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Neoclassical Growth in an Interdependent World*

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We develop a tractable, multi-country, open-economy model of neoclassical growth. We use this quantitative framework to study the determinants of growth and convergence (as a central issue in macroeconomics) and the welfare effects of international integration or disintegration (as a central issue in international economics). Trade and capital market frictions interact to determine steady-state outcomes, growth along the transition path, and welfare. Capital accumulation is a key margin through which both frictions affect welfare. Speeds of convergence for assets and capital differ and are jointly determined. Unexpected shocks have valuation effects that depend on bilateral gross capital positions.

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1 Introduction

The world economy features rich networks of bilateral trade and capital holdings. Understanding the interactions between these networks is central for multiple questions in international economics and macroeconomics. For example, how do trade and capital openness affect capital accumulation and economic growth and the speed of convergence to steady state? To what extent do the gains from international trade depend on capital market openness? What are the effects of integration and disintegration in goods and capital markets — such as the economic decoupling of the United States and China — both on these countries and third countries?

To study such questions, we develop a tractable, multi-country, open-economy model of neoclassical growth, with imperfect substitutability in both goods and capital markets. Relative to standard static trade models, our framework incorporates dynamic capital accumulation that depends on capital market openness. Compared to conventional neoclassical growth models with open capital markets, our framework features a tractable, multi-country network of bilateral capital holdings with a realistic degree of substitutability across alternative investments. Relative to canonical international macro models, we incorporate many asymmetric countries and rich networks of bilateral frictions in both goods and capital markets, and analyze the relationships between international capital holdings, capital accumulation and economic growth. Our framework incorporates intratemporal trade in goods, a capital allocation decision across countries, and an intertemporal consumption-savings decision. We show that it is consistent with a number of key features of the observed data, such as gravity equations for bilateral trade and capital holdings.

In our framework, openness in capital markets can be summarized by a country's domestic portfolio share, in a similar way that openness in goods markets can be captured by a country's domestic expenditure share. Trade and capital market frictions affect steady-state real gross domestic product (GDP), economic growth along the transition path, and welfare. Capital accumulation is a key margin through which these frictions affect welfare and the dynamic effect of trade frictions depends on capital market frictions (and vice versa). Since assets differ from capital, the speeds of convergence for these two variables differ and are jointly determined. Unexpected changes in trade and capital market frictions have valuation effects that depend on gross capital positions. Bilateral frictions have third-country effects, because of cross substitution in goods and capital markets. Applying our framework to a disintegration of the United States from the world economy and a decoupling between the United States and China, we show that these interactions between openness in goods and capital markets are sizable quantitatively. We find that the third-country effects of higher U.S.-Chinese trade and capital market frictions are negatively correlated with one another, highlighting the importance of jointly studying both of these dimensions of international openness.

We consider a world economy of many countries. The representative consumer in each country chooses consumption and savings to maximize the net present value of her discounted stream of utility. We assume no aggregate uncertainty, such that the representative consumer has perfect foresight for all aggregate variables. Preferences each period are defined over a non-traded final good that can be used for local consumption or local investment. This non-traded final good is produced using the differentiated intermediate varieties supplied by each country. Intermediate varieties can be traded between countries subject to iceberg bilateral trade costs. The expenditure share of each importing country on each exporting country satisfies a constant elasticity gravity equation. Although we develop our baseline specification for an Armington model of trade, our results hold throughout the class of trade models with a constant elasticity gravity equation for goods trade.

We assume that the savings of the representative consumer are managed by a wealth fund that consists of a continuum of fund managers. Fund managers in each investor country buy and sell claims on units of capital in each host country in an international capital market. Buying a claim on a unit of capital allows a fund manager to control its productive use by communicating knowledge between countries. The productivity of this capital management depends on bilateral management costs and idiosyncratic efficiency shocks. The bilateral management costs capture all frictions to managing capital, including information, communication, and search costs. The idiosyncratic efficiency shock represents the quality of the match between the fund manager and the host country, through which the fund manager's knowledge or expertise augments the productivity of capital. Under the assumption that the idiosyncratic efficiency shocks are drawn from an extreme value distribution, each investor country's share of the assets held as capital in each host country satisfies a constant elasticity gravity equation.

Countries can differ in labor endowments, productivity, capital market efficiency, labor intensity, and bilateral trade and capital market frictions. We refer to these exogenous characteristics of the economy as fundamentals. The state variables of the model are the matrix of bilateral capital holdings between each pair of investor and host countries. Along a perfect foresight equilibrium path, we can reduce the matrix of state variables to the two vectors of the capital and asset stocks in each country. Unanticipated shocks that move the economy between perfect foresight equilibrium paths give rise to valuation effects, because they change the value of the assets held by each investor country as capital in each host country. Given constant values of fundamentals, and the capital and asset stocks, each country converges along a transition path to its own steady-state equilibrium values of capital, assets, and real income per capita. Given observed data on the model's endogenous variables, we show how to recover unique values of the unobserved fundamentals (up to normalizations), and how to solve for the economy's counterfactual transition path in response to changes in these fundamentals.

Our model is consistent with key features of global imbalances observed in the data. Each country's current account equals its trade balance in goods plus net investment income, where net investment income is equal to the net income from international trade in capital management services. Gross capital holdings exceed net capital holdings, because of the idiosyncratic efficiency shocks, which generate two-way capital holdings. The resulting two-way trade in capital management services allows for international capital holdings even in the absence of international trade in goods. Each country's financial account is positive if it sells more claims on domestic capital than it buys on foreign capital (and vice versa) and is equal to minus its current account. Along the transition path to steady state, the current and financial account can be imbalanced, as a country accumulates or decumulates net foreign assets. In steady state, the current and financial account are balanced, such that each country has constant net foreign assets. However, this does not require balanced trade: a steady-state trade imbalance can be offset by net investment income. Therefore, some countries can specialize as exporters of goods in steady state (trade surplus and negative net investment income), while others specialize as exporters of capital (trade deficit and positive net investment income).

Our model nests several existing frameworks as special cases. The class of static trade models with a constant trade elasticity corresponds to a special case with no physical capital and only labor used in production. The closed-economy neoclassical growth model (CNGM) is a special case with autarky in both goods and capital markets. The frictionless neoclassical growth model (FNGM) is the special case with homogeneous goods and capital and zero frictions in both goods and capital markets. Dynamic trade models with capital accumulation under capital autarky correspond to another special case with open trade but prohibitive capital market frictions. More generally, our open-economy neoclassical growth model (ONGM) allows for open goods and capital markets with imperfect substitutability across countries and finite frictions in both markets.

We use our framework to study the determinants of growth and convergence (as a central issue in macroeconomics) and the welfare effects of international integration or disintegration (as a central issue in international economics). Open capital markets introduce two related distinctions between assets and capital and between gross domestic product (GDP) and gross national income (GNI). The speeds of convergence to steady state for assets and capital are different from one another and jointly determined. These speeds of convergence for any one country depend on the entire network of goods and capital market frictions and the initial stocks of assets and capital in all countries. Higher capital market openness can increase the speed of convergence for capital (thereby reducing differences in the marginal product of capital across countries) and yet reduce the speed of convergence for assets (by reducing differences in the return to saving across countries). In the limiting case of frictionless capital markets, there is a single global portfolio and a common return on saving for all countries, such that initial differences in assets can persist forever.

Since our quantitative model rationalizes the observed data on bilateral trade and capital holdings and features endogenous consumption-savings decisions, it provides a suitable framework for examining a disintegration of the United States from world markets and a decoupling between the

United States and China. As in conventional trade models, higher trade frictions raise a country's own final goods price index, and lead to forgone static welfare gains from trade. In contrast to those models, higher trade frictions affect capital accumulation, and the magnitude of these dynamic effects depends on capital market openness. Trade and capital market frictions have valuation effects that depend on gross capital positions. Higher trade frictions raise the final goods price index that corresponds to the cost of investment, and hence initially improve the trade balance (by reducing investment relative to savings), before eventually worsening the trade balance. In contrast, higher capital market frictions initially reduce the rate of return to savings, and hence initially worsen the trade balance (by reducing saving relative to investment), before ultimately improving the trade balance. We show that the third-country effects of a decoupling between the United States and China are negatively correlated, because of different initial trade and capital networks, and the different effects of these two frictions on the steady-state composition of the current account.

Our model is consistent with key features of observed international trade and capital holdings, as discussed in Obstfeld and Rogoff (2000). First, it matches empirical findings that bilateral trade and capital holdings are both well approximated by a gravity equation, such that both depend on origin and destination fixed effects, and measures of bilateral frictions (e.g., Portes and Rey 2005; Head and Mayer 2014). Second, it allows for home bias in both trade and capital holdings (e.g., French and Poterba 1991; McCallum 1995) because of bilateral trade and capital market frictions. Third, it generates a strong positive correlation between domestic saving and investment (e.g., Feldstein and Horioka 1980) if bilateral capital market frictions are sufficiently high and the degree of substitution between domestic and foreign capital is sufficiently low. Fourth, it rationalizes empirical findings that gross capital holdings are substantially larger than net capital holdings (e.g., Obstfeld 2012) because of the two-way trade in capital management services. Finally, it allows capital-abundant countries to have low investment in capital-scarce countries (e.g., Lucas 1990; Caselli and Feyrer 2007; Monge-Naranjo et al. 2019), because of bilateral capital market frictions, and matches empirical estimates of the dispersion of the marginal product of capital across countries.

The remainder of the paper is structured as follows. Section 2 discusses the related literature. Section 3 develops our theoretical framework. Section 4 characterizes the properties of the steady-state equilibrium of our model. Section 5 analyzes the transition dynamics of our model. Section 6 describes the data and undertakes our quantitative analysis for growth and convergence and the welfare effects of international disintegration. Section 7 concludes.

2 Related Literature

Our paper is related to a number of different strands of research. First, we connect with the macroeconomics literature on neoclassical growth and convergence following Ramsey (1928), Solow (1956) and Swan (1956). Empirical support for the CNGM's prediction of conditional convergence in income per capita is provided by the cross-country growth literature following Barro (1991) and Mankiw et al. (1992). But the CNGM's assumptions of autarky in goods and capital markets stand in disconnect with observed international trade and capital holdings.

Open-economy versions of the neoclassical growth model often assume perfect substitutability and frictionless goods and capital markets, which sits awkwardly with the observed gravity equations for international trade and capital holdings. These assumptions also imply perfectly elastic international capital movements to equalize returns on capital across countries, which contrasts with the relatively small capital flows from rich to poor countries, as discussed in Lucas (1990). However, whether the observed differences in capital-labor ratios across countries imply differences in marginal products depends on the extent to which there is also variation in capital income shares, as discussed in Caselli and Feyrer (2007) and Monge-Naranjo et al. (2019).

To explain observed growth miracles, Ventura (1997) combines the CNGM with the Heckscher-Ohlin model's assumptions of frictionless trade and perfect substitutability in goods markets. Although production is characterized by diminishing marginal returns to capital, countries can accumulate capital at a constant rental rate if their endowments lie within the factor price equalization set. In contrast, Acemoglu and Ventura (2002) consider a model of capital autarky and open trade with an AK production technology, where countries supply differentiated goods under frictionless trade. In equilibrium, countries accumulate capital at different rates, but there is a stable world income distribution because of endogenous changes in the terms of trade in goods markets. Relative to that paper, we incorporate frictions in goods markets and introduce open capital markets with frictions and imperfect substitutability, in order to match the observed gravity equations for goods and capital. Therefore, our framework features terms of trade effects in both goods and capital markets, which depend on goods and capital market frictions.

Second, our work is related to the class of quantitative trade models that feature a constant elasticity gravity equation. This class of models includes differentiation by country of origin (Armington 1969), Ricardian technology differences (Eaton and Kortum 2002), and horizontally-differentiated firm varieties and increasing returns to scale (Krugman 1980 and Melitz 2003 with a Pareto distribution), as examined in Arkolakis et al. (2012).[1] Much of this research assumes exogenous trade imbalances, but Ju et al. (2014), Reyes-Heroles (2016), Eaton et al. (2016), and Ravikumar et al. (2019) endogenize these imbalances following Obstfeld and Rogoff (1996). Related research examines the relationship between international trade and capital accumulation, including Anderson et al. (2015), Alvarez (2017), Brooks and Pujolas (2018), and Ravikumar et al. (2019). Compared to these studies, we introduce open capital markets with frictions and imperfect substitutability in order to rational-

[1] One strand of this research incorporates static foreign direct investment (FDI), as in Ramondo and Rodríguez-Clare (2013), but abstracts from portfolio investment, debt, and endogenous capital accumulation.

ize the observed gravity relationship for international capital holdings. We show that the degree of capital openness matters for the effect of trade on capital accumulation and for the welfare implications of changes in trade frictions.

Third, our analysis relates to several lines of research in international finance and macroeconomics. A first group of studies examines global imbalances and exorbitant privilege, including Gourinchas and Rey (2007), Jin (2012), Gourinchas and Jeanne (2006) and Gourinchas and Jeanne (2013), Maggiori et al. (2020), Auclert et al. (2020), Coppola et al. (2021), Davis et al. (2021), Atkeson et al. (2022), Aguiar et al. (2025), and Itskhoki and Mukhin (2025). A second group examines imperfect substitutability in capital markets, including Koijen and Yogo (2019), Koijen and Yogo (2020), Auclert et al. (2022), and Maggiori (2021). A third group evaluates the international propagation of shocks through goods and capital markets, including Backus et al. (1992), Kose et al. (2003), and Huo et al. (2019).

A fourth group is concerned with the international risk diversification, including Cole and Obstfeld (1991), Obstfeld (1994), Mendoza et al. (2009), Fitzgerald (2012), Jiang et al. (2022), Chau (2022), Hu (2022), Kucheryavyy (2022), and Caliendo et al. (2025). One of the early challenges for this literature was explaining home bias and gravity in capital holdings. In response to this challenge, models of international risk diversification have been developed that are consistent with gravity in capital holdings, including Martin and Rey (2004), Martin and Rey (2006), Coeurdacier and Rey (2013), Heathcote and Perri (2013), Koijen and Yogo (2020), and Pellegrino et al. (2025). A related empirical literature has provided evidence of gravity in capital holdings, including Portes and Rey (2005), Lane and Milesi-Ferretti (2008), and Okawa and Wincoop (2012).

In contrast to this research, we abstract from international risk diversification by assuming no aggregate uncertainty. This abstraction allows us to develop a tractable, multi-country, quantitative model that simultaneously incorporates international trade, international capital holdings, and growth through capital accumulation. We are therefore able to study how goods and capital openness interact to determine growth and convergence, as a central issue in macroeconomics, and the welfare effects of international integration, as a central question in international economics. We allow for rich networks of frictions in both goods and capital markets in order to rationalize the observed data. Our multi-country framework can be taken directly to observed data on income, trade and capital holdings, and used to evaluate empirically-realistic counterfactuals.

3 Theoretical Framework

We develop a discrete-time, infinite-horizon production economy with multiple countries. We index time by $t \in \{1, \ldots, \infty\}$ and countries by $n \in \{1, \ldots, N\}$. Each country produces a differentiated good under a constant returns production technology, using labor and capital. Labor and capital markets are perfectly competitive. Countries trade goods subject to bilateral iceberg trade costs. The representative consumer in each country chooses consumption and savings. Her savings are managed by a wealth fund that invests these savings as capital in each host country. Bilateral capital holdings are subject to bilateral capital management costs and idiosyncratic efficiency shocks. There is no aggregate uncertainty, and the representative consumer has perfect foresight for all aggregate variables along the equilibrium path. In Subsection 3.1, we describe the economic environment. In Subsection 3.2, we characterize the market equilibrium.

3.1 Economic Environment

We describe the economic environment, including preferences, production technology, trade frictions, and capital market frictions.

Preferences The representative consumer in country n has a fixed labor endowment ℓ_n. Let c_{nt} be her consumption of the non-traded final good in period t. Her lifetime utility is

$$u_{nt} = \sum_{s=0}^{\infty} \beta^{t+s} \frac{c_{nt+s}^{1-1/\psi}}{1-1/\psi}, \tag{1}$$

where $\beta \in (0,1)$ is the discount factor and $\psi > 0$ is the elasticity of intertemporal substitution.

Final-Good Production Technology Each country n produces y_{nt} units of a non-traded final good in period t, by importing $\mathcal{Y}_{nit}$ units of a differentiated intermediate variety from each country i. The production technology takes the constant elasticity of substitution (CES) form:

$$y_{nt} = \left(\sum_{i=1}^{N} \mathcal{Y}_{nit}^{1-1/\sigma} \right)^{\frac{1}{1-1/\sigma}}, \qquad \sigma > 1. \tag{2}$$

Although we focus on an Armington specification for simplicity, Online Appendix K shows that our results hold throughout the class of constant elasticity trade models. Output of the final good y_{nt} can be used for domestic consumption c_{nt} or domestic investment ι_{nt}:

$$y_{nt} = c_{nt} + \iota_{nt}. \tag{3}$$

Intermediate-Good Production Technology Each country i produces $\mathcal{Y}_{it}$ units of a differentiated intermediate variety in period t, using ℓ_{it} units of labor and k_{it} units of capital. Let z_{it} be country i's total factor productivity in period t. The production technology takes the Cobb-Douglas form with constant returns to scale:

$$\mathcal{Y}_{it} = z_{it} \left(\frac{\ell_{it}}{\mu_i} \right)^{\mu_i} \left(\frac{k_{it}}{1-\mu_i} \right)^{1-\mu_i}, \tag{4}$$

where $\mu_i \in (0,1)$ is the labor share that varies across countries.

Countries trade intermediate varieties subject to bilateral iceberg trade costs, such that $\tau_{nit} \geq 1$ units must be shipped from country i for one unit to arrive in country n. We normalize the domestic trade cost to $\tau_{nnt} = 1$ and assume that foreign trade is more costly (i.e., $\tau_{nit} > 1$ for $n \neq i$). Market clearing for the intermediate variety produced by country i in period t requires:

$$\mathcal{Y}_{it} = \sum_{n=1}^{N} \tau_{nit} \mathcal{Y}_{nit}. \tag{5}$$

Capital Management Technology Each country n has a wealth fund managed by a unit continuum of fund managers, indexed by $\nu \in [0,1]$. Fund managers in each investor country n manage capital in each host country i by communicating knowledge between countries. After capital k_{it} in host country i is used for production, it depreciates at the rate $\delta \in (0,1)$ in period t. Let $k_{nit}(\nu)$ be the units of host country i's capital managed by fund manager ν from investor country n at the end of period t. Given the investment ι_{it} of the final good into the capital stock in host country i, market clearing for host country i's capital at the end of period t requires:

$$(1-\delta) k_{it} + \iota_{it} = \sum_{n=1}^{N} \int_0^1 k_{nit}(\nu) \, \mathrm{d}\nu, \tag{6}$$

where k_{it} and ι_{it} are measured in units of the final good.

Bilateral capital holdings are subject to capital management costs and idiosyncratic efficiency shocks from period t to $t+1$. The parameter $\kappa_{nit} \geq 1$ represents the bilateral capital management costs for investor country n in host country i. We normalize the domestic capital management costs to $\kappa_{nnt} = 1$ and assume higher foreign capital management costs (i.e., $\kappa_{nit} > 1$ for $n \neq i$). The bilateral capital management costs represent all frictions to managing capital between countries, including information and communication costs (Portes et al. 2001) and search and matching costs (Hortaçsu and Syverson 2004).

Before making capital holding decisions, fund manager ν in investor country n draws a set $\{\varphi(n,i,t,\nu)\}_{i=1}^{N}$ of idiosyncratic efficiency shocks for each host country i. If fund manager ν chooses to manage capital in host country i, each unit of capital in period t becomes $\varphi(n,i,t,\nu)/\kappa_{nit}$ units of capital in period $t+1$. The idiosyncratic efficiency shock represents the quality of the match between the fund manager and the host country, through which the fund manager's knowledge or expertise augments the productivity of capital. The idiosyncratic efficiency shocks are drawn from a Fréchet distribution independently across managers, host countries, and time. We denote the cumulative distribution function for host country i as $F_i(\varphi) = \exp\left(-(\varphi/\eta_{it})^{-\epsilon}\right)$. The scale parameter η_{it} determines the average efficiency of capital in host country i. The shape parameter ϵ determines the dispersion of the idiosyncratic efficiency shocks.

Therefore, the capital stock in host country i at the beginning of period $t+1$ is

$$k_{it+1} = \sum_{n=1}^{N} \int_0^1 k_{nit}\left(\nu\right) \frac{\varphi\left(n,i,t,\nu\right)}{\kappa_{nit}} \, \mathrm{d}\nu, \tag{7}$$

where $\varphi\left(n,i,t,\nu\right)$ and κ_{nit} in period t affect the capital stock in period $t+1$ (k_{it+1}).

All idiosyncratic risk diversifies because of the assumption of unit continuum of fund managers, which implies that there is no uncertainty in the capital stock (7) or any other aggregate variable. Although we refer to k_{it} as the capital stock throughout the paper, a more accurate description is efficiency units of capital, which incorporate both the bilateral capital management costs and idiosyncratic efficiency shocks.

If we shut down the bilateral capital management costs (i.e., $\kappa_{nit} = 1$) and the idiosyncratic efficiency shocks (i.e., $\varphi\left(n,i,t,\nu\right) = 1$), equations (6) and (7) simplify to the standard capital accumulation equation: $k_{it+1} = \left(1-\delta\right)k_{it} + \iota_{it}$. The idiosyncratic efficiency shocks create imperfect substitutability in the capital managed by fund managers from different investor countries. The bilateral management costs introduce capital market frictions, such that capital is less productive when managed abroad than at home.

In this specification, bilateral capital holdings involve the provision of capital management services by fund managers in each investor country to each host country. The productivity of these capital management services depends on the idiosyncratic efficiency shocks and the bilateral capital management costs. Note that although capital in each country is produced from a non-traded final good, variable trade costs affect the cost of the intermediate varieties used to produce that non-traded final good, and hence the cost of investment in each country.

We show below that this capital market specification provides microfoundations for a gravity equation for bilateral capital holdings and can be tractably embedded in a multi-country quantitative neoclassical model of growth that connects directly to national accounts data.

3.2 Market Equilibrium

We now characterize the market equilibrium of the above economic environment. We assume that all markets are perfectly competitive.

Production and Factor Prices Let w_{it} be the wage rate in country i in period t. Let r_{it} be the rental rate of capital in country i in period t. Let $\mathcal{P}_{iit}$ be the "free on board" price (before trade costs) of the intermediate good produced by country i in period t. Given the production technology for the intermediate variety (4), cost minimization and zero profits imply the following relationship between price and unit cost:

$$\mathcal{P}_{iit} = \frac{w_{it}^{\mu_i} r_{it}^{1-\mu_i}}{z_{it}}. \tag{8}$$

Cost minimization, given the Cobb-Douglas production technology, implies that relative factor payments are proportional to relative factor shares:

$$\frac{w_{it}\ell_i}{r_{it}k_{it}} = \frac{\mu_i}{1-\mu_i}, \tag{9}$$

where we substitute $\ell_{it} = \ell_i$ by labor market clearing. Using equation (9), we can write the value of a country's gross domestic product (GDP) as

$$\mathcal{P}_{iit}\mathcal{Y}_{it} = w_{it}\ell_i + r_{it}k_{it} = \frac{w_{it}\ell_i}{\mu_i}. \tag{10}$$

We choose world GDP as our numeraire, such that $\sum_{i=1}^{N}\mathcal{P}_{iit}\mathcal{Y}_{it} = 1$.

Trade and Price Indexes The price "inclusive of freight" in importing country n for the intermediate variety produced by exporting country i in period t is

$$\mathcal{P}_{nit} = \tau_{nit}\mathcal{P}_{iit}, \tag{11}$$

where τ_{nit} is the bilateral trade cost. Given the production technology (2), the corresponding dual price index for the non-traded final good in country n in period t is

$$p_{nt} = \left[\sum_{i=1}^{N}\mathcal{P}_{nit}^{1-\sigma}\right]^{\frac{1}{1-\sigma}} = \left[\sum_{i=1}^{N}\left(\frac{\tau_{nit}w_{it}^{\mu_i}r_{it}^{1-\mu_i}}{z_{it}}\right)^{-\theta}\right]^{-\frac{1}{\theta}}, \tag{12}$$

where $\theta = \sigma - 1 > 0$ is the trade elasticity; p_{nt} corresponds to the price index for both consumption and investment; and the relative values of these price indexes across countries (p_{nt}/p_{it}) correspond to real exchange rates.

Country n's expenditure on its final good is $p_{nt}y_{nt} = p_{nt}\left(c_{nt} + \iota_{nt}\right) = \sum_{i=1}^{N}\mathcal{P}_{nit}\mathcal{Y}_{nit}$ in period t. Its expenditure share on the intermediate good produced by country i is:

$$s_{nit} = \frac{\mathcal{P}_{nit}\mathcal{Y}_{nit}}{\sum_{h=1}^{N}\mathcal{P}_{nht}\mathcal{Y}_{nht}} = \frac{\mathcal{P}_{nit}^{-\theta}}{\sum_{h=1}^{N}\mathcal{P}_{nht}^{-\theta}} = \frac{\left(\tau_{nit}w_{it}^{\mu_i}r_{it}^{1-\mu_i}/z_{it}\right)^{-\theta}}{\sum_{h=1}^{N}\left(\tau_{nht}w_{ht}^{\mu_h}r_{ht}^{1-\mu_h}/z_{ht}\right)^{-\theta}}, \tag{13}$$

where the final equation follows by substituting equations (8) and (11).

Therefore, our model implies a gravity equation for goods trade (13), in which trade between countries n and i depends on bilateral trade costs in the numerator ("bilateral resistance") and on trade costs with all other countries in the denominator ("multilateral resistance").

Consumption-Saving Decisions At the beginning of period t, the representative consumer inherits a stock of assets (a_{nt}), which equals the sum of her asset holdings in each host country i (a_{nit}):

$$a_{nt} = \sum_{i=1}^{N} a_{nit}. \tag{14}$$

We denote investor country n's gross nominal return on savings from period t to $t+1$ by $\mathcal{R}_{nt}$, such that $\mathcal{R}_{nt}/\left(p_{nt+1}/p_{nt}\right)$ is the gross real return on savings deflated by the domestic price index. The representative consumer has perfect foresight over the sequence of future wages $\{w_{nt+s}\}_{s=0}^{\infty}$, price indexes $\{p_{nt+s}\}_{s=0}^{\infty}$, and returns $\{\mathcal{R}_{nt+s}\}_{s=0}^{\infty}$. Given her nominal assets a_{nt} at the beginning of period t, her intertemporal budget constraint is:

$$a_{nt+1} = \mathcal{R}_{nt}\left(a_{nt} + w_{nt}\ell_n - p_{nt}c_{nt}\right). \tag{15}$$

She chooses her consumption (c_{nt}) to maximize her lifetime utility (1) subject to this budget constraint (15). From the first-order conditions for this problem, equilibrium consumption expenditure is linear in total wealth, as in Angeletos (2007):

$$p_{nt}c_{nt} = \varsigma_{nt}\left(a_{nt} + w_{nt}\ell_n + h_{nt}\right), \tag{16}$$

where total wealth includes assets (a_{nt}), current labor income ($w_{nt}\ell_n$), and human capital (h_{nt}). Human capital is defined as the present value of future labor income:

$$h_{nt} = \sum_{s=1}^{\infty} \frac{w_{nt+s}\ell_n}{\prod_{u=1}^{s}\mathcal{R}_{nt+u-1}}. \tag{17}$$

The consumption-wealth ratio ς_{nt} is defined recursively as:

$$\varsigma_{nt}^{-1} = 1 + \beta^{\psi}\left(\frac{\mathcal{R}_{nt}p_{nt}}{p_{nt+1}}\right)^{\psi-1}\varsigma_{nt+1}^{-1}, \tag{18}$$

as shown in Online Appendix B.2.1. In the special case of log utility (i.e., $\psi = 1$), the equilibrium saving rate is constant, and equal to $1 - \varsigma_{nt} = \beta$, as in Moll (2014). More generally, for $\psi \neq 1$, the equilibrium saving rate is variable along the transition path, but equals β in steady state.

Capital Holding Decisions After production and consumption take place in each period, the unit continuum of competitive fund managers in each country take domestic savings and purchase claims on domestic and foreign capital in an international capital market. For example, a domestic fund manager can channel domestic savings to buy and manage capital in a foreign country. The relative prices of these claims on capital are the relative prices of capital in each host country, which equal the relative final goods price indexes (the real exchange rate). In our baseline model, fund managers in each investor country can only trade claims on capital in each host country.[2] Online Appendix N contains an extension in which fund managers can also trade bonds.

[2]We focus on a single class of assets (physical capital) in our baseline specification to stay as close as possible to the conventional closed-economy Ramsey model (in which physical capital is the single asset). In practice, we find similar elasticities of capital holdings to distance when we estimate separate gravity equations for the different types of assets that are observed in the data (debt versus equity in Koijen and Yogo (2020) and portfolio investment versus other capital holdings in Online Appendix P.2).

Buying a claim on a unit of capital allows a fund manager to control its productive use. Domestic savings are allocated equally across the unit continuum of competitive fund managers, who are *ex ante* identical before drawing their idiosyncratic efficiency shocks. Before making her capital holding decisions, fund manager ν from investor country n draws her set of idiosyncratic efficiencies $\{\varphi(n,i,t,\nu)\}_{i=1}^{N}$ for managing capital in each host country i. After observing these idiosyncratic efficiencies, she allocates her assets to the host country that offers the highest return in the international capital market. We assume that short selling of claims on capital is not possible.

If fund manager ν in investor country n allocates her funds to host country i, she pays price p_{it} per unit of capital. Each unit of capital in period t becomes $\varphi(n,i,t,\nu)/\kappa_{nit}$ units of capital in period $t+1$. Each of these $\varphi(n,i,t,\nu)/\kappa_{nit}$ units of capital earns a rental rate r_{it+1} from production, and depreciates at the rate δ in period $t+1$, after which the fund manager can sell each unit of capital at the price p_{it+1}. Therefore, the fund manager's gross nominal return on capital from period t to $t+1$ is $\frac{\varphi(n,i,t,\nu)}{\kappa_{nit}}R_{it}$, where we define

$$R_{it} = \frac{(1-\delta)\,p_{it+1} + r_{it+1}}{p_{it}} \tag{19}$$

as the gross nominal return on capital in host country i before bilateral capital management costs and idiosyncratic efficiency shocks.

Fund manager ν in investor country n allocates her assets to the host country that offers the highest return, given her set of idiosyncratic efficiency draws. Since the idiosyncratic efficiencies are drawn from an independent Fréchet distribution, the probability that a fund manager from investor country n allocates her assets to host country i in period t is

$$b_{nit} = \frac{\left(\eta_{it}R_{it}/\kappa_{nit}\right)^{\epsilon}}{\sum_{h=1}^{N}\left(\eta_{ht}R_{ht}/\kappa_{nht}\right)^{\epsilon}}, \tag{20}$$

as shown in Online Appendix B.2.2. With a unit continuum of fund managers, equation (20) also corresponds to the share of assets that investor country n allocates to host country i. Thus, the total capital holding across fund managers from investor country n in host country i is

$$p_{it}\int_0^1 k_{nit}(\nu)\,\mathrm{d}\nu = b_{nit}\left(a_{nt} + w_{nt}\ell_n - p_{nt}c_{nt}\right). \tag{21}$$

The left-hand side is the value of claims on capital in host country i held by investor country n, which is equal to the value of assets in investor country n allocated to host country i on the right-hand side.

Equation (20) implies that our capital market specification provides microfoundations for a gravity equation for capital holdings, consistent with the empirical evidence in Portes and Rey (2005), Lane and Milesi-Ferretti (2008), and Okawa and Wincoop (2012).[3] The capital allocated

[3] In Online Appendix P.1, we provide additional empirical evidence in support of these predictions of a gravity equation for bilateral capital holdings.

by investor country n to host country i depends on bilateral management costs in the numerator ("bilateral resistance") and also on management costs with all other host countries in the denominator ("multilateral resistance"). Each host country faces an upward-sloping capital supply function from each investor country, such that it has to offer a higher gross return on capital (R_{it}) in order to attract units of capital with lower idiosyncratic efficiencies for that investor country. The dispersion of these idiosyncratic efficiency draws (ϵ) controls the degree of imperfect substitutability of capital across countries and hence the elasticity of the capital supply function for each host country.

Another implication of our capital market specification is that each investor country's average return across fund managers that allocate assets to a host country is the same for all host countries. Furthermore, with a unit continuum of fund managers, all idiosyncratic uncertainty diversifies by the law of large numbers. Therefore, the average return to saving from period t to $t+1$ for each investor country n is equal to the common average return across host countries:

$$\mathcal{R}_{nt} = \int_0^1 \max_i \left\{ \frac{\varphi(n,i,t,\nu)}{\kappa_{nit}} R_{it} \right\} \mathrm{d}\nu = \gamma_\epsilon \left[\sum_{i=1}^{N} \left(\frac{\eta_{it} R_{it}}{\kappa_{nit}} \right)^{\epsilon} \right]^{\frac{1}{\epsilon}}, \tag{22}$$

as shown in Online Appendix B.2.2; $\gamma_\epsilon = \Gamma(1-1/\epsilon)$; where $\Gamma(\cdot)$ is the gamma function. Intuitively, capital markets that offer higher gross returns on capital (R_{it}) attract units of capital with lower idiosyncratic efficiency draws. With a Fréchet distribution of idiosyncratic efficiencies, this composition effect exactly offsets the higher gross returns, such that the average return conditional on allocating assets to each host country is the same across host countries.

Although we derive the gravity equation for bilateral capital holdings (20) from capital management frictions and idiosyncratic efficiencies, this relationship can be derived from alternative microfoundations, including international risk diversification, as shown in Online Appendix L.[4] Therefore, the gravity equation predictions of our model would be similar under alternative microfoundations. However, the model's other general equilibrium conditions and its predictions for welfare typically would be different under alternative microfoundations. Two key advantages of our specification are that it can be tractably embedded in a neoclassical model of growth (with the closed and open-economy Ramsey models as special cases) and that it remains quantitatively tractable in a multi-country environment (such that it easily can be taken to data and used to evaluate empirically-realistic counterfactuals).

Assets and Intermediate Goods Markets Asset accounting requires that the value of capital after depreciation plus rental income in each host country i is equal to the sum across investor countries

[4] For models of international risk diversification with a gravity equation, see Martin and Rey (2004), Martin and Rey (2006), Coeurdacier and Rey (2013), Heathcote and Perri (2013), Koijen and Yogo (2020), and Pellegrino et al. (2025).

n of the return-inclusive assets allocated to that host country i:

$$(1-\delta)\,p_{it}k_{it}+r_{it}k_{it}=\sum_{n=1}^{N}b_{nit-1}a_{nt}, \tag{23}$$

where the left-hand side is the value of capital in host country i after period t rental income and depreciation; we define assets as post-return assets, such that a_{nt} on the right-hand side is the value of assets for investor country n after period t returns; capital is constructed from the non-traded final good in each country (hence p_{it} appears in the first term on the left-hand side); and rental income $(r_{it}k_{it})$ and assets (a_{nt}) are measured in terms of the numeraire.

From the capital accumulation technology (7), the capital stock in period t is determined by portfolio allocation decisions in period $t-1$, such that the portfolio shares (b_{nit-1}) in equation (23) are defined one period before the other variables. Bilateral asset holdings (a_{nit}) and bilateral ownership of capital (k_{nit}) have an analogous relationship: $a_{nit}=b_{nit-1}a_{nt}=[(1-\delta)\,p_{it}+r_{it}]\,k_{nit}$.

Market clearing for the tradable intermediate variety produced by country i requires that revenue from production equals expenditure on that variety by all countries n (including consumption and investment). From equation (5), we can write this intermediate variety market clearing condition as: $\mathcal{P}_{iit}\mathcal{Y}_{it}=\sum_{n=1}^{N}s_{nit}p_{nt}\left(c_{nt}+\iota_{nt}\right)$. Using cost minimization and zero profits from equation (10), the capital market clearing condition (6), and equilibrium capital holdings (21), we can rewrite this intermediate variety market clearing condition as:

$$\frac{w_{it}\ell_i}{\mu_i}=\sum_{n=1}^{N}s_{nit}\left(p_{nt}c_{nt}+\sum_{h=1}^{N}b_{hnt}\left(a_{ht}+w_{ht}\ell_h-p_{ht}c_{ht}\right)-(1-\delta)\,p_{nt}k_{nt}\right), \tag{24}$$

where the first term inside the parentheses is total consumption expenditure in country n; the remaining terms inside the parentheses are total investment expenditure in country n, which equals the total value of assets from all investor countries h held in country n minus the undepreciated capital stock there.

Balance of Payments The conventional balance of payments identity holds in our model, as shown in Online Appendix C:

$$-\underbrace{FA_{nt}}_{\text{financial account}}=\underbrace{TB_{nt}}_{\text{trade balance}}+\underbrace{NII_{nt}}_{\text{net investment income}}. \tag{25}$$

Net purchases and sales of claims on foreign and domestic capital determine the financial account (FA_{nt}) on the left-hand side of equation (25). Net trade in intermediate varieties determines the trade balance (TB_{nt}) in the first term on the right-hand side. Net investment income (NII_{nt}) in the second term on the right-hand side is determined by income from claims on domestic and foreign capital and corresponds to net payments for capital management services.

Our model provides a natural explanation for the empirical finding that gross capital flows are much larger than net capital flows. The idiosyncratic efficiency shocks imply that some fund managers from country n choose to hold capital in country i, while other fund managers from country i choose to hold capital in country n. This feature not only enables our model to match the data but also implies that it behaves differently from frameworks with only net capital holdings. In particular, even with prohibitive trade frictions and zero trade in goods, there can be positive international capital holdings in our model. Each country can use revenue from its exports of capital management services to pay for expenditure on imports of capital management services (even if net investment income is zero, there is positive two-way trade in capital management services). Along the transition path to steady state, the financial account and current account can be imbalanced, such that each country can accumulate or decumulate net foreign assets. In steady state, both the financial and current account are balanced, but there can be a deficit or surplus for trade in goods that is offset by net investment income (net trade in capital management services).

Our framework allows for international borrowing and lending, such that the total value of domestic claims on capital in all foreign countries (domestic assets) in any given time period can be different from the total value of the claims of all foreign countries on domestic capital (domestic liabilities). Since our production technology satisfies the Inada conditions, the capital stock in each country is strictly positive in each time period. Since we assume no short selling of claims on capital, this property in turn implies that assets (including claims on domestic capital) are strictly positive in each time period. Nevertheless, net foreign assets can be either negative or positive in any given time period, as in the data.

Summary of Market Equilibrium The market equilibrium is referenced by the model parameters and fundamentals. The model parameters are the intertemporal elasticity of substitution (ψ); the discount rate (β); the depreciation rate (δ); the labor share (μ_n); the trade elasticity (θ); and the capital elasticity (ϵ). The fundamentals are the labor endowment $\{\ell_n\}_{n=1}^{N}$; productivity $\{z_{nt}\}_{n=1}^{N}$; and capital efficiency $\{\eta_{nt}\}_{n=1}^{N}$ for each country; and trade frictions $\{\tau_{ni}\}_{n,i=1}^{N,N}$ and capital market frictions $\{\kappa_{ni}\}_{n,i=1}^{N,N}$ for each pair of countries.

The model's state variables are the matrix of bilateral capital holdings for each investor country n in each host country i in period t $\{k_{nit}\}_{n,i=1}^{N,N}$, where recall that capital and asset holdings are related through $a_{nit} = [(1-\delta)\, p_{it} + r_{it}]\, k_{nit}$. Along a perfect foresight equilibrium path, we can reduce the model's state variables to the vector of assets in each investor country in period t $\{a_{nt}\}_{n=1}^{N}$ and the vector of capital in each host country in period t $\{k_{it}\}_{i=1}^{N}$. Using the equilibrium conditions of the model, we can recover the matrix of bilateral capital holdings $\{k_{nit}\}_{n,i=1}^{N,N}$ from these two vectors of state variables and model fundamentals. The law of motion for the asset state variables $\{a_{nt}\}_{n=1}^{N}$ is determined by the intertemporal budget constraint (15). The law of motion for the capital stock

$\{k_{it}\}_{i=1}^{N}$ is determined by the capital management technology (7).

Given the state variables $\{a_{nt}\}_{n=1}^{N}$ and $\{k_{it}\}_{i=1}^{N}$, we can recover all other endogenous variables: wages $\{w_{it}\}_{i=1}^{N}$; rental rates of capital $\{r_{it}\}_{i=1}^{N}$; price indices $\{p_{nt}\}_{n=1}^{N}$; consumption $\{c_{nt}\}_{n=1}^{N}$; expenditure shares $\{s_{nit}\}_{n,i=1}^{N,N}$; and portfolio shares $\{b_{nit}\}_{n,i=1}^{N,N}$. These endogenous variables solve the system of equations (9), (12), (13), (16), (20), and (24). These equations depend on the definitions of human capital (17), the saving rate (18), the return R_{it} (19), and the return to saving (22). Finally, we choose the world GDP as the numeraire such that:

$$\sum_{i=1}^{N} \frac{w_{it}\ell_i}{\mu_i} = 1. \tag{26}$$

In response to unanticipated shocks to fundamentals that shift the economy from one perfect foresight equilibrium path to another, our model features valuation effects, because the resulting changes in final goods price indexes ($\{p_{nt}\}_{n=1}^{N}$) and rental rates ($\{r_{it}\}_{i=1}^{N}$) lead to jumps in the values of bilateral asset holdings ($\{a_{nit}\}_{n,i=1}^{N,N}$) for given bilateral capital holdings $\{k_{nit}\}_{n,i=1}^{N,N}$.

4 Steady-State Equilibrium

We now characterize the model's steady-state equilibrium. The steady-state equilibrium is defined by time-invariant values of model fundamentals ($\{\ell_n\}_{n=1}^{N}$, $\{z_n\}_{n=1}^{N}$, $\{\eta_n\}_{n=1}^{N}$, $\{\tau_{ni}\}_{n,i=1}^{N,N}$, $\{\kappa_{ni}\}_{n,i=1}^{N,N}$). We denote the corresponding steady-state values of the model's endogenous variables with an asterisk ($\{a_n^*\}_{n=1}^{N}$, $\{k_i^*\}_{i=1}^{N}$, $\{w_i^*\}_{i=1}^{N}$, $\{r_i^*\}_{i=1}^{N}$, $\{p_n^*\}_{n=1}^{N}$, $\{c_n^*\}_{n=1}^{N}$, $\{s_{ni}^*\}_{n,i=1}^{N,N}$, $\{b_{ni}^*\}_{n,i=1}^{N,N}$).

4.1 Steady-State Capital-Labor Ratio and Real GDP per Capita

Using constant steady-state values of variables in equation (18), the steady-state saving rate $(1-\varsigma_n^*)$ and return to saving ($\mathcal{R}_n^*$) are common across countries and pinned down by the discount rate:

$$1-\varsigma^* = \beta, \qquad \mathcal{R}^* = \frac{1}{\beta}, \tag{27}$$

where we report the full steady-state derivations in Online Appendix E. The steady-state gross return on capital (R_n^*) is inversely related to capital efficiency (η_n) and capital market openness (as measured by the inverse of the domestic portfolio share b_{nn}^*):

$$R_n^* = \frac{1}{\beta\gamma_\epsilon\eta_n\left(b_{nn}^*\right)^{-\frac{1}{\epsilon}}}, \tag{28}$$

where recall that $\gamma_\epsilon = \Gamma\left(\frac{\epsilon-1}{\epsilon}\right)$ and $\Gamma(\cdot)$ is the gamma function. The steady-state capital-labor ratio (k_n^*/ℓ_n) and real GDP per capita ($\mathcal{P}_{nn}^*\mathcal{Y}_n^*/\left(p_n\ell_n\right)$) can be expressed as the following closed-form solutions of productivity (z_n), capital efficiency (η_n), labor intensity (μ_n), the domestic trade share (s^*_{nn}), and the domestic portfolio share (b^*_{nn}):

$$\left(\frac{k^*_n}{\ell_n}\right) = \left(\frac{1-\mu_n}{\mu_n}\right) z_n^{\frac{1}{\mu_n}} \left(s^*_{nn}\right)^{-\frac{1}{\theta\mu_n}} \left[\frac{1}{\beta\gamma_\epsilon\eta_n \left(b^*_{nn}\right)^{-\frac{1}{\epsilon}}} - (1-\delta)\right]^{-\frac{1}{\mu_n}}, \tag{29}$$

$$\frac{\mathcal{P}^*_{nn}\mathcal{Y}^*_n}{p^*_n\ell_n} = \frac{1}{\mu_n} z_n^{\frac{1}{\mu_n}} \left(s^*_{nn}\right)^{-\frac{1}{\theta\mu_n}} \left[\frac{1}{\beta\gamma_\epsilon\eta_n \left(b^*_{nn}\right)^{-\frac{1}{\epsilon}}} - (1-\delta)\right]^{-\frac{1-\mu_n}{\mu_n}}, \tag{30}$$

where we require $\mathcal{R}^*_n > 1-\delta$, and hence $\frac{1}{\beta\gamma_\epsilon\eta_n(b^*_{nn})^{-\frac{1}{\epsilon}}} - (1-\delta) > 0$, for the steady state to be well defined; and real GDP per capita is proportional to the real wage ($\mathcal{P}^*_{nn}\mathcal{Y}^*_n/\left(p^*_n\ell_n\right) = (1/\mu_n)\, w^*_n/p^*_n$).

Intuitively, the return to saving ($\mathcal{R}^*_n$) is equalized in steady state in equation (27), because countries with superior fundamentals (e.g., higher productivity z_n) accumulate more assets and capital, and have a higher steady-state capital-labor ratio and real GDP per capita in equations (29) and (30). This additional accumulation reduces marginal returns until $\mathcal{R}^*_n = \mathcal{R}^* = 1/\beta$.

The CNGM corresponds to the special case of our model with prohibitive goods and capital market frictions ($\tau_{ni}, \kappa_{ni} \to \infty$, such that $s^*_{nn} = b^*_{nn} = 1$). In this special case, a country's steady-state capital-labor ratio and real GDP per capita in equations (29) and (30) depend only on its *own* productivity (z_n), capital-use efficiency (η_n), and labor share (μ_n).

More generally, in our ONGM, a country's steady-state capital-labor ratio (29) and real GDP per capita (30) also depend on goods market frictions (τ_{ni}), capital market frictions (κ_{ni}), and the capital efficiencies (η_i), productivities (z_i), and labor intensities (μ_i) of all other countries $i \neq n$. The domestic trade share (s^*_{nn}) and the domestic portfolio share (b^*_{nn}) are sufficient statistics for the impact of these foreign variables on the domestic capital-labor ratio and real GDP per capita.

Comparing open goods and capital markets to the three limiting cases of prohibitive trade and capital market frictions ($\tau_{ni}, \kappa_{ni} \to \infty$), prohibitive goods market frictions and finite capital market frictions ($\tau_{ni} \to \infty$ and $1 < \kappa_{ni} < \infty$), and prohibitive capital market frictions and finite goods market frictions ($\kappa_{ni} \to \infty$ and $1 < \tau_{ni} < \infty$), we obtain the following result.

Proposition 1. ***Closed Versus Open Economy.*** *The steady-state capital-labor ratio (k^*_n/ℓ_n) and real income per capita (y^*_n/ℓ_n) in every country are higher with either open goods markets ($0 < s^*_{nn} < 1$) and/or open capital markets ($0 < b^*_{nn} < 1$) than with closed goods and capital markets ($s^*_{nn} = b^*_{nn} = 1$).*

Proof. See Online Appendix E.2. □

Intuitively, the opening of trade in goods markets reduces final goods price indexes, because countries' goods are imperfect substitutes for one another, which acts like an improvement in productivity ($(s^*_{nn})^{-\frac{1}{\theta}}$ enters multiplicatively with z_n). This reduction in the final goods price index directly raises real income per capita in equation (30), but also raises it indirectly through greater capital accumulation in response to a lower cost of investment in equation (29).

Similarly, the opening of capital markets ($0 < b_{nn}^* < 1$) acts like an improvement in capital efficiency in each host country, because it expands the range of investor countries from which each host country can source capital holdings, and the holdings of different investor countries are imperfect substitutes ($(b_{nn}^*)^{-\frac{1}{\epsilon}}$ enters multiplicatively with η_n). This increase in capital efficiency raises the effective supply of capital, which reduces the steady-state gross return on capital (R_n^*) in equation (28), increases the steady-state capital-labor ratio in equation (29), and hence increases real GDP per capita in equation (30).

Once goods and capital markets are open, further reductions in trade or capital market frictions can either raise or reduce the real GDP of any one country, depending on the incidence of the resulting changes in the terms of trade in goods and capital markets. We now establish some properties of the open-economy steady state.

Proposition 2. ***Open Economy.*** *In the open-economy steady state, (a) the real return to savings ($\mathcal{R}^*$) is equalized across countries; (b) the gross return on capital (R_n^*) depends only on capital market frictions and capital efficiencies; (c) the portfolio shares (b_{ni}^*) depend only on capital market frictions (κ_{ni}) and capital efficiencies (η_i); (d) the current and financial accounts are balanced; and (e) the trade balance is equal to minus net investment income.*

Proof. See Online Appendix E.3. □

Intuitively, countries with higher productivity and lower trade frictions accumulate more assets and capital, until the return to saving ($\mathcal{R}^*$) is equalized, at which point the gross return to capital (R_n^*) and portfolio shares (b_{ni}^*) depend on capital market frictions and efficiencies alone. Along the transition path to steady state, the trade, current and financial accounts of the balance of payments can all be imbalanced. However, in steady state, the current and financial accounts must be balanced in order for the asset state variables (a_n^*) to be constant, with any trade imbalance offset by net investment income. Nevertheless, in steady state, countries can specialize in either exporting goods and importing capital (a trade surplus and negative net investment income) or importing goods and exporting capital (a trade deficit and positive net investment income).

4.2 Steady-State Consumption and Welfare

Steady-state welfare is proportional to steady-state consumption, which in turn is proportional to steady-state real assets (a_n^*/p_n^*) plus the present value of (current and future) real labor income ($(w_n^*\ell_n + h_n^*)/p_n^*$):

$$c_n^* = (1-\beta)\left(\frac{a_n^*}{p_n^*} + \frac{w_n^*\ell_n + h_n^*}{p_n^*}\right), \tag{31}$$

where the derivations are in Online Appendix E. The steady-state present value of real labor income is proportional to the real wage:

$$\frac{w_n^* \ell_n + h_n^*}{p_n^*} = \frac{\ell_n}{(1-\beta)} \frac{w_n^*}{p_n^*}. \tag{32}$$

Steady-state real assets can be written in terms of the steady-state capital stock (k_n^*), domestic portfolio share (b_{nn}^*), and domestic capital ownership share ($x_{nn}^* \equiv k_{nn}^*/k_n^*$) as:

$$\frac{a_n^*}{p_n^*} = \frac{k_n^*}{\beta \gamma_\epsilon \eta_n} \frac{x_{nn}^*}{\left(b_{nn}^*\right)^{\frac{\epsilon-1}{\epsilon}}}. \tag{33}$$

Therefore, openness in capital markets affects steady-state consumption and welfare in two different ways. First, it affects the steady-state real wage and real GDP per capita, as analyzed in the previous subsection. Second, it implies that steady-state consumption and welfare cannot be inferred from these objects alone, because of assets held as capital overseas. The steady-state present value of real labor income remains proportional to the steady-state real wage in equation (32). But steady-state consumption in equation (31) also depends on real assets (a_n^*/p_n^*) rather than on capital (k_n^*). This difference between real assets and capital is captured in equation (33) by the domestic portfolio share (b_{nn}^*) and the domestic capital payments share (x_{nn}^*), which are both positive and less than one for finite capital market frictions ($0 < \kappa_{ni} < \infty$).

The gains in steady-state consumption ($\widehat{c}_n^*$) from opening the closed economy can be expressed as a weighted average of the increases in the real wage ($\frac{\widehat{w}_n^*}{\widehat{p}_n^*}$) and real assets ($\frac{\widehat{a}_n^*}{\widehat{p}_n^*}$):

$$\widehat{c}_n^* = \xi_n^* \frac{\widehat{a}_n^*}{\widehat{p}_n^*} + (1-\xi_n^*) \frac{\widehat{w}_n^*}{\widehat{p}_n^*}, \tag{34}$$

where a hat above a variable denotes a relative change between an initial equilibrium (no prime) and a counterfactual equilibrium (prime), such that $\widehat{x} \equiv x'/x$. The weight $\xi_n^* \equiv a_n^* / \left(a_n^* + w_n^* \ell_n + h_n^*\right)$ is the initial share of assets in overall wealth.

5 Transition Dynamics

We now provide an analytical characterization of our model's transition dynamics. We show that goods and capital market openness not only play a role in determining steady-state levels of economic activity (previous section), but also shape economic growth along the transition path to steady state and the impulse response of the economy to fundamental shocks (this section).

5.1 Notation

For the remainder of the paper, we denote vectors in bold lowercase and matrices in bold uppercase. To simplify the notation, we suppress the time subscript throughout this subsection.

Let $\boldsymbol{S}$ be an $N \times N$ *expenditure share* matrix, where the ni-th element is importer n's expenditure share on buying from exporter i ($S_{ni} \equiv [s_{ni}]$). Let $\boldsymbol{T}$ be an $N \times N$ *income share* matrix, where the in-th element is exporter i's income share from selling to importer n ($T_{in} \equiv \frac{s_{ni}\left(p_n c_n + \sum_{h=1}^{N} b_{hn}(a_h + w_h \ell_h - p_h c_h) - (1-\delta) p_n k_n\right)}{\sum_{h=1}^{N} s_{hi}\left(p_h c_h + \sum_{j=1}^{N} b_{jh}(a_j + w_j \ell_j - p_j c_j) - (1-\delta) p_h k_h\right)}$). Intuitively, S_{ni} captures the importance of exporter i as a seller to importer n, and T_{in} captures the importance of importer n as a buyer from exporter i. Note the order of the subscripts. The rows are importers and the columns are exporters in matrix $\boldsymbol{S}$, whereas the rows are exporters and the columns are importers in matrix $\boldsymbol{T}$.

Similarly, let $\boldsymbol{B}$ be an $N \times N$ *portfolio share* matrix, where the ni-th element is the share of investor n's assets in host country i ($B_{ni} \equiv [b_{ni}]$). Let $\boldsymbol{X}$ be an $N \times N$ *ownership share* matrix, where the in-th element is the share of host i's capital payments made to investor n ($X_{in} \equiv \frac{[(1-\delta)p_{it} + r_{it}]k_{in}}{[(1-\delta)p_{it} + r_{it}]k_i} = \frac{k_{in}}{k_i}$). Intuitively, B_{ni} captures the importance of host i as a destination of asset holdings from investor n, and X_{in} captures the importance of investor n as an origin of asset holdings to host i. Again, note the order of subscripts. The rows are investors and the columns are hosts in matrix $\boldsymbol{B}$, whereas the rows are hosts and the columns are investors in matrix $\boldsymbol{X}$.[5]

Finally, let $\boldsymbol{q}$ be an $N \times 1$ vector of labor income, where the n-th element is country n's income from labor ($q_n \equiv w_n \ell_n$). Let ζ be an $N \times 1$ vector of income from assets, where the n-th element is country n's income from assets ($\zeta_n \equiv \mathcal{R}_n a_n$).

5.2 Model Inversion and Dynamic Exact-Hat Algebra

We begin by showing how we can invert the equilibrium conditions of the model to recover unobserved fundamentals from the observed endogenous variables. We recover these fundamentals under our assumption of perfect foresight, without making any assumptions about how far the economy is from steady state, and without imposing any additional restrictions on the expected convergent sequence of future changes in country fundamentals.

We suppose that we observe data on population $\{\ell_{it}\}_{i=1}^{N}$, GDP $\{w_{it}\ell_{it}/\mu_i\}_{i=1}^{N}$, nominal capital $\{p_{it}k_{it}\}_{i=1}^{N}$, trade and capital shares ($\{S_{nit}\}_{n,i=1}^{N,N}$, $\{B_{nit-1}\}_{n,i=1}^{N,N}$), consumption growth $\{c_{it+1}/c_{it}\}_{i=1}^{N}$, and relative changes in the price index $\{p_{it+1}/p_{it}\}_{i-1}^{N}$ for some period t. The portfolio shares are lagged one period, because the capital stock in period t depends on portfolio shares in period $t-1$ from the capital accumulation technology (7).

Proposition 3. ***Model Inversion.*** *Given observed data on population $\{\ell_{it}\}_{i=1}^{N}$, GDP $\{w_{it}\ell_{it}/\mu_i\}_{i=1}^{N}$, nominal capital $\{p_{it}k_{it}\}_{i=1}^{N}$, trade and capital shares ($\{S_{nit}\}_{n,i=1}^{N,N}$, $\{B_{nit-1}\}_{n,i=1}^{N,N}$), consumption growth*

[5] For theoretical completeness, we maintain two assumptions on these matrices, which are satisfied empirically in all years of our data. First, we assume that the $\boldsymbol{S}$ and $\boldsymbol{B}$ matrices are irreducible, such that all locations are connected directly or indirectly by trade flows and capital holdings. For any i, n, there exists k such that $\left[\boldsymbol{S}^k\right]_{in} > 0$ and $\left[\boldsymbol{B}^k\right]_{in} > 0$. Second, we assume that each location consumes a positive amount of domestic goods and allocates a positive share of capital domestically. For all i, $\boldsymbol{S}_{ii} > 0$ and $\boldsymbol{B}_{ii} > 0$.

$\{c_{it+1}/c_{it}\}_{i=1}^{N}$, *and relative changes in the price index* $\{p_{it+1}/p_{it}\}_{i=1}^{N}$ *for some period* t*, there exists a unique set (up to a normalization) of country fundamentals (*$\{z_{nt}\}_{n=1}^{N}$, $\{\eta_{nt}\}_{n=1}^{N}$, $\{\tau_{nit}\}_{n,i=1}^{N,N}$, $\{\kappa_{nit}\}_{n,i=1}^{N,N}$*) that is consistent with the observed data being an equilibrium of the model.*

Proof. See Online Appendix H. □

We recover the initial assets $\{a_{nt}\}_{n=1}^{N}$ from the observed nominal capital stocks $\{p_{it}k_{it}\}_{i=1}^{N}$ and bilateral portfolio shares $\{B_{nit-1}\}_{n,i=1}^{N,N}$, as shown in Online Appendix H. We solve for the transition path in the nonlinear model using a generalization of existing dynamic exact-hat algebra techniques. These methods were first introduced in Caliendo et al. (2019) and were applied in a model of capital autarky in Kleinman et al. (2023). Here we show that they generalize to our setting with open goods and capital markets. We solve for the economy's transition path in response to any convergent sequence of fundamental shocks in time differences ($\dot{x}_{it+1} = x_{it+1}/x_{it}$), without requiring information on the initial level of fundamentals.

Proposition 4. ***Dynamic Exact-Hat Algebra.*** *Given observed initial populations* $\{\ell_{i0}\}_{i=1}^{N}$ *and wages* $\{w_{i0}\}_{i=1}^{N}$*, an initial observed allocation of the economy, (*$\{a_{i0}\}_{i=1}^{N}$, $\{k_{i0}\}_{i=1}^{N}$, $\{S_{ni0}\}_{n,i=1}^{N,N}$, $\{B_{ni,-1}\}_{n,i=1}^{N,N}$*), and a convergent sequence of future changes in fundamentals under perfect foresight:*

$$\left\{ \{\dot{z}_{it}\}_{i=1}^{N}, \{\dot{\eta}_{it}\}_{i=1}^{N}, \{\dot{\tau}_{ijt}\}_{i,j=1}^{N,N}, \{\dot{\kappa}_{ijt}\}_{i,j=1}^{N,N} \right\}_{t=1}^{\infty},$$

the solution for the sequence of changes in the model's endogenous variables does not require information on the level of fundamentals:

$$\left\{ \{z_{it}\}_{i=1}^{N}, \{\eta_{it}\}_{i=1}^{N}, \{\tau_{ijt}\}_{i,j=1}^{N,N}, \{\kappa_{ijt}\}_{i,j=1}^{N,N} \right\}_{t=1}^{\infty}.$$

Proof. See Online Appendix G. □

Intuitively, we can solve for the transition path using the observed endogenous variables to control for unobserved fundamentals. Applying Proposition 4 for the special case of no future changes in fundamentals, we can compute the unobserved initial steady state. More generally, we can use Proposition 4 to solve for the economy's transition path in response to shocks to fundamentals.

5.3 Dynamics in the Linearized Model

We next provide a further analytical characterization of our model's transition dynamics by linearizing its system of general equilibrium conditions around the unobserved initial steady state. We show that the evolution of the state variables and the speed of convergence in the linearized model can be characterized in terms of the eigenvectors and eigenvalues of a transition matrix that governs the updating of the state variables.

We begin by totally differentiating the general equilibrium conditions of the model around an initial steady state with trade and capital share matrices $(\boldsymbol{S}, \boldsymbol{T}, \boldsymbol{B}, \boldsymbol{X})$. We thus obtain a system of linear equations that fully characterizes the economy's transition path up to first-order, as shown in Online Appendix I. We use a tilde above a variable to denote a log deviation from this initial steady state (e.g., $\widetilde{a}_{it} = \ln a_{it} - \ln a_i^*$). We define measures of incoming and outgoing trade and capital market frictions that aggregate across partners using initial trade and capital share weights: $\widetilde{\tau}_{nt}^{in} \equiv \sum_{i=1}^{N} S_{ni}\widetilde{\tau}_{nit}$, $\widetilde{\tau}_{it}^{out} \equiv \sum_{n=1}^{N} T_{in}\widetilde{\tau}_{nit}$, $\widetilde{\kappa}_{nt}^{out} \equiv \sum_{i=1}^{N} B_{ni}\widetilde{\kappa}_{nit}$, and $\widetilde{\kappa}_{it}^{in} \equiv \sum_{n=1}^{N} X_{in}\widetilde{\kappa}_{nit}$. We denote the value of fundamentals relative to this initial steady state by $\widetilde{\boldsymbol{f}}_{\boldsymbol{t}} \equiv \left[\begin{array}{cccccc} \widetilde{\boldsymbol{z}}_{\boldsymbol{t}} & \widetilde{\eta}_t & \widetilde{\tau}_t^{in} & \widetilde{\tau}_t^{out} & \widetilde{\kappa}_t^{in} & \widetilde{\kappa}_t^{out} \end{array} \right]'$.

We now characterize our model's transition dynamics allowing for unanticipated shocks that shift the economy from one perfect foresight path to another. We suppose that we observe the economy along a perfect foresight transition path towards an unobserved steady state. We denote the log deviations in fundamentals, assets and capital relative to the initial steady state by $\widetilde{\boldsymbol{f}}$, $\widetilde{\boldsymbol{a}}_{\boldsymbol{t}}$, and $\widetilde{\boldsymbol{k}}_{\boldsymbol{t}}$, respectively. If $\widetilde{\boldsymbol{f}} = 0$, the economy is on a transition path towards the initial steady state, such that only the state variables $(\widetilde{\boldsymbol{a}}_{\boldsymbol{t}}, \widetilde{\boldsymbol{k}}_{\boldsymbol{t}})$ differ from this initial steady state. However, for full generality, we allow for the possibility that fundamentals have already changed relative to the initial steady state, such that $\widetilde{\boldsymbol{f}} \neq 0$ and the economy is on a transition path to another steady state implied by these fundamentals $\widetilde{\boldsymbol{f}}$. At time $t = 0$, agents learn about an unexpected, one-time, permanent change in fundamentals from time $t = 1$ onwards. We denote the values of assets, capital and fundamentals after learning about this fundamental shock by $\widetilde{a}_{it}'$, $\widetilde{k}_{it}'$, and $\widetilde{f}_i'$, again expressed as log deviations relative to the initial steady state. At time $t = 0$, capital is pre-determined $(\widetilde{k}_{i0}' = \widetilde{k}_{i0})$, but assets jump immediately $(\widetilde{a}_{i0}' \neq \widetilde{a}_{i0})$, because of unexpected valuation effects from the resulting changes in the price of capital in each country.

Proposition 5. ***Linearization.*** *Suppose that the economy at time $t = 0$ is on a perfect foresight equilibrium path toward the steady state implied by the fundamentals $\widetilde{\boldsymbol{f}}$. At time $t = 0$, agents learn about a one-time, permanent change in fundamentals from $\widetilde{\boldsymbol{f}}$ to $\widetilde{\boldsymbol{f}}'$ from time $t = 1$ onwards. The evolution of the economy's asset and capital state variables from time $t = 0$ onwards satisfies the following difference equation up to first order:*

$$\left[\begin{array}{c} \widetilde{\boldsymbol{k}}_{t+1}' \\ \widetilde{\boldsymbol{a}}_{t+1}' \end{array} \right] = \boldsymbol{P} \left[\begin{array}{c} \widetilde{\boldsymbol{k}}_t' \\ \widetilde{\boldsymbol{a}}_t' \end{array} \right] + \boldsymbol{R}\widetilde{\boldsymbol{f}}', \tag{35}$$

with the initial condition given by:

$$\widetilde{\boldsymbol{k}}_{\boldsymbol{0}}' = \widetilde{\boldsymbol{k}}_{\boldsymbol{0}}, \qquad \widetilde{\boldsymbol{a}}_{\boldsymbol{0}}' = \widetilde{\boldsymbol{a}}_{\boldsymbol{0}} + \widetilde{\boldsymbol{v}}_{\boldsymbol{0}},$$

$$\widetilde{\boldsymbol{v}}_{\boldsymbol{0}} = \left(\boldsymbol{I} - \boldsymbol{B}\boldsymbol{E}^{\boldsymbol{a}}\right)^{-1} \boldsymbol{B}\boldsymbol{E}^{\boldsymbol{f}} \Delta\widetilde{\boldsymbol{f}},$$

where $\Delta\widetilde{\boldsymbol{f}} = \widetilde{\boldsymbol{f}}' - \widetilde{\boldsymbol{f}}$ is the change in fundamentals and $\widetilde{\boldsymbol{v}}_{\boldsymbol{0}}$ captures unexpected valuation effects. The matrices $(\boldsymbol{P}, \boldsymbol{R}, \boldsymbol{E}^{\boldsymbol{a}}, \boldsymbol{E}^{\boldsymbol{f}})$ are functions of the trade and capital share matrices $(\boldsymbol{S}, \boldsymbol{T}, \boldsymbol{B}, \boldsymbol{X})$ and model parameters $(\psi, \theta, \beta, \delta, \epsilon, \mu_i)$.

Proof. See Online Appendices I.2 and I.3. □

In Proposition 5, the impact matrix ($\boldsymbol{R}$) regulates the initial impact of the shock to fundamentals on the state variables; the transition matrix ($\boldsymbol{P}$) governs the updating of the state variables from one period to the next; and the unexpected valuation effects are captured by $\widetilde{\boldsymbol{v}}_{\boldsymbol{o}}$. We solve for the transition matrix ($\boldsymbol{P}$) using the methods of Blanchard and Kahn (1980) and King and Watson (1998) from the Dynamic Stochastic General Equilibrium (DSGE) literature. A key difference from the model of capital autarky in Kleinman et al. (2023) is that the model's state variables are a matrix of bilateral capital holdings rather than the vector of domestic capital stocks. Along a perfect foresight equilibrium path, we can reduce this matrix of bilateral capital holdings to the two vectors of assets ($\widetilde{\boldsymbol{a}}_t$) and capital ($\widetilde{\boldsymbol{k}}_t$). However, in response to unanticipated shocks to fundamentals that shift the economy from one perfect foresight equilibrium path to another, there are unexpected valuation effects from the changes in the value of capital in each host country ($\widetilde{\boldsymbol{a}}_t' \neq \widetilde{\boldsymbol{a}}_t$) that need to be taken into account. Having solved for the model's state variables, all other endogenous variables can be recovered up to first-order as linear functions of the state variables.

The transition matrix has the following eigendecomposition: $\boldsymbol{P} = \boldsymbol{U}\boldsymbol{\Lambda}\boldsymbol{U}^{-1}$, where $\boldsymbol{\Lambda}$ is a diagonal matrix of $2 \times N$ stable eigenvalues $\{\lambda_k\}_{k=1}^{2N}$ and $\boldsymbol{U}$ is a matrix stacking the corresponding $2 \times N$ eigenvectors $\{\boldsymbol{u}_k\}_{k=1}^{2N}$. Therefore, the deviations of the capital and asset state variables from steady state for each country can be expressed as linear combinations of the eigenvectors, using the property that the eigenvectors of the transition matrix span the state space. In general, the half-lives of convergence to steady state are different for the capital and asset state variables of a given country, because the deviations of these two state variables from steady state are different linear combinations of the eigenvectors. Similarly, the half-lives of convergence to steady state for the capital and asset state variables differ across countries, again because deviations in the state variables for each country are different linear combinations of the eigenvectors.

In the CNGM, the speed of convergence depends solely on the initial gap of a country's own capital stock from steady state, as in the cross-country growth literature on β-convergence following Barro and Sala-i-Martin (1992). In contrast, in our ONGM, the speed of convergence depends on the initial gaps of a country's own asset and capital stocks from steady state, goods and capital market frictions, and the gaps of all other countries' asset and capital stocks from steady state. Intuitively, the entire network matters, because countries can close the gap of capital from steady state by attracting domestic or foreign capital holdings. Similarly, countries can close the gap of assets from steady state by allocating assets to either domestic or foreign capital. Each of these adjustment processes is influenced by frictions in goods markets (which affect final goods prices in each country) and frictions in capital markets (which influence the ease of managing capital abroad).

5.4 Transition Dynamics and Goods and Capital Openness

We now illustrate the roles of goods and capital openness in determining the speed of convergence by considering the three limiting cases of (AA) trade and capital autarky; (FA) frictionless trade and capital autarky; and (FF) frictionless trade and capital.[6] For simplicity, we focus in this subsection on the case of log utility ($\psi = 1$) and N symmetric countries, but as we demonstrate in our quantitative analysis below, the results extend to the more general case.

Proposition 6. ***Eigencomponents.*** *Consider the following limiting cases with log utility ($\psi = 1$) and N symmetric countries: (AA) trade and capital autarky; (FA) frictionless trade and capital autarky; and (FF) frictionless trade and capital. In each case, the transition matrix ($\boldsymbol{P}$) from Proposition 5 admits two eigenvalues $\bar{\lambda} > 0$ and $\lambda_0 = 0$, each with multiplicity one, and two eigenvalues $\lambda_k, \lambda_a \in [0, 1]$ each with multiplicity $N - 1$. The corresponding eigenvectors take the following form:*

$$\boldsymbol{u}_0 = \begin{bmatrix} \mathbf{0} \\ \mathbf{1} \end{bmatrix}, \quad \bar{\boldsymbol{u}} = \begin{bmatrix} \mathbf{1} \\ \mathbf{0} \end{bmatrix}, \quad \boldsymbol{u}_k^{(i)} = \begin{bmatrix} \boldsymbol{e}_i - \frac{1}{N} \cdot \mathbf{1} \\ \upsilon \cdot \left(\boldsymbol{e}_i - \frac{1}{N} \cdot \mathbf{1}\right) \end{bmatrix}, \quad \boldsymbol{u}_a^{(i)} = \begin{bmatrix} \mathbf{0} \\ \boldsymbol{e}_i - \frac{1}{N} \cdot \mathbf{1} \end{bmatrix},$$

for $i = 1, \ldots, N-1$, where $\mathbf{0}$ is $N \times 1$ vector of zeros; $\mathbf{1}$ is $N \times 1$ vector of ones; $\boldsymbol{e}_i$ is the i-th elementary vector; and υ is a proportionality constant.

Proof. See Online Appendix J. □

We now discuss the interpretation of these eigencomponents. Note that the first N entries of each state vector correspond to capital, and the second N entries correspond to assets, where both are measured as log-deviations from the symmetric steady state. Along a perfect foresight path, the state variables affect the equilibrium path only through the total capital stock in each location, $k_{it} \equiv \sum_{n=1}^{N} k_{nit}$, and relative assets at the start of time t in each location, $\frac{a_{it}}{\sum_{j=1}^{N} a_{jt}}$, as discussed further in Online Appendix D. Therefore, we solve for the transition path using the N capital stocks and N asset shares (recognizing that there are $N-1$ degrees of freedom for the asset shares because they sum to one), such that the asset entries of the eigenvectors refer to deviations in relative asset positions from steady state. The eigenvalue $\bar{\lambda}$ governs convergence of the global average capital stock towards steady state, without reallocation across countries along the transition path. This associated eigenvector $\bar{\boldsymbol{u}}$ captures a uniform deviation in capital from steady state for all countries, with relative assets equalized at their steady-state level.

The eigenvalue λ_k governs cross-country capital reallocation. The first block of N entries in the corresponding eigenvectors ($\boldsymbol{u}_k^{(i)}$) represents a configuration, where country i has capital above steady state, balanced by capital below steady state elsewhere, such that the global capital stock is at

[6] We omit the case of frictionless capital and trade autarky for brevity to streamline the exposition.

its steady-state level. The transition dynamics feature decumulation of capital in country i and accumulation of capital elsewhere. Starting from $\widetilde{\boldsymbol{k}}_0 = \boldsymbol{e}_i - \frac{1}{N} \cdot \mathbf{1}$, the capital stock evolves as $\widetilde{\boldsymbol{k}}_t = \lambda_k^t \widetilde{\boldsymbol{k}}_0$, converging towards its steady state at rate λ_k. The second block of N entries in the corresponding eigenvectors ($\boldsymbol{u}_k^{(i)}$) describes asset dynamics that are proportional to capital dynamics, with the constant υ depending on parameters and openness. The multiplicity $N-1$ reflects the fact that $\boldsymbol{u}_k^{(N)}$ lies in the span of $\left\{\boldsymbol{u}_k^{(i)}\right\}_{i=1}^{N-1}$.

The eigenvalue λ_a regulates convergence dynamics in asset shares that is decoupled from the cross-country reallocation of capital. Each eigenvector $\boldsymbol{u}_a^{(i)}$ represents a configuration where country i's asset share deviates from the rest of the world, independently of its capital stock. Finally, the eigenvalue $\lambda_0 = 0$ reflects the normalization that asset shares sum to one across countries and has no impact on transition dynamics. The corresponding eigenvector $\boldsymbol{u}_0$ captures a common deviation in asset shares from steady state across all countries.

We next compare speeds of convergence to steady state across these three limiting cases. We show that moving from trade autarky to frictionless trade raises the speed of convergence for both capital and assets. In contrast, moving from capital autarky to frictionless capital raises the speed of convergence for capital, but reduces the speed of convergence for assets.

Proposition 7. ***Speed of Convergence.*** *Under trade and capital autarky (AA),* $\bar{\lambda}_{AA} = \lambda_{AA}^k$ *and* $\lambda_{AA}^a = 0$. *Under frictionless trade and capital autarky (FA),* $\lambda_{FA}^k < \bar{\lambda}_{FA} = \bar{\lambda}_{AA}$, $\frac{\partial \lambda_{FA}^k}{\partial \theta} > 0$, *and* $\lim_{\theta \to \infty} \lambda_{FA}^k = \bar{\lambda}_{FA}$. *Under frictionless trade and capital (FF) :* $\bar{\lambda}_{FF} > \bar{\lambda}_{AA}$, $\lambda_{FF}^k = 0$, $\lambda_{FF}^a = 1$, $\frac{\partial \bar{\lambda}_{FF}}{\partial \epsilon} < 0$, *and* $\lim_{\epsilon \to \infty} \bar{\lambda}_{FF} = \bar{\lambda}_{AA}$.

Proof. See Online Appendix J. □

These results for the speed of convergence in Proposition 7 have an intuitive interpretation. Trade and capital autarky (AA) features the same dynamics as in the CNGM. Capital and assets are equal to one another for each of the symmetric countries. There is no cross-country reallocation of capital/assets. Each country's capital stock converges at the same rate as the world's average capital stock ($\lambda_{AA}^k = \bar{\lambda}_{AA}$). There are no asset dynamics decoupled from the capital stock ($\lambda_{AA}^a = 0$).

Frictionless trade and capital autarky (FA) features similar dynamics as in Acemoglu and Ventura (2002). Assets are again equal to capital for each of the symmetric countries and have no independent dynamics. The global average capital stock converges at the same rate as in autarky ($\bar{\lambda}_{FA} = \bar{\lambda}_{AA}$). But the cross-country dispersion in capital declines faster than in autarky ($\lambda_{FA}^k < \bar{\lambda}_{FA}$), because of terms of trade effects in goods markets. Intuitively, as capital accumulates in a given country, its output increases, which lowers the relative price of the country's good under frictionless trade. Therefore, capital accumulation not only leads to a decline in the marginal physical product of capital as in the closed economy (captured by μ), but also leads to a fall in the price of a country's good (to an extent determined by the trade elasticity θ).[7] As a result, capital accumulation leads to a faster fall in the value marginal product of capital under FA than under AA. As goods become perfectly substitutable ($\theta \to \infty$), this terms-of-trade effect vanishes, and all countries converge at the same rate as the global average.

Frictionless trade and capital (FF) converges to the frictionless neoclassical growth model (FNGM) as the trade elasticity (θ) and capital elasticity (ϵ) converge to infinity. Even with a finite capital elasticity (ϵ), frictionless goods and capital markets ensure that portfolio shares take the same value for each of the symmetric countries. The world average capital stock converges to steady state at a slower rate than in either of the two prior cases with capital autarky ($\bar{\lambda}_{FF} > \bar{\lambda}_{AA} = \bar{\lambda}_{FA}$). Since the capital holdings from different investor countries are imperfect substitutes, the opening of capital markets acts like an improvement in capital efficiency, which raises the productivity of the investment technology in each country and magnifies the impact of differences in initial conditions. As the capital elasticity (ϵ) increases, the capital holdings from different investor countries become closer substitutes, and in the limit as $\epsilon \to \infty$, this efficiency gain disappears ($\lim_{\epsilon \to \infty} \bar{\lambda}_{FF} = \bar{\lambda}_{AA}$).

Most notably, the convergence properties of capital and assets across countries are qualitatively different in this case. With frictionless trade and capital, there is an immediate cross-country reallocation of capital, such that each investor country receives the same gross return from any given host country, and the only capital dynamics are in the world capital stock ($\lambda^k_{FF} = 0$). In contrast, the equalization of the return to saving induced by frictionless trade and capital implies that all countries accumulate assets at the same rate, and initial differences in assets persist forever ($\lambda^a_{FF} = 1$). In the presence of capital market frictions, countries with initial assets further below steady state enjoy higher returns to savings along the transition path, and hence catch up. Without capital market frictions, this mechanism disappears, the equalization of the return to saving implies that countries' relative asset positions remain fixed over time.

6 Quantitative Analysis

We now show that our tractable, multi-country model can be taken directly to observed data on trade, capital holdings, and national accounts. In Subsection 6.1, we summarize the data construction. In Subsection 6.2, we calibrate our model's parameters. In Subsection 6.3, we examine its quantitative implications for economic growth and convergence. In Subsection 6.4, we evaluate its quantitative implications for the welfare effects of disintegration in goods and capital markets.

[7] In contrast, in our ONGM, there are terms of trade effects in both goods and capital markets, which affect the marginal product of capital across countries, as discussed further in Online Appendix M.

6.1 Data Construction

We use publicly available data on the national accounts, bilateral trade, and bilateral capital holdings. Our sample covers 44 countries, and we choose 2017 as our baseline year for our quantitative analysis, given limited data availability on bilateral capital holdings for more recent years. Online Appendix Q reports further details on the data construction.

National Accounts The data on gross domestic product (GDP), the labor share (i.e., labor compensation as a share of GDP), the capital stock, and the population are from the Penn World Tables (Feenstra et al. 2015). We map the model to these data as μ_{it} for the labor share, $p_{it}k_{it}$ for the nominal capital stock, and ℓ_i for the population. We construct the wage w_{it} as the labor compensation divided by the population. We construct the capital payment $r_{it}k_{it}$ as GDP minus the labor compensation.

Bilateral Trade The data on bilateral trade are from the Comtrade Database (United Nations 2001–2020). Following Feenstra et al. (2005), we use the import data, which are more likely to be accurate than the export data, because importers typically levy trade policies. As detailed in Online Appendix Q, we use these data to construct bilateral expenditure shares S_{nit} to exactly match the observed trade deficits and surpluses from the Balance of Payments (International Monetary Fund 2001–2020a).

Bilateral Capital Holdings We construct a comprehensive measure of bilateral capital holdings as the sum of bilateral portfolio holdings (in debt securities, equity securities, and fund shares) and bilateral direct investment. We construct the total amounts outstanding in debt securities, equity securities, and fund shares, based on OECD (2001–2020) for the OECD countries and Bank for International Settlements (2001–2020) and World Bank (2001–2020) for the non-OECD countries. The availability of the data on total amounts outstanding limits our sample to 44 countries. Our data on bilateral portfolio holdings are from the Coordinated Portfolio Investment Survey (International Monetary Fund 2001–2020b). To account for investments through tax havens, we restate both the total amounts outstanding and bilateral portfolio holdings from the issuer's residency to nationality, using the restatement matrices of the Global Capital Allocation Project (Coppola et al. 2021). We construct domestic portfolio holdings as the amount outstanding minus the sum of foreign portfolio holdings. Our data on bilateral direct investment, restated from residency to nationality accounting, are from Damgaard et al. (2019).

As detailed in Online Appendix Q, we use the domestic portfolio investment shares as the diagonal elements X_{iit} of the bilateral capital ownership shares because we do not observe domestic direct investment. For the off-diagonal elements X_{int}, we use the sum of bilateral portfolio and direct investment. Any unobserved factor that affects the capital held in a particular host country by all investor countries cancels out from the numerator and denominator of these bilateral ownership shares. Our quantitative analysis uses these bilateral ownership shares (X_{int}) and the nominal capital stocks from the Penn World Tables (k_{it}) and solves for the implied portfolio shares (B_{nit}), assets (a_{nt}), and model fundamentals, using the equilibrium conditions of the model, as shown in Online Appendix H. This approach has the advantage that the nominal capital stocks from the Penn World Tables are relatively well measured and ensures that our model is internally consistent and matches the standard national income accounting identities.

Global Imbalances The measures of global imbalances implied by our data closely match those in the official balance of payments data. We construct bilateral expenditure shares S_{nit} to exactly match the observed trade deficits and surpluses from the Balance of Payments. We also match the gross domestic product (GDP), capital stocks, labor compensation and population data from the Penn World Tables (PWT). However, in principle, there could be some discrepancies between the current accounts implied by our model and those reported in the balance of payments data. First, we restate bilateral international capital holdings by nationality instead of residency (in order to deal with tax havens). Second, since we use data on bilateral capital holdings (stock) rather than bilateral capital income (flow), the implied flows of net investment income in our model need not exactly align with those reported in the Balance of Payments data. Third, while we model key components of the current account (trade balance and capital holdings), we abstract from other components such as remittances and transfers. Nevertheless, in practice, we find a strong correlation between the sum of the trade balance and net investment income implied by our model and the values reported in the Balance of Payments data, as shown in Online Appendix Q.

6.2 Parameterization

We calibrate the model using standard parameter values from the literature. We set the depreciation rate to $\delta = 0.05$. We set the discount factor to $\beta = 0.95$. We set the elasticity of intertemporal substitution to $\psi = 0.5$, which is at the upper range of the confidence intervals for a cross section of countries (Yogo 2004). We use $\theta = 5$ for the trade elasticity, as a central value in existing research in international trade, and the baseline value in Costinot and Rodríguez-Clare (2014). Existing research in international finance considers a range of alternative values for the capital elasticity (ϵ). Martin and Rey (2006) uses calibration values from 3 to 8. Using a demand system approach, Koijen and Yogo (2020) estimates an elasticity of 1.2 (standard error 1.1) with respect to the log equity price, implying an elasticity of 8 (standard error of 7) with respect to the expected return, which is the relevant metric for our model.[8] To be conservative about the degree of imperfect substitutability, we

[8] Table 3 in Koijen and Yogo (2020) estimates a predictive regression coefficient of -0.15 on the log equity price, which implies an elasticity of $1.2/0.15 = 8$ with respect to the expected return.

choose the high end of these values and use $\epsilon = 10$ for our baseline capital elasticity. We demonstrate the robustness of our quantitative results to alternative values of the trade and capital elasticities in Online Appendix P.3.

6.3 Economic Growth and Convergence

One of the central implications of our ONGM is that steady-state economic activity and growth along the transition path for any one country depend on the network of trade and capital market frictions and fundamentals for all countries. Goods and capital market openness shape steady-state real GDP per capita, the speed of convergence to steady state, and welfare.

6.3.1 Steady-State Economic Activity

We demonstrate the impact of openness in goods and capital markets on steady state by comparing steady-state real GDP per capita in the closed and open economies. We solve for the steady-state capital-labor ratio in the closed and open economies (k_n^{*A}, k_n^{*O}) and the steady-state open-economy domestic trade and portfolio shares $(s_{nn}^{*O}, b_{nn}^{*O})$, using our model-inverted fundamentals from Section 5.2. From equation (30), the log change in steady-state real GDP per capita between the closed and open economies can be expressed in terms of these variables:

$$\log\left(\frac{\mathcal{P}_{nn}^{*O}\mathcal{Y}_n^{*O}/p_n^{*O}}{\mathcal{P}_{nn}^{*A}\mathcal{Y}_n^{*A}/p_n^{*A}}\right) = \underbrace{-\frac{1}{\theta}\log s_{nn}^{*O}}_{\text{Static Gains}} + \underbrace{(1-\mu_{nt})\log\left(\frac{k_n^{*O}}{k_n^{*A}}\right)}_{\text{Capital Accumulation}}, \tag{36}$$

where the superscripts A and O denote the closed and open economies, respectively.

A conventional static trade model that is calibrated to the same steady-state domestic trade shares (abstracting from capital) would feature only the first term, as in Arkolakis et al. (2012). This first term captures the reduction in the consumer price index from the opening of goods markets, which acts like an improvement in productivity. Our framework also highlights the second term, which captures endogenous capital accumulation induced by the opening of the closed economy.

We next use equation (29) to decompose this induced capital accumulation into the contributions from open goods markets and capital markets:

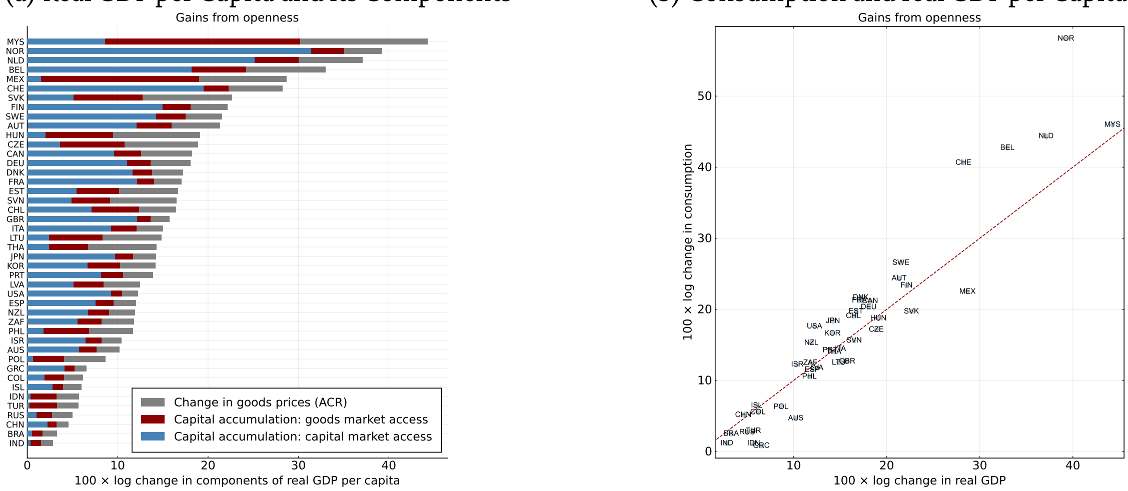
$$\log\left(\frac{k_n^{*O}}{k_n^{*A}}\right) = \underbrace{-\frac{1}{\theta\mu_n}\log s_{nn}^{*O}}_{\substack{\text{Capital Accumulation}\\\text{Open Goods Market}}} \underbrace{-\frac{1}{\mu_n}\log\left[\frac{\frac{1}{\beta\gamma_\epsilon\eta_n(b_{nn}^{*O})^{-\frac{1}{\epsilon}}}-(1-\delta)}{\frac{1}{\beta\gamma_\epsilon\eta_n}-(1-\delta)}\right]}_{\substack{\text{Capital Accumulation}\\\text{Open Capital Market}}}. \tag{37}$$

A dynamic trade model with capital autarky that is calibrated to the same steady-state domestic trade shares and capital stocks (abstracting from international capital holdings) would feature only the first term, as in Alvarez (2017), Brooks and Pujolas (2018), and Ravikumar et al. (2019). This first term captures the capital accumulation induced by the lower cost of investment as a result of the reduction in the final goods price index from the opening of goods trade. In addition, our framework also highlights the second term for the capital accumulation induced by access to imperfectly substitutable investment opportunities, which acts like an improvement in capital efficiency that raises the return to investment. Substituting equation (37) into equation (36), we can express the increase in real GDP per capita from the opening of the closed economy in terms of the two sufficient statistics of the domestic trade share (s_{nn}^{*O}) and the domestic portfolio share (b_{nn}^{*O}).

Figure 1: Gains in Steady-State Real GDP per Capita and Consumption Between the Open and Closed Economies

(a) Real GDP per Capita and its Components

(b) Consumption and real GDP per Capita



Note: Panel (a) shows log changes in steady-state GDP per capita and its components between the open economy ($\{s_{nn}^{*O}, b_{nn}^{*O}\} \in (0,1)$) and closed goods and capital markets ($s_{nn}^{*A} = b_{nn}^{*A} = 1$) using equations (36) and (37); goods prices component (ACR) equals $\left(s_{nn}^{*O}\right)^{-\frac{1}{\theta}}$ and holds the capital-labor ratio constant at its autarky value; capital accumulation (goods component) uses the increase in the capital-labor ratio implied by open goods markets alone ($0 < s_{nn}^{*O} < 1$ and $b_{nn}^{*A} = 1$); capital accumulation (capital component) uses the increase in the capital-labor ratio implied by open capital markets alone ($s_{nn}^{*A} = 1$ and $0 < b_{nn}^{*O} < 1$); Panel (b) plots log changes in consumption (vertical axis) between the open and closed steady states against the corresponding log changes in real GDP per capita (horizontal axis); open and closed steady states are computed using 2017 fundamentals from our model inversion (Proposition 3).

Panel (a) of Figure 1 compares the gains in steady-state real GDP per capita implied by a conventional static trade model (gray bar), a dynamic trade model with capital autarky (gray bar plus red bar), and our ONGM (gray plus red plus blue bar), all calibrated to the same steady-state domestic trade and portfolio shares (s_{nn}^{*O}, b_{nn}^{*O}). We find conventional static gains from trade in line with existing estimates, as summarized in Costinot and Rodríguez-Clare (2014). Relative to these conventional static gains, we find a substantial contribution from capital accumulation (comparing the gray bar to the sum of the blue and red bars). For most countries, the sum of the static gains from trade and the capital accumulation induced by goods market access (gray bar plus red bar) exceeds the capital accumulation induced by capital market access (blue bar). But for some small economies with open capital markets (such as the Netherlands and Norway), the capital accumulation induced by capital market access (blue bar) can be sizable.

The relative magnitude of the three terms in Panel (a) is tightly disciplined by the observed data and model parameters. The conventional static gains depend solely on the open-economy steady-state domestic trade shares (s_{nn}^{*O}) and the trade elasticity (θ). In the special case of capital autarky ($b_{nn}^{*O} \to 1$), the magnification of these conventional static gains by capital accumulation is determined by the labor share (μ_n) alone. More generally, with open capital markets ($0 < b_{nn}^{*O} < 1$), this magnification depends on the labor share (μ_n), the open-economy steady-state domestic portfolio share (b_{nn}^{*O}), and the capital elasticity (ϵ). In Online Appendix P.3, we show that we also find sizable contributions from capital accumulation and the component of capital accumulation driven by open capital markets for alternative values of the trade and capital elasticities.

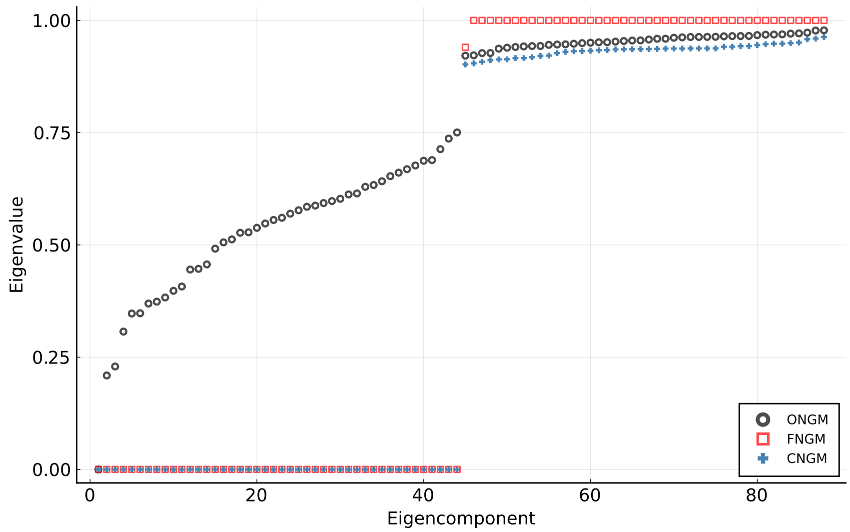
Open capital markets also introduce the distinction between steady-state real GDP per capita in equation (30) and steady-state consumption in equation (31), because of the domestic ownership of foreign capital and foreign ownership of domestic capital. In Panel (b) of Figure 1, we compare these gains in steady-state consumption (vertical axis) and real GDP per capita (horizontal axis) between the closed and open economies. The open-economy steady-state matrix of portfolio shares features a relatively large share of assets held domestically. Therefore, we find a strong correlation between the gains in steady-state consumption and those in real GDP per capita, but this correlation is far from perfect. The gains in steady-state consumption can be either larger or smaller than those in real GDP per capita (observations can be either above or below the 45-degree line in panel (b)). For individual countries, the distinction between the steady-state gains in consumption and those in real GDP per capita can be substantial.

6.3.2 Speed of Convergence

We next demonstrate the impact of openness in goods and capital markets on growth and the speed of convergence. In Figure 2, we display the $2 \times N$ eigenvalues for our baseline open-economy neoclassical growth model (ONGM) model (dark gray circles) and the following two special cases: (i) the closed economy neoclassical growth model (CNGM) with trade and capital autarky (blue pluses) and (ii) the frictionless neoclassical growth model (FNGM) with frictionless trade and capital and $\epsilon \to \infty$ (red squares). Larger eigenvalues imply slower speeds of convergence.

In the CNGM (blue pluses), the first N eigenvalues are equal to zero, because each country's assets are equal to the value of its capital stock, and hence the asset state variables cannot move independently of the capital state variables. The second N eigenvalues lie in between zero and one, which reflects the gradual convergence of capital towards steady state in each country under capital autarky. These second N eigenvalues vary across countries in Figure 2, because countries have different labor shares (μ_n) and different investment efficiencies (η_n).

Figure 2: Eigenvalues of the Transition Matrix in the ONGM, CNGM and FNGM



Note: $2 \times N$ eigenvalues sorted in ascending order; zero implies instantaneous convergence; one implies no convergence; values in between zero and one imply finite half-lives of convergence to steady state; dark gray circles correspond to our ONGM ($\{\tau_{ni}, \kappa_{ni}\} \in (1, \infty)$ for $n \neq i$, $\theta = 5$, and $\epsilon = 10$); blue crosses correspond to the special case of the CNGM ($\tau_{ni} = \kappa_{ni} = \infty$); red squares correspond to the special case of the FNGM ($\tau_{ni} = \kappa_{ni} = 1$ for all n, i and $\theta = \epsilon = \infty$); eigenvalues for our ONGM are computed using the 2017 steady-state trade and capital share matrices.

In the FNGM (red squares), the first N eigenvalues are again equal to zero, which reflects the instantaneous reallocation of capital across countries to equalize the gross return on capital in frictionless goods and capital markets. The $(N + 1)$'th eigenvalue reflects homogeneous accumulation of capital and assets across countries, where global dynamics reflect those of a closed economy. The last $N - 1$ eigenvalues are equal to one, which captures the perfect persistence of initial asset differences over time, because of the equalization of the return to savings in frictionless goods and capital markets. Therefore, all countries accumulate assets at the same rate and initial differences in assets persist over time.

In our ONGM, (dark gray circles), the values for all $2 \times N$ eigenvalues lie strictly in between zero and one, because asset dynamics are different from capital dynamics, and both exhibit gradual convergence along the transition path to steady state. The first N eigenvalues in our ONGM (the first N dark gray circles) are substantially lower than the second N eigenvalues in the CNGM (the second N blue crosses), because capital can be reallocated across countries in our ONGM, which speeds up convergence of capital to steady state. The second N eigenvalues in our ONGM (the second N dark gray circles) are marginally higher than the second N eigenvalues in the CNGM (the second N blue crosses), because the ability to hold capital overseas in our ONGM dampens the variation in the return to saving across countries, which slows down the speed of convergence of wealth to steady state.

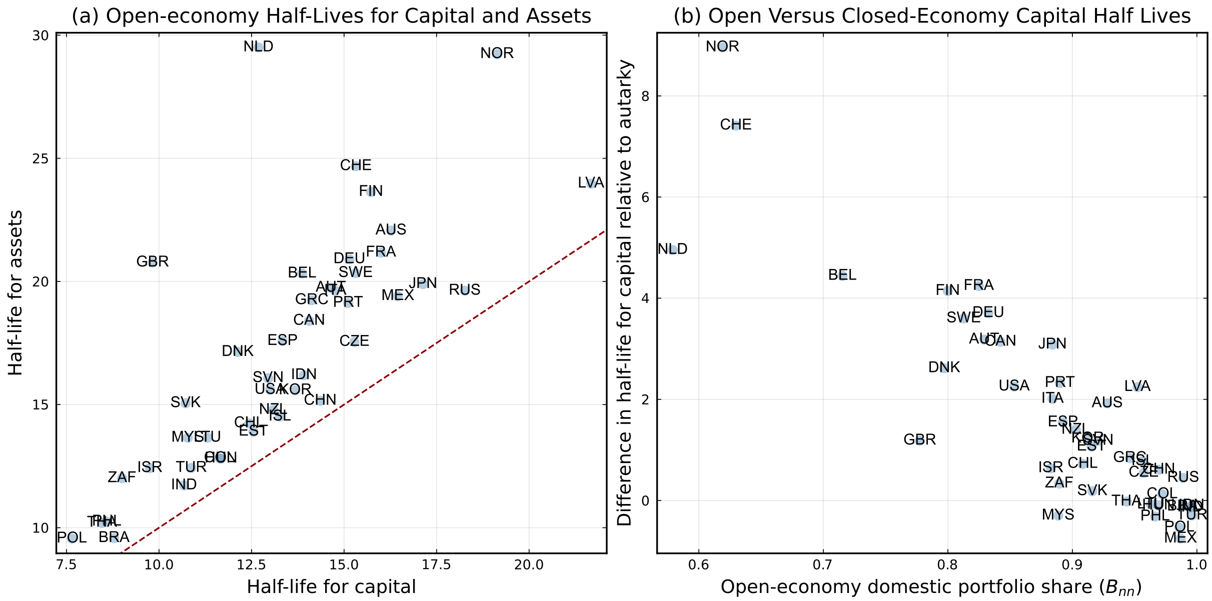
The first N eigenvalues in our ONGM (the first N dark gray circles) are higher than the first N eigenvalues in the FNGM (the first N red squares), because capital market frictions imply that the reallocation of capital occurs gradually over time in our ONGM, which reduces the speed of convergence of capital to steady state. The second N eigenvalues in our ONGM (the second N dark gray circles) are lower than the second N eigenvalues in the FNGM (the second N red squares), because capital market frictions imply that the return to saving is not fully equalized across countries in our ONGM, which increases the speed of convergence of assets to steady state.

We next compute empirical half-lives of convergence for capital and assets for each country, using the property that the deviations of the capital and asset state variables from steady state can be expressed as linear combinations of the eigenvectors of the transition matrix. In Panel (a) of Figure 3, we display these empirical half-lives for capital and assets for each country in response to a 1 percent shock to productivity in each country.[9] We find relatively slow convergence to steady state, with half-lives from around 10-30 years. Since the open-economy portfolio shares matrix features a relatively high share of assets held domestically, there is a strong correlation across countries between the empirical half-lives for capital and assets. Nevertheless, these two half-lives can differ substantially from one another for individual countries, particularly for small countries with relatively open capital markets, such as the Netherlands. In general, we find slower convergence for assets than for capital, with the half-lives lying above the 45-degree line. This pattern of results reflects the reallocation of capital across countries that occurs in open capital markets, which speeds up the convergence of capital (by reducing the variation in marginal products of capital), but slows down the convergence in assets (by dampening the variation in the return to saving).

We find that capital market openness is more important than goods market openness in explaining the variation in these empirical half-lives for capital and assets. Panel (b) of Figure 3 displays the change in the empirical half-lives for capital between the closed and open economies against the open-economy value of capital market openness. In general, these empirical half-lives can be either higher or lower under open capital markets than under capital autarky. Under capital autarky, there are only N non-zero eigenvalues, as shown in Figure 2. In contrast, there are $2 \times N$ non-zero eigenvalues under open capital markets, where the first N eigenvalues are lower than the non-zero eigenvalues under capital autarky (faster convergence), and the second N eigenvalues are higher than the non-zero eigenvalues under capital autarky (slower convergence), as again shown in Figure 2. Therefore, depending on the weights of the empirical deviations of the capital and asset state variables from steady state on these different eigencomponents, the empirical half-life in the open economy can be higher or lower than under autarky.

[9] We find similar half-lives for alternative sizes of productivity shocks, which reflects the fact that the half-lives are defined in proportional terms (the time taken to close half the gap to steady state), and the linearization provides a relatively good approximation to the nonlinear model.

Figure 3: Empirical Half-Lives of Convergence to Steady State for Capital and Assets



Note: Panel (a) shows half-lives of convergence to steady state for the asset state variable (vertical axis) and the capital state variable (horizontal axis) for our ONGM ($\{\tau_{ni}, \kappa_{ni}\} \in (1, \infty)$ for $n \neq i$, $\theta = 5$, and $\epsilon = 10$); eigenvalues computed for the transition matrix implied by the 2017 steady-state trade and capital share matrices; Panel (b) plots the difference in the capital half-lives of convergence between the open and closed economies (vertical axis) against the 2017 steady-state open-economy domestic portfolio share (B_{nn}) (horizontal axis); asset and capital half-lives computed for a 1 percent productivity shock, using the property that the deviations in the asset and capital state variables from steady state are weighted averages of the eigenvectors of the transition matrix; three-letter country codes are International Organization for Standardization (ISO) 3-digit codes.

For most countries, we find empirical half-lives for capital and assets that are higher in the open economy than in the closed economy (slower convergence), as reflected in most observations having positive values of the difference relative to autarky on the vertical axis in panel (b) of Figure 3.[10] As capital market frictions increase, and the domestic portfolio share converges to one on the horizontal axis, the difference between the open and closed half-lives becomes smaller, thereby generating the negative relationship shown in panel (b). We find a similar pattern of results for the empirical half-lives for assets, which reflects the strong correlation between the half-lives for capital and assets in panel (a). While we find that goods market openness also has predictive power for these empirical half-lives, its explanatory power is substantially lower (lower regression R^2), highlighting the importance of taking into account open capital markets.

[10]Therefore, this finding of slower convergence in our ONGM with imperfect substitutability of capital provides a natural approach to addressing the concern that the speed of convergence in the CNGM is too fast relative to empirical transitions for plausible values of the elasticity of intertemporal substitution (King and Rebelo 1993).

6.4 Welfare Effects of International Disintegration

Since our quantitative model rationalizes the observed data on national income, trade, and capital holdings across countries as an equilibrium outcome, and allows for endogenous global imbalances, it provides a suitable framework for examining a disintegration of the United States from world markets and a decoupling between the United States and China. We show that trade and capital market frictions interact with one another, such that the impact of higher trade frictions is quite different under open capital markets than under capital autarky. In our multi-country model, bilateral frictions have third-country effects through cross-substitution in goods and capital markets.

6.4.1 Goods Market Disintegration

We suppose that we observe the world economy somewhere along the transition path to an unobserved initial steady state. We use our closed-form solutions for the linearized model from Proposition 5 to evaluate the change in the economy's transition path in response to a counterfactual increase in goods market frictions. In the linearized model, this transition path is additively separable in convergence dynamics based on initial conditions and fundamental shocks. Therefore, the terms for convergence dynamics cancel out when we take the difference between the economy's actual and counterfactual transition paths.

We focus on goods market disintegration in the form of increases in real trade frictions (which involve the loss of real resources) rather than increases in tariffs (which raise revenue) for three main reasons. First, the recent changes in international integration are broader than changes in tariffs, including frictions from heightened geopolitical tensions and quantitative restrictions that incur real resource costs.[11] Second, capital market frictions often involve real resource costs rather than taxes, and when we compare them to trade frictions, we want to make a like-for-like comparison. Third, although tariffs raise revenue, some of this revenue may not be redistributed lump sum to the representative consumer. Real resource costs can be incurred by the government, or the tariff revenue can be used unproductively, where real trade frictions correspond to the limiting case in which all tariff revenue is wasted. In Online Appendix P.5, we report a robustness test using tariffs instead of real trade frictions, assuming that all tariff revenue is redistributed lump sum. We begin by examining an increase in U.S. trade frictions with all foreign countries (both inward and outward), before later considering an increase in bilateral trade frictions between the United States and China.

Consumption Response We solve for the impact of an increase in U.S. trade frictions with all foreign countries on the transition path of U.S. consumption, which is a sufficient statistic for its impact on welfare. We also decompose this transition path of U.S. consumption into the contribu-

[11] See, for example, the discussions of export controls in Bown (2023) and non-tariff barriers in Chen et al. (2022).

tions of (i) conventional static terms of trade effects; (ii) capital accumulation or decumulation; (iii) consumption-GNI ratio; and (iv) GNI-GDP ratio:

$$\log \widehat{c}_{nt} = \underbrace{-\frac{1}{\theta}\log \widehat{s}_{nnt}}_{\text{static gains}} + \underbrace{(1-\mu_n)\log \widehat{k}_{nt}}_{\text{capital accumulation}} + \underbrace{\log\left(\frac{\widehat{p}_{nt}\widehat{c}_{nt}}{\widehat{GNI}_{nt}}\right)}_{\text{consumption-GNI}} + \underbrace{\log\left(\frac{\widehat{GNI}_{nt}}{\widehat{\mathcal{P}}_{nnt}\widehat{\mathcal{Y}}_{nt}}\right)}_{\text{GNI-GDP}}, \tag{38}$$

where hats denote changes relative to the initial transition path before the change in trade frictions.

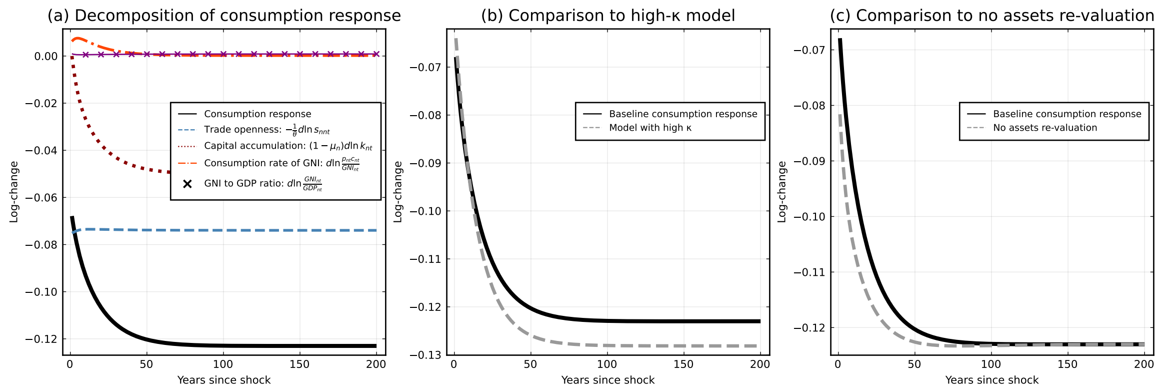
Figure 4 shows impulse responses for U.S. consumption with respect to this increase in U.S. trade frictions with all foreign countries (for both imports and exports). We display these impulse responses as the elasticities of the endogenous variables with respect to a small change in trade frictions in the linearized model. Therefore, a value of 0.1 for a log outcome on the vertical axis implies that a 1 percent increase in trade frictions leads to a 0.1 percent increase in that outcome.

Panel (a) shows the time path of consumption (solid black line) and its components. First, higher U.S. trade frictions have the direct effect of raising the U.S. final goods price index and lead to an immediate drop in consumption from forgone static welfare gains from trade (blue dashed line). Second, the higher U.S. final goods price index raises the cost of investment, which leads to capital decumulation over time (red dotted line). This contribution from capital decumulation is sizable relative to that from forgone static welfare gains from trade, but occurs gradually over time along the transition path. Finally, for trade shocks, we find relatively little response of the consumption-GNI and GNI-GDP ratios (orange dash-dotted line and purple crosses), although, as we show later, these responses are more pronounced for other shocks. In particular, because a trade shock can be interpreted as a permanent change in an economy's consumption possibility frontier, it induces relatively little adjustment in the economy's saving rate of income.

Panel (b) contrasts the impulse responses of U.S. consumption under open capital markets (solid black line) with those in the special case of a dynamic trade model with capital autarky (high κ_{ni} as shown by the dashed gray line). For most of the transition path and in steady state, the reduction in U.S. consumption is smaller under open capital markets than under capital autarky. The reason is that a share of domestic assets is held as foreign capital under open capital markets and is therefore insulated from the adverse effects of higher own trade frictions on own production. As a result, asset decumulation is more muted, and consequently the long-run decline in domestic capital is smaller under open capital markets. However, the initial drop in consumption is marginally larger under open capital markets than under capital autarky. Without access to foreign investment opportunities, the negative effect of higher own trade frictions on the return to savings is larger, which induces stronger substitution from savings toward consumption, thereby increasing initial consumption under capital autarky relative to that under open capital markets.

Panel (c) compares the impulse responses for U.S. consumption in our ONGM (solid black line) with a hypothetical transition path in which we eliminate the initial jump in assets from unexpected

Figure 4: Impulse Responses for U.S. Consumption and its Components for an Increase in U.S. Trade Frictions with all Foreign Countries (Elasticities)



Note: Impulse responses for an increase in U.S. trade frictions with all foreign countries ($\tau_{\text{USA}i}$ and $\tau_{i\text{USA}}$ for all $i \neq$ USA). Impulse responses computed using the linearized model and the 2017 steady-state trade and capital share matrices; impulse responses show log relative changes ($\log(\widehat{x}) = \log(x'/x)$) in a variable's transition path relative to that before the change in U.S. trade frictions (such that zero is no change). Vertical axis corresponds to an elasticity (such that 0.10 implies that a 1 percent increase in trade frictions leads to a 0.10 percent increase in the variable). Panel (a) shows impulse responses for log consumption and its four components in equation (38). Panel (b) compares impulse responses for consumption in our baseline model with open goods and capital markets (solid line) to those in a dynamic trade model with capital autarky (dashed line), in which $\kappa_{ni} \to \infty$ for $n \neq i$. Panel (c) compares impulse responses for consumption in our baseline model with open goods and capital markets (solid line) to their values if the unexpected valuation effects are set equal to zero (dashed line).

valuation effects (dashed gray line). After removing these unexpected valuation effects, we find a larger initial drop in consumption. As the trade shock induces a relocation of consumption toward domestic goods, valuation effects generate a temporary increase in the value of U.S. assets relative to the counterfactual without valuation effects, leading to higher income and consumption in the short run. In the long run, the two series converge by construction, since the only difference in the counterfactual economy without unexpected valuation effects lies in the level of assets at the beginning of the transition path.

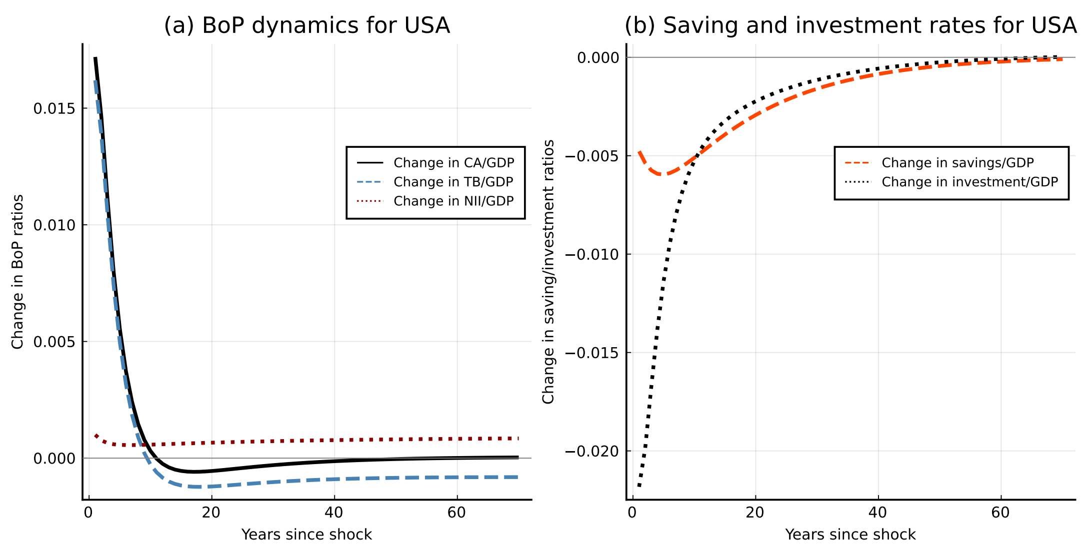
In Online Appendix P.4, we show that we find a similar pattern of results for U.S. consumption if we instead consider an increase in bilateral real trade frictions between the United States and China. In Online Appendix P.5, we show that we find similar consumption comparative statics for tariffs as for real trade frictions, with the usual qualification that the terms of trade improvement contributes positively to welfare through tariff revenue.

Balance of Payments Response Figure 5 shows analogous impulse responses for the balance of payments (Panel (a)) and savings and investment (Panel (b)) relative to GDP in the United States in response to the same increase in U.S. real trade frictions with all foreign countries. The higher trade frictions on U.S. imports raise the domestic final goods price index and hence the cost of investment in the United States. At the same time, the higher trade frictions on U.S. exports make the United

States a less attractive production location, and reduce the return to investment in the United States. Together these forces lead to an initial fall in investment in the United States (black dotted line in Panel (b)).

The increase in the final goods price index also reduces the real return to saving in the United States, which leads to an initial fall in savings (Panel (b)). However, with open capital markets, the reduction in the real return to saving is smaller than the reduction in the domestic return to investment, because the representative consumer can save overseas. Therefore, savings fall by less than investment, which leads to an initial improvement in both the trade balance and the current account (Panel (a)). This differential response of savings and investment, and hence the adjustment in the trade balance, can only occur because of open capital markets, as otherwise savings and investment necessarily equal one another under capital autarky.

Figure 5: Impulse Responses for U.S. Balance of Payments and Savings and Investment for an Increase in U.S. Trade Frictions with all Foreign Countries (Elasticities)



Note: Impulse responses for an increase in U.S. trade frictions with all foreign countries ($\tau_{\text{USA}i}$ and $\tau_{i\text{USA}}$ for all $i \neq$ USA). Impulse responses computed using the linearized model and the 2017 steady-state trade and capital share matrices; impulse responses show changes in a variable's transition path relative to that before the change in U.S. trade frictions (such that zero is no change). Vertical axis corresponds to a semi-elasticity (such that 0.10 implies that a 1 percent increase in trade frictions leads to a 0.10 percentage-points increase in the variable). Panel (a) shows changes in the U.S. balance of payments and its components; black solid line shows the change in the current account as a share of GDP; blue dashed line shows change in trade balance as a share of GDP; red dotted line shows the change in net investment income as a share of GDP; Panel (b) shows the change in U.S. saving as a share of GDP (orange dashed line) and the change in U.S. investment as a share of GDP (black dotted line).

In the long run, saving and investment must balance, and the current account converges to zero. Long-run rates of saving and investment as a share of GDP are both largely unchanged in response to trade shocks, resembling the invariance of these ratios to productivity shocks in a closed-economy neoclassical growth model. However, the long-run composition of the current account does change:

a deterioration in the U.S. trade balance is offset by a permanent increase in net investment income. Intuitively, higher trade frictions reduce the U.S. comparative advantage in exporting goods relative to providing capital services to the rest of the world, thereby leading to lower net exports and higher net income from capital services.

6.4.2 Capital Market Disintegration

We next consider an increase in U.S. capital market frictions with all foreign countries (both inward and outward), before later examining an increase in bilateral capital market frictions between the United States and China.

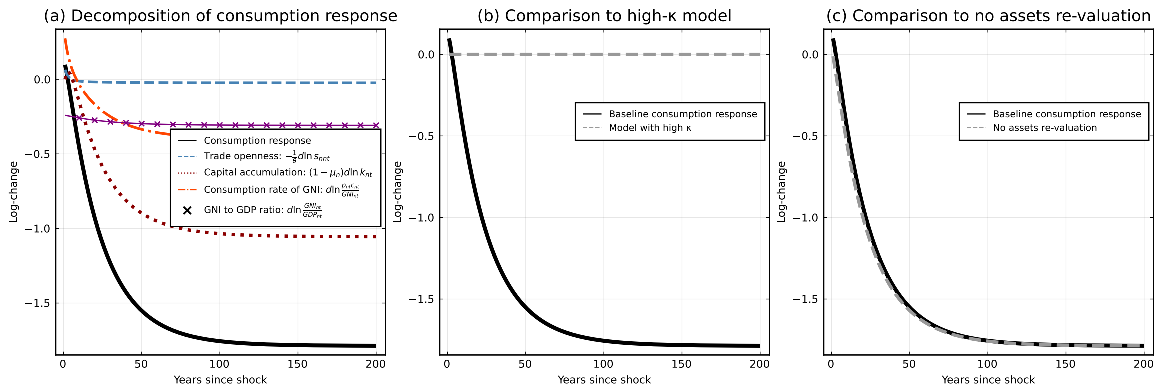
Consumption Response Figure 6 shows impulse responses for U.S. consumption with respect to an increase in U.S. capital market frictions with all foreign countries. Panel (a) shows the time path of consumption (solid black line) and its four components, again as the elasticities of the endogenous variables with respect to a small change in frictions in the linearized model. We find a substantially different pattern of results for capital market frictions than for trade frictions above. First, capital market frictions do not directly affect expenditure shares in goods markets, which ensures modest effects on trade openness (blue dashed line). Second, the higher capital market frictions permanently reduce the income from the United States's gross holdings of capital overseas, as reflected in a decline in the ratio of GNI to GDP (the downward-drop in the purple crossed line).

Third, the higher capital market frictions on foreign assets held as capital in the United States increase the cost of investment and reduce the steady-state equilibrium U.S. capital stock, which leads to capital decumulation over time (red dotted line). Again this capital decumulation accounts for a substantial fraction of the overall consumption response (comparing the black solid and red dotted lines). Finally, unlike higher trade frictions, higher capital market frictions lead to substantial changes in the consumption-to-GNI ratio. In the short run, the decline in foreign income and the return on overseas investments generates a substitution effect that lowers saving and raises consumption relative to income in the United States. In the long run, however, the consumption rate of income is determined by the ratio of assets to income, which falls as capital market frictions rise.[12]

For consistency with Figure 4 for trade frictions above, panel (b) contrasts the impulse responses for U.S. consumption under open capital markets (solid black line) with those in the special case of a dynamic trade model with capital autarky (dashed gray line). Since capital market frictions are already prohibitive under capital autarky ($\kappa_{ni} \to \infty$ for $n \neq i$), the dashed line in the figure shows no change. Panel (c) compares the impulse responses for U.S. consumption in our model (solid black

[12]Note that the household budget constraint in steady state implies the following relationship $\frac{p_n c_n}{GDP_n} = \mu_n + (1-\beta)\frac{a_n}{GDP_n}$. Therefore, the consumption-to-GDP ratio is increasing in the assets-to-GDP ratio, and the savings-to-GDP ratio is decreasing in the assets-to-GDP.

Figure 6: Impulse Responses for U.S. Consumption and its Components for an Increase in U.S. Capital Market Frictions with all Foreign Countries (Elasticities)



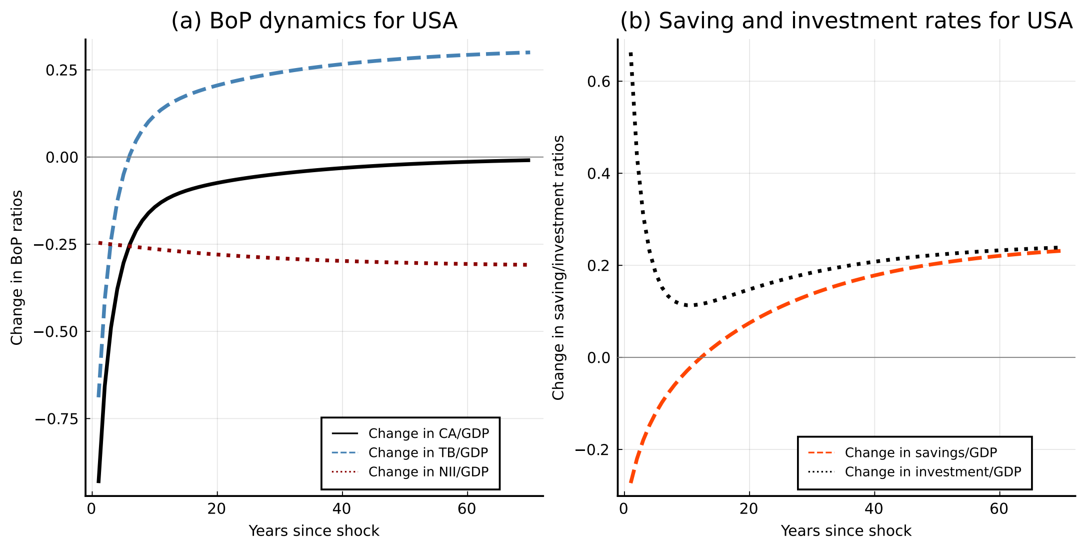
Note: Impulse responses for an increase in U.S. capital market frictions with all foreign countries ($\kappa_{\text{USA}i}$ and $\kappa_{i\text{USA}}$ for all $i \neq$ USA). Impulse responses computed using the linearized model and the 2017 steady-state trade and capital share matrices; impulse responses show log relative changes ($\log(\widehat{x}) = \log(x'/x)$) in a variable's transition path relative to that before the change in U.S. capital market frictions (such that zero is no change). Vertical axis corresponds to an elasticity (such that 0.10 implies that a 1 percent increase in capital market frictions leads to a 0.10 percent increase in the variable). Panel (a) shows impulse responses for log consumption and its four components in equation (38). Panel (b) compares impulse responses for consumption in our baseline model with open goods and capital markets (solid line) to those in a dynamic trade model with capital autarky (dashed line); in that dynamic trade model, capital market frictions are already prohibitive ($\kappa_{ni} \to \infty$ for $n \neq i$), such that the dashed line in the figure shows no change. Panel (c) compares impulse responses for consumption in our baseline model with open goods and capital markets (solid line) to their values if the unexpected valuation effects are set equal to zero (dashed line).

line) to a hypothetical transition path in which we subtract all unexpected valuation effects from the time path of consumption (dashed gray line). We find that the unexpected valuation effects are much smaller for capital market frictions than for trade frictions, such that the two lines in Panel (c) track one another relatively closely. Whereas trade frictions directly affect goods prices and hence the value of the existing stock of capital in the United States, capital market frictions mostly change the valuation of future capital, with more limited unexpected valuation effects.

Balance of Payments Response Figure 7 shows analogous impulse responses of the balance of payments (Panel (a)) and savings and investment (Panel (b)) in the United States in response to the same increase in U.S. capital market frictions with all foreign countries. Again, we find a strikingly different pattern of results for capital market frictions than for trade frictions.

First, the higher U.S. capital market frictions with foreign countries reduce the return to saving for the United States, which leads to an initial drop in domestic savings as a share of GDP (red dashed line). Second, higher U.S. capital market frictions induce a reallocation of existing U.S. assets toward domestic capital, generating an initial jump in domestic investment as a share of GDP (dotted line). In the long run, investment and savings must equalize, and – mirroring the decline in the consumption-to-income ratio discussed above – both rise as a share of GDP following the gradual decline in U.S. assets. Along the transition path, as U.S. assets decline relative to GDP, the saving rate gradually increases. The investment rate follows a non-monotonic path, which reflects offsetting forces: after the initial jump in the investment rate, the decline in foreign investment in domestic capital pushes the investment rate down, while the gradual increase in the U.S. saving rate pushes the investment rate up.

Figure 7: Impulse Responses for U.S. Balance of Payments and Savings and Investment for an Increase in U.S. Capital Market Frictions with all Foreign Countries (Elasticities)



Note: Impulse responses for an increase in U.S. capital market frictions with all foreign countries ($\kappa_{\text{USA}i}$ and $\kappa_{i\text{USA}}$ for all $i \neq$ USA). Impulse responses computed using the linearized model and the 2017 steady-state trade and capital share matrices; impulse responses show changes in a variable's transition path relative to that before the change in U.S. capital market frictions (such that zero is no change). Vertical axis corresponds to a semi-elasticity (such that 0.10 implies that a 1 percent increase in capital market frictions leads to a 0.10 percentage-points increase in the variable). Panel (a) shows changes in the U.S. balance of payments and its components; black solid line shows the change in the current account as a share of GDP; blue dashed line shows change in trade balance as a share of GDP; red dotted line shows the change in net investment income as a share of GDP; Panel (b) shows the change in U.S. saving as a share of GDP (red dashed line) and the change in U.S. investment as a share of GDP (blue dotted line).

The initial jump in the investment rate and initial drop in the savings rate lead to an immediate deterioration in the trade balance as a share of GDP (blue dashed line in Panel (a)), which is reflected in an immediate deterioration in the current account as a share of GDP (black solid line in Panel (a)). Since the higher capital market frictions lower income from the U.S.'s gross holdings of capital overseas, and raise the rental rate in the United States as a result of the reduction in effective units of foreign-owned capital, there is an initial drop in net investment income as a share of GDP (red dotted line in Panel (a)). This initial drop in net investment income further contributes to the initial deterioration in the current account (black solid line), which is larger than the initial deterioration in the trade balance (blue dashed line). As the saving rate rises along the transition path to steady state, there is a gradual improvement in the trade balance (blue dashed line), which drives the gradual improvement in the current account (black solid line). While the current account returns to zero in steady state (black solid line), there is a permanent improvement in the trade balance (blue dashed line), which offsets the permanent deterioration in net investment income (red dotted line). In contrast to the effect of higher trade frictions, the rise in capital market frictions in the United States lowers its comparative advantage in providing capital services, thus shifting the composition of the current account towards increased net exports of goods.

Therefore, we find starkly different effects of trade and capital market frictions on the balance of payments. Higher trade frictions lead to an initial improvement in the trade balance, followed by an ultimate deterioration. In contrast, higher capital market frictions lead to an initial deterioration in the trade balance, followed by an eventual improvement.

6.4.3 Third-Country Effects

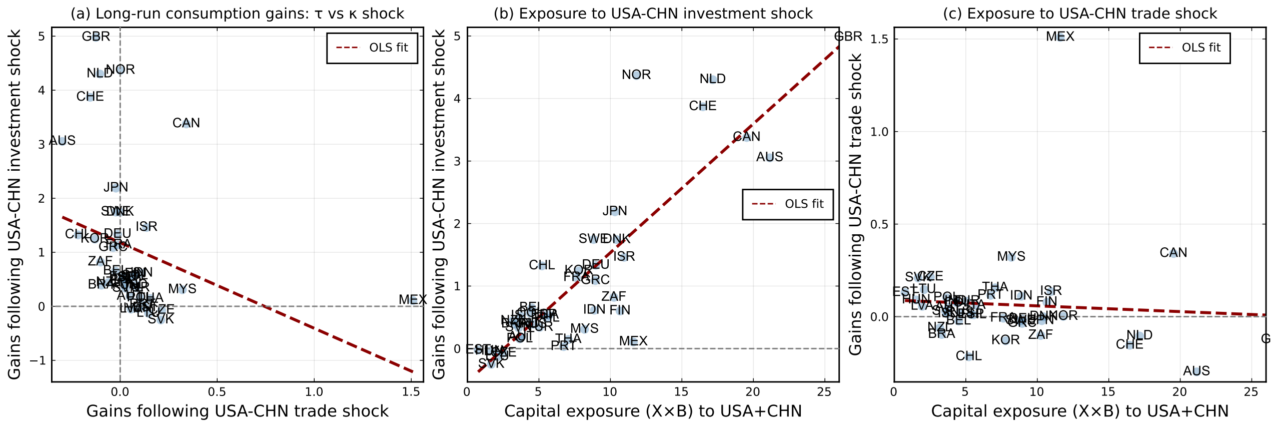
A key difference between our multi-country model and two-country settings is that changes in bilateral frictions have third-country effects. We now examine these third-country effects from a decoupling of the United States and China through higher bilateral trade or capital market frictions.

In goods markets, an increase in U.S.-Chinese trade frictions makes Chinese goods more expensive in the U.S. market and U.S. goods more expensive in the Chinese market. As a result, consumers in both markets substitute towards the goods of other suppliers. Our model implies that these cross-substitution effects are largest for third countries that account for a high share of U.S. and Chinese expenditure and that derive a high share of their income from the U.S. and Chinese markets. We therefore measure exposure to a U.S.-Chinese trade shock based on the product of the expenditure share ($\boldsymbol{S}$) and income share matrices ($\boldsymbol{T}$), averaged across both the U.S. and Chinese markets. Higher exposure implies more positive third-country effects.

In capital markets, an increase in U.S.-Chinese capital market frictions makes Chinese capital more expensive in the U.S. market and U.S. capital more expensive in the Chinese market. In response, firms in both markets substitute towards the capital of other suppliers. Our model implies that these cross-substitution effects are largest for third countries that account for a high share of capital in the United States and China and that hold a large share of their portfolio in the U.S. and Chinese markets. We therefore measure exposure to a U.S.-Chinese investment shock based on the product of the portfolio share ($\boldsymbol{B}$) and capital share matrices ($\boldsymbol{X}$), averaged across both the U.S. and Chinese markets. Again higher exposure implies more positive third-country effects.

In Panel (a) of Figure 8, we compare the log changes in steady-state consumption in third countries in response to an increase in bilateral U.S.-Chinese trade frictions (horizontal axis) and bilateral U.S.-Chinese capital market frictions (vertical axis). Again we display these log changes as the elasticities of the endogenous variables with respect to a small change in frictions in the linearized model. We find a strong negative correlation between these third country effects of higher bilateral trade and capital markets frictions that is statistically significant at conventional levels.

Figure 8: Third-Country Effects from Increases in U.S.-Chinese Bilateral Trade Frictions Versus Increases in U.S.-Chinese Bilateral Capital Market Frictions (Elasticities)



Note: Log relative changes ($\log(\widehat{x}) = \log(x'/x)$) in third countries in response to an increase in U.S.-Chinese bilateral trade or capital market frictions. Counterfactuals computed using the linearized model and the 2017 steady-state trade and capital share matrices. Log changes expressed as elasticities multiplied by 100 (such that 1 implies that a 1 percent increase in trade frictions leads to a 0.01 percent increase in the variable). Panel (a) shows the steady-state log changes in consumption in response to higher capital market frictions (vertical axis) and higher trade frictions (horizontal axis); Panel (b) displays the steady-state log changes in consumption in response to higher capital market frictions (vertical axis) against initial capital market exposure based on the product of the portfolio share ($\boldsymbol{B}$) and capital share ($\boldsymbol{X}$) matrices (horizontal axis); Panel (c) shows the steady-state log changes in consumption in response to higher trade frictions (vertical axis) against the same measure of initial capital market exposure (horizontal axis).

Panels (b) and (c) illustrate what is driving this negative correlation. In Panel (b), we display the log change in steady-state consumption in third countries (vertical axis) as a result of higher U.S.-Chinese capital market frictions against our measure of initial capital market exposure to the U.S. and Chinese (horizontal axis). We find an intuitive pattern in which the gains in steady-state consumption in third countries as a result of higher U.S.-Chinese capital market frictions are strongly positively related to capital market exposure. As capital market frictions between the U.S. and China increase, third countries with high portfolio exposure to the U.S. and China (through the $\boldsymbol{B}$ matrix), such as Canada, experience higher returns on their foreign investments due to substitution in capital markets toward them. Multiplying by the $\boldsymbol{X}$ matrix captures not only the positive income effects from foreign assets, but also the feedback into domestic capital.

In Panel (c), we display the log change in steady-state consumption in third countries (vertical axis) as a result of higher U.S.-Chinese trade frictions against our measure of initial capital market exposure to the U.S. and China (horizontal axis). In contrast to the pattern in Panel (b), we find, if anything, a negative correlation between the gains in steady-state consumption in third countries as a result of higher U.S.-Chinese trade frictions and capital market exposure. When U.S.-Chinese trade frictions rise, high capital-market exposure to these countries has a negative effect: countries with larger portfolio shares in the U.S. and China experience an adverse shock to their destination markets, while receiving no positive cross-substitution effect in capital markets. Naturally, cross-substitution effects in goods markets also play an important role in shaping exposure to U.S.-Chinese trade frictions, as illustrated by the outlier countries in Panel (c), such as Mexico.

Therefore, the negative correlation between third country effects from higher U.S.-Chinese trade and capital market frictions in Panel (a) reflects quite different patterns of cross-substitution in goods and capital markets. Some countries, such as the Netherlands and Great Britain, have high levels of capital market exposure, but relatively low levels of trade exposure in the U.S. market, which results in gains from an investment shock but losses from a trade shock in panel (a). Other countries, such as Mexico, have low levels of capital exposure, but high levels of trade exposure, which results in losses from an investment shock but gains from a trade shock in panel (a). Yet other countries, such as Canada, have relatively high levels of both trade and capital exposure, which results in gains from both an investment and trade shock in panel (a). These differences in trade and capital market exposure reflect different bilateral networks of linkages in goods and capital markets and different multilateral trade balances. In the steady state of our model, the current account is balanced for all countries, but some countries can specialize as exporters of goods (with a trade surplus offset by negative net investment income), while other countries specialize as exporters of capital in steady state (with a trade deficit offset by positive net investment income).

7 Conclusion

We develop a tractable, multi-country, open-economy model of neoclassical growth to understand the role of networks in goods and capital markets in determining economic growth and convergence and the welfare effects of international integration or disintegration. We simultaneously model intratemporal trade in goods, a capital allocation decision across countries, and an intertemporal consumption-savings decision. Our framework rationalizes key features of the observed data, such as gravity equations for goods trade and capital holdings; home bias for goods trade and capital holdings; gross capital positions that exceed net capital positions; a positive correlation between savings and investment; and limited capital movements from rich to poor countries.

Openness in capital markets can be summarized by a country's domestic portfolio share, in a similar way that openness in goods markets can be captured by a country's domestic expenditure share. Trade and capital market frictions affect steady-state real gross domestic product (GDP), economic growth along the transition path, and welfare. The speeds of convergence to steady state for assets and capital are different from one another and jointly determined. These speeds of convergence for any one country depend on the entire network of goods and capital market frictions and the initial stocks of assets and capital in all countries. Higher capital market openness can increase the speed of convergence for capital (by reducing differences in the marginal product of capital across countries) and yet reduce the speed of convergence for assets (by reducing differences in the return to saving across countries).

Since our quantitative model rationalizes the observed data on bilateral trade and capital holdings, and features endogenous consumption-savings decisions, it provides a suitable framework for examining a disintegration of the United States from world markets and a decoupling between the United States and China. Capital accumulation is a key margin through which trade frictions affect welfare and the dynamic effect of trade frictions depends on capital market frictions (and vice versa). Unexpected changes in trade and capital market frictions have valuation effects that depend on gross capital positions. Higher trade frictions raise the final goods price index that corresponds to the cost of investment, and hence initially improve the trade balance (by reducing investment relative to saving), before eventually worsening the trade balance. In contrast, higher capital market frictions reduce the rate of return to saving, and hence initially worsen the trade balance (by reducing saving relative to investment), before ultimately improving the trade balance.

Increases in bilateral trade and capital market frictions between the United States and China have cross substitution effects on third countries that are negatively correlated with one another, because of different initial networks in goods and capital markets, and different effects of the two frictions on the steady-state composition of the current account. Overall, our framework emphasizes the importance of jointly modelling goods and capital market openness for understanding growth and convergence and the welfare effects of international integration or disintegration.

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