NBER WORKING PAPER SERIES

A PORTFOLIO APPROACH TO GLOBAL IMBALANCES

Zhengyang Jiang
Robert J. Richmond
Tony Zhang

Working Paper 30253
http://www.nber.org/papers/w30253

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
July 2022

For comments and discussions we would like to thank Max Croce, Riccardo Colacito, Xiang Fang, Ralph Koijen, Hanno Lustig, Matteo Maggiori, Alessandro Rebucci, Jesse Schreger, Adrien Verdelhan, Eric van Wincoop, Frank Warnock, Motohiro Yogo, and seminar participants at Boston University, the European Finance Association, the Federal Reserve Board, Imperial College, John Hopkins University, London Business School, New York University, Northwestern Kellogg, University of Geneva, University of Minnesota, University of Virginia, University of Wisconsin, the Triangle Macro-Finance Workshop, the Vienna Symposium on Foreign Exchange Markets, the Online International Finance and Macro Seminar, the Virtual Finance Workshop, and CEPR - 6th International Macroeconomics and Finance Conference 2021. Steven Zheng and Cody Wan provided excellent research assistance. The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System, any other person associated with the Federal Reserve System, or the National Bureau of Economic Research.

At least one co-author has disclosed additional relationships of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w30253.ack

A Portfolio Approach to Global Imbalances
Zhengyang Jiang, Robert J. Richmond, and Tony Zhang
NBER Working Paper No. 30253
July 2022
JEL No. E44,F32,G15

ABSTRACT

We use a portfolio-based framework to understand what drives the decline of the U.S. net foreign asset (NFA) position and the reversal in returns earned on the US NFA (exorbitant privilege). We show that global savings gluts and monetary policies widened the U.S. NFA position, while investor demand shifts partially offset this widening. Moreover, U.S. privilege declined after 2010, in accordance with increasing foreign demand for U.S. equity. We also highlight a quantity dimension of the U.S. privilege: the U.S. can issue substantially more debt than other countries for a given yield increase.

Zhengyang Jiang
Kellogg School of Management
Northwestern University
2211 Campus Drive
Evanston, IL 60208
and NBER
zhengyang.jiang@kellogg.northwestern.edu

Robert J. Richmond
Leonard N. Stern School of Business
Kaufman Management Center
44 West Fourth Street, 9-81
New York, NY 10012
rrichmon@stern.nyu.edu

Tony Zhang
Federal Reserve Board
20th Street and Constitution Avenue N.W.
Washington, DC 20551
tony.zhang@frb.gov

In the recent decades the net external portfolio position of the U.S. has become substantially more negative. At the end of 2019, non-U.S. investors held 17.1 trillion dollars' worth of U.S. investment assets. By contrast, U.S. investors held only 8.6 trillion dollars in foreign investment assets.[1] This difference between the external portfolio assets and liabilities resulted in a −$8.4 trillion net foreign asset (NFA) position for the U.S. in 2019, which amounted to 39% of U.S. GDP.[2] This is a substantial decrease from an external portfolio position of −$1.5 trillion in 2002, or 14% of U.S. GDP. The solid line in Figure 1 shows this downward trend. The sustained net capital flows into the U.S. financial markets have been referred to as *global imbalances* (Lane and Milesi-Ferretti 2007; Gourinchas and Rey 2014). These imbalances play an important role in our understanding of the international financial system, as they are closely tied to the global risk-sharing arrangement and the unique international position of the U.S.

Changes in the U.S. external portfolio are driven by both the quantity of capital flows into and out of the U.S. and the returns on the existing portfolio. A prominent view holds that the U.S. earns a higher return on its external assets than what it pays to foreigners on its external liabilities, since the U.S. holds more foreign risky assets while foreign investors hold more U.S. safe assets. This asymmetry in portfolio returns has been referred to as the *exorbitant privilege* of the U.S. (Gourinchas, Rey, and Govillot 2010). The dashed line in Figure 1 depicts the cumulative net capital flows to the U.S. net of any valuation gains. The difference between the solid and dashed lines therefore measures how the return differential affects the U.S. external positions.

From 2002 to 2010, the U.S. indeed earned an exorbitant privilege—A positive return differential between U.S. external assets and liabilities allowed the U.S. NFA position to decline less than the cumulative amount of net capital flows. However, from 2010 to 2019, this return differential reversed. As a result of this reversal in the return differential, the gap between the U.S. NFA position and the cumulative net capital flows vanished. The bottom panel of Figure 1 further illustrates this point by plotting the percent difference between the

[1] These numbers are measured using our sample of reallocated international portfolio holdings described in Section 3.

[2] Throughout this paper, we use the term "NFA" to refer specifically to the portfolio investment component of the U.S. NFA. More broadly, a country's NFA also consists of foreign direct investment and financial derivatives.

net portfolio position and cumulative net flows, along with a smoothed trend line.

What are the key drivers of global imbalances? Why did the U.S. external position decline over the past two decades? What were the sources of the reversal in the U.S. exorbitant privilege after 2010? To answer these questions, we use a portfolio-based demand system approach to decompose the level of and the returns on the U.S. external portfolio position. Our approach allows us to attribute drivers of the U.S. external portfolio positions to various factors proposed in the literature, such as changes in investor savings and asset issuances, monetary policies, and changes in asset quality and investor demand.

We present three key findings. First, countervailing forces underlie the seemingly uniform widening of the U.S. NFA position. While the supply of global savings and issuances and monetary policies contribute to the widening of the U.S. NFA position, shifts in investors' demand partially offset this trend. As a result, any theory that seeks to explain the decline in the U.S. portfolio imbalance with just one of these channels alone is unlikely to succeed quantitatively. Second, we show a shift in investor demand towards U.S. equities increased realized returns on U.S. external liabilities, and was primarily responsible for the reversal of privilege.

Our third key finding showcases a novel quantity dimension of exorbitant privilege for U.S. debt issuers. Previous analyses of U.S. exorbitant privilege focused only on prices and the relatively low returns earned on U.S. liabilities. By contrast, we show that the U.S. can issue a substantially larger quantity of long-term debt for a given rise in interest rates, relative to other developed economies. Interestingly, this ranking almost completely reverses when we scale issuance by each country's GDP. This quantity dimension of exorbitant privilege is crucial for fully characterizing the benefits earned by the U.S. through its unique position in the financial system.

Our approach builds on the demand system approach to asset pricing (Koijen and Yogo 2019a,b; Koijen, Richmond, and Yogo 2019). We adopt the demand system of Koijen and Yogo (2019b) with important modifications to wealth dynamics which allow us to decompose the drivers of global imbalances. We model and estimate investors' asset demand curves as functions of observed and unobserved (latent) asset characteristics. Investor's are able to substitute across countries and across asset classes. In equilibrium, investor countries and central banks must hold the total quantity of assets outstanding.

We estimate our framework using a comprehensive dataset of bilateral equity and debt portfolio positions. Using data from multiple sources, we improve the quality of the standard databases along several important dimensions. Our dataset covers both private and public sector holdings, which allow us to assess the effect of asset purchases by the U.S. Federal Reserve and specific foreign central banks. We verify that the U.S. NFA implied from these portfolio positions closely traces out the aggregate data, and that our data capture cross-country holdings that are traditionally poorly represented due to indirect holdings through tax havens (Coppola, Maggiori, Neiman, and Schreger (2020)). We estimate our model by exploiting exogenous variation in investor portfolios driven by exogenous variation in asset characteristics across countries.[3].

This asset demand system allows us to evaluate how asset prices and investor portfolio holdings change in response to three sets of variables: (i) investors' savings and asset issuances, (ii) central banks' monetary policies, and (iii) changes in asset characteristics and shifts in investors' latent demand. We show how these variables map to the classic balance of payments decompositions and how they correspond to existing explanations for global imbalances and asymmetries which have been proposed in the literature.

We treat these variables as exogenous in our framework, and they jointly explain the endogenous asset prices, exchange rates, and investors' wealth and portfolio allocations. For each year, had all of the exogenous variables remained unchanged, the endogenous variables, including asset prices and portfolio holdings, would have remained the same. By iteratively restoring the changes in exogenous variables from the previous year to the current year, and recomputing equilibrium asset prices and portfolio choices along the way, we are able to attribute variations in the level of and the return on the U.S. NFA to different drivers.

We begin by measuring the effects of the global private savings in excess of domestic investment opportunities. This group of variables broadly maps to saving glut explanations for global imbalances. These savings and issuances variables contribute to a 7.6% widening of the U.S. NFA per annum. In comparison, the actual U.S. NFA widened by 9.4% per

[3] We also perform a battery of robustness exercises to show our results are not highly sensitive to alternative estimation procedures for international asset demand systems.

annum in our sample from 2002 to 2019. In other words, the global private savings and asset issuances can account for about 80% of the trend in U.S. portfolio imbalances. We further differentiate the contributions from different regions, and find that asset issuances in the U.S. and foreign savings from European and Asian-Pacific developed economies are the predominant drivers.

Next, we measure the effects of central bank holdings and monetary policy rates. We find that these monetary policy variables further widen the U.S. NFA by 9.9% per annum. Foreign central banks' reserve purchases of U.S. assets are responsible for about half of this widening with policy rates driving the other half. We further disaggregate the contribution of foreign central bank reserve policy by employing data on the currency composition of central bank's reserves. Consistent with explanations of emerging market savings being channeled through central bank reserves, we find that emerging market reserves are a salient source of the decline in U.S. NFA, contributing 4.3% per year versus 0.2% per year for developed market central banks. Taken together with our evidence on private savings and issuances, the savings glut from developed economies still dominates the emerging economies.

Finally, and perhaps most surprisingly, we show that changes in asset characteristics and investor demand partially offset these trends, driving a reversal of 8.2% per annum in the U.S. NFA growth. These drivers broadly map to explanations for global imbalances based upon shifts in asset quality and investor demand, but are not directly observable in the aggregate time series because they are overshadowed by the effects of savings and issuances and monetary policies. As a result, when we consider all three sets of drivers, the U.S. external portfolio imbalances becomes substantially more negative, but this decline would have been much greater if asset (country) characteristics and investor demand had remained constant. We also investigate specific components of changes in investors' demand and find that its contribution is primarily driven by (i) a market-wide shift from debt assets to equity assets, which impacts the U.S. external imbalance because U.S. debt is widely held by foreigners, and (ii) a decline of the appeal of U.S. debt assets in terms of their observable and latent characteristics.

Having explained the trend in the U.S. NFA, we next decompose the main drivers of the valuation effects on the U.S. external portfolio. It is well known that, historically, the

U.S. has earned a large positive excess return on its external portfolio. From 2002 to 2010, these valuation effects helped reduce the U.S. NFA position by 18.3% per annum. Perhaps less well-known is that this trend completely reverses after 2010. Between 2010 and 2019, valuation effects actually widen the U.S. NFA by an average of 6.9% per annum. We use our model to shed new light on which economic forces explain this reversal in valuation effects.

We show that the overwhelming share of the trends in realized returns can largely be explained by an increase in investor demand for U.S. equity post-2010. Increasing demand for U.S. equities relative to equities of other countries, raised the realized returns on U.S. external liabilities and explain the decline in the net valuation effects on the U.S. NFA.

In the final section of the paper, we explore how heterogeneity in investor demand and downward sloping demand curves influence a novel notion of privilege. Taking demand curves and portfolios as given in 2019, we estimate the quantity of new long-term debt which can be issued by each of the G10 countries until yields increase by 1%. We find that, relative to all other G10 countries, the U.S. could issue approximately 3 to 5 times the amount of debt before its yield increases by 1%. These findings help to further quantify a notion of exorbitant privilege enjoyed by the U.S.—the ability to borrow large quantities at low rates.

Literature Review. Our paper contributes to a large literature that studies the drivers of net foreign asset dynamics and the composition of global portfolios (Lane and Milesi-Ferretti 2007; Gourinchas and Rey 2007a,b; Curcuru, Dvorak, and Warnock 2008). In particular, our paper focuses on the imbalances in the U.S. NFA position (Caballero, Farhi, and Gourinchas 2008; Gourinchas, Rey, and Govillot 2010; Gourinchas and Rey 2014). We contribute to this literature by taking a financial perspective and model the net foreign asset position as the outcome of a portfolio decision. A number of related papers study portfolio models and their theoretical implications for international imbalances (Ghironi, Lee, and Rebucci 2007; Devereux and Sutherland 2009; Cova, Pisani, and Rebucci 2009; Tille and Van Wincoop 2010). By contrast, we directly estimate a flexible portfolio choice model which matches observed portfolio holdings and permits a broad decomposition of the drives of the U.S. external portfolio.

A key contribution to the global imbalances literature showed that the U.S. benefits from an exorbitant privilege in asset returns. From 1952 to 2004, the U.S. external imbalance was partially reduced by a positive difference between the returns on its external asset and liability positions (Gourinchas and Rey (2007a)). Atkeson, Heathcote, and Perri (2021) also uncover and study changes in these return dynamics, and attribute these changes to high returns on U.S. equities driven by mark-ups and profits.

Our paper contributes to this literature by also highlighting the reversal in U.S. privilege and decomposing sources of variation in the returns on the U.S. external portfolio. We also contribute to the literature on exorbitant privilege by measuring a novel quantity dimension of U.S. privilege.

A large literature studies drivers of capital flows to and from countries. Drivers of capital flows in the previous literature include institutional quality (Alfaro, Kalemli-Ozcan, and Volosovych 2008), demographic factors (Lane and Milesi-Ferretti 2001; Carvalho, Ferrero, and Nechio 2016), financial development (Caballero, Farhi, and Gourinchas 2008), oil shocks (Kilian, Rebucci, and Spatafora 2009), and interactions between financial frictions and international trade (Antras and Caballero 2009)[4]. Our contribution is to evaluate the relative importance of different channels in driving flows in a unified framework. This allows us to draw the conclusion that the U.S. NFA dynamics are likely to be driven by multiple factors that are partially offsetting each other.

Finally, the methodology we use in this paper builds upon a literature that explicitly measures asset demand elasticities to understand changes in asset prices (Krishnamurthy and Vissing-Jorgensen 2012; Koijen and Yogo 2019b; Koijen, Richmond, and Yogo 2019; Koijen, Koulischer, Nguyen, and Yogo 2020).[5] Most closely related to our work is Koijen and Yogo (2019b), which develops the demand system for international financial assets that we employ. A primary application of the demand system in their paper is to provide a variance decomposition of exchange rates and asset prices globally. In contrast, our paper uses the demand system approach to study the drivers of portfolio holdings and the U.S.

[4]Additional drivers of flows include banking flows (Shin 2012), the abilities to insure against idiosyncratic risk (Mendoza, Quadrini, and Rios-Rull 2009; Angeletos and Panousi 2011), information and transaction cost (Portes, Rey, and Oh 2001; Portes and Rey 2005)

[5]A related literature on the asset price dynamics in the bond market also adopts a quantity-centric view (Vayanos and Vila 2009; Greenwood, Hanson, and Stein 2010; Greenwood and Vayanos 2014; Malkhozov, Mueller, Vedolin, and Venter 2016; Greenwood, Hanson, Stein, and Sunderam 2019; Liao and Zhang 2020).

external imbalance. We further extend the setup in Koijen and Yogo (2019b) to study the joint dynamics of flows, returns, and portfolios.

This paper proceeds as follows. Section 1 provides a theoretical framework for connecting the NFA dynamics to portfolio choices and market clearing. Section 1 also relates the components of the framework to the literature on global imbalances. Section 2 specifies our model in detail. Section 3 reports data sources and summary statistics, discusses the estimation procedure and identification strategy, and presents the estimation results. Section 4 presents our empirical results. Section 5 concludes.

1 Model Overview

In this section, we provide a broad overview of our model of international asset markets. Our approach is to understand the net foreign asset dynamics from the perspective of portfolio allocation. After laying out the key equations in our portfolio choice model we show how the model's components relate to the standard balance of payments identity.

Time is discrete. There are N issuer countries in the world that issue assets, and I investor countries that contain representative investors who allocate their wealth across the asset space. These two sets of countries can be overlapping. We allow investors' wealth to respond endogenously to portfolio choices and asset revaluation over time, which is crucial for our application of the demand system in the context of international portfolio dynamics.

1.1 Key Ingredients

We begin by discussing the three key equations that characterize our portfolio choice approach. We let $A_{i,t}$ denote investor country i's total wealth, which includes its holdings of both domestic and foreign assets. Let $w_{i,t}(n)$ denote its portfolio weight on issuer country n's asset. Then, its NFA position is the difference between of its external assets and its external liabilities. For example, the U.S. NFA position in period t is

$$\text{(NFA Definition)} \qquad NFA_{US,t} = A_{US,t} \sum_{n \neq US} w_{US,t}(n) - \sum_{i \neq US} A_{i,t} w_{i,t}(US). \tag{1}$$

To understand the dynamics of the U.S. NFA position, we need to model how investor's wealth varies over time, and how the investors choose their portfolios. Investor's wealth evolves as a result of realized financial returns from existing positions and new savings added to their accounts. Let $R_t(n)$ denote the ex-dividend return (capital gains) on issuer country n's asset in U.S. dollars, and let $D_t(n)$ denote the dividend yield on the same asset. Let $X_{i,t}$ denote the net financial savings (excluding any dividend payout) within country i from period $t-1$ to t. Then, the law of motion for investor country i's wealth is

$$\text{(Wealth Dynamics)} \qquad A_{i,t} = A_{i,t-1} \sum_n w_{i,t-1}(n)(R_t(n) + D_t(n)) + X_{i,t}. \tag{2}$$

In period t, the investors can adjust their portfolio holdings $w_{i,t}$. In the presence of downward sloping demand curves, if there is a higher aggregate demand for a certain issuer country n's asset, then, the contemporaneous return $R_t(n)$ on this asset will increase. This revaluation effect will in turn affect the wealth dynamics (2) of all investors who hold this asset. Since total dividend payouts in period t depend only on past investment decisions, we will find it useful to lump dividends with net financial savings. We let $F_{i,t}$ denote net financial savings inclusive of dividend payouts:

$$F_{i,t} = X_{i,t} + A_{i,t-1} \sum_n w_{i,t-1}(n) D_t(n).$$

The last equation we introduce is market clearing for issuer country n's asset. The U.S. asset's market clearing can be expressed as

$$\text{(Market Clearing)} \qquad \sum_i A_{i,t} w_{i,t}(US) = Q_t(US) P_t(US) = Q_t(US) P_{t-1}(US) R_t(US), \tag{3}$$

where $Q_t(US)$ denotes the quantity of US assets available at time t. This market clearing condition determines the asset price $P_t(US)$ based on investors' demand, which in turn affects the the asset's ex-dividend return $R_t(US)$ relative to the last period as well. In the following sections, we specify the relation between how portfolio weights $w_{i,t}(n)$, asset returns $R_t(n)$, and asset quantity $Q_t(US)$.

1.2 Relation to Balance of Payments

The portfolio approach we employ is closely related to the standard elements in the balance of payments identity, which expresses changes in the U.S. NFA as

$$NFA_{US,t} - NFA_{US,t-1} \;=\; TB_{US,t} + IB_{US,t} + CG_{US,t}, \tag{4}$$

where TB is the trade balance, IB is the income balance, and CG is the capital gains. In the macroeconomics literature, the trade balance and the income balance are bundled together as the current account: $CA = TB + IB$. In this paper, we express these components based on investor wealth and portfolio choices. The income balance captures earnings on foreign investments minus payments made to foreign investors:

$$IB_{US,t} \;=\; A_{US,t-1} \sum_{k \neq US} w_{US,t-1}(k) D_t(k) - \sum_{k \neq US} A_{k,t-1} w_{k,t-1}(US) D_t(US).$$

The capital gains capture changes in the value of assets held abroad minus changes in the value of domestic assets held by foreign investors:

$$CG_{US,t} \;=\; A_{US,t-1} \sum_{k \neq US} w_{US,t-1}(k)(R_t(k) - 1) - \sum_{k \neq US} A_{k,t-1} w_{k,t-1}(US)(R_t(US) - 1).$$

Moreover, let $V_t(US) = \sum_k A_{k,t} w_{k,t}(US)$ denote the total market value of U.S. assets. Then, the U.S. trade balance is equal to the U.S. net financial savings $X_{US,t}$ minus the net issuance of U.S. assets:

$$TB_{US,t} \;=\; X_{US,t} - (V_t(US) - V_{t-1}(US)(R_t(US) + D_t(US))),$$

where net issuance is new issuance, $V_t(US) - V_{t-1}(US)R_t(US)$, minus dividend payouts, $V_{t-1}(US)D_t(US)$. The derivation of these equations are in Appendix B.1. This set of equations offers us a mapping from the standard elements in the balance of payments identity to disaggregated bilateral portfolio choices.

1.3 Drivers of Imbalances

Having expressed the U.S. NFA dynamics as a portfolio problem, we can study its variation using asset pricing tools. Our approach allows us to decompose its dynamics into the following components, which we discuss in the context of existing views on causes of the widening U.S. NFA position.

Savings and Issuances First, a *saving glut* view argues that foreign savings in excess of their domestic investment opportunities contribute to the flows into the U.S. debt market (Bernanke 2005). One source of the saving glut is the strong savings motive of developed countries with aging populations and inequality (Rachel and Smith 2018; Mian, Straub, and Sufi 2020; Auclert, Malmberg, Martenet, and Rognlie 2021). Another source is emerging countries with high growth and willingness to save in the developed markets, in particular in the U.S. (Caballero 2006; Caballero, Farhi, and Gourinchas 2008).

To capture these forces, we group investor savings and asset issuances as the first block of variables we examine. They are measured by and investor country i's net financial savings, $F_{i,t}$, in excess of that country's asset issuance, $\Delta Q_t(i)$. Intuitively, these excess savings have to be allocated to a foreign country such as the U.S., which, according to the market clearing Eq. (3), will contribute to higher asset prices in the U.S. as well as net inflows of capital into the U.S. This excess saving is also closely connected to the trade balance, which, as we have shown, is equal to the net savings minus the net asset issuance. We consider each country's consumption and export decisions as exogenous, and trace out how the excess savings and the corresponding trade balance drive movements in asset prices and capital flows.

Monetary Policies Second, central banks' monetary policies could play an important role in shaping global imbalances. We consider two forms of monetary policies: (i) reserve accumulation and (ii) changes in nominal short-term interest rates. Reserve accumulation includes both official reserve holdings (Bernanke 2005; Farhi, Gourinchas, and Rey 2011) and quantitative easing (Krishnamurthy and Vissing-Jorgensen 2013; Koijen, Koulischer, Nguyen, and Yogo 2017; Krishnamurthy, Nagel, and Vissing-Jorgensen 2018; Acharya and Krishnamurthy 2018). To capture these central bank holdings, we differentiate private and official holdings of assets in our framework. When foreign or U.S. official holdings of U.S. debt assets increase, U.S. asset valuations also increase via the market clearing Eq. (3).

Interest rate policies could also affect the U.S. external imbalances (Ahmed, Bertaut, Liu, Vigfusson, et al. 2018; Jiang, Krishnamurthy, and Lustig 2020a). To understand the impact of short-term interest rate changes, our framework differentiates between investment in equity, long-term debt, and short-term debt as separate asset classes. We model the nominal short-term interest rate as an exogenous policy outcome for each country that impacts the demand for short-term debt.

Demand Shifts and Asset Characteristics Third, global imbalances are adriven by changes to asset quality and investor demand. A prominent type of taste shift is flight-to-safety (Blanchard, Giavazzi, and Sa (2005); Krishnamurthy and Vissing-Jorgensen (2012); Caballero, Farhi, and Gourinchas (2017); Maggiori (2017); Jiang, Krishnamurthy, and Lustig (2020b)). Under this view, foreign investors may want to save their excess savings in safer assets. As the supply of safe assets is limited and concentrated in a small number of advanced economies, foreign investors have a strong desire to purchase assets in these destinations – especially during periods of financial turmoil. More generally, changes in risk appetite, investor taste, and asset characteristics themselves (Atkeson et al. (2021)) can shift investors' portfolio positions across asset classes and across countries. Koijen and Yogo (2019b); Gabaix and Koijen (2021); Bacchetta et al. (2021, 2022) show these shifts in investor demand account for a large fraction of variations in portfolio flows and asset returns.

Our framework captures shifts in investor demand by modeling both investor preferences for specific asset characteristics (e.g., country size or domestic inflation) as well as exogenous demand shifts both within and across asset classes. Over time, a country's characteristics can change and make its financial assets more desirable to international investors. We thus differentiate between increases in investor demand for assets that originate from increases in the supply to savings, and increases in investor demand for assets with particular features.

2 Empirical Portfolio Choice Model

In the following section, we fill in the details of our model. Our empirical approach uses the demand system approach to asset pricing (Koijen and Yogo 2019a,b; Koijen et al. 2019). Our specification of international portfolio demand curves follows Koijen and Yogo (2019a), while the wealth dynamics are modified in our setting in order to study the dynamics of international portfolios, their returns, and investor savings.

2.1 Modeling Demand for Assets

In order to operationalize the portfolio based framework, we need a realistic specification of portfolio weights, $w_{i,t}(n)$. We first introduce asset classes indexed by ℓ: short-term debt ($\ell = 1$), long-term debt ($\ell = 2$), and equity ($\ell = 3$). We use the pair (n, ℓ) to denote issuer country n's asset of asset class ℓ. For example, we denote investor country i's portfolio weight for this asset as $w_{i,t}(n, \ell)$. Moreover, each asset class contains $N + 1$ assets — one for each issuer country and an "outside" asset indexed by $n = 0$. This outside asset contains investors' holdings in small countries that are not in our main sample of issuer countries due to data availability limitations.

The portfolio weight of investor country i in issuer country n and asset class ℓ can be decomposed into a within asset class weight and a cross asset class weight:

$$w_{i,t}(n, \ell) = w_{i,t}(n|\ell) \cdot w_{i,t}(\ell), \tag{5}$$

where $w_{i,t}(n|\ell)$ is investor country i's portfolio weight on issuer country n within asset class ℓ, and $w_{i,t}(\ell)$ is investor country i's total portfolio weight on asset class ℓ.

Step 1: Demand within Asset Class. Within an asset class ℓ, the portfolio weight for investor i at time t in country n is a logistic function[6]:

$$w_{i,t}(n|\ell) = \frac{\delta_{i,t}(n, \ell)}{1 + \sum_{k=1}^{N} \delta_{i,t}(k, \ell)}, \tag{6}$$

[6]By construction, the total sum of shares invested into each asset equals 1, $\sum_{n=0}^{N} w_{i,t}(n|\ell) = 1$. The portfolio weight in the outside asset in asset class ℓ is therefore given by $w_{i,t}(0|\ell) = 1/(1 + \sum_{n=1}^{N} \delta_{i,t}(n, \ell))$.

where $\delta_{i,t}(n,\ell)$ captures the relative desirability of a country's asset in this asset class:

$$\delta_{i,t}(n,\ell) = \exp(\beta_\ell \mu_{i,t}(n,\ell) + \boldsymbol{\theta}_\ell' \mathbf{x}_{i,t}(n) + \kappa_{i,t}(n,\ell)). \tag{7}$$

This desirability term has three components. First, $\mu_{i,t}(n,\ell)$ denotes the expected return at time t for country i's investor in country n's asset of class ℓ, which we measure using the combination of market-to-book ratios and exchange rates that best predicts future returns — the details of this regression are in the following section. The second component is a set of observable asset characteristics $\mathbf{x}_{i,t}(n)$ that can be country-specific or bilateral in nature. The loadings, $\boldsymbol{\theta}_\ell$, capture the weight investors place on the characteristics within each asset class. The third component, $\kappa_{i,t}(n,\ell)$, is referred to as latent demand and describes additional variation in the portfolio weights that is not captured by the expected return or observed asset characteristics.

For concreteness, consider the U.S. representative investor deciding on her portfolio weight on German long-term debt. Thus, i is the U.S., n is Germany, and $\ell = 2$ represents long-term debt. $\mu_{i,t}(n,\ell)$ captures the local currency return the U.S. investor expects to earn on German long-term debt. $\mathbf{x}_{i,t}(n)$ captures characteristics such as the size (GDP) of Germany and the geographic distance between the U.S. and Germany. Finally, $\boldsymbol{\theta}_\ell$ captures how much these characteristics matter for the long-term bond portfolio allocation. By assumption, the importance of asset characteristics to the portfolio allocation is the same across investors within an asset class.

Step 2: Demand across Asset Classes. Next, to allow for substitution across asset classes, the asset class portfolio weight is specified as a nested logit.[7] The portfolio weight for investor i at time t in asset class ℓ is given by

$$w_{i,t}(\ell) = \frac{(1 + \sum_{k=1}^{N} \delta_{i,t}(n,\ell))^{\lambda_\ell} \exp(\alpha_\ell + \xi_{i,t}(\ell))}{\sum_{m=1}^{3} (1 + \sum_{k=1}^{N} \delta_{i,t}(k,m))^{\lambda_m} \exp(\alpha_m + \xi_{i,t}(m))}, \tag{8}$$

[7] Similar to the standard logit structure for portfolio weights, the nested-logit structure can also be derived as an approximation to a Merton (1973) portfolio allocation problem in which the covariance matrix of returns is a polynomial function of asset characteristics, and this polynomial function can differ by asset class. See Appendix B.2 for details.

where α_ℓ captures asset class fixed effects and $\xi_{i,t}(\ell)$ captures asset class latent demand. The terms $(1 + \sum_{k=1}^{N} \delta_{i,t}(n, \ell))$ are referred to as inclusive values for a given asset class ℓ, which capture the relative attractiveness of investing in each asset class. For example, when average relative prices of assets within an asset class increases, the asset class becomes less desirable as a whole, and investors may substitute away from the asset class accordingly.

Expected Excess Returns. Investors care about expected excess returns in their own currency when forming their portfolios. We construct expected excess returns in USD and convert them to each investor's own currency. Let $r_{t+1}(n, \ell) = \log(R_{t+1}(n, \ell))$ denote the log return in USD on asset class ℓ in country n from time t to $t + 1$. To construct a measure of expected returns in USD, we use a forecasting regression as in Koijen and Yogo (2019b):

$$r_{t+1}(n, \ell) - r_{t+1}(US, 1) = \phi_\ell \cdot pb_t(n, \ell) + \psi_\ell \cdot (e_t(n) - z_t(n)) + \chi_{n,\ell} + \nu_{t+1}(n, \ell). \tag{9}$$

This regression projects the excess return of each asset n from the US perspective at time $t + 1$ onto its log market-to-book ratio $pb_t(n, \ell)$ at time t and the log real exchange rate $(e_t(n) - z_t(n))$ between country n and the USD. Specifically, the book value in the market-to-book ratio is the standard equity book value in the case of equity, and the par value in the case of debt. The log real exchange rate is the difference between the log nominal exchange rate $e_t(n) = \log E_t(n)$ and the log consumer price index $z_t(n)$. The exchange rate, $E_t(n)$, is in USD per unit of foreign currency. The regression coefficients ϕ_ℓ and ψ_ℓ are specific to each asset class ℓ.

Based on this forecasting regression, the expected log excess return on asset n in investor i's currency is

$$\begin{aligned} \mu_{i,t}(n, \ell) &= \mathbb{E}_t[r_{t+1}(n, \ell) - r_{t+1}(i, 1)] \\ &= \phi_\ell pb_t(n, \ell) + \psi_\ell(e_t(n) - z_t(n)) + \chi_{n,\ell} - \phi_1 pb_t(i, 1) - \psi_1(e_t(i) - z_t(i)) - \chi_{i,1}. \end{aligned} \tag{10}$$

Central Banks. We differentiate between asset demand by private investors and by central banks. We use $B_{i,t}(n, \ell)$ to denote the quantity of country n's assets held by country i's central bank, which we take as exogenous.[8] The units for these central bank holdings are book value in local currency.

2.2 Wealth Dynamics and Market Clearing

For our purposes of studying the variation in portfolio positions across countries, it is important to specify realistic dynamics for investor wealth or assets under management (AUM). In each period, an investor's AUM adjusts according to the returns on the assets the investor holds. The law of motion for the AUM for investor i in dollars is:

$$A_{i,t} = A_{i,t-1} \sum_{\ell=1}^{3} \sum_{n=0}^{N} w_{i,t-1}(\ell) w_{i,t-1}(n|\ell) R_t(n,\ell) + F_{i,t}, \tag{11}$$

where $R_t(n,\ell)$ is the capital gains on asset k in asset class ℓ in time t in dollar terms, and $F_{i,t}$ is investor i's net financial savings at time t in dollars including any dividend yield. Equation 11 is analogous to Equation 2 except that we now account for all asset classes.

The capital gains earned by the investor country is determined by changes in asset prices and changes in exchange rates, $E_t(k)$. Because we assume investors form expectations of asset returns based on market-to-book ratios, we explicitly model realized dollar returns as a function of market-to-book ratios:

$$R_t(k,\ell) = \frac{PB_t(k,\ell) E_t(k) S_t(k,\ell)}{PB_{t-1}(k,\ell) E_{t-1}(k) S_{t-1}(k,\ell)}, \tag{12}$$

where $S_t(k,\ell)$ is the conversion factor between book value and share number (i.e. book-per-share) in local currency terms. When mapping our framework to equities data, we translate changes in market-to-book ratios into changes in prices, because the demand curve specification depends on the market-to-book ratio and the dynamics of countries' portfolios depend on capital gains. We compute the multiplicative factor $S_t(k,\ell)/S_{t-1}(k,\ell)$ that achieves this

[8] In practice, we acknowledge that central banks hold assets for several motives. For example, central banks may hold foreign long-term debt as currency reserves, which can be used to buffer the movements of the domestic currency. In recent years, central banks have purchased their own domestic assets through quantitative easing programs in attempts to lower domestic long-term interest rates. By reducing long-term interest rates, the central bank further stimulate the economy even when the short-term interest rate reaches zero. However, modeling the reaction functions of international central banks is beyond the scope of this paper.

conversion using the return, market-book and exchange rate data.[9] Because $PB_t(k,\ell)$ denotes the market-to-book ratio, $PB_t(k,\ell)S_t(k,\ell)E_t(k,\ell)$ is the dollar price per asset share. For bonds, the book value is the par value, and hence the conversion factor $S_t(k,\ell)$ is always 1.

Let $Q_t(n,\ell)$ denote the book quantity supplied by country n in asset class ℓ in its local currency. $Q_t(n,\ell)$ is the total book value in local currency for equity, and the par value in local currency for long-term and short-term debt. We assume the quantity of assets outstanding in each period is exogenously determined. Nevertheless, the dollar book value, $E_t(n)Q_t(n,\ell)$, and the dollar market value, $PB_t(n,\ell)E_t(n)Q_t(n,\ell)$, of any asset are endogenous, because exchange rates and market-to-book ratios are endogenously determined.

The market clearing condition for asset (n,ℓ) in dollars is

$$PB_t(n,\ell)E_t(n)Q_t(n,\ell) = \sum_{i=1}^{N} A_{i,t}w_{i,t}(\ell)w_{i,t}(n|\ell) + PB_t(n,\ell)E_t(n)\sum_{i=1}^{N} B_{i,t}(n,\ell). \tag{13}$$

The left-hand side is the total market value, and the right-hand side is the sum of the dollar value of investors' portfolio holdings of the asset plus the sum of the dollar value of central banks' reserve holdings. As shown above, portfolio weights are a function of asset prices and exchange rates.

There are 3 asset classes with N assets each, which leads to $3N$ market clearing conditions. Taking short-term bond prices as given, there are N long-term bond prices, N equity prices, and $N-1$ exchange rates with respect to the dollar. Following Koijen and Yogo (2019b) we assume that the Federal Reserve adjusts the supply of U.S. short term debt to clear markets. This assumption leads to an exactly determined system in the N long-term bond prices, N equity prices, $N-1$ exchange rates, and the US short-term debt supply.[10] We use this system in the following section to study how various components have driven variation in the U.S. NFA position.

[9]Implicitly, the ratio $S_t(k,\ell)/S_{t-1}(k,\ell)$ captures changes in the shares of assets outstanding relative to the book value of assets outstanding.

[10]Pegged exchange rates are cleared by assuming that the country's central bank maintains the peg by adjusting the supply of short-term debt.

3 Model Estimation

3.1 Data

We rely on three types of data: (1) cross-country bilateral portfolio holdings, (2) asset/country characteristics, and (3) realized asset returns. At each stage of our data construction, we combine the best available data to get an accurate representation of cross-border holdings and asset returns while paying special attention to the U.S. NFA position and U.S. portfolio returns. We summarize our data here and relegate the details and data sources to Appendix C.

Compared with existing studies of international capital flows, we improve the quality of cross-border holdings and returns data in three ways. First, we use the reallocation matrices from Coppola, Maggiori, Neiman, and Schreger (2020) to account for mis-attributed investments in offshore financial centers. Second, we estimate the reserve holdings of specific central banks to dis-aggregate the quantities attributed to official asset purchases at the country and region level. Third, we use detailed estimates of asset returns from the TIC data to construct reliable estimates of capital gains and net savings.

Our resulting sample ranges from 2002 to 2019, and consists of 35 investor countries and 33 issuer countries for which we have comprehensive holdings and characteristics. Table C.1 presents the specific set of countries in our sample and their classifications. Table C.2 presents the list of central banks for which we are able to construct bilateral holdings. Holdings in issuer countries for which we do not observe a complete panel of characteristics and asset price data are aggregated into a single "outside" country. Investments into the outside country only comprise 3.5% percent of all observed holdings in our data.

Table 1 presents the top 5 bilateral positions in the U.S. assets and liabilities for each asset class in 2002 and 2019, as well as the total positions for all other foreign countries. On the liability side, the largest long-term U.S. debt liabilities in 2019 are held by the Fed, the European Union, and China's central bank. For equity, the largest liabilities are held by the European Union and the United Kingdom. On the asset side, the largest U.S. equity positions in 2019 are held by China, the United Kingdom, and Japan. Importantly, these bilateral positions are consistent with those found in Coppola et al. (2020).

In addition to the holdings data, we build a panel of asset characteristics to construct the vector $\mathbf{x}_{i,t}(n)$. We choose a set of characteristics that investors likely use to proxy for expected returns and the riskiness of assess. These characteristics include asset-level characteristics such as the total market-to-book value of equity and the yields on short-term and long-term debt. We use yields on 3-month government debt to capture the yield on short-term debt, and we use the yield on 10-year government debt to capture the yield on long-term debt. We also observe country-level characteristics that may affect the risk profile for all assets in a country. These country-level characteristics include proxies for country size and development (GDP, population), trade network centrality (Richmond 2016), sovereign default risk, and market volatility. Finally, we include a standard set of macroeconomic characteristics: real exchange rates, inflation, bilateral export shares, bilateral import shares and the distance between countries.

3.2 Demand Estimation and Identification

In the following section, we describe how we estimate demand curves both within and across asset classes. Equations (6) and (7) imply

$$\log\left(\frac{w_{i,t}(n,\ell)}{w_{i,t}(0,\ell)}\right) = \beta_\ell \mu_{i,t}(n,\ell) + \boldsymbol{\theta}_\ell' \mathbf{x}_{i,t}(n) + \kappa_{i,t}(n,\ell). \tag{14}$$

This regression equation determines the within-asset-class demand, which we estimate separately for each asset class ℓ. We obtain the estimation equation for across asset class demand by dividing equation (8) for short-term ($\ell = 1$) and long-term debt ($\ell = 2$) by the equation for equity ($\ell = 3$):

$$\log\left(\frac{w_{i,t}(\ell)}{w_{i,t}(3)}\right) = \lambda_\ell \log\left(1 + \sum_{n=1}^{N} \delta_{i,t}(n,\ell)\right) - \lambda_3 \log\left(1 + \sum_{n=1}^{N} \delta_{i,t}(n,3)\right) + \alpha_\ell + \xi_{i,t}(\ell). \tag{15}$$

We first provide an overview of our identification strategy, and then we present the details along with the actual estimates.

Identification Overview. The main challenge to consistently estimating equations (14) and (15) is that expected returns may be endogenous to the latent demand of investors, $\kappa_{i,t}(n,\ell)$ and $\xi_{i,t}(\ell)$. Consider the estimation of the within-asset-class demand curves, equation (14). If investors have high latent demand for a particular issuer's asset, the price of this asset will be higher, which will impact this asset's expected return and bias the estimated demand coefficient β_ℓ due to the correlation between the regressor, $\mu_{i,t}(n,\ell)$, and the residual, $\kappa_{i,t}(n,\ell)$. A similar argument applies to the estimation of the across asset demand curves in equation (15). If a particular asset class has high latent demand, this will increase the price of this asset class and potentially bias the estimation since the inclusive value, $1+\sum_{n=1}^{N}\delta_{i,t}(n,\ell)$, contains the price. To address these endogeneity concerns we construct instruments for both estimation equations, building on the identification strategy in Koijen and Yogo (2019b).

To construct instruments we need cross-sectional variation in country-level expected returns that is uncorrelated with latent demand.[11] Country-level expected returns are related to prices and exchange rates through the return forecasting regression, equation (10). Therefore, we can use exogenous variation in prices and exchange rates as instruments for expected returns. To obtain such variation, we use our model to construct instruments for prices under the assumption that investor portfolios are determined by exogenous characteristics. Once we construct these instruments, we validate that they are correlated with expected returns and are therefore relevant and strong. The fact that the instruments constructed using the model structure are correlated with measured expected returns further validates our instrument construction strategy.

To gain institution for how we construct exogenous variation in country-level expected returns, we begin from market clearing. Equation (13) implies that asset prices are higher for assets which have higher weights in portfolios of investors with more wealth. To this end, our baseline instrument construction focuses on measuring exogenous variation in portfolio weights. Taking asset supply and the wealth distribution as given, we can compute counterfactual prices under the assumption that portfolio weights are determined entirely by the

[11] Our goal is to estimate the cross-sectional demand elasticities, which are determined by the coefficients in equations (14) and (15). We therefore do not require that our instruments vary over time.

exogenous components using market clearing.

Formally, the identifying assumption for our baseline procedure is that asset characteristics, asset supply, and investment in outside assets (investor wealth) are exogenous to latent demand:

$$\mathbb{E}\left[\begin{array}{c}\kappa_{i,t}(n,\ell)\\ \xi_{i,t}(\ell)\end{array}\middle|\hat{\mathbf{x}}_t,\hat{\mathbf{Q}}_t,\hat{\mathbf{O}}_t,\right]=\mathbf{0}, \tag{16}$$

where $\hat{\mathbf{x}}_t$ is a matrix of characteristics for all countries, $\hat{\mathbf{Q}}_t$ is the vector of asset supplies, and $\hat{\mathbf{O}}_t$ is the vector of holdings of outside assets.

To address additional concerns that may arise about our baseline estimation procedure, in Appendix A.1 we present several variations of our estimation that relax different parts of our identifying assumption in Equation 16. Important variations include: allowing asset characteristics such as GDP to be endogenously determined, using exogenous variation in asset supply, and using exogenous variation in investor wealth. In Section 4.5 we show that our key results are robust to these specific variations. Finally, beyond these specific variations, we show that our key results are robust to using a range of demand elasticities that is consistent with those found in the literature.

Estimating Cross-Asset-Class Demand. In the following section, we detail our estimation procedure and discuss the estimation results. We begin by constructing exogenous portfolio weights. To do so, we estimate a simplified version of the within-asset-class demand equation:

$$\log\left(\frac{w_{i,t}(n,\ell)}{w_{i,t}(0,\ell)}\right)=\boldsymbol{\theta}_\ell'\mathbf{x}_{i,t}(n)+\kappa_{i,t}(n,\ell). \tag{17}$$

In this equation, we omit expected returns and use a set of characteristics which are exogenous and where the source of variation is clear: the bilateral distance between countries, issuer country population, an own country dummy to capture home bias, and investor fixed effects. By including investor fixed effects we control for the cross-sectional variation in investor's weights in the outside asset, which implicitly uses the assumption that outside asset holdings are exogenous.

The results of estimating equation (17) are reported in Table D.4. Investors tend to have higher portfolio weights in countries which are larger and geographically closer. For all asset classes there is a large home bias in portfolio holdings. These characteristics explain a substantiate amount of the variation in bilateral portfolio weights, with the R-squared ranging from 50 to 67% across the three asset classes. Furthermore, these characteristics explain a substantial share of the within investor country variation in portfolio weights, with a within R-squared of approximately 20%. We compute the predicted values from these regressions, which we refer to as exogenous asset desirabilities, $\hat{\delta}_{i,t}(n,\ell)$. These desirabilities are driven entirely by variation in these exogenous characteristics.

The cross-asset-class equation determines how investors substitute across asset classes when the relative desirability of all assets in a particular asset class changes. For example, when equities become more desirable relative to long-term debt, investors may substitute toward equity and away from long-term debt. The amount of this substitution is determined by the elasticities λ_ℓ. To estimate this equation we need exogenous variation in the overall desirability of each asset class. With our exogenous asset desirabilities, $\hat{\delta}_{i,t}(n,\ell)$, we are able to compute instruments for the the overall asset level desirabilities, or inclusive values, in equation (15):

$$1 + \sum_{n=1}^{N} \hat{\delta}_{i,t}(n,\ell).$$

Using this instrument, we are able to consistently identify the parameters in equation (15).

The results for estimating equation (15) are reported in Table D.5.[12] The first thing to note is that the first-stage F-statistics in the bottom three rows of the table are all greater than 100 (Stock and Yogo 2002). These high first-stage F-statistics imply that the instruments for the inclusive value are all highly correlated with the asset-class level desirabilities, even though they are constructed entirely from exogenous asset characteristics. Next, all λ_ℓ values are between 0 and 1. This implies that there is some substitution between asset classes when the relative value of an asset class varies. This is in contrast to the case when $\lambda_\ell = 0$, in which the allocations across asset classes are independent of the relative desirabilities of individual assets. When $\lambda_\ell = 1$, the substitution between asset classes only depends on the desirabilities of individual issuer countries' assets, and the demand system

[12]We normalize α and $\xi_{i,t}$ for equity to 0. The first stages for this regression are reported in Table D.6.

collapses to one tier. Our estimates are between these two polar cases, implying that there is some segmentation across asset classes.[13]

Estimating Within-Asset-Class Demand. The next step is to estimate the within-asset-class demand curves, as given by equation (14). To do so, we use the estimated cross-asset demand parameters, the exogenous desirabilities, and market clearing to construct instruments for prices and exchange rates. Given exogenous asset desirabilities $\hat{\delta}_{i,t}(n,\ell)$, and estimated cross-asset demand parameters, $\hat{\lambda}_\ell$ and $\hat{\alpha}_\ell$, we compute the model implied portfolio weights:

$$\hat{w}_{i,t}(n,\ell) = \frac{\hat{\delta}_{i,t}(n,\ell)}{1+\sum_{n=1}^{N}\hat{\delta}_{i,t}(n,\ell)} \frac{\left(1+\sum_{n=1}^{N}\hat{\delta}_{i,t}(n,\ell)\right)^{\hat{\lambda}_\ell}\exp\left(\hat{\alpha}_\ell\right)}{\sum_{m=1}^{3}\left(\left(1+\sum_{n=1}^{N}\hat{\delta}_{i,t}(n,m)\right)^{\hat{\lambda}_m}\exp\left(\hat{\alpha_m}\right)\right)}. \tag{18}$$

These exogenous weights are calculated using Equations (5), (6), (7), and (8), but using the exogenous asset desirabilities. As a result, these weights can be thought of as the counterfactual portfolio weights for issuer country n's asset in asset class ℓ if portfolios were determined by bilateral distance between countries, issuer country population, and home bias.

Given these exogenous portfolio weights, we use the market clearing equation (13) to calculate the implied asset prices and exchange rates, and use them as instruments to estimate the within-asset-class demand curve. Specifically, we set each investor country's total assets under management as

$$\hat{A}_{i,t} = \frac{\hat{O}_{i,t}}{1-\sum_{k=1}^{3}\sum_{m=1}^{N}\hat{w}_{i,t}(m,k)},$$

where $\hat{O}_{i,t}$ is investor i's total investment into outside assets. We also plug in the quantity of assets outstanding, $\hat{Q}_t(n,\ell)$. Market clearing in the short-term debt market yields our instruments for exchange rates:

$$\hat{E}_t(n) = \frac{1}{\hat{Q}_t(n,1)}\sum_{i=1}^{N}\hat{A}_{i,t}\hat{w}_{i,t}(n,\ell),$$

[13]See Koijen and Yogo (2019b) for more discussion on the interpretation of these parameters. Our estimates here are consistent with their findings.

and market clearing in long-term bonds and equities gives:

$$\hat{PB}_t(n,\ell) = \frac{1}{\hat{E}_t(n)\hat{Q}_t(n,\ell)} \sum_{i=1}^{N} \hat{A}_{i,t}\hat{w}_{i,t}(n,\ell).$$

For our baseline estimation we take asset supply and investments into outsider assets as exogenous and use the values from the data. For robustness, we consider variations of our estimation procedure in which they are also instrumented by exogenous variables in Appendix A.1. Hence, we label these values with hats.

Intuitively, the above procedure identifies differences in expected returns that arise due to the fact that asset prices are higher in countries that are geographically closer to large investor countries, and countries that tend to issue fewer assets. In this way, we obtain instruments for exchange rates and asset prices, which we use next to identify the within-asset-class demand curve.

With our instruments in hand for asset-class desirabilities and for expected returns, we estimate the regression equation (14). The issuer country characteristics are its log GDP, log population, trade network centrality, sovereign default risk, volatility, real exchange rate, and inflation. Bilateral characteristics are import and export exposures and distance. We also include indicator variables for domestic investment, US issuer, investor country, and year fixed effects. For short-term debt, we instrument expected returns with $\hat{E}_t(n)$. For long-term debt and equity we instrument expected returns with $\hat{E}_t(n)$ and $\hat{P}_t(n,\ell)$ for $\ell = 2, 3$.

The baseline estimates for within-asset-class demand curves are presented in Appendix Table D.7.[14] The coefficients on expected returns are all positive, which implies that conditional on our set of asset characteristics, assets with higher expected returns are preferred by investors. The coefficients on asset characteristics are all intuitive. Investors prefer assets that provide better hedges against systematic risks, such as the assets of larger countries (higher GDP). Conditional of countries having higher GDP, investors prefer countries with lower population, which implies they tend to prefer countries with higher GDP per capita. Investors also prefer assets from countries that are closer and with whom they have a stronger

[14] The first stages are presented in Table D.8. Consistent with the expected return regression (10), expected returns are negatively related to the instruments for prices and exchange rates. Furthermore the first-stage F-statistic for all three asset classes is high which implies these are strong instruments.

trade relationship. Finally, the next-to-last row of Appendix Table D.7 shows there is strong home bias in all asset classes.

Our estimates imply average demand elasticities of 229 for short-term debt, 2.0 for long-term debt, and 1.8 for equities.[15] These numbers are comparable to those found in Koijen and Yogo (2019b) which we would expect since we employ a variation on the estimation methodology. For short-term debt with a maturity of 3-months this elasticities implies that a 1% increase in annualized yield increases demand for short-term debt by 58%. For long-term debt with a maturity of 10-years this demand elasticity implies that a 1% increase in annualized yield increases demand for long-term debt by 20%.

To ensure the robustness of our findings, we present estimates from a number of alternative identification and estimation procedures in Section 4.5. While different estimation procedures lead to somewhat different point estimates, the elasticities do not substantively change. Most importantly, we show in that our key results are robust to these variations. Finally, beyond studying these specific estimation variations, we also show that our results are robust to using a range of demand elasticities that is consistent with those found in the literature.

4 Decomposing the U.S. NFA Position

In this section, we use our model to decompose and explain the trends in the U.S. NFA position over the past 20 years. We begin by describe our decomposition methodology that attributes the changes in the U.S. NFA position to primitive variables. We then describe the specific sequence of steps in our decomposition exercise. Finally, we present our results.

4.1 Decomposition Method

To decompose changes in the U.S. NFA position in year t, we begin by setting all primitive exogenous variables in our model back to their values in the previous year $t-1$. We compute the equilibrium NFA position through market clearing condition, and refer to this equilibrium as the *baseline* step. We then sequentially restore the primitive variables to their actual year-

[15] We discuss the details of this conversion in Appendix B.3.

t values, and recompute equilibrium asset prices and portfolio holdings at each stage. After restoring all variables, we arrive at the actual observed year-t NFA in the data which we refer to as *observed* step.

More concretely, consider the sequence of $J+1$ steps starting with the baseline step 0 and ending with the observed step J. In each step, we turn one set of more primitive variable from its value in year $(t-1)$ to its value in year t, and recompute the equilibrium. Let $\widetilde{NFA}^{j}_{US,t}$ denote the implied U.S. NFA position in step j. By construction, in step 0, $\widetilde{NFA}^{0}_{US,t}$ is equal to the actual U.S. NFA in the previous year $NFA_{US,t-1}$. In step J, all primitive variables take their actual values in year t, and $\widetilde{NFA}^{J}_{US,t}$ is equal to the actual U.S. NFA in the current year $NFA_{US,t}$.

Our focus is on understanding what drove the trend in the U.S. NFA position. To do so, we report the log change in U.S. NFA at each step. Let $\Delta_{j,t}$ denote the difference in the log of the implied U.S. NFA between the $(j-1)$-th step and the j-th step:

$$\Delta_{j,t} = \log\left(\widetilde{NFA}^{j}_{US,t} / \widetilde{NFA}^{j-1}_{US,t}\right). \tag{19}$$

Because the U.S. NFA position is negative in our sample, a positive value for $\Delta_{j,t}$ contributes to a more negative level of the U.S. NFA position. We report the average of each step's incremental contribution across all years:

$$\overline{\Delta}_j = \frac{1}{T}\sum_{j} \Delta_{j,t}, \tag{20}$$

and we interpret $\overline{\Delta}_j$ as the average contribution of the variables restored in step j to the trend in the U.S. NFA position. As the sum of $\Delta_{j,t}$ across all J steps is equal to the actual log change in the U.S. NFA: $\sum_j \Delta_{j,t} = \log NFA_{US,t} - \log NFA_{US,t-1}$, the sum of $\overline{\Delta}_j$ is equal to the actual cumulative change in the U.S. NFA.

We further decompose the changes in NFA positions in each step into a flow effect and a valuation effect. The valuation effects are particularly relevant for understanding the returns to the U.S. NFA position, and are a key result that we discuss in Section 4.4. For each step j, we compute a hypothetical "constant-price" NFA position by holding asset prices and exchange rates constant at the values in the $(j-1)$-th step:

$$\widetilde{NFA}_{US,t}^{ConstPrice,j} = \sum_{n\neq US}\frac{\widetilde{A}_{US,t}^{j}\widetilde{w}_{US,t}^{j}(n,\ell)}{\rho_t^j(n,\ell)} - \sum_{i\neq US}\frac{\widetilde{A}_{i,t}^{j}\widetilde{w}_{i,t}^{j}(US,\ell)}{\rho_t^j(US,\ell)},$$

where

$$\rho_t^j(n,\ell) = \frac{\widetilde{P}_t^j(n)\widetilde{E}_t^j(n)S_t^j(n,\ell)}{\widetilde{P}_t^{j-1}(n)\widetilde{E}_t^{j-1}(n)S^{j-1}(n,\ell)}$$

is the ratio that converts the dollar price per share of asset n in asset class ℓ from the j-th step to the $(j-1)$-th step.

We define the *flow* effect as the change in the NFA position while holding asset prices and exchange rates constant:

$$\Delta_{j,t}^{Flow} = \log\left(1+\frac{\widetilde{NFA}_{US,t}^{ConstPrice,j}-\widetilde{NFA}_{US,t}^{j-1}}{\widetilde{NFA}_{US,t}^{j-1}}\right).$$

We define the *valuation* effect as the change in the NFA position that is due to updates in asset prices and exchange rates:

$$\Delta_{j,t}^{Val} = \log\left(1+\frac{\widetilde{NFA}_{US,t}^{j}-\widetilde{NFA}_{US,t}^{ConstPrice,j}}{\widetilde{NFA}_{US,t}^{j-1}}\right).$$

Thus, $\Delta_{j,t}^{Flow}$ sheds light on how changes in the quantity of capital held affect the U.S. NFA position, while $\Delta_{j,t}^{Val}$ sheds light on how changes in asset prices and exchange rates affect the U.S. NFA position.[16]

4.2 Decomposition Steps

Having specified our decomposition framework, we now describe the sequence of J steps we take in our exercise. As we discussed in Section 1.3, our choice of the primitive variables are

[16]The flow and valuation components sum together to equal the overall change in the NFA position in the j-th case in levels:

$$\exp(\Delta_{j,t})-1 = \left(\exp(\Delta_{j,t}^{Flow})-1\right)+\left(\exp(\Delta_{j,t}^{Val})-1\right).$$

In logs, however, this summing-up relationship is only approximate, $\Delta_{j,t}\approx\Delta_{j,t}^{Flow}+\Delta_{j,t}^{Val}$.

inspired by various literatures that study the global imbalances from different perspectives. In particular, these variables should represent (1) investor savings and asset issuances, (2) monetary policies, and (3) shifts in investor demand and asset characteristics.

Savings and Issuances We start by measuring the contribution of investors' net savings, $F_{i,t}$, and asset issuances, $Q_t(n, \ell)$, in various geographic regions. In each step, we restore investors' savings and issuances simultaneously for a given geographic region.[17] In doing so, our exercise allows us evaluate the effects of private saving glut, which is driven by an excess of foreign savings that are not satiated by local investment opportunities. More precisely, we first restore the savings and issuances in the U.S., then in the developed markets in the Asia Pacific region, then in the developed markets in the Europe region, and finally in the remaining developed and emerging markets.

Monetary Policies Next, we account for the various forms of monetary policies. We start by restoring the changes in the U.S. Federal Reserve holdings of domestic debt assets via quantitative easing (QE). Afterwards, we restore the portfolio changes in foreign central bank currency reserves, first for developed markets and then for emerging markets. Having restored these quantities, we turn to the monetary policy rates by restoring first the U.S. short-term interest rate, and then foreign short-term interest rates.

Demand Shifts and Asset Characteristics Finally, we restore the changes in country characteristics $\mathbf{x}_{i,t}(n)$, within-asset-class latent demand $\kappa_{i,t}(n, \ell)$, and across-asset-class latent demand $\xi_{i,t}(\ell)$. These steps accounts for changes in the relative desirability of assets that arise from changes in asset fundamentals (such as economic growth), as well as changes in the desirability of assets and asset classes that are not captured by observed characteristics. After these steps, we have restored all variables and fully accounted for the realized changes in the U.S. NFA position.

[17] When resetting net savings $F_{i,t}$ in step 0, we set the values to zero.

4.3 Trend Decomposition of the U.S. NFA Position

Table 2 reports the decomposition results for the overall trend in the U.S. NFA position. The first column reports the average contribution $\overline{\Delta}_j$ of each set of primitive variables to the log change of the U.S. NFA in the full sample. The second and third columns report the separate contributions of the flow and the valuation effects.

Looking first at the bottom row of Table 2, we see that the U.S. NFA position widened (i.e. became more negative) by an average of 9.4% each year in our sample period. This decline in the U.S. NFA position represents a dramatic increase in the value of U.S. external liabilities relative to the value of U.S. external assets. The second and third columns show the decline in the U.S. NFA position was partially mitigated by valuation effects. Without accounting for the changes in asset prices and exchange rates, flows in the quantity of capital would have resulted in an even larger widening in the U.S. NFA position of 13.3% per year. However, these capital flows coincided with lower returns on the U.S. external liabilities relative to the U.S. external assets, and these valuation effects helped dampen the widening by an average of 5.0% per year.

Each row in Table 2 decomposes this average 9.4% per year widening in the U.S. NFA position into the various blocks of primitive variables that we discussed above. Within each block, the bottom row reports the average contribution of the entire block. The main blocks are savings and issuances, monetary policies (which we further break down into central bank reserves and interest rates), and demand shifts and asset characteristics.

The main takeaway from these rows is that the simple downward trend in the U.S. NFA position is driven by multiple countervailing forces together, as opposed to by a single factor. First, accounting for savings and issuances around the world explains a widening in the U.S. NFA of 7.6% per year. Accounting for changes in central bank reserves and monetary policy rates around the world contributes another 9.9% per year to the average widening in the U.S. NFA position. The effects of these forces vastly overshoot the actual trend in the data. The changes in the asset characteristics and investor demand shifts partially reverse the trend in the U.S. NFA, offsetting its growth by 8.2% per year.

The implication of Table 2 is that any theory that relies primarily on a single explanation for the change in the U.S. NFA position is unlikely to succeed quantitatively. Instead, theories explaining the decline in the U.S. NFA position need to account for the interaction of multiple narratives. In the rest of this section, we discuss each block of primitive variables in greater detail.

Savings and Issuances The first block in Table 2 describes the contributions of countries' savings and issuances. A country's savings and issuances affects its NFA position through two channels. First, as a country issues more assets, the price of its assets decline, foreign investors tend to purchase more of its assets, and therefore capital flows into the country on net. Second, as an investor country saves more, domestic capital will flow towards foreign issuer countries based on the investor country's existing portfolio weights. If the investor country allocates much its savings to domestic assets, then its savings will also result in the appreciation of the domestic assets.

Figure 3 depicts the cumulative net savings flows to/from the U.S. by different regions. Savings flows to the U.S. from each region are computed by taking holdings in each period and assuming those holdings are increased proportionally to the investors increase/decrease in the total AUM. Savings from the U.S. to each foreign region are computed in the same manner. Net savings flows are the difference between these two flows. Over our sample, Developed Europe was the largest net saver into the U.S. with this particular measure having an average value of $220 billion per year. Developed market Asia had average flows of $57 billion into the U.S. per year and countries in our other group had average net outflows from the U.S. of $33 billion per year.

Turning to the contribution of these savings flows and issuances to the U.S. NFA, we find that U.S. savings and issuances explain a 6.4% growth in the U.S. NFA per year. For the U.S. this effect is mainly driven by issuances. As the U.S. issues more equity and debt assets, part of these new issuances are purchased by the foreign investors, leading to an increase in the U.S. external liabilities. The magnitude of capital flows into the U.S. is even more stark when we hold asset prices constant, as suggested by the flow effects in column (2) of Table 2. In Column (3), the valuation effects partially offset the changes in quantities, as the U.S. issuance also depresses the valuation of its foreign liabilities.

The savings and issuances from the Asia Pacific and Europe developed markets lead to further widening of the U.S. NFA position, by 2.4% and 2.1% per year respectively. This effect is mainly driven by increases in Asian Pacific and European savings. As foreign investors accumulate savings, a substantial share of these savings is allocated to U.S. financial assets due to the characteristics of the U.S. that make it a desirable destination for foreign capital as measured by the estimated demand curves. This leads to net capital inflows to the U.S. (i.e., a positive flow component) and a higher return on the U.S. assets (i.e., a positive valuation component). While non-U.S. issuances of debt and equity assets can potentially attract capital away from the U.S., this countervailing pull of foreign issuances on U.S. savings is relatively weak.

Finally, foreign savings and issuances in the other markets lead to a narrowing of the U.S. NFA positions. This is at first surprising, since countries like China and India are known to invest in the U.S. asset markets. That said, much of the financial savings in these developing countries are invested via their central banks instead of by their private investors. As a result, the effects of their aggregate savings remain to be seen in our next block that deals with central bank reserve holdings.

Overall, our analysis of global issuances and savings relates most closely with the literature on the global saving glut, which studies large increases in the global savings that seek foreign investment opportunities. Our decomposition reveals that this effect on the U.S. NFA is mainly driven by a combination of the developed economies' investment needs and U.S. issuances.

Monetary Policies We next examine the second block in Table 2, which captures the effects of central bank reserves on the U.S. NFA. U.S. quantitative easing takes part of the supply of the U.S. long-term debt out of the market and pushes up its price. As a result, this operation squeezes out foreign holdings of U.S. issued liabilities in quantities, but increases the value of the remaining foreign liabilities. Consistent with this intuition, U.S. QE explains a narrowing in the NFA position in terms of flows, but a widening in the NFA position due to valuation effects. The two effects roughly cancel out.

In the next two rows of Table 2, we find that emerging market central banks (such as

China) play a major role in widening the U.S. NFA, as foreign reserve purchases of U.S. long-term debt increase U.S. external liabilities both in quantities and value. By comparison, the central banks in developed markets play a much smaller role. Overall, the role of central bank reserves on the widening U.S. NFA is explained by reserve holdings in emerging markets.

The third block in Table 2 explains the effects of monetary policy rates. Changes in U.S. monetary policy rates tend to slightly widen the U.S. NFA position. By inspecting these effects year by year, we find that an increase in the U.S. short-term interest rate makes U.S. debt and the U.S. dollar more attractive, raising the U.S. external liabilities as a result. On the other hand, a decline in the U.S. short-term interest rate makes U.S. debt and the U.S. dollar less attractive, thereby lowering the U.S. external liabilities. Our sample from 2002 to 2019 is dominated by rate increases, first in early 2000s and then again after the financial crisis, and the U.S. short-term interest rate at the end of 2019 is slightly higher than the interest rate in 2002. As a result, the overall effect is dominated by the rising policy rate that makes the U.S. assets more attractive, leading to a more negative U.S. NFA position.

Foreign monetary policy rates have been declining more in our sample period. By a similar logic, this makes U.S. assets relatively more attractive for foreign investors and explains a further 4.1% per year widening in the U.S. NFA position.

Demand Shifts and Asset Characteristics Up to this point, savings and issuances and monetary policies jointly explain a counterfactual U.S. NFA dynamics with an average widening of 17.5% per year, which roughly doubles the actual widening in the U.S. NFA of 9.4% per year. The last block in Table 2 shows that changes in asset characteristics and latent demand partially offset the other primitive variables by shrinking the U.S. NFA by 8.2% per year.

Within this block we find that changes in characteristics had little effect on the aggregate trend in the U.S. NFA overall. Instead, changes in latent demand both within and across asset classes contributed to substantial narrowing (less negative) of the U.S. NFA. Changes in in cross-asset-class latent demand were due to a shift in capital away from long-term debt investment to towards equity investment globally. Since the U.S. is the preferred destination for bond investors, this shift towards the equity asset class narrowed the U.S. NFA position by an average of 2.9% per year.

Shifts in within asset-class latent demand further contributed to a narrowing of U.S. NFA by 4.6% per year. While, by definition, it is not immediately clear what features of the data within asset-class latent demand capture, the influence of latent demand is useful for generating additional hypotheses about drivers of capital flows. For example, a recent paper by Atkeson et al. (2021) argues that a rise in the profitability of U.S. firms is important for explaining trends in international equity positions and returns. Unfortunately, we do not observe measures of firm profitability across our issuer country sample. Thus, the explanatory power of firm profitability largely falls into the latent demand block, which is indeed an important factor offsetting the trends generated by savings and issuances, reserves and policy rates. Our decomposition therefore provides a quantitative assessment of the potential effects of unobserved country characteristics after, accounting for the other primitive explanatory factors.

4.4 Valuation Effects and the Decline of Exorbitant Privilege

In the previous section, we highlighted the main factors that explain the overall widening U.S. portfolio imbalance over the last two decades. Returning to Figure 1, we observe that, on top of the overall downward trend in the U.S. NFA, the U.S. experienced a stark reversal in the valuation effects earned on its NFA position. Between 2002 to 2010, the U.S. earned a positive return on its NFA portfolio (i.e., an exorbitant privilege), which counterbalanced net capital inflows into the U.S. and contributed to a narrowing of U.S. NFA position. However, from 2011 to 2019, the U.S. exorbitant privilege reversed, and the valuation effects further widened the U.S. NFA position.

Building on our decomposition methodology, we first compute the valuation effects ($\Delta_{j,t}^{Val}$) on the U.S. NFA position by asset class before and after 2010 in Table 3. While much of the literature on global imbalances reports the return differences between U.S. external asset and external liability positions (e.g., Gourinchas and Rey (2007a) and Curcuru et al. (2008)), we prefer our quantity-weighted decomposition methodology because it also takes into account the relative size of the U.S. asset and liability positions. Given that the U.S. liability position is notably larger than the U.S. asset position, a 1% return on the U.S. liability position has a much larger impact on the overall NFA position than a 1% return on the U.S. asset position.

The top row in Table 3 reports the valuation effects on the U.S. NFA position. In the full sample, consistent with what we reported in Table 2, this component helped reduce the impact of capital flows into the U.S. by 5.0% per year. The second column shows that, between 2002 and 2010, valuation effects dampened the effects of capital inflows by an average of 18.3% per year. By contrast, the third column shows that valuation effects amplified the widening in the U.S. NFA position by an average of 6.9% per year post 2010.

In the remainder of Table 3, we report the average returns on the U.S. external assets and liabilities in different asset classes. For U.S. external assets, we also break down the returns into (foreign) local currency terms and the exchange rate movements. Panel A shows this reversal can be attributed to both a large decrease in the returns on U.S. external assets (from 10.5% to 1.7% per annum) and a slightly smaller increase in the returns on U.S. external liabilities (from 0.8% to 3.6%). About half of the decrease in the returns on U.S. external assets can be attributed to changes in returns in foreign currency units, and the other half can be attributed to exchange rate movements.

We now turn to a decomposition over time to understand the variables that explain the large reversal in valuation effects on the U.S. external portfolio after 2010. Table 4 shows the contribution of each block of primitive variables in driving the valuation component of the U.S. external portfolio position pre- and post-2010. There are three blocks of primitive variables that show a large change between the two time periods: savings and issuances, reserves, and demand shifts and characteristics.

The first two blocks of Table 4 show that changes in savings and issuances and central bank reserves between the first and second half of our sample mostly offset each other. Prior to 2010, savings and issuances helped narrow the U.S. NFA position by 18.6% per year. After 2010, the contribution of savings and issuances to the narrowing of NFA dropped to 9.1% per year. This effect was primarily driven by declining U.S. issuance post-2010 relative to pre-2010, which led to relatively higher realized returns on U.S. liabilities post 2010. Changes to emerging market reserves display the opposite pattern. Emerging market central bank reserve accumulation prior to 2010 contributed to a wider U.S. NFA by 5% per year. After 2010, this contribution declines to 0% per year as emerging market central bank reserve accumulation slowed.

Another major contributor to the reversal in the valuation component was changes in latent demand, primarily within asset classes. The contribution of latent demand to the valuation component was 3.1% before 2010 and 12.5% after 2010, contributing 9.2% per year to the reversal. To understand the source of this change, Figure 4 presents the relative latent demand for U.S.-issued financial assets, relative to the latent demand for foreign-issued financial assets for both long-term debt and equity.[18] Increases in these measures imply stronger demand for U.S.-issued financial assets. As is evident from Figure 4, the latent demand for U.S. long-term debt assets remained relatively flat over time, but latent demand for U.S. equity assets, relative to equity from different countries, exhibited a strong V-shaped pattern of much greater magnitude. Prior to 2010, U.S. equities became increasingly less desirable relative to foreign equities, which depressed U.S. equity values and the realized returns paid on equity liabilities. After 2010, however, this narrative completely reversed. A substantial increase in latent demand for U.S. equity captures a significant rise in U.S. equity returns, and a significant widening of the U.S. portfolio imbalance. Finally, we also note that changes in characteristics, specifically GDP and inflation, also contributed around 5% to the reversal.

In sum, our decomposition of valuation effects shows a number of forces coalesce to drive up realized returns of U.S. external liabilities and down returns on U.S. external assets. Combined, these valuation forces contributed to a widening the U.S. external position over the last ten years. Declines in U.S. asset issuances relative to the aggregate investor demand drive up the valuation of the U.S. liabilities, while foreign private savings and central bank reserve accumulation lowers the the valuation of the U.S. liabilities. While these two effects offset each other, changes in assets' characteristics and shifts towards U.S. equities further increase the return on U.S. liabilities relative to assets. Our decomposition not only clarifies the economic factors explaining the decline in the valuation effects earned on the U.S. NFA position, but it also suggests we should re-evaluate the notion of exorbitant privilege entirely. Under the current definition, a decline in the U.S. exorbitant privilege is synonymous with

[18] For equity and long-term debt we de-mean latent demand by investor-issuer pair. We then compute the difference between the AUM weighted average latent demand for US assets and the mean of the AUM weighted average latent demand for all other countries assets.

increasing demand for the unobserved characteristics of U.S. financial assets.

4.5 Robustness: Variation in Estimated Demand

In this section, we evaluate the robustness of our findings to variations in our estimated demand curves. A potential concern is that our findings may be sensitive to the specific estimation and identification procedure we used for our demand equations (14) and (15). To demonstrate the robustness of our findings, we present two sets of results. First, we study the sensitivity of our decompositions to variations in our identification strategy. Second, we set the demand elasticities to a range of plausible values and show how our findings vary as we systematically iterate over this range. While the first set of results requires us to make alternative identification assumptions, the second set of results allows us to understand the robustness of our findings even in absence of a perfect identification strategy for our demand curves. Both exercises demonstrate that the conclusions drawn from our decompositions are robust to perturbations in estimated demand curves.

We first present the robustness exercises for our trend decomposition and then present the same exercises for our valuation effects decomposition. We begin with the results from the five alternative estimation and identification procedures. In these alternative specifications we allow GDP to be endogenous and we instrument various model components such as asset supply and outside asset holdings by exogenous variables. The goal of instrumenting these variables is to alleviate concerns about the endogeneity of supply and assets under management to latent demand. We specify the details of these different procedures in Appendix A.1 and focus here on how these estimates impact our decompositions. The estimated coefficients on expected returns for these alternative procedures is given in Table D.9. To understand how our results vary with these estimates, we re-compute our trend and valuation decompositions for each of these sets of estimates.

Using these 5 alternative specifications, Table 5 presents the results our trend decomposition. The top panel presents the implied demand elasticities from these estimates.[19] We discuss how these elasticities compare to values from the literature below. The second panel presents our trend decomposition. The baseline column re-iterates our decomposition

[19]The details of the calculation of these elasticities can be found in Appendix B.3.

of the changes in the U.S. NFA position that we discussed in Section 4.3. Columns (1) through (5) present the alternative estimation and identification procedures along with the corresponding decompositions of the U.S. NFA position. As we look across the columns in Table 5, we observe that the decomposition of trends in the U.S. NFA position does not vary substantially across the specifications. Total savings and issuances decrease the U.S. NFA position by an average of 6.2% to 11.8% per year, and reserves and policy rates decrease the U.S. NFA position by an additional 6.9% to 12.2% per year. Thus, the combination of these first three blocks always overshoots the widening observed in the U.S. NFA position in the data. Similarly, regardless of the specification, changes in asset characteristics and shifts in demand counteract the variables in the first three blocks by around 8-10%.

In our second set of exercises we show that, even as we systematically vary the coefficient on expected returns in the demand curve, the decomposition of the trends in the U.S. NFA remains largely unchanged. We focus on a range of coefficients on expected returns that imply demand elasticities that are consistent with those found in the recent literature which measures demand elasticities in financial markets.Gabaix and Koijen (2021) provide a discussion and summary of this literature.

While there are few direct measures of the elasticities which we use in our paper, a reasonable benchmark for the elasticity of demand for country-level portfolios of long-term debt and equity is approximately 0.75-5.[20] We base this range on a number of facts. First, this range includes the range of demand elasticities shown in Table 5, which are direct estimates of our desired elasticities. Second, this range of estimates is also consistent with those found in Koijen and Yogo (2019b). Third, the literature on equity inclusion effects (see Wurgler and Zhuravskaya (2002) for example) finds values in the range of 1, although these estimates are based on individual stocks and on equity index inclusion, which limits their direct translation to our elasticities. Fourth, a more recent literature has found some elasticities to below 1, which we include, although they are lower than we find across our various estimation procedures.

To understand how our results vary across this range of demand elasticities, we take

[20] We also vary the elasticity on short-term debt, but maintain a range that is of a similar magnitude to the range which is found in our various estimations discussed above and in Koijen and Yogo (2019b) since there is no benchmark that we are aware of for this elasticity for short-term debt.

the minimum and maximum coefficient on expected returns from our various estimates and proportionally lower and raise them to achieve demand elasticities in this range for long-term debt and equity. To ensure that demand is consistent with the chosen coefficients on expected returns, we fix these coefficients and re-estimate the remaining parameters in the demand curves. Table 6 shows the results of this sensitivity analysis. The first three rows present the elasticities that are implied by the coefficients on expected returns which we use for a range of 7 different demand elasticities, along with our baseline values. Consistent with our targeted range, these elasticities range from 0.7 to 5.2 for long-term debt and 0.9 to 2.7 for equity.

Each column of Table 6 presents the decomposition of the U.S. NFA position analogous to column (1) of Table 2. As we look across the columns of Table 6, we see the contribution of each primitive variable does not vary substantively across the various specifications of demand curves. Thus, our main qualitative results continue to hold under each of these alternative demand elasticities.

We also perform our two robustness exercises for our decomposition of changes in valuation effects. Specifically, for the 5 alternative estimates, Table 7 presents the difference (post-2010 minus pre-2010) between the valuation contribution to U.S. NFA. We report the difference here because we are primarily interested in which components changed after 2010 that contributed to the decline in exorbitant privilege which we observe. Importantly, this table shows that the conclusions regarding the valuation effects are highly robust to specific estimated variations in demand curves. The main contributing variables to the decline in valuation effects on the U.S. NFA position remain consistent.

Table 8 presents the exercise where we scale the coefficient on expected returns. For this table, we also separately present the valuation contribution from 2002-2010, 2011-2019, and their difference. Again, as we look across the rows of the table which report the difference, the variables most responsible for the decrease in the valuation effect over time remain consistent across all specification. Thus, we conclude that our decomposition of the valuation effects on the U.S. NFA position is also robust to a variety of parameterizations of the demand curve.

As a final set of robustness checks, we fix the estimated within asset-class demand curves to our baseline values and vary the cross-asset substitution parameters, λ.[21] Table D.10 presents the results for the trend decomposition and Table D.11 presents the difference between the valuation component pre and post 2010. Overall, these tables show that our results are robust to variation in the estimated cross-asset demand curves as well.

4.6 Exorbitant Privilege in Debt Issuance

Up to this point, we have studied the sources of variation in U.S. NFA position and its returns over the last 20 years. One salient feature of our estimated demand system is that it highlights the large differences in investor demand for financial assets issued by different countries. These differences give rise to substantial heterogeneity in a country's ability to borrow in international financial markets. In this section, we take a forward-looking perspective and ask the question: how much additional long-term debt can a country issue until its long-term yield increases by 1%? These results help quantify a quantity dimension of the U.S. exorbitant privilege, which depends not only on the relatively high prices investors pay to hold U.S. assets, but also on the quantity of long-term debt that the U.S. can issue without affecting prices too much (Farhi and Maggiori 2017).

Formally, we take the state of the economy at the end of 2019 as given, and conduct the following experiment. For each issuer country, we increase the amount of its long-term debt outstanding until its (endogenous) long-term yield increases by 1%. Figure 5 shows the results of this exercise for the G-10 countries. The left-hand panel of Figure 5 shows, clearly, that global investors have the greatest appetite for U.S. long-term debt in pure dollar amounts. Investors would absorb about 1.5 trillion dollars of U.S. long-term debt before requiring U.S. issuers to pay an additional 1% in yield. This amount is nearly triple the implied quantity for any other G-10 country, suggesting the U.S. has the potential to extract more surplus from international bond markets.

The right-hand panel of Figure 5 scales issuances by 2019 GDP, and reveals that, although global investors are willing to absorb much more U.S. debt in absolute terms, the U.S. had much less room to issue debt at the end of 2019, after accounting for the size of the U.S. economy. Instead, our estimates suggest Norway and the United Kingdom have the most

[21] We fix the λ values in Equation 15 and re-estimate the remaining cross-asset demand coefficients.

room to issue long-term debt as a share of their respective GDP. In this sense, the glass is half full and half empty: the U.S. can still issue a fairly large amount of debt assets before yields go up, but this amount is quite small relative to the size of its economy.

5 Conclusion

This paper uses a portfolio approach to evaluate the impact of savings and issuances, monetary policies, asset characteristics and demand shifts on U.S. NFA dynamics. Our framework highlights three key insights that are important to consider for theories of global imbalances. First, the simple downward trend of the U.S. NFA position masks several countervailing forces. In particular, while global savings and central bank policies contribute to a widening in the U.S. NFA, shifts in asset characteristics and investor demand partially reverse this trend. Second, we observe a decline in the exorbitant privilege earned by the U.S. after 2010. We attribute this decline to a increase in global investor demand for U.S. equity, which drove up the the realized returns of U.S. external liabilities. Finally, looking ahead, we show that demand for U.S. debt is quite stable. As a result, U.S. debt issuers have the privilege of issuing substantially more debt before suffering from higher yields. These results shed new light on the sources of the global imbalances, as well as reveal a new quantity dimension of U.S. privilege.

References

Acharya, Viral V, and Arvind Krishnamurthy, 2018, Capital flow management with multiple instruments, Technical report, National Bureau of Economic Research.

Ahmed, Shaghil, Carol Bertaut, Jessica Liu, Robert Vigfusson, et al., 2018, Should we be concerned again about us current account sustainability?, *IFDP Notes. Washington: Board of Governors of the Federal Reserve System* .

Alfaro, Laura, Sebnem Kalemli-Ozcan, and Vadym Volosovych, 2008, Why doesn't capital flow from rich to poor countries? and empirical investigation, *The Review of Economics and Statistics* 90, 347–368.

Angeletos, George-Marios, and Vasia Panousi, 2011, Financial integration, entrepreneurial risk and global imbalances, *Journal of Economic Theory* 146, 863–896.

Antras, Pol, and Ricardo J. Caballero, 2009, Trade and capital flows: a financial frictions perspective, *Journal of Political Ecoonmy* 117, 701–744.

Atkeson, Andrew, Jonathan Heathcote, and Fabrizio Perri, 2021, The end of privilege: A reexamination of the net foreign asset position of the united states, Working paper. UCLA.

Auclert, Adrien, Hannes Malmberg, Frederic Martenet, and Matthew Rognlie, 2021, Demographics, wealth, and global imbalances in the twenty-first century, Technical report, National Bureau of Economic Research.

Bacchetta, Philippe, Margaret Davenport, and Eric Van Wincoop, 2022, Can sticky portfolios explain international capital flows and asset prices?, *Journal of International Economics* 103583.

Bacchetta, Philippe, Eric van Wincoop, and Eric R Young, 2021, Infrequent random portfolio decisions in an open economy model, *Swiss Finance Institute Research Paper* .

Bernanke, Ben S, 2005, The global saving glut and the us current account deficit, Technical report.

Bertaut, Carol, and Ruth Judson, 2014, Estimating u.s. cross-border securities positions: New data and new methods, International Finance Discussion Paper 1113.

Bertaut, Carol, and Ralph W. Tryon, 2007, Monthly estimates of u.s. cross-border securities positions, International Finance Discussion Papers 910.

Blanchard, Olivier J, Francesco Giavazzi, and Filipa Sa, 2005, The us current account and the dollar.

Caballero, Ricardo J, 2006, On the macroeconomics of asset shortages.

Caballero, Ricardo J., Emmanuel Farhi, and Pierre-Olivier Gourinchas, 2008, An equilibrium model of global imbalances and low interest rates, *American Economic Review* 98, 358–393.

Caballero, Ricardo J., Emmanuel Farhi, and Pierre-Olivier Gourinchas, 2017, The safe assets shortage conundrum, *Journal of Economic Perspectives* 31, 29–46.

Carvalho, Carlos, Andrea Ferrero, and Fernanda Nechio, 2016, Demographics and real interest rates: Inspecting the mechanism, *European Economic Review* 88, 208–226.

Coppola, Antonio, Matteo Maggiori, Brent Neiman, and Jesse Schreger, 2020, Redrawing the map of global capital flows: The role of cross-border financing and tax havens, Technical report, National Bureau of Economic Research.

Cova, Pietro, Massimiliano Pisani, and Alessandro Rebucci, 2009, Global imbalances: The role of emerging asia, *Review of International Economics* 17, 716–733.

Curcuru, Stephanie E., Tomas Dvorak, and Francis E. Warnock, 2008, Cross-border return differentials, *The Quarterly Journal of Economics* 123, 1495–1530.

Devereux, Michael B, and Alan Sutherland, 2009, A portfolio model of capital flows to emerging markets, *Journal of Development Economics* 89, 181–193.

Farhi, Emmanuel, Pierre-Olivier Gourinchas, and Hélène Rey, 2011, *Reforming the international monetary system* (CEPR).

Farhi, Emmanuel, and Matteo Maggiori, 2017, A model of the international monetary system, *The Quarterly Journal of Economics* 133, 295–355.

Gabaix, Xavier, and Ralph SJ Koijen, 2021, In search of the origins of financial fluctuations: The inelastic markets hypothesis, Technical report, National Bureau of Economic Research.

Ghironi, Fabio, Jaewoo Lee, and Alessandro Rebucci, 2007, The valuation channel of external adjustment.

Gourinchas, Pierre-Olivier, and Helene Rey, 2007a, From world bank to world venture capitalist, in Richard H. Clarida, ed., *G-7 Current Account Imbalances: Sustainability and Adjustment*, 11–55 (University of Chicago Press).

Gourinchas, Pierre-Olivier, and Helene Rey, 2007b, International financial adjustment, *Journal of political economy* 115, 665–703.

Gourinchas, Pierre-Olivier, and Helene Rey, 2014, External adjustment, global imbalances, valuation effects, in *Handbook of International Economics, Volume 4*, chapter Chapter 10, 585–645 (Elsevier B.V.).

Gourinchas, Pierre-Olivier, Helene Rey, and Nicolas Govillot, 2010, Exorbitant privilege and exorbitant duty, Technical report, Institute for Monetary and Economic Studies, Bank of Japan.

Greenwood, Robin, Samuel Hanson, and Jeremy C. Stein, 2010, A gap-filling theory of corporate debt maturity choice, *Journal of Finance* 65, 993–1028.

Greenwood, Robin, Samuel G. Hanson, Jeremy C. Stein, and Adi Sunderam, 2019, A quantity-driven theory of term premiums and exchange rates, Technical report, Harvard University and NBER.

Greenwood, Robin, and Dimitri Vayanos, 2014, Bond supply and excess bond returns, *Review of Financial Studies* 27, 663–713.

Iancu, Alina, Gareth Anderson, Sakai Ando, Ethan Boswell, Andrea Gamba, Shushanik Hakobyan, Lusine Lusinyan, Neil Meads, and Yiqun Wu, 2020, Reserve currencies in an evolving international monetary system, IMF Departmental Paper No. 2020/002.

Jiang, Zhengyang, Arvind Krishnamurthy, and Hanno Lustig, 2020a, Dollar safety and the global financial cycle, Technical report, National Bureau of Economic Research.

Jiang, Zhengyang, Arvind Krishnamurthy, and Hanno Lustig, 2020b, Foreign safe asset demand and the dollar exchange rate, Technical report.

Kilian, Lutz, Alessandro Rebucci, and Nikola Spatafora, 2009, Oil shocks and external balances, *Journal of international Economics* 77, 181–194.

Koijen, Ralph, Robert Richmond, and Motohiro Yogo, 2019, Which investors matter for equity valuations and expected returns?, Technical report.

Koijen, Ralph SJ, François Koulischer, Benoît Nguyen, and Motohiro Yogo, 2017, Euro-area quantitative easing and portfolio rebalancing, *American Economic Review* 107, 621–27.

Koijen, Ralph SJ, François Koulischer, Benoît Nguyen, and Motohiro Yogo, 2020, Inspecting the mechanism of quantitative easing in the euro area, *Journal of Financial Economics* .

Koijen, Ralph S.J., and Motohiro Yogo, 2019a, A demand system approach to asset pricing, *Journal of Political Economy* 127, 1475–1515.

Koijen, Ralph S.J., and Motohiro Yogo, 2019b, Exchange rates and asset prices in a global demand system, Technical report.

Krishnamurthy, Arvind, Stefan Nagel, and Annette Vissing-Jorgensen, 2018, Ecb policies involving government bond purchases: Impact and channels, *Review of Finance* 22, 1–44.

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen, 2012, The aggregate demand for treasury debt, *Journal of Political Economy* 120, 233–267.

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen, 2013, The ins and outs of lsaps, in *Kansas City Federal Reserve Symposium on Global Dimensions of Unconventional Monetary Policy*, 57–111.

Lane, Philip, and Gian Maria Milesi-Ferretti, 2001, The external wealth of nations: measures of foreign assets and liabilities for industrial and developing countries, *Journal of International Economics* 55, 263–294.

Lane, Philip R, and Gian Maria Milesi-Ferretti, 2007, The external wealth of nations mark ii: Revised and extended estimates of foreign assets and liabilities, 1970–2004, *Journal of International Economics* 73, 223–250.

Liao, Gordon, and Tony Zhang, 2020, The hedging channel of exchange rate determination, International Finance Discussion Papers 1283.

Maggiori, Matteo, 2017, Financial intermediation, international risk sharing, and reserve currencies, *American Economic Review* 107, 3038–71.

Malkhozov, Aytek, Philippe Mueller, Andrea Vedolin, and Gyuri Venter, 2016, Mortgage risk and the yield curve, *Review of Financial Studies* 29, 1220–1253.

Mendoza, Enrique G., Vincenzo Quadrini, and Jose-Victor Rios-Rull, 2009, Financial integration, financial development, and global imbalances, *Journal of Political Economy* 117, 371–416.

Merton, Robert C., 1973, An intertemporal capital asset pricing model, *Econometrica* 41, 867–887.

Mian, Atif R, Ludwig Straub, and Amir Sufi, 2020, The saving glut of the rich and the rise in household debt, Technical report, National Bureau of Economic Research.

Portes, Richard, and Helene Rey, 2005, The determinants of cross-border equity flows, *Journal of international Economics* 65, 269–296.

Portes, Richard, Hélène Rey, and Yonghyup Oh, 2001, Information and capital flows: The determinants of transactions in financial assets, *European economic review* 45, 783–796.

Rachel, Lukasz, and Thomas D Smith, 2018, Are low real interest rates here to stay?, *50th issue (September 2017) of the International Journal of Central Banking* .

Richmond, Robert J, 2016, Trade network centrality and currency risk premia, *The Journal of Finance* .

Shin, Hyun Song, 2012, Global banking glut and loan risk premium, *IMF Economic Review* 60, 155–192.

Stock, James H, and Motohiro Yogo, 2002, Testing for weak instruments in linear iv regression.

Tabova, Alexandra, and Francis Warnock, 2021, Foreign investors and u.s. treasuries, NBER Working Paper 29313.

Tille, Cedric, and Eric Van Wincoop, 2010, International capital flows, *Journal of international Economics* 80, 157–175.

Vayanos, Dimitri, and Jean-Luc Vila, 2009, A preferred-habitat model of the term structure of interest rates, Technical report, NBER Working Paper No. 15487.

Wurgler, Jeffrey, and Ekaterina Zhuravskaya, 2002, Does arbitrage flatten demand curves for stocks?, *The Journal of Business* 75, 583–608.

Tables and Figures

Table 1
Top Holdings in U.S. External Assets and Liabilities

2002				2019			
Assets		**Liabitlities**		**Assets**		**Liabitlities**	
Long-Term Debt							
Canada	97	European Union	467	Canada	379	Federal Reserve	3,271
United Kingdom	82	Japan	410	United Kingdom	357	European Union	2,756
Germany	51	Federal Reserve	307	France	155	China Central Bank	1,904
France	39	China Central Bank	227	Japan	147	Japan	1,622
Japan	34	United Kingdom	146	Australia	136	United Kingdom	596
All Other	162	All Other	464	All Other	664	All Other	2,575
Short-Term Debt							
United Kingdom	75	Japan	108	Canada	105	European Union	268
Canada	12	European Union	73	United Kingdom	80	Japan	62
Germany	12	Mexico	23	Japan	58	United Kingdom	45
France	9	Russia	22	Australia	46	Singapore	30
Sweden	7	China	15	France	24	Switzerland	26
All Other	27	All Other	70	All Other	93	All Other	155
Equity							
United Kingdom	227	European Union	393	China	1,031	European Union	2,400
Japan	154	United Kingdom	159	United Kingdom	1,016	United Kingdom	1,058
France	91	Canada	141	Japan	930	Canada	949
Switzerland	82	Japan	118	Canada	567	Japan	591
Canada	74	Switzerland	92	France	490	Norway	328
All Other	379	All Other	189	All Other	2,387	All Other	1,773
Total	**1,613**	**Total**	**3,423**	**Total**	**8,666**	**Total**	**20,408**

This table reports the top destinations of U.S. external assets and the top holders of U.S. external liabilities in each asset class in 2002 and 2019. Values are reported in billions of U.S. dollars.

Table 2
Trend Decomposition of U.S. NFA

	NFA	Flow	Valuation
Savings and Issuances			
U.S.	6.4	11.8	-12.3
Asia Pacific Dev. Markets	2.4	2.0	0.9
Europe Dev. Markets	2.1	2.6	0.9
Other Markets	-3.4	-1.1	-2.3
Total Savings and Issuances	7.6	15.9	-13.5
Monetary Policies (Reserves)			
U.S. QE	0.1	-1.9	1.6
Dev. Market Reserves	0.2	0.1	0.1
Emr. Market Reserves	4.3	2.1	2.4
Total Reserves	4.5	0.2	4.1
Monetary Policies (Rates)			
U.S. Rate	1.3	0.5	-1.7
Foreign Rates	4.1	3.2	1.0
Total Rates	5.4	3.9	-0.5
Demand Shifts and Characteristics			
Characteristics	-0.7	-0.1	-0.6
Within-Asset Latent Demand	-4.6	-7.0	8.1
Across-Asset Latent Demand	-2.9	-1.7	-1.4
Total Demand and Characteristics	-8.2	-7.4	6.3
Total	**9.4**	**13.3**	**-5.0**

This table reports our decomposition of the U.S. NFA position into primitive variables. Each row reports the average effect attributed to each set of primitive variables over the full sample period. The first column reports the decomposition of the log U.S. NFA. A positive number indicates the variable widened the U.S. NFA position, and a negative number indicates the variable narrowed the U.S. NFA position. The last row in each block reports the cumulative effect of all components within the block. The second and third columns decompose the change in the NFA position into a component capturing capital flows and a component capturing valuation effects.

Table 3
Components of U.S. External Portfolio Return Differential

	Full Sample	2002-2010	2011-2019
Valuation Effects	**-5.0**	**-18.3**	**6.9**
Panel A: All Asset Classes			
Asset Return (USD)	5.9	10.5	1.7
Asset Return (LC)	5.8	8.1	3.8
Asset Return (FX)	0.7	3.9	-2.0
Liability Return (USD)	2.3	0.8	3.6
Panel B: Long-term Debt			
Asset Return (USD)	4.7	8.4	1.5
Asset Return (LC)	4.2	5.4	3.2
Asset Return (FX)	0.5	3.3	-1.9
Liability Return (USD)	0.1	0.0	0.2
Panel C: Short-term Debt			
Asset Return (USD)	2.7	6.6	-0.8
Asset Return (LC)	2.3	3.6	1.2
Asset Return (FX)	0.4	3.2	-2.1
Liability Return (USD)	1.7	2.7	0.8
Panel D: Equity			
Asset Return (USD)	6.7	11.8	2.1
Asset Return (LC)	6.8	9.6	4.3
Asset Return (FX)	0.8	4.1	-2.2
Liability Return (USD)	4.4	-1.4	9.5

This table presents the average valuation effects on U.S. external assets and U.S. external liabilities by asset class in U.S. dollars. The valuation effect, Δ_t^{Val} is computed as the change in the position attributed to changes in asset prices. For the U.S. NFA position $NFA_{US,t}$,

$$\Delta_t^{Val} = \log\left(1 + \frac{NFA_{US,t} - NFA_{US,t}^{ConstPrice}}{NFA_{US,t-1}}\right),$$

where $NFA_{US,t}^{ConstPrice}$ is hypothetical "constant-price" NFA position holding asset prices and exchange rates constant at $t-1$ values (computed according to Section 4). Asset Return (LC) and Asset Return (FX) attribute Asset Return (USD) into local currency returns and exchange rate changes, respectively, under the assumption that all assets are denominated in local currency. The Liability Return (USD) row reports average valuation effects on the U.S. external liability position. The first column reports the average valuation effects for the full sample period, while the second and third columns report average valuation effects for the two subsamples. On the top row, a negative valuation effect implies the change in asset prices narrowed the U.S. NFA position, and a positive valuation implies the change in asset prices widened the U.S. NFA position.

Table 4
Trend Decomposition of U.S. Valuation: Subsamples

	2002-2010	2011-2019
Savings and Issuances		
U.S.	-21.9	-3.7
Asia Pacific Dev. Markets	3.7	-1.5
Europe Dev. Markets	1.5	0.3
Other Markets	-1.1	-3.3
Total Savings and Issuances	-18.6	-9.1
Monetary Policies (Reserves)		
U.S. QE	2.2	1.0
Dev. Market Reserves	0.0	0.2
Emr. Market Reserves	5.0	0.0
Total Reserves	7.3	1.2
Monetary Policies (Rates)		
U.S. Rate	-1.8	-1.6
Foreign Rates	2.7	-0.5
Total Rates	1.3	-2.1
Demand Shifts and Characteristics		
Characteristics	-3.6	2.1
Within-Asset Latent Demand	3.1	12.5
Across-Asset Latent Demand	-3.4	0.4
Total Demand and Characteristics	-3.0	14.5
Total	**-18.3**	**6.9**

This table reports the valuation effects in the trend decomposition of the U.S. NFA position in the first and second half of our sample. Each row reports the average valuation effect attributed to each set of primitive variables in the 2002-2010 and the 2011-2019 subsamples. Recall, the valuation effect is the change in the counterfactual U.S. NFA position that is attributed to changes in the prices of U.S. external assets and liabilities.

Table 5
Trend Decomposition of U.S. NFA. Vary Estimation.

	Estimation Variation					
	Baseline	(1)	(2)	(3)	(4)	(5)
Demand Elasticity						
Short-Term Debt	206.6	197.3	219.0	214.0	122.0	378.1
Long-Term Debt	2.5	4.4	3.7	1.3	1.6	3.6
Equity	1.8	1.1	1.4	1.7	1.4	2.4
Trend Decomposition						
Total Savings and Issuances	7.6	11.8	10.1	7.3	9.8	6.2
Total Reserves	4.5	2.6	3.4	6.2	4.5	4.7
Total Rates	5.4	4.3	5.1	6.0	3.2	7.7
Total Demand and Characteristics	-8.2	-9.4	-9.2	-10.1	-8.1	-9.2
Total	9.4	9.4	9.4	9.4	9.4	9.4

This table presents the trend decomposition of the U.S. NFA position under variations of the instrumental variables strategy. The top panel presents the average elasticity of demand with respect to asset prices in each of the variations. The "Baseline" column re-iterates the trend decomposition shown in Table 2. The remaining columns present the results under alternative assumptions taken to construct the instrumental variables. These alternatives are described in Appendix Section A.1. In order to conserve space, we only report the effects of the blocks of variables.

Table 6
Trend Decomposition of U.S. NFA. Scaling Elasticities.

	Demand Elasticity Variant							
	Baseline	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Demand Elasticity								
Short-Term Debt	206.6	34.8	107.8	180.7	253.6	326.5	399.5	472.4
Long-Term Debt	2.5	0.7	1.4	2.2	2.9	3.7	4.4	5.2
Equity	1.8	0.9	1.2	1.5	1.8	2.1	2.4	2.7
Trend Decomposition								
Total Savings and Issuances	7.6	8.6	10.8	9.0	7.8	7.1	6.6	6.4
Total Reserves	4.5	4.0	4.1	4.3	4.4	4.4	4.3	4.3
Total Rates	5.4	0.1	2.7	4.6	6.2	7.3	7.6	7.3
Total Demand and Characteristics	-8.2	-3.2	-8.3	-8.6	-9.0	-9.4	-9.2	-8.6
Total	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4

This table presents the trend decomposition of U.S. NFA position as we scale the coefficients on expected returns in all asset classes. The "Baseline" column re-iterates the trend decomposition shown in Table 2. Columns (1) through (7) scale the coefficients on expected return in each asset class up an down to systematically vary the elasticity of demand. The top panel presents the average elasticity of demand with respect to asset prices under each alternative specification.

Table 7
Return Decomposition Difference. Vary Estimation.

	Estimation Variation					
	Baseline	(1)	(2)	(3)	(4)	(5)
Demand Elasticity						
Short-Term Debt	206.6	197.3	219.0	214.0	122.0	378.1
Long-Term Debt	2.5	4.4	3.7	1.3	1.6	3.6
Equity	1.8	1.1	1.4	1.7	1.4	2.4
Return Decomposition Difference						
Total Savings and Issuances	9.5	8.9	8.3	5.2	4.5	12.0
Total Reserves	-6.1	-3.7	-4.5	-8.1	-7.0	-5.1
Total Rates	-3.4	-2.5	-3.2	-2.2	-2.2	-0.9
Total Demand and Characteristics	17.5	11.8	14.6	18.5	18.7	13.6
Total	25.1	25.1	25.1	25.1	25.1	25.1

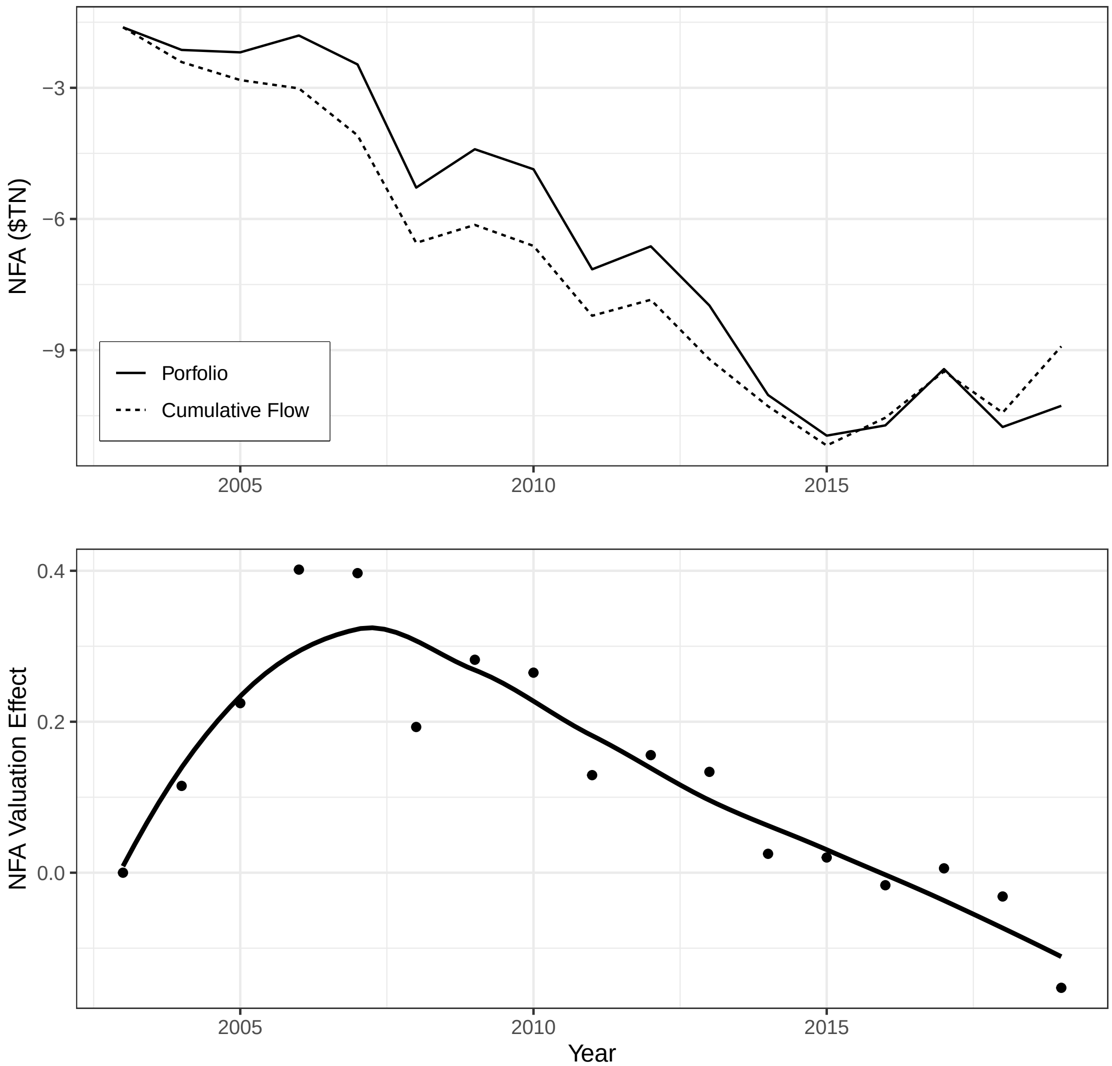
This table presents the decomposition of the valuation effect under the alternative variations of the instrumental variables strategy presented in Table 5. The top panel presents the average elasticity of demand with respect to asset prices in each of the variations. The bottom panel presents the change in the valuation effect between the first and second halves of our sample under each alternative estimation strategy. A positive value indicates that the valuation effect explained by a given block of variables increased between the first and second half of our sample. To re-iterate, an increase in the valuation effect implies a greater widening of the U.S. NFA position. Please see Table 5 for additional details.

Table 8
Return Decomposition Difference. Scale.

	Demand Elasticity Variant							
	Baseline	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Demand Elasticity								
Short-Term Debt	206.6	34.8	107.8	180.7	253.6	326.5	399.5	472.4
Long-Term Debt	2.5	0.7	1.4	2.2	2.9	3.7	4.4	5.2
Equity	1.8	0.9	1.2	1.5	1.8	2.1	2.4	2.7
Return Decomposition Difference								
Savings and Issuances								
2002-2010	-18.6	-20.1	-12.7	-15.2	-17.4	-18.8	-19.7	-20.2
2011-2019	-9.1	-2.2	-6.9	-8.2	-8.2	-7.9	-7.4	-6.9
Difference	9.5	17.8	5.8	7.0	9.2	11.0	12.3	13.3
Total Monetary Policies (Reserves)								
2002-2010	7.3	8.3	7.7	7.2	6.6	6.1	5.7	5.3
2011-2019	1.2	1.0	1.0	1.1	1.1	1.1	1.1	1.1
Difference	-6.1	-7.3	-6.7	-6.1	-5.5	-5.0	-4.6	-4.2
Total Rates								
2002-2010	1.3	-2.0	1.2	1.6	0.7	-1.4	-4.5	-8.9
2011-2019	-2.1	-0.1	-0.1	-1.3	-2.6	-3.8	-4.9	-6.1
Difference	-3.4	1.9	-1.3	-2.9	-3.3	-2.4	-0.4	2.8
Total Demand and Characteristics								
2002-2010	-3.0	-1.9	-7.1	-4.2	-1.7	0.8	3.8	7.7
2011-2019	14.5	7.2	10.1	13.0	14.5	15.5	16.3	17.2
Difference	17.5	9.1	17.2	17.2	16.2	14.7	12.5	9.5
Total								
2002-2010	-18.3	-18.3	-18.3	-18.3	-18.3	-18.3	-18.3	-18.3
2011-2019	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Difference	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1

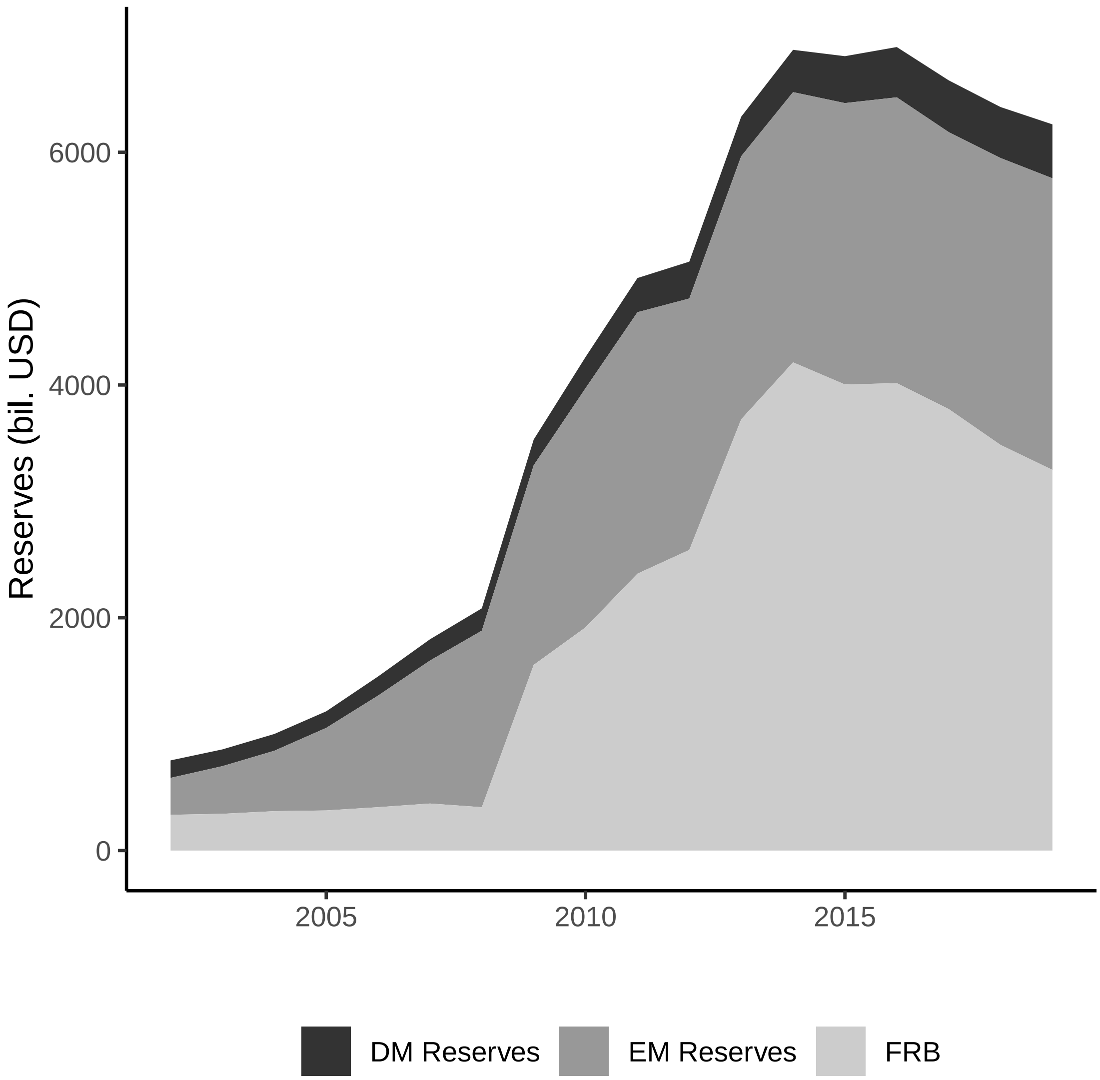
This table reports the difference in the valuation effect between the first and second halves of our sample as we scale the coefficients on expected returns in all asset classes. The top panel presents the average elasticity of demand with respect to asset prices under each alternative specification. The bottom panel presents the change in the valuation effect between the first and second halves of our sample under each alternative estimation strategy. A positive value indicates that the valuation effect explained by a given block of variables increased between the first and second half of our sample. To re-iterate, an increase in the valuation effect implies a greater widening of the U.S. NFA position.

Figure 1. U.S. Net Portfolio Position



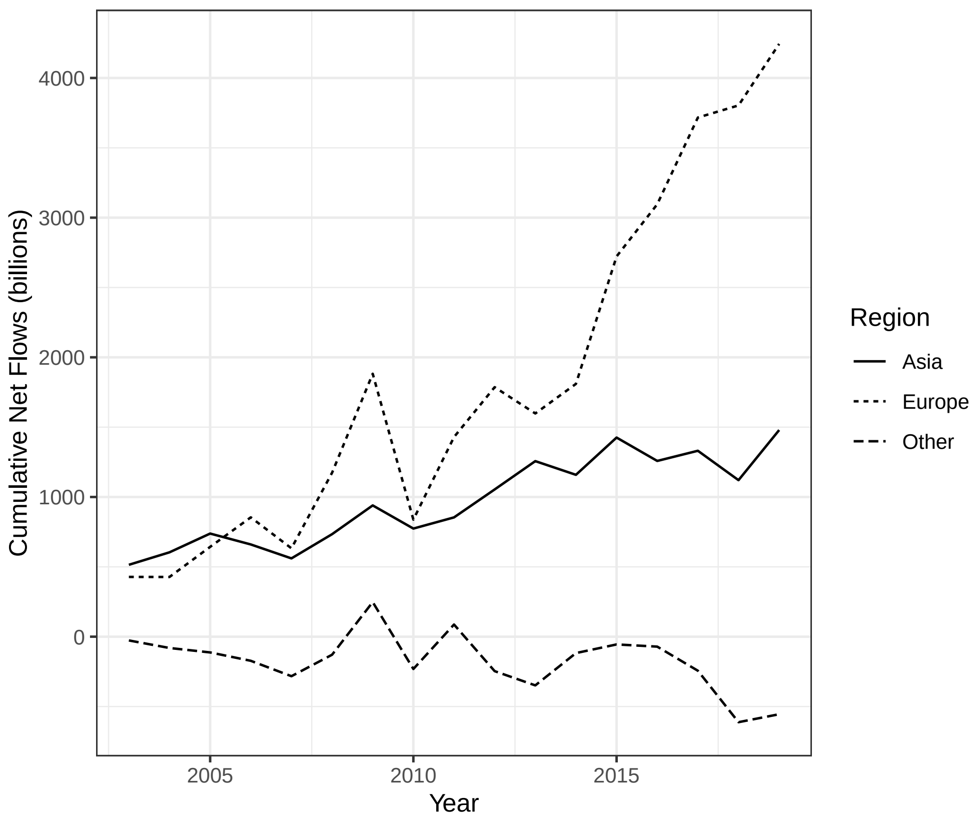
The top figure presents the aggregate U.S. net portfolio position along with the cumulative sum of portfolio flows since 2002. The bottom figure presents the effect of changes in valuations on the U.S. net external asset position in each year computed as the difference between the NFA position and the cumulative sum of flows divided by the cumulative sum of flows.

Figure 2. Long-term Debt Holdings by Central Banks



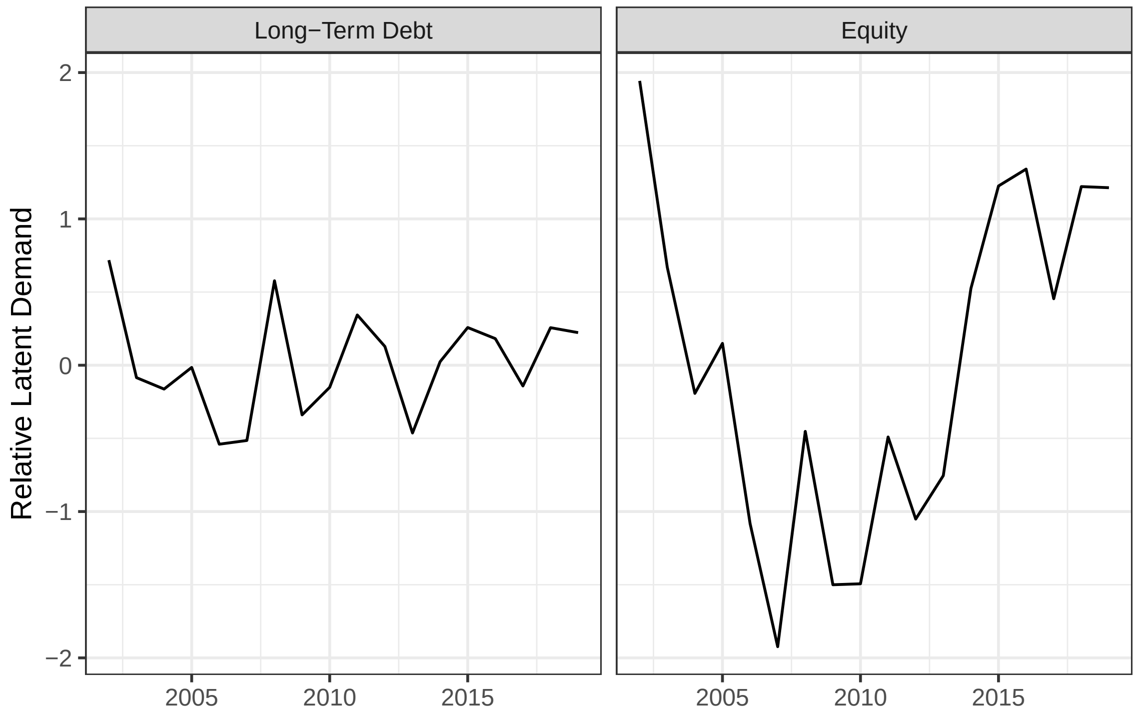
This figure presents the value of U.S. dollar reserves held by the central banks in our sample. We divide central banks into the developed market, the emerging market and the Federal Reserve Bank.

Figure 3. Cumulative Net Savings Flows to U.S. by Region



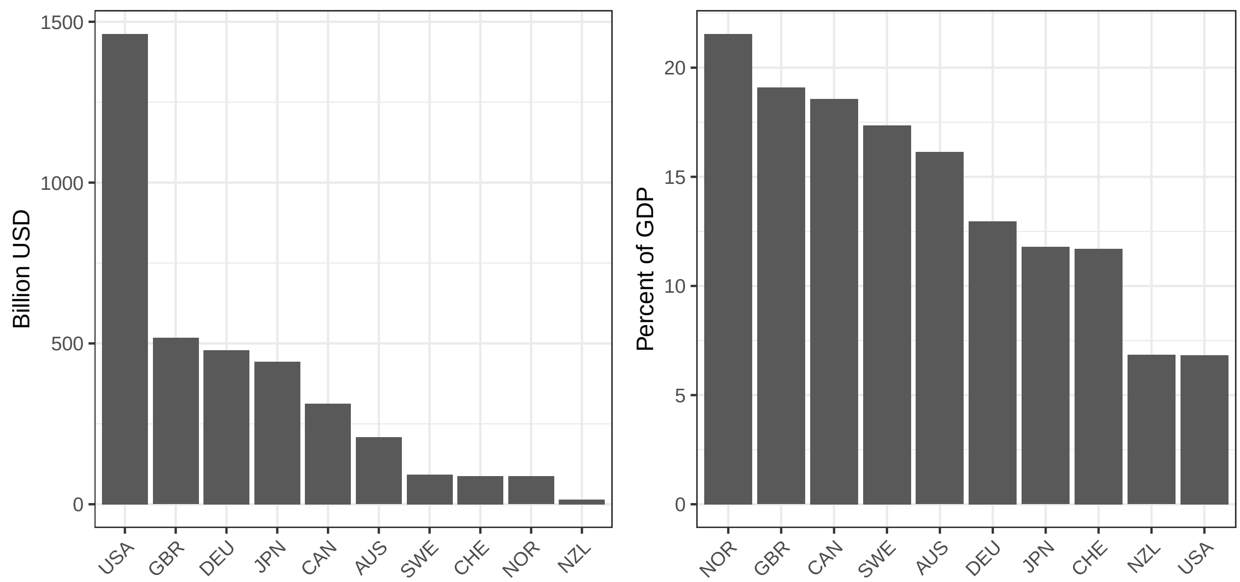
The figure plots the cumulate net savings flows to/from the U.S. by region. avings flows to the U.S. from each region are computed by taking holdings in each period and assuming those holdings are increased proportionally to the investors increase/decrease in the total AUM. Savings from the U.S. to each foreign region are computed in the same manner. Net savings flows are the difference between these two flows.

Figure 4. Relative Latent Demand for US Long-term Debt and Equity



The figure plots the relative latent demand for investing in U.S. long-term debt and equity relative to the rest of the world. For each asset type latent demand is demeaned by investor-issuer pair. This figure plots the difference between the aum weighted average latent demand for US assets versus the mean of the aum weighted average latent demand for all other countries assets.

Figure 5. Additional Issuance Needed to Change Long-term By 1%



The figure plots the amount of additional long-term debt each country can issue before increasing its domestic long-term yield by one percent at the end of 2019. The left-hand panel shows the values in billions of U.S. dollars, and the right-hand panel shows the values as a percent of each country's GDP.

Appendix

A Appendix

A.1 Robustness Under Different Instrument Construction

Section 3.2 presents our baseline instrument construction and estimation. To ensure that our key findings are robust, we present five alternative versions of our estimates with varying instrument constructions. Using these different estimates for the demand curves, in Section 4.5 we show that our key results are robust to these variations. We also show that our key results are robust to using a range of demand elasticities that is consistent with those found in the literature.

Our baseline estimation constructs exogenous asset desireabilities using log population, log distance, investor fixed effects and an own country dummy. We then construct instruments using market clearing with actual asset supply and outside asset holdings. We study five variations on this instrument construction and estimation:

1. Instead of using actual supply, we predict supply in USD from a regression of log asset supply on log issuer country population by asset type.[1] Using instrumented supply alleviates any concerns about the endogeneity of supply to latent demand.

2. Instead of using actual holdings of outside assets, we predict holdings of outside assets from a regression of log holdings on log investor country population. We run this regression pooled across all countries and years, but separately by asset type. Using instrumented outside asset holdings alleviates any concerns about the endogeneity of wealth to latent demand.

3. We predict both supply and outside asset holdings using log population as in variants (1) and (2).

4. We use our baseline construction of instruments except instead of population for prediting exogenous asset desireabilities we use issuer country log GDP. This specification replicates that of Koijen and Yogo (2019b).

5. We relax the assumption that GDP is exogenous to latent demand. In particular, we allow for country-level GDP to depend on asset prices, as would be the case in settings where growth is related to capital flows.[2] We model country-level GDP as a function year fixed effects and prices (which are potentially a function of latent demand):

$$\log GDP_t(n) = \alpha_t + \beta_2 pb_t(n,2) + \beta_3 pb_t(n,3) + \nu_t(n) \tag{A.1}$$

[1]For short-term debt supply we convert to USD at the exchange rate in 2001, since we use short-term debt to clear the exchange rate market. This is done simply to ensure that the supply across countries is in the same numeraire while avoiding using contemporaneous exchange rates.

[2]This procedure builds on a similar procedure to endogenize characteristics in Koijen et al. (2019).

We estimate this equation using our instruments for prices, where the instruments for prices are constructed as in our baseline procedure. Importantly, these instruments for prices do not use GDP to construct predicted weights. We then extract the residuals from this regression, which we refer to as GDP shocks. Finally, we estimate our within asset-class equation, but instead of directly including log GDP as a characteristic we instrument for log GDP with these GDP shocks.

The coefficients on expected returns and their standard errors for our baseline construction and these five variations can be found in Table D.9. The point estimates vary across the specifications, though most are not significantly different than each other. To understand how these differing estimates might impact our key results we recompute our decompositions for each of these variations. The details can be found in Sections 4.5.

B Internet Appendix (Theory)

B.1 Derivation of Trade Balance

Proof. Substitute the NFA, IB, CG expressions into Equation 4 to get:

$$\begin{aligned} & A_{US,t} \sum_{k \neq US} w_{US,t}(k) - \sum_{k \neq US} A_{k,t} w_{k,t}(US) \\ = \; & TB_{US,t} + A_{US,t-1} \sum_{k \neq US} w_{US,t-1}(k)(R_t(k) + D_t(k)) - \sum_{k \neq US} A_{k,t-1} w_{k,t-1}(US)(R_t(US) + D_t(US)) \end{aligned} \tag{B.2}$$

Recall, the evolution of U.S. AUM given by Equation 2 is:

$$A_{US,t} = A_{US,t-1} \sum_{k} w_{US,t-1}(k)(R_t(k) + D_t(k)) + X_{US,t}$$

Subtract Equation B.2 from the previous equation:

$$\sum_{k} A_{k,t} w_{k,t}(US) = X_{US,t} - TB_{US,t} + \sum_{k} A_{k,t-1} w_{k,t-1}(US)(R_t(US) + D_t(US)) \tag{B.3}$$

which can be re-arranged to derive:

$$TB_{US,t} = X_{US,t} - \sum_{k} A_{k,t} w_{k,t}(US) + \sum_{k} A_{k,t-1} w_{k,t-1}(US)(R_t(US) + D_t(US)) \tag{B.4}$$

□

B.2 Deriving the Nested-Logit Portfolio Weight

The following appendix derives the nested-logit structure for portfolio weights starting from a Merton (1973)-style portfolio problem. The proof in this appendix largely follows Koijen and Yogo (2019a), which shows the logit structure of portfolio weights can be derived from a micro-founded portfolio optimization problem if we assume expected returns and the covariance matrix of returns can be represented as a polynominal function of asset characteristics. The only difference in this proof is that we assume a slightly modified restriction on the polynomial function relating expected returns and covariances to asset characteristics. Specifically, we allow the polynominal function relating expected returns and covariances on asset characteristics to differ by asset class.

Let $\mathbf{w}_{i,t}$ denote the vector of portfolio weights across issuer countries and asset classes that the country i representative investor chooses at date t. The investor chooses the portfolio weights to maximize the expected log utility over wealth at date $t+1$:

$$\max_{\mathbf{w}_{i,t}} \mathbb{E}\left[\log\left(A_{i,t+1}\right)\right]$$

subject to

$$A_{i,t+1} = A_{i,t} \mathbf{w}'_{i,t} \mathbf{R}_{t+1}$$

where $\mathbf{R}$ is the vector of returns on each asset.

The well-known solution to this portfolio optimization problem is:

$$\mathbf{w}_{i,t} = \Sigma_t^{-1}\mu_t,$$

where Σ_t is the variance-covariance matrix of asset returns and μ_t is the vector of expected excess returns.

Motivated by the empirical asset pricing literature, we assume asset returns have a factor structure and that expected returns and factor loadings depend on the assets' own characteristics.

Assumption 1. **(Koijen and Yogo (2019a))** Assume the covariance matrix of log excess returns is $\Sigma_t = \Gamma_t\Gamma_t' + \gamma_t\mathbf{I}$, where Γ_t is a vector of factor loadings and γ_t is idiosyncratic variance. Also assume the expected excess returns and factor loadings are polynomial functions of characteristics:

$$\begin{aligned} \mu_t(n,\ell) &= y_t(n,\ell)'\mathbf{\Phi}_t + \phi_t, \\ \Gamma_t(n,\ell) &= y_t(n,\ell)'\mathbf{\Psi}_t + \psi_t, \end{aligned}$$

where $\mathbf{\Phi}_t$ and $\mathbf{\Psi}_t$ are vectors and ϕ_t and ψ_t are scalar constant across assets.

Proposition 1. *Under Assumption 1, the optimal portfolio weight on each asset n in asset class ℓ is:*

$$w_t(n) = y_t(n)'\Pi_t + \pi_t \tag{B.5}$$

where

$$\begin{aligned} \Pi_t &= \frac{1}{\gamma_t}(\Phi_t - \Psi_t\kappa_t) \\ \pi_t &= \frac{1}{\gamma_t}(\phi_t - \psi_t\kappa_t) \end{aligned}$$

are constants across asset n.

The derivation of Equation B.5 follows directly from Proposition 1 in Koijen and Yogo (2019a).

Given the above proposition, we furthermore follow the proof of Corollary 1 in Koijen and Yogo (2019a) to derive the restrictions needed for the nested-logit structure for portfolio weights.

Corollary 1. **(Nested-Logit)** A restricted version of the optimal portfolio under Assumption 1 gives rise to a nested-logit structure for asset demand:

$$w_{i,t}(n,\ell) = \frac{\delta(n,\ell)}{1+\sum_{k=1}^{N}\delta_{i,t}(k,\ell)} \frac{\exp\left(\alpha_\ell + \xi_{i,t}(\ell)\right)\left(1+\sum_{k=1}^{N}\delta_{i,t}(k,\ell)\right)^{\lambda_\ell}}{\sum_{m=1}^{3}\left(\exp\left(\alpha_m + \xi_{i,t}(m)\right)\left(1+\sum_{k=1}^{N}\delta_{i,t}(k,m)\right)^{\lambda_m}\right)}$$

Proof. Suppose we assume:

$$\frac{\Pi_{i,t}(\ell)}{w_{i,t}(0|\ell)} = \begin{bmatrix} \hat{\beta}_{i,t}(\ell) \\ \frac{1}{2}\text{vec}\left(\hat{\beta}_{i,t}(\ell)\hat{\beta}_{i,t}(\ell)'\right) \\ \vdots \end{bmatrix}$$

and $\pi_{i,t}(\ell) = w_{i,t}(0|\ell)$, then equation (B.5) implies:

$$\frac{w_{i,t}(n|\ell)}{w_{i,t}(0|\ell)} = \exp(\beta_{i,t}(\ell)' x_{i,t}(n) + \kappa_{i,t}(n|\ell))$$

Moreover, we assume $w_{i,t}(0|\ell)$ satisfies:

$$w_{i,t}(0|\ell) = \frac{\exp\left(\alpha_\ell + \xi_{i,t}(\ell)\right)\left(1 + \sum_{k=1}^N \delta_{i,t}(k,\ell)\right)^{\lambda_\ell - 1}}{\sum_{m=1}^3 \left(\exp\left(\alpha_m + \xi_{i,t}(m)\right)\left(1 + \sum_{k=1}^N \delta_{i,t}(k,m)\right)^{\lambda_m}\right)}$$

Then, the portfolio weight of sector ℓ in the investor's aggregate portfolio is:

$$\begin{aligned} w_{i,t}(\ell) &= w_{i,t}(0|\ell)\left(1 + \sum_{k=0}^N \delta_{i,t}(k,\ell)\right) \\ &= \frac{\exp\left(\alpha_\ell + \xi_{i,t}(\ell)\right)\left(1 + \sum_{k=1}^N \delta_{i,t}(k,\ell)\right)^{\lambda_\ell - 1}\left(1 + \sum_{k=1}^N \delta_{i,t}(k,\ell)\right)}{\sum_{m=1}^3 \left(\exp\left(\alpha_m + \xi_{i,t}(m)\right)\left(1 + \sum_{k=1}^N \delta_{i,t}(k,m)\right)^{\lambda_m}\right)} \\ &= \frac{\exp\left(\alpha_\ell + \xi_{i,t}(\ell)\right)\left(1 + \sum_{k=1}^N \delta_{i,t}(k,\ell)\right)^{\lambda_\ell}}{\sum_{m=1}^3 \left(\exp\left(\alpha_m + \xi_{i,t}(m)\right)\left(1 + \sum_{k=1}^N \delta_{i,t}(k,m)\right)^{\lambda_m}\right)} \end{aligned}$$

□

B.3 Demand Elasticities and the Price Impact Multiplier

In this section, we derive expressions for demand elasticities with respect to price. We first derive bilateral demand elasticities for each investor-issuer country pair and then we aggregate demand elasticities for each issuer country.

The log demand by country i for country n assets in sector ℓ is given by

$$\hat{q}_{i,t}(n,\ell) = \log\left(A_{i,t} w_{i,t}(\ell) w_{i,t}(n|\ell)\right) - p_t(n,\ell). \tag{B.6}$$

Changes in the log price of assets affect the quantity of assets demanded through its influence on the across-sector weight $w_{i,t}(\ell)$, the within-sector weight $w_{i,t}(n|\ell)$, and the price of the loan itself $p_t(n,\ell)$.

To derive the elasticity of demand for a given investor i to asset n in sector ℓ, we plug equations (6), (7), (8) and (10) into equation (B.6), and differentiate with respect to price:

$$-\frac{\partial \hat{q}_{i,t}(n,\ell)}{\partial p_t(n,\ell)} = 1 - \underbrace{(1 - w_{i,t}(\ell))w_{i,t}(n|\ell)\lambda_\ell \beta_\ell \phi_\ell}_{\frac{\partial \log(w_{i,t}(\ell))}{\partial p_t(n,\ell)}} - \underbrace{(1 - w_{i,t}(n|\ell))\beta_\ell \phi_\ell}_{\frac{\partial \log(w_{i,t}(n|\ell))}{\partial p_t(n,\ell)}}. \tag{B.7}$$

The aggregate log demand for country n assets in sector ℓ is equal to:

$$\hat{q}_t(n,\ell) = \log\left(\sum_i A_{i,t} w_{i,t}(\ell) w_{i,t}(n|\ell)\right) - p_t(n,\ell).$$

To derive the aggregate demand elasticity for sector ℓ of country n, we take the derivative of the above expression with respect to $p_t(m,\ell)$:

$$-\frac{\partial \hat{q}_t(n,\ell)}{\partial p_t(n,\ell)} = \sum_i \left(\frac{A_{i,t} w_{i,t}(n,\ell)}{\sum_j A_{j,t} w_{j,t}(n,\ell)}\right)\left(-\frac{\partial \hat{q}_{i,t}(n,\ell)}{\partial p_t(n,\ell)}\right) \tag{B.8}$$

Equation (B.8) shows the aggregate demand elasticity for the country n sector ℓ asset is just a weighted sum of the bilateral demand elasticities of each individual investor country.

C Internet Appendix (Data)

Our estimation exercise and NFA decomposition requires three types of data: cross-country portfolio holdings, country/asset characteristics, and realized returns in each asset class. We discuss our measurement of these data, below. Afterwards, we also discuss how we use these data to impute net financial savings.

C.1 Cross-Country Portfolio Holdings

We observe cross-country portfolio holdings data for non-U.S. countries from the Coordinated Portfolio Investment Survey (CPIS) provided by the IMF, and for the U.S. from the Treasury International Capital System (TIC). The TIC data reports U.S. external assets and U.S. external liabilities only. Thus, for U.S. external assets and liabilities, we use all available data from TIC. For all external positions between non-U.S. countries, we use CPIS data. In the end, for each investor country i, we observe year-end holdings of foreign financial assets in US dollars by asset class and issuer country. The asset classes comprise short-term debt, long-term debt and equity. The asset holders include corporations, and individuals, government entities (such as sovereign wealth funds, but not including the central bank foreign reserve holdings).

A well-known issue with portfolio holdings data is that flows to and from offshore financial centers can present a highly distorted view of capital allocation. For example, Coppola, Maggiori, Neiman, and Schreger (2020) point out that investments by countries in the European Monetary Union are often funneled through Luxembourg. As a result, in the raw CPIS data, Luxembourg is in the top 10 investors for all asset classes. In order to mitigate this issue, after merging the CPIS and TIC data, we apply the reallocation matrices from Coppola, Maggiori, Neiman, and Schreger (2020) to reattribute portfolio holdings to their investor nationality as much as possible. These reallocation matrices are provided from 2007 to 2017. We extend these matrices forwards and backwards in time to cover the full sample period from 2002 to 2019, by assuming a constant share of funds pass through each offshare center before 2007 and after 2017. Following Coppola, Maggiori, Neiman, and Schreger (2020), we also aggregate all investment holdings by Euro Area countries into a single European Monetary Union (EMU) investor entity, because the vast majority of investment in the euro area is funnelled through a small number of tax haven countries. After applying the reallocation matrices there remain some funds held by tax haven countries. We redistribute these remaining holdings proportinally to the countries which have inward investment into the tax havens.

We split off central bank and other official holdings, and treat changes in these official holdings as exogenous policy decisions when estimating our structural model. For all non-U.S. countries, we use the IMF Securities Held as Foreign Exchange Reserves (SEFER) survey to estimate the value of each country's assets that are held as reserve assets by central banks.[3] For the United States, official and private holdings of U.S. liabilities are reported together in the TIC data.[4] We parse out the value of foreign official holdings of

[3]The CPIS does not contain reserve holdings of central banks. Thus, the sum of the CPIS and SEFER holdings should capture all holdings held by foreign private and foreign official investors.

[4]For example, the publicly available TIC data only reports that Canadian private and official investors

U.S. liabilities using data describing the currency composition of countries' reserve assets with data capturing the total size of countries' reserve portfolio. The next Appendix Section C.2 describes our procedure in detail.

Finally, the cross-country portfolio holdings data do not record domestic holdings of financial assets. Thus, we estimate domestic portfolio holdings by subtracting foreign holdings from total market capitalization data. We observe the country-level stock market capitalization from the World Bank, and we observe the aggregate value of outstanding short-term and long-term debt securities from the BIS.

C.2 Central Bank Reserve Holdings of U.S. Liabilities

As stated in Appendix C.1, the TIC data report both private and official holdings of U.S. liabilities together. Our main challenge is to parse out official holdings from total holdings, because we would like to treat official holdings as an exogenous policy variable in the benchmark analysis of our structural model.

Our procedure involves three steps. First, we estimate the size of each country's official dollar holdings. Then, we attribute each country's official dollar holdings to official holdings into the three asset classes (i.e., short-term debt, long-term debt and equity). Finally, we subtract the estimated official holdings from the TIC holdings data to disaggregate the TIC holdings data into private and official holdings.

To estimate the size of each country's official U.S. dollar holdings, we multiply the share of each country's reserve portfolio held in U.S. dollars (Iancu et al. (2020)) with the total size of each country's reserve portfolio. The total size of each country's reserve portfolio is taken from its "Securities" position from the IMF's International Reserves and Foreign Currency Liquidity Survey. We assume that all countries' U.S. dollar reserves are U.S. issued liabilities. While it is true that non-U.S. entities can issue dollar liabilities, we think our assumption is reasonable given that the vast majority of dollar reserves are comprised of U.S. treasury securities.

To attribute total official dollar holdings to separate asset classes, we use the breakdown of the aggregate official holdings of U.S. liabilities from TIC. For each year, TIC reports the aggregate official holdings of U.S. short-term debt, long-term debt, and equity. We divide each country's official U.S. holdings into these three sectors based on the distribution of the aggregate official holdings.

Finally, we subtract out the estimated official holdings by each investor country and in each asset class from the total TIC holdings of U.S. liabilities. Due to potential differences in sample coverage between the TIC data and the IMF data[5], as well as potential measurement errors introduced by our estimation procedure, the total value of official holdings of U.S. liabilities for a given asset class ℓ and investor country n may be larger than the observed TIC holdings. In these instances, we attribute the entirety of the TIC holdings to official holdings and set private holdings for the investor to zero.

held a total of 1,262 billion dollars of U.S. portfolio liabilities in 2019.

[5]For example, the IMF data often rely on each country's domestic statistical agency to report reserve assets, whereas the TIC holdings are built off of surveys of custodial bank in the U.S. For a detailed descriptions of various sources of reserves holdings data, see: https://ticdata.treasury.gov/resource-center/data-chart-center/tic/Documents/fohdefs1.904.pdf

Ultimately, our procedure is able to parse out between 21 to 39 percent of the total official holdings for each year in our sample.[6]. Finally, we attribute all holdings of U.S. long-term debt by China to Chinese Central Bank reserves.

C.3 Country Characteristics

We observe country level market-to-book values of equity, yields on short-term debt, and yields on long-term debt from Datastream. We observe GDP, GDP per capita, and population from the World Bank. We obtain trade network centrality measures from Richmond (2016). We observe S&P sovereign debt ratings and impute sovereign default probabilities using S&P 5-year default rates. Market volatility is annual volatility from each countries MSCI Equity market index in local currency. We obtain dollar exchange rates from Datastream, inflation rates from the IMF, and trade and distance variables from CEPII.

C.4 Realized Capital Gains

We want to decompose the changes holdings over time into changes in the valuation of existing assets (*capital gains*), and the net value of additional asset purchases (*capital flows*) between any two periods $t-1$ and t. We therefore need the best possible measurement of realized capital gains and capital flows.

For all investments between two non-U.S. countries, we impute realized capital gains on equity by computing changes in country-level equity price return indicies obtained through Datastream, and we impute realized returns on debt using 3-month and 10-year yields. For short-term debt, the realized return is computed by compounding the four 3-month yields over the course of each year. For long-term debt, the realized return is the annualized 10-year yield from the previous year.

For the U.S. investor and for countries investing in the U.S., we provide a more accurate view of returns to equity and long-term debt assets by imputing the realized capital gains earned by foreign investors using granular capital flows and positions data from Bertaut and Tryon (2007) and Bertaut and Judson (2014). Tabova and Warnock (2021) show the capital flows data from these two papers are more representative and internally consistent than TIC S capital flows data.

Because the data from Bertaut and Tryon (2007) and Bertaut and Judson (2014) are provided at the monthly frequency, we simply need to aggregate the monthly flows and positions data to the annual frequency. We impute the realized capital gains from investing in country n in asset class ℓ, $R_t(n,\ell)$, from periods $t-1$ and t using the valuation change in the data:

$$R_t(n,\ell) = 1 + \text{VALUATION CHANGE}_t(n,\ell)/\text{POSITION}_{t-1}(n,\ell).$$

[6] As mentioned previously, even though the TIC data do not provide a bilateral breakdown of official and private holdings of U.S. liabilities, the TIC data do report the aggregate value of U.S. liabilities held by foreign official sources. For example, in 2019, foreign official investors held 6.1 trillion dollars of U.S. liabilities. We are able to parse out 1.4 trillion dollars based on our reallocation methodology.

Due to data quality concerns, we winzorize the lower bound of $R_t(n, \ell)$ at 0.01. We compound the monthly returns into annual returns.

C.5 Net Financial Savings

Having obtained data on investor holdings and realized returns in each period, it is straightforward to back out net financial savings $F_{i,t}$ for each investor country using Equation 11:

$$F_{i,t} = A_{i,t} - A_{i,t-1} \sum_{\ell=1}^{3} \sum_{n=0}^{N} w_{i,t-1}(\ell) w_{i,t-1}(n|\ell) R_t(n, \ell).$$

When restoring the actual net savings $F_{i,t}$, we use a multiplicative growth rate $f_{i,t}$ equal to $F_{i,t}$ divided by time-t value of the portfolio from period $t-1$, and plug in

$$\widetilde{F}_{i,t}^{j} = f_{i,t} \cdot A_{i,t-1} \sum_{\ell=1}^{3} \sum_{n=0}^{N} w_{i,t-1}(\ell) w_{i,t-1}(n|\ell) \widetilde{R}_t^{j}(n, \ell)$$

at step j of the counterfactual.

C.6 Sample

Table C.1
List of Investor and Issuer Countries

Country	Region	Investor	Issuer
Australia	Asia-Pacific Developed	✓	✓
Austria	Europe Developed		✓
Belgium	Europe Developed		✓
Brazil	Other	✓	
Canada	Other	✓	✓
Chile	Other	✓	
China	Other	✓	✓
Czechia	Other	✓	✓
Denmark	Europe Developed	✓	✓
Estonia	Other	✓	
European Union	Europe Developed	✓	
Finland	Europe Developed		✓
France	Europe Developed		✓
Germany	Europe Developed		✓
Greece	Europe Developed		✓
Hungary	Other	✓	✓
Iceland	Other	✓	
India	Other	✓	✓
Indonesia	Other	✓	
Italy	Europe Developed		✓
Japan	Asia-Pacific Developed	✓	✓
Latvia	Other	✓	
Lithuania	Other	✓	
Malaysia	Other	✓	✓
Mexico	Other	✓	✓
New Zealand	Europe Developed	✓	✓
Norway	Europe Developed	✓	✓
Pakistan	Other	✓	
Philippines	Other	✓	✓
Poland	Europe Developed	✓	✓
Portugal	Europe Developed		✓
Romania	Other	✓	
Russia	Other	✓	✓
Singapore	Asia-Pacific Developed	✓	✓
Slovakia	Other	✓	
South Africa	Other	✓	✓
South Korea	Asia-Pacific Developed	✓	✓
Spain	Europe Developed		✓
Sweden	Europe Developed	✓	✓
Switzerland	Europe Developed	✓	✓
Thailand	Other	✓	✓
Turkey	Other	✓	
United Kingdom	Europe Developed	✓	✓
United States	United States	✓	✓

This table lists the countries in our sample, classifies them by region and marks whether each country enters as an investor or issuer country.

Table C.2
List of Central Banks in Sample

Central Bank	Region
Australia	Developed
Belgium	Developed
Brazil	Emerging
Canada	Developed
Chile	Emerging
China	Emerging
Colombia	Emerging
Croatia	Emerging
Czechia	Emerging
Denmark	Developed
Estonia	Emerging
European Central Bank	Developed
Federal Reserve	Emerging
Finland	Developed
Germany	Developed
Hong Kong SAR China	Emerging
Iceland	Emerging
Italy	Developed
Latvia	Emerging
Netherlands	Developed
New Zealand	Developed
Norway	Developed
Philippines	Emerging
Poland	Developed
Slovenia	Emerging
South Africa	Emerging
Spain	Developed
Sweden	Developed
Switzerland	Developed
Turkey	Emerging
United Kingdom	Developed

This table lists the Central Banks in our sample for which we can impute holdings data.

D Internet Appendix (Empirical)

D.1 Demand Estimation Results

Table D.3
Predicting Expected Excess Returns

	DebtLong (1)	DebtShort (2)	Equity (3)
Log market-to-book	-0.37***	-8.33***	-0.11***
	(0.05)	(1.22)	(0.04)
Log real exchange rate	-0.42***	-0.35***	-0.80***
	(0.06)	(0.03)	(0.09)
Observations	576	576	576
R^2	0.30	0.28	0.16
Country fixed effects	✓	✓	✓

This table displays results from estimating equation (9). For debt, the log market-to-book ratio is minus the maturity times the yield. All specifications include country fixed effects. Standard errors are clustered by year.

Table D.4

Predictive Model for Weights

	ST Debt (1)	LT Debt (2)	Equity (3)
Log Population	0.95***	0.65***	0.98***
	(0.06)	(0.08)	(0.09)
Distance	-0.95***	-1.25***	-1.51***
	(0.13)	(0.16)	(0.22)
Indicator: Own Country	6.98***	5.22***	4.43***
	(0.56)	(0.56)	(0.82)
Observations	17,411	20,087	20,142
R^2	0.49	0.62	0.67
Within R^2	0.19	0.20	0.21
Investor fixed effects	✓	✓	✓

This table displays results from estimating equation (9). For debt, the log market-to-book ratio is minus the maturity times the yield. All specifications include country fixed effects. Standard errors are clustered by year.

Table D.5

Demand Estimation Across Asset Classes

	(1)
λ (Short-Term Debt)	0.14**
	(0.06)
λ (Long-Term Debt)	0.16**
	(0.07)
λ (Equity)	0.26***
	(0.07)
α (Long-Term Debt)	0.96***
	(0.15)
α (Short-Term Debt)	-1.15***
	(0.13)
Observations	1,228
F-test (1st stage), λ (Short-Term Debt)	766.9
F-test (1st stage), λ (Long-Term Debt)	316.5
F-test (1st stage), λ (Equity)	272.3

This table estimates equation (15) $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table D.6
Demand Estimation Across Asset Class. First Stage.

	(1)	(2)	(3)
Inclusive Value Instrument (Short-Term Debt)	0.85***	-0.04	-0.35***
	(0.03)	(0.03)	(0.05)
Inclusive Value Instrument (Long-Term Debt)	0.00	0.58***	-0.19***
	(0.03)	(0.03)	(0.06)
Inclusive Value Instrument (Equity)	0.00	-0.05*	0.41***
	(0.03)	(0.03)	(0.05)
α (Long-Term Debt)	0.00	1.78***	-2.25***
	(0.09)	(0.10)	(0.16)
α (Short-Term Debt)	1.28***	-0.06	-1.37***
	(0.10)	(0.10)	(0.17)
Observations	1,228	1,228	1,228
F-test (1st stage)	766.9	316.5	272.3

Table D.7
Demand Estimation Within Asset Class

	ST Debt (1)	LT Debt (2)	Equity (3)
E[Excess Return]	45.16***	6.95	10.70**
	(13.98)	(5.65)	(3.83)
Log GDP	2.38***	1.97***	2.20***
	(0.36)	(0.20)	(0.33)
Centrality	-0.04	-0.08	0.02
	(0.09)	(0.06)	(0.10)
Log Population	-0.58*	-0.63***	-0.62*
	(0.30)	(0.19)	(0.30)
Default	0.01	-0.19	-0.04
	(0.11)	(0.19)	(0.09)
Distance	-0.88***	-1.15***	-1.25***
	(0.20)	(0.17)	(0.23)
Import Exposure	0.11	0.14*	0.09
	(0.12)	(0.08)	(0.13)
Export Exposure	0.09	0.06	0.25
	(0.11)	(0.09)	(0.15)
Inflation	-0.28	0.11	-0.03
	(0.22)	(0.10)	(0.12)
Volatility	-0.15*	-0.21***	-0.06
	(0.09)	(0.06)	(0.07)
Indicator: Own Country	7.30***	5.74***	5.36***
	(1.01)	(0.77)	(1.07)
Indicator: USA Issuance	1.85**	2.31***	0.84
	(0.66)	(0.57)	(0.59)
Observations	17,411	20,087	20,142
F-test (1st stage), E[Excess Return]	26.7	37.6	159.5
Investor fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Developed Market fixed effects	✓	✓	✓

This table estimates equation (14) separately for each asset class when we instrument for expected excess returns. The sample comprises annual data from 2002 to 2019. Default is the 5-year default probability for the sovereign debt category imputed by S&P. All specifications include investor country, year and issuer country MSCI market fixed effects. Standard errors are reported parentheses are double clustered by investor country and year. $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table D.8
Demand Estimation Within Asset Class. First Stage.

	ST Debt (1)	LT Debt (2)	Equity (3)
Log NER Instrument	-0.004***	-0.005***	-0.013***
	(0.001)	(0.001)	(0.002)
Log Price Instrument		-0.011**	-0.007**
		(0.004)	(0.003)
Log GDP	-0.026**	-0.027*	-0.097***
	(0.010)	(0.014)	(0.023)
Log Population	0.018**	0.002	0.075***
	(0.007)	(0.013)	(0.018)
Centrality	0.004*	0.010***	0.020***
	(0.002)	(0.002)	(0.006)
Default	0.001	0.028***	-0.002
	(0.002)	(0.005)	(0.006)
Distance	0.003	0.002	-0.003
	(0.003)	(0.002)	(0.003)
Import Exposure	0.002	0.002	0.006
	(0.003)	(0.003)	(0.003)
Export Exposure	0.001	0.000	-0.005
	(0.003)	(0.003)	(0.003)
Inflation	0.007**	0.010**	0.011**
	(0.003)	(0.005)	(0.005)
Volatility	0.001	0.006*	0.004
	(0.002)	(0.004)	(0.004)
Indicator: Own Country	0.013	0.008	0.002
	(0.010)	(0.010)	(0.013)
Indicator: USA Issuance	0.019	0.003	0.125***
	(0.014)	(0.017)	(0.033)
Observations	17,411	20,087	20,142
F-test (1st stage)	26.7	37.6	159.5
Investor fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Developed Market fixed effects	✓	✓	✓

Table D.9
Estimation Variations. Coefficients on Expected Returns

	Estimation Variation					
	Baseline	(1)	(2)	(3)	(4)	(5)
Short-Term Debt	45.2	43.1	47.9	46.8	29.7	82.8
	(14.0)	(20.2)	(19.9)	(40.6)	(10.9)	(33.2)
Long-Term Debt	7.0	15.4	12.3	1.2	3.1	11.8
	(5.6)	(14.7)	(5.7)	(9.4)	(4.6)	(5.1)
Equity	10.7	1.7	5.8	9.5	5.2	18.8
	(3.8)	(2.4)	(3.7)	(3.1)	(2.1)	(5.1)

This table presents the coefficients on expected returns for each asset class under each of our alternative methodologies for constructing the instrumental variable. These variations are described in Appendix A.1.

Table D.10
NFA Decomposition. Vary Across Estimates.

	Across Estimate Variant						
	Baseline	(1)	(2)	(3)	(4)	(5)	(6)
Across Estimate							
Short-Term Debt	0.14	0.00	0.10	0.20	0.30	0.40	0.50
Long-Term Debt	0.16	0.00	0.10	0.20	0.30	0.40	0.50
Equity	0.26	0.00	0.10	0.20	0.30	0.40	0.50
Trend Decomposition							
Total Savings and Issuances	7.58	8.81	8.48	8.11	7.73	7.36	7.02
Total Reserves	4.51	4.55	4.40	4.32	4.27	4.25	4.24
Total Rates	5.44	3.83	4.82	6.14	7.68	9.26	10.74
Total Demand and Characteristics	-8.17	-7.82	-8.33	-9.20	-10.32	-11.51	-12.63
Total	9.36	9.36	9.36	9.36	9.36	9.36	9.36

This table presents the decomposition of the valuation effect under the different values for the cross-asset substitutition coefficient. The top panel presents the value for each asset-class substitution coefficent. The "Baseline" column re-iterates the trend decomposition shown in Table 2. Columns (1) through (6) change the cross-asset substitution coefficients across a range of values.

Table D.11
Return Decomposition Difference. Vary Across Estimates.

	Across Estimate Variant						
	Baseline	(1)	(2)	(3)	(4)	(5)	(6)
Across Estimate							
Short-Term Debt	0.14	0.00	0.10	0.20	0.30	0.40	0.50
Long-Term Debt	0.16	0.00	0.10	0.20	0.30	0.40	0.50
Equity	0.26	0.00	0.10	0.20	0.30	0.40	0.50
Trend Decomposition							
Total Savings and Issuances	9.47	4.31	6.77	8.95	11.01	13.04	15.13
Total Reserves	-6.06	-6.57	-6.12	-5.85	-5.65	-5.50	-5.38
Total Rates	-3.37	-2.86	-2.92	-3.02	-3.15	-3.28	-3.42
Total Demand and Characteristics	17.47	18.99	17.88	16.97	16.20	15.54	15.01
Total	25.13	25.13	25.13	25.13	25.13	25.13	25.13

This table reports the difference in the valuation effect between the first and second halves of our sample under different values for the cross-asset substitutition coefficientas. The top panel presents the value for each asset-class substitution coefficent. The "Baseline" column re-iterates the trend decomposition shown in Table 2. Columns (1) through (6) change the cross-asset substitution coefficients across a range of values.

D.2 Calculating Counterfactual Asset Prices

In the following appendix, we apply an approximation of Newton's Method to calculate the equilibrium price in the counterfactual analysis. Our algorithm closely follows Koijen and Yogo (2019a). For each asset j in sector l at time t, we want to find the zero of the following function:

$$H(\mathcal{P}) = p_{j,t}^{l} + q_{j,t} - \log\left[\sum_{i=1}^{N} A_{i,t} w_{i,t}^{l} w_{i,j,t}^{l}\right],$$

where the vector of parameters:

$$\mathcal{P} = \left[e_{j,t}, q_{j,t}, p_{j,t}^{lt}, p_{j,t}^{eq}\right]$$

comprises nominal exchange rates, short-term debt quantities for issuers in fixed exchange rate regimes, prices of long-term debt, and prices of equity. To re-iterate, the share of investor i assets within asset type l that are allocated to country j at time t is:

$$w_{i,j,t}^{l} = \frac{\exp\left(\beta^{l}\mu_{i,j,t}^{l} + \Theta_{i,j,t}^{l}\mathbf{x}_{i,j,t} + \kappa_{i,j,t}\right)}{1 + \sum_{n=1}^{N}\exp\left(\beta^{l}\mu_{i,n,t}^{l} + \Theta_{i,n,t}^{l}\mathbf{x}_{i,n,t} + \kappa_{i,n,t}\right)}$$

The share of investor i assets allocated to asset type l is:

$$w_{i,t}^{l} = \frac{\left(1 + \sum_{n=1}^{N}\exp\left(\beta^{l}\mu_{i,n,t}^{l} + \Theta_{i,n,t}^{l}\mathbf{x}_{i,n,t} + \kappa_{i,n,t}\right)\right)^{\lambda^{l}}\exp\left(\alpha^{l} + \xi_{i,t}^{l}\right)}{\sum_{m=\{st,lt,eq\}}\left[\left(1 + \sum_{n=1}^{N}\exp\left(\beta^{m}\mu_{i,n,t}^{m} + \Theta_{i,n,t}^{m}\mathbf{x}_{i,n,t} + \kappa_{i,n,t}\right)\right)^{\lambda^{m}}\exp\left(\alpha^{m} + \xi_{i,t}^{m}\right)\right]},$$

and the expected return of asset j of type l for investor i at time t is defined:

$$\mu_{i,j,t}^{l} = \gamma_{p}^{l} p_{j,t}^{l} + \gamma_{e}^{l}\left(e_{j,t} - \pi_{j,t}\right) - \left(\gamma_{p}^{st} p_{j,t}^{st} + \gamma_{e}^{st}\left(e_{i,t} - \pi_{j,t}\right)\right)$$

Given any initial parameter vector $\mathcal{P}$, Newton's Method would update the price vector with:

$$\mathcal{P}' = \mathcal{P} - \mathcal{J}_{H}^{-1} H(\mathcal{P})$$

where $\mathcal{J}_H$ represents the Jacobian of the multivariate function H. However, rather than calculate the full Jacobian, we approximate $\mathcal{J}_H$ with its diagonal. Let $H_{j,t}^{l}$ denote the row of H that corresponds to the market clearing condition for asset j of asset type l in period t.

For an asset j in the short-term debt market with floating exchange rates, the diagonal element of $\mathcal{J}_H$ is:

$$\frac{\partial H_{j,t}^{st}}{\partial e_{j,t}} = -\frac{\sum_{i=1}^{N} A_{i,t}\left(\frac{\partial w_{i,t}^{st}}{\partial e_{j,t}} \times w_{i,j,t}^{st} + \frac{\partial w_{i,j,t}^{st}}{\partial e_{j,t}} \times w_{i,t}^{st}\right)}{\sum_{i=1}^{N}\left(A_{i,t} w_{i,t}^{st} w_{i,j,t}^{st}\right)} \tag{D.9}$$

where

$$\frac{\partial w^{st}_{i,t}}{\partial e_{j,t}} = \begin{cases} \lambda^{st}\beta^{st}\gamma^{st}_e w^{st}_{i,t} w^{st}_{i,j,t} - w^{st}_{i,t}\left(\sum_{m=st,lt,eq} \lambda^m \beta^m \gamma^m_e w^m_{i,t} w^m_{i,j,t}\right) & \text{if } i \neq j \\ -\lambda^{st}\beta^{st}\gamma^{st}_e w^{st}_{i,t}\left(\sum_{k\neq i} w^{st}_{i,k,t}\right) + w^{st}_{i,t}\left(\sum_{m=st,lt,eq} \lambda^m \beta^m \gamma^m_e w^m_{i,t}\left(\sum_{k\neq i} w^m_{i,k,t}\right)\right) & \text{if } i = j \end{cases}$$

and

$$\frac{\partial w^{st}_{i,j,t}}{\partial e_{j,t}} = \begin{cases} \beta^{st}\gamma^{st}_e w^{st}_{i,j,t}\left(1 - w^{st}_{i,j,t}\right), & \text{if } i \neq j \\ -\beta^{st}\gamma^{st}_e w^{st}_{i,j,t}\left(\sum_{k\neq i} w^{st}_{i,k,t}\right), & \text{if } i = j \end{cases} \tag{D.10}$$

For an asset j in the short-term debt market that is part of a currency union, the diagonal element of $\mathcal{J}_H$ is:

$$\frac{\partial H^{st}_{j,t}}{\partial q_{j,t}} = 1, \tag{D.11}$$

where we update the quantity $q_{j,t}$ of short-term debt outstanding.

For long-term debt and equity assets, the diagonal element of $\mathcal{J}_H$ is:

$$\frac{\partial H^l_{j,t}}{\partial p^l_{j,t}} = 1 - \frac{\sum_{i=1}^N A_{i,t}\left(\frac{\partial w^l_{i,t}}{\partial p^l_{j,t}} \times w^l_{i,j,t} + \frac{\partial w^l_{i,j,t}}{\partial p^l_{j,t}} \times w^l_{i,t}\right)}{\sum_{i=1}^N \left(A_{i,t} w^l_{i,t} w^l_{i,j,t}\right)} \tag{D.12}$$

where

$$\frac{\partial w^l_{i,t}}{\partial p^l_{j,t}} = \lambda^l \beta^l \gamma^l_p w^l_{i,j,t} w^l_{i,t}\left(1 - w^l_{i,t}\right) \tag{D.13}$$

and

$$\frac{\partial w^l_{i,j,t}}{\partial p^l_{j,t}} = \beta^l \gamma^l_p w^l_{i,j,t}\left(1 - w^l_{i,j,t}\right) \tag{D.14}$$

We start with an initial parameter vector $\mathcal{P}$ equal to the observed market prices and quantities, and we update the parameter vector according to:

$$\mathcal{P}' = \mathcal{P} - \left(\text{diag}\left[\mathcal{J}_H\right]\right)^{-1} H\left(\mathcal{P}\right).$$

We continue to iterate until convergence.