,t}\hat{d}^{i}_{nk,t}\right)^{-\theta_i}, \\
\hat{P}^{i}_{n,t} &= \left(\hat{\Phi}^{i}_{n,t}\right)^{-\frac{1}{\theta_i}}.
\end{aligned}$$

16. Update $\hat{P}^{i}_{n,t}$ using a convex combination with smoothing parameter λ_P.

17. End $\boxed{\text{Loop 3}}$

18. Investment decision

$$\begin{aligned}
i^{h}_{n,j,t} &= \frac{s^{h}_{n,j}w_{n,t}}{P^{I}_{n,t}} \times \mathbb{1}[j < J], \qquad i^{k}_{n,j,t} = \frac{s^{k}_{n,j}w_{n,t}}{P^{I}_{n,t}} \times \mathbb{1}[j < J], \\
i^{h}_{n,J,t} &= -(1-\delta_n)h_{n,J,t}, \qquad i^{k}_{n,J,t} = -(1-\delta_n)k_{n,J,t}.
\end{aligned}$$

19. Law of motion for housing and capital

$$h_{n,j+1,t+1} = (1-\delta_n)h_{n,j,t} + i^h_{n,j,t}, \qquad k_{n,j+1,t+1} = (1-\delta_n)k_{n,j,t} + i^k_{n,j,t}.$$

20. Compute government expenditure and debt

$$\begin{aligned} X^G_{n,t} &= \xi^X_{n,t} \sum_{i\in\mathcal{I}} GO^i_{n,t}, \\ B^G_{n,t} &= -\xi^B_{n,t} \frac{\sum_{i\in\mathcal{I}} GO^i_{n,t}}{P^C_{n^\star,t}}. \end{aligned}$$

21. Compute government transfers

$$\mathcal{T}_{n,j,t} = -\frac{X^G_{n,t} + \frac{P^C_{n^\star,t}}{R_{t+1}} B^G_{n,t+1} - P^C_{n^\star,t} B^G_{n,t}}{\sum_{a=0}^{\bar{J}} L_{n,a,t}} \times \mathbb{1}[J_{\min} \le j \le J_{\max}].$$

22. Start $\boxed{\text{Loop 4}}$ (loop over bequest $\Omega_{n,j,t}$; solve using `fsolve` or `fzero` in MATLAB)

23. Solve households' problem

- Interest rate function

$$\begin{aligned} \kappa_{n,t+1}(b') &= R_{t+1} + \phi_{n,t+1}\Big(\frac{1}{1+e^{1000b'}}\Big), \\ \kappa'_{n,t+1}(b') &= -\phi_{n,t+1}\frac{1000e^{1000b'}}{(1+e^{1000b'})^2}. \end{aligned}$$

- Housing investment decision

$$\begin{aligned} i^h_{n,j+h,t+h} &= s^h_{n,j+h} w_{n,t+h} \times \mathbb{1}[h < J-j], \\ i^h_{n,J,t+J-j} &= -(1-\delta_n)h_{n,J,t+J-j}. \end{aligned}$$

- Capital investment decision

$$i^k_{n,j+h,t+h} = s^k_{n,j+h} w_{n,t+h} \times \mathbb{1}[h < J - j],$$
$$i^k_{n,J,t+J-j} = -(1-\delta_n) k_{n,J,t+J-j}.$$

- Laws of motion for housing and capital

$$h_{n,j+h+1,t+h+1} = (1-\delta_n) h_{n,j+h,t+h} + i^h_{n,j+h,t+h},$$
$$k_{n,j+h+1,t+h+1} = (1-\delta_n) k_{n,j+h,t+h} + i^k_{n,j+h,t+h}.$$

- Guess $c_{n,j,t}(h)$ (consumption after h periods for an individual of age j in economy n at time t).
- Compute $b_{n,j,t}(h+1)$ (saving after h periods)

$$b_{n,j,t}(h+1) = \frac{\kappa_{n,t+h+1}(b_{n,j,t}(h+1))}{P^C_{n^\star,t+h}} \Bigg(P^C_{n^\star,t+h} b_{n,j,t}(h) + r^k_{n,t+h} k_{n,j+h,t+h} + w_{n,t+h} e_{n,j+h} + \Omega_{n,j+h,t+h} + \mathcal{T}_{n,j+h,t+h} - P^C_{n,t+h} c_{n,j,t}(h) - P^I_{n,t+h}\big(i^h_{n,j+h,t+h} + i^k_{n,j+h,t+h}\big) \Bigg).$$

- Compute $c_{n,j,t}(h+1)$

$$\Psi^C_{n,j+h,t+h} \equiv \left(\frac{\beta_{n,j+1}}{\beta_{n,j}}\right)\left(\frac{\chi_{n,j+h+1,t+h+1}}{\chi_{n,j+h,t+h}}\right)\left(\frac{e^{\varepsilon_{n,j+h+1,t+h+1}}}{e^{\varepsilon_{n,j+h,t+h}}}\right)\frac{P^C_{n,t+h}}{P^C_{n,t+h+1}},$$
$$\Psi^b_{n,j+h,t+h}(b') \equiv \frac{1}{\kappa_{n,t+h+1}(b')}\left(1 - \frac{b'\,\kappa'_{n,t+h+1}(b')}{\kappa_{n,t+h+1}(b')}\right)\frac{P^C_{n^\star,t+h}}{P^C_{n^\star,t+h+1}},$$
$$c_{n,j,t}(h+1) = \left(\Psi^b_{n,j+h,t+h}(b_{n,j,t}(h+1))\right)^{-\frac{1}{\nu}}\left(\Psi^C_{n,j+h,t+h}\right)^{\frac{1}{\nu}} c_{n,j,t}(h).$$

- Compute forward until $j = J$.

- Compute $b_{n,j,t}(J-j+1)$ and the terminal residual

$$(b_{n,j,t}(J-j+1))^{LHS} = \tau_n \Big(R_{t+J-j+1}\Big)^{\frac{1}{\nu}} \Big(\frac{P^C_{n,t+J-j+1}}{P^C_{n^\star,t+J-j+1}}\Big) c_{n,j,t}(J-j),$$

$$\begin{aligned}(b_{n,j,t}(J-j+1))^{RHS} = \frac{R_{t+J-j+1}}{P^C_{n^\star,t+J-j+1}} \Bigg(& P^C_{n^\star,t+J-j} b_{n,j,t}(J-j) + r^k_{n,t+J-j} k_{n,J,t+J-j} \\ & + w_{n,t+J-j} e_{n,J} + \Omega_{n,J,t+J-j} + \mathcal{T}_{n,J,t+J-j} - P^C_{n,t+J-j} c_{n,j,t}(J-j) \\ & - P^I_{n,t+J-j}(i^h_{n,J,t+J-j} + i^k_{n,J,t+J-j}) \Bigg),\end{aligned}$$

$$residual_C = (b_{n,j,t}(J-j+1))^{LHS} - (b_{n,j,t}(J-j+1))^{RHS}.$$

- Use `fsolve` in MATLAB to find $c_{n,j,t}(0)$ such that $residual_C = 0$.

24. Compute bequest

$$(BV_{n,t})' = \sum_{j=1}^{J} P^C_{n^\star,t} b_{n,j,t} \Big(L_{n,j-1,t-1} - L_{n,j,t}\Big) + P^C_{n^\star,t} b_{n,J+1,t}\, L_{n,J,t-1},$$

$$residual_\Omega = (BV_{n,t})' - \sum_{j=J_{\min}}^{J_{\max}} L_{n,j,t}\, \Omega_{n,j,t}.$$

25. Use `fzero` or `fsolve` in MATLAB to find $\Omega_{n,j,t}$ such that $residual_\Omega = 0$.

26. End $\boxed{\text{Loop 4}}$

27. Compute financial expenditure

$$X^F_{n,t} = P^C_{n^\star,t} \sum_{j=0}^{J} \left(\frac{1}{R_{t+1}} - \frac{1}{\kappa_{n,t+1}(b_{n,j+1,t+1})}\right) \left(-b_{n,j+1,t+1}\right) \mathbb{1}\left[b_{n,j+1,t+1} < 0\right] L_{n,j,t}.$$

28. Compute final consumption expenditures

$$X^C_{n,t} \equiv \Big(\sum_{j=0}^{J} P^C_{n,t} c_{n,j,t} L_{n,j,t}\Big) + X^F_{n,t}.$$

29. Compute investment expenditure

$$X_{n,t}^{I} \equiv \sum_{j=0}^{J} P_{n,t}^{I} \left(i_{n,j,t}^{h} + i_{n,j,t}^{k} \right) L_{n,j,t}.$$

30. Compute sector-level expenditure

$$X_{n,t}^{i} = \alpha_{n}^{i,C} X_{n,t}^{C} + \alpha_{n}^{i,I} X_{n,t}^{I} + \alpha_{n}^{i,G} X_{n,t}^{G} + \sum_{k \in \mathcal{I}} \gamma_{n}^{k} \gamma_{n}^{k,i} \sum_{m \in \mathcal{N}} \pi_{mn,t}^{k} X_{m,t}^{k}.$$

31. Solve for sector-level expenditure using Leontief inverse where the world gross output is normalized to 1

$$\begin{aligned}
\vec{F}_{n,t} &= \vec{\alpha}_{n}^{C} X_{n,t}^{C} + \vec{\alpha}_{n}^{I} X_{n,t}^{I} + \vec{\alpha}_{n}^{G} X_{n,t}^{G}, \\
\mathbf{F}_{t} &= [\vec{F}_{n,t}]_{n \in \mathcal{N}}, \\
\mathbb{A}_{t}[(n-1)I + i, \, (m-1)I + k] &= \gamma_{n}^{k} \cdot \gamma_{n}^{k,i} \cdot \pi_{mn,t}^{k}, \\
\mathbf{L}_{t} &= \left(\mathbf{I}_{NI \times NI} - \mathbf{A}_{t} \right)^{-1}, \qquad \mathbf{X}_{t} = \mathbf{L}_{t} \cdot \mathbf{F}_{t}, \\
\|\mathbf{X}_{t}\|_{1} &= 1.
\end{aligned}$$

32. Compute sector-level gross output

$$GO_{n,t}^{i} = \sum_{m \in \mathcal{N}} \pi_{mn,t}^{i} \, X_{m,t}^{i}.$$

33. Update wage using labor market clearing condition

$$w_{n,t} = \frac{\sum_{i \in \mathcal{I}} (1 - \gamma_{n}^{i}) \eta_{n}^{i} \, GO_{n,t}^{i}}{\sum_{j=0}^{J} e_{n,j} L_{n,j,t}}.$$

34. Update rental rate using capital market clearing condition

$$r_{n,t}^{k} = \frac{\sum_{i \in \mathcal{I}} (1 - \gamma_{n}^{i})(1 - \eta_{n}^{i}) \, GO_{n,t}^{i}}{\sum_{j=0}^{J} k_{n,j,t} L_{n,j,t}}.$$

35. End $\boxed{\text{Loop 2}}$

36. Update world interest rate using bond market clearing condition (use `fzero`)

$$
\begin{aligned}
WB_{t+1} &= \sum_{n\in\mathcal{N}} \Big(-B^G_{n,t+1} + \sum_{j=0}^{J} b_{n,j+1,t+1} L_{n,j,t}\, \mathbb{1}[b_{n,j+1,t+1} < 0] \Big), \\
WS_{t+1} &= \sum_{n\in\mathcal{N}} \sum_{j=0}^{J} b_{n,j+1,t+1} L_{n,j,t}\, \mathbb{1}[b_{n,j+1,t+1} > 0], \\
residual^R_t &= WS_{t+1} - WB_{t+1}.
\end{aligned}
$$

37. Use `fsolve` (or `fzero`) in MATLAB to find R_{t+1} that minimizes $residual^R_t$.

38. End $\boxed{\text{Loop 1}}$

39. Compute sector-level trade balance

$$
TB^i_{n,t} \equiv GO^i_{n,t} - X^i_{n,t}.
$$

40. Compute economy-level trade balance

$$
TB_{n,t} = \sum_{i\in\mathcal{I}} TB^i_{n,t}.
$$

41. Compute net foreign asset position and total liability

$$
\begin{aligned}
NFA_{n,t+1} &= P^C_{n^\star,t+1} \left(B^G_{n,t+1} + \sum_{j=0}^{J} b_{n,j+1,t+1}\, L_{n,j,t} \right), \\
TL_{n,t+1} &= -\left(B^G_{n,t+1} + P^C_{n^\star,t+1} \sum_{j=0}^{J} b_{n,j+1,t+1}\, \mathbb{1}[b_{n,j+1,t+1} < 0]\, L_{n,j,t} \right).
\end{aligned}
$$