Decomposing Persistent Trade Imbalances *

David D. Shin

University of Tennessee, Knoxville

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Abstract

This paper investigates the drivers of persistent trade imbalances in seven advanced and emerging economies from 2000 to 2014. Using a dynamic general equilibrium framework, I rationalize the observed imbalances as outcomes of four key forces commonly discussed in the literature: (i) demographic factors such as life expectancy, (ii) life cycle factors such as voluntary bequest motives, (iii) institutional and policy factors such as financial frictions and trade costs, and (iv) macroeconomic and residual factors such as productivity growth. The decomposition analysis based on the calibrated model shows that, for the United States and the United Kingdom, weaker voluntary bequest motives and lower financial intermediation costs are key deficit-inducing factors, while faster productivity growth explains persistent deficits in Mexico and India. For China, Germany, and Korea, stronger bequest motives, longer life expectancy, and steeper labor income profiles toward the end of the life cycle are the main drivers of their persistent surpluses. Finally, I find that China's accession to the World Trade Organization in 2001 reduced the trade balance of the United States by an average of 0.08 percentage points of GDP from 2000 to 2014.

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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, and Ting Lan 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 the imbalances are driven by frictions or economic fundamentals, policy decisions can exacerbate distortions rather than enhance efficiency and welfare.[1] From a national income accounting perspective, trade imbalances reflect the difference between national income and national expenditure. They capture the asymmetry between domestic production in an economy and the sum of consumption, investment, and government spending. Persistent imbalances therefore stem from differences in how these components evolve differently across economies.

A wide range of factors shape expenditure and production decisions, making it challenging to identify the drivers of persistent trade imbalances. Traditional explanations centered on productivity growth often fail to fully account for observed trade-balance dynamics (Gourinchas and Jeanne, 2013). This limitation has prompted the literature to explore other mechanisms in isolation, including financial frictions (Caballero et al., 2008; Mendoza et al., 2009; Coeurdacier et al., 2015), demographic changes (Backus et al., 2014; Sposi, 2021; Bárány et al., 2023), and trade costs (Reyes-Heroles, GE16; Alessandria et al., 2024). While these studies illuminate important aspects of trade imbalances, questions remain about the sufficiency and relative importance of these forces in explaining trade imbalances of multiple economies.

To address this gap, 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 considers demographic factors such as life expectancy and population growth; life-cycle patterns in labor income, investment,

[1]For instance, policies aimed at reducing deficits driven by distortions may help prevent unsustainable borrowing that increases foreign liabilities and financial instability (Obstfeld, 2012). On the other hand, when deficits reflect economic fundamentals, such policies could distort investment and innovation.

and bequest motives; institutional and policy factors such as financial intermediation costs, government spending, and 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.

The model integrates workhorse frameworks from the international trade and global imbalances literature, capturing trade imbalances driven by (i) resource flows influenced by endogenous trade activities and (ii) financial flows shaped by endogenous saving decisions. Similar to Caliendo and Parro (2015), bilateral trade flows between sectors and economies are governed by Ricardian comparative advantage, trade costs, input–output linkages; in addition, Heckscher–Ohlin motives influence bilateral trade flows due to differences and changes in labor and capital supplies across economies.

To incorporate demographic and life-cycle dynamics, the model embeds overlapping generations within each economy, similar to Bárány et al. (2023), with individuals differing in life expectancy, labor income, and investment motives over the life cycle. As populations and age structures evolve, these demographic transitions affect aggregate saving and, hence, global financial flows. The model also introduces economy-specific financial intermediation costs, which capture financial frictions that raise borrowing costs. Relative to existing frameworks, the model allows government expenditures, as well as profiles of labor income, investment, and voluntary bequest motives, to vary across economies and time.

In the model, aggregate saving in each economy depends on private saving by households. In particular, household saving is shaped by several channels arising from differences in income, prices, interest rates, and mortality risks.

First, changes in productivity and in export and import costs affect the paths of households' real income and purchasing power, leading to saving behavior driven by the motive to smooth consumption over time. Second, differences in investment demand across age groups create variation in saving incentives, as cohorts with greater investment needs

[2] Intertemporal distortions, typically modeled as variations in time preferences, capture residual factors influencing saving behavior that account for imbalances unexplained by other modeled mechanisms. The term "distortions" is therefore 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.

borrow more to finance capital accumulation. Third, government expenditures influence household saving through taxation, since higher spending financed by current or anticipated taxes reduces disposable income. Fourth, changes in financial intermediation costs (i.e., financial frictions) alter the incentives to save and borrow by changing the relative cost of borrowing. Finally, life expectancy and voluntary bequest motives determine how much cohorts value future consumption, shaping life-cycle saving behavior.

Aggregate private saving in an economy results from the combined choices of cohorts with varying sizes and at different life cycle stages. The size of the cohort entering the labor market changes 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 savings for retirement and voluntary bequests, counterbalancing the borrowing of younger generations. The composition of the economy, therefore, influences aggregate saving, expenditures, and trade imbalances.

I calibrate the model using various data sources to reflect a world comprising eight economies that have shown persistent trade imbalances from 2000 to 2014: the United States, China, Germany, the United Kingdom, the Republic of Korea, Mexico, India, and the Rest of World (ROW).[3] Using data and the hat algebra technique developed in Dekle et al. (2007), I calibrate changes in productivity, trade costs, financial intermediation costs, population inflows, mortality risks, government spending intensities, labor income and investment profiles, and voluntary bequest motives, without using information on trade imbalances. These variables are treated as exogenous throughout the analysis.

Finally, I calibrate economy-specific intertemporal distortions to precisely replicate the observed evolution of trade imbalances, capturing saving behaviors not addressed by other model components. This calibration ensures the model accurately matches the trade imbalances of all economies from 2000 to 2014.

Through the lens of the calibrated model, I quantify how economy-specific factors shape trade imbalances. For each of the 88 factors considered in the analysis, I conduct

[3]The 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 Survey of Consumer Finances (SCF) for the United States and the National Survey of Tax and Benefit (NaSTaB) for the Republic of Korea.

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, between 2000 and 2014, reflecting the effect of removing economy-specific variation in that factor. This measure captures whether a factor is surplus or deficit-inducing and enables direct comparison of its quantitative importance across all factors considered in the analysis.

The results reveal that persistent trade imbalances arise from multiple forces rather than from a single dominant driver. Among deficit-running economies, including the United States, the United Kingdom, Mexico, and India, weaker bequest motives and low saving propensities are the primary deficit-inducing factors, together with lower financial intermediation costs in advanced economies and rapid productivity growth in emerging economies. In contrast, among surplus-running economies, stronger bequest motives, longer life expectancy, and steeper labor income profiles at the end of the life cycle are the main surplus-inducing factors for China, Germany, and the Republic of Korea. These results highlight that differences in life-cycle saving behavior across economies play a central role in generating persistent trade imbalances.

Finally, I evaluate the role of international trade through a counterfactual experiment that removes the China shock, referring to China's accession to the World Trade Organization (WTO) in 2001 and the associated decline in bilateral trade costs. I find that while the China shock had a measurable effect on China's trade balance, reducing it by about 4 percentage points of GDP, its aggregate impact on the United States was modest, about 0.08 percentage points. More importantly, this result shows that a deficit-inducing factor in China can also be deficit-inducing in the United States, contrary to the prediction from a two-country framework in which one country's deficit necessarily implies another country's surplus.

Related Literature This paper contributes to the literature on global imbalances by introducing the first unified framework that quantitatively assesses the distinct roles of differences in productivity growth, trade costs, financial frictions, fiscal policies, and demographic and life cycle factors across economies as drivers of trade imbalances within a dynamic multi-economy general equilibrium setting. In addition, I document significant heterogeneity in life cycle behavior across economies by combining micro datasets from multiple sources. In particular, using individual-level datasets from the Luxembourg Income Study (LIS) covering multiple countries, together with household level balance sheet datasets, the Survey of Consumer Finances (SCF) for the United States and the National Survey of Tax and Benefit (NaSTaB) for the Republic of Korea, I show substantial differences in life cycle profiles of labor income and investment behavior across economies have quantitatively significant effects on trade imbalances.

This paper contributes to a growing strand of literature that links international trade and trade imbalances (Dekle et al., 2007; Dix-Carneiro et al., 2023; Dix-Carneiro and Traiberman, 2023; Cuñat and Zymek, 2024; Alessandria et al., 2024). Within this literature, Reyes-Heroles (GE16) shows that the global decline in trade costs accounted for most of the increase in global imbalances from 1970 to 2007 by facilitating intertemporal trade and generating consumption-smoothing-driven imbalances. Similarly, Alessandria and Choi (2021) finds that changes in trade barriers between the United States and other economies explain much of the evolution of U.S. trade imbalances from 1991 to 2015. This paper extends this literature by evaluating how changes in trade costs compare with other factors in driving trade imbalances across multiple economies within a unified framework. In addition, I show the importance of considering multiple economies and international trade when evaluating trade imbalances. In the presence of bilateral trade costs, a deficit-inducing factor in one economy need not be deficit-inducing for others. For example, the model shows that the China shock is deficit-inducing for both China and the United States, contrary to the prediction from two-country models where one economy's deficit necessarily implies the other country's surplus.

Another body of literature suggests that financial frictions can increase savings in fast-growing but financially underdeveloped economies by limiting domestic asset storage (Caballero et al., 2008), restricting borrowing for households and firms (Song et al., 2011; Coeurdacier et al., 2015; Wang et al., 2017), or hindering insurance against individual risks (Mendoza et al., 2009; Angeletos and Panousi, 2011; Coeurdacier et al., 2015). However, most existing models include only two economies, making it difficult to explain why some, like Germany and China, consistently run trade surpluses, while others, such as the United States and India, persistently run deficits. I complement this literature by showing that financial frictions play a significant role in explaining persistent trade imbalances; however, their importance is concentrated in advanced economies such as the United States and the United Kingdom, where lower financial intermediation costs facilitate capital inflows and contribute to sustained trade deficits.

This paper also relates to a strand of literature that examines how persistent global imbalances can arise from differences in demographic transitions across economies (Ferrero, 2010; Backus et al., 2014; Sposi, 2021; Bárány et al., 2023). Increases in life expectancy, which often accompany economic growth, can lead to higher aggregate saving as households plan for longer lifespans. Similarly, declines in fertility rates can reduce the number of younger, borrowing-prone households, thereby increasing aggregate saving through a compositional effect. I extend this literature by incorporating heterogeneity in age-specific labor income profiles, age-specific investment profiles, and voluntary bequest motives across economies. I show that these differences in life cycle patterns are quantitatively important drivers of persistent trade imbalances.

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), 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.[4]

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.

[4] 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 (GE16), Kehoe et al. (2018), and Dix-Carneiro et al. (2023).

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 across economies. Moreover, I capture financial frictions as time-varying borrowing costs rather than credit constraints.[5]

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 $j \in \{0, ..., J\}$. 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 foresight over aggregate variables.

2.1 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 $\{Y_{n,t}^{i}\}$, hereafter called sectoral goods. There are three types of final goods: a final consumption good $Y_{n,t}^{C}$, a final investment good $Y_{n,t}^{I}$, and a final government good $Y_{n,t}^{G}$. 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.

[5] 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.

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

$$Y_{n,t}^{f} = \prod_{i \in \mathcal{I}} \left(Y_{n,t}^{i}\right)^{\alpha_n^{i,f}}, \tag{1}$$

where $\alpha_n^{i,f}$ is the expenditure share on sector i in economy n for use f, with $\sum_{i \in \mathcal{I}} \alpha_n^{i,f} = 1$.

Given the sectoral prices $\{P_{n,t}^{i}\}$, the corresponding price index for use f is

$$P_{n,t}^{f} = \prod_{i \in \mathcal{I}} \left(\frac{P_{n,t}^{i}}{\alpha_n^{i,f}}\right)^{\alpha_n^{i,f}}. \tag{2}$$

Equations (1) and (2) show that expenditure shares can vary across uses and economies. These differences reflect variation in the composition of consumption, investment, and government baskets. As a result, composite goods and price indices may differ even when underlying sectoral prices are identical.

2.2 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 $Y_{n,t}^{i}$ in sector i of economy n at time t is a Constant Elasticity of Substitution (CES) aggregate of tradable sector-specific varieties $y_{n,t}^{i}(\omega)$:

$$Y_{n,t}^{i} = \int_0^1 \left(\left(y_{n,t}^{i}(\omega)\right)^{\frac{\sigma-1}{\sigma}} d\omega\right)^{\frac{\sigma}{\sigma-1}}, \tag{3}$$

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

The demand for the variety ω, denoted as $y_{n,t}^{i}(\omega)$, in sector i needed to produce $Y_{n,t}^{i}$ units of sectoral-i goods in economy n at time t is given by

$$y_{n,t}^{i}(\omega) = \left(\frac{p_{n,t}^{i}(\omega)}{P_{n,t}^{i}}\right)^{-\sigma} Y_{n,t}^{i}, \tag{4}$$

where $p_{n,t}^{i}(\omega)$ represents the price of variety ω in economy n at time t.

Moreover, the price of sector-i good, $P^i_{n,t}$, in economy n at time t is is given by

$$P^i_{n,t} = \Big(\int_0^1 \big(p^i_{n,t}(\omega)\big)^{1-\sigma} d\omega \Big)^{\frac{1}{1-\sigma}}. \tag{5}$$

Equation (5) shows that the sectoral price index depends on the distribution of prices of varieties. Since varieties are tradable, the sectoral price index will depend on the prices of both domestic and foreign varieties.

2.3 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:

$$\max_{l^i_{n,t}(\omega),k^i_{n,t}(\omega),m^i_{n,t}(\omega)} \quad p^i_{n,t}(\omega)y^i_{n,t}(\omega)^i(\omega) - w_{n,t}l^i_{n,t}(\omega) - r^k_{n,t}k^i_{n,t}(\omega) - P^{i,M}_{n,t}m^i_{n,t}(\omega) \tag{6}$$

$$\text{s.t.} \qquad y^i_{n,t}(\omega) = z^i_{n,t}(\omega)\Big(\big(l^i_{n,t}(\omega)\big)^{\eta^i_n}\big(k^i_{n,t}(\omega)\big)^{1-\eta^i_n}\Big)^{1-\gamma^i_n}\Big(m^i_{n,t}(\omega)\Big)^{\gamma^i_n}, \tag{7}$$

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 $\{m^{i,k}_{n,t}(\omega)\}$:

$$m^i_{n,t}(\omega) = \prod_{k\in\mathcal{I}}\Big(m^{i,k}_{n,t}(\omega)\Big)^{\gamma^{i,k}_n}, \tag{8}$$

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 $\sum_{k\in\mathcal{I}}\gamma^{i,k}_n = 1$. 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. The shares $\{\gamma_n^{i,k}\}$ governing input-output linkages vary across sectors and economies.

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 $z_{n,t}^i(\omega)$ equals the unit cost of production, $\frac{mc_{n,t}^i}{z_{n,t}^i(\omega)}$, where $mc_{n,t}^i$ denotes the economy-sector-specific cost of an input bundle given by

$$mc_{n,t}^i = \Upsilon_n^i \Big((w_{n,t})^{\eta_n^i} (r_{n,t}^k)^{1-\eta_n^i} \Big)^{1-\gamma_n^i} \left(\prod_{k \in \mathcal{I}} \Big(P_{n,t}^k(\omega) \Big)^{\gamma_n^{i,k}} \right)^{\gamma_n^i}, \tag{9}$$

where Υ_n^i is a constant specific to sector i of economy n.[6]

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

$$F_{n,t}(z_{n,t}^i(\omega)) = e^{-T_{n,t}^i (z_{n,t}^i(\omega))^{-\theta_i}}, \tag{10}$$

which depends on two parameters: $T_{n,t}^i$ and θ_i. $T_{n,t}^i$ represents the state of productivity in sector i of economy n at time t. As $T_{n,t}^i$ increases, producers in sector i of economy n become more likely to receive high productivity draws. θ_i governs the dispersion of productivity draws within sector i. As θ_i increases, producers in sector i of economy n have similar productivity levels. 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.

[6]Specifically, $\Upsilon_n^i = (1-\gamma_n^i)^{-(1-\gamma_n^i)} (\eta_n^i)^{-\eta_n^i(1-\gamma_n^i)} (1-\eta_n^i)^{-(1-\eta_n^i)(1-\gamma_n^i)} \Big(\prod_{k \in \mathcal{I}} \Big(\gamma_n^{i,k} \gamma_n^i \Big)^{-\gamma_n^{i,k}\gamma_n^i} \Big)$.

2.4 International Trade

Shipping goods from sector i of economy m to economy n at time t entails an iceberg shipping cost $d^i_{nm,t} \geq 1$.[7] This assumption implies that producers in economy n need to ship $d^i_{nm,t}$ units of good for one unit of good to arrive in economy m.

Consumers derive the same amount of utility from 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

$$p^i_{n,t}(\omega) = \min_{m \in \mathcal{N}} \left\{ \frac{mc^i_{m,t}}{z^i_{m,t}(\omega)} d^i_{nm,t} \right\}. \tag{11}$$

Equation (11) 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

$$X^i_{nm,t} = \pi^i_{nm,t} X^i_{n,t}, \tag{12}$$

where

$$\pi^i_{nm,t} = \frac{T^i_{m,t} \left(mc^i_{m,t} d^i_{nm,t} \right)^{-\theta_i}}{\sum_{k \in \mathcal{N}} T^i_{k,t} \left(mc^i_{k,t} d^i_{nk,t} \right)^{-\theta_i}} \tag{13}$$

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 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

[7]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: $d^i_{nm,t} \leq d^i_{nh,t} d^i_{hm,t}, \forall n, m, h \in \mathcal{N}, i \in \mathcal{I}, t \in \mathcal{T}$.

(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 follows:

$$P^i_{n,t} = \Psi^i \left(\Phi^i_{n,t}\right)^{-\frac{1}{\theta_i}} \tag{14}$$

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.[8] 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 $\{mc^i_{n,t}\}$.

2.5 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 consumption good $P^C_{n^\star,t}$.[9] 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 borrowed amount b. Under perfect competition, global banks offer economy-specific interest rates $\kappa_{n,t}(b)$ such that they earn zero profits: $\kappa_{n,t}(b) = R_t + \phi_{n,t}\,\mathbb{1}[b < 0]$. 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.[10]

[8] 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.

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

[10] In the quantitative analysis, I estimate $\phi_{n,t}$ as the spread between economy-specific lending rates and the world interest rate observed in the data. These spreads may capture not only the intermediation costs

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:

$$X^F_{n,t} = P^C_{n^\star,t} \sum_{j=0}^{J} \left(\frac{1}{R_{t+1}} - \frac{1}{\kappa_{n,t+1}(b_{n,j+1,t+1})} \right) \cdot \left(-b_{n,j+1,t+1}\right) \cdot \mathbb{1}\left[b_{n,j+1,t+1} < 0\right] \cdot L_{n,j,t} \quad (15)$$

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.

2.6 Households

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

To ensure that investment decisions of households capture the life-cycle patterns observed in the data while keeping the model tractable, I specify an exogenous rule for investment. For all non-terminal ages $j < J$, investment $i_{n,j,t}$ is not a choice variable but is instead determined by an age-specific profile, $s_{n,j}$, the price of investment good $P^I_{n,t}$, and

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
$s_{n,j}$	Age-specific investment share of wage income
δ_n	Economy-specific capital depreciation rate
Variables	
$b_{n,j,t}$	Household's financial asset position at age j and time t
$k_{n,j,t}$	Household's capital holdings at age j and time t
$c_{n,j,t}$	Household's consumption at age j and time t
$i_{n,j,t}$	Household's investment at age j and time t
$\kappa_{n,t}(\cdot)$	Function determining the asset-position-specific interest rate
$\varepsilon_{n,t}$	Intertemporal distortion
$w_{n,t}$	Wage per unit of effective labor
$r^k_{n,t}$	Rental rate of 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

the wage per unit of effective labor in economy n, $w_{n,t}$:

$$i_{n,j,t} = \frac{s_{n,j} w_{n,t}}{P^I_{n,t}}. \tag{16}$$

This functional form allows investment to respond to both the household's life-cycle stage and the time-varying state of the economy.[11]

[11]The age-specific investment profile reflects predictable life-cycle spending patterns, especially age-related housing purchases. Furthermore, the functional form allows investment to respond to aggregate fluctuations in wages and the price of investment goods, thereby generating comovement of output and investment, consistent with the macroeconomic literature (Greenwood et al., 1997; King and Rebelo, 1999). For tractability, the model abstracts from investment responses to changes in interest rates, credit constraints, and adjustment costs.

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

$$V_{n,j,t}(b,k) = \max_{c,\, b'} \left\{ \frac{c^{1-\nu}}{1-\nu} + \beta\, e^{\varepsilon_{n,t+1}} \chi_{n,j+1,t+1}\, V_{n,j+1,t+1}(b',k') \right\}, \tag{17}$$

subject to the budget constraint and the law of motion for capital:

$$P^C_{n,t} c \;+\; s_{n,j} w_{n,t} \;+\; \frac{P^C_{n^\star,t}}{\kappa_{n,t+1}(b')} b' = P^C_{n^\star,t} b \;+\; r^k_{n,t} k \;+\; w_{n,t} e_{n,j} \tag{18}$$

$$+ \Omega_{n,j,t} + \mathcal{T}_{n,j,t},$$

$$k' = (1-\delta_n)k + \frac{s_{n,j} w_{n,t}}{P^I_{n,t}}. \tag{19}$$

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

$$V_{n,J,t}(b,k) = \max_{c,\, b'} \left\{ \frac{c^{1-\nu}}{1-\nu} + \frac{\tau_n^\nu}{1-\nu} \left(\frac{P^C_{n^\star,t+1}}{P^C_{n,t+1}} b' \right)^{1-\nu} \right\}, \tag{20}$$

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 $t+1$. To ensure bequests are only made with financial assets, the terminal investment condition satisfies $i_{n,J,t} = -(1-\delta_n)k$, which implies households liquidate all capital at the end of the life cycle.[12]

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 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, $e_{n,j}$.[13] Similarly, capital income

[12] This assumption reflects the real-world practice where non-financial assets, such as real estate, are typically liquidated so their value can be easily divided among beneficiaries.

[13] The age-specific effective labor supply can be interpreted as a result of human capital accumulation,

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 this capital stock is driven by an age-specific investment profile, $s_{n,j}$. 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 $\kappa_{n,t}(\cdot)$, 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.

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.[14] In addition to these intended

experience, and/or seniority. It can differ across economies due to differences in labor market institutions.

[14] I have incorporated a voluntary bequest motive in the model to account for the sluggish decline in asset position after retirement and the significant amount of assets held by older households, as observed in data sources such as the Survey of Consumer Finances and the National Survey of Tax and Benefit. While it is theoretically possible to also include utility from accidental bequest, this extension presents challenges due to limited data availability.

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.

2.7 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

$$BV_{n,t} = \underbrace{\sum_{j=1}^{J} P^C_{n^\star,t} b_{n,j,t} \left(L_{n,j-1,t-1} - L_{n,j,t} \right)}_{\text{Accidental Bequests}} + \underbrace{P^C_{n^\star,t} b_{n,J+1,t} L_{n,J,t-1}}_{\text{Voluntary Bequests}}. \tag{21}$$

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.

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

$$\Omega_{n,j,t} = \frac{BV_{n,t}}{\sum_{j=J_{\min}}^{J_{\max}} L_{n,j,t}}. \tag{22}$$

2.8 Government

In each economy n at time t, the government spends $X^G_{n,t}$ and levies lump-sum taxes on households in order to maintain a balanced budget. To tractably capture empirically observed differences in government spending across economies and over time, I assume that government expenditures are exogenously determined by

$$X^G_{n,t} = \xi_{n,t} \sum_{i \in \mathcal{I}} GO^i_{n,t}, \tag{23}$$

where $GO^i_{n,t}$ denotes the gross output of sector i in economy n at time t, and $\xi_{n,t}$ is an exogenous time-varying parameter governing the intensity of government spending relative to aggregate output.

The government finances this expenditure through uniform lump-sum transfers, defined to be negative when they represent taxes, levied each period on households of working age ($j \leq \bar{J}$). Hence, the per-capita transfer is given by

$$\mathcal{T}_{n,j,t} = -\frac{X^G_{n,t}}{\sum_{j=0}^{\bar{J}} L_{n,j,t}} \tag{24}$$

where $\bar{J}$ denotes 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.

2.9 Aggregate Variables

The aggregate final expenditures $\{X^C_{n,t}, X^I_{n,t}, X^G_{n,t}\}$, sectoral expenditures $\{X^i_{n,t}\}$, sectoral gross outputs $\{GO^i_{n,t}\}$, and the trade balance (net exports) $\{TB_{n,t}\}$ of economy n at time t are given by:

$$X^C_{n,t} \equiv \underbrace{\sum_{j=0}^{J} P_{n,t} c_{n,j,t} L_{n,j,t}}_{\text{Aggregate Consumption}} + \underbrace{X^F_{n,t}}_{\text{Aggregate Financial Expenditure}}, \tag{25}$$

$$X^I_{n,t} \equiv \underbrace{\sum_{j=0}^{J} P_{n,t} i_{n,j,t} L_{n,j,t}}_{\text{Aggregate Investment}}, \tag{26}$$

$$X^i_{n,t} = \underbrace{\sum_{f \in \{C,I,G\}} \alpha^{i,f}_n X^f_{n,t}}_{\text{Final Good Expenditure}} + \underbrace{\sum_{k \in \mathcal{I}} \gamma^k_n \gamma^{k,i}_n \sum_{m \in \mathcal{N}} \pi^k_{mn,t} X^k_{m,t}}_{\text{Intermediate Good Expenditure}}, \tag{27}$$

$$GO^i_{n,t} \equiv \underbrace{\sum_{m \in \mathcal{N} \setminus \{n\}} \pi^i_{mn,t} X^i_{m,t}}_{\text{Exports}} + \underbrace{\pi^i_{nn,t} X^i_{n,t}}_{\text{Domestic Absorption}}, \tag{28}$$

$$TB_{n,t} \equiv \underbrace{\sum_{i \in \mathcal{I}} GO^i_{n,t}}_{\text{Aggregate Revenue/Output}} - \underbrace{\sum_{i \in \mathcal{I}} X^i_{n,t}}_{\text{Aggregate Expenditure}}, \tag{29}$$

where $\sum_{m \in \mathcal{N}} \pi^i_{mn,t} X^i_{m,t}$ is the total revenue earned by sector i of economy n from sales to all economies (including itself). The gross domestic product (GDP) of economy n is defined as value added: $GDP_{n,t} = \sum_{j=0}^{J} (w_{n,t} e_{n,j} + r^k_{n,t} k_{n,j,t}) L_{n,j,t}$. 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 $TA_{n,t+1}$:

$$NFA_{n,t+1} = \sum_{j=0}^{J} b_{n,j+1,t+1} L_{n,j,t}, \tag{30}$$

$$TL_{n,t+1} = -\sum_{j=0}^{J} b_{n,j+1,t+1} \, \mathbb{1}[b_{n,j+1,t+1} < 0] \, L_{n,j,t}, \tag{31}$$

$$TA_{n,t+1} = \sum_{j=0}^{J} b_{n,j+1,t+1} \, \mathbb{1}[b_{n,j+1,t+1} > 0] \, L_{n,j,t}, \tag{32}$$

where $b_{n,j+1,t+1}$ is the asset position of a household of age $j+1$ at time $t+1$, and $L_{n,j,t}$ is the population of age j at time t.

The law of motion for the population age distribution of economy n is governed by the inflow of new labor-market entrants $L_{n,0,t}$ and survival probabilities $\{\chi_{n,j,t}\}_{j=0}^{J}$. In particular, for each cohort $j \in \{1, \ldots, J\}$, the law of motion is

$$L_{n,j,t} = \chi_{n,j,t} \, L_{n,j-1,t-1}. \tag{33}$$

As a result, the total population of economy n at time t is given by

$$L_{n,t} = L_{n,0,t} + \sum_{j=1}^{J} \chi_{n,j,t} \, L_{n,j-1,t-1}. \tag{34}$$

2.10 Sequential Equilibrium

The sequential equilibrium of the model is defined by sequences of prices and interest rates, $\mathbb{P}$, together with sequences of decisions by households, producers, and banks, as well as government and international trade variables, $\mathbb{Y}$, given households' initial financial asset and capital distributions $\{b_{n,j,0}, k_{n,j,0}\}_{n\in\mathcal{N},j\in\mathcal{J}}$, and the set of parameters, Θ, such that:

1. Households maximize their lifetime utilities subject to their budget constraints, the life-cycle investment rule, and the law of motion for capital.

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:

$$\kappa_{n,t}(b) = R_t + \phi_{n,t}\,\mathbb{1}[b < 0], \quad \forall n \in \mathcal{N},\ t \in \mathcal{T}. \tag{35}$$

4. Labor, capital, and goods markets clear:

$$w_{n,t} \sum_{j=0}^{J} e_{n,j} L_{n,j,t} = \sum_{i\in\mathcal{I}} (1-\gamma_n^i)\eta_n^i GO_{n,t}^i, \quad \forall n \in \mathcal{N},\, t \in \mathcal{T}, \tag{36}$$

$$r_{n,t}^k \sum_{j=0}^{J} k_{n,j,t} L_{n,j,t} = \sum_{i\in\mathcal{I}} (1-\gamma_n^i)(1-\eta_n^i) GO_{n,t}^i, \quad \forall n \in \mathcal{N},\, t \in \mathcal{T}, \tag{37}$$

$$X_{n,t}^i = \sum_{f\in\{C,I,G\}} \alpha_n^{i,f} X_{n,t}^f + \sum_{k\in\mathcal{I}} \gamma_n^k \gamma_n^{k,i} \sum_{m\in\mathcal{N}} \pi_{mn,t}^k X_{m,t}^k, \quad \forall n \in \mathcal{N},\, i \in \mathcal{I},\, t \in \mathcal{T}. \tag{38}$$

5. Government budgets balance:

$$X_{n,t}^G + \mathcal{T}_{n,j,t} \sum_{j=0}^{\bar{J}} L_{n,j,t} = 0, \quad \forall n \in \mathcal{N},\, t \in \mathcal{T}. \tag{39}$$

6. The international asset market clears:

$$\sum_{n\in\mathcal{N}} \sum_{j=0}^{J} b_{n,j+1,t+1} L_{n,j,t} = 0, \quad \forall t \in \mathcal{T} \tag{40}$$

For readability, detailed descriptions of the sets of parameters Θ, prices $\mathbb{P}$, and endogenous variables $\mathbb{Y}$ are relegated to Appendix A.3.

In equilibrium, the balance-of-payments (BOP) condition must hold for all economies:

$$\sum_{i\in\mathcal{I}} X^i_{n,t} + NFA_{n,t+1} = R_t NFA_{n,t} + \sum_{i\in\mathcal{I}} GO^i_{n,t} \tag{41}$$

for all $n \in \mathcal{N}$ and $t \in \mathcal{T}$. The condition captures the contribution of current trade imbalances to the accumulation or depletion of external wealth:

$$TB_{n,t} = \Big(\sum_{i\in\mathcal{I}} GO^i_{n,t}\Big) - \Big(\sum_{i\in\mathcal{I}} X^i_{n,t}\Big) = NFA_{n,t+1} - R_t NFA_{n,t}. \tag{42}$$

In other words, an increase (decrease) in aggregate saving leads to an increase (decrease) in the trade balance, since higher saving corresponds to a greater accumulation of external assets.

3 Quantification

I map the model to a world consisting of eight distinct economies: the United States, China, Germany, the United Kingdom, the Republic of Korea, Mexico, India, and the Rest of World (ROW). The selection of economies is motivated by the observation that they exhibited persistent trade imbalances during this period. Specifically, the United States, the United Kingdom, Mexico, and India experienced persistent trade deficits, whereas China, Germany, and the Republic of Korea maintained persistent trade surpluses. This choice of economies keeps the model computationally manageable while enabling a closer examination of the factors underlying persistent trade imbalances across both emerging and advanced 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). 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).

Table 2: Summary of Parameters

Parameter	Value(s)	Description	Source
Panel A. Externally Calibrated			
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. and 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
$\alpha_n^{i,C}$		Final consumption expenditure shares	WIOD
$\alpha_n^{i,I}$		Final investment expenditure shares	WIOD
$\alpha_n^{i,G}$		Final government expenditure shares	WIOD
η_n^i		Labor shares	WIOD
γ_n^i		Intermediate input shares	WIOD
$\gamma_n^{i,k}$		Input–output shares	WIOD
$\xi_{n,t}$		Government spending intensity	WIOD
δ_n		Capital depreciation rate	PWT
$\chi_{n,j,t}$		Conditional survival probabilities	WPP
$\phi_{n,t}$		Financial intermediation cost	See text
$e_{n,j}$		Labor income by age	LIS
$s_{n,j}$		Investment by age	SCF, 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	0.863	Discount factor	
τ_n		Voluntary bequest	

Notes: WIOD = World Input-Output Database 2016 Release, WPP = UN World Population Prospects, LIS = Luxembourg Income Study, SCF = Survey of Consumer Finances, NaSTaB = National Survey of Tax and Benefit, PWT = Penn World Table, CP = Caliendo and Parro (2015).

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.[15] The Fréchet parameters θ_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.[16] 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 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.[17] Finally, the base economy in which the financial asset is denominated is expressed in units of final consumption good of the United States (i.e., $n^\star =$ USA), so that the U.S. consumption good serves as the global numeraire or unit of account for financial transactions.[18]

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 final expenditure shares α_n^i, labor shares η_n^i, intermediate input shares γ_n^i, and input–output shares $\gamma_n^{i,k}$ are computed directly from the dataset. For each parameter, annual values are first calculated and then averaged across the time periods. Government spending intensities $\{\xi_{n,t}\}$ are computed as government expenditure relative to economy-level gross output and are assumed constant after 2014.

[15] 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.

[16] 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; and, the value for Services is 4.49 based on the aggregate estimate.

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

[18] 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.

Capital Depreciation The capital depreciation rates δ_n are obtained from the Penn World Table. 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. Using data on population by age from the UN World Population Prospects (WPP) for 2000–2021, the probabilities are computed as $\chi_{n,j,t} = \frac{L_{n,j,t}}{L_{n,j-1,t-1}}, \quad j > 0.$ [19] After 2021, both the age-20 population and the conditional probabilities are held constant.

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 nominal 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 average

[19] 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.

of the other seven economies considered in the analysis. The world nominal interest rate is computed as the minimum of the 10-year government bond yields for 10 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.[20] A detailed description of data sources and the procedure is provided in Appendix A.1.1. 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 below the global average and trend downward.

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. 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 are 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), the profile is constructed using data from Brazil, Canada, France, Italy, and Japan. A detailed description of data sources and the estimation procedure is provided in Appendix A.1.2.

Figure A1 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;

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

similarly, Germany exhibits a pronounced decline after age 60.

Age-Specific Investment Age-specific investment profiles, $\{s_{n,j}\}$, are calibrated using cross-sectional household-level data on non-financial assets for two countries: the United States and the Republic of Korea. For the United States, I use the Survey of Consumer Finances (SCF) from 2001 to 2013, available at a triennial frequency; for the Republic of Korea, I use the National Survey of Tax and Benefit (NaSTaB) from 2008 to 2014, available at an annual frequency. Since both datasets are cross-sectional and the SCF is triennial, the calibration relies on the distribution of average age-specific non-financial asset positions across age groups for each year. Specifically, I assume that a representative household of age j in year t with non-financial assets $k_{n,j,t}^{\text{Data}}$ invests $i_{n,j,t}^{\text{Data}}$ to reach the average asset position of households aged $j+1$ in year t, denoted $k_{n,j+1,t}^{\text{Data}}$, in the following year. Accordingly, investment expenditures $i_{n,j,t}^{\text{Data}}$ are computed to satisfy the law of motion for capital: $i_{n,j,t}^{\text{Data}} = k_{n,j+1,t}^{\text{Data}} - (1-\delta_n)k_{n,j,t}^{\text{Data}}$. The computed investment expenditures $i_{n,j,t}^{\text{Data}}$ are then normalized by the average labor income of age-40 households and averaged across years to construct the time-invariant age-specific investment profiles $s_{n,j}^{\text{Data}}$.

Next, I map the age-specific investment profiles of the United States and the Republic of Korea, computed from household-level data, to investment profiles $\{s_{n,j}\}$ that are consistent with aggregate moments. Formally, for each economy, I construct a mapping $\mathcal{K}_n : \{s_{USA,j}^{\text{Data}}, s_{KOR,j}^{\text{Data}}\} \rightarrow \{s_{n,j}\}$ such that $\{s_{n,j}\}$ reproduce the economy-level investment expenditures in 2000, sourced from the WIOD. A detailed description of the data sources and calibration procedure is provided in Appendix A.1.3.

Figure A2 presents the calibrated age-specific investment profile for each economy. The figure suggests that investment is front-loaded across all economies: a sharp spike early in the life cycle is followed by a quick drop, a modest midlife hump, and a taper toward (and occasionally slightly below) zero at older ages. Relative to the global average, China and Mexico display the largest early-life spikes and generally higher investment, whereas investment in the United States, the United Kingdom, and Germany tends to be lower than the global average.

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 the appendix, changes in productivity and trade costs can be recovered given the Frechet parameter θ_i, proportional changes in observed bilateral trade shares $(\hat{\pi}^i_{mn,t})^{Data}$, and the proportional changes in observed sector-level price indices $(\hat{P}^i_{n,t})^{Data}$:

$$\hat{T}^i_{n,t} = (\hat{\pi}^i_{nn,t})^{Data} \left(\frac{(\hat{mc}^i_{n,t})^{Data}}{(\hat{P}^i_{n,t})^{Data}} \right)^{\theta_i}, \tag{43}$$

$$\hat{d}^i_{mn,t} = \left(\frac{(\hat{\pi}^i_{nn,t})^{Data}}{(\hat{\pi}^i_{mn,t})^{Data}} \right)^{\frac{1}{\theta_i}} \left(\frac{(\hat{P}^i_{m,t})^{Data}}{(\hat{P}^i_{n,t})^{Data}} \right). \tag{44}$$

In words, Equation (43) 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 (44) 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 allocates more expenditure to imports from exporter n while the expenditure share of exporter n on its own products remains unchanged, this implies that the cost of importing from exporter n has fallen for importer m. 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.[21]

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 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 detrend labor and capital compensation by dividing them by world gross output, and I detrend 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.1.4.

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, reflecting the idea 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.1.4.

Figure A6 presents sector-level productivity measures, $(\hat{T}^i_{n,t})^{1/\theta_i}$, relative to their levels in 2000. Figures A7 and A8 report economy-level averages of bilateral trade costs relative to their levels in 2000. Figure A7 presents the average costs of exporting to each destination, and Figure A8 presents the average costs of importing from each origin.

Discount Factor and Voluntary Bequest Panel C of Table 2 reports the parameters calibrated using the method of simulated moments (MSM). I solve the full dynamic general equilibrium model and choose parameters by minimizing the distance between

[21] Changes in trade costs obtained using Equation (44) may reflect any barriers to bilateral trade including but not limited to tariffs, non-tariff barriers, geographical distance, political distance, and exchange rate policies.

Table 3: Calibration of Discount Factor and Voluntary Bequest Parameters

Panel A. Calibrated Parameters		
Parameter	Description	Value
β	Discount factor	0.863
τ_{USA}	Bequest motive, United States	105.72
τ_{CHN}	Bequest motive, China	732.57
τ_{DEU}	Bequest motive, Germany	93.75
τ_{GBR}	Bequest motive, United Kingdom	82.16
τ_{KOR}	Bequest motive, Korea	214.68
τ_{MEX}	Bequest motive, Mexico	457.91
τ_{IND}	Bequest motive, India	821.72
τ_{ROW}	Bequest motive, Rest of World	237.73
Panel B. Targeted Moments		
Moment	Data	Model
World real interest rate (2000–2024)	-0.0142	-0.0142
Asset in 2013 of age 40 in 2000, USA	5.92	5.93
Asset in 2013 of age 40 in 2000, CHN	7.75	7.77
Asset in 2013 of age 40 in 2000, DEU	6.52	6.54
Asset in 2013 of age 40 in 2000, GBR	5.50	5.52
Asset in 2013 of age 40 in 2000, KOR	9.15	9.17
Asset in 2013 of age 40 in 2000, MEX	9.72	9.74
Asset in 2013 of age 40 in 2000, IND	8.21	8.22
Asset in 2013 of age 40 in 2000, ROW	10.99	11.00

Notes: The world real interest rate (2000-2014) refers to the average world interest rate across 2000–2024, constructed by deflating world nominal interest rates with the U.S. Personal Consumption Expenditures Price Index. Asset in 2013 of age 40 in 2000 refers to the average asset position in 2013 of the cohort that was age 40 in 2000, expressed relative to the average labor income of age-40 households.
Sources: World Input-Output Database 2016 Release. Survey of Consumer Finances (SCF), National Survey of Tax and Benefit (NaSTaB), Lane and Milesi-Ferretti (2018).

model-generated and empirical moments. The discount factor β is chosen so that the model's average world interest rate over 2000–2024 matches the observed average world real interest rate of -1.42%. World real interest rates are constructed by deflating world nominal interest rates with inflation computed using the U.S. Personal Consumption

Expenditures (PCE) price index.[22] This yields an implied value of $\beta = 0.863$.

The model implies that in economies with strong voluntary bequest motives (i.e., high τ_n), middle-aged households accumulate greater assets during their working years in order to leave bequests to future generations at the end of the life cycle. Accordingly, I calibrate the voluntary bequest parameters $\{\tau_n\}$ to match the average asset holdings in 2013 of households that were age 40 in 2000. The empirical moments are constructed using economy-level data on external assets and liabilities from Lane and Milesi-Ferretti (2018), together with household-level asset data from the 2013 waves of the Survey of Consumer Finances (SCF) and the National Survey of Tax and Benefit (NaSTaB).

Table 3 reports the calibrated values of τ_n across economies, which range from 82.16 in the United Kingdom to 821.72 in India. The results reveal large differences in voluntary bequest motives across economies. For example, the estimate for China, $\tau_{\text{CHN}} = 732.57$, is nearly seven times larger than that for the United States, $\tau_{\text{USA}} = 105.72$, suggesting stronger incentives for middle-aged households in China to save in order to leave bequests, all else equal.

Initial Conditions I calibrate the initial distributions of financial assets, $\{b_{n,j,0}\}$, and capital, $\{k_{n,j,0}\}$, across age cohorts using household-level profiles of financial and non-financial assets from the SCF for the United States and the NaSTaB for the Republic of Korea, combined with aggregate moments from the WIOD SEA and Lane and Milesi-Ferretti (2018). For each economy, these profiles are mapped through a scaled convex combination of the U.S. and Korean data so that, in 2000, the aggregate moments match empirical targets: (i) net foreign asset position and total liabilities for $\{b_{n,j,0}\}$, and (ii) the economy-level capital stock for $\{k_{n,j,0}\}$. The mapping procedure is analogous to that used for the calibration of investment profiles, with full details provided in Appendix A.1.3. Figures A9 and A10 present financial asset positions and capital holdings by age group in 2000, respectively.

Intertemporal Distortions Intertemporal distortions, $\{\varepsilon_{n,t}\}$, are introduced to absorb the residual trade imbalances from 2000–2014, after accounting for all modeled fundamentals

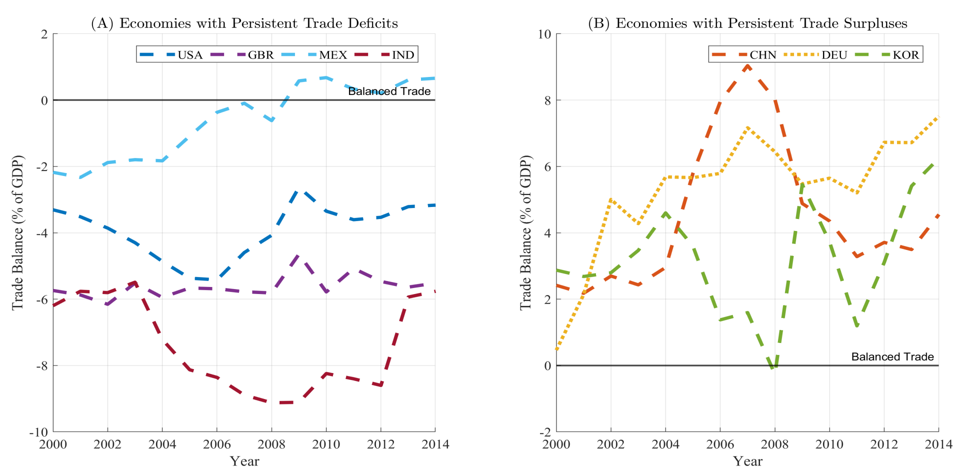
[22] Retrieved from https://fred.stlouisfed.org/series/PCEPI.

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 function as economy-specific shifts in households' time preferences. For example, a trade surplus in China in year t that cannot be explained by other model features can be rationalized by increasing China's intertemporal distortion, $\varepsilon_{\mathrm{CHN},t+1}$. A higher distortion induces Chinese households to save more and consume less, thereby increasing production and exports relative to consumption and imports. The distortions are calibrated in this way so that model-implied trade imbalances exactly replicate the observed imbalances from 2000 to 2014, as measured in the WIOD. After 2014, all intertemporal distortions are set to zero, since the WIOD only covers 2000–2014. Figure A11 presents the calibrated intertemporal distortions, $\varepsilon_{n,t}$.

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 (42) 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 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 investment profile $s_{n,j}$, and the voluntary bequest motive τ_n; (iii) institutional and policy factors, captured by financial intermediation costs $\phi_{n,t}$, government spending intensities $\xi_{n,t}$, 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 4 lists the factors included in the analysis and describes the mechanism through which each economy-specific factor influences aggregate saving and, in turn, the trade balance. Given that there are 11 factors for each of the 8 economies, the total number of factors considered in the analysis is 88.

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 global averages are provided in Appendix A.2.

Formally, I define an impact measure that quantifies how much a specific factor contributes to the level of trade imbalance. The impact measure $\mathcal{M}_m(\vec{x}_n \to \vec{x})$, which

Table 4: Factors Considered in the Decomposition Analysis

Factor	**Variable**	**Mechanism**
Life Expectancy	$\chi_{n,j,t}$	Longer lifespans raise middle-aged saving for future consumption, increasing the trade balance
Population Growth	$L_{n,0,t}$	Larger inflow of borrowing-prone young households increases aggregate borrowing and reduces the trade balance
Labor Profile	$e_{n,j}$	Steeper rise (fall) in income promotes borrowing (saving) to smooth consumption and reduces (raises) the trade balance
Investment Profile	$s_{n,j}$	Greater investment demand increases borrowing to finance investment and reduces the trade balance
Bequest	τ_n	Stronger voluntary bequest motive raises asset accumulation of middle-aged households and increases the trade balance
Financial Cost	$\phi_{n,t}$	Higher financial intermediation costs limit household borrowing and increase the trade balance
Fiscal Policy	$\xi_{n,t}$	Greater government spending raises taxes and lowers household saving, reducing the trade balance
Import Cost	$\hat{d}^i_{nm,t}$	Faster import cost declines increase real income and consumption smoothing-driven borrowing, lowering the trade balance
Export Cost	$\hat{d}^i_{mn,t}$	Faster export cost declines increase income, and consumption smoothing-driven borrowing, lowering the trade balance
Productivity	$\hat{T}^i_{n,t}$	Faster productivity growth encourages household borrowing to smooth consumption, which reduces the trade balance
Distortion	$\varepsilon_{n,t}$	Stronger time preference for future consumption increases saving and raises the trade balance

Notes: Economy-specific factors affecting aggregate saving, thereby generating differences in trade balances across economies.

captures the change in the trade balance of economy m when factor $\vec{x}_n$ originating from economy n is replaced by its global average $\vec{x}$, is defined as:

$$\mathcal{M}_m(\vec{x}_n \to \vec{x}) = \frac{1}{15}\sum_{t=2000}^{2014}\left(\frac{TB_{m,t}^{Data}}{GDP_{m,t}^{Data}} - \frac{TB_{m,t}^{Model}(\vec{x}_n \to \vec{x})}{GDP_{m,t}^{Model}(\vec{x}_n \to \vec{x})}\right) \times 100 \tag{45}$$

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 5: Major Deficit-Inducing Factors in Deficit-running Economies

United States (USA)			United Kingdom (GBR)		
Origin	Factor	Impact	Origin	Factor	Impact
USA	Bequest	-48.43	GBR	Bequest	-49.28
ROW	Productivity	-7.97	GBR	Financial Cost	-10.53
USA	Financial Cost	-7.57	ROW	Productivity	-7.14
CHN	Bequest	-4.94	USA	Productivity	-7.04
IND	Bequest	-2.45	CHN	Bequest	-3.65
Mexico (MEX)			**India (IND)**		
Origin	Factor	Impact	Origin	Factor	Impact
MEX	Productivity	-41.67	IND	Productivity	-55.19
ROW	Productivity	-9.69	IND	Life Expectancy	-11.39
MEX	Investment Profile	-8.92	USA	Productivity	-6.76
USA	Productivity	-8.51	IND	Export Cost	-4.85
MEX	Life Expectancy	-6.23	CHN	Bequest	-3.80

Notes: Five major deficit-inducing factors in the United States, the United Kingdom, Mexico, and India. The impact measure $\mathcal{M}(\cdot)$ denotes the time-averaged deviation between observed trade balances to GDP and model-generated trade balances to GDP.

Table 5 reports the five 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 dominant deficit-inducing factor is the domestic bequest motive, which lowers the model-implied trade balance relative to the level observed in the data by an average of 48.43 percentage points of GDP from 2000 to 2014. This result indicates that U.S. households exhibit a weaker preference for intergenerational wealth transfer ($\tau_{USA} = 105.72$) compared with the global average ($= 343.28$), leading to lower saving and higher consumption. Lower domestic saving, combined with strong consumption demand, generates persistent trade deficits.

In addition, lower financial intermediation costs within the United States, shown in Figure A5, reduce the trade balance by 7.57 percentage points of GDP by allowing households to borrow more easily than the global average and sustain consumption beyond current income. Finally, stronger bequest motives in China and India decrease the U.S. trade balance by 4.94 and 2.45 percentage points, respectively, as higher saving abroad expands the global supply of financial assets and lowers the world interest rate, making borrowing cheaper for U.S. households.

United Kingdom For the United Kingdom, the domestic bequest motive is again the dominant deficit-inducing factor, lowering the trade balance relative to the level observed in the data by an average of 49.28 percentage points of GDP from 2000 to 2014. As in the United States, the weak bequest motive implies a lower propensity to save across generations, leading to higher consumption levels financed by borrowing. Lower domestic financial intermediation costs decrease the trade balance by 10.53 percentage points of GDP by easing access to credit relative to the global average and sustaining domestic expenditure above current income.

The table shows that spillovers from foreign economies also play a substantial role for the United Kingdom. Slower productivity growth in the United States, as shown in Figure A6, reduces the trade balance of the United Kingdom by 7.04 percentage points of GDP on average. This effect arises because slower income growth in the United States increases U.S. household saving to smooth consumption, lowering the world interest rate and encouraging borrowing in the United Kingdom. Finally, stronger bequest motives in China reduce the U.K. trade balance by 3.65 percentage points of GDP on average by increasing global saving and lowering the world interest rate, which supports greater borrowing in the United Kingdom.

Mexico For Mexico, the key deficit-inducing factor is domestic productivity growth, which lowers the model-implied trade balance relative to the level observed in the data by an average of 41.67 percentage points of GDP from 2000 to 2014. Faster productivity growth relative to the global average, concentrated in the Agriculture/Mining and Manufacturing sectors as shown in Figure A6, raised household income and induced borrowing to smooth consumption, increasing the trade deficit.

Domestic investment behavior, captured by the investment profile in Figure A2, lowers the trade balance by 8.92 percentage points of GDP. Higher investment demand in Mexico relative to the global average implies greater borrowing to finance capital accumulation. Finally, the decline in life expectancy in Mexico, shown in Figure A3, decreases the trade balance by 6.23 percentage points of GDP, as shorter expected lifespans reduce saving for consumption at the later stage of the life cycle and increase current consumption.

India For India, the largest deficit-inducing factor is also the domestic productivity growth, which lowers the model-implied trade balance relative to the level observed in the data by an average of 55.19 percentage points of GDP from 2000 to 2014. Rapid productivity expansion across all sectors, as shown in Figure A6, raised income faster than the global average, inducing borrowing to smooth consumption and generating persistent trade deficits.

The decline in life expectancy, shown in Figure A3, lowers the trade balance by 11.39 percentage points of GDP on average, as shorter expected lifespans reduce saving for consumption at the later stage of the life cycle and increase current consumption. Faster declines in export costs reduce the trade balance by 4.85 percentage points of GDP, as the resulting increases in global demand and purchasing power lead to higher borrowing driven by the consumption-smoothing motive. Finally, the strong bequest motive in China reduces India's trade balance by 3.8 percentage points of GDP on average by increasing global saving and lowering the world interest rate, which facilitates borrowing in India.

Across all deficit-running economies, bequest motives, financial costs, and productivity growth emerge as the dominant deficit-inducing forces. Financial costs appear to be more relevant for advanced economies such as the United States and the United Kingdom, while the productivity channel matters more for emerging economies such as Mexico and India.

4.1.3 Surplus-inducing Factors for Surplus-running Economies

Table 6: Major Surplus-Inducing Factors in Surplus-running Economies

China (CHN)			Germany (DEU)		
Origin	Factor	Impact	Origin	Factor	Impact
CHN	Bequest	42.06	USA	Bequest	20.36
CHN	Labor Profile	16.77	DEU	Labor Profile	11.77
USA	Bequest	15.32	DEU	Life Expectancy	9.60
ROW	Distortion	11.09	ROW	Distortion	7.96
CHN	Life Expectancy	6.49	DEU	Productivity	6.75
Republic of Korea (KOR)					
Origin	Factor	Impact			
KOR	Life Expectancy	16.20			
USA	Bequest	15.77			
ROW	Distortion	9.61			
ROW	Bequest	7.33			
USA	Financial Cost	3.46			

Notes: Five major surplus-inducing factors in China, Germany, and the Republic of Korea. The impact measure $\mathcal{M}(\cdot)$ denotes the time-averaged deviation between observed trade balances to GDP and model-generated trade balances to GDP.

Table 6 reports the five 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 factor is the domestic bequest motive, which raises the model-implied trade balance relative to the level observed in the data by an average of 42.06 percentage points of GDP from 2000 to 2014. This result indicates that Chinese households exhibit a stronger desire for intergenerational wealth transfer, leading to greater asset accumulation, higher aggregate saving, and persistent trade surpluses. China's labor income profile raises the trade balance relative to the data by 16.77 percentage points of GDP on average, reflecting a steeper decline in labor income for middle-aged households (i.e., those older than age 40) relative to the global average, as shown in Figure A1. This pattern induces greater saving in China to smooth consumption and prepare for a decline in income later in life, thereby increasing China's trade balance.

Spillovers from other economies also play a substantial role. The U.S. bequest motive ($\tau_{USA} = 105.72$), which is lower than the global average ($= 343.28$), increases China's trade balance by 15.32 percentage points of GDP relative to the data. Finally, the rise in China's life expectancy, shown in Figure A3, raises the trade balance by 6.49 percentage points of GDP relative to the data, as households save more for retirement in response to longer lifespans.

Germany For Germany, the largest surplus-inducing factor is the U.S. bequest motive, which raises Germany's trade balance relative to the level observed in the data by an average of 20.36 percentage points of GDP from 2000 to 2014. Germany's own labor income profile increases the trade balance by 11.77 percentage points of GDP, driven by a steeper decline in labor income after age 60 compared with the global average, as shown in Figure A1. Anticipating this sharper decline, German households save more during middle age than the global average, increasing aggregate saving and the trade balance.

The rapid increase in life expectancy in Germany, illustrated in Figure A3, raises the trade balance by 9.60 percentage points on average, as longer expected lifespans induce greater saving among working-age households. Finally, slower domestic productivity growth across all sectors in Germany relative to the global average, shown in Figure A6, increases the trade balance by 6.75 percentage points of GDP. Lower productivity growth implies slower income growth and weaker future earnings, inducing German households to save more to smooth consumption over time.

Republic of Korea For the Republic of Korea, the leading surplus-inducing factor is domestic life expectancy, which raises the trade balance relative to the level observed in the data by an average of 16.20 percentage points of GDP from 2000 to 2014. This effect is driven by a sharp increase in life expectancy in the Republic of Korea, shown in Figure A3, which induces greater saving among middle-aged households.

The U.S. bequest motive, which is lower than the global average, increases Korea's trade balance by 15.77 percentage points. The U.S. financial intermediation costs, which are lower than the global average as shown in Figure A5, increase Korea's trade balance by 3.46 percentage points relative to the data. This result implies that U.S. households can borrow at lower rates due to lower financial intermediation costs, increasing borrowing and raising the world interest rate, which in turn stimulates saving in Korea.

Across all three surplus-running economies, bequest motives, life expectancy, and labor income profiles over the life cycle emerge as common drivers of persistent surpluses. These results underscore how heterogeneity in life-cycle saving behavior can significantly influence aggregate expenditures and shape persistent trade imbalances.

4.2 Counterfactual Analysis: China Shock

There are ongoing debates in policy and political circles over 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 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 debate, I use the calibrated model to evaluate the role of international trade in shaping trade imbalances through the lens of the China shock, referring to China's accession to the World Trade Organization (WTO) in 2001. The China shock led to persistent declines in bilateral trade costs faced by China and its trading partners, as shown in Figures A7 and A8. To assess its impact, I conduct a counterfactual experiment in which bilateral trade costs between China and other economies are fixed at their year 2000 levels. I consider three cases: (i) the costs of exporting to China remain at the year 2000 levels for all other economies ("No China Export Cost Shock"); (ii) the costs of importing from China remain at the year 2000 levels for all other economies ("No China Import Cost Shock"); and (iii) both ("No China Trade Cost Shocks"). Table 7 reports the impact of the China shock on trade balances across seven economies

Table 7: China Shocks on Trade Imbalances

Economy	Impact on Trade Balance (% of GDP)		
	No China Export Cost Shock	No China Import Cost Shock	No China Trade Cost Shocks
United States	-0.003	-0.074	-0.076
China	-0.292	-3.904	-4.066
Germany	-0.049	0.233	0.240
United Kingdom	-0.008	-0.164	-0.164
Republic of Korea	0.068	0.944	0.992
Mexico	-0.021	1.555	1.526
India	-0.067	2.598	2.555

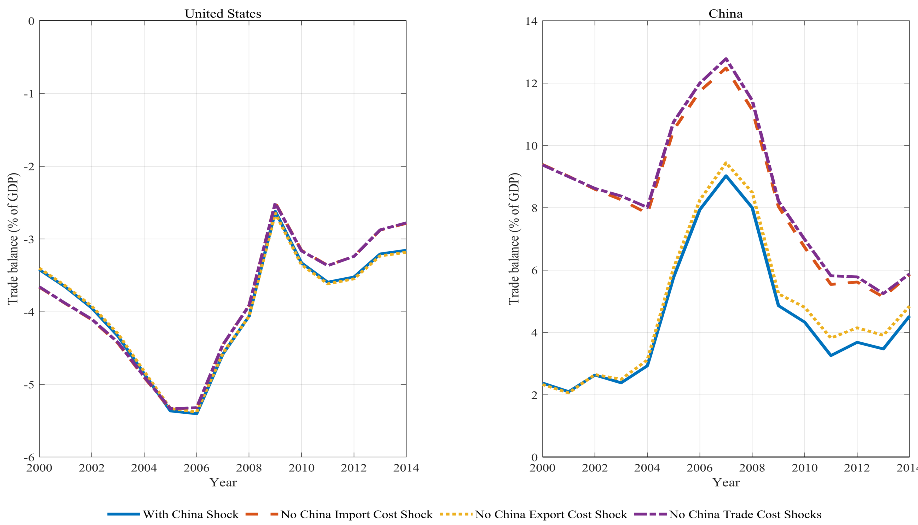
Notes: Each column reports the level impact from counterfactual simulations that remove the respective China trade cost shock by fixing bilateral trade costs at their year 2000 levels. Impacts are time-averaged deviations between model-generated and observed trade imbalances as a share of gross output.

United States For the United States, the China shock reduced the trade balance by 0.076 percentage points of GDP in the "No China Trade Cost Shocks" case, by 0.074 percentage points of GDP in the "No China Import Cost Shock" case, and by 0.003 percentage points of GDP in the "No China Export Cost Shock" case. As shown in Figure 2, these magnitudes indicate a modest but consistent deficit inducing effect, driven mainly by lower import costs.

China For China, the China shock reduced the trade balance by 4.066 percentage points of GDP in the "No China Trade Cost Shocks" case, by 3.904 percentage points of GDP in the "No China Import Cost Shock" case, and by 0.292 percentage points of GDP in the "No China Export Cost Shock" case. Thus, as shown in Figure 2, the China shock is strongly deficit-inducing for China, with the import cost channel dominating.

Germany and the United Kingdom For Germany, the China shock increased the trade balance by 0.240 percentage points of GDP in the "No China Trade Cost Shocks" case and by 0.233 percentage points of GDP in the "No China Import Cost Shock" case, while the "No China Export Cost Shock" effect is a small reduction of 0.049 percentage points of

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.

GDP. Overall, the net effect is surplus-inducing for Germany.

For the United Kingdom, the China shock reduced the trade balance by 0.164 percentage points of GDP in both the “No China Trade Cost Shocks” and “No China Import Cost Shock” cases, and by 0.08 percentage points of GDP in the “No China Export Cost Shock” case, indicating a small deficit-inducing effect.

Republic of Korea, Mexico, and India For Korea, the China shock increased the trade balance by 0.992 percentage points of GDP in the “No China Trade Cost Shocks” case and by 0.944 percentage points of GDP in the “No China Import Cost Shock” case, with a 0.068 percentage points of GDP reduction in tge “No China Export Cost Shock” case; the net effect is surplus inducing.

For Mexico, the China shock increased the trade balance by 1.526 percentage points in “No China Trade Cost Shocks” and by 1.555 percentage points of GDP in the “No China Import Cost Shock” case, with a 0.021 percentage points of GDP reduction in the “No China Export Cost Shock” case; the net effect is surplus inducing.

For India, the China shock increased the trade balance by 2.555 percentage points in "No China Trade Cost Shocks" and by 2.598 percentage points of GDP in the "No China Import Cost Shock" case, with a 0.067 percentage points of GDP reduction in the "No China Export Cost Shock" case; the net effect is surplus-inducing.

Discussion Taken together, these results suggest that changes in bilateral trade costs associated with the China shock have measurable but limited effects on the aggregate trade balances of some economies. For China, changes in trade costs had a sizable negative impact on its trade balance. For the United States, the direction of impact is consistent with arguments that trade with China contributed to its trade deficit, but the magnitudes are small, less than 0.1 percentage points of GDP, relative to overall trade imbalances.

More importantly, the results show that a deficit-inducing factor in China can also be deficit-inducing in the United States, contrary to the prediction from a two-country framework in which one country's deficit necessarily implies another country's surplus. This outcome highlights the importance of a multi-country framework for evaluating trade imbalances, as a change in one economy can generate asymmetric effects across others through differential changes in relative prices that arise from heterogeneous international trade linkages.

5 Conclusion

This paper develops a unified dynamic general equilibrium framework to identify the forces driving persistent trade imbalances across seven major economies from 2000 to 2014. Using the calibrated model, I quantify how productivity growth, trade costs, financial intermediation costs, population inflows, survival probabilities, government spending intensities, labor income profiles, investment profiles, and voluntary bequest motives jointly shape trade balances over this period.

The results show that persistent trade imbalances arise from the interaction of multiple factors rather than a single dominant force. Among deficit economies such as the United States, the United Kingdom, Mexico, and India, weaker bequest motives and low financial intermediation costs are key deficit inducing factors in advanced economies, while faster productivity growth plays a larger role in emerging economies. Among surplus economies such as China, Germany, and Korea, stronger bequest motives, longer life expectancy, and steeper labor income profiles at the end of the life cycle explain their persistent surpluses. These findings highlight the central role of heterogeneity in life cycle saving behavior across economies in shaping global trade imbalances.

The paper also demonstrates that bilateral trade costs can generate asymmetric effects across economies. The China shock reduced China's trade balance by about 4 percentage points of GDP, yet its effect on the trade balance of the United States was less than 0.1 percentage points of GDP. I find that a deficit-inducing factor in one economy can also be deficit-inducing in another, emphasizing the importance of using a multi-economy framework with trade linkages to understand trade imbalances.

Intertemporal distortions remain quantitatively important but should be interpreted as capturing residual saving behavior driven by differences in pension systems, reserve accumulation motives, or precautionary saving that are not captured by the model's explicit mechanisms. Future research could extend the framework by endogenizing these residual channels and incorporating nominal rigidities and uncertainty in household decision making to better capture the interaction between policies, expectations, and global saving behavior.

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A Appendix

A.1 Detailed Description of Data and Calibration

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

A.1.1 Financial Intermediation Costs

Economy-specific lending interest rate I construct economy-specific lending rates using various sources. For the United States, I use the 30-year fixed-rate mortgage from Freddie Mac's Primary Mortgage Market Survey, accessed via FRED.[23] For the United Kingdom, I use historical mortgage rate series compiled by Mortgageable and Statista.[24] For Germany, I use mortgage interest rate series reported by Global Property Guide that track annualised agreed rates and narrowly defined effective rates.[25] For Korea, I use mortgage interest rate data compiled by TheGlobalEconomy with the Bank of Korea as the underlying source.[26] For Mexico, I use mortgage interest rate series reported by Global Property Guide.[27] 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.[28] For India, I use the State Bank of India benchmark prime lending rate as a representative lending rate.[29] For the Rest of the World, I set the lending rate in each year equal to the simple average of the seven observed economies above.

World interest rate The world interest rate equals the minimum of ten-year 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.[30] For each country, I take the long-term government bond yield series, and then take the

[23] Sourced from FRED: MORTGAGE30US.
[24] Sourced from Mortgageable and Statista.
[25] Sourced from Global Property Guide: Germany.
[26] Sourced from TheGlobalEconomy: Korea.
[27] Sourced from Global Property Guide: Mexico.
[28] Sourced from MacroMicro: PBC benchmark lending rate.
[29] Sourced from SBI: Benchmark Prime Lending Rate (historical).
[30] Sourced from FRED government bond yields.

minimum across the ten countries for each year. This construction matches the assumption that global banks can search internationally and borrow at the lowest available interest rate.

A.1.2 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 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.

I estimate profiles using the following LIS waves: United States (2000–2023); China (2013, 2018); Germany (2000–2020); United Kingdom (2000–2021); 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.

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.1.3 Initial Financial Asset and Capital Profiles and Age-Specific Investment

I use two household-level cross-sectional datasets, in addition to the WIOD, for the calibration of $s_{n,j}$. The Survey of Consumer Finances (SCF) is a triennial, nationally representative survey of U.S. households that includes information on the age of the household reference person, labor income, financial assets, non-financial assets, liabilities (debt), and person-level 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.

Initial conditions for financial assets and capital I construct initial age distributions of financial assets $\{b_{n,j,0}\}$ and capital $\{k_{n,j,0}\}$ by combining household-level data from the United States and the Republic of Korea with aggregate targets. For the United States, I use the 2001 wave of the Survey of Consumer Finances (SCF), the closest to the base year 2000. For Korea, I use the 2008 wave of the National Survey of Tax and Benefit (NaSTaB), which is the earliest available wave. In each wave, I restrict the sample to ages 20–80 and trim the top and bottom deciles within each age to remove outliers. I then construct age profiles of average net financial assets and non-financial assets, scaled by the average labor income at age 40 and weighted by person-level survey weights. To reduce noise, I smooth the age profiles with a standard two-pass moving-average filter that preserves levels and overall shape.

For each economy n and source country $c \in \{\text{USA}, \text{KOR}\}$, let $\tilde{b}_{c,j}$ and $\tilde{k}_{c,j}$ denote the resulting age profiles of financial assets and capital, respectively. Next, I compute scale parameters ζ_c^b and ζ_c^k so that, after scaling, the profile implied by country c is consistent with the observed total liabilities and aggregate capital stock of economy n in 2000:

$$b_{n,j,0}^c = \zeta_c^b \, \tilde{b}_{c,j}, \quad k_{n,j,0}^c = \zeta_c^k \, \tilde{k}_{c,j},$$

where

$$\zeta_c^b = \frac{TL_{n,0}}{\sum_{j=0}^{J} w_{n,0} L_{n,j,0} \, \tilde{b}_{c,j}}, \quad \zeta_c^k = \frac{K_{n,0}}{\sum_{j=0}^{J} w_{n,0} L_{n,j,0} \, \tilde{k}_{c,j}},$$

and $L_{n,j,0}$ is the population-by-age distribution, $TL_{n,0}$ is total liabilities, and $K_{n,0}$ is the aggregate capital stock of economy n in year 2000.

I then construct economy-specific initial profiles as convex combinations of the scaled profiles:

$$b_{n,j,0} = \lambda_n^b \, b_{n,j,0}^{\text{USA}} + \left(1 - \lambda_n^b\right) b_{n,j,0}^{\text{KOR}}, \quad k_{n,j,0} = \lambda_n^k \, k_{n,j,0}^{\text{USA}} + \left(1 - \lambda_n^k\right) k_{n,j,0}^{\text{KOR}}.$$

The weights λ_n^b and λ_n^k are chosen so that, in 2000, the model reproduces each economy's net foreign asset position and aggregate capital stock:

$$NFA_{n,0} = \sum_{j=0}^{J} b_{n,j,0}\, w_{n,0} L_{n,j,0}, \quad K_{n,0} = \sum_{j=0}^{J} k_{n,j,0}\, w_{n,0} L_{n,j,0}.$$

Given that any value of λ_n^k rationalizes the aggregate capital stock, I set $\lambda_n^k = \lambda_n^b$. Information on aggregate capital stock and value added is taken from the WIOD Socio-Economic Accounts, and NFA positions and total liabilities are taken from Lane and Milesi-Ferretti (2018), which provides annual series on countries' external assets and liabilities, including net foreign asset positions.

Age-specific investment profiles Given that both the SCF and NaSTaB are cross-sectional datasets, I infer the investment profile by age from the difference in average non-financial assets across adjacent ages within a given year. Let $k_{c,j,t}^{\text{Data}}$ denote the average non-financial asset position at age j in country c and year t, scaled by the age-40 wage. I assume that the implied investment for age j in year t is $i_{c,j,t}^{\text{Data}} = k_{c,j+1,t}^{\text{Data}} - (1-\delta_c)\, k_{c,j,t}^{\text{Data}}$, where δ_c is the depreciation rate used for country c. I average $i_{c,j,t}^{\text{Data}}$ over waves 2001, 2004, 2007, 2010, and 2013 in the SCF for the United States and waves 2008–2014 in NaSTaB for the Republic of Korea to obtain time-invariant source profiles $s_{\text{USA},j}^{\text{Data}}$ and $s_{\text{KOR},j}^{\text{Data}}$.

Then, for each economy n, I map these source profiles to model investment profiles via a scaled convex combination:

$$s_{n,j} = \zeta_{\text{USA},n}^{s}\, \lambda_n^s\, s_{\text{USA},j}^{\text{Data}} + \zeta_{\text{KOR},n}^{s}\, (1-\lambda_n^s)\, s_{\text{KOR},j}^{\text{Data}}.$$

Here, λ_n^s is the economy-specific weight on the U.S. profile, and $\zeta_{\text{USA},n}^s$ and $\zeta_{\text{KOR},n}^s$ are scale factors that allow the profiles to match aggregate investment expenditure in 2000, sourced from WIOD:

$$\zeta_{c,n}^{s} = \frac{X_{n,0}^{I}}{\sum_{j=0}^{J} w_{n,0} L_{n,j,0}\, s_{c,j}^{\text{Data}}}, \qquad c \in \{\text{USA}, \text{KOR}\}.$$

Given that any value of λ_n^s rationalizes aggregate investment expenditure, I set $\lambda_n^s = \lambda_n^b$.

A.1.4 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 $(\widehat{mc}^{i}_{n,t})^{\text{Data}}$ 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 in Table A6. I project levels by chaining $\hat{d}^i_{mn,t} = \hat{d}^i_{mn,t-1} \exp(g^d_{m,n,i,t})$, 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.2 Construction of Global Averages

This section explains how I construct the global averages $\vec{x}$ discussed in Section 4.1.1. I describe the weighting schemes, and the construction of world averages for each factor.

Weights I use three weighting schemes. Value added weights vary by economy n and year t and are proportional to WIOD value added for 2000-2014, then fixed at their 2014 values afterward. Simple average weights assign $1/N$ to each economy in every year. Population weights vary by economy and year and are proportional to population.

Average life expectancy Let $\chi_{n,j,t}$ denote the conditional survival probability at age j in economy n. For each age-year (j,t), I compute a population weighted geometric mean across economies:

$$\bar{\chi}_{j,t} = \exp\Big(\sum_{n \in \mathcal{N}} \omega_{n,t}^{POP} \ln \chi_{n,j,t} \Big).$$

In the decomposition analysis for economy n, I set $\chi_{n,j,t} = \bar{\chi}_{j,t}$ for all ages and years and then regenerate the age distribution with $L_{n,j,t} = \chi_{n,j,t} \, L_{n,j-1,t-1}$ for $t, j \geq 2$.

Average population growth Let $L_{n,j,t}$ denote the population of age j in economy n and year t, and let the population inflow be $L_{n,t}^{\text{in}} = L_{n,20,t}$ (i.e., age 20 population). I compute the inflow growth rate $g_{n,t}^{\text{in}} = L_{n,t}^{\text{in}} / L_{n,t-1}^{\text{in}}$. Then, I construct the global average, $\bar{g}_t^{\text{in}}$, as the population-weighted geometric mean each year to respect the multiplicative structure of growth:

$$\bar{g}_t^{\text{in}} = \exp\Big(\sum_{n \in \mathcal{N}} \omega_{n,t}^{POP} \ln g_{n,t}^{\text{in}} \Big).$$

For economy n, I impose the average inflow path by recursion $L_{n,t}^{\text{in}} = \bar{g}_t^{\text{in}} \, L_{n,t-1}^{\text{in}}$ for $t \geq 2$. I then rebuild the entire age distribution using the survival probabilities: $L_{n,j,t} = \chi_{n,j,t} \, L_{n,j-1,t-1}$ for $t, j \geq 2$.

Average labor profile Let $e_{n,j}$ denote the effective labor supply by age. I compute a simple arithmetic mean for each age, $\bar{e}_j = \frac{1}{N}\sum_{n\in\mathcal{N}} e_{n,j}$. In the decomposition analysis for economy n, I set $e_{n,j} = \bar{e}_j$ for all ages.

Average investment profile Let $s_{n,j}$ denote the investment by age as a share of age-40 wage. I compute the world average for each age as a simple arithmetic mean across economies: $\bar{s}_j = \frac{1}{N}\sum_{n\in\mathcal{N}} s_{n,j}$. In the decomposition analysis for economy n, I replace $s_{n,j}$ with $\bar{s}_j$ for all ages.

Average bequest motive Let τ_n denote the voluntary bequest parameter for economy n. I compute the global average as the simple arithmetic mean across economies: $\bar{\tau} \equiv \frac{1}{N}\sum_{m\in\mathcal{N}} \tau_m$. Then, in the decomposition analysis for economy n, I replace τ_n with $\bar{\tau}$.

Average financial intermediation cost The global average financial intermediation cost is the simple average across eight economies used in the analysis. For each year t, define the global average as follows: $\bar{\phi}_t = \frac{1}{N}\sum_{m\in\mathcal{N}} \phi_{m,t}$. In the decomposition analysis, I replace the financial intermediation cost of the economy n in each year with $\bar{\phi}_t$.

Average government expenditure Let $\xi_{n,t}$ denote government purchases as a share of gross output. I compute the year-specific arithmetic mean across economies: $\bar{\xi}_t = \frac{1}{N}\sum_{n\in\mathcal{N}} \xi_{n,t}$. Then, in the decomposition analysis for economy n, I replace the economy-specific values with the global average: $\xi_{n,t} = \bar{\xi}_t$.

Average bilateral trade costs Let $\hat{d}^i_{nm,t}$ denote the bilateral trade cost hat variable for exporting from economy m to economy n in sector i and year t. I construct two economy level averages using value-added weights and geometric means. The average cost of exporting to a given destination n is

$$\hat{d}^i_{n,t,\text{avg,ex}} = \exp\Big(\sum_{m\in\mathcal{N}} \omega^{VA}_{m,t} \ln \hat{d}^i_{nm,t}\Big).$$

The average cost of importing from a given origin n is

$$\hat{d}^{i}_{n,t,\text{avg,im}} = \exp\Big(\sum_{m\in\mathcal{N}} \omega^{VA}_{m,t} \ln \hat{d}^{i}_{mn,t} \Big).$$

I set the domestic element to one in every period to preserve the iceberg normalization, $\hat{d}^{i}_{nn,t} = 1$.

In the decomposition analysis, to isolate the effect of export costs of economy n in sector i, for every partner $m \neq n$, I replace the cost of exporting from economy n to economy m, $\hat{d}^{i}_{mn,t}$, with the average cost of exporting to economy m, $\hat{d}^{i}_{m,t,\text{avg,ex}}$. To isolate the impact of import costs of economy n in sector i, for every partner $m \neq n$, I replace the cost of importing from economy m, $\hat{d}^{i}_{nm,t}$, with the average cost of import from economy m, $\hat{d}^{i}_{m,t,\text{avg,im}}$. I keep $\hat{d}^{i}_{nn,t} = 1$ at all times.

Average productivity Let $\hat{T}^{i}_{n,t}$ denote the productivity hat variable for economy n, sector i, and year t. For each sector-year (i, t) I compute the world average productivity, $\hat{T}^{i}_{\text{avg},t}$, as a value added weighted geometric mean across economies, which matches the multiplicative nature of hat variables:

$$\hat{T}^{i}_{\text{avg},t} = \exp\Big(\sum_{n\in\mathcal{N}} \omega^{VA}_{n,t} \ln \hat{T}^{i}_{n,t} \Big).$$

In the decomposition analysis for economy n, I replace its sector-level productivity hat variables with $\hat{T}^{i}_{\text{avg},t}$.

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

A.3 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
$P^C_{n^\star,t}$	Consumption price index of the base economy $n^\star$
$P^{i,M}_{n,t}$	Price of the intermediate-input bundle used by sector i producers 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: fraction of 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
$s_{n,j}$	Age-specific investment shares of wage income
$\phi_{n,t}$	Financial intermediation cost parameter
$\xi_{n,t}$	Government spending 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	
$c_{n,j,t}$, $i_{n,j,t}$	Consumption and investment of age-j households
$b_{n,j,t}$, $k_{n,j,t}$	Financial asset and capital of age-j households
$b_{n,j+1,t+1}$, $k_{n,j+1,t+1}$	Next-period asset position and capital
$V_{n,j,t}(\cdot)$	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
$m^{i,k}_{n,t}(\omega)$	Intermediate 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 used to construct final and intermediate goods
$Y^C_{n,t}$, $Y^I_{n,t}$	Final consumption and investment goods quantities
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.4 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), IMF, IFS.

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	-0.064	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	0.524	-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	0.586	-0.049	0.328	-0.034	0.673	-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.

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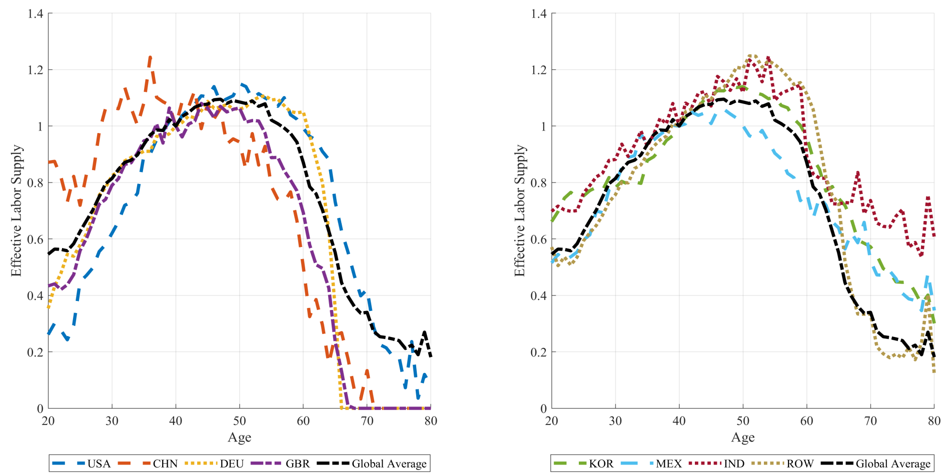
Table A6: Trade Cost Process Parameters used for Projection ($\rho^d_{nm,i}$)

	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	-0.149	-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

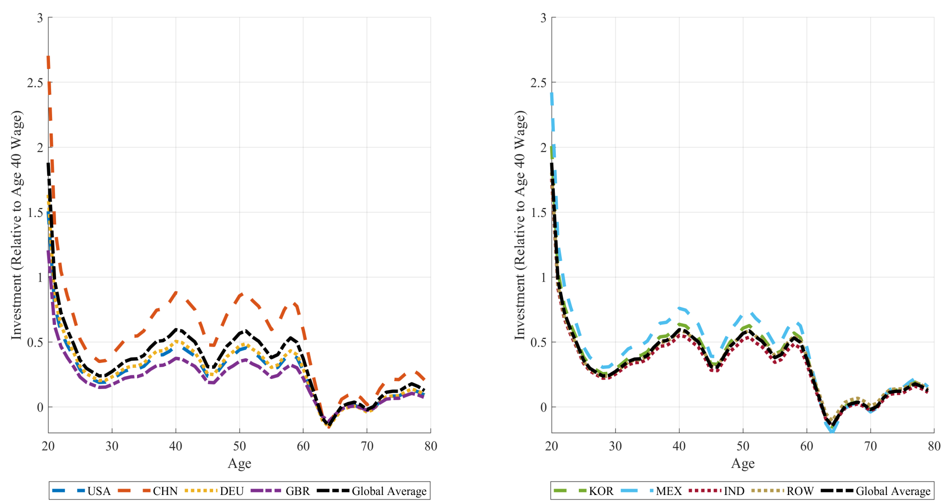
Notes: Each panel reports the estimated persistence parameter $\rho^d_{nm,i}$ for bilateral trade costs between origin n and destination m for a given sector.

Figure A1: Effective Labor Supply by Age (Share of Age 40 Wage)



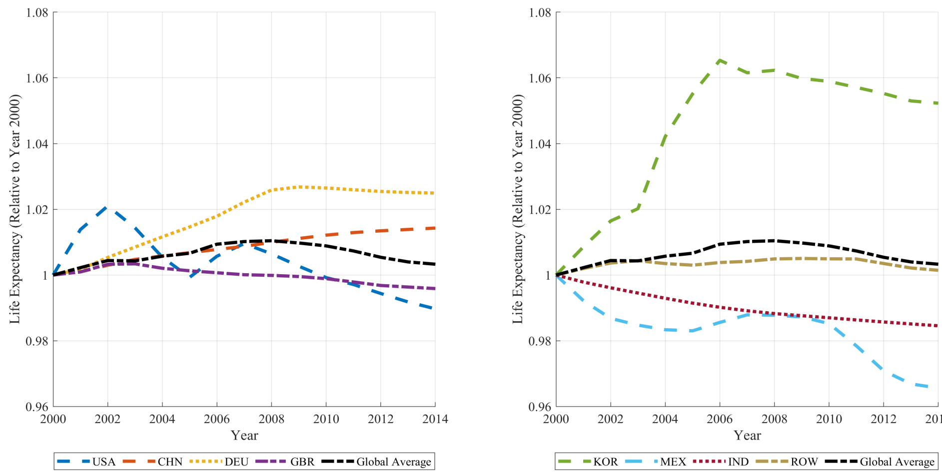
Notes: The profiles of the supply of effective labor by age were computed using income relative to age 40 income. It is assumed that a household of age 40 supplies one unit of effective labor. Estimates are based on the Luxembourg Income Study (LIS).

Figure A2: Investment by Age (Share of Age 40 Wage)



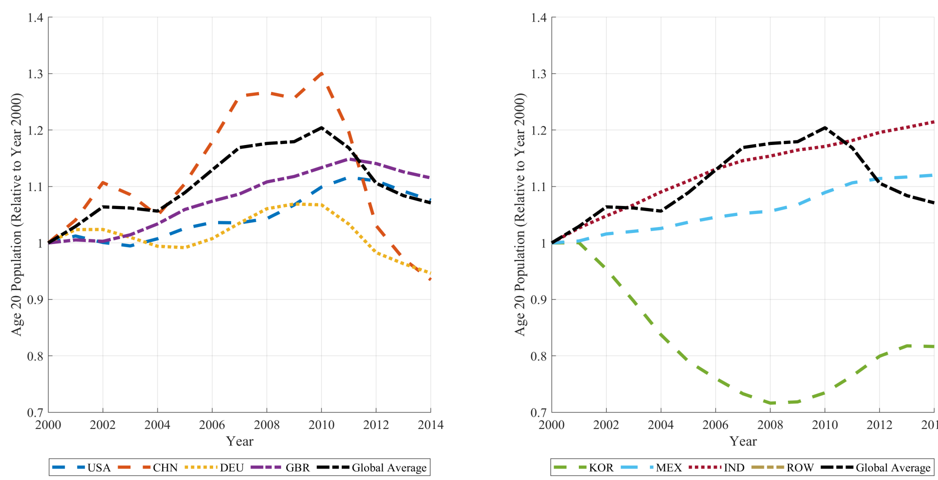
Notes: The investment profiles were computed based on the relative non-financial asset position of households in the Survey of Consumer Finances (SCF) and National Survey of Tax and Benefit (NaSTaB).

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



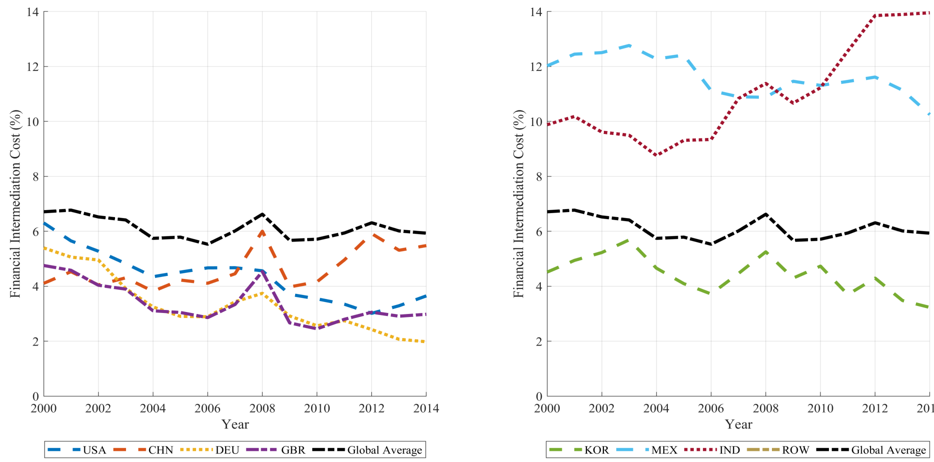
Notes: An index of life expectancy for a household aged 40 in year t, normalized to 1 in 2000. For economy n, the index equals $\prod_{h=1}^{J-20}\left(\chi_{n,20+h,t+h}/\chi_{n,20+h,2000+h}\right)$, i.e., the product of conditional survival probabilities from age 41 to the terminal age in year t relative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

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



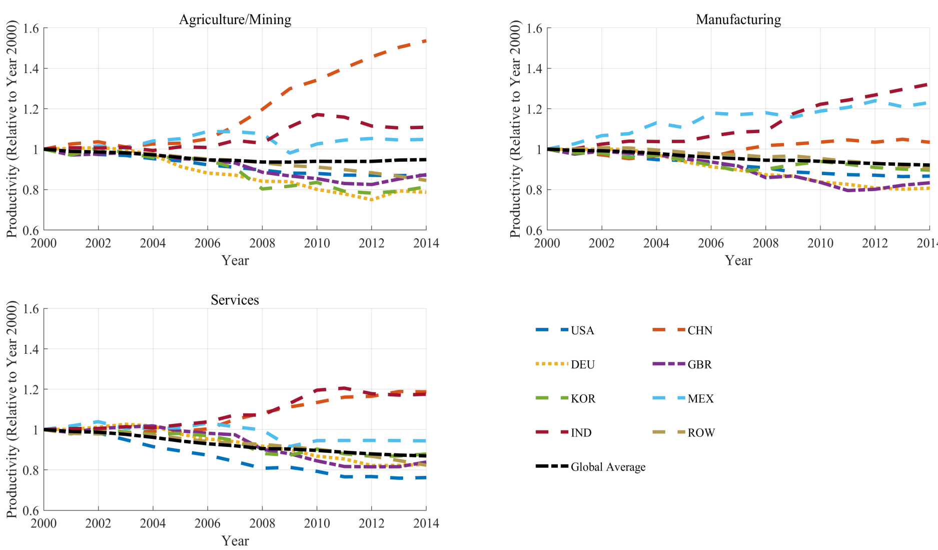
Notes: Age 20 population relative to 2000 level from 2000 to 2014. Estimates are computed based on data from UN World Population Prospects (WPP).

Figure A5: Financial Intermediate Cost from 2000 to 2014



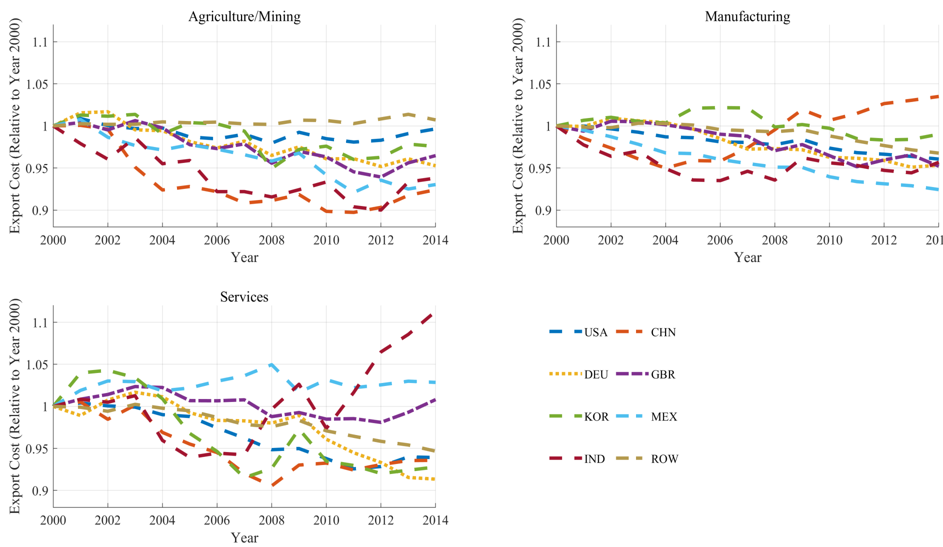
Notes: Financial intermediation cost from 2000 to 2014. Estimates are computed based on lending interest rates and the world interest rate described in Section A.1.1.

Figure A6: Productivity from 2000 to 2014



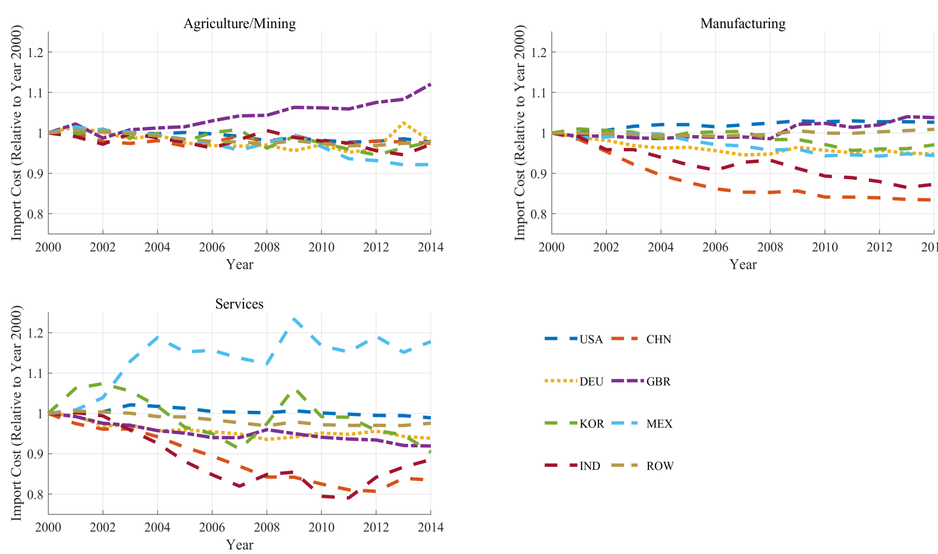
Notes: Productivity measures $((\hat{T}^i_{n,t})^{\frac{1}{\theta_i}})$ relative to year 2000 levels from 2000 to 2014. Estimates are computed based on data from the World Input-Output Database 2016 Release. The values of productivity dispersion parameters $\{\theta_i$ are 9.11 for Agriculture, 7.10 for Manufacturing, and 4.49 for Services.

Figure A7: Average Costs of Exporting to Economies from 2000 to 2014



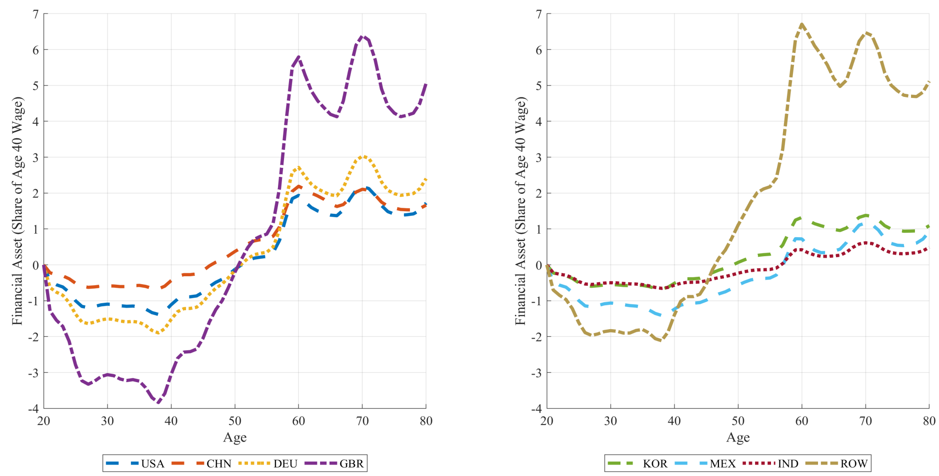
Notes: Average costs of exporting to economies (relative to Year 2000) from 2000 to 2014. Estimates are computed based on data from the World Input-Output Database 2016 Release.

Figure A8: Average Costs of Importing from Economies from 2000 to 2014



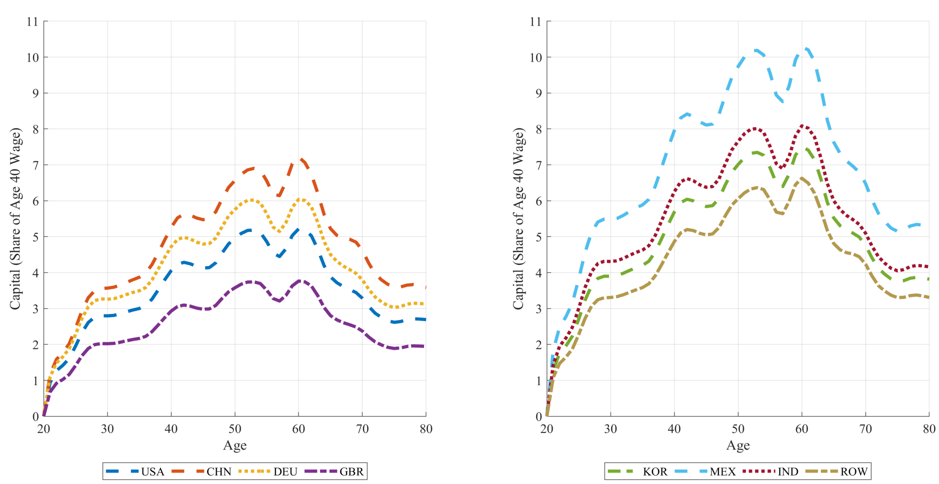
Notes: Average costs of importing from economies (relative to 2000 levels)from 2000 to 2014. Estimates are computed based on data from the World Input-Output Database 2016 Release.

Figure A9: Financial Asset Position by Age in 2000 (Share of Age 40 Wage)



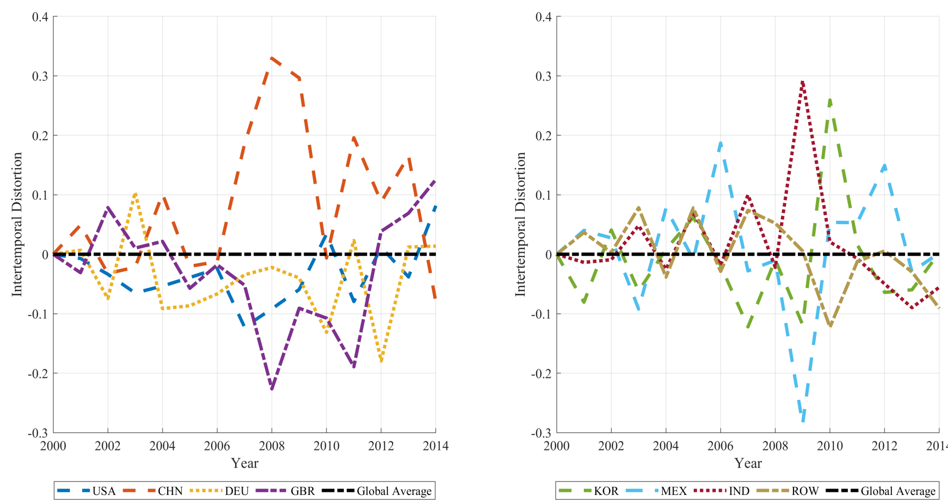
Notes: Financial asset position by age in 2000 (as a share of age 40 wage). The estimates are computed based on data from Lane and Milesi-Ferretti (2018), the National Survey of Tax and Benefit (NaSTaB), and the Survey of Consumer Finances (SCF).

Figure A10: Capital by Age in 2000 (Share of Age 40 Wage)



Notes: Asset position by age in 2000 (as a share of age 40 wage). The estimates are computed based on data from Lane and Milesi-Ferretti (2018), the National Survey of Tax and Benefit (NaSTaB), and the Survey of Consumer Finances (SCF).

Figure A11: Intertemporal Distortions (ε_{nt}) from 2000 to 2014



Notes: Intertemporal distortions from 2000 to 2014 that rationalize the trade imbalances that cannot be rationalized by other differences across economies in the model.

A.5 Derivations

A.5.1 Exact Hat Algebra

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

Bilateral Import Shares (Gravity Equation) The share of country n's expenditure on goods from exporter m in sector i is given by

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

Sectoral Price Index The corresponding sectoral price index satisfies

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

which implies

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

Changes in Trade Costs Starting from the gravity equation,

$$\pi^i_{mn,t} = \frac{T^i_{n,t}\left(mc^i_{n,t}d^i_{mn,t}\right)^{-\theta_i}}{\sum_{k=1}^{N} T^i_{k,t}\left(mc^i_{k,t}d^i_{ik,t}\right)^{-\theta_i}},$$

rearranging and substituting for the price index yields

$$\pi^i_{mn,t}\gamma^{\theta_i}(p^i_{i,t})^{-\theta_i} = T^i_{n,t}\left(mc^i_{n,t}d^i_{mn,t}\right)^{-\theta_i}.$$

Similarly, for domestic expenditure shares,

$$\pi^i_{nn,t}\gamma^{\theta_i}(p^i_{n,t})^{-\theta_i} = T^i_{n,t}\big(mc^i_{n,t}d^i_{nn,t}\big)^{-\theta_i}.$$

Taking ratios across partner and domestic pairs gives

$$\frac{\pi^i_{mn,t}}{\pi^i_{nn,t}}\left(\frac{p^i_{i,t}}{p^i_{n,t}}\right)^{-\theta_i} = \left(\frac{d^i_{mn,t}}{d^i_{nn,t}}\right)^{-\theta_i}.$$

Hence, bilateral trade costs relative to domestic costs can be expressed as

$$\frac{d^i_{mn,t}}{d^i_{nn,t}} = \left(\frac{\pi^i_{mn,t}}{\pi^i_{nn,t}}\right)^{-\frac{1}{\theta_i}}\left(\frac{p^i_{i,t}}{p^i_{n,t}}\right).$$

Using hat variables to express proportional changes over time yields the exact hat-algebra relationship:

$$\hat{d}^i_{mn,t} = \left(\frac{\hat{p}^i_{i,t}}{\hat{p}^i_{n,t}}\right)\left(\frac{\hat{\pi}^i_{nn,t}}{\hat{\pi}^i_{mn,t}}\right)^{\frac{1}{\theta_i}}.$$

Changes in Productivity From the gravity condition,

$$\pi^i_{nn,t}\gamma^{\theta_i}(p^i_{n,t})^{-\theta_i} = T^i_{n,t}\big((mc^i_{n,t}d^i_{nn,t})^{-\theta_i}\big),$$

the log-change (hat) version becomes

$$\hat{\pi}^i_{nn,t}(\hat{p}^i_{n,t})^{-\theta_i} = \hat{T}^i_{n,t}\big((\hat{mc}^i_{n,t})^{-\theta_i}\big),$$

which can be rearranged to isolate productivity changes:

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

A.6 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)

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

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

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

7. Compute time-change in prices

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

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

9. Compute final consumption good price

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

10. Compute investment good price

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

11. Compute intermediate good price

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

12. Compute marginal cost of production

$$\hat{mc}^i_{n,t} = \left((\hat{w}_{n,t})^{\eta^i_n} (\hat{r}^k_{n,t})^{1-\eta^i_n} \right)^{1-\gamma^i_n} \left(\hat{P}^{i,M}_{n,t} \right)^{\gamma^i_n}$$

13. Compute bilateral trade share

$$\hat{\pi}^i_{in,t} = \left(\frac{\hat{T}^i_{n,t} \left(\hat{mc}^i_{n,t} \hat{d}^i_{in,t} \right)^{-\theta_i}}{\sum_{k=1}^N \pi^i_{ik,0} \hat{T}^i_{k,t} \left(\hat{mc}^i_{k,t} \hat{d}^i_{ik,t} \right)^{-\theta_i}} \right)$$

14. Compute sectoral good price

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

15. Update using convex combination with smoothing parameter λ_P

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

17. Investment decision

$$\begin{aligned} i_{n,j,t} &= s_{n,j} w_{n,t} \times \mathbb{1}[h < J], \\ i_{n,J,t} &= -(1 - \delta_n) k_{n,J,t} \end{aligned}$$

18. Law of motion for capital

$$k_{n,j+1,t+1} = (1-\delta_n)k_{n,j,t} + i_{n,j,t}$$

19. Compute valued added

$$VA_{n,t} = w_{n,t}\sum_{j=0}^{J} e_{n,j}L_{n,j,t} + r^k_{n,t}\sum_{j=0}^{J} k_{n,j,t}L_{n,j,t}$$

20. Compute government expenditure

$$X^G_{n,t} = \xi_{n,t}VA_{n,t}$$

21. Compute government transfers

$$\mathcal{T}_{n,j,t} = -\frac{X^G_{n,t}}{\sum_{j=0}^{J_y} L_{n,j,t}} \times \mathbb{1}[J_{min} \leq j \leq J_{max}]$$

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

23. Solve households' problem

    - Interest rate function

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

    - Investment decision

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

- Law of motion for capital

$$k_{n,j+h+1,t+h+1} = (1-\delta_n)k_{n,j+h,t+h} + i_{n,j+h,t+h}$$

- Guess $c_{n,j,t}(h)$
  i.e., consumption after h periods for an individual of age j in economy n at time t

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

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

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

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

- Compute forward until $j = J$

- Compute $b_{n,j,t}(J-j+1)$

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

- Compute residual $residual_C = (b_{n,j,t}(J-j+1))^{LHS} - (b_{n,j,t}(J-j+1))^{RHS}$
- Use fsolve to find $c_{n,j,t}(0)$ such that $residual_C = 0$

24. Compute bequest

$$
\begin{aligned}
(BV_{n,t})' &= \sum_{j=1}^{J} P^C_{n^\star,t}b_{n,j,t}\left(L_{n,j-1,t-1}-L_{n,j,t}\right)+P^C_{n^\star,t}b_{n,J+1,t}L_{n,J,t-1}\\
residual_\Omega &= (BV_{n,t})' - \sum_{j=0}^{J_y} L_{n,j,t}\Omega_{n,j,t}
\end{aligned}
$$

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

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

27. Compute financial expenditure

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

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

$$X^I_{n,t} \equiv \Big(\sum_{j=0}^{J} P^I_{n,t} i_{n,j,t} L_{n,j,t}\Big)$$

30. Compute sector-level expenditure

$$X^i_{n,t} = \alpha^{i,C}_n X^C_{n,t} + \alpha^{i,I}_n X^I_{n,t} + \alpha^{i,G}_n X^G_{n,t} + \sum_{k \in \mathcal{I}} \gamma^k_n \gamma^{k,i}_n \sum_{m \in \mathcal{N}} \pi^k_{mn,t} X^k_{m,t}$$

31. Solve for sector-level expenditure using Leontief inverse

$$\begin{aligned}
\vec{F}_{n,t} &= \vec{\alpha}^C_n X^C_{n,t} + \vec{\alpha}^I_n X^I_{n,t} + \vec{\alpha}^G_n X^G_{n,t} \\
\mathbf{F}_t &= [\vec{F}_{n,t}]_{n \in \mathcal{N}} \\
\mathbb{A}_t[(n-1)I + i, (m-1) * I + k] &= \gamma^k_n \cdot \gamma^{k,i}_n \cdot \pi^k_{mn,t} \\
\mathbf{L}_t &= (\mathbf{I}_{NI \times NI} - \mathbf{A}_t)^{-1} \\
\mathbf{X}_t &= \mathbf{L}_t \cdot \mathbf{F}_t \\
||\mathbf{X}_t||_1 &= 1
\end{aligned}$$

32. Compute sector-level gross output

$$GO^i_{n,t} = \sum_{m \in \mathcal{N} \setminus \{n\}} \pi^i_{mn,t} X^i_{m,t} + \pi^i_{nn,t} X^i_{n,t}$$

33. Update wage using labor market clearing condition

$$w_{n,t} = \frac{\sum_{i \in \mathcal{I}} (1 - \gamma^i_n)(\eta^i_n) GO^i_{n,t}}{\sum_{j=0}^{J} e_{n,j} L_{n,j,t}}$$

34. Update rental rate using capital market clearing condition

$$r^k_{n,t} = \frac{\sum_{i \in \mathcal{I}} (1-\gamma^i_n)(1-\eta^i_n) GO^i_{n,t}}{\sum_{j=0}^{J} k_{n,j,t} L_{n,j,t}}$$

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

36. Update world interest rate using bond market clearing condition using fzero

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

37. Use fsolve 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

$$\begin{aligned} NFA_{n,t+1} &= P^C_{n^\star,t+1} \sum_{j=0}^{J} b_{n,j+1,t+1} \cdot L_{n,j,t} \\ TL_{n,t+1} &= -P^C_{n^\star,t+1} \sum_{j=0}^{J} b_{n,j+1,t+1} \cdot \mathbb{1}[b_{n,j+1,t+1} < 0] \cdot L_{n,j,t} \end{aligned}$$