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A Theory of Net Capital Flows over the Global Financial Cycle *

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Abstract

We develop a theory to account for changes in net capital flows of safe and risky assets over the global financial cycle. We show empirically that countries that have a net debt of safe assets experience a rise in net outflows of safe assets (reduced accumulation of safe debt) during a downturn in the global financial cycle. This is accomplished through a rise in total net outflows and a drop in net outflows of risky assets. We develop a multi-country portfolio choice model that can account for these facts. The theory relies on cross-country heterogeneity in the share of an investor's portfolio invested in risky assets. A global drop in risky asset prices changes relative wealth across countries due to this heterogeneity, which leads to changes in net flows of safe and risky assets. The model is applied to 20 advanced countries and calibrated to reflect observed cross-country heterogeneity of net foreign asset positions of safe and risky assets. The implications of the calibrated model for net capital flows are quantitatively consistent with the data.

Keywords: Global Financial Cycle; Capital Flows; Current Account; Portfolio Heterogeneity

JEL: F30; F40

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1 Introduction

Rey (2015) has characterized a global financial cycle (GFC) as exhibiting a strong global co-movement in asset prices, capital flows, leverage, credit and risk premia. In this paper we will focus on fluctuations in net capital flows over the global financial cycle. We will show that heterogeneity in risky asset shares across countries leads to changes in relative wealth following a change in global asset prices that can explain observed fluctuations in net flows of both safe and risky assets.[1]

We will consistently define net capital flows as net capital outflows, i.e. capital outflows (purchases of foreign assets by domestic residents) minus capital inflows (purchases of domestic assets by foreign residents). One should keep in mind though that for a country with a net external debt like the US, an increase in net capital outflows means that net borrowing declines. Net capital outflows are also equal to the current account, which is saving minus investment. We therefore also consider evidence related to saving and investment. We distinguish between capital flows of risky assets (portfolio equity and FDI) and safe assets (debt flows, banking flows and reserves).

We aim to understand the following two facts related to capital flows during a downturn in the GFC (the opposite applies to an upturn):

1. Countries that are net debtors of safe assets (negative net foreign asset position of safe assets) experience a rise in net outflows of safe assets. This is accomplished both through a rise in overall net capital outflows (rise in saving and drop in investment relative to other countries) and a drop in net outflows of risky assets. The opposite is the case for countries that are net creditors of safe assets.

2. The net foreign asset position of risky assets has no predictive power for the response of net capital flows, saving and investment to the GFC.

In the next section we provide reduced form empirical evidence to establish these two facts. The first fact says that during a downturn in the GFC, net debtors of safe assets reduce their incurrence of new safe asset liabilities. They accomplish this both through an increase in saving and exchanging risky for safe assets. In terms of balance of payments accounting, it takes the form of a rise in the current account (increase in saving and reduction in investment relative to other countries) and a drop in net purchases of risky assets from other countries (drop in net outflow of risky assets). Similarly, net creditors of safe assets reduce their acquisition of new safe assets during a downturn of the GFC.

[1]We focus here exclusively on net capital flows. In a separate paper, Davis and van Wincoop (2023), we consider the effect of a global asset price shock on gross capital flows. There the focus is on within-country portfolio heterogeneity as opposed to cross-country heterogeneity.

This is related to findings by Davis, Valente, and van Wincoop (2021b). They show that a global factor of gross capital inflows and outflows also accounts for 21 percent of the variance of net capital flows.[2] While they do not consider net capital flows of safe and risky assets, they do document that total net capital outflows load positively on the product of the GFC and the net foreign asset position of safe assets, but do not depend on the product of the GFC and the net foreign asset position of risky assets.[3]

To account for these facts, we develop a multi-country portfolio choice model with one risky asset in each country and a world-wide safe asset. Given significant evidence that changes in the global financial cycle are driven by shifts in global risk-aversion, we will consider a rise in global risk-aversion as the driver of the decline in the GFC.[4] But any other shock that leads to a global decline in risky asset prices will have similar implications. We consider the impact of the shock on a country's net flow of safe and risky assets.

Key to the model is heterogeneity across countries in the net foreign asset positions of safe and risky assets. We model this through heterogeneity across countries in risk-aversion and expected dividends of the risky assets. But what matters is the imbalances themselves, not the particular parameters that give rise to them. The response of net capital flows (risky, safe and total) depends on whether a country is a net debtor or creditor of safe assets. A country that is a net debtor of safe assets has a higher portfolio share of risky assets and therefore faces a greater fall in wealth following a global drop in risky asset prices. This shift in relative wealth from debtor countries to creditor countries is key to understanding the subsequent fluctuations in net capital flows, savings, and investment.[5]

Consider two groups of countries. Group 1 countries are net debtors of safe assets, while group 2 countries are net creditors of safe assets. Group 1 investors have a relatively high share of their portfolio in risky assets, while group 2 investors have a relatively low share of

[2]Related, Ghosh, Qureshi, Kima, and Zalduendo (2014) show that global factors are key determinants of net capital flow surges to emerging markets. Eichengreen and Gupta (2016) show that sudden stops (an increase in net capital outflows) are increasingly driven by global factors. Lane and Milesi-Ferretti (2012) document a current account reversal in many countries as a result of the 2009 global financial crisis.

[3]Also related to Fact 1 is the finding by Forbes and Warnock (2014) that most episodes of large capital flow changes are dominated by debt flows rather than equity flows. This is in line with our finding that total net outflows and net outflows of safe assets fluctuate together along the GFC cycle, while net outflows of risky assets go in the opposite direction. Related, Shen (2022) provides evidence for 104 countries that net equity flows and net debt flows are negatively correlated.

[4]Forbes and Warnock (2012) find that an increase in global risk (proxied by the VIX) predicts a drop in capital outflows ("retrenchment") and a drop in capital inflows ("sudden stops"). Miranda-Agrippino and Rey (2020) and Habib and Venditti (2019) find that the GFC, as measured by a common component in global asset prices, is closely related to the VIX and the risk premium on corporate bonds. Jorda, Schularick, Taylor, and Ward (2019) find that the increase in stock price synchronization since the early 1990s is associated with a synchronization of risk-appetite across countries. Chari, Dilts-Stedman, and Lundblad (2020) document the significant impact of changes in global risk-aversion on capital flows to emerging markets and emerging market equity and bond prices.

[5]Gourinchas, Rey, and Truempler (2012) and Gourinchas and Rey (2022) detail the wealth transfer from the US to the rest of the world during the 2008 financial crisis.

their portfolio in risky assets. The relative wealth of group 1 countries falls when risky asset prices fall. This leads to a larger drop in consumption (larger rise in saving) and therefore an increase in the current account (larger net capital outflows).[6]

The response of net capital flows of risky assets also depends on changes in relative wealth across countries. The drop in relative wealth of group 1 countries when risky asset prices fall implies that in equilibrium they will sell risky assets. The higher relative wealth of group 2 countries implies that in equilibrium they will buy risky assets. For net debtors of safe assets (group 1) this implies a drop in capital outflows of risky assets and a rise in capital inflows of risky assets. Net capital flows of risky assets then drop in countries that are net debtors of safe assets.

The combination of the increase in saving (rise in total net outflows) and selling of risky assets (drop in net outflows of risky assets) leads to a rise in net outflows of safe assets in a country that is a net debtor of safe assets. The GFC downturn therefore reverses the accumulation of safe asset debt.

Acalin (2023) also models fluctuations in net capital flows over the global financial cycle. There are two differences relative to our paper. First, Acalin considers total net capital flows, while we model both net risky and net safe capital flows. Second, Acalin considers a different mechanism that focuses on banking flows. Countries whose banks have relatively high returns borrow from countries whose banks have relatively low returns, intermediated through global banks. These net flows go down when the global banks reduce their leverage and therefore tighten borrowing constraints. This has in common with our model that net borrowing declines in countries that are net debtors. While in Acalin the GFC exerts an impact on net capital flows through the leverage of global banks, in our model the GFC impacts net capital flows through portfolio reallocation in response to changes in relative wealth after a common global shock to risky asset prices. We do not explicitly model banks and a financial sector, although the model is sufficiently general that it makes no difference whether the holders of risky assets are thought of as banks or as individual investors. But importantly, we do not include collateral constraints or financial frictions. Any fluctuations in capital flows are in response to changes in relative wealth and portfolio reallocation.

Papers like Maggiori (2017), Mendoza, Quadrini, and Rios-Rull (2009) and Gourinchas and Rey (2022), introduce just one type of cross-country heterogeneity to account for the fact that in the US the net foreign asset position of safe assets is negative and the net foreign asset position of risky assets is positive. In this paper we specifically introduce two types of cross-country heterogeneity. This allows us to independently vary the net foreign asset

[6]When extending the model to include investment, there is a further increase in the current account. Due to portfolio home bias and the larger drop in wealth of net debtors of safe assets, their domestic risky asset price drops more than average. Investment then drops more than average in a standard Tobin Q model of investment.

position of safe and risky assets across countries. We find that the response of capital flows depends on whether a country is a net debtor or creditor of safe assets. The net foreign asset position of risky assets does not matter (Fact 2).

Intuitively, what happens to the relative wealth of a country depends on its portfolio share of all risky assets, both home and foreign. This wealth exposure to a decline in risky asset prices does not necessarily depend on a country's net foreign asset position of risky assets. Two countries may have the same exposure to risky assets overall, and therefore experience the same drop in wealth, even though one holds more domestic risky assets and the other more foreign risky assets. In addition, external risky liabilities do not affect the wealth of a country's investors.

While the model is rich in the sense that it allows for a large number of countries and cross-country heterogeneity, we keep the model otherwise sufficiently tractable that we can derive closed form analytical proofs for the two facts. This helps in establishing the intuition behind the results. After discussing the theoretical results, we calibrate the parameters of a slightly extended model to evidence from 20 countries in order to compare the theoretical predictions regarding net safe and risky capital flows to those in the data.

The remainder of the paper is organized as follows. Section 2 presents empirical evidence related to the two Facts. Section 3 describes the model. Section 4 discusses the impact of a global risk-aversion shock on risky asset prices and the interest rate of safe assets. Section 5 discusses the implications for net capital flows. Closed-form analytical proofs related to Facts 1 and 2 are in the Appendix. Section 6 introduces a couple of additional features and then calibrates the model to the net foreign asset positions of safe and risky assets of individual countries. It shows that a drop in global risky asset prices has implications for net capital flows that are quantitatively consistent with the data discussed in Section 2. Section 7 concludes.

2 Empirical Results

In this section we will empirically establish the two stylized facts listed in the introduction, as well as provide a benchmark that we will use later to judge the quantitative predictions of the model.

We first describe the data used for the analysis. After that we estimate a static factor model of capital outflows and inflows of safe and risky assets in 20 developed countries over the sample 1996-2020. We show that the first factor is highly correlated with the asset price factor from Miranda-Agrippino and Rey (2020) and refer to it as the GFC factor. We then regress net safe and risky capital flows, and savings and investment, on this GFC factor and the factor interacted with global imbalances.

2.1 Data Description

We use capital flow data from twenty developed countries over the period 1996-2020.[7] We use annual capital flows data, which have less noise associated with measurement error than quarterly capital flows data. But for robustness we use data at the quarterly frequency in the Online Appendix.

Capital flows are obtained from the Balance of Payments data in the IMF's International Financial Statistics (IFS). For country n in year t, outflows and inflows of risky assets, $OF^{risky}_{n,t}$ and $IF^{risky}_{n,t}$, include FDI and portfolio equity flows. Outflows of safe assets, $OF^{safe}_{n,t}$, includes portfolio debt flows, "other" outflows (bank lending and deposits), and central bank foreign exchange reserve accumulation. Inflows of safe assets, $IF^{safe}_{n,t}$, includes portfolio debt flows and "other" inflows. Net flows are denoted $NF^{risky}_{n,t}$ and $NF^{safe}_{n,t}$ and are equal to outflows minus inflows. We use external assets and liabilities from the IMF International Investment Position data to obtain the net foreign asset positions of risky and safe assets, $NFA^{risky}_{n,t}$ and $NFA^{safe}_{n,t}$. We use the same classification of FDI and portfolio equity as risky assets and portfolio debt, "other", and official reserves as safe assets. We normalize all flows and stock variables in country n and year t by that country's prior year GDP. Normalized variables are written in lower case.

We believe that this separation between safe and risky assets is reasonable given the available data. Some of the portfolio debt and banking categories include high yield corporate debt, which would be better to add to the "risky" category. We only have a finer level of disaggregation available for inflows, not outflows. For portfolio debt and banking inflows, it is possible to observe the sector that issues the security: government, central bank, deposit taking corporations, and other sectors (other financial corporates, non-financial corporate, households, and non-profits). If we designate the last category (other sectors) as risky, and the rest as safe, we show in the Online Appendix that 80 to 90 percent of the variance of portfolio debt and banking inflows involves relatively safe assets. The inability to disaggregate portfolio debt and banking outflows along this line is therefore not likely to be a major concern.

In addition to safe and risky capital flows, we also look at the response of saving and investment. This data is also from IFS. Investment is defined as gross fixed capital formation from the national accounts data. Saving is constructed from the national accounts and

[7] We do not include emerging markets. Davis, Fujiwara, Huang, and Wang (2021a) show that central bank foreign exchange reserve flows are one of the largest and most volatile components of the balance of payments in emerging market economies, while being only a minor part of the balance of payments in most advanced countries. Since we do not model foreign exchange reserve flows, it makes sense to focus on advanced countries in the empirical analysis. The countries included are United States, Singapore, Australia, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Iceland, Israel, Italy, Japan, Korea, Netherlands, Norway, Portugal and Sweden.

balance of payments data, as GDP plus net primary income plus net secondary income minus private consumption minus government consumption minus inventory investment. Like the capital flow data, we normalize saving and investment by the prior year's GDP.

Finally, we also look at the response of risky asset prices. For this we consider year-end stock market indices for each country in the sample from the OECD Main Economic Indicators.

2.2 Factor analysis

Consider the following static factor model with k factors:

$$y_{n,t} = \bar{y}_n + F_t \lambda_n + \epsilon_{n,t} \tag{1}$$

for $y_{n,t} = of^{risky}_{n,t}$, $if^{risky}_{n,t}$, $of^{safe}_{n,t}$, $if^{safe}_{n,t}$, where λ_n is a $k \times 1$ vector of factor loadings and F_t is a $1 \times k$ vector of global factors, and $\bar{y}_n$ is simply the average value of $y_{n,t}$ over the sample period.

The sample length is $T = 25$ years. Define y_n as a $T \times 1$ vector that stacks the country-period scalars $y_{n,t} - \bar{y}_n$. We can then compactly write the factor model as

$$\mathbf{y} = \mathbf{F}\Lambda + \epsilon \tag{2}$$

where $\mathbf{y}$ is a matrix that that stacks the series side by side. Λ is a matrix that stacks $k \times 1$ vectors of factor loadings for each series side-by-side. $\mathbf{F}$ is a $T \times k$ matrix that contains the factors F_t. The factor analysis gives us a matrix of loadings Λ. We regress the vector of capital inflows and outflows in each period t on the matrix of loadings Λ to estimate the values of the k factors in period t.

Figure 1 plots the first factor from the factor model (blue line) together with the Miranda-Agrippino and Rey (2020) asset price factor (red line). The latter is a monthly factor. We normalize the Miranda-Agrippino and Rey monthly factor to have a standard deviation and mean of respectively 1 and 0, and then annualize by taking the average over a year. Our factor based on capital flow data is clearly closely related to this factor based on asset prices. The correlation between our first factor and the Miranda-Agrippino and Rey factor is 0.80. Below we refer to the factor based on capital flow data as the GFC factor. While we will use this factor in the upcoming regression analysis, we show in the Online Appendix that very similar results are obtained if we run the same regressions but instead use the Miranda-Agrippino and Rey asset price factor.

2.2.1 Effect of the GFC factor on Net Flows

To establish Facts 1 and 2 in the introduction, we now ask how the interaction between a country's net foreign asset position in safe and risky assets and the GFC factor affects net outflows of safe assets, net outflows of risky assets, total net outflows (i.e. the current account), national saving and investment, and risky asset prices. Net capital outflows are zero at a global level, but we can ask whether the increase or decrease of net capital outflows in individual countries in response to a negative GFC shock is related to cross-country heterogeneity in net foreign asset positions.

It is useful to first take a look at the size of net foreign asset positions. Table 1 reports some basic descriptive statistics for nfa_n, nfa_n^{safe} and nfa_n^{risky}. These are the average global imbalances across the 25 year sample for each of the 20 countries. Two points are worth making. First, there is less variation across countries in the net foreign asset position of risky assets than safe assets, with cross-country standard deviations of respectively 28% and 77%. Second, there is not a strong relationship between these two imbalances. The correlation is -0.20. In 40 percent of the countries they have the same sign, while in 60 percent they have opposite signs. To account for this requires more than one type of heterogeneity.

We then consider the following panel data regression:

$$\begin{aligned}\Delta y_{n,t} \quad = \quad & \alpha_n + \boldsymbol{\gamma Z_{n,t-1}} + \beta_1 \Delta F_t + \beta_2 \left(nfa_{n,t-1}^{risky} \times \Delta F_t \right) + \beta_3 \left(nfa_{n,t-1}^{safe} \times \Delta F_t \right) \\ & + \beta_4 \left(nfa_{n,t-1}^{risky} \right) + \beta_5 \left(nfa_{n,t-1}^{safe} \right) + \varepsilon_{n,t} \end{aligned} \tag{3}$$

where for the dependent variable $\Delta y_{n,t}$ we consider the year-over-year changes in net outflows of safe assets, total net outflows, net outflows of risky assets, savings, investment, and log risky asset prices: $\Delta nf_{n,t}^{safe}$, $\Delta nf_{n,t}$, $\Delta nf_{n,t}^{risky}$, $\Delta save_{n,t}$, $\Delta invest_{n,t}$, and $\Delta q_{n,t}$.

The regressors include a country-fixed effect, the change in the GFC factor ΔF_t, one or both of the net foreign asset positions, nfa_n^{safe} and nfa_n^{risky}, and their interaction with ΔF_t. We also include lagged dependent variables. These are contained in $\boldsymbol{Z_{n,t-1}}$, which includes $\Delta nf_{n,t-1}^{safe}$, $\Delta nf_{n,t-1}^{risky}$ and $\Delta save_{n,t-1}$. We cannot include all lagged dependent variables in $\boldsymbol{Z_{n,t-1}}$ as they are linearly related. Including $\boldsymbol{Z_{n,t-1}}$ as opposed to just $\Delta y_{n,t-1}$ has the advantage that the regression coefficients are related. For example, the regression for $\Delta nf_{n,t}$ has coefficients that are equal to the sum of the coefficients for the regressions of $\Delta nf_{n,t}^{safe}$ and $\Delta nf_{n,t}^{risky}$. In the regression of the yearly log change in the risky asset price, the only variable in $\boldsymbol{Z_{n,t-1}}$ is the one year lag of the log change in the risky asset price, $\Delta q_{n,t-1}$.

The results from these regressions are shown in Table 2. For brevity we only present the coefficients on the GFC factor and the interactions between the GFC factor and the net foreign asset position. The coefficients of the non-interacted $nfa_{n,t-1}^{risky}$ and $nfa_{n,t-1}^{safe}$ are generally insignificant. It is first useful to note that for the net capital flow variables the coefficients on ΔF_t are generally insignificant. This makes sense as net capital flows cannot go up or down in all countries in the same direction in response to a change in the GFC since net capital flows aggregate to zero globally. For saving and investment the coefficients on ΔF_t are positive and highly significant. A downturn in the GFC therefore lowers both saving and investment. Globally the decline in saving and investment must be equal as world saving equals world investment.

The coefficient on $nfa^{safe}_{n,t-1} \times \Delta F_t$ is always positive and significant for net capital outflows of safe assets. This means that a country that is a net debtor of safe assets will experience a rise in net outflows of safe assets during a downturn of the GFC ($\Delta F_t < 0$), reducing the incurrence of new safe asset liabilities. This is accomplished through a rise in total net outflows and a drop in net outflows of risky assets. Table 2 shows that the coefficient on the interaction term is positive and significant for total net outflows and negative and significant for net outflows of risky assets. The coefficient on the interaction term is positive and significant for saving, and negative for investment. The rise in total net outflows is therefore accomplished both through a rise in saving and drop in investment relative to other countries. To summarize, during a downturn in the GFC, countries with a net debt of safe assets pay down their debt by selling foreign risky assets (negative net outflows of risky assets) and by increasing saving relative to investment (i.e. increase the current account).

In all of the regressions, the coefficient on the interaction term between the GFC factor and the country's net foreign asset position of risky assets, $nfa^{risky}_{n,t-1} \times \Delta F_t$, is insignificant. Moreover, when $nfa^{safe}_{n,t-1} \times \Delta F_t$ and $nfa^{risky}_{n,t-1} \times \Delta F_t$ are both included in the regression, the goodness of fit of the regression is little changed from the regression when $nfa^{safe}_{n,t-1} \times \Delta F_t$ enters alone. We can conclude that the impact of the GFC factor on net capital flows, savings, and investment does not depend on the net foreign asset position of risky assets.

Finally, in the regression of the yearly log change in the risky asset price, we see that the coefficient on the change in the GFC factor is positive and significant. A decrease in the GFC factor is associated with a decrease in global risky asset prices. The point estimate for the coefficient of the interaction term $nfa^{safe}_{n,t-1} \times \Delta F_t$, is negative, but not statistically significant. There is weak evidence that in a downturn in the GFC the risky asset price falls by more in a debtor country with $nfa^{safe}_{n,t-1} < 0$, but this is definitely second-order.

3 Model Description

We now turn to a model that can replicate the stylized facts discussed above. There are $N + 1$ countries with investors and borrowers, and a single good. Although all agents have infinite horizons, we effectively collapse the future into a single period by assuming that all uncertainty is resolved in period 2. This simplification allows us to focus on portfolio heterogeneity across countries that is central to the main results.

A representative investor in each country solves a portfolio choice problem to allocate wealth to a global safe asset and a risky asset from each country. Risky assets are shares in country-specific capital that pay a stochastic dividend. The safe asset is supplied by a representative borrower in each country. These borrowers hold an initial stock of debt of the safe asset. They adjust their consumption/savings decisions, and thus the supply of the safe asset, in response to changes in the risk-free interest rate. Examples of these safe asset suppliers could be governments or certain financial institutions that issue safe debt.

Countries are heterogeneous with respect to risk-aversion and expected dividends of the risky assets. We take period 0 as given. The analysis focuses on the impact of a negative GFC shock in period 1 in the form of a rise in global risk-aversion.

3.1 Assets

3.1.1 Safe Assets

Safe assets are produced by the representative borrower in each country. For simplicity we assume they are identical across countries, so we can omit the country subscript. The gross interest rate on the safe asset is R_t from period t to $t+1$. Borrowers have an initial debt of B_0, and receive an endowment of Y each period.

Borrowers in any one of the countries maximize

$$\sum_{s=0}^{\infty} \beta^s \frac{\left(C_{t+s}^b\right)^{1-\frac{1}{\rho}}}{1-\frac{1}{\rho}} \tag{4}$$

Their safe debt evolves as

$$B_t = R_{t-1}B_{t-1} + C_t^b - Y \tag{5}$$

The first-order condition of the borrower's problem is

$$C_t^b = (R_t\beta)^{-\rho} C_{t+1}^b \tag{6}$$

We show later that this first order condition leads to a safe asset supply, B_t, that depends on the risk free interest rate and the previous period's stock of borrower debt, B_{t-1}.

3.1.2 Risky Assets

There are country-specific risky assets. The country n risky asset has a supply of K_n, a price of $Q_{n,t}$ and pays a dividend $D_{n,t}$ in period t. Throughout the analytical section of the paper we will treat K_n as exogenous and constant. Later in section 6, when computing numerical results from the model, we will introduce physical capital investment that produces new units of the risky asset.

The return on the risky asset from country n is

$$\frac{Q_{n,t+1} + D_{n,t+1}}{Q_{n,t}} \tag{7}$$

The period 1 dividend is set at 1 for all risky assets. There is uncertainty about future dividends, but this uncertainty is resolved at time 2. After that dividends will remain constant: $D_{n,t} = D_{n,2}$ for $t \geq 2$. In what follows it is useful to denote

$$D_n = \frac{D_{n,2}}{1-\beta} \tag{8}$$

where β is the time discount rate. D_n is the present value of dividends at time 2, which is proportional to $D_{n,2}$.

Throughout the analytical section of the paper we assume that D_n is uncorrelated across countries. We relax this assumption in section 6 when computing numerical results.

3.2 Investors

The representative investor in each country holds the safe asset and the risky asset from each country. They solve a portfolio choice problem to allocate their wealth across these assets.

3.2.1 Budget Constraint and Preferences

In period t the investor from country n invests a fraction $z_{n,m,t}$ in the risky asset of country m. A fraction $1 - \sum_{m=1}^{N+1} z_{n,m,t}$ is invested in the safe asset. Wealth of the investor in country n evolves according to

$$W_{n,t+1} = (W_{n,t} - C_{n,t})\, R^{p,n}_{t+1} \tag{9}$$

where $C_{n,t}$ is consumption and $R^{p,n}_{t+1}$ is the portfolio return from t to $t+1$:

$$R^{p,n}_{t+1} = R_t + \sum_{m=1}^{N+1} z_{n,m,t} \left(\frac{Q_{m,t+1} + D_{m,t+1}}{Q_{m,t}} - R_t \right) \tag{10}$$

The term in brackets is the excess return of the risky asset from country m over the safe asset.

Investors are assumed to have Rince preferences, which for the investor from country n

we can write as

$$\ln(V_{n,t}) = \underset{C_{n,t},\mathbf{z}_t}{max} \left\{ (1-\beta)\ln(C_{n,t}) + \beta \ln \left(\left[E_t(V_{n,t+1})^{1-\gamma_n} \right]^{\frac{1}{1-\gamma_n}} \right) \right\} \tag{11}$$

where $\mathbf{z}_t = (z_{n,1,t}, .., z_{n,1+N,t})$ is the vector of portfolio shares chosen by the investor at time t. The investor makes consumption and portfolio decisions. The rate of risk-aversion γ_n will generally vary across investors and countries. Risk-aversion only matters at time 1 as we take period 0 as given and uncertainty is resolved from time 2 onward.

3.2.2 Risk aversion

The risk aversion coefficient in the Bellman equation takes the following form:

$$\gamma_n = \frac{1}{\Gamma\left(1+\epsilon_n^G\right)G} \tag{12}$$

Here Γ determines average risk aversion across countries, while ϵ_n^G determines cross-country heterogeneity in investor risk aversion. The latter has a cross-country mean of zero. If for a given country $\epsilon_n^G > 0$, investors from that country are less risk averse than average. Before the global risk-aversion shock we set $G = 1$. We then consider the effect of a rise in global risk-aversion, where $G < 1$.

3.2.3 Risky asset dividends

As discussed earlier, all risky assets pay a dividend of 1 in period $t = 1$. The dividend in period $t = 2$ is stochastic. It determines D_n, the present discounted value of dividends from period 2 onwards. In period 1 country n investors perceive the variance of D_n to be σ^2. For any foreign asset $m \neq n$, investors from country n perceive the variance of D_m to be σ^2/κ, with $0 < \kappa \leq 1$. When $\kappa = 1$, all risky assets are perceived to be equally risky and there will be no home bias. When $\kappa < 1$ as a result of information asymmetries, foreign assets are perceived to be riskier, leading to a bias towards the domestic risky asset. The lower κ, the stronger the home bias.

For expected dividends, we denote the expectation at time 1 of D_n as $\bar{D}_n$ and assume

$$\bar{D}_n = 1 + a + \bar{z}\frac{\sigma^2}{a\psi}\left(1+\epsilon_n^D\right) \tag{13}$$

Here $a = \frac{\beta}{1-\beta}$ and $\psi = \Gamma(1 + N\kappa)$. The parameter $\bar{z} < 1$ will be equal to the mean risky share (share of portfolio invested in risky assets) across all investors in all countries in the equilibrium of the model prior to the global risk-aversion shock.

Both ϵ_n^G and ϵ_n^D affect the country level risky share, while ϵ_n^D also affects the foreign share (share of the risky asset portfolio allocated to foreign risky assets). Both variation in the risky share and foreign share across countries lead to heterogeneity in the two net foreign assets positions nfa_n^{safe} and nfa_n^{risky} that are critical to Facts 1 and 2. The cross-sectional relationship between these two global imbalances is different for risk-aversion heterogeneity (negative relationship) and expected dividend heterogeneity (positive relationship). To separate out the impact of the two imbalances on net capital flows, all that matters is that they are imperfectly correlated across countries. This will almost always be the case as long as there are at least two sources of heterogeneity. We chose risk-aversion and expected dividend heterogeneity for concreteness, though this is not important for the results.

3.2.4 Optimal Consumption and Portfolios

The value function will be proportional to the wealth of the agent: $V_{n,1} = \alpha_1 W_{n,1}$ and $V_{n,t} = \alpha_2 W_{n,t}$ for $t \geq 2$. The coefficients α_1 and α_2 can be derived from the Bellman equation and depend on structural model parameters (see Appendix A), but are not important to the analysis. Using (9), investors at time t therefore maximize

$$(1-\beta)\ln(C_{n,t}) + \beta ln(W_{n,t} - C_{n,t}) + \beta \ln\left(\left[E_t\left(R_{t+1}^{p,n}\right)^{1-\gamma_n}\right]^{\frac{1}{1-\gamma_n}}\right) \tag{14}$$

Optimal consumption is then

$$C_{n,t} = (1-\beta)W_{n,t} \tag{15}$$

All investors consume a fraction $1-\beta$ of their wealth during each period. This leaves the investor with financial wealth $\beta W_{n,t}$ that is invested in safe and risky assets.

Since uncertainty is resolved at time 2, there is only a portfolio problem at time 1. Therefore the only portfolio return that matters is $R_2^{p,n}$, which for simplicity we will denote $R^{p,n}$. From (14) optimal portfolio shares are chosen to maximize the certainty equivalent of the portfolio return:

$$\left[E(R^{p,n})^{1-\gamma_n}\right]^{\frac{1}{1-\gamma_n}} \tag{16}$$

Using a second order Taylor expansion of $(R^{p,n})^{1-\gamma_n}$ around the expected portfolio return, one can approximate this as maximizing[8]

$$E\left(R^{p,n}\right) - 0.5\gamma_n var\left(R^{p,n}\right) \tag{17}$$

[8] A second-order Taylor expansion gives $(R^{p,n})^{1-\gamma_n} = (ER^{p,n})^{1-\gamma_n} + (1-\gamma_n)(ER^{p,n})^{-\gamma_n}(R^{p,n} - ER^{p,n}) - 0.5\gamma_n(1-\gamma_n)(ER^{p,n})^{-\gamma_n-1}(R^{p,n} - ER^{p,n})^2$. Taking the expectation, we have $E(R^{p,n})^{1-\gamma_n} = (ER^{p,n})^{1-\gamma_n} - 0.5\gamma_n(1-\gamma_n)(ER^{p,n})^{-\gamma_n-1}var(R^{p,n})$. Taking this to the power $1/(1-\gamma_n)$, and linearly expanding around $ER^{p,n} = 1$ and $var(R^{p,n}) = 0$, gives (17).

This leads to simple mean-variance portfolios.

As shown in the Online Appendix, risky asset prices at time 2 are $Q_{m,2} = [a/(1+a)]D_m$. The period 2 asset payoffs are then $Q_{m,2} + D_{m,2} = D_m$. For ease of notation, from hereon we remove time subscripts from all time 1 variables. The portfolio return then becomes

$$R^{p,n} = R + \sum_{m=1}^{N+1} z_{n,m} \left(\frac{D_m - RQ_m}{Q_m} \right) \tag{18}$$

Maximizing (17) leads to the following optimal portfolios

$$z_{n,n} = Q_n \Gamma \left(1 + \epsilon_n^G\right) G \frac{\bar{D}_n - RQ_n}{\sigma^2} \tag{19}$$

$$z_{n,m} = Q_m \Gamma \kappa \left(1 + \epsilon_n^G\right) G \frac{\bar{D}_m - RQ_m}{\sigma^2} \qquad m \neq n \tag{20}$$

For a given interest rate and risky asset prices, higher values of Γ, ϵ_n^G and G (lower risk-aversion) imply a proportionally higher portfolio share allocated to all risky assets. A larger κ implies a higher portfolio share allocated to foreign risky assets, without changing the portfolio share allocated to domestic risky assets (for given asset prices). Finally, a higher expected dividend $\bar{D}_m$ implies that investors from all countries allocate a larger portfolio share to country m risky assets.

3.3 Asset Market Clearing

The period t market clearing conditions for risky assets are

$$\beta \sum_{m=1}^{N+1} z_{m,n,t} W_{m,t} = Q_{n,t} K_n \qquad n = 1, ..., N+1 \tag{21}$$

In addition there is a market clearing condition for safe assets. We can also use the aggregate market clearing condition for all assets that equates the demand to the supply of all assets:

$$\beta \sum_{n=1}^{N+1} W_{n,t} = \sum_n Q_{n,t} K_n + (N+1) B_t \tag{22}$$

We can show that (22) corresponds to zero world saving. This needs to be the case as there is no investment in the model. In the extension in Section 6 that introduces investment the aggregate asset market equilibrium condition corresponds to equality between world saving and investment.

3.4 Pre-Shock Equilibrium

We are interested in the impact of a global risk-aversion shock that lowers G. But we first describe the pre-shock equilibrium, for which $G = 1$. We make a set of assumptions regarding initial conditions at time 0 that are intended to make sure that equilibrium values of endogenous variables are the same at time 1 as at time 0 before the shock. We can think of this as a type of pre-shock steady state.

Assumption 1 *Assume the following initial conditions for period 0:* $W_{n,0} = (1+a)/\bar{z}$ *for all investors,* $Q_{n,0} = a$, $R_0 = (1+a)/a$, $B_0 = a\left(\frac{1}{\bar{z}} - \frac{1}{N+1}\sum_{n=1}^{N+1} K_n\right)$, *and*

$$z_{n,n,0} = \Gamma \frac{1}{\psi} \bar{z} \left(1 + \epsilon_n^G\right)\left(1 + \epsilon_n^D\right) \tag{23}$$

$$z_{m,n,0} = \Gamma \kappa \frac{1}{\psi} \bar{z} \left(1 + \epsilon_m^G\right)\left(1 + \epsilon_n^D\right) \quad m \neq n \tag{24}$$

Also assume $K_n = \left(\Gamma\left(1 + \epsilon_n^G\right) + \Gamma\kappa \sum_{m\neq n}\left(1 + \epsilon_m^G\right)\right)\frac{1}{\psi}(1 + \epsilon_n^D)$.

The period 0 assumptions are such that the market clearing conditions (21)-(22) are satisfied for period 0.

Appendix A proves the following regarding the pre-shock equilibrium:

Theorem 1 *Under Assumption 1 and* $G = 1$, *there is an equilibrium where in period 1:* $Q_n = a$, $W_n = (1+a)/\bar{z}$, $z_{n,n} = z_{n,n,0}$ *and* $z_{n,m} = z_{n,m,0}$. *In all periods* $t \geq 1$: $R_t = (1+a)/a$, $B_t = B_0$. *In all periods* $t \geq 2$: $Q_{n,t} = [a/(1+a)]D_n$, $W_{n,t} = W_{n,2}$.

Therefore risky asset prices, the interest rate, wealth, portfolio allocation and borrower safe debt are all the same in period 1 as in period 0. Since quantities of asset holdings are also the same in periods 0 and 1, there will be zero capital flows in the pre-shock equilibrium in period 1.

A couple of comments about the asset supplies K_n are in order. Without cross-country heterogeneity ($\epsilon_n^G = \epsilon_n^D = 0$ for all n), Assumption 1 implies that $K_n = 1$ in all countries. When we introduce cross-country heterogeneity, equal supplies of risky assets in all countries will generally imply that the prices of risky assets vary across countries. We adjust the risky asset supplies such that the prices of risky assets are identical across countries in the pre-shock equilibrium. In a model with investment, a higher demand for an asset would eventually be accommodated through a higher supply. We think of the pre-shock equilibrium as capturing such an initial state.

3.5 Period 1 Capital Flows

After the risk-aversion shock, capital flows are generally no longer zero. Time 1 capital outflows OF_n^{risky} are defined as purchases of foreign risky assets by investors in country n, while time 1 capital inflows IF_n^{risky} are purchases of country n risky assets by foreign investors. These are equal to[9]

$$OF_n^{risky} = \beta \sum_{m \neq n} z_{n,m} W_n - \sum_{m \neq n} Q_m \frac{z_{n,m,0}}{\bar{z}} \tag{25}$$

$$IF_n^{risky} = \beta \sum_{m \neq n} z_{m,n} W_m - Q_n \sum_{m \neq n} \frac{z_{m,n,0}}{\bar{z}} \tag{26}$$

$$NF_n^{risky} = OF_n^{risky} - IF_n^{risky} \tag{27}$$

Define the fraction that the investor from country n invests in all risky assets (the "risky share") as

$$z_n = \sum_{m=1}^{N+1} z_{n,m} \tag{28}$$

with its time zero value denoted $z_{n,0}$. Period 1 net capital outflows of safe assets are then

$$NF_n^{safe} = B_0 - B + \beta\left(1 - z_n\right) W_n - \frac{a}{\bar{z}}(1 - z_{n,0}) \tag{29}$$

Here $B_0 - B$ is a drop in safe debt of borrowers, while the rest captures the change in safe asset holdings from period 0 to 1 by investors.

4 Impact of the GFC Shock on Asset Prices

The key results of the paper relate to the impact of a negative GFC shock on net capital flows, which depend critically on the wealth effects of a global decline in risky asset prices. But before addressing this, in this section we will first show how a rise in global risk-aversion gives rise to a global drop in risky asset prices, as well as a drop in the interest rate. We do so in the simplest version of the model where there is no cross-country heterogeneity (and therefore no net capital flows). Specifically, we assume $\epsilon_n^G = \epsilon_n^D = 0$.

The negative GFC shock takes the form of a rise in global risk-aversion in period 1 (drop in G). All analytical results consider the derivatives of time 1 endogenous variables with respect to G at $G = 1$. Without cross-country heterogeneity, all period 1 risky asset prices

[9] The time 0 portfolio shares divided by $\bar{z}$ correspond to time 0 quantities of assets. By Assumption 1, the investor in country n has a financial wealth of $\beta W_{n,0} = a/\bar{z}$ at time 0, so that the value of the country m risky asset held by the investor is $(a/\bar{z}) z_{n,m,0}$. This corresponds to a quantity of $z_{n,m,0}/\bar{z}$ as $Q_{m,0} = a$ by Assumption 1.

will be the same and denoted Q. The risky asset price Q and interest rate R can be jointly solved from the asset market clearing conditions (21)-(22) in period 1. After substituting optimal portfolio shares (19)-(20), investor wealth

$$W_n = \frac{1+a}{\bar{z}} + Q - a$$

and the borrower budget constraint (5), these become

$$(\bar{D} - RQ)\left(\frac{1+a}{\bar{z}} + Q - a\right) = \frac{1+a}{a\psi}\frac{\sigma^2}{G} \tag{30}$$

$$(1 - R_0)B_0 + Y - C^b - \frac{Q-a}{1+a} = 0 \tag{31}$$

The first equation is the risky asset market equilibrium condition (RAE). The left hand side of (30) shows that demand for risky assets depends on the risky asset price Q both negatively (first term) and positively (second term). On the one hand, a rise in Q lowers the expected return on risky assets, lowering its demand. On the other hand, it raises wealth of investors, which raises demand for risky assets. We adopt the rather weak Assumption 2 to make sure that the first effect dominates.

Assumption 2 $\psi(1+a)^2 > \bar{z}^2\sigma^2$

This assumption assures that a higher asset price always reduces demand for risky assets. It implies that in the pre-shock equilibrium $\frac{\bar{D}}{Q} - R < R_0^2/\bar{z}$. With $\bar{z} < 1$, this condition says that the expected excess return on risky assets must be less than a number that is above 1, or 100 percent. This is evidently a very weak condition. A rise in Q then lowers demand for risky assets, while a drop in R raises it.

The aggregate asset market equilibrium condition (31) is equivalent to a zero saving condition ($S = 0$). Since world saving is zero, and there is no cross-country heterogeneity, saving must be zero in each country. The term $(1 - R_0)B_0 + Y - C^b$ is equal to saving by borrowers, while the term $-(Q - a)/(1 + a)$ is saving by investors. Borrower saving depends on the interest rate, while saving by investors depends on the risky asset price. The higher the risky asset price, the higher the wealth of the investors, which raises consumption and lowers saving.

Saving by borrowers depends on the interest rate as their consumption depends on the interest rate. Period 1 consumption by borrowers is[10]

$$C^b = \frac{1}{1 + a^{\rho}(1+a)^{1-\rho}R^{\rho-1}}\left(Y + \frac{1+a}{R}Y - \frac{1+a}{a}B_0\right) \tag{32}$$

[10]This is derived using $C_2^b = Y - (R/(1+a))B_1$, the first-order condition (6) and the budget constraint (5) for $t = 1$.

Taking the derivative of (32) at the pre-shock equilibrium, we have

$$\frac{\partial C^b}{\partial R} = -\left(Y + (\rho - 1)\, C^b\right) \frac{a^2}{(1+a)^2} \equiv -\lambda \tag{33}$$

where $C^b = Y + 1 - (1/\bar{z})$ is constant consumption of borrowers in the pre-shock equilibrium. A higher interest rate lowers consumption, which raises saving, and more so the higher ρ.[11] It follows that (31) implies a positive relationship between Q and R.

The equilibrium is illustrated in Figure 2. The zero saving condition $S = 0$ is the upward sloping line and is not affected by a drop in G. The risky asset market equilibrium schedule RAE is downward sloping. The pre-shock equilibrium is at point A. From (30) we can see that a rise in global risk-aversion (drop in G) shifts the RAE schedule to the left. The new equilibrium is at point C. The increase in global risk-aversion leads to a reallocation from risky to safe assets that lowers both Q and R.

How much risky asset prices drop depends on how much the interest rate falls. The more the interest rate falls, the less risky asset prices drop. We can consider two extremes. One is a situation where saving by borrowers does not depend on the interest rate, which occurs when $\lambda = 0$. The safe asset supply is then fixed (not interest rate elastic). In that case the $S = 0$ schedule is vertical. The risky asset price Q is then unaffected by the global risk-aversion shock. Although higher risk-aversion lowers demand for risky assets, this is neutralized by a lower interest rate that equally raises demand for risky assets. Since saving by borrowers is unaffected by the interest rate, investor saving cannot change either in equilibrium. This can only be the case when the risky asset price does not change.

The other extreme is where $\rho \to \infty$, so that saving by borrowers and the safe asset supply are infinitely interest rate elastic. The $S = 0$ schedule is then horizontal. In this case the interest rate does not change. This leads to an equilibrium at point B, where the drop in Q is largest as there is no reallocation back to risky assets due to a lower interest rate. In general, in order for the risky asset price to drop, there must be an interest rate elastic demand or supply for safe assets. This implies that either aggregate saving depends positively on the interest rate or aggregate investment (assumed zero here) depends negatively on the interest rate. When introducing investment, the $S = 0$ schedule becomes the $S = I$ schedule.

Algebraically, the changes in Q and R in response to a change in G are:

$$\frac{dQ}{dG} = \frac{\bar{z}(1+a)\frac{\sigma^2}{\psi}}{(1+a)^2 - \frac{\bar{z}^2\sigma^2}{\psi} + \frac{a^2}{\lambda}} \tag{34}$$

$$\frac{dR}{dG} = \frac{1}{\lambda\,(1+a)} \frac{dQ}{dG} \tag{35}$$

[11] Note that $Y + (\rho - 1)\, C^b > 0$ as long as $\bar{z} < 1$.

If Assumption 2 holds, the denominator of (34) is positive. The more sensitive saving by borrowers is to the interest rate (larger λ), the larger the drop in the risky asset price and the smaller the drop in the interest rate. Also note that both the risky asset price and interest rate drop more when σ^2/ψ is higher, with $\psi = \Gamma(1 + N\kappa)$. This happens when risk or risk-aversion are higher. The RAE schedule in Figure 4 then shifts further to the left when G falls.

These findings are summarized as follows:

Theorem 2 *Assume that there is no heterogeneity of investors across countries, and Assumptions 1 and 2 hold. Then a rise in global risk-aversion lowers risky asset prices equally in all countries and also lowers the interest rate on the safe asset.*

While a rise in global risk aversion naturally lowers risky asset prices, and is typically viewed as the driver behind a downturn of the global financial cycle, in what follows any other shock that lowers global risky asset prices will have similar effects. What matters for net capital flows is the impact of such a global decline in risky asset prices on relative wealth as a result of portfolio heterogeneity.

5 Impact of the GFC Shock on Net Capital Flows

We now analyze what happens in response to the global risk-aversion shock when there is cross-country heterogeneity in either risk-aversion (ϵ_n^G varies across countries) or the expected dividends of the risky assets (ϵ_n^D varies across countries). These asymmetries lead to pre-shock global imbalances in the form of non-zero net foreign asset positions of safe and risky assets. We analyze the role that these imbalances play in the impact of the global risk-aversion shock on net capital flows and risky asset prices.

5.1 Net Foreign Asset Positions

Global imbalances are the pre-shock net foreign asset positions of safe and risky assets in period 1, which are equal to those in period 0. For country n these are

$$NFA_n^{safe} = -B + (1 - z_n)\,\beta W_n \tag{36}$$

$$NFA_n^{risky} = \sum_{m \neq n} z_{n,m}\beta W_n - \sum_{m \neq n} z_{m,n}\beta W_m \tag{37}$$

where $z_n = \sum_{m=1}^{N+1} z_{n,m}$ is the risky share of the investor in country n.

First consider the net foreign asset position of safe assets. Since we have assumed that borrowers are the same in all countries, this is determined by the portfolio allocation to safe assets by investors. Subtracting the average NFA_n^{safe} across all countries, which is zero, and using that $\beta W_n = a/\bar{z}$ in the pre-shock equilibrium, we have

$$NFA_n^{safe} = -\frac{a}{\bar{z}} \left(z_n - \frac{1}{N+1} \sum_{m=1}^{N+1} z_m \right) \tag{38}$$

A country with a relatively large risky share is therefore a net debtor of safe assets.

Under risk-aversion heterogeneity, using pre-shock portfolio shares, we have

$$z_n = \bar{z}(1 + \epsilon_n^G) \tag{39}$$

When $\epsilon_n^G > 0$, investors in country n are less risk averse than average. They therefore have a larger risky share and a smaller portfolio share of safe assets. The net foreign asset position of safe assets is then negative:

$$NFA_n^{safe} = -a\epsilon_n^G \tag{40}$$

Under expected dividend heterogeneity, using pre-shock portfolio shares, we have

$$z_n = \bar{z} \left(1 + \frac{1-\kappa}{1+N\kappa} \epsilon_n^D \right) \tag{41}$$

If $\epsilon_n^D > 0$, the risky asset of country n has a relatively high expected dividend. When there is home bias ($\kappa < 1$), this additional appeal of the country n risky asset will raise the overall risky share of country n and therefore lower the share allocated to safe assets. This again leads to a negative net foreign asset position of safe assets:

$$NFA_n^{safe} = -a \frac{1-\kappa}{1+N\kappa} \epsilon_n^D \tag{42}$$

Therefore both countries with lower risk-aversion and higher expected dividends will be net debtors of safe assets.

Next consider the net foreign asset position of risky assets. Under risk-aversion heterogeneity we have

$$NFA_n^{risky} = a \frac{(N+1)\kappa}{1+N\kappa} \epsilon_n^G \tag{43}$$

Countries with low risk-aversion ($\epsilon_n^G > 0$) will have a positive net foreign asset position of risky assets. Country n investors then allocate a larger portfolio share to foreign risky assets than foreign countries do to the country n risky asset.

Under expected dividend heterogeneity we have

$$NFA_n^{risky} = -a \frac{(N+1)\kappa}{1+N\kappa} \epsilon_n^D \tag{44}$$

When $\epsilon_n^D > 0$, the high expected dividend of the country n asset will reduce the holding of foreign risky assets by country n investors and increase the holding of country n risky assets by foreigners. This leads to a negative net foreign asset position of risky assets.

While both low risk-aversion and a high expected dividend of the domestic risky asset give rise to a negative net foreign asset position of safe assets, they have opposite effects on the net foreign asset position of risky assets. Low risk aversion leads to a positive net foreign asset position of risky assets, while a high expected domestic dividend leads to a negative net foreign asset position of risky assets. Any combination of NFA_n^{safe} and NFA_n^{risky} that we observe in the data can then be achieved in the model with a combination of ϵ_n^G and ϵ_n^D. We will use this in the calibration of the model in the next section.

5.2 Net Capital Flows

We now consider how cross-country portfolio heterogeneity, and the associated global imbalances, impacts net capital flows in response to the global risk-aversion shock.

We assume either risk-aversion or expected dividend heterogeneity. Specifically, assume either $\epsilon_n^G = g_n\epsilon$ and $\epsilon_n^D = 0$ or $\epsilon_n^D = d_n\epsilon$ and $\epsilon_n^G = 0$, where $\sum_{n=1}^{N+1} g_n = \sum_{n=1}^{N+1} d_n = 0$. For example, when $\epsilon > 0$, countries for which $g_n > 0$ are less risk-averse and those for which $g_n < 0$ are more risk-averse.

Now consider a country-specific variable X_n, which can be the risky asset price or net capital flows of safe or risky assets, or total net capital flows. Appendices B and C consider the impact of a global risk-aversion shock under respectively risk-aversion heterogeneity and expected dividend heterogeneity. To do so, we compute the second-order derivative

$$\frac{\partial^2 X_n}{\partial G \partial \epsilon} \tag{45}$$

at $\epsilon = 0$ and $G = 1$. We show that it is proportional to g_n (risk-aversion heterogeneity) or d_n (expected dividend heterogeneity), either positively or negatively. This tells us how the response to the global risk-aversion shock will vary across countries.[12] Using the findings from Appendices B and C, Appendix D proves the following Theorem.

Theorem 3 *Assume that there is either cross-country heterogeneity in risk-aversion or expected dividends. Assumptions 1 and 2 hold as well. Then, in response to a rise in global risk-aversion, countries that are net debtors of safe assets (negative net foreign asset position of safe assets) experience (1) a positive net outflow of safe assets, (2) a positive total net capital outflow, (3) a negative net outflow of risky assets and (4) a larger than average drop*

[12]For example, when X_n is a net capital flow variable, we have $\partial X_n/\partial G = 0$ at $\epsilon = 0$. When the second-order derivative (45) depends positively on g_n, it means that countries that are less risk-averse experience a drop in X_n (negative net outflows) in response to a rise in global risk-aversion ($dG < 0$).

in the risky asset price. The opposite is the case for countries that have a positive net foreign asset position of safe assets. Moreover, the size of these changes is monotonically related to the size of the net foreign asset position of safe assets.

A country with a net debt of safe assets therefore reverses the accumulation of safe debt through a rise in saving (increase in current account) and net selling of risky assets to the rest of the world. The intuition is critically associated with the impact of asset price changes on relative wealth. Countries with a negative net foreign asset position of safe assets have a larger risky share. They therefore experience a relatively large drop in wealth when risky asset prices fall in response to the rise in global risk aversion. This lowers relative consumption and therefore raises relative saving, leading to overall net capital outflows.

The drop in net outflows of risky assets can be understood as follows. Let $k_{n,m}$ be the quantity of the country m risky asset held by country n investors in period 1. $k_{n,m,0}$ is the analogous period 0 quantity. In Appendix E we show that

$$k_{n,m} = \frac{W_n}{\sum_{l=1}^{N+1} \omega_{l,m} W_l} k_{n,m,0} \tag{46}$$

Here W_n is the wealth of country n and $\omega_{l,m}$ is the share of the country m risky asset supply that is held by investors from country l. These shares therefore add to 1. The quantity of risky assets held is therefore determined by relative wealth.

(46) implies that countries whose wealth drops relative to that of a weighted average of all countries will sell risky assets. Net debtors of safe assets experience a larger drop in wealth and will therefore sell risky assets. Consider an example with just two countries, a Home country that is a net debtor of safe assets and a Foreign country that is a net lender of safe assets. The larger drop in wealth in the Home country implies that it will sell risky assets, including Foreign risky assets. The smaller wealth drop in Foreign implies that it will buy more risky assets, including Home risky assets. The Home country therefore experiences negative outflows and positive inflows of risky assets. The net outflow of risky assets will then be negative.

The positive net outflow of safe assets follows from both the the increase in overall net capital outflows and the drop in net outflows of risky assets. In Appendix E we show that net outflows of safe assets can be written as

$$NF_n^{safe} = S_n - \sum_{m=1}^{N+1} \left(k_{n,m} - k_{n,m,0}\right) Q_m \tag{47}$$

where S_n is country n saving. We have seen that the relative drop in wealth of a country that is a net debtor of safe assets leads to both a rise in saving and selling of risky assets.

Both contribute to a reduction in safe asset debt.

Theorem 3 also says that the relative price of the risky asset of a country that is a net debtor of safe assets will drop in response to the negative GFC shock. We have seen that such countries will reduce their demand for risky assets as a result of their larger drop in wealth. Since they are biased towards their domestic asset ($\kappa < 1$), there will be a drop in relative demand of risky assets from countries that are net debtors of safe assets, which lowers their relative risky asset price. In terms of net capital flows, this has two implications. First, it reinforces the decline in relative wealth of net debtors of safe assets and therefore the net capital flow results discussed above. Second, in the next section we extend the model to include investment, which depends on the asset price (Tobin's Q). This implies a larger drop of investment in countries that are net debtors of safe assets, which reinforces the increase in the current account in these countries.

The following Corollary follows immediately from Theorem 3.

Corollary 1 *Assume that there is either cross-country heterogeneity in risk-aversion or expected dividends. Assumptions 1 and 2 hold as well. Then, in response to a rise in global risk-aversion, knowing the sign of the net foreign asset position of risky assets is not informative about the sign of net capital outflows (total, safe and risky).*

As we discussed above, what matters for the response to the global risk-aversion shock is whether a country is a net debtor or creditor of safe assets. For a given sign of the net foreign asset position of safe assets, the net foreign asset position of risky assets can be either positive or negative, depending on the type of heterogeneity. Countries with a negative net foreign asset position of safe assets are either less risk-averse or have a risky asset whose expected dividend is relatively high. Low risk-aversion implies a positive net foreign asset position of risky assets, while high expected domestic dividends implies negative net foreign asset position of risky assets. Thus, knowing the sign of the net foreign asset position of risky assets is therefore not informative about the sign of the net foreign asset position of safe assets, which is what drives the results in Theorem 3.

6 Numerical Analysis

In the analytical results so far we have considered a model with either cross-country risk aversion heterogeneity or expected dividend heterogeneity. We now turn to the numerical implications of the model, where we include both types of cross-country heterogeneity. We will compare the quantitative results from the model to the empirical results in Section 2.

In the analytical model presented thus far we make a few simplifying assumptions to ensure that the model has a closed form solution. For the purpose of the numerical exercise, we first relax two of these assumptions. After that we discuss the calibration of the model's parameters. We finally consider the impact of the global risk-aversion shock and make comparisons to the empirical results in Section 2.

6.1 Relaxing two model assumptions

We relax two assumptions in the model discussed so far. The first assumption is that the period 2 returns on risky assets are uncorrelated across countries. This simplifies the portfolio expressions.

The second assumption is that there is no investment and the capital stock therefore remains constant. Following the shock, there is trade in existing risky assets, but no creation of new risky assets. Investment plays several roles. First, it affects net capital flows as the current account is saving minus investment. Second, as we have seen in Section 2, in the data both saving and investment drop in response to a decline in the GFC. In the model so far, saving cannot systematically drop across countries as global saving is zero.

6.1.1 Correlated risky asset returns

The period 2 return on the country m risky asset is D_m/Q_m. We now allow for correlated dividends D_m that lead to correlated period 2 returns on the risky assets. This affects the period 1 portfolios of investors. Assume that D_m has a common component D and an idiosyncratic component F_m:

$$D_m = D + F_m \tag{48}$$

Assume that D and F_m are uncorrelated and that F_m is uncorrelated across countries. Assume that for investors from country n the variance of F_n is σ^2, while the variance of F_m for $m \neq n$ is σ^2/κ. Also let σ_d^2 be the variance of D.

Define

$$\eta = \frac{\nu}{\nu - 1 + \nu(1 + N\kappa)}$$

where $\nu = \frac{\sigma_d^2}{\sigma_d^2+\sigma^2}$ is the cross-country correlation of dividends. The Online Appendix then shows that for investors from country n, the optimal portfolio expressions are:

$$z_{n,n} = \frac{Q_n\Gamma\left(1+\epsilon_n^G\right)G}{\sigma^2}\left((1-\eta)(\bar{D}_n - RQ_n) - \eta\kappa\sum_{m\neq n}(\bar{D}_m - RQ_m)\right) \tag{49}$$

and for $m \neq n$

$$z_{n,m} = \frac{Q_m \Gamma \left(1 + \epsilon_n^G\right) G}{\sigma^2} \left(-\eta\kappa(\bar{D}_n - RQ_n) + (\kappa - \eta\kappa^2)(\bar{D}_m - RQ_m) - \eta\kappa^2 \sum_{k \neq n,m} (\bar{D}_k - RQ_k) \right) \tag{50}$$

Notice that the previous case of uncorrelated returns corresponds to $\eta = 0$ as in that case $\nu = \sigma_d^2 = 0$. This yields the portfolio expressions that we presented earlier in equations (19) and (20).

6.1.2 Investment

We introduce installment firms that can produce I_n new capital goods in period 1 in country n at the price of Q_n. These raise the capital stock at time 2. Production of capital goods requires a quadratic adjustment cost. Producing I_n units of the capital good requires

$$aI_n + \frac{\xi}{2} \frac{(aI_n)^2}{K_n} \tag{51}$$

units of the consumption good. Here K_n is the period 1 capital stock. The installment firms maximize the profit

$$Q_n I_n - aI_n - \frac{\xi}{2} \frac{(aI_n)^2}{K_n} \tag{52}$$

This implies

$$\frac{I_n}{K_n} = \frac{1}{a^2 \xi}(Q_n - a) \tag{53}$$

The period 2 capital stock is then

$$K_{n,2} = K_n + I_n \tag{54}$$

The period 1 asset market clearing conditions (21)-(22) remain the same, with the capital stock K_n replaced with $K_{n,2}$. The $S = 0$ schedule discussed in Section 4 in the absence of heterogeneity now becomes an $S = I$ schedule, where I is the value of investment, $Q_n I_n$.

6.2 Parameters

First consider the cross-country heterogeneity parameters ϵ_n^G and ϵ_n^D. They jointly determine nfa_n^{risky} and nfa_n^{safe} prior to the shock. Using a numerical solver, we set ϵ_n^G and ϵ_n^D to match the 1996-2020 sample averages of nfa_n^{risky} and nfa_n^{safe} in the data for the 20 countries in the empirical analysis of Section 2.[13]

The other model parameters and their calibrated values are shown in Table 3. The number of countries $N+1$ is set at 20, corresponding to the empirical exercise in Section 2. We set $a = \frac{\beta}{1-\beta} = 25$, implying a 4 percent pre-shock interest rate. We set $Y = 2$. Combined with a dividend of 1, this means that GDP is $Y + 1 = 3$, so that capital income is one-third of GDP. We set the intertemporal elasticity of substitution at $\rho = 0.5$, in line with the evidence from Beaudry and van Wincoop (1996).

To calibrate the home bias parameter κ we target the observed mean foreign portfolio share for the countries and years in our empirical sample. The mean foreign share is calculated as country's external portfolio equity assets divided by total domestic equity market capitalization minus external portfolio equity liabilities plus external portfolio equity assets. The external portfolio equity assets and liabilities are from the same source as in Section 2, while the domestic market capitalization is from the World Bank's World Development Indicators. For the countries in our sample where we have a complete series for market capitalization over the years in our empirical sample, we calculate a mean foreign share of 27%. We set $\kappa = 0.0195$, which gives an average foreign share of 27%.

We set $\bar{z} = 0.5$ using data from the US Flow of Funds accounts. We use the average ratio of equity assets to total assets in the U.S. non-financial sector over the years 1996-2020. Here equity assets are corporate equity, mutual fund shares, equity in non-corporate business, equity FDI, and miscellaneous assets. It should be noted though that this average risky share matters much less for the results than the cross-country dispersion of the risky share that determines the variation across countries of the net foreign asset positions of safe assets.

We set the cross-country risky asset correlation ν to 0.33 based on the findings from Quinn and Voth (2008), who compute a century of global equity market correlations. Using correlations among 120 country pairs of monthly equity returns for non-overlapping 4-year intervals, they find an average correlation of 0.33.

We cannot calibrate both σ^2 and Γ, only their ratio. The portfolio expressions depend on Γ/σ^2. The pre-shock premium on risky assets is

$$\frac{\bar{z}\sigma^2}{a^2\psi} = \frac{\bar{z}}{a^2}\frac{\sigma^2}{\Gamma}\frac{1}{(1+N\kappa)}$$

We then set σ^2/Γ such that the risk premium is 4.6 percent. In Table 3 we set $\Gamma = 0.1$ and $\sigma = 2.2$, but any other values with the same ratio of σ^2/Γ lead to the same results.

[13]In the data the average across countries of the net foreign asset positions (as a share of GDP) is not exactly zero. To be consistent with the model, we recenter the net foreign assets positions in the data (as a share of GDP) by subtracting the cross-sectional mean.

Finally, we calibrate the investment adjustment cost parameter ξ as follows. From Table 2 we see that on average the investment/GDP ratio falls by about 0.5 percent and the savings/GDP ratio falls by about 0.7 percent for every 16.2 percent fall in the risky asset price. Since of course world savings has to equal world investment, we take the average of these two and calibrate the model to generate a 0.6 percent fall in the investment/GDP ratio for every 16.2 percent fall in the risky asset price. See again the Online Appendix for further details.

6.3 Results

In Table 4 we consider a rise in global risk-aversion (drop in G) that leads to a 10 percent drop in the average risky asset price. In the data this is done as follows. Table 2 implies that $\Delta F_t = -1$ is associated with a 16.2 percent drop in equity prices. We therefore set $\Delta F_t = -10/16.2$ in order to generate a 10% drop in risky asset prices. In the model we simply consider a shock to G that will produce a 10% fall in the average risky asset price.

Table 4 reports changes in endogenous variables in response to this negative GFC shock in both the data and the model. Since we are particularly interested in the role of the net foreign asset position of safe assets, we report changes in endogenous variables for an economy where nfa_n^{safe} is -100 percent of GDP minus that for an economy where $nfa_n^{safe} = 0$. So these are the additional changes in the endogenous variables in response to the risk-aversion shock that are related to a negative net foreign asset position of safe assets.

Consider for example total net capital outflows as a share of GDP, nf_n. Table 2 reports a coefficient of 0.01 in the regression of $\Delta nf_{n,t}$ on $nfa_{n,t-1}^{safe} \times \Delta F_t$. This means that when $\Delta F_t = -10/16.2$, net capital outflows rise by 0.60 percent of GDP for a country with $nfa_n^{safe} = -100$ compared to the average country. In the model we obtain the corresponding result by computing the net capital flow response in each of the 20 countries and regressing this on nfa_n^{safe}. The first column of Table 4 reports the results for the data. The second column shows results from the benchmark version of the model described so far, which are discussed in this subsection. The third column shows results from an extension of the model with imperfect substitution between safe assets from different countries, which is discussed in the next subsection.

The results for saving, investment, net capital outflows, and the yearly log change in the risky asset price in the model are all very close to those in the data. We see that saving is higher and investment is lower in a country that has a net external debt of safe assets. For saving this is because of the larger drop in wealth of such a country, which leads to a larger drop in consumption and therefore higher saving. For investment it is because countries with a larger drop in wealth have a somewhat larger drop in their risky asset price and therefore a larger drop in investment. As in the data, the net external debt of safe assets has a substantially larger impact on the saving response to the GFC shock than the investment response. In the data we see that a net debtor country sees a slightly larger fall in the risky asset price in a downturn in the GFC, but this effect is small. If the average country sees a 10% fall in the risky asset price, the country with $nfa_n^{safe} = -100$ sees a 10.4% fall. The result is quantitatively similar in the model.

Since total net capital outflows equals the current account, which is saving minus investment, a country with a net external debt of safe assets experiences an increase in net capital outflows, due both to the higher saving and lower investment compared to a country with a zero net foreign asset position of safe assets. The magnitude is very close in the model to that in the data.

Next consider the results for net capital outflows of risky and safe assets. As in the data, a country that has a net external debt of safe assets experiences an increase in net capital outflows of safe assets and a decrease in net outflows of risky assets in response to a negative GFC shock. However, this reallocation between risky and safe assets is much larger in the model than in the data. The sum of nf_n^{safe} and nf_n^{risky} is equal to total net capital outflows nf_n, where the model is close to the data. In the next subsection we present an extension of the model where each country has its own safe asset. When these safe assets are imperfect substitutes we can resolve this quantitative discrepancy between the model and the data.

Figure 3 presents scatter plots of changes in the model in net capital flows (safe, risky, total), and saving and investment, in response to a GFC shock that leads to a 10% drop in the average risky asset price. These changes are plotted against both nfa^{safe} (left column) and nfa^{risky} (right column). The slopes of the regression lines in the left column correspond to the model numbers reported in the second column of Table 4. There is clearly a strong link in the model between the changes in these variables in response to a negative GFC shock and the net foreign asset position of safe assets. By contrast, when plotting the changes against the net foreign asset position of risky assets in the right column, there is no clear relationship. This corresponds to Fact 2.

6.4 Imperfect Safe Asset Substitution

We now address the quantitative discrepancy between the model and the data regarding the response of net safe and risky capital outflows to the GFC shock. There is too much reallocation in the model between safe and risky assets for a given net foreign asset position of safe assets. We need a speedbump to slow this down, without affecting any of the other results. A natural way to do so is to assume that each country has its own safe asset and these safe assets are imperfect substitutes. We have seen that in response to a negative GFC shock, a country n with a negative net foreign asset position of safe assets both saves more and exchanges risky for safe assets. If there are $N + 1$ safe assets and country n investors are biased towards their domestic safe asset, there would be a relative increase in demand for the country n safe asset. This leads to drop in the interest rate of the country n safe asset, which weakens the reallocation in country n from risky to safe assets.

It is beyond the scope of this paper to develop of full portfolio choice model with both $N+1$ risky and $N+1$ safe assets. Such a model would involve $N+1$ currencies as well. We consider here a much simpler framework that is similar to Gabaix and Maggiori (2015). It is assumed that investors only hold the domestic safe assets.[14] There are identical arbitrageurs in each country, which are like the financial intermediaries in Gabaix and Maggiori (2015). A full description of this extension is in the Online Appendix. Arbitrageurs maximize

$$\sum_{n=1}^{N+1} R_n A_n - \frac{1}{2} a_0 \sum_{n=1}^{N+1} \left(A_n - \bar{A}_n\right)^2 \tag{55}$$

where A_n are country n safe asset holdings and R_n is the interest rate on country n safe assets. They therefore maximize the return on their safe asset portfolio minus quadratic costs of deviating from their pre-shock safe asset holdings $\bar{A}_n$. They enter with zero wealth, so that $\sum_{m=1}^{N+1} A_m = 0$. The optimal safe asset portfolio of arbitrageurs is then

$$A_n - \bar{A}_n = \frac{1}{a_0}\left(R_n - \frac{1}{N+1}\sum_{m=1}^{N+1} R_m\right) \tag{56}$$

The net foreign asset position of safe assets of country n is $NFA_n^{safe} = -(N+1)A_n$. Dividing by GDP, using (56), we can derive

$$R_n - \frac{1}{N+1}\sum_{m=1}^{N+1} R_m = -\chi\left(nfa_n^{safe} - nfa_{n,0}^{safe}\right) \tag{57}$$

where $\chi = a_0 \frac{Y+1}{N+1}$ and nfa_0^{safe} is the pre-shock net foreign asset position of safe assets. $nfa_n^{safe} - nfa_{n,0}^{safe}$ is equal to net outflows of safe assets, relative to GDP. When a country increases net borrowing of safe assets, arbitrageurs need to take the other side. To incentivize them to lend more to the country, the interest rate of that country's safe assets needs to rise relative to the average interest rate. When a country increases net lending of safe assets, arbitrageurs need to be incentivized to take a smaller position of that country's safe assets. The interest rate then needs to fall.

Consider a country n that is a net debtor of safe assets before the shock. We have seen that investors from this country reallocate from risky to safe assets as a result of the shock,

[14] We continue to assume that borrowers are the same in each country. They hold an equally weighted portfolio of all safe assets.

leading to reduced net borrowing of safe assets. This lowers the interest rate, which reduces the equilibrium reallocation from risky to safe assets by country n investors. Similarly, consider a country n that is a net lender of safe assets. We have seen that this country reallocates from safe to risky assets as a result of the shock, leading to reduced net lending of safe assets. This raises the interest rate on the country n safe asset, which reduces the equilibrium reallocation from safe to risky assets by investors from country n. The larger the parameter χ, the bigger the speedbump that limits the equilibrium reallocation between safe and risky assets.

The impact of this imperfect substitution of safe assets depends critically on the value of χ. When $\chi = 0$ the model reverts to the model with a single safe asset. Adrian, Erceg, Kolasa, Linde, and Zabczyk (2022) calibrate a model that incorporates this Gabaix and Maggiori (2015) friction. They calibrate the model with a value of $\chi = 0.02$ for advanced economies. That is the value we use in this extension.

The last column of Table 4 presents the results from introducing imperfect safe asset substitution into the model. It shows that imperfect substitution reduces the magnitude of net flows of safe and risky assets in response to the GFC shock. They are now closely in line with the data. Also note that imperfect substitution has little effect on the response of the other variables, which remain closely in line with the data.

7 Conclusion

We have developed a theory to account for changes in net capital flows over the global financial cycle (GFC). The theory relies critically on portfolio heterogeneity among investors across countries. This portfolio heterogeneity affects relative wealth across countries in response to global asset prices changes during the global financial cycle. These relative wealth changes in turn affect net capital flows in a way that is quantitatively consistent with the data for 20 advanced countries.

The model can be extended in numerous other directions to consider features of the GFC from which we have abstracted here. One direction is to consider the role of monetary policy and associated exchange rate fluctuations. Another is to allow for financial frictions, which would allow us to consider the need for macroprudential policies. Related to that, a third direction is to more explicitly model financial institutions and the constraints under which they operate. Finally, we have abstracted from the special role that the United States and the dollar play in the international financial system.

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Appendix

A Proof of Theorem 1

With period 1 dividends of 1, $R_0 = (1+a)/a$ and $Q_{n,0} = Q_{n,1} = a$, (10) implies that $R_1^{p,n} = (1+a)/a$. We have $W_{n,0} - C_{n,0} = \beta W_{n,0} = a/\bar{z}$, so that from (9) $W_{n,1} = (1+a)/\bar{z}$ for all investors. Substituting $\bar{D}_n$ (equation (13)), as well as $Q_n = a$ and $R = (1+a)/a$, into the portfolio expressions (19)-(20) gives time 1 portfolio shares that are the same as the time zero portfolio shares (23)-(24). Substituting these portfolio expressions, as well as $W_n = (1+a)/\bar{z}$ and $Q_n = a$, into the risky asset market clearing conditions (21), the markets clear in period 1 under Assumption 1 about K_n. The aggregate asset market clearing condition (22) also holds in period 1, after substituting $B_1 = B_0$, $W_n = (1+a)/\bar{z}$, $Q_{n,1} = a$ and the expression for B_0 in Assumption 1.

Since $R_t = 1/\beta$ for all $t \geq 1$, first-order condition (6) implies that consumption of borrowers is constant over time. Since income is constant, this implies $C_t^b = Y - B_0/a$. The budget constraint (5) then implies $B_t = B_0$ for all $t \geq 1$. Since there is no uncertainty starting in period 2, we must have $R_t = (Q_{n,t+1} + D_{n,2})/Q_{n,t}$ for $t \geq 2$. This is satisfied when $R_t = (1+a)/a$, $Q_{n,t} = Q_{n,t+1} = (a/(1+a))D_n = aD_{n,2}$. Investor wealth remains constant after period 2 since $W_{n,t+1} = \beta R_t W_{n,t}$ for $t \geq 2$ and $R_t = 1/\beta$.

We finally need to check the aggregate asset market clearing condition (22) for $t \geq 2$. Since safe debt of borrowers, investor wealth and asset prices remain constant from period 2 onward, we only need to check it for $t = 2$. We have

$$\sum_{n=1}^{N+1} W_{n,2} = \beta \frac{1+a}{\bar{z}} \sum_{n=1}^{N+1} R^{p,n} = \frac{a}{\bar{z}} R(N+1) + \frac{a}{\bar{z}} \sum_{n=1}^{N+1} \sum_{m=1}^{N+1} z_{n,m} \frac{D_m - RQ_m}{Q_m}$$

From (23)-(24), $\sum_{n=1}^{N+1} z_{n,m} = \bar{z} K_m$. Therefore

$$\sum_{n=1}^{N+1} W_{n,2} = \frac{(1+a)(N+1)}{\bar{z}} + \sum_{m=1}^{N+1} K_m \left(D_m - (1+a)\right)$$

Using $B_2 = B_0$, the period 2 aggregate asset market equilibrium can then be written as

$$\frac{1}{\bar{z}} a(N+1) + \frac{a}{1+a} \sum_{n=1}^{N+1} D_n K_n - a \sum_{n=1}^{N+1} K_n = \sum_{n=1}^{N+1} Q_{n,2} K_n + (N+1) B_0$$

Using $Q_{n,2} = (a/(1+a))D_n$ and the expression for B_0 in Assumption 1, it is immediate that this is satisfied.

We finally point out that the conjectured value functions are correct. We conjectured $V_{n,1} = \alpha_1 W_{n,1}$ and $V_{n,t} = \alpha_2 W_{n,t}$ for $t \geq 2$. First substituting the latter into the Bellman equation (11) for $t \geq 2$, together with $C_{n,t} = (1-\beta) W_{n,t}$ and $W_{n,t+1} = W_{n,t}$, we have $\alpha_2 = 1 - \beta$. Substituting $V_{n,1} = \alpha_1 W_{n,1}$ into the Bellman equation (11) at time 1, together with $C_n = (1-\beta)W_n$ and $W_{n,2} = \beta R^{p,n} W_n$, we have

$$ln(\alpha_1) = ln(1-\beta) + \frac{\beta}{1-\beta} ln(\beta) + \frac{\beta}{1-\beta}\frac{1}{1-\gamma_n} ln\left(E(R^{p,n})^{1-\gamma_n}\right)$$

Substituting the portfolio shares (23)-(24), $Q_m = a$ and $R = a/(1+a)$ into the portfolio return expression (18), α_1 becomes a function of structural model parameters.

B Cross Country Heterogeneity in Risk Aversion

Appendix D will proof Theorem 3. To do so, we first need to to derive the second order derivatives of risky asset prices and net capital flows (safe, risky, total) with respect to G and ϵ. In this section we do so for cross-country risk aversion heterogeneity. In Section C we do so for heterogeneity in expected dividends. We start by describing the market clearing conditions. After that we derive the second-order derivatives for risky asset prices, total net capital outflows and net outflows of risky assets as linear functions of g_n. The last two also give us the second-order derivative for net flows of safe assets.

B.1 Market Clearing Conditions

The market clearing conditions are

$$\frac{a}{1+a}\sum_{m=1}^{N+1} z_{m,n} W_m = Q_n K_n \qquad n = 1, ..., N+1 \tag{B.1}$$

$$\frac{a}{1+a}\sum_{n=1}^{N+1} W_n = \sum_n Q_n K_n + (N+1)B \tag{B.2}$$

First consider wealth. Using the expressions for portfolio shares (23)-(24) in the pre-shock equilibrium, we have

$$W_n = \frac{1+a}{\bar{z}} + \left(1+\epsilon_n^G\right)\frac{1-\kappa}{1+N\kappa}(Q_n - a) + \left(1+\epsilon_n^G\right)\frac{\kappa}{1+N\kappa}\sum_m (Q_m - a) \tag{B.3}$$

From Assumption 1 we have

$$K_n = \frac{1-\kappa}{1+N\kappa}\left(1+\epsilon_n^G\right) + \frac{(N+1)\kappa}{1+N\kappa} \tag{B.4}$$

Since $\sum_n \left(1+\epsilon_n^G\right) = N+1$, it follows that $\sum_n K_n = N+1$, so that from Assumption 1 $B_0 = a((1/\bar{z})-1)$. Therefore $B = (1+a)((1/\bar{z})-1) + C^b - Y$. Together with the expressions for K_n and W_n, we can then write the aggregate asset market clearing condition (B.2) as

$$\frac{1-\kappa}{1+N\kappa}\sum_{m=1}^{N+1}(Q_m - a)\epsilon_m^G + \sum_{m=1}^{N+1}(Q_m - a) = (N+1)(1+a)\left(1 - \frac{1}{\bar{z}} + Y - C^b\right) \tag{B.5}$$

Taking the derivative with respect to G, this implies:

$$\frac{\partial R}{\partial G}=\frac{1}{(N+1)(1+a)\lambda}\frac{1-\kappa}{1+N\kappa}\sum_{m=1}^{N+1}\frac{\partial Q_m}{\partial G}\epsilon_m^G+\frac{1}{(N+1)(1+a)\lambda}\sum_{m=1}^{N+1}\frac{\partial Q_m}{\partial G} \tag{B.6}$$

Next consider the market clearing conditions for risky assets (B.1). Substituting the portfolio shares (19)-(20) and wealth expressions (B.3) into (B.1), the market clearing conditions for risky assets are

$$\begin{aligned}&\frac{1+a}{\bar{z}}\left(1+\epsilon_n^G\right)(1-\kappa)+\kappa(N+1)\frac{1+a}{\bar{z}}+\frac{(1-\kappa)^2}{1+N\kappa}\left(1+\epsilon_n^G\right)^2(Q_n-a)\\&+\frac{(1-\kappa)\kappa}{1+N\kappa}\left(1+\epsilon_n^G\right)^2\sum_m(Q_m-a)+\frac{(1-\kappa)\kappa}{1+N\kappa}\sum_m\left(1+\epsilon_m^G\right)^2(Q_m-a)\\&+\frac{\kappa^2}{1+N\kappa}\left(\sum_m\left(1+\epsilon_m^G\right)^2\right)\left(\sum_m(Q_m-a)\right)=\frac{1+a}{a}K_n\frac{1}{\Gamma G}\frac{\sigma^2}{\bar{D}-RQ_n}\end{aligned} \tag{B.7}$$

Differentiating (B.7) and substituting (B.6) gives

$$\begin{aligned}&\frac{(1-\kappa)^2}{1+N\kappa}\left(1+\epsilon_n^G\right)^2\frac{\partial Q_n}{\partial G}+\frac{(1-\kappa)\kappa}{1+N\kappa}\left(1+\epsilon_n^G\right)^2\sum_m\frac{\partial Q_m}{\partial G}+\frac{(1-\kappa)\kappa}{1+N\kappa}\sum_m\left(1+\epsilon_m^G\right)^2\frac{\partial Q_m}{\partial G}\\&+\frac{\kappa^2}{1+N\kappa}\left(\sum_m\left(1+\epsilon_m^G\right)^2\right)\left(\sum_m\frac{\partial Q_m}{\partial G}\right)=-\frac{1+a}{a}K_n\frac{1}{\Gamma G^2}\frac{\sigma^2}{\bar{D}-RQ_n}\\&+\frac{1+a}{a}RK_n\frac{1}{\Gamma G}\frac{\sigma^2}{(\bar{D}-RQ_n)^2}\frac{\partial Q_n}{\partial G}+Q_nK_n\frac{1}{\Gamma G}\frac{\sigma^2}{(\bar{D}-RQ_n)^2}\frac{1}{(N+1)a\lambda}\sum_{m=1}^{N+1}\frac{\partial Q_m}{\partial G}\\&+Q_nK_n\frac{1}{\Gamma G}\frac{\sigma^2}{(\bar{D}-RQ_n)^2}\frac{1}{(N+1)a\lambda}\frac{1-\kappa}{1+N\kappa}\sum_{m=1}^{N+1}\frac{\partial Q_m}{\partial G}\epsilon_m^G\end{aligned} \tag{B.8}$$

B.2 Impact on Relative Prices Risky Assets

We first consider the impact of the global risk-aversion shock on relative prices of risky assets. We set $\epsilon_n^G=g_n\epsilon$, with $\sum_n g_n=0$. To show that the risky asset price Q_n drops more the lower risk-aversion in country n, and therefore the higher g_n when $\epsilon>0$, we need to show that

$$\frac{\partial^2 Q_n}{\partial G\partial\epsilon} \tag{B.9}$$

depends positively on g_n.

To this end we need to differentiate (B.8) with respect to ϵ and evaluate at $\epsilon=0$ and $G=1$. At that point $\epsilon_m^G=0$, $Q_m=a$, $R=(1+a)/a$, $\bar{D}-RQ=\sigma^2/(a\Gamma(1+N\kappa))$ and $K_n=1$. We also have from (B.4) that $\partial K_n/\partial\epsilon=(1-\kappa)g_n/(1+N\kappa)$. We use that the pre-shock equilibrium for risky asset prices and the interest rate do not depend on ϵ, so that $\partial Q_m/\partial\epsilon=\partial R/\partial\epsilon=0$. Since all first order derivatives of risky asset prices with respect to

G will be the same, we simply denote them $\partial Q/\partial G$ (see (34)). This gives

$$\frac{(1-\kappa)^2}{1+N\kappa}\frac{\partial^2 Q_n}{\partial G\partial\epsilon}+\frac{(2-\kappa+N\kappa)\kappa}{1+N\kappa}\sum_m\frac{\partial^2 Q_m}{\partial G\partial\epsilon}+2(1-\kappa)g_n\frac{\partial Q}{\partial G}=-\frac{1}{\bar{z}}(1+a)(1-\kappa)g_n$$
$$+\frac{1}{\bar{z}^2}(1+a)^2 g_n(1+N\kappa)\Gamma\left(1-\kappa\right)\frac{1}{\sigma^2}\frac{\partial Q}{\partial G}+\frac{1}{\bar{z}^2}(1+a)^2(1+N\kappa)^2\Gamma\frac{1}{\sigma^2}\frac{\partial^2 Q_n}{\partial G\partial\epsilon}$$
$$+\frac{1}{\bar{z}^2}\frac{a^2(1-\kappa)\Gamma(1+N\kappa)}{\lambda\sigma^2}g_n\frac{\partial Q}{\partial G}+\frac{1}{\bar{z}^2}\frac{a^2\Gamma(1+N\kappa)^2}{(N+1)\lambda\sigma^2}\sum_m\frac{\partial^2 Q_m}{\partial G\partial\epsilon} \tag{B.10}$$

Taking the sum over all n, using that $\sum_n g_n = 0$, it follows that $\sum_m \partial^2 Q_m/\partial G\partial\epsilon = 0$. Therefore

$$\frac{\partial^2 Q_n}{\partial G\partial\epsilon}=\frac{(1-\kappa)}{1+N\kappa}g_n\frac{\frac{1+a}{\bar{z}}+\left(2-\frac{1}{\bar{z}^2}(1+a)^2\psi\frac{1}{\sigma^2}-\frac{1}{\bar{z}^2}a^2\psi\frac{1}{\lambda\sigma^2}\right)\frac{\partial Q}{\partial G}}{(1+a)^2\psi\frac{1}{\sigma^2\bar{z}^2}-\frac{(1-\kappa)^2}{(1+N\kappa)^2}} \tag{B.11}$$

Assumption 2 says $\psi(1+a)^2 > \sigma^2\bar{z}^2$. It is immediate from this condition that the denominator of (B.11) is positive. To see that the numerator is positive, we can substitute the solution for $\partial Q/\partial G$ from (34). Multiplying through by the denominator of (34), which is positive, the numerator of the large ratio in (B.11) becomes $(1+a)\bar{z}\sigma^2/\psi$, which is positive. It follows that (B.9) is a positive linear function of g_n, which implies that the risky asset price drops more in countries with lower risk-aversion, which are more leveraged.

B.3 Impact on Total Net Flows

We now consider the impact of the shock on total net capital flows (risky plus safe assets), which is equal to the current account, which is equal to saving. Therefore net flows of country n are

$$NF_n=(1-R_0)B_0+Y-C^b+\frac{1}{\bar{z}}-\frac{1}{1+a}W_n \tag{B.12}$$

Here $(1-R_0)B_0+Y-C^b$ is saving by borrowers and $(1/\bar{z})-W_n/(1+a)$ is saving by investors. They earn dividend and interest income equal to $1/\bar{z}$ and consume $W_n/(1+a)$. Using (B.3), $\sum_m CA_m = 0$, and that consumption by borrowers is the same in all countries, we can write

$$CA_n=\frac{1}{1+N}\sum_m(CA_n-CA_m)=-\frac{1}{1+N}\frac{1}{1+a}\sum_m(W_n-W_m)= \tag{B.13}$$
$$-\frac{1}{1+a}\frac{1}{1+N}\frac{1-\kappa}{1+N\kappa}\sum_m\left((1+\epsilon_n^G)(Q_n-a)-(1+\epsilon_m^G)(Q_m-a)\right)-\frac{1}{1+a}\frac{\kappa}{1+N\kappa}\epsilon_n^G\sum_m(Q_m-a)$$

The effect of a risk aversion shock is

$$\frac{\partial CA_n}{\partial G}=-\frac{1}{1+a}\frac{1}{1+N}\frac{1-\kappa}{1+N\kappa}\sum_m\left((1+\epsilon_n^G)\frac{\partial Q_n}{\partial G}-(1+\epsilon_m^G)\frac{\partial Q_m}{\partial G}\right)-\frac{1}{1+a}\frac{\kappa}{1+N\kappa}\epsilon_n^G\sum_m\frac{\partial Q_m}{\partial G} \tag{B.14}$$

Next take the derivative with respect to ϵ and evaluate at $\epsilon=0$ and $G=1$. Using that

$\sum_{m=1}^{N+1} \partial^2 Q_m / [\partial G \partial \epsilon] = 0$, we have

$$\frac{\partial^2 CA_n}{\partial G \partial \epsilon} = -\frac{1}{1+a}\frac{1-\kappa}{1+N\kappa}\frac{\partial^2 Q_n}{\partial G \partial \epsilon} - \frac{1}{1+a} g_n \frac{\partial Q}{\partial G} \tag{B.15}$$

Since $\partial Q / \partial G > 0$, the last term is a negative linear function of g_n. The same is the case for the first term as we have already established that $\partial^2 Q_n / [\partial G \partial \epsilon]$ is a positive linear function of g_n. It therefore follows that lower risk-aversion (higher g_n with positive ϵ) implies a higher current account when G falls. Net capital outflows will therefore be higher in response to a global risk-aversion shock in countries that are less risk-averse.

B.4 Net Outflows Risky Assets

From (25) and (26), outflows and inflows of risky assets are

$$OF_n^{risky} = \frac{a}{1+a}\sum_{m \neq n} z_{n,m} W_n - \left(1+\epsilon_n^G\right)\frac{\kappa}{1+N\kappa}\sum_{m \neq n} Q_m \tag{B.16}$$

$$IF_n^{risky} = \frac{a}{1+a}\sum_{m \neq n} z_{m,n} W_m - Q_n \frac{\kappa}{1+N\kappa}\sum_{m \neq n}\left(1+\epsilon_m^G\right) \tag{B.17}$$

This uses (24) for $z_{n,m,0}$ and $z_{m,n,0}$. Substituting the time 1 portfolio shares in (20), net outflows of risky assets are

$$NF_n^{risky} = \frac{a}{1+a}\left(1+\epsilon_n^G\right) W_n G \Gamma \kappa \sum_m Q_m \frac{\bar{D} - RQ_m}{\sigma^2} \tag{B.18}$$

$$-\frac{a}{1+a} G\Gamma\kappa Q_n \frac{\bar{D} - RQ_n}{\sigma^2}\sum_m \left(1+\epsilon_m^G\right) W_m + (N+1) Q_n \frac{\kappa}{1+N\kappa} - \left(1+\epsilon_n^G\right)\frac{\kappa}{1+N\kappa}\sum_m Q_m$$

Taking the derivative with respect to G, we have

$$\begin{aligned}
\frac{\partial NF_n^{risky}}{\partial G} &= \frac{a}{1+a}\left(1+\epsilon_n^G\right)\Gamma\kappa\left(\sum_m Q_m \frac{\bar{D} - RQ_m}{\sigma^2}\right)\left(G\frac{\partial W_n}{\partial G} + W_n\right) \\
&+ \frac{a}{1+a}\frac{\left(1+\epsilon_n^G\right) W_n G\Gamma\kappa}{\sigma^2}\sum_m\left((\bar{D} - 2RQ_m)\frac{\partial Q_m}{\partial G} - Q_m^2\frac{\partial R}{\partial G}\right) \\
&- \frac{a}{1+a}\Gamma\kappa\frac{\bar{D}Q_n - RQ_n^2}{\sigma^2}\left(\sum_m\left(1+\epsilon_m^G\right) W_m + G\sum_m\left(1+\epsilon_m^G\right)\frac{\partial W_m}{\partial G}\right) \\
&- \frac{a}{1+a}\frac{G\Gamma\kappa}{\sigma^2}\left(\sum_m\left(1+\epsilon_m^G\right) W_m\right)\left((\bar{D} - 2RQ_n)\frac{\partial Q_n}{\partial G} - Q_n^2\frac{\partial R}{\partial G}\right) \\
&+ \frac{\kappa(N+1)}{1+N\kappa}\frac{\partial Q_n}{\partial G} - \left(1+\epsilon_n^G\right)\frac{\kappa}{1+N\kappa}\sum_m\frac{\partial Q_m}{\partial G}
\end{aligned} \tag{B.19}$$

Next we take the derivative with respect to ϵ at the starting point where $\epsilon = 0$ and

$G=1$. It is useful to first compute the derivatives involving wealth, using (B.3). Since the first-order derivatives of risky asset prices with respect to ϵ are zero, so is the first-order derivative of W_n with respect to ϵ. It is also useful to derive an expression for $\partial^2 W_n/\partial G\partial\epsilon$. We have

$$\frac{\partial W_n}{\partial G} = \left(1+\epsilon_n^G\right)\frac{1-\kappa}{1+N\kappa}\frac{\partial Q_n}{\partial G} + \left(1+\epsilon_n^G\right)\frac{\kappa}{1+N\kappa}\sum_m \frac{\partial Q_m}{\partial G} \tag{B.20}$$

Evaluated at the initial point, this is equal to $\partial Q/\partial G$. The second order derivative is

$$\frac{\partial^2 W_n}{\partial G\partial\epsilon} = g_n\frac{\partial Q}{\partial G} + \frac{1-\kappa}{1+N\kappa}\frac{\partial^2 Q_n}{\partial G\partial\epsilon} + \frac{\kappa}{1+N\kappa}\sum_m \frac{\partial^2 Q_m}{\partial G\partial\epsilon} \tag{B.21}$$

We also use that $\partial R/\partial G = (\partial Q/\partial G)/((1+a)\lambda)$ from (B.6).

Using this, taking the derivative of (B.19) with respect to ϵ, and subtracting the same expression for country k, gives

$$\begin{aligned}
\frac{\partial^2\left(NF_n^{risky} - NF_k^{risky}\right)}{\partial G\partial\epsilon} &= 2\frac{a}{1+a}\frac{\kappa(N+1)}{1+N\kappa}(g_n-g_k)\bar{z}\frac{\partial Q}{\partial G} + a\left(g_n-g_k\right)\frac{\kappa(N+1)}{1+N\kappa} \\
&+\frac{a}{1+a}\frac{\kappa(1-\kappa)(N+1)}{(1+N\kappa)^2}\frac{\partial^2(Q_n-Q_k)}{\partial G\partial\epsilon} + \left(g_n-g_k\right)\frac{\kappa(N+1)}{1+N\kappa}\left(1-\frac{a(1+a)(1+N\kappa)\Gamma}{\sigma^2\bar{z}}\right)\frac{\partial Q}{\partial G} \\
&-\frac{1}{\bar{z}}\frac{a^3(N+1)\Gamma\kappa}{(1+a)\lambda\sigma^2}\left(g_n-g_k\right)\frac{\partial Q}{\partial G} - \frac{\kappa(N+1)}{1+N\kappa}\left(1-\frac{a(1+a)(1+N\kappa)\Gamma}{\sigma^2\bar{z}}\right)\frac{\partial^2(Q_n-Q_k)}{\partial G\partial\epsilon} \\
&+\frac{\kappa(N+1)}{1+N\kappa}\frac{\partial^2(Q_n-Q_k)}{\partial G\partial\epsilon} - \frac{\kappa(N+1)}{1+N\kappa}(g_n-g_k)\frac{\partial Q}{\partial G}
\end{aligned}$$

Aggregating across k and using that $\sum_k NF_k^{risky}=0$, we have

$$\begin{aligned}
\frac{\partial^2 NF_n^{risky}}{\partial G\partial\epsilon} &= 2\frac{a}{1+a}\frac{\kappa(N+1)}{1+N\kappa}g_n\bar{z}\frac{\partial Q}{\partial G} + ag_n\frac{\kappa(N+1)}{1+N\kappa} \\
&+\frac{a}{1+a}\frac{\kappa(1-\kappa)}{(1+N\kappa)^2}\sum_k\frac{\partial^2(Q_n-Q_k)}{\partial G\partial\epsilon} + g_n\frac{\kappa(N+1)}{1+N\kappa}\left(1-\frac{a(1+a)(1+N\kappa)\Gamma}{\sigma^2\bar{z}}\right)\frac{\partial Q}{\partial G} \\
&-\frac{1}{\bar{z}}\frac{a^3(N+1)\Gamma\kappa}{(1+a)\lambda\sigma^2}g_n\frac{\partial Q}{\partial G} - \frac{\kappa}{1+N\kappa}\left(1-\frac{a(1+a)(1+N\kappa)\Gamma}{\sigma^2\bar{z}}\right)\sum_k\frac{\partial^2(Q_n-Q_k)}{\partial G\partial\epsilon} \\
&+\frac{\kappa}{1+N\kappa}\sum_k\frac{\partial^2(Q_n-Q_k)}{\partial G\partial\epsilon} - \frac{\kappa(N+1)}{1+N\kappa}g_n\frac{\partial Q}{\partial G}
\end{aligned} \tag{B.22}$$

We need to show that (B.22) is a positive linear function of g_n. If so, it follows that countries with lower risk-aversion (higher g_n when $\epsilon>0$) have lower net outflows of risky assets when global risk aversion rises (G falls). Using that $\sum_{k=1}^{N+1}\partial^2 Q_k/[\partial G\partial\epsilon]=0$, collecting terms gives

$$\frac{\partial^2 NF_n^{risky}}{\partial G \partial \epsilon} = \frac{\kappa(N+1)}{1+N\kappa}\left(\frac{a}{1+a}\frac{1-\kappa}{1+N\kappa} + a(1+a)(1+N\kappa)\frac{\Gamma}{\sigma^2 \bar{z}}\right)\frac{\partial^2 Q_n}{\partial G \partial \epsilon} +$$
$$\frac{\kappa(N+1)}{1+N\kappa} g_n \left[a + \left(2\frac{a\bar{z}}{1+a} - \frac{a(1+a)(1+N\kappa)\Gamma}{\sigma^2 \bar{z}} - \frac{a^3\Gamma(1+N\kappa)}{(1+a)\lambda\sigma^2\bar{z}}\right)\frac{\partial Q}{\partial G}\right] \quad \text{(B.23)}$$

The first line is clearly a positive linear function of g_n as we have already shown that $\partial^2 Q_n/\partial G\partial\epsilon$ is a positive linear function of g_n. Substituting the expression for $\partial Q/\partial G$ in (34), the second line becomes

$$\frac{\kappa(N+1)}{1+N\kappa} g_n \frac{a\sigma^2\bar{z}^2}{(1+a)^2\Gamma(1+N\kappa) - \sigma^2\bar{z}^2 + \frac{a^2\Gamma(1+N\kappa)}{\lambda}}$$

This is also a positive linear function of g_n. The denominator is positive by Assumption 2 that $\sigma^2\bar{z}^2 < \Gamma(1+N\kappa)(1+a)^2$.

Since the second-order derivative of total net outflows is a negative function of g_n, and the second-order derivative of net outflows of risky assets is a positive function of g_n, it follows that the second-order derivative of net outflows of safe assets is a negative function of g_n. Therefore a country with lower than average risk-aversion will have negative net outflows of risky assets due to the global risk-aversion shock, and positive total net outflows and net outflows of safe assets.

C Cross Country Heterogeneity in Expected Dividends

Following the same steps as in Appendix B, we now consider the impact of heterogeneity across countries in expected dividends.

C.1 Market Clearing Conditions

The market clearing conditions remain the same as (21)-(22). Using the period 0 portfolio shares, which correspond to (23)-(24), wealth is

$$W_n = \frac{1+a}{\bar{z}} + \frac{1-\kappa}{1+N\kappa}(1+d_n\epsilon)(Q_n - a) + \frac{\kappa}{1+N\kappa}\sum_m (1+d_m\epsilon)(Q_m - a) \quad \text{(C.1)}$$

From Assumption 1 we have $K_n = 1 + d_n\epsilon$. Since $\sum_n d_n = 0$, it follows that $\sum_n K_n = N+1$, so that from Assumption 1 $B_0 = a((1/\bar{z}) - 1)$. Therefore $B = (1+a)((1/\bar{z}) - 1) + C^b - Y$. Together with the expressions for K_n and W_n, we can then write the aggregate asset market clearing condition (22) as

$$\sum_{m=1}^{N+1}(1+d_m\epsilon)(Q_m - a) = (N+1)(1+a)\left(1 - \frac{1}{\bar{z}} + Y - C^b\right) \quad \text{(C.2)}$$

Taking the derivative with respect to G, we have

$$\frac{\partial R}{\partial G} = \frac{1}{(N+1)(1+a)\lambda} \sum_{m=1}^{N+1} (1+d_m\epsilon) \frac{\partial Q_m}{\partial G} \tag{C.3}$$

Next consider the market clearing conditions for risky assets (21). Substituting the portfolio shares (19)-(20) and wealth expressions (C.1) into (21), the market clearing conditions for risky assets are

$$\begin{aligned} &\frac{(1+a)(1+N\kappa)}{\bar{z}} + \frac{(1-\kappa)^2}{1+N\kappa}(1+d_n\epsilon)(Q_n - a) + \kappa\left(1 + \frac{1-\kappa}{1+N\kappa}\right)\sum_m (1+d_m\epsilon)(Q_m - a) \\ &= \frac{1+a}{a}(1+d_n\epsilon)\frac{1}{\Gamma G}\frac{\sigma^2}{\bar{D}_n - RQ_n} \end{aligned} \tag{C.4}$$

Differentiating with respect to G and substituting (C.3), we have

$$\begin{aligned} &\frac{(1-\kappa)^2}{1+N\kappa}(1+d_n\epsilon)\frac{\partial Q_n}{\partial G} + \kappa\left(1+\frac{1-\kappa}{1+N\kappa}\right)\sum_m (1+d_m\epsilon)\frac{\partial Q_m}{\partial G} \\ &= -\frac{1+a}{a}(1+d_n\epsilon)\frac{1}{\Gamma G^2}\frac{\sigma^2}{\bar{D}_n - RQ_n} + \frac{1+a}{a}(1+d_n\epsilon)\frac{1}{\Gamma G}\frac{\sigma^2}{(\bar{D}_n - RQ_n)^2} R \frac{\partial Q_n}{\partial G} \\ &+ \frac{1}{(N+1)a\lambda}(1+d_n\epsilon)\frac{1}{\Gamma G}\frac{\sigma^2}{(\bar{D}_n - RQ_n)^2} Q_n \sum_{m=1}^{N+1}(1+d_m\epsilon)\frac{\partial Q_m}{\partial G} \end{aligned} \tag{C.5}$$

C.2 Impact on Relative Prices Risky Assets

We first consider the impact of the global risk-aversion shock on relative prices of risky assets. To show that the risky asset price Q_n drops more in countries with a higher expected dividend, and therefore a higher d_n when $\epsilon > 0$, we need to show that $\partial^2 Q_n/[\partial G \partial \epsilon]$ depends positively on d_n.

To this end we need to differentiate (C.5) with respect to ϵ and evaluate at $\epsilon = 0$ and $G = 1$. At that point $Q_m = a$, $R = (1+a)/a$ and $\bar{D}_n - RQ = \sigma^2 \bar{z}/(a\Gamma(1+N\kappa))$. From the expression for $\bar{D}_n$ in Assumption 1 we have that $\partial \bar{D}_n/\partial\epsilon = d_n \sigma^2 \bar{z}/[a\Gamma(1+N\kappa)]$. We use that the pre-shock equilibrium for risky asset prices and the interest rate does not depend on ϵ, so that $\partial Q_m/\partial \epsilon = \partial R/\partial\epsilon = 0$. Since all first order derivatives of risky asset prices with respect to G will be the same, we simply denote them $\partial Q/\partial G$ (see (34)). This gives

$$\begin{aligned} &\frac{(1-\kappa)^2}{1+N\kappa} d_n \frac{\partial Q}{\partial G} + \frac{(1-\kappa)^2}{1+N\kappa}\frac{\partial^2 Q_n}{\partial G \partial \epsilon} + \kappa\left(1+\frac{1-\kappa}{1+N\kappa}\right)\sum_m \frac{\partial^2 Q_m}{\partial G\partial\epsilon} = \\ &+(1+a)^2 \frac{\Gamma(1+N\kappa)^2}{\sigma^2 \bar{z}^2}\frac{\partial^2 Q_n}{\partial G\partial\epsilon} - \frac{\Gamma(1+N\kappa)^2}{\sigma^2\bar{z}^2} d_n \left((1+a)^2 + \frac{a^2}{\lambda}\right)\frac{\partial Q}{\partial G} + \frac{\Gamma(1+N\kappa)^2 a^2}{(N+1)\lambda\sigma^2\bar{z}^2}\sum_{m=1}^{N+1}\frac{\partial^2 Q_m}{\partial G\partial\epsilon} \end{aligned} \tag{C.6}$$

Taking the sum across n, using that $\sum_{n=1}^{N+1} d_n = 0$, gives $\sum_{n=1}^{N+1} \partial^2 Q_n/[\partial G\partial\epsilon] = 0$. We then have

$$\frac{\partial^2 Q_n}{\partial G \partial \epsilon} = d_n \frac{\frac{(1-\kappa)^2}{1+N\kappa} + \frac{1}{\sigma^2 \bar{z}^2}\Gamma(1+N\kappa)^2 \left((1+a)^2 + \frac{a^2}{\lambda}\right)}{(1+a)^2\Gamma(1+N\kappa)^2 \frac{1}{\sigma^2 \bar{z}^2} - \frac{(1-\kappa)^2}{1+N\kappa}} \frac{\partial Q}{\partial G} \tag{C.7}$$

The numerator of this ratio is positive. The denominator is positive as well since from Assumption 2 we have $\bar{z}^2\sigma^2 < (1+a)^2\Gamma(1+N\kappa)$. Since $\partial Q/\partial G$ is positive, it follows that (C.7) is a positive linear function of d_n, which implies that the risky asset price drops more in countries with a higher expected dividend.

C.3 Impact on Total Net Flows

We now consider the impact of the shock on total net capital flows, which is equal to the current account as in (B.13). As in (B.13), we have $CA_n = -\sum_m (W_n - W_m)/[(1+a)(1+N)]$. Using the wealth expression (C.1), we have

$$CA_n = \frac{1}{1+a}\frac{1-\kappa}{1+N\kappa}\left(-(1+d_n\epsilon)(Q_n - a) + \frac{1}{1+N}\sum_m (1+d_m\epsilon)(Q_m - a)\right)$$

The effect of a risk aversion shock is

$$\frac{\partial CA_n}{\partial G} = \frac{1}{1+a}\frac{1-\kappa}{1+N\kappa}\left(-(1+d_n\epsilon)\frac{\partial Q_n}{\partial G} + \frac{1}{1+N}\sum_m (1+d_m\epsilon)\frac{\partial Q_m}{\partial G}\right)$$

Next take the derivative with respect to ϵ and evaluate at $\epsilon = 0$ and $G = 1$. This gives

$$\frac{\partial^2 CA_n}{\partial G \partial \epsilon} = -\frac{1}{1+a}\frac{1-\kappa}{1+N\kappa}\left(d_n \frac{\partial Q}{\partial G} + \frac{\partial^2 Q_n}{\partial G \partial \epsilon}\right) \tag{C.8}$$

Since $\partial Q/\partial G > 0$ and we have already shown that $\partial^2 Q_n/[\partial G \partial \epsilon]$ is a positive linear function of d_n, it follows that this second derivative is a negative linear function of d_n. Therefore countries with higher expected dividends (higher d_n when $\epsilon > 0$) have larger net capital outflows when G falls.

C.4 Net Outflows Risky Assets

From (25) and (26), substituting the portfolio expressions (20) and (24), net outflows of risky assets are

$$NF_n^{risky} = \frac{a}{1+a} W_n G \Gamma \kappa \sum_m Q_m \frac{\bar{D}_m - RQ_m}{\sigma^2} - \frac{a}{1+a} G\Gamma\kappa Q_n \frac{\bar{D}_n - RQ_n}{\sigma^2}\sum_m W_m$$
$$+ \frac{\kappa(N+1)}{1+N\kappa}(1+d_n\epsilon)Q_n - \frac{\kappa}{1+N\kappa}\sum_m (1+d_m\epsilon)Q_m \tag{C.9}$$

Taking the derivative with respect to G, we have

$$\frac{1+a}{a}\frac{\partial NF_n^{risky}}{\partial G} = W_n\frac{\Gamma\kappa}{\sigma^2}\sum_m \left(\bar{D}_m Q_m - RQ_m^2\right) \tag{C.10}$$

$$+\frac{\partial W_n}{\partial G}\frac{G\Gamma\kappa}{\sigma^2}\sum_m \left(\bar{D}_m Q_m - RQ_m^2\right) + W_n\frac{G\Gamma\kappa}{\sigma^2}\sum_m \left[\left(\bar{D}_m - 2RQ_m\right)\frac{\partial Q_m}{\partial G} - Q_m^2\frac{\partial R}{\partial G}\right]$$

$$-\frac{\Gamma\kappa}{\sigma^2}\left(\bar{D}_n Q_n - RQ_n^2\right)\sum_m W_m$$

$$-\frac{G\Gamma\kappa}{\sigma^2}\left(\bar{D}_n - 2RQ_n\right)\frac{\partial Q_n}{\partial G}\sum_m W_m$$

$$-\frac{G\Gamma\kappa}{\sigma^2}\left(\bar{D}_n Q_n - RQ_n^2\right)\sum_m \frac{\partial W_m}{\partial G}$$

$$+\frac{G\Gamma\kappa}{\sigma^2}Q_n^2\frac{\partial R}{\partial G}\sum_m W_m + \frac{1+a}{a}\frac{\kappa(N+1)}{1+N\kappa}\frac{\partial Q_n}{\partial G}(1+d_n\epsilon) - \frac{\kappa}{1+N\kappa}\sum_m (1+d_m\epsilon)\frac{\partial Q_m}{\partial G}$$

We will evaluate this derivative with respect to ϵ at the starting point where $\epsilon = 0$ and $G = 1$. Use that the derivative of any asset price Q_m and wealth W_m with respect to ϵ is zero at this point. It is also useful to derive an expression for $\partial^2 W_n/\partial G\partial\epsilon$. We have

$$\frac{\partial W_n}{\partial G} = \frac{1-\kappa}{1+N\kappa}(1+d_n\epsilon)\frac{\partial Q_n}{\partial G} + \frac{\kappa}{1+N\kappa}\sum_m (1+d_m\epsilon)\frac{\partial Q_m}{\partial G} \tag{C.11}$$

Evaluated at the initial point, this is equal to $\partial W_n/\partial G = \partial Q/\partial G$. The second order derivative is

$$\frac{\partial^2 W_n}{\partial G\partial\epsilon} = \frac{1-\kappa}{1+N\kappa}d_n\frac{\partial Q}{\partial G} + \frac{1-\kappa}{1+N\kappa}\frac{\partial^2 Q_n}{\partial G\partial\epsilon} + \frac{\kappa}{1+N\kappa}\sum_m \frac{\partial^2 Q_m}{\partial G\partial\epsilon} \tag{C.12}$$

Taking the derivative of (C.10) with respect to ϵ then gives

$$\frac{\partial^2 NF_n^{risky}}{\partial G\partial\epsilon} = \frac{a}{1+a}\frac{\kappa(1-\kappa)(N+1)}{(1+N\kappa)^2}\bar{z}d_n\frac{\partial Q}{\partial G} + \frac{a}{1+a}\frac{\kappa(1-\kappa)(N+1)\bar{z}}{(1+N\kappa)^2}\frac{\partial^2 Q_n}{\partial G\partial\epsilon}$$

$$-a\frac{\kappa(N+1)}{1+N\kappa}d_n - \frac{\kappa(N+1)}{1+N\kappa}d_n\frac{\partial Q}{\partial G} + \frac{\kappa(N+1)}{1+N\kappa}\left(\frac{(1+a)(1+N\kappa)\Gamma a}{\sigma^2\bar{z}} - 1\right)\frac{\partial^2 Q_n}{\partial G\partial\epsilon}$$

$$-\frac{a}{1+a}\frac{\kappa(N+1)\bar{z}}{1+N\kappa}d_n\frac{\partial Q}{\partial G} + \frac{\kappa(N+1)}{1+N\kappa}\frac{\partial^2 Q_n}{\partial G\partial\epsilon} + \frac{\kappa(N+1)}{1+N\kappa}d_n\frac{\partial Q}{\partial G}$$

Collecting terms, we have

$$\frac{\partial^2 NF_n^{risky}}{\partial G\partial\epsilon} = -a\frac{\kappa(N+1)}{1+N\kappa}d_n - \frac{a}{1+a}\frac{\kappa^2(N+1)^2\bar{z}}{(1+N\kappa)^2}d_n\frac{\partial Q}{\partial G}$$

$$+\frac{a}{1+a}\frac{\kappa(N+1)}{1+N\kappa}\left(\frac{(1-\kappa)\bar{z}}{1+N\kappa} + \frac{1}{\sigma^2\bar{z}}(1+a)^2(1+N\kappa)\Gamma\right)\frac{\partial^2 Q_n}{\partial G\partial\epsilon} \tag{C.13}$$

Using that $\sum_{k=1}^{N+1} \partial^2 Q_k / [\partial G \partial \epsilon] = 0$, substituting (34) and (C.7) and collecting terms, we have

$$\frac{\partial^2 NF_n^{risky}}{\partial G \partial \epsilon} = \tag{C.14}$$

$$\frac{a\kappa(N+1)}{(1+N\kappa)} \frac{(2+(N-1)\kappa)(1-\kappa)\Gamma\left(2(1+a)^2+\frac{a^2}{\lambda}\right)d_n}{\left((1+a)^2\Gamma(1+N\kappa)-\sigma^2\bar{z}^2+\frac{a^2}{\lambda}\Gamma(1+N\kappa)\right)\left((1+a)^2\Gamma(1+N\kappa)^2\frac{1}{\sigma^2\bar{z}^2}-\frac{(1-\kappa)^2}{1+N\kappa}\right)}$$

This is clearly a positive linear function of d_n. The terms in the denominator are positive since $\sigma^2\bar{z}^2 < (1+a)^2\Gamma(1+N\kappa)$.

Since the second-order derivative of total net outflows is a negative function of d_n, and the second-order derivative of net outflows of risky assets is a positive function of d_n, it follows that the second-order derivative of net outflows of safe assets is a negative function of d_n. Therefore a country with a higher than average expected dividends will have negative net outflows of risky assets due to the global risk-aversion shock, and positive total net outflows and net outflows of safe assets.

D Proof of Theorem 3

Given the results in Appendix B and C, Theorem 3 is now easy to prove. Let X_n be either Q_n, NF_n, NF_n^{risky} or NF_n^{safe}. We have seen that for risk-aversion heterogeneity

$$\frac{\partial^2 X_n}{\partial G \partial \epsilon} \tag{D.1}$$

is a positive linear function of g_n when X_n is Q_n or NF_n^{risky}, while it is a negative linear function of g_n when X_n is NF_n or NF_n^{safe}. Similarly, under expected dividend heterogeneity (D.1) is a positive linear function of d_n when X_n is Q_n or NF_n^{risky}, while it is a negative linear function of d_n when X_n is NF_n or NF_n^{safe}.

Assume without loss of generality that $\epsilon > 0$. First assume that there is risk-aversion heterogeneity. From Section 5.1, a country for which $g_n > 0$ then has a negative net foreign asset position in safe assets. The results then imply that as a result of a rise in global risk-aversion Q_n and NF_n^{risky} are lower than in the average country, while NF_n and NF_n^{safe} are higher than in the average country. This means that a country with a negative net foreign asset position of safe assets has a larger than average drop in the risky asset price, negative net outflows of risky assets and positive total net outflows and net outflows of safe assets. This uses that the first-order derivatives of all net outflow variables with respect to G are zero. Since (D.1) is linear in g_n, the opposite will be the case for countries with a positive net foreign asset position of safe assets. It also follows that the size of these changes (in the relative risky asset price and net capital flow variables) is larger the larger the absolute size of the net foreign asset position of safe assets. The exact same results apply under expected dividend heterogeneity, using from Section 5.1 that a country for which $d_n > 0$ has a negative net foreign asset position of safe assets.

E Section 5 Results

Here we derive (46) and (47). The quantity that country n holds at time 1 of risky assets from country m is equal to

$$k_{n,m} = \beta \frac{z_{n,m} W_n}{Q_m} \tag{E.1}$$

Using the portfolio expressions (19)-(20), this gives

$$k_{m,m} = \beta \Gamma (1+\epsilon_m^G) G \frac{\bar{D}_m - RQ_m}{\sigma^2} W_m \tag{E.2}$$

$$k_{n,m} = \beta \Gamma \kappa (1+\epsilon_n^G) G \frac{\bar{D}_m - RQ_m}{\sigma^2} W_n \tag{E.3}$$

In period 0 we have

$$k_{m,m,0} = \frac{1}{1+N\kappa}(1+\epsilon_m^G)(1+\epsilon_m^D) \tag{E.4}$$

$$k_{n,m,0} = \frac{\kappa}{1+N\kappa}(1+\epsilon_n^G)(1+\epsilon_m^D) \tag{E.5}$$

Therefore for all n

$$\frac{k_{n,m}}{k_{n,m,0}} = a_m W_n \tag{E.6}$$

where

$$a_m = \beta(1+N\kappa)\Gamma G \frac{\bar{D} - RQ_m}{\sigma^2} \frac{1}{1+\epsilon_m^D} \tag{E.7}$$

The market equilibrium condition for country m risky assets is

$$\sum_{l=1}^{N+1} k_{l,m} = K_m \tag{E.8}$$

or

$$a_m \sum_{l=1}^{N+1} k_{l,m,0} W_l = K_m \tag{E.9}$$

It follows that

$$a_m = \frac{K_m}{\sum_{l=1}^{N+1} k_{l,m,0} W_l} = \frac{1}{\sum_{l=1}^{n+1} \omega_{l,m} W_l} \tag{E.10}$$

where

$$\omega_{l,m} = \frac{k_{l,m,0}}{K_m} \tag{E.11}$$

is the fraction of the country m quantity of risky assets that is held by country l at time 0. It then follows that

$$k_{n,m} = a_m k_{n,m,0} W_n = \frac{W_n}{\sum_{l=1}^{n+1} \omega_{l,m} W_l} k_{n,m,0} \tag{E.12}$$

This is equation (46).

Next we derive (47). Start from (29):

$$NF_n^{safe} = B_0 - B + \beta\left(1 - \sum_{m=1}^{N+1} z_{n,m}\right) W_n - \beta\left(1 - \sum_{m=1}^{N+1} z_{n,m,0}\right) W_{n,0} \tag{E.13}$$

We have $\beta z_{n,m} W_n = k_{n,m} Q_m$. Therefore

$$NF_n^{safe} = B_0 - B + \beta(W_n - W_{n,0}) - \sum_{m=1}^{N+1} k_{n,m} Q_m + \sum_{m=1}^{N+1} k_{n,m,0} Q_{m,0} \tag{E.14}$$

We can further rewrite this as

$$NF_n^{safe} = B_0 - B + \beta(W_n - W_{n,0}) - \sum_{m=1}^{N+1} \left(k_{n,m} - k_{n,m,0}\right) Q_m - \sum_{m=1}^{N+1} k_{n,m,0}(Q_m - Q_{m,0}) \tag{E.15}$$

The first term is saving of borrowers. The second term is the change in financial wealth of investors, which is saving of investors plus valuation effects. The latter is $\sum_{m=1}^{N+1} k_{n,m,0}(Q_m - Q_{m,0})$. We then have

$$NF_n^{safe} = S_n - \sum_{m=1}^{N+1} \left(k_{n,m} - k_{n,m,0}\right) Q_m \tag{E.16}$$

where S_n is country n saving. This corresponds to (47).

Table 1: Cross-country Statistics for Net Foreign Asset Positions

Descriptive Statistics (as % of GDP)			
	nfa_n	nfa_n^{safe}	nfa_n^{risky}
Mean	1.84	-11.00	12.84
Median	-5.33	-24.86	9.01
p25	-26.33	-42.29	-9.71
p75	17.89	13.34	28.25
St Dev.	76.61	77.02	28.24
min	-171.00	-208.23	-31.91
max	217.60	208.57	77.88

Cross-Country Correlation			
	nfa_n	nfa_n^{safe}	nfa_n^{risky}
nfa_n	1.00		
nfa_n^{safe}	0.93	1.00	
nfa_n^{risky}	0.17	-0.20	1.00

Notes: nfa_n^{safe} and nfa_n^{risky} are the net foreign asset positions in safe and risky assets in country n, and nfa_n is their sum. All variables are normalized by the prior years GDP in country n. The maximum and minimum values of nfa_n^{safe} and nfa_n occur in Singapore and Iceland, respectively. The maximum and minimum values of nfa_n^{risky} occur in Norway and Portugal, respectively.

Table 2: Panel Regressions on First Capital Flows Factor

	$\Delta nf_{n,t}^{safe}$	$\Delta nf_{n,t}^{safe}$	$\Delta nf_{n,t}^{safe}$	$\Delta nf_{n,t}^{risky}$	$\Delta nf_{n,t}^{risky}$	$\Delta nf_{n,t}^{risky}$
ΔF_t	-0.795	-0.436	-0.474	1.016*	0.795*	0.616*
	(0.790)	(0.445)	(0.410)	(0.613)	(0.458)	(0.324)
$nfa_{n,t}^{safe} \times \Delta F_t$		0.025***	0.026***		-0.016**	-0.012**
		(0.008)	(0.009)		(0.007)	(0.005)
$nfa_{n,t}^{risky} \times \Delta F_t$			0.004			0.020
			(0.013)			(0.023)
R^2	0.084	0.205	0.205	0.480	0.519	0.526
	$\Delta nf_{n,t}$	$\Delta nf_{n,t}$	$\Delta nf_{n,t}$	$\Delta save_{n,t}$	$\Delta save_{n,t}$	$\Delta save_{n,t}$
ΔF_t	0.222	0.360	0.142	0.627***	0.722***	0.669***
	(0.321)	(0.230)	(0.361)	(0.197)	(0.130)	(0.109)
$nfa_{n,t}^{safe} \times \Delta F_t$		0.010***	0.014**		0.007***	0.008***
		(0.002)	(0.007)		(0.002)	(0.002)
$nfa_{n,t}^{risky} \times \Delta F_t$			0.024			0.006
			(0.021)			(0.004)
R^2	0.458	0.475	0.487	0.104	0.172	0.177
	$\Delta invest_{n,t}$	$\Delta invest_{n,t}$	$\Delta invest_{n,t}$	$\Delta q_{n,t}$	$\Delta q_{n,t}$	$\Delta q_{n,t}$
ΔF_t	0.540***	0.509***	0.484***	16.170***	16.206***	16.130***
	(0.089)	(0.069)	(0.060)	(0.982)	(0.984)	(0.961)
$nfa_{n,t}^{safe} \times \Delta F_t$		-0.002*	-0.002*		-0.007	-0.007
		(0.001)	(0.001)		(0.009)	(0.009)
$nfa_{n,t}^{risky} \times \Delta F_t$			0.003			0.005
			(0.002)			(0.037)
R^2	0.191	0.205	0.208	0.376	0.379	0.380

Notes: $\Delta nf_{n,t}^{safe}$ is the year-over-year change in net safe capital outflows, $\Delta nf_{n,t}^{risky}$ is the year-over-year change in net risky capital outflows, $\Delta nf_{n,t}$ is the year-over-year change in total net capital outflows (safe plus risky), $\Delta save_{n,t}$ is the year-over-year change in saving, $\Delta invest_{n,t}$ is the year-over-year change in investment, $nfa_{n,t-1}^{safe}$ and $nfa_{n,t-1}^{risky}$ are a country's net foreign asset positions of safe and risky assets. All variables are normalized by the prior years GDP. All regressions include a country-fixed effect and a one-year lag of the year-over-year change in net risky capital outflows, net safe capital outflows, and saving. Robust standard errors are clustered by country. ***/**/* denotes significance at the 1/5/10% level.

Table 3: Parameter Values

Parameter	Value	Target
$N+1$	20	Number of countries
a	25	4 percent annual interest rate
Y	2	Labor income share of 67%
ρ	0.5	Intemporal elasticity 0.5
$\bar{z}$	0.5	U.S. Flow of Funds Data
κ	0.0195	Foreign portfolio share of 27%
ν	0.33	Cross-country equity market correlations
Γ	0.1	Risk aversion of 10
σ	2.17	Equity risk premium 4.6 percent
ξ	9	Decline in investment following change in asset prices

Table 4: Responses to 10 Percent Fall Risky Asset Prices

	Data	Model Benchmark	Model Imperfect Substitution
Change after 10% fall in risky asset prices in a country with $nfa^{safe}_{n,0} = -100\%$ relative to a country with $nfa^{safe}_{n,0} = 0\%$			
$nf_{n,t}$	0.603	0.564	0.561
$save_{n,t}$	0.418	0.504	0.501
$invest_{n,t}$	-0.137	-0.061	-0.060
$nf^{risky}_{n,t}$	-0.967	-3.687	-0.786
$nf^{safe}_{n,t}$	1.570	4.251	1.346
$q_{n,t}$	-0.413	-0.577	-0.563

Notes: Data moments are based on Tables 1 and 2, setting $\Delta F_t = -10/16.2$, leading to 10 percent drop in average risky asset price. Model moments are based on drop in G that leads to an average drop in risky asset prices of 10 percent. Moments in italics are targeted. The last column is based on extension in Section 6.5 where there are $N+1$ safe assets that are imperfect substitutes.

Figure 1: First Factor from Capital Flow Factor Model and MAR factor

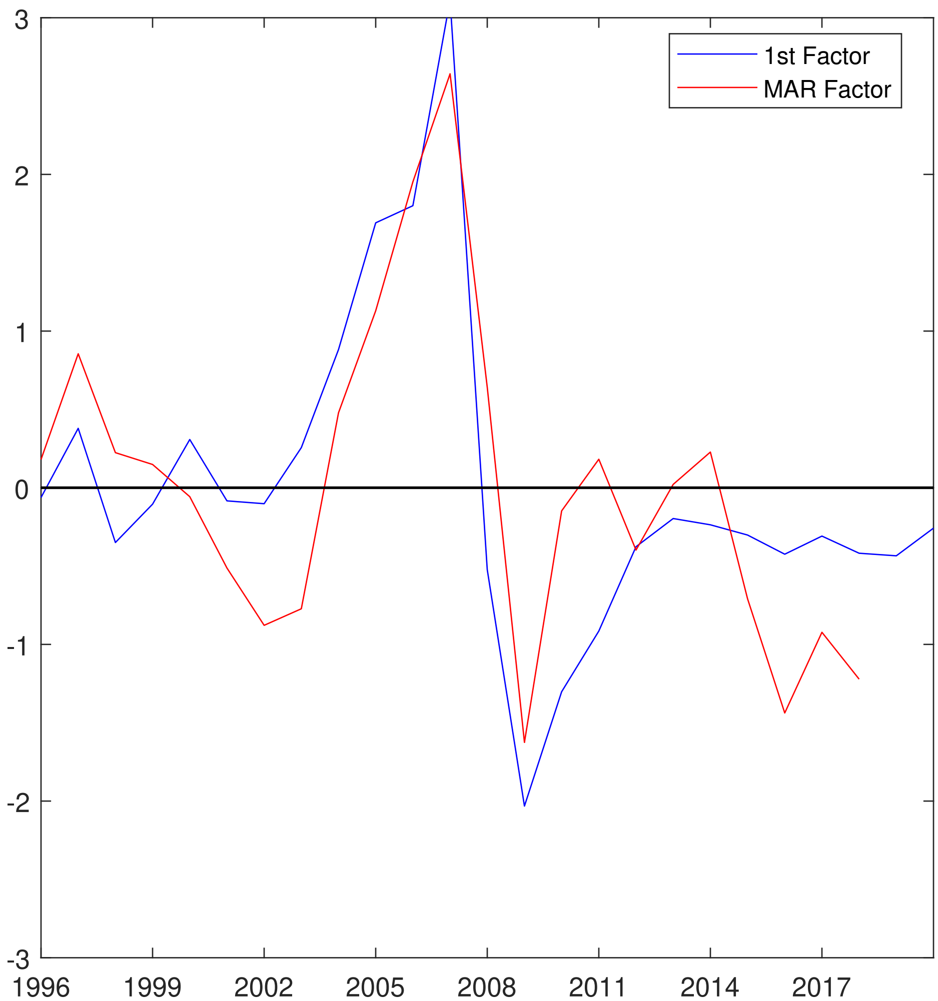


Figure 2: Asset Market Equilibrium following Global Risk Aversion Shock

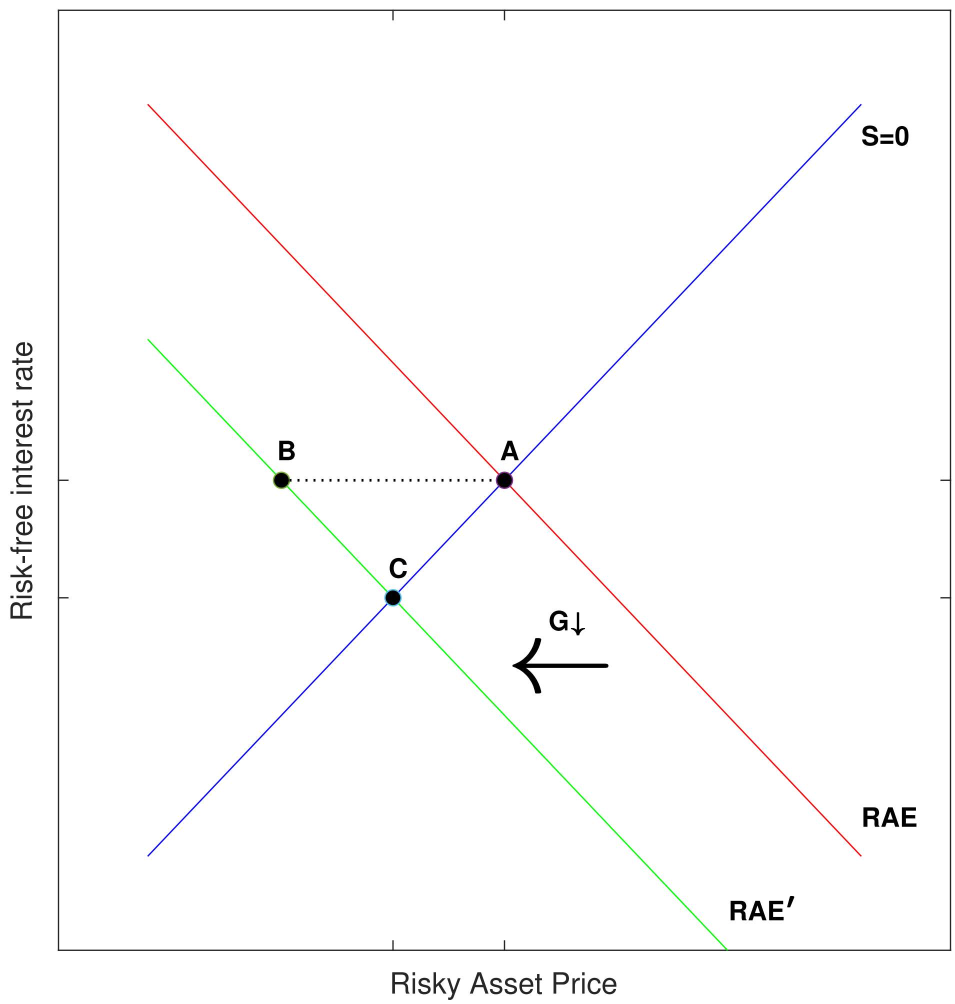
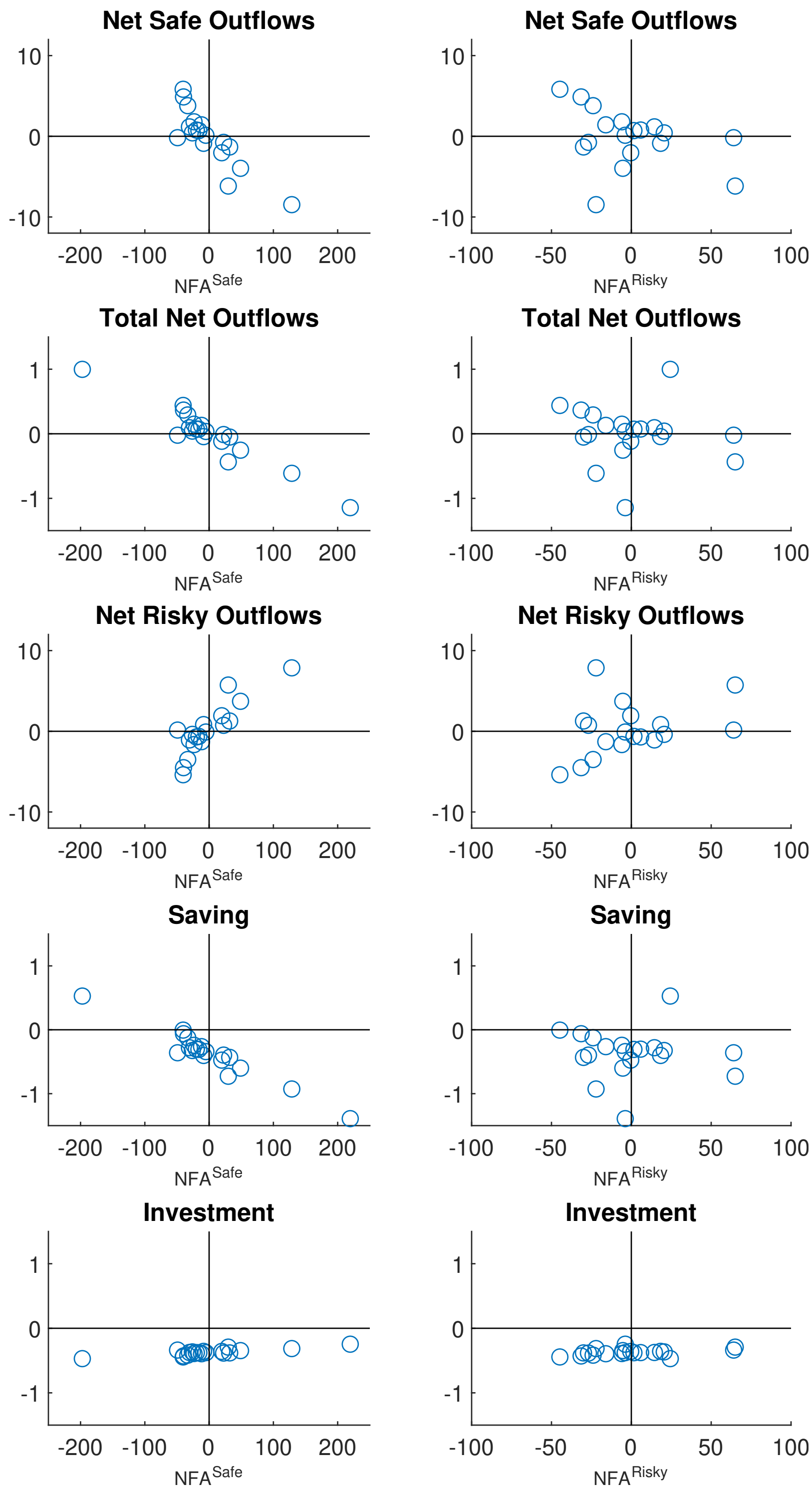


Figure 3: Changes in Model after 10% Fall Risky Asset Prices



Notes: Scatter plots are generated from the model where NFA^{Safe} and NFA^{Risky} positions are calibrated to match the 20 countries in the empirical section.