Global Collateral and Capital Flows

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Abstract

Cross-border financial flows arise when otherwise identical countries differ in their abilities to use assets as collateral to back financial contracts. Countries have access to the same financial instruments—there are no interest rate differentials, nor risk-sharing motives to trade assets. Trade in financial assets is a way to internationally share scarce collateral. Financial integration leads to a divergence in the prices of assets with identical payoffs due to a gap in collateral values. Home (financially advanced) runs a trade deficit, which reverses in crises. Financial integration increases asset price volatility, and flows driven by collateral differences are procyclical.

Keywords: Collateral, gross capital flows, asset prices, trade balance, securitized markets, asset-backed securities.

JEL classification: D52, D53, E32, E44, F34, F36, G01, G11, G12.

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1 Introduction

We propose that cross-country differences in the ability to use assets as collateral to back financial promises can generate gross financial flows between advanced economies. Collateral driven financial integration generates pro-cyclical gross financial flows and an increase in global asset price volatility. In our model, the financially advanced country typically runs a trade deficit, but this can switch in a global crisis, as the financially advanced country makes large wealth transfers to the rest of the world.

The standard textbook case for financial integration is simple. Capital flows from advanced economies to high-return developing ones. These flows promote investment and growth in receiving countries, help reduce volatility, and allow for better consumption smoothing. This story, however, does not describe what we have observed in international financial markets in recent decades. The following empirical observations motivates our analysis.

Observation 1: There are substantial gross financial flows between rich, similarly-developed countries. In some cases, offsetting flows (capital inflows by foreigners and capital outflows by domestic agents) are heavily concentrated in financial assets and in particular in securitized mortgage securities.

There are substantial gross flows between the U.S. and Europe (see for example, Lane and Milesi-Ferretti, 2007; Obstfeld, 2012, 2015; Bertaut et al., 2012; Forbes and Warnock, 2012; Broner et al., 2013; Bruno and Shin, 2014). These flows were most striking pre-crisis, and while they have partially reversed post-crisis (as did all gross flows), the patterns remain (See BIS locational banking statistics). Among developed countries there are substantial foreign holdings of government bonds, and for many countries non-residents make up the largest investor base (Andritzky, 2012), and there are substantial gross flows within Europe (see Hale and Obstfeld, 2016). These flows are concentrated in just a few countries: Germany, Belgium, and France stand out among the core countries, and crucially Ireland behaves much like the core countries, intermediating funds to the other peripheral countries as well as to the core. From 2000–2007 core European banks increased their balance sheets, intermediating funds from the rest of the world, to finance the net current accounts of the periphery countries—Greece, Italy, Ireland, Portugal, and Spain ("GIIPS"). As a result, core banks borrowed from abroad to invest in GIIPS.

One could expect the proliferation of capital gross flows, if driven by diversification motives, to be associated with lower volatility and less amplification. But instead we observe the following.

Observation 2: Gross flows are procyclical and financial integration tends to increase co-movement and volatility, particularly in response to financial shocks, and particularly through banking flows and securitized markets.

Gross capital flows are large and volatile, both in absolute terms and relative to the size and volatility of net capital flows. Moreover, gross capital flows are procyclical: during contractions, foreigners reduce their investments in domestic assets and domestic agents reduce their investments abroad. (see Broner et al., 2013; Brunnermeier et al., 2012; Forbes and Warnock, 2012). Rey (2015); Miranda-Agrippino and Rey (2020) also document a Global Financial Cycle, which denotes fluctuations in financial activity on a global scale and is characterized by the comovements of risky asset prices, leverage of financial intermediaries, credit growth and gross capital flows around the world. Kalemli-Ozcan, Papaioannou and Perri (2013) find that financial crises induce co-movements among financially integrated countries. Additionally, Acharya and Schnabl (2010) find that the geography of financial crises is determined by global banks and securitized markets, not by "global imbalances" and net flows.

In this paper we propose that cross-country differences in the ability to use assets as collateral can account for both observations. We consider a two-country model with incomplete markets and collateralized financial markets. The two countries, Home and Foreign, are identical in every way except for the sophistication with which their financial systems can use collateral. The Home country has an advanced financial system that enables investors to use a risky asset as collateral to issue state-contingent financial promises. In contrast, in the Foreign country investors can use a risky asset (with identical payoffs as the Home asset) as collateral to issue non-contingent promises only (collateralized debt). Financial systems differ in a myriad of both subtle and complex ways but the salient features that we are focusing on are the ability to leverage, securitize, and tranche assets, which is reflected in the financial structures we assume. The different ability to collateralize financial promises gives rise to different abilities to create risk-free and negative-beta financial securities (only Home can tranche the asset into negative-beta securities). Our model provides precise predictions about the effects of financial integration on asset prices and capital flows

We first conduct a static analysis. First, we show that differences in the ability to collateralize financial promises across borders are enough to generate gross international financial flows. In our model, financially integrated countries have access to the same set of financial instruments: there are no interest rate differentials (e.g., arising from differences in precautionary savings), nor hedging or risk-sharing motives to trade assets (agents are risk-neutral and assets have identical payoffs). International trade in financial assets is a way to internationally share scarce collateral. We provide precise predictions for gross capital flows directions. Second, with financial integration, asset prices do not converge but actually widen further. This difference is due to the gap in collateral values: the Home asset is better collateral since it can be tranched into state-contingent promises whereas the Foreign asset can only be used to issue debt. Finally, Home always run a trade deficit financed by trade in more expensive financial assets. In fact, the trade deficit is proportional to the gap in collateral values.

We next take our theoretical results and study their implications in a dynamic setting. In our numerical exercises, we find that financial integration generally increases global price volatility and produces procyclical gross and net flows. Asset prices in Foreign become more volatile due to fluctuations in the attractiveness of alternative investments (Home assets that can be tranched). Furthermore, Foreign demand for collateral-backed financial promises (negative-beta securities) increases the collateral value of Home assets, amplifying price fluctuations. Hence, asset prices in both countries become more volatile as a result of financial integration. This increased global price volatility gets mirrored in the large procyclical swings in financial flows.

Finally, our model predicts procyclical trade deficits for Home, with the trade balance flipping signs during severe global crises. In our dynamic model, Home makes large wealth transfers to Foreign during a downturn, matching an important empirical stylized fact (Maggiori, 2017), these wealth transfers can result in a trade surplus during global crises.

Our model provides interesting testable implications which can guide future empirical work. First, our theoretical mechanism relies on the fact that there are meaningful cross-country differences in the use of collateral. There has been great progress in understanding how differences in institutional leverage (e.g., bank leverage) across countries affect capital flows (see for example Kalemli-Ozcan, Sorensen and Yesiltas, 2012). Whereas this certainly suggests that our mechanism is relevant, there is need for data at the security level to assess the importance of our theoretical mechanism in the real world. Data on the loan terms for U.S. securities used as collateral in domestic funding markets are only beginning to be collected and used in limited samples (see Copeland, Martin and Walker (2014) and Baklanova et al. (2017) for evidence). There is suggestive evidence, however, that there are differences in collateral use across mature economies. Bertaut et al. (2012) show that during the 2000s European investors purchased U.S. asset-backed securities and similar securities, whereas many other countries (notably China) purchased Treasuries. Additionally, Bertaut et al. (2012) provide consistent evidence of differential abilities to supply securitized assets. Similarly, Shin (2012) documents how European banks greatly expanded their balance sheets by increasing both U.S. assets and liabilities (European banks borrowed from U.S. markets and purchased U.S. assets).

Second, in terms of our results, trades driven by global demands to share collateral lead to gross international flows even among countries that are otherwise identical. We propose that differences in financial innovation between the U.S. and Europe contributed to the expansion of European banks' balance sheets. (European banks may also have an advantage at intermediation (one explanation for the pre-crisis expansion), but our results imply that gross flows would arise even if they do not). In particular, the ability of the U.S. financial system to leverage and tranche U.S. assets (especially mortgages) created securities in demand by European banks.[1] Our story provides an attractive hypothesis to explain some of the differences between Ireland, Germany, and the rest of Europe. Since the ability of a country to use assets as collateral is the feature that differentiates countries that are otherwise similarly developed. Finally, if collateral-based financial innovations are an important driver of gross flows, then a logical conjecture is that the wave of securitization beginning in the late 1990s could possibly explain the recent divergence between gross and net global flows.

Third, although our analysis is positive and not normative, our story has important implications for asset prices, global financial stability, and crisis transmission. Financial integration tends to increase asset prices, export volatility across borders, and lead to procyclical flows.[2] While Shin (2012) emphasizes how expanded intermediation by European banks depresses credit spreads in the U.S., we document how global banking flows and financial linkages of the type seen between the U.S. and Europe could create spillovers, exporting US volatility to European markets.

Related Literature Our paper builds on the collateral general equilibrium literature starting with Geanakoplos (1997) and developed since then.[3]

Our paper is related to a large literature on how differences in financial systems drive capital flows. This "global imbalances" literature has tended to focus on how *net* capital flows arise between developed and developing countries. The literature has broadly considered differences in (i) state-completeness, (ii) the ability to supply financial assets, (iii) sharing idiosyncratic risk, and (iv) funding costs. In this literature, financial flows are driven primarily by interest rate (or investment return) differentials that manifest in different savings across countries. Financial integration leads to a convergence in savings levels and interest rates, and current account deficits can be financed indefinitely because

[1]Shin (2012) argues that the regulatory environment in Europe and the advent of the Euro enabled banks to easily expand their balance sheets. We argue that it remains to explain why European banks expanded by intermediating U.S. assets and liabilities as much as they did.

[2]Bekaert and Harvey (2000) provide empirical evidence that financial integration increases domestic asset prices.

[3]See Fostel and Geanakoplos (2008, 2012*b*,*a*, 2015, 2016), Araujo, Kubler and Schommer (2012); Araujo, A., F. Kubler and Schommer (2009); Brumm et al. (2015); Gottardi and Kubler (2015), Simsek (2013), Geanakoplos and Zame (2014), Phelan (2015), and Gong and Phelan (2019, 2022)

the financially "deep" country earns intermediation rents.

Willen (2004) shows that market incompleteness across countries causes trade imbalances because superior risk-sharing in one country leads to a lower precautionary demand for saving. Caballero, Farhi and Gourinchas (2008) emphasize the role of heterogeneous domestic financial systems in explaining global imbalances in which financial imperfections are captured by a country's ability to supply assets in a deterministic model. Their paper assumes that "Home" can supply more financial assets from real assets, which affects autarkic savings and interest rates, and the model can explain capital flows, current account deficits, and low interest rates.

Mendoza, Quadrini and Rios-Rull (2009) and Angeletos and Panousi (2011) have emphasized how net capital flows arise when the developed country can better insure idiosyncratic risk. Poor risk sharing increases buffer-stock savings and decreases autarkic interest rates. Within this literature, Phelan and Toda (2018) study how the risk-sharing qualities of securitized markets affect international capital flows, growth, and welfare, showing that capital flows from the high- to low-margin country. Maggiori (2017) provides a model in which Home financiers can take on greater financial risk as a result of funding advantages. This leads Home to run persistent current account deficits financed by the risk-premium earned by its financial sector, which can better absorb aggregate shocks.

While these interest rate and risk-sharing mechanisms are clearly important for understanding global flows and imbalances, we emphasize instead the role of collateral to facilitate gross flows, especially among developed countries. In our model, agents are risk-neutral, assets are identical, and interest rates do not change with financial integration (they are always zero). Flows are not driven by different savings demand. In our model all agents have identical savings demand, but agents have different portfolio demands. Instead, leverage and tranching create contingent securities from underlying collateral, and international trade allows investors to buy securities that are not available domestically. In our model, flows emerge because agents trade in underlying assets and not simply in a risk-free bond. Furthermore, our earlier observations suggest that focusing on net flows alone is insufficient, as the differentiation between gross inflows and outflows has become more important (Forbes and Warnock, 2012). While, in the early and mid 1990s net and gross flows used to move together, more recently the size and volatility of gross flows have increased while net capital flows have been more stable.

Finally, our focus on how financial integration leads to excess volatility and procyclicality is related to several theoretical papers. Caballero and Simsek (2016), consider a model in which gross flows are driven by demands for liquidity (diversification) and the "fickle" reversal of capital flows creates instability. They focus on the implications for policy ex ante taking fickle flows as given. Mendoza and Quadrini (2010) extend the model in Mendoza, Quadrini and Rios-Rull (2009) (flows between U.S. and rest of the world driven by precautionary savings) to include financial intermediaries and study how financial integration affects the consequences of a one-time non-anticipated shock to intermediary capital. They find that shocks propagate as a result of financial integration; importantly, however, asset price declines are smaller than would be in autarky and the crisis would have been worse for the U.S. if it had not been financially integrated. In contrast, in our model price crashes are larger with financial integration, not in autarky. Theoretical work by Devereux and Yetman (2010) and Ueda (2012) present models, with financial intermediaries or with leverage constraints, in which financial integration affects spillovers, propagation through interdependent portfolios, and business-cycle synchronization.

Organization The rest of the paper is organized as follows. Section 2 presents the basic general equilibrium model with collateral. Section 3 studies the effects of financial integration in a static model. Section 4 uses a three-period model to study the consequences of financial integration on the volatility and cyclicality of prices and flows. Section 5 concludes. Supplemental material is presented in the Appendix.

2 General Equilibrium Model with Collateral

In this section we present a one-country general equilibrium model with collateral, which we later extend to an international two-country setting in Sections 3 and 4. Following Fostel and Geanakoplos (2012*a*) we call this model the *C*-model.

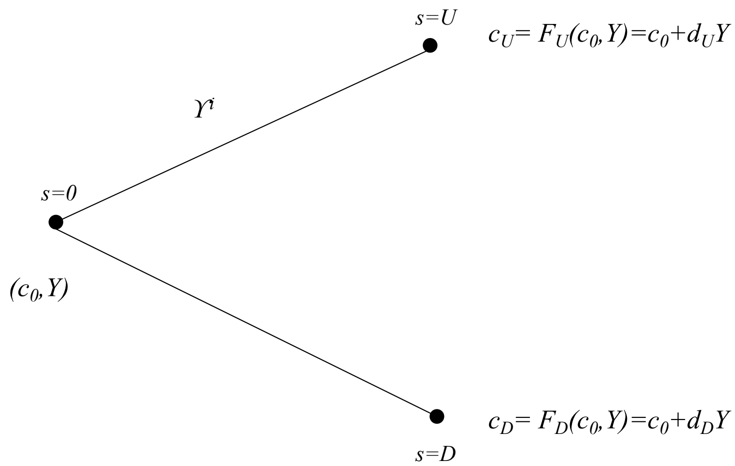


Figure 1: Time, commodities and assets.

Time, Commodities and Assets

There are two time periods, $t = 0,1$. Uncertainty is represented by a tree $S = \{0,U,D\}$ with a root $s = 0$ at time 0 and two terminal states of nature $S_T = \{U,D\}$ at time 1. Let $L_0 = \{c_0,Y\}, L_U = \{c_U\}, L_D = \{c_D\}$ be the set of commodities in states $0,U$ and D. Denote by $L_T = \cup_{s\in S_T} L_s$ the set of commodities in terminal states.

Let $F_s(c_0,Y) = c_0 + d_sY$, $s \in S_T$ be an inter-period durability function connecting any vector of commodities at state $s = 0$ with the vector of commodities it becomes in each state $s \in S_T$. As shown in Figure 1, c_0 is a (perfectly) durable consumption good and Y is a physical risky asset, which produces dividends (in units of the consumption good) d_U in state U and $0 < d_D < d_U$ in state D.

We normalize the price of consumption c_s in each state $s \in S$ to 1. We denote the price of the asset Y at time 0 by p.

Agents

Agents are uniformly distributed in the continuum $I = [0,1]$. Each investor $i \in I$ is risk-neutral, does not discount the future, and consumes only at time 1. The expected utility to agent i is

$$U^i(c_0, Y, c_U, c_D) = \gamma(i)c_U + (1-\gamma(i))c_D, \tag{1}$$

where $\gamma(i)$ is the subjective probabilities for the U state, which we assume to be strictly increasing and continuous in i. Since only the output of Y depends on the state and $0 < d_D < d_U$, higher i denotes more optimism. Heterogeneity among the agents stems entirely from the dependence of $\gamma(i)$ on i.

Each investor $i \in I$ has initial endowments of commodities at time 0 only, i.e. $e = (e_{c_0}, e_Y, e_{c_U}, e_{c_D}) = (e_{c_0}, e_Y, 0, 0)$.

Financial Contracts and Collateral

We explicitly incorporate repayment enforceability problems, and we suppose that collateral acts as the only enforcement mechanism. Agents trade non-recourse collateralized financial contracts at time 0. A financial contract j is defined by a pair consisting of a promise (j_U, j_D) of payment in units of the consumption good at each future state, and the one unit of Y serving as collateral.[4]

Borrowers, sellers of contracts, must own collateral in order to make promises. Lenders have the right to seize the posted collateral , but no more. Hence, the delivery of the non-recourse contract in each state is given by

$$\delta_s(j) = \min(j_s, d_s). \tag{2}$$

We denote the total set of contracts by J. Each contract $j \in J$ trades at price π_j. We denote the sale of contract j by $\varphi_j < 0$ and the purchase of the same contract by $\varphi_j > 0$. The sale of a financial contract corresponds to borrowing the sale price, π_j, and the purchase

[4]Restricting contracts to be collateralized by one unit of Y is without loss of generality, e.g., a contract promising $(0.4, 0.4)$ backed by two units of Y is identical to two units of a contract promising $(0.2, 0.2)$ backed by one unit of Y.

is tantamount to lending the same price in return for the promise. We model investors as directly borrowing against assets, but these trades could also capture the role of financial intermediaries in producing the financial contracts. We return to this distinction in Section 3.3.

Budget Set

Given asset and contract prices at time 0, $(p,(\pi_j)_{j\in J})$, each agent $i \in I$ chooses asset holdings y, contract trades φ_j, and consumption c_0 in state 0, and consumption in final states c_U, c_D, in order to maximize utility (1) subject to the budget set defined by

$$
\begin{aligned}
B^i(p,\pi) = \Bigg\{ & (c_0, y, \varphi, c_U, c_D) \in R_+^{L_0} \times R^J \times R_+^{L_T} : \\
& c_0 + py + \sum_{j\in J} \varphi_j \pi_j \leq e_{c_0} + pe_Y, \\
& \sum_{j\in J} \max(0, -\varphi_j) \leq y, \\
& c_s = F_s(c_0, Y) + \sum_{j\in J} \varphi_j \delta_s(j), s \in S_T \Bigg\}.
\end{aligned}
$$

At time 0, total expenditures on the consumption good, the asset and financial contracts has to be financed by the value of initial endowments. Notice that whereas agents can short financial contracts (provided they hold the collateral), short sales of the consumption good and physical asset are not allowed. The second constraint is the collateral constraint, which states that the total short position on financial contracts cannot exceed the total asset holdings required as collateral, i.e., borrowers need to hold collateral.[5] Finally, consumption in the terminal states is derived from the receipts of storage, asset dividends and financial contracts net deliveries.

[5] Notice that this collateral constraint is automatically satisfied for lenders since $\varphi_j \geq 0$ and they cannot go short on the asset Y.

Collateral Equilibrium

A Collateral Equilibrium consists of prices and holdings by all the agents $((p,\pi),(c_0^i,y^i,\varphi^i,c_U^i,c_D^i)_{i\in I}) \in (R_+ \times R_+^J)\times(R_+^{L_0}\times R^J\times R_+^{L_T})^I$, such that

1. $\int_0^1 c_0^i di = e_{c_0}$
2. $\int_0^1 y^i di = e_Y$
3. $\int_0^1 \varphi_j^i di = 0 \; \forall j \in J$
4. $(c_0^i,y^i,\varphi^i,c_U^i,c_D^i) \in B^i(p,\pi), \forall i$
5. $(c_0,y,\varphi,c_U,c_D) \in B^i(p,\pi) \Rightarrow U^i(c_0,y,\varphi,c_U,c_D) \le U^i(c_0^i,y^i,\varphi^i,c_U^i,c_D^i), \forall i$

In equilibrium, all markets clear and agents optimize their utilities in their budget sets.[6] Geanakoplos and Zame (2014) show that equilibrium in this model always exists.

3 A Static Model of Global Flows

We now consider a C-model with two countries, Home and Foreign, each defined as in Section 2.

The key—and only—difference between the two countries is that Home has a more advanced financial system than Foreign, as defined by the set of financial contracts J. We assume that Foreign assets can be used as collateral to issue non-contingent financial promises (i.e., collateralized debt); in other words, Foreign assets can be *leveraged*. In contrast, we consider a more sophisticated use of Y as collateral by the Home financial sector: Home assets can be used as collateral to issue state-contingent financial promises; in other words, Home assets can be *tranched*. This feature intends to capture the advanced ability of the U.S. financial system to securitize and tranche mortgages and other financial assets.

[6] By Walras' Law, markets in terminal nodes also clear for the consumption good.

We first describe autarkic equilibria in each country and then describe the equilibrium with financial integration. In what follows, we use * to denote Foreign variables and $\hat{}$ to denote variables with financial integration.

3.1 Foreign Autarky: Leverage

In autarky, the Foreign financial sector can issue non-contingent promises using the asset as collateral. In this case $J^* = \{j : j = ((j, j), 1_Y)\}$. With slight abuse of notation, we let j denote both the contract and the promise for that contract. Each debt contract j promises j at $t = 1$, and is collateralized by one unit of the asset Y^*. Hence, by buying Y^* and selling any contract j (thus borrowing π_j), agents can leverage their purchases of Y^*.

Leverage is endogenous in the model. All contracts are priced in equilibrium, but since collateral is scarce, a limited set is actively traded. Fostel and Geanakoplos (2012*b*) show that in C-models the only contract actively traded is the "*maxmin*" contract $j^* = \min\{d_s\} = d_D$, ruling out default in equilibrium, with an associated price $\pi_j = d_D$ (the risk-free interest rate is zero). Note that when agents leverage a unit of the risky asset Y^* by selling the maxmin contract $j^* = d_D$, they receive $d_U - d_D > 0$ in state U and $d_D - d_D = 0$ in state D. Thus, leveraged investors are effectively buying an "Arrow U^*" security that pays in state U.

Equilibrium is easy to characterize because of the linear utilities, the continuity of utility in i and the connectedness of the set of agents I. In equilibrium there is a marginal buyer i_1^* who is indifferent between leveraging Y^* and holding the consumption good c^*. As shown in Figure 2a, all agents $i > i_1^*$ buy all the Y^* in the economy with leverage: they borrow d_D by selling debt contract promising $j = d_D$ using Y^* as collateral. Agents $i < i_1^*$ lend to the more optimistic investors, holding the durable consumption good c^* and risk-free debt $j^* = d_D$. Equilibrium is described by a system of two equations in two unknowns, the price of the asset, denoted by p^*, and a marginal investor, denoted by i_1^*.

$$e_Y = (1 - i_1^*) \frac{(e_{c_0} + e_Y p^*)}{p^* - d_D}. \tag{3}$$

$$p^* = \gamma(i_1^*)d_U + (1-\gamma(i_1^*))d_D. \tag{4}$$

Equation (3) is the market clearing condition for the asset market.[7] The top $1-i_1^*$ agents are leveraging the asset by spending the total value of their initial endowment of $e_{c_0}+e_Y p^*$ on the downpayment, p^*-d_D; their demand equals the total supply of e_Y.

Equation (4) states that the asset is priced according to the marginal buyer's beliefs. The marginal buyer is indifferent between the leveraged position and holding a riskless position. Hence the ratio of prices must equal the ratio or marginal utilities. Both the price of the consumption good and its marginal utility are one, yielding equation (4). Notice that equation (4) can also be written as $1 = \frac{\gamma(i_1^*)(d_U-d_D)}{p^*-d_D}$, where the right-hand side is the return of the leveraged position (or the return of an Arrow U^*).

3.2 Home Autarky: Tranching

We suppose that $J = \{j_T : j_T = ((0,d_D),1_Y)\}$, i.e., J at Home consists of the single contingent contract denoted j_T promising payoffs $(0,d_D)$ collateralized by one unit of Y. We refer to this contract as a "down tranche" since it pays only in state D. When buying Y and using it as collateral to issue the down tranche, an agent is effectively buying an Arrow U security that pays $(d_U,0)$; the buyer of the tranche is buying an Arrow D security that pays $(0,d_D)$. The down tranche allows agents to completely tranche the asset payoffs of Y into Arrow securities.[8]

As showed in Figure 2b, in equilibrium there are two marginal buyers. Optimistic agents $i > i_1$ buy all the Y in the economy and use it as collateral to sell the down tranche j_T at price π_T, effectively holding an Arrow U security. Moderate agents $i \in [i_2, i_1]$ hold the consumption good c. The most pessimistic agents $i < i_2$ buy the down tranche j_T, effectively buying an Arrow D security.

Equilibrium at Home is described by a system of four equations in four unknowns: the price of the asset p, the price of the down tranche π_T, and two marginal buyers with

[7] The risk-free market (consumption good and the riskless bond) clears by Walras' Law.

[8] Considering this single promise is without loss of generality. Fostel and Geanakoplos (2015) show show that we can always assume in this type of binomial model with financial assets that $j_T = ((0,d_D),1_Y$ is the only contract actively traded in equilibrium.

$i_2 < i_1$. Equations (5) and (6) are the market clearing conditions for the asset Y and the tranche j_T:

$$e_Y = (1-i_1)\frac{(e_{c_0}+e_Y p)}{p-\pi_T}, \tag{5}$$

$$e_Y = i_2\frac{(e_{c_0}+e_Y p)}{\pi_T}. \tag{6}$$

The top $1-i_1$ agents buy the asset and sell off the down tranche: they each have wealth $e_{c_0}+e_Y p$, and the downpayment for the portfolio is $p-\pi_T$; their demand must equal the total supply of e_Y. Because every agent purchasing Y issues a down tranche, the supply of down tranches equals the supply of Y in equilibrium. Agents $i \leq i_2$ spend all their wealth on down tranches, which must equal the aggregate supply of down tranche e_Y. Equations (7) and (8) are the optimality conditions:

$$\frac{\gamma(i_1)d_U}{p-\pi_T} = 1, \tag{7}$$

$$\frac{(1-\gamma(i_2))d_D}{\pi_T} = 1. \tag{8}$$

Equation (7) states that the marginal buyer i_1 is indifferent between the return from tranching the asset (or the Arrow U) and the return from holding the consumption good. Equation (8) states that the marginal buyer i_2 is indifferent between the return from the down tranche and the return from holding the consumption good.[9]

3.3 Financial Integration

With financial integration (FI), Home and Foreign agents have access to the same set of financial instruments; however, there remain limitations on what financial contracts can be *backed* by Home and Foreign assets. For this reason, there are two possible interpretations for international trades. The first is to describe international flows is in the space of original commodities, Y and Y^* and consumptions goods c and c^*. In this first interpretation,

[9] Despite the fact that both Arrow securities can be created through tranching the asset, markets are not complete because Arrow securities are created through the asset Y only (collateral equilibrium fails to implement the Arrow-Debreu equilibrium).

countries trade in assets and use them as collateral to issue financial promises domestically. The second is to describe international flows in the space of derivatives created by collateralized contracts, Arrow U and U^*, and D tranches, and consumption goods c and c^*. This last interpretation emphasizes that the source of different collateral capacities across assets resides in domestic institutions: only financial institutions at Home can tranche the risky asset. This may be due to a more advanced court system, etc. In this second view, there is a financial intermediary, that makes zero profits in equilibrium, tranching the asset at Home (and leveraging the asset in the Foreign country). Although the distinction has no bite in our model, we will be explicit about this difference throughout our analysis.

In what follows, we first characterize the equilibrium, and then we study the effects of FI on prices, the trade balance, and gross financial flows.

In the FI equilibrium the marginal investors across countries are the same because the assets have identical payoffs and agents have the same endowments and preferences. As shown in Figure 2c in each country there are two *common* marginal investors with $\hat{i}_1 > \hat{i}_2$. Optimistic agents $i \geq \hat{i}_1$ in both countries tranche Y and leverage Y^*, effectively holding Arrow U and U^* securities.[10] Moderate investors $\hat{i}_2 < i < \hat{i}_1$ in both countries hold consumption goods c and c^* and riskless bonds $j^* = d_D$. Finally, pessimistic investors $i \leq \hat{i}_2$ in both countries buy the down tranche from the most optimistic agents (hence holding an Arrow D). FI equilibrium is described by a system of five equations in five unknowns: Home and Foreign asset prices $\hat{p}$ and $\hat{p}^*$, the price of the down tranche $\hat{\pi}_T$ backed by the Home asset, and two marginal buyers $\hat{i}_1, \hat{i}_2$. Agents that buy Y or Y^* and issue contracts hold Arrow U and U^*securities. Equation (9) states that by no-arbitrage, the return from tranching Y and leveraging Y^* is the same in equilibrium:

$$\frac{d_U}{\hat{p} - \hat{\pi}_T} = \frac{d_U - d_D}{\hat{p}^* - d_D}. \tag{9}$$

[10] We keep the notation U and U^* for the 2 Arrow securities to underscore that these are created through tranching Y and leveraging Y^* respectively.

Equation (10) is the combined market clearing condition for Y and Y^*:

$$(1-\hat{i}_1)\frac{(2e_{c_0}+e_Y(\hat{p}+\hat{p}^*))}{\hat{p}-\hat{\pi}+\hat{p}^*-d_D}=e_Y. \tag{10}$$

Equation (10) states that agents buying risky assets spend a downpayment of $\hat{p}-\hat{\pi}_T$ on Y and $\hat{p}^*-d_D$ on Y^*, and thus the denominator reflects the total value required to purchase the supply of Y and Y^* together. Because every agent purchasing Y issues a down tranche, the supply of down tranches equals the supply of Y in equilibrium. Equation (11) corresponds to the market clearing condition for the down tranche, reflecting that agents $i \leq \hat{i}_2$ in both countries spend all their wealth on down tranches:

$$\hat{i}_2\frac{(2e_{c_0}+e_Y(\hat{p}+\hat{p}^*))}{\hat{\pi}_T}=e_Y. \tag{11}$$

Compared to their autarky counterparts (equations (3), (5) and (6)), the market clearing conditions in FI include wealth from *both* countries $(2e_{c_0}+e_Y(\hat{p}+\hat{p}^*))$.[11]

Finally, equations (12) and (13) are the optimality conditions for marginal buyers. (12) states that the marginal buyer $\hat{i}_1$ is indifferent between an Arrow U via tranching the Home asset (or an Arrow U^*via leveraging the Foreign asset) and a safe position (holding consumption goods and riskless bonds)

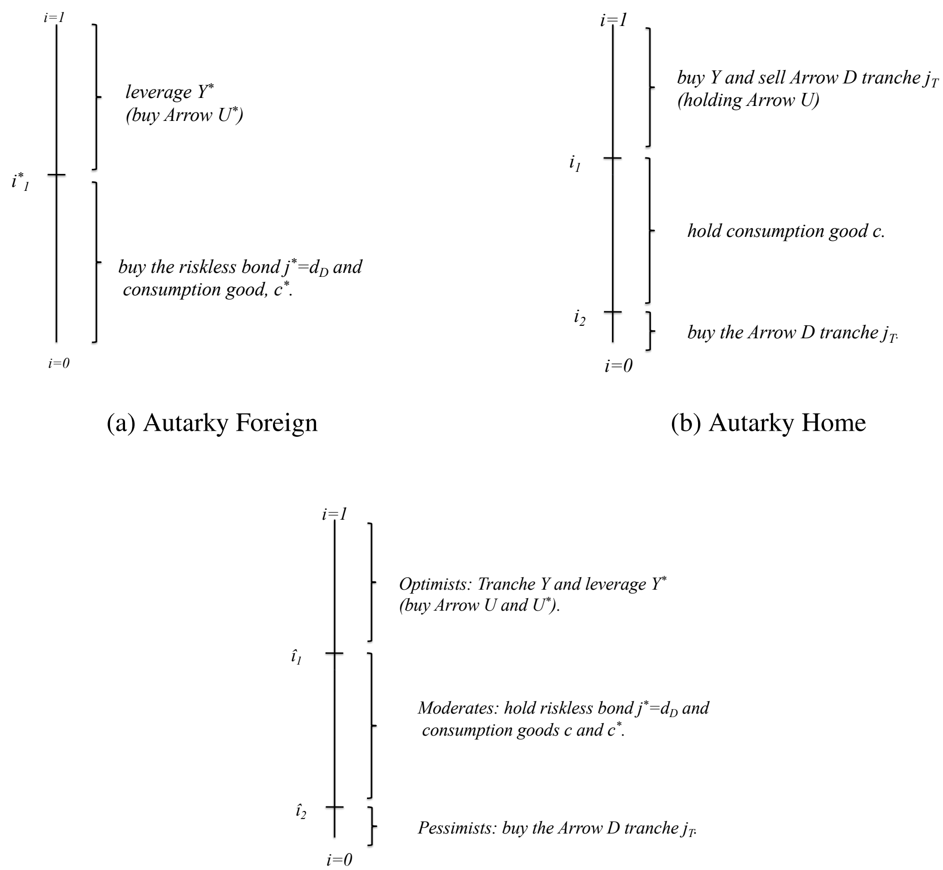
$$\frac{\gamma(\hat{i}_1)d_U}{\hat{p}-\hat{\pi}_T}=1. \tag{12}$$

Equation (13) states that the marginal buyer $\hat{i}_2$ is indifferent between the down tranche and

[11]For example, in the case of the down tranche market, investors will buy $\frac{1}{\hat{\pi}_T}$ units of the tranche for every unit of wealth. Home investors have wealth $1+\hat{p}$ and Foreign investors have wealth $1+\hat{p}^*$. Since all investors $i \leq \hat{i}_2$ in each country buy the down tranche, the total global demand for down tranches is given by

$$\int_0^{\hat{i}_2}\left(\frac{e_{c_0}+e_Y\hat{p}}{\hat{\pi}_T}\right)di+\int_0^{\hat{i}_2}\left(\frac{e_{c_{0^*}}+e_{Y^*}\hat{p}^*}{\hat{\pi}_T}\right)di=\hat{i}_2\left(\frac{2e_{c_0}+e_Y(\hat{p}+\hat{p}^*)}{\hat{\pi}_T}\right).$$

Notice that we are assuming that countries are identical in everything except the set J, and we are hence using the fact that endowments are the same in the above equation.



(a) Autarky Foreign

(b) Autarky Home

(c) FI Home and Foreign

Figure 2: Equilibrium regimes in the static *C*-model.

a safe position (holding consumption goods and riskless bonds):

$$\frac{(1-\gamma(\hat{i}_2))d_D}{\hat{\pi}_T} = 1. \tag{13}$$

3.3.1 Financial Integration and Asset Prices

Standard models of international finance predict that the prices of assets with identical payoffs should converge with financial integration. That is not the case in our setting with collateral. As in Fostel and Geanakoplos (2008), Home and Foreign asset prices include a payoff value as well as a non-negative *collateral value*. Trade occurs, despite the identical assets' payoffs in both economies because assets have different collateral capacities. The Home asset, which can be tranched into state-contingent promises, is better collateral than the Foreign asset, which can only be used to issue debt. Financial integration increases the difference in collateral values by even more, causing asset prices to diverge even further. This has important consequences in our model.

Define the collateral gap $\hat{\Delta} \equiv \hat{p} - \hat{p}^*$ as difference between the Home and Foreign asset prices in equilibrium. Since both assets have identical payoffs and hence identical payoffs values, this difference exactly represents the equilibrium gap in collateral values. The following proposition provides a useful characterization of $\hat{\Delta}$ and shows that it is always positive.[12]

Proposition 1. *Consider a C-model with two countries Home and Foreign. Then* $\hat{\Delta} = \hat{p} - \hat{p}^* = d_D(\gamma(\hat{i}_1) - \gamma(\hat{i}_2)) > 0$.

See Appendix A for the proof.

In FI, the Home asset price always exceeds the Foreign asset price, and hence the collateral gap is always positive. Whereas the collateral gap $\hat{\Delta}$ measures the price difference *within* an equilibrium, the autarky spread $p - p^*$ measures the price difference *across* equilibria. While the collateral gap is positive, the autarky spread may not be. The following proposition compares the collateral gap to the autarky spread, a result that will have interesting consequences when we look at dynamics in Section 4.

Proposition 2. *Consider a C-model with two countries Home and Foreign. Then, in the FI equilibrium* $\hat{p}^* < p^*$*,* $\hat{p} > p$*, and* $\hat{\Delta} > p - p^*$.

See Appendix A for the proof.

Financial integration increases the Home asset price, decreases the Foreign asset price relative to autarky, and therefore the collateral gap is bigger than the autarky spread. A way to intuitively understand this result is as follows. First, financial integration increases the

[12] Although the collateral value is investor specific, the gap in collateral values $\hat{\Delta}$ is not. It is easy to show that the agent-specific collateral value for Y exceeds the agent-specific collateral value for Y^* for any agent buying risky assets (see Fostel and Geanakoplos (2008)).

price of the Home asset Y because it is comparatively better collateral. With financial integration pessimistic Foreign investors demand down tranches—contingent promises that were previously unavailable. Hence their price increases, and the marginal buyer that prices the tranche, i_2, decreases in FI. Moreover, because buyers of Y can now issue a more expensive tranche, fewer optimists are required to buy up all of Y, and so the marginal buyer, i_1, increases in FI. Both of these effects cause the price of Y to increase (from equations (12) and (13) we have $\hat{p} = \gamma(\hat{i}_1)d_U + (1-\gamma(\hat{i}_2))d_D$). Second, financial integration decreases the price of Y^* because the attractiveness of alternative investments increases, namely the Home asset. With financial integration, investors in the Foreign asset compare investing in the asset to a tranched return in the Home asset, as shown by equation (9), rather than simply a safe position, as was the case in autarky.

3.3.2 Financial Integration, Net Flows and Trade Balance

Our model has precise predictions regarding the trade balance, TB. Home always runs a trade deficit, as the following proposition states.

Proposition 3. *Consider a C-model with two countries Home and Foreign. Then in the FI equilibrium, the Home trade balance TB is given by*

$$TB = -k\hat{\Delta} < 0.$$

where $k > 0$.

See Appendix A for the proof.

The trade deficit is proportional to the collateral gap. The basic intuition for this result is that Home is selling expensive assets (due to higher collateral values) and using the receipts from this sale to buy consumption goods from the rest of the world.[13]

We conjecture that this positive collateral gap would also provide a force leading to a current account deficit in a full intertemporal model with production. The definition of the

[13] Technically, risk-free bonds and goods are perfect substitutes in our economy, and thus the consumption of goods is indeterminate. We pin down consumption of goods using a Home-bias assumption we discuss in Section 3.3.3

current account is the trade balance plus net financial income, or savings minus investment, which by market clearing is identically zero in any static economy. In Appendix B we present a simple economy with production, intertemporal consumption, and investment to study the implications of our result in Proposition 3 for the current account. In that simple model, the current account (aggregate savings minus investment) is directly proportional to the collateral gap of the assets. The mechanisms determining net financial flows within the static model are precisely the mechanisms driving savings minus investment in the simple intertemporal model of Appendix B.

3.3.3 Financial Integration and Gross Flows

Our model also makes predictions regarding gross flows.

Determining the portfolio holdings and flows in the FI equilibrium requires some care because there are many securities that are perfect substitutes, most notably the Arrow U (created by tranching Y) and the Arrow U^* (created by leveraging Y^*). Hence, pinning down gross flows requires additional assumptions. We consider two alternative—and extreme—strategies to pin down gross flows and show that, in either case, our model of collateral-driven financial integration produces gross flows in assets.[14]

Home Bias We first suppose that agents satisfy demand with domestic assets or goods before trading abroad. In this case, we can characterize gross flows in equilibrium as the following proposition shows.

Proposition 4. *Consider a C-model with two countries Home and Foreign. Assume both, Home and Foreign exhibit Home-Bias. Then in the FI equilibrium Home experiences gross inflows.*

See Appendix A for the proof.

As explained in the proof of the proposition, in FI Home experiences gross inflows since it is selling risky assets Y to Foreign. Or in terms of the second interpretation dis-

[14] Determining the most appropriate way to pin down portfolio holdings is an important empirical question, beyond the scope of this paper. Our goal here is to bring home the theoretical point that collateral driven financial integration generates gross flows among otherwise identical economies.

cussed before, Home is selling Arrow U^* and D tranches to Foreign. Those gross inflows are used to buy goods c^* from Foreign.

Caps to Leverage in Foreign We now consider the realistic feature of frictions in Foreign that limit the ability to issue collateralized debt. We formalize this friction by supposing that the Foreign asset can be used to issue debt with maximum promise $j^{max} < d_D$. This could capture regulation or other informational frictions, such as moral hazard or agency issues, that limit pledgeability.

Caps to Leverage affect equilibrium flows, because leveraging the Foreign asset no longer produces an Arrow U payoff. Since j^{max} is strictly less than d_D, agents that buy Y^* with leverage will consume $d_D - j^{max} > 0$ in state D, and so their consumption profile will differ from an Arrow U. As the following proposition shows, we determine gross flows since the model with Foreign leverage limits converges to the model without the friction as $j^{max} \to d_D$, thus supporting our portfolio allocations.

Proposition 5. *Consider a C-model with two countries Home and Foreign. Assume a cap to Leverage in Foreign. Then in the FI equilibrium Home experiences gross inflows and gross outflows.*

See Appendix A for the proof.

As explained in the proof of the proposition, in FI Home experiences gross inflows and gross outflows since it is selling risky assets Y to Foreign and buying risky assets Y^* from Foreign. Or in terms of the second interpretation discussed before, Home is selling Arrow U and D tranches to Foreign, and at the same time buying Arrows U^* from Foreign. The net flows (the difference between gross inflows and outflows) are equal to the trade balance, corresponding to purchases of goods c^* from Foreign.

Finally, note that while the down tranche is a state-contingent security (and therefore very risky), the creation of down tranches could also be interpreted as the creation of "safe assets," which as it turns out tend to increase in value in bad states of the world (i.e., negative-beta assets are truly safe assets).[15]

[15] First, long-maturity bonds increase in price in bad states because long-term interest rates decline (even

4 A Dynamic Model of Global Flows

The static model in Section 3 illustrates how financial integration affects prices, the trade balance, and creates cross-border gross flows. In this section we numerically solve a three-period variation of the C-model introduced in Section 2, with bad news arriving at an interim date, to consider the effect of financial integration on volatility and cyclicality of flows and prices.

Consistent with *Observation 2* in the Introduction, our dynamic analysis shows that collateral-driven financial integration amplifies price volatility of both Home and Foreign assets, thus increasing global volatility, and that capital flows are procyclical.

4.1 Dynamic C-Model

We consider a model introduced by Geanakoplos (2003), characterized by increases in volatility after interim bad news.[16]

There are three periods $t = 0, 1, 2$. Uncertainty is represented by a tree $S = \{0, U, D, UU, DU, DD\}$, illustrated in Figure 3, with a root $s = 0$ at time 0 and terminal states $S_T = \{UU, DU, DD\}$ at time 2. Denote by s^* the unique predecessor of state s. Let $L_s = \{c_s, Y_s\}$ be the set of commodities in each non-terminal state $s \in \{0, U, D\}$, and $L_s = \{c_s\}$ the set of commodities in terminal states $s \in S_T$. Let the inter-period durability functions be as $F_s(c_0, Y) = (c_0, Y)$, $s = U, D$, (i.e., the consumption good and the asset Y are durable) and $F_s(c_{s^*}, Y_{s^*}) = c_{s^*} + d_s Y_{s^*}$ $s \in S_T$. The consumption good is perfectly durable and assets pay dividends in units of the consumption good only in the terminal states. For exposition we set $d_{UU} = d_{DU} = 1$ and numerically evaluate with $d_{DD} \in (0, 1)$ to demonstrate the robustness of our results.

as the face value of the promised payoffs remain the same). Second, because the U.S. Dollar tends to appreciate during crises, dollar-denominated bonds provide a natural hedge for foreign buyers. This is a point made in Maggiori (2017), which, in a different financial context, describes the rest of the world buying "down state" Arrow securities from Home in order to achieve safer portfolios.

[16] Fostel and Geanakoplos (2012*b*) show that this type of uncertainty, where volatility increases after bad news, arises endogenously in models in which agents can choose which type of uncertain technologies to invest in with leverage.

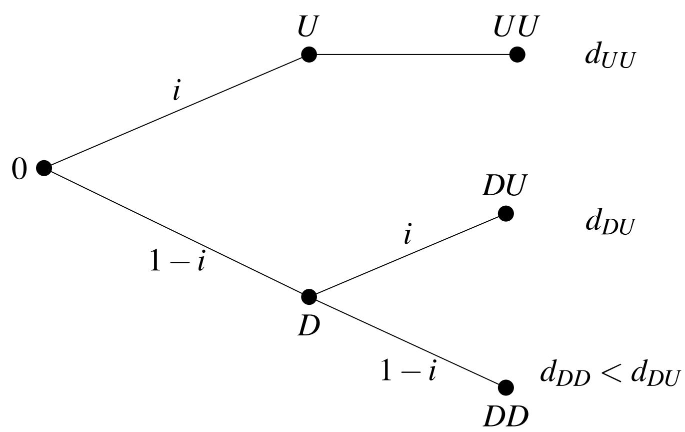


Figure 3: Asset payoffs in dynamic C-model.

Consider the same type of agents as in Section 2, with expected utility

$$U^i = ic_{UU} + i(1-i)c_{DU} + (1-i)^2 c_{DD}, \tag{14}$$

which corresponds to agent i having belief i of receiving good news at $t = 1$, and having belief i that, conditional on receiving bad news, assets will pay high dividends at $t = 2$ (thus, with probability $(1-i)^2$ the economy receives bad news twice and the asset pays the low dividend d_{DD}). Agents have endowments of the consumption good and the asset at all non-terminal nodes. In particular, we set $(e_{c_s}, e_{Y_s}) = (1,1)$ for $s = 0, U, D$. All assets, whether endowed at $t = 0$ or $t = 1$, pay identical dividends in $t = 2$ (i.e., the endowments of assets at time 1 are of a separate *vintage* of assets).

At $t = 0$ and $t = 1$, agents can trade one-period financial contracts collateralized by Y. For each $j \in J$, the contract is defined by a promise in the following period, collateralized by one unit of the risky asset denoted by the pair $(A_j, C_j) \in R_+^{L/L_0} \times R_+^{L/L_T}$. For each state $s \in S/\{0\}$, $A_{sj} \in R_+^{L_s}$ specifies the promises that are due, backed by the collateral $C_{s^*j} \in R_+^{L_{s^*}}$ deposited in state s^*.

As before, we normalize the price of c_s in state $s \in S$ to be one. The price of the asset Y at non-terminal nodes 0, U and D is denoted by p_0, p_U and p_D respectively. Budget sets and collateral equilibrium are analogous to the static model and are presented in detail in

Appendix C.

4.2 Two Country Dynamic C-Model

As we did in Section 3, in what follows we consider the 3-period C-model with two countries, Home and Foreign. Both countries are identical in every way except for the feasible financial contracts J available in each country. As before, we use * to denote Foreign variables and $\hat{}$ to denote variables after financial integration. We first characterize the autarky equilibrium in Foreign and Home to demonstrate how leverage and tranching affect dynamics, and then we consider the equilibrium with financial integration.

The dynamic equilibrium is essentially different from the static equilibrium due to wealth transfers that occurs to repay debts following bad news and changes in collateral values; however, the equilibrium regimes in each state resemble the equilibrium regime in the static economy of Section 3. For expositional ease, all equations for this section are provided in Appendix C.

Finally, the static propositions apply to the description of the economy at $s = 0$. However, these static results do not help us to understand how prices and flows respond to news. We solve the model numerically for $d_{DD} \in (0,1)$ and present results graphically. We show that the behavior of prices and flows characterized in Propositions 1, 2, 4 and 5 holds across parameters for all values of the down payoff d_{DD}. Our dynamic analysis underscores, however, that the value of d_{DD} matters for how the trade balance (Proposition 3) behave in equilibrium, in particular in Proposition 6 below we show that the behavior of the Home trade balance can reverse and become a surplus for severe financial crises.

4.2.1 Foreign Autarky: Leverage Cycle

At each non-terminal node, agents can trade one-period debt contracts promising (j, j) in the following period, backed by one unit of Y^*. Since at U all uncertainty is resolved, $p^* = 1$ and there is no trade; hence we only need to focus on $s = 0, D$. As before, in equilibrium the only contract traded each period is the maxmin contract: $j_0^* = p_D^*$ at $s = 0$ and $j_D^* = d_{DD}$ at $s = D$. These contracts have prices $\pi_0^* = p_D^*$ and $\pi_D^* = d_{DD}$ respectively.

At $s = 0$ there is a marginal buyer i_0^* such that all investors with $i > i_0^*$ buy Y^* with leverage and investors $i < i_0^*$ hold the consumption good and the safe bond $j_0^* = p_D^*$ In state D all investors that bought the asset with leverage lose their initial investments (the debt they owe is the value of their entire asset holdings) and their only wealth comes from the new endowments. Hence, the asset must be bought by more pessimistic investors: in state D there is a marginal buyer $i_D^* < i_0^*$, such that all remaining investors with $i > i_D^*$ leverage Y^*. Pessimistic investors $i < i_D^*$ hold the consumption good and the safe bond $j_D^* = d_{DD}$.

The economy exhibits what Geanakoplos (2003) called the Leverage Cycle: leverage is pro-cyclical and creates excess volatility above fundamentals. Figure 4a shows how the asset prices falls after bad news. In fact, the asset price falls for three reasons. First, fundamentals are worse (a bad payoff is more likely). Second, after bad news there is a wealth distribution away from optimistic buyers; the new marginal buyer in state D is someone more pessimistic with a lower asset valuation. Third, the increased down-risk at D reduces the amount investors can leverage (i.e., required margins increase).

4.2.2 Home Autarky: Securitization Cycle

As before, we assume that each non-terminal node agents can trade a one-period down tranche: at $s = 0$ agents can trade a down tranche promising $(0, p_D)$ at $t = 1$, and at $s = D$ agents can trade a down tranche promising $(0, d_{DD})$ at $t = 2$, backed by one unit of Y.

In equilibrium, there are two marginal buyers in each state. In $s = 0$, investors $i > i_0^1$ buy the risky asset and issue a down tranche promising p_D at $t = 1$, investors with $i \in [i_0^2, i_0^1]$ hold all the consumption good, and investors with $i < i_0^2$ buy the down tranche at the price π_0^T. After bad news, in $s = D$, investors $i > i_0^1$ lose all their initial wealth after repaying the down tranche promise. Hence, there is a new marginal buyer $i_D^1 < i_0^1$ such that all investors $i > i_D^1$ buy the supply of asset $Y$and issue a new down tranche promising d_{DD}. Moderate investors $i \in [i_D^2, i_D^1]$ buy the consumption good and pessimistic investors $i, < i_D^2$ buy the new down tranches at price π_D^T.

The price crash is much larger than in the leverage economy (see Figure 4a). The model with Home tranching exhibits what Fostel and Geanakoplos (2012*a*) called a Securitization Cycle. Because tranching greatly increases the collateral value of the asset, which decreases following bad news, tranching creates excess volatility even compared to a Leverage Cycle.

4.2.3 Financial Integration in the Dynamic Model

With financial integration, Home and Foreign agents have access to the same set of financial instruments in every non-terminal state. In period 0 there are two marginal buyers, $\hat{i}_0^1$ and $\hat{i}_0^2$, in both countries. The most optimistic investors, with $i \geq \hat{i}_0^1$, buy assets and use them as collateral to finance their purchases: they buy the Home asset Y, selling the down tranche at price $\hat{\pi}_0^T$ due at $t = 1$ (which pays $\hat{p}_D$ in $s = D$); and buy Y^* selling debt due at $t = 1$ (promising $\hat{p}_D^*$). Optimistic agents are effectively buying the Arrow U and U^* securities. Moderate agents with $i \in [\hat{i}_0^2, \hat{i}_0^1]$ hold the consumption goods and risk-free debt backed by Y^*. The most pessimistic agents, with $i < \hat{i}_0^2$, buy down tranches.

As before, important wealth distributions take place after bad news: the optimists holding risky assets have limited wealth after debt repayment/margin calls, and the pessimists holding down tranches have increased wealth. In D there are two marginal buyers, $\hat{i}_D^1$ and $\hat{i}_D^2$, in both countries. The original investors in assets use their new endowments to purchase assets, but they have no other wealth to use after selling their initial asset holdings in order to repay their financial obligations due at $t = 1$. The assets sold are purchased by new, but less optimistic, buyers with $i > \hat{i}_D^1$, with$\hat{i}_D^1 < \hat{i}_0^1$. Moderate investors $i \in [\hat{i}_D^2, \hat{i}_D^1]$ hold the consumption good and the most pessimistic investors, with $i < \hat{i}_D^2$, buy down tranches.

Financial Integration and Asset Prices

As we saw in Section 3, financial integration has important implications for asset prices.

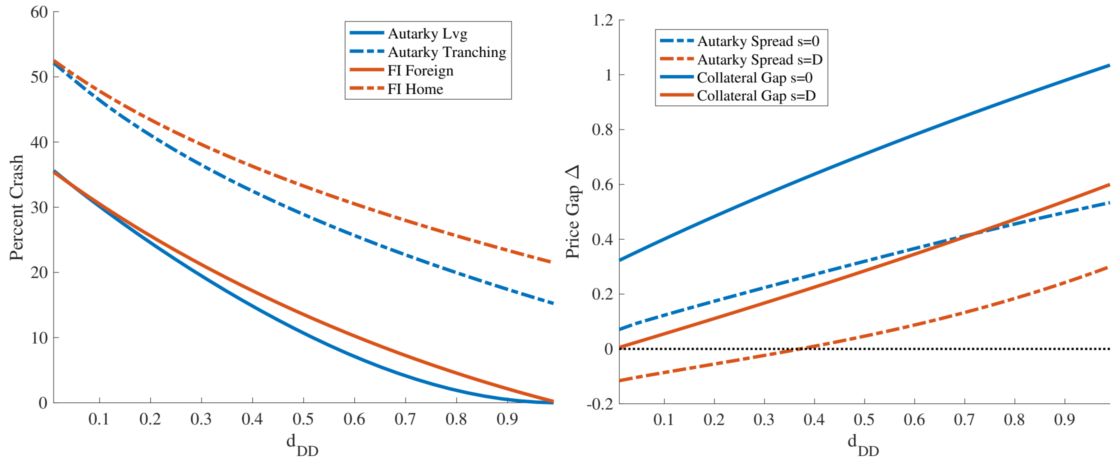
Our main dynamic result regarding asset prices is that the collateral-driven trades both export and amplify Home volatility. As shown in Figure 4a, price crashes following bad news are generally higher for each country with FI than in autarky.[17] The Securitization Cycle mechanisms amplifying volatility in the Home autarkic equilibrium affect both Home and Foreign asset prices with financial integration. First, financial integration amplifies volatility at Home because financial integration has increased the value of tranching, which increases the collateral value of the Home asset at $s = 0$.[18] Second, because the Foreign asset is priced relative to the Home asset price, the excess volatility of the Home asset transfers to the Foreign asset. Thus, even though in the static model the Foreign asset price decreases with financial integration, which might suggest that the economy is more stable, the Foreign price following bad news is even lower with financial integration compared to autarky because of the additional amplifying mechanisms absorbed through financial integration.

Another important property is that there is a positive collateral gap in both states (Proposition 1 applies), and the collateral gap is procyclical. As shown in Figure 4b, the collateral gap decreases following bad news. Note also that as shown in Figure 4b, the collateral gap with financial integration in both states is higher than autarky spread (the dynamic equivalent of Proposition 2), and it is not necessarily the case that the autarkic values of the across-equilibria collateral gaps are positive. This last fact helps explain why the Foreign price gets depressed in FI: whereas a negative spread can emerge in autarky, a positive collateral gap in FI must push down the Foreign asset price relative to the Home asset price.

To further understand the price dynamics, we study how the collateral values for Y and Y^* change following bad news, in autarky and with FI (see Figure 5). Since the collateral value is an agent-specific measure, we calculate the collateral value for a single marginal investor i_0^*, the marginal buyer in Foreign Autarky, and we keep this marginal buyer constant across states and economies. Figures 5a and 5b plot the change in the

[17]For d_{DD} sufficiently small, the crash for Foreign in FI is slightly lower than it is in autarky. However, the sum of the crashes for Home and Foreign is greater.

[18]Gong and Phelan (2019) derive a similar result in a closed-economy setting by studying how equilibrium changes when debt contracts can be used as collateral to make financial promises ("debt collateralization"). They show that debt collateralization increases the collateral value of the risky asset and increases the volatility of asset prices.



(a) Price Crashes from 0 to D.

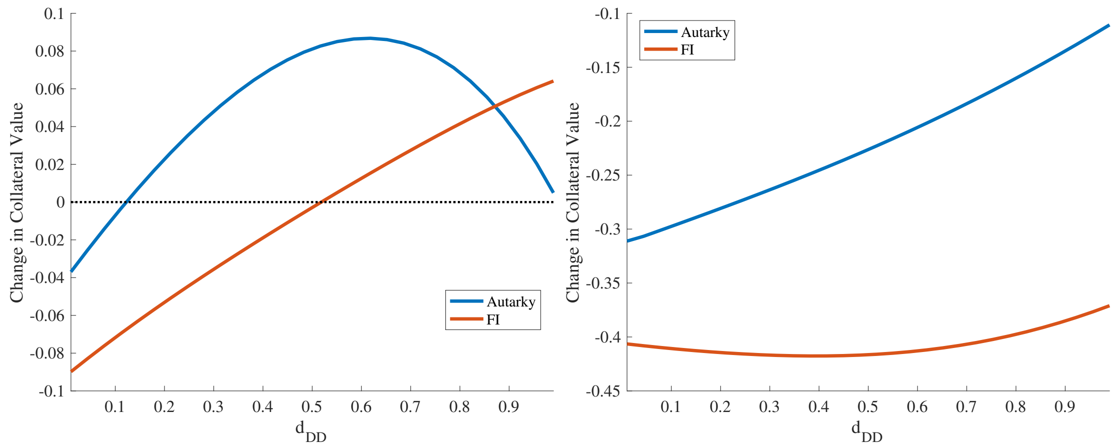
(b) Collateral Gaps and Autarky Spreads.

Figure 4: Prices in dynamic model. Panel 4a plots price crashes in D in autarky and financial integration; blue lines plot crashes in autarky and orange lines plot crashes in FI; solid lines correspond to Foreign variables and dashed lines correspond to Home variables. Panel 4b plots collateral gaps across states with financial integration and the autarky spreads; blue lines correspond to price gaps at $s = 0$ and orange lines correspond to price gaps at $s = D$; solid lines plot the collateral gap in FI and the dashed lines plot the autarkic spreads..

collateral value (state D minus state 0, hence a negative value means that the collateral value falls after bad news) of the Foreign asset Y^* and Yin autarky and in FI as a function of the down payoff.

The collateral value for the Home asset Y always falls after bad news, and it falls by even more with FI. The decrease in the collateral value reflects the decreased collateral capacity of Y in $s = D$: the down tranche that can be issued by the asset Y is of much lesser value in $s = D$. Financial integration amplifies this mechanism, given the foreign demand for down tranches. This means that FI inflates the initial collateral value of Y by much more than it increases the collateral value at $s = D$. This amplified fluctuation in the collateral value helps explain the larger price crash with FI in Figure 4a.

The behavior of the collateral value for the Foreign asset Y^* is more subtle. For sufficiently low d_{DD}, the collateral value falls for precisely the reasons discussed above as the collateral capacity declines. However, when d_{DD} is not so small, the collateral value can actually increase following bad news. In the both the leverage and the tranche economy,



(a) Collateral Value for Y^* (b) Collateral Value for Y.

Figure 5: Changes in collateral values in dynamic model. Panel 5a plots the change in the collateral value for Y^* in autarky and financial integration. Panel 5b plots the change in the collateral value for Y in autarky and financial integration. Autarkic values plotted in blue; FI values plotted in orange.. Collateral values are calculated in both figures taking into account the marginal buyer i_0^* in Foreign Autarky.

the desire to issue financial contracts increases after bad news when borrowers are more liquidity constrained, but it is only in the leverage economy that this mechanism can be sufficiently strong to offset the lower collateral capacity. For this reason, in the leverage economy (Foreign autarky), the change in the collateral value is hump-shaped and can be positive. For most values of d_{DD}, the decreased collateral capacity of Y^* drives the change in the collateral value with FI, reflecting the fact that Y^* is priced relative to an alternative (the Home asset) that has better collateral value. Whereas Y^* was the only way to create an Arrow U security in autarky, in FI Y performs not only that service but it can also create an Arrow D. As a result, the collateral value of Y^* can drop by even more than in autarky, contributing to larger price crashes. For very high values of d_{DD}, the collateral value can increase by more in FI than in autarky, reflecting the fact that the down tranche has relative less appeal and hence the relative collateral superiority of Y over Y^* is lower.

Financial Integration, Net flows and the Trade Balance

Proposition 3 in the static model predicts that Home runs a trade deficit that is proportional to the collateral gap, which we have just noted is procyclical. Our dynamic analysis reveals that the behavior of the trade balance in the dynamic model is even more interesting than simply reflecting the behavior of the collateral gap. Indeed, the trade deficit is procyclical in our model, with the deficit decreasing following bad news; as illustrated in Figure 6, the deficit in state D is always below the deficit in $s = 0$. Figure 6 shows, however, that when d_{DD} is sufficiently low—as would occur in a global crisis—the deficit can completely reverse and turn into a surplus (a negative number on the figure). This dynamic result reflects important wealth transfers that occur as a result of the initial asset sales and is proved in the next proposition.

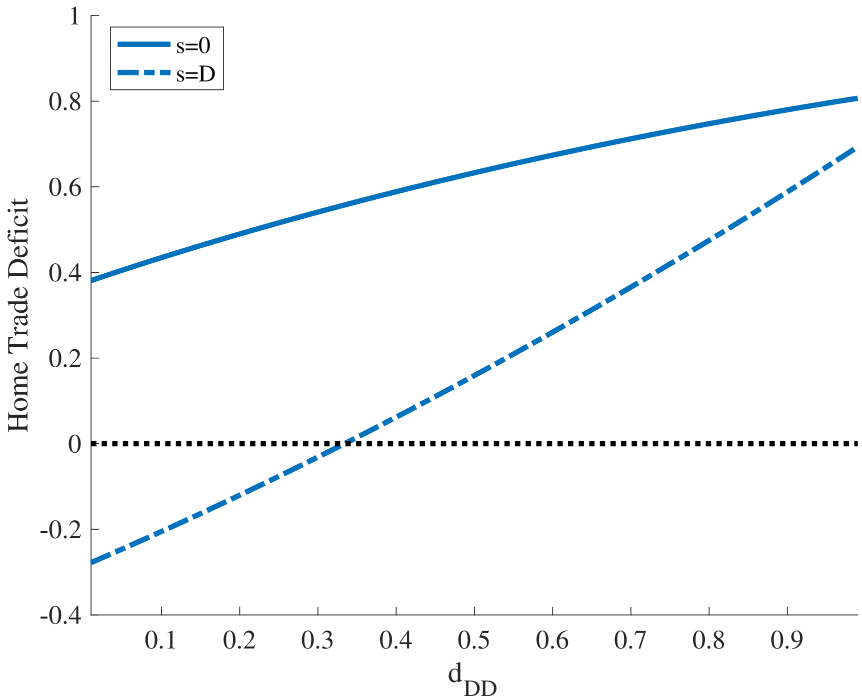


Figure 6: Home trade deficits in dynamic model. Solid line plots deficit at $s = 0$, and the dashed line plots the deficit at $s = D$; a negative value for the dashed line for low d_{DD} corresponds to a TB surplus.

Proposition 6. *Consider the dynamic C-model. There exists $\bar{d}_{DD}$ such that for all $d_{DD} > \bar{d}_{DD}$ Home runs a trade deficit and for $d_{DD} < \bar{d}_{DD}$ net flows reverse and Home runs a trade surplus.*

See Appendix A for the proof.

We could consider a relatively high d_{DD} to be a standard global downturn, and a sufficiently low d_{DD} to constitute a global crisis. The reversal of the trade balance in a global crisis reflects important wealth transfers that occur following bad news. The easiest way to understand the intuition for Proposition 6 is by considering our second interpretation for flows in the space of U and D tranches issued by a local intermediary at Home.

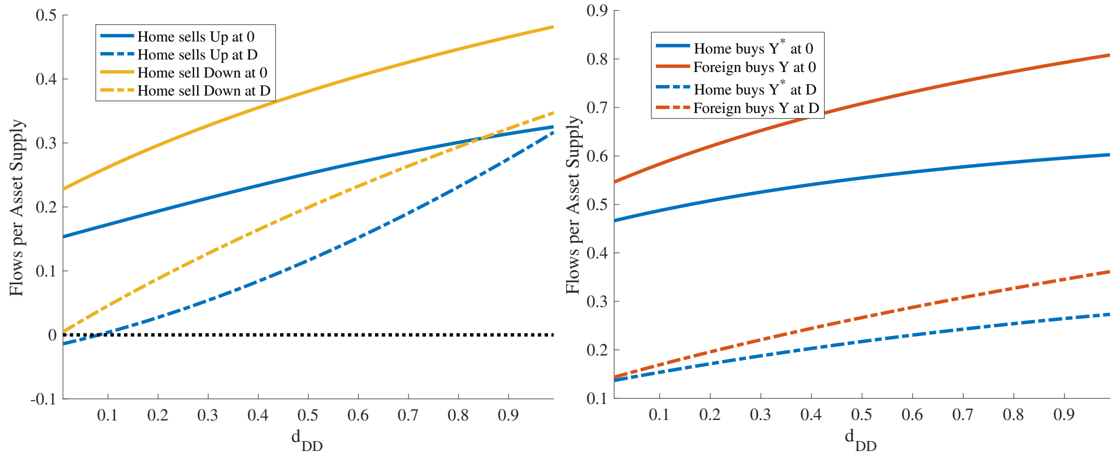
To start, there is an important wealth transfer that occurs in a downturn. Foreign investors have bought a down tranche that gets paid in state D. Hence, as a result of trades at $s = 0$, there is a transfer from Home to Foreign that must be financed. Home finances this wealth transfer in part by selling financial assets. First, Home sells down tranches in D: the previous vintage of tranches matured, so any investment in down tranches comes from flows. When the final payoff is low, then the tranche price at D is low. In this case, Home investors raise less from tranche sales at D than the required transfer to Foreign. As a result, to finance the wealth transfer, Home also needs to sell goods, and so the trade balance must be in surplus to finance the payment. Of course, when tranche prices are high (which occurs when the final payoff is sufficiently high), then Home can finance the wealth transfer by selling new tranches, without a need to sell goods as well.

As noted by Maggiori (2017), wealth transfers from deep financial countries to the rest of the world in times of global crisis constitute an important empirical stylized fact. Our model highlights how these transfers would put pressure on the trade balance, even absent any intertemporal savings and investment decisions.

4.2.4 Financial Integration and Procylical Gross Flows

Gross capital flows are also procyclical. In what follows, for the sake of concreteness, we use the second way of pinning gross flows used above: Cap on Leverage in Foreign. Figure 7 plots gross flows across states, using both interpretations, the space of derivatives and the space of original assets that can be used as collateral. Since the supply of assets at $s = D$ has doubled, we present flows as a fraction of outstanding supply.

In all cases, flows are procyclical, declining following bad news. As Figure 7a illustrates, flows in the space of derivatives, the net sale of U and D tranches by Home in D is always below the value in $s = 0$ and can even be negative, reflecting purchases (i.e.,



(a) Gross flows in U and D tranches.

(b) Gross flows in risky assets Y^* and Y.

Figure 7: Flows in dynamic model. Panel 7a plots gross flows across states in terms of Up and Down tranches per unit of asset supply. Panel 7b plots gross flows across states in terms of the risky assets Y and Y^*, pinned down using leverage cap in Foreign, per unit of asset supply.

Proposition 4 applies at $s = 0$ but the transfers to Foreign can undo those results at $s = D$). Figure 7b shows gross flows in Y and Y^* at $s = 0$ and following bad news at $s = D$. As in Proposition 5, equilibrium features gross inflows and outflows in both states. Furthermore, these flows are procyclical: the value of Foreign purchases of Home assets and the value of Home purchases of Foreign assets decrease following bad news.[19] Finally, whereas our analysis has been positive and not normative, for the sake of completeness we provide very simple welfare calculations to study the implications of financial integration in Appendix C.5

5 Conclusion

We presented a two-country general equilibrium model with collateralized lending and tranching in which global capital flows are driven by different abilities to use assets as collateral across countries. All countries have access to the same financial instruments after financial integration, yet price-convergence does not occur due to gap in collateral

[19]This is not a mechanical result driven by greater supply: the absolute sizes of asset flows not adjusted for supply are still procyclical.

values. Instead, financial integration increases the collateral gap. Financial integration provides Foreign access to attractive Home financial assets, and cross-border flows arise in both directions as a result of general equilibrium changes in the prices of currently available assets. These flows arise as a way for countries to share scarce collateral and to trade contingent claims. Differences in the ability to use collateral are enough to generate global financial flows. Moreover, Home always run an initial trade deficit, proportional to the positive collateral gap. However, sufficiently bad fundamentals (a crisis) can flip the Home trade balance to surplus, which is required to finance wealth transfers from Home to Foreign.

Our results imply that collateral-driven flows increase asset price volatility globally and create procyclical flows. Financial integration leads to portfolio rebalancing and cross-country asset purchases, especially among investors with the highest demand for leverage. The resulting procyclical flows have important consequences for financial stability, exporting volatility abroad and amplifying volatility globally. Thus, our results can explain flows among similarly-developed countries that increase volatility rather than dampen shocks. Furthermore, our model captures the empirically realistic feature that in times of global crisis, Home transfers wealth to Foreign. Our model shows that this can place significant pressure on trade deficits, even reversing to surpluses, even in a model without an intertemporal savings-investment decision.

A relevant question is whether our results would continue to hold when news about the Home and Foreign assets are only partially correlated. In this case, there would be diversification motives for trade. We conjecture that indeed, diversification mechanisms can reinforce collateral-based mechanisms rather than undoing them. The reason for this is that with partially correlated states of nature, there would be multiple interim states (not just two) and thus agents would issue risky debt contracts that would default in the worst state (bad news about bad assets). The issuance of default-free and defaultable debt would serve to reinforce and amplify volatility rather than to dampen it. Solving such a model is beyond the scope of this paper.

The empirical literature on margins, haircuts, and collateral use is developing, but to date there is scant data characterizing cross-country differences in margins or the ability to tranche assets. Our model provides precise, and at times subtle, testable predictions regarding how cross-country differences in the ability to tranche collateral drive net and gross capital flows and affect asset prices and volatility. The testable predictions informed by Propositions 1 to 6 can guide future empirical work as data becomes more available.

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Appendices for Online Publication

A Proofs of Propositions

A.1 Proofs

A.1.1 Proof of Proposition 1

Proof of Proposition 1. From equations (9), (12), and (13), we can write asset prices as

$$\begin{aligned}\hat{p} &= \gamma(\hat{i}_1)d_U + \hat{\pi}_T = \gamma(\hat{i}_1)d_U + \left(1-\gamma(\hat{i}_2)\right)d_D,\\ \hat{p}^* &= \gamma(\hat{i}_1)(d_U - d_D) + d_D.\end{aligned}$$

Hence we have $\Delta = d_D(\gamma(\hat{i}_1) - \gamma(\hat{i}_2))$, which is positive since $\hat{i}_1 > \hat{i}_2$ and beliefs are monotonic. $\square$

A.1.2 Proof of Proposition 2

Proof of Proposition 2. Since the prices of Y and Y^* are determined by the marginal buyer $\hat{i}_1$, it suffices to show that $i_1 < \hat{i}_1 < i_1^*$ (we already know that the tranche investor is lower with financial integration, i.e., $i_2 > \hat{i}_2$).

With financial integration, since we have common marginal investors across countries, the economy is isomorphic to a single economy with an asset Z, delivering 1 or d_D, that can be tranched into a down payoff promising $d_D - zd_D$ and into a debt contract promising zd_D, with $z = 0.5$. This economy has marginal buyers $i_1^z = \hat{i}_1$ and $i_2^z = \hat{i}_2$. Furthermore, the asset price $p_z = \frac{\hat{p}+\hat{p}^*}{2}$. To prove the proposition, it suffices to show that $i_1^* > i_1^z > i_1$.

We first show that $i_1^* > i_1^z$. Note that we can write the equilibrium prices as

$$p^* = d_D + \gamma(i_1^*)(1-d_D)$$

and

$$\begin{aligned} p_z &= \gamma(i_1^z)(1-zd_D)+zd_D+(1-\gamma(i_2^z))(d_D-zd_D) \\ &> d_D+\gamma(i_1^z)(1-d_D). \end{aligned}$$

First, suppose that $p^* > p_z$. Thus, if $p^* > p_z$ then $\gamma(i_1^*) > \gamma(i_1^z)$ and so $i_1^* > i_1^z$ and we are done. Second, suppose instead that $p^* < p_z$. Then market clearing yields

$$i_1^* = \frac{1+d_D}{1+p^*}, \quad \text{and} \quad i_1^z = \frac{1+zd_D+\pi_z}{1+p_z}$$

Note however that $\pi_z < d_D - zd_D$ and hence we have

$$i_1^z < \frac{1+d_D}{1+p_z} < \frac{1+d_D}{1+p^*} = i_1^*$$

where the final inequality uses the assumption that $p^* < p_z$. And thus we are done.

Now we show that $\hat{i}^1 > i^1$. Note that we can write the asset prices as

$$\begin{aligned} p &= \gamma(i_1)+\pi = \gamma(i_1)+(1-\gamma(i_T))\,d_D \\ &= \gamma(i_1)+d_D-\gamma(i_T)d_D, \\ p_z &= \gamma(i_1^z)(1-zd_D)+\pi_z+zd_D = \gamma(i_1^z)(1-zd_D)+\left(1-\gamma(i_2^z)\right)(d_D-zd_D)+zd_D \\ &= \gamma(i_1^z)+d_D-\gamma(i_2^z)d_D-zd_D\left(\gamma(i_1^z)-\gamma(i_2^z)\right). \end{aligned}$$

First, suppose that $p < p_z$. Assume also that $i_1 > i_1^z$ (the opposite of what we want to prove). From market clearing for the risky assets and the pricing equations, we have

$$\begin{aligned} (1-i_1)(1+p) &= p-\pi = \gamma(i_1) \\ (1-i_1^z)(1+p_z) &= p_z-\pi_z-zd_D = \gamma(i_1^z)(1-zd_D). \end{aligned}$$

But if $p < p_z$ and $1-i_1 < 1-i_1^z$, then $\gamma(i_1) < \gamma(i_1^z)(1-zd_D) < \gamma(i_1^z)$ and so $i_1 < i_1^z$.

Now suppose that $p > p_z$. If $\pi_z + zd_D < \pi$, then $i^T < i_2^z$ from the tranche pricing equation. From market clearing for the tranche we have

$$i_2 = \frac{\pi}{1+p} > \frac{\pi_z}{1+p} > \frac{\pi_z}{1+p_z} = i_2^z$$

a contradiction, so this condition can't occur. If instead $\pi_z + zd_D > \pi$, then from market clearing for the risky assets we have

$$i_1 = \frac{1+\pi}{1+p} < \frac{1+\pi_z+zd_D}{1+p} < \frac{1+\pi_z+zd_D}{1+p_z} = i_1^z,$$

and so we have $i_1 < i_1^z$. Unlike the "across-equilibria results" in Fostel and Geanakoplos (2012*a*), the within equilibrium property does not need concavity of beliefs. $\square$

A.1.3 Proof of Proposition 3

Proof of Proposition 3. That Home sells Down tranches is immediate. To show that Home runs a trade balance deficit, we must show $(\hat{i}_Y - \hat{i}_T)(1+\hat{p}) > 1$, i.e., Home consumption of goods exceeds the endowment. First, market clearing for assets can be written as

$$(1-\hat{i}_Y)(2+\hat{p}+\hat{p}^*) = p+\hat{p}^* - \hat{\pi} - d_D \implies \hat{i}_Y(2+\hat{p}+\hat{p}^*) = 2+\hat{\pi}+d_D.$$

Agents with $i < \hat{i}_Y$ hold goods, debt, and tranches, and their total demand equals the total supply of goods, debt, and tranches, which is $2+\hat{\pi}+d_D$. Market clearing for tranches is

$$\hat{i}_T(2+\hat{p}+\hat{p}^*) = \hat{\pi}.$$

Subtracting these equations, we have

$$(\hat{i}_Y - \hat{i}_T)(2+\hat{p}+\hat{p}^*) = 2+d_D.$$

Now, suppose that Home consumption of goods is less than 1. From the previous equation we have

$$(\hat{i}_Y - \hat{i}_T)(1+\hat{p}) + (\hat{i}_Y - \hat{i}_T)(1+\hat{p}^*) = 1+1-d_D,$$

and therefore if $(\hat{i}_Y - \hat{i}_T)(1+\hat{p}) < 1$ then $(\hat{i}_Y - \hat{i}_T)(1+\hat{p}^*) > 1+d_D$. Recall that $\hat{p} > \hat{p}^*$ in equilibrium. Thus

$$(\hat{i}_Y - \hat{i}_T)(1+\hat{p}) > (\hat{i}_Y - \hat{i}_T)(1+\hat{p}^*)$$

and by our hypothesis this would imply

$$(\hat{i}_Y - \hat{i}_T)(1+\hat{p}) > (\hat{i}_Y - \hat{i}_T)(1+\hat{p}^*) > 1+d_D > 1.$$

Thus, it must be that $(\hat{i}_Y - \hat{i}_T)(1+\hat{p}) > 1$.

To show that Home net sells risky Up tranches to Foreign, we must show that $(1-\hat{i}_Y)(1+\hat{p}) < \hat{p} - \hat{\pi}$ i.e., Home investment in risky assets (with leverage) is less than the value of the Home downpayment. Thus, Home net sells the risky asset (Up tranches) to Foreign (Home therefore net sells Up and Down tranches). We can equivalently write $(1-\hat{i}_Y)(1+\hat{p}) < \hat{p} - \hat{\pi}$ as

$$\hat{i}_Y(1+\hat{p}) > 1+\hat{\pi}.$$

In other words the Home agents with $i < \hat{i}_Y$ hold investments that exceed the domestic supply of $1+\hat{\pi}$. (Note already that we know that Home sells some of the Tranche abroad.) Again we have

$$\hat{i}_Y(2+\hat{p}+\hat{p}^*) = 2+\hat{\pi}+d_D,$$

which can be written

$$\hat{i}_Y(1+\hat{p}) + \hat{i}_Y(1+\hat{p}^*) = 1+\hat{\pi}+1+d_D.$$

Now, suppose that Home investment in Up tranches is worth less than the Home downpayment. Therefore if $\hat{i}_Y(1+\hat{p}) < 1+\hat{\pi}$ then $\hat{i}_Y(1+\hat{p}^*) > 1+d_D$. Again, $\hat{p} > \hat{p}^*$ in equilibrium. Thus

$$\hat{i}_Y(1+\hat{p}) > \hat{i}_Y(1+\hat{p}^*)$$

and by our hypothesis this would imply

$$\hat{i}_Y(1+\hat{p}) > \hat{i}_Y(1+\hat{p}^*) > 1+d_D > 1+\hat{\pi},$$

where the last line follows because $\hat{\pi} < d_D$. Thus, it must be that $\hat{i}_Y(1+\hat{p}) > 1+\hat{\pi}$.

It remains to show that the trade balance is proportional to the collateral gap. Let V_{c^*} and V_c^* denote the value of Home purchases of c^* and Foreign purchases of c :

$$V_{c^*} = \frac{(e_{c_0} + e_Y \hat{p})}{2e_{c_0} + e_Y(\hat{p} + \hat{p}^*)},\ V_c^* = \frac{(e_{c_{0^*}} + e_{Y^*}\hat{p}^*)}{2e_{c_0} + e_Y(\hat{p} + \hat{p}^*)}.$$

Hence we have that:

$$V_{c^*} - V_c^* = \frac{(e_{c_0} + e_Y \hat{p})}{2e_{c_0} + e_Y(\hat{p} + \hat{p}^*)} - \frac{(e_{c_{0^*}} + e_{Y^*}\hat{p}^*)}{2e_{c_0} + e_Y(\hat{p} + \hat{p}^*)} = \frac{e_Y \hat{\Delta}}{2e_{c_0} + e_Y(\hat{p} + \hat{p}^*)}.$$

Hence, by Proposition 1, Home always runs a trade deficit. □

A.1.4 Proof of Proposition 4

Proof of Proposition 4. The result is an immediate consequence of the proof for Proposition 3, which showed that Home net sells Up and Down tranches, thus receiving gross inflows from the asset sales. The Home bias assumption then states that demand for assets is first satiated domestically and then with international trade. Since Home net sells Up and Down tranches, this requires gross inflows. □

A.1.5 Proof of Proposition 5

Proof of Proposition 5. First consider autarky. In equilibrium there is a marginal buyer i_1^*, who is indifferent between holding consumption goods and buying Y^* with leverage promising j^{max}. All agents $i > i_1^*$ buy Y^* with leverage; however, since j^{max} is strictly less than d_D, these agents will consume $d_D - j^{max} > 0$ in state D, and so their consumption profile will differ from an Arrow U. Agents $i < i_1^*$ sell their endowment of Y^* and lend to the more optimistic investors, holding goods and risk-free financial promises. Equilibrium is described by a system of two equations in two unknowns:

$$1 = (1 - i_1^*) \frac{(1 + p^*)}{p^* - j^{max}}, \tag{15}$$

$$p^* = \gamma(i_1^*)1 + (1 - \gamma(i_1^*))d_D. \tag{16}$$

Equation (15) is market clearing, which now reflects that agents borrow j^{max}. The top $1 - i_1^*$ agents are buying the asset and issuing debt to finance their purchases, thus borrowing d_D and paying only the downpayment $p^* - d_D$. Equation (16) states that the asset is priced according to the marginal buyer.

Now consider equilibrium with financial integration. Since $j^{max} < d_D$, in equilibrium, in each country there are three *common* marginal investors: $\hat{i}_1$, who is indifferent between buying Y against a tranche and buying Y^* with leverage promising j^{max}; $\hat{i}_1^* < \hat{i}_1$, who is indifferent between buying Y^* with leverage and holding goods; and $\hat{i}_2 < \hat{i}_1^*$ who is indifferent between buying the down tranche and goods. Accordingly, investors *in both countries* with $i \geq \hat{i}_1$ buy Y and issue the down tranche using the asset as collateral (hence holding an Arrow U security). Investors $i \in (\hat{i}_1^*, \hat{i}_1)$ buy Y^* with leverage promising j^{max} (hence holding a combination of Arrow U and Arrow D securities). Investors with $i \in (i_2\hat{\ } < \hat{i}_1^*)$ hold the goods, as well as risk-free debt issued by holders of Y^*. Finally, investors $i < \hat{i}_2$ buy the down tranche (holding an Arrow D).

The equilibrium equations are standard, where market clearing and marginal valuations reflect that Y^* can be used to promise j^{max}. In particular, the marginal buyer $\hat{i}_1$ is indifferent between the return on Y (by issuing a down tranche), and the *leveraged* return Y^* promising j^{max}:

$$\frac{\gamma(\hat{i}_1) \times 1}{\hat{p} - \hat{\pi}_T} = \frac{\gamma(\hat{i}_1)(1 - j^{max}) + (1 - \gamma(\hat{i}_1)(d_D - j^{max}))}{\hat{\pi}^* - j^{max}}. \tag{17}$$

Notice that as $j^{max} \to d_D$, this equation converges to $\frac{\gamma(\hat{i}_1) \times 1}{\hat{p} - \hat{\pi}_T} = \frac{\gamma(\hat{i}_1)(1 - j^{max})}{\hat{\pi}^* - d_D}$, which is the same condition in the main model. In this way, the model with Foreign leverage limits converges to the baseline model as $j^{max} \to d_D$, thus supporting our portfolio allocations.

We now characterize the gross flows. With leverage frictions determining gross flows in both countries, there is a fraction ϕ of wealth that goes toward Y and $1-\phi$ toward Y^*. The quantity of Y purchased by Foreign is

$$y_F = \frac{\phi(1-i)(1+p^*)}{p-\pi}$$

and so the value purchased is py_F which is

$$p\frac{\phi(1-i)(1+p^*)}{p-\pi}.$$

The value of Y^* purchased by Home is

$$p^*\frac{(1-\phi)(1-i)(1+p)}{p^*-d_D}.$$

Let $dp \equiv p-\pi$ and $dp^* \equiv p^*-d_D$ denote the downpayments for the Home and Foreign assets. Using the no-arbitrage relation, we have $dp^* = (1-d_D)dp$. Market clearing for risky assets together can be written

$$(1-i^1)(2+p+p^*) = dp + dp^* = dp(2-d_D).$$

We can write market clearing for Y as

$$\phi(1-i^1)(1+p)+\phi(1-i^1)(1+p^*) = dp.$$

The LHS can be written as

$$\phi(1-i^1)(2+p+p^*) = \phi dp(2-d_D),$$

and therefore we have

$$\phi = \frac{1}{2-d_D}.$$

We now show that Foreign purchases exceed Home purchases. Consider the ratio of Home-to-Foreign gross flows, denoted by ρ:

$$\begin{aligned}\rho &= \frac{p^* \frac{(1-\phi)(1-i)(1+p)}{dp^*}}{p\frac{\phi(1-i)(1+p^*)}{dp}},\\ &= \frac{p^*}{p}\frac{1-\phi}{\phi}\frac{(1+p)}{(1+p^*)}\frac{dp}{dp^*}.\end{aligned}$$

Recall that $dp^* = (1-d_D)dp$ and note that $\frac{1-\phi}{\phi} = 1-d_D$. Then we have

$$\begin{aligned}\rho &= \frac{p^*}{p}(1-d_D)\frac{(1+p)}{(1+p^*)}\frac{1}{1-d_D},\\ &= \frac{1+\frac{1}{p}}{1+\frac{1}{p^*}},\end{aligned}$$

and since $p > p^*$, we have $1+\frac{1}{p} < 1+\frac{1}{p^*}$, yielding $\rho < 1$. Thus, Home purchases are less than Foreign purchases, so that Home net sells assets. □

A.1.6 Proof of Proposition 6

Proof of Proposition 6. At $s = D$, the Down tranche issued at $s = 0$ pays in full. Since Home net sold Down tranches to Foreign investors, Home transfers $\hat{p}_D > d_{DD} > \hat{\pi}_D$ to Foreign investors. Let τ_m denote the net sales by Home for $j = U, D, X$, for Up tranches, Down tranches, and goods respectively. The following accounting identity holds.

$$\tau_U + \tau_D + \tau_X = \hat{p}_D.$$

In other words, the net sales of goods and assets equal the value of the transfer to pay the Down tranche.

Suppose $d_{DD} = 0$. Then there is no Home Down tranche to issue at $s = D$ and and so $\tau_D = 0$. Furthermore, if d_{DD}, then the Home and Foreign risky assets are equivalent at $s = D$ (but not at $s = 0$). Thus, $\hat{p}_D = \hat{p}_D^*$. Home wealth invested in risky assets is

$$(1 - i_D^1)(1 + \hat{p}_D) + (i_0^1 - i_D^1)(1 + \hat{p}_0),$$

where the first term is new endowments that get invested and the second term is wealth from initial endowments that had been invested in cash at $s = 0$. Note that $\hat{p}_0 > \hat{p}_0^*$, and so Home wealth invested in risky assets exceeds Foreign wealth invested in risky assets. But with $d_{DD} = 0$, the downpayment on both assets is the same, and so Home net buys risky assets. Finally, this implies that Home runs a trade surplus.

By continuity, for d_{DD} sufficiently low, Home runs a trade surplus at $s = D$ to pay for the payment on the Down tranche issued at $s = 0$. □

B Consumption, Investment, and Current Account

Consider a general macro-style model with two periods, $t = 0, 1$. Both economies have identical fundamentals, so we will describe the Home economy. Agents are endowed at $t = 0$ with e_0 units of a consumption good, which can be consumed or invested. At $t = 0$ agents have access to an investment technology f that produces risky output at $t = 1$, which can be capitalized into a tradable asset: ι units of the endowment good produce $f(\iota)$ units of the risky asset Y. The productive asset Y can be traded at an endogenous price p at $t = 0$ and produces dividends d_s at $t = 1$. The production function f is increasing and strictly concave.

Agents choose ι to maximize profits from production,

$$\Pi(\iota) = pf(\iota) - \iota.$$

Consumers have utility with curvature and derive utility from consumption c_0 and c_1 in both periods. We need not specify exact utility functions but simply suppose there is sufficient heterogeneity over consumption in states at $t = 1$—whether from beliefs over states or endowments across states—that agents have heterogeneous demand for consumption in the Up and Down states.

In this setup, it is still true that

$$p > p^*.$$

The only difference in the proof is that we now keep track of the risk-free interest rate, which may be non-zero. As a result, Home investment producing the risky asset is greater:

$$\iota > \iota *,$$

which also means that $\Pi > \Pi^*$. Since agents in both countries have the same initial endowment e_0 and face the same interest rate (or subjective returns buying risky assets), and since Home agents have greater wealth owing to higher production profits, it follows that initial Home consumption exceeds Foreign consumption:

$$c_0 > c_0^*.$$

Let nx and nx^* denote net exports in each country. By accounting, market clearing in each country is given by

$$c_0 + \iota + nx = e_0, \quad c_0^* + \iota^* + nx^* = e_0,$$

which implies that

$$nx < 0, \quad nx^* > 0.$$

In sum, in an economy with investment and consumption, since the Home asset price exceeds the Foreign asset price, Home runs a current account deficit.

C Dynamic Model

C.1 Budget Set and Collateral Equilibrium in the Dynamic Model

Budget Set

Denote by s^* the unique predecessor of state s. Let $L_s = \{c_s, Y_s\}$ be the set of commodities in each non-terminal state $s \in \{0, U, D\}$, and $L_s = \{c_s\}$ the set of commodities in terminal states $s \in S_T$. Let the inter-period production functions be as $F_s(c_0, Y) = (c_0, Y)$, $s = U, D$, (i.e., consumption and the asset Y are durable) and $F_s(c_{s^*}, Y_{s^*}) = c_{s^*} + d_s Y_{s^*}\ s \in S_T$. Given asset and contract prices in each state s, $(p, (\pi_j)_{j \in J})$, each agent $i \in I$ choses asset holdings y_s of Y, contract trades $\varphi_{j,s}$ and consumption c_s in state s, subject to the budget set defined by

$$
\begin{aligned}
B^i(p,\pi) = \Bigg\{ &(c_s, y_s, \varphi_s) \in R_+^L \times R^J : \\
&c_0 + p_0 y_0 + \sum_{j \in J} \varphi_{j,0} \pi_{j,0} \leq e_{c_0} + p_0 e_Y, \\
&\sum_{j \in J} \max(0, -\varphi_{j,0}) \leq y_0, \\
&c_U + p_U y_U + \sum_{j \in J} \varphi_{j,U} \pi_{j,U} \leq c_0 + p_U y_0 + \sum_{j \in J} \varphi_{j,U} \min(j_U, p_U), \\
&\sum_{j \in J} \max(0, -\varphi_{j,U}) \leq y_U, \\
&c_D + p_D y_D + \sum_{j \in J} \varphi_{j,D} \pi_{j,D} \leq c_0 + p_D y_0 + \sum_{j \in J} \varphi_{j,U} \min(j_D, p_D), \\
&\sum_{j \in J} \max(0, -\varphi_{j,D}) \leq y_D, \\
&c_s = F_s(c_{s^*}, Y_{s^*}) + \sum_{j \in J} \varphi_j \min(j_s, d_s), s \in S_T \Bigg\}.
\end{aligned}
$$

Collateral Equilibrium

A Collateral Equilibrium in this economy is a price of asset Y, contract prices, asset holdings, contract trades and consumption decisions by all the agents $((p,\pi),(c_0^i,y^i,\varphi^i,c_U^i,c_D^i)_{i\in I}) \in (R_+ \times R_+^J) \times (R_+^L \times R^J)^I$, such that

1. $\int_0^1 c_s^i di = e_{c_s}\ \forall s \in \{0,U,D\}$
2. $\int_0^1 c_s^i di = F(e_{c_{s^*}}, e_{Y_{s^*}})\ \forall s \in S_T$
3. $\int_0^1 y_s^i di = e_{Y_S}\ \forall s \in \{0,U,D\}$
4. $\int_0^1 \varphi_{j,s}^i di = 0$, $\forall j \in J$ and $\forall s \in \{0,U,D\}$
5. $(c_s^i, y_s^i, \varphi_s^i) \in B^i(p,\pi), \forall i$ and $(c_s, y_s, \varphi_s) \in B^i(p,\pi) \Rightarrow U^i(c_s,y_s) \leq U^i(c_s^i, y_s^i), \forall i$

The following equations for for the parameter values used in numerical simulations.

C.2 Equations for Autarky Leverage

The equilibrium conditions with leverage and no trade are

$$
\begin{aligned}
&(1-i_0^1)\frac{1+p_0}{p_0-p_D} = 1 \\
&(i_0^1 - i_D^1)\frac{1+p_0}{p_D-d_{DD}} + (1-i_D^1)\frac{1+p_D}{p_D-0.2} = 2 \\
&\frac{i_0^1(1-p_D)}{p_0-p_D} = i_0^1 + (1-i_0^1)\frac{i_0^1(1-d_{DD})}{p_D-d_{DD}} \\
&i_D^1 + (1-i_D^1)d_{DD} = p_D.
\end{aligned}
$$

C.3 Equations for Autarky Tranching

Denote by $i_0^1, i_0^2, i_D^1, i_D^2$ the marginal buyers in state 0 and D:

$$(1-i_0^1)\frac{(1+p_0)}{p_0-\pi_0^T}=1$$

$$i_0^2(1+p_0)=\pi_0^T$$

$$\frac{i_0^1}{p_0-\pi_0^T}=i_0^1+(1-i_0^1)\frac{i_0^1}{p_D-\pi_D^T}$$

$$p_D(1-i_0^2)=\pi_0^T$$

$$\frac{(i_0^1-i_D^1)(1+p_0)}{p_D-\pi_D^T}+\frac{(1-i_D^1)(1+p_D)}{p_D-\pi_D^T}=2$$

$$\frac{i_D^2}{i_0^2}p_D+i_D^2(1+p_D)=2\pi_D^T$$

$$\frac{i_D^1}{p_D-\pi_D^T}=1$$

$$d_{DD}(1-i_D^2)=\pi_D^T$$

C.4 Equations for Financial Integration

$$
\begin{aligned}
&(1-\hat{i}_0^1)\frac{2+\hat{p}_0+\hat{p}_0^*}{\hat{p}_0-\hat{\pi}_0^T+\hat{p}^*-\hat{p}_D^*}=1\\
&\hat{i}_0^2(2+\hat{p}_0+\hat{p}_0^*)=\hat{\pi}_0^T\\
&\frac{\hat{i}_0^1}{\hat{p}_0-\hat{\pi}_0^T}=\hat{i}_0^1+(1-\hat{i}_0^1)\frac{\hat{i}_0^1}{\hat{p}_D-\hat{\pi}_D^T}\\
&\frac{\hat{i}_0^1}{\hat{p}_0-\hat{\pi}_0^T}=\frac{\hat{i}_0^1(1-\hat{p}_D^*)}{\hat{p}_0^*-\hat{p}_D^*}\\
&\hat{p}_D(1-\hat{i}_0^2)=\hat{\pi}_0^T\\
&(\hat{i}_0^1-\hat{i}_D^1)\frac{2+\hat{p}_0+\hat{p}_0^*}{\hat{p}_D-\hat{\pi}_D^T+\hat{p}_D^*-0.2}+(1-\hat{i}_D^1)\frac{2+\hat{p}_D+\hat{p}_D^*}{\hat{p}_D-\hat{\pi}_D^T+\hat{p}_D^*-d_{DD}}=2\\
&\frac{\hat{i}_D^2}{\hat{i}_0^2}\hat{p}_D+\hat{i}_D^2(2+\hat{p}_D+\hat{p}_D^*)=2\hat{\pi}_D^T\\
&\frac{\hat{i}_D^1}{\hat{p}_D-\hat{\pi}_D^T}=1\\
&\frac{\hat{i}_D^1}{\hat{p}_D-\hat{\pi}_D^T}=\frac{\hat{i}_D^1(1-d_{DD})}{\hat{p}_D^*-d_{DD}}\\
&d_{DD}(1-\hat{i}_D^2)=\hat{\pi}_D^T;
\end{aligned}
$$

C.5 Welfare in the Dynamic Model

Thus far we have focused on how financial integration affects flows, prices, and volatility, but the implications for agents' utility (let alone for an aggregate measure of welfare) are more subtle given the heterogeneity in the model. To evaluate the effects of financial integration on welfare, we calculate utility according to agents' subjective beliefs. We also consider a utilitarian welfare function and compare how the weighted sums of utilities changes across equilibrium regimes. Figure 8 plots the ratio of welfare with financial integration to welfare in autarky (a number above 1 means an investor gains from financial integration) when we set $d_{DD} = 0.2$. The patterns are similar to what occurs in the static model.

Foreign optimists gain because they can more cheaply by Up securities, and pessimists

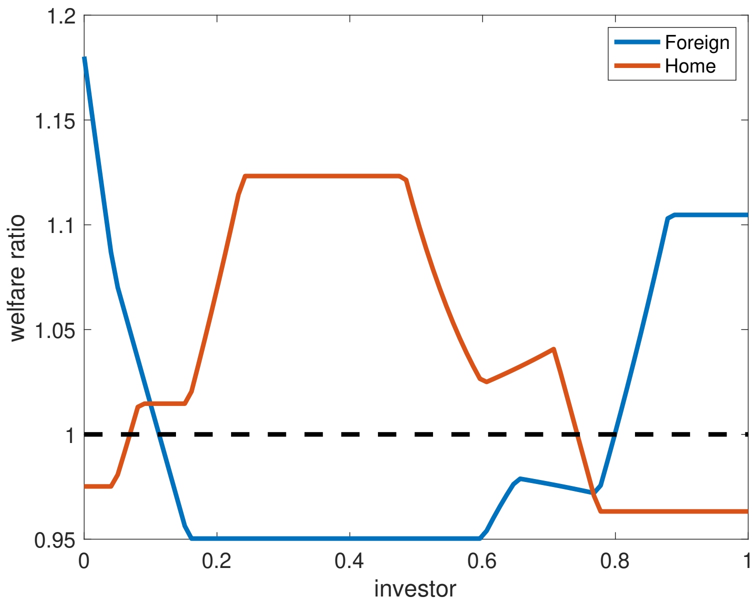

Figure 8: Welfare Gains in the Dynamic Model.

gain because they can now buy Down securities (tranches). Foreign moderates lose because their wealth declines. Home investors experience the opposite because the Home asset price increases, as does the price of the Down tranche. Computing the utilitarian measure of welfare, Home gains and Foreign is almost not affected at all. This finding is also true if $d_{DD} = 0.25$. However, for higher d_{DD} both countries gain, and for very large d_{DD} Foreign may gain by comparatively more.[20]

[20] While Brunnermeier, Simsek and Xiong (2014) provide a welfare criterion that is often useful in models with heterogeneous beliefs, their criterion is not appropriate in our setting. In their definition, one allocation x is "Pareto better" than another y if utility of x, according to *every* convex combination of agents' beliefs, is better than utility of y. Our setting does not permit a Pareto dominance from one equilibrium to the next because in our endowment economy there are no costs of default, and and thus any trades are just transfers between agents. Because final consumption just comes from asset dividends, social utility (fixing a belief) is constant. Trade is valuable *precisely* because agents have different marginal utility/beliefs.