U.S. Liquid Government Liabilities and Emerging Market Capital Flows*

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Abstract

We identify the liquidity channel through which Federal Reserve quantitative easing (QE) and quantitative tightening (QT) affect capital flows to emerging markets. Using weekly data on the Fed's purchases and sales of long-term U.S. Treasury securities, we find that large purchases lead to a significant increase in capital flows to emerging markets, and that sales have the reverse effect. We then show that QE lowers, and QT raises, the convenience yield on U.S. Treasuries, measured by covered interest parity deviations, and that the induced changes in the convenience yield drive the capital flow responses. Our model based on liquidity rationalizes these findings: QE shifts publicly held government debt toward more liquid assets, providing investors a greater buffer against the risk of low consumption. Better insured through liquid asset holdings, investors are willing to increase illiquid investments, including lending to emerging markets.

JEL Classification Codes: F32, F41, G15

Keywords: liquidity, capital flows, emerging markets, quantitative easing

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1 Introduction

Government bonds issued by the U.S. are safe, liquid, and offer a convenience yield.[1] Especially short-term T-bills or reserves held at the Federal Reserve appear to be the ultimate prize for investors that require liquidity. Therefore policymakers and academics have emphasized the importance of liquidity in the market for U.S. government liabilities in facilitating efficient functioning of financial markets.[2] However, the provision of greater liquidity to the markets has implications for the demand for other types of assets, including those issued by emerging market firms and governments.

This paper examines how changes in the supply of liquid U.S. debt influence capital flows to emerging markets with a focus on the effects of quantitative easing (QE) and quantitative tightening (QT).[3] We provide empirical evidence on how shifts in the U.S. liquidity policy impact capital flows to emerging markets and propose a theory to account for the empirical findings.

Figure 1 illustrates the effects of QE and QT on capital flows to emerging markets. In May 2013, the chairman of the Federal Reserve, Ben Bernanke, hinted that the Fed could begin to scale back its purchases of long-term bonds. The so-called "taper tantrum" ensued. In the figure, we plot the capital flows into 16 emerging markets in 2012–2014.[4] It is apparent that there was a sharp decline in flows immediately following Bernanke's signal of quantitative tightening. The figure also picks up an acceleration of flows into those countries following the announcement of QE3, the third round of quantitative easing by the Fed, in September 2012.

The framework in which we rationalize these empirical regularities is one in which *some* U.S. government liabilities are very liquid in the sense that they are traded in deep markets and can easily be sold on secondary markets. In particular, short-term Treasury bills and reserves held at the Fed are very liquid government liabilities, while longer term bonds may be less liquid. We investigate the consequences of changing the composition of government debt issuance as the U.S. government's portfolio of debt shifts from longer term, less liquid debt to shorter term, more liquid debt. We are concerned about the effects on loan availability to emerging markets. We therefore want to understand the effect of a shift in the composition of the U.S. government debt per se, holding the total debt issuance constant.

In the model, households in the U.S. and ROW decide on a portfolio of loans — short-term liquid U.S. bills, long-term less liquid U.S. bonds, and loans to EMs — before the realization of their uncertain income or investment opportunities. When uncertainty is resolved, they can adjust

[1] See Krishnamurthy and Vissing-Jorgensen (2011), Krishnamurthy and Vissing-Jorgensen (2012), Greenwood et al. (2015), Nagel (2016), Diamond and Van Tassel (2021), He et al. (2019), Jiang et al. (2021) and Gorton and Ordonez (2022).

[2] See Duffie (2023), Copeland et al. (2021), Acharya and Rajan (2022), Acharya et al. (2023), Diamond et al. (2023) and Afonso et al. (2022).

[3] A discussion on how QE and QT influence the liquidity of U.S. government liabilities follows later in the introduction.

[4] See Section 2 for details on the data.

Figure 1: Quantitative Easing and Tightening in the U.S. and Capital Flows to Emerging Markets

Notes: Each line shows monthly bond fund flows as a ratio of the bond fund allocation for 16 emerging market countries. The data on monthly bond fund flows are from the Emerging Portfolio Fund Research dataset.

their portfolio by trading with other households that have different outcomes. If a household/lender finds its income is higher than expected, or it has less need for funds for investment in real assets, it can buy liquid bonds from households whose income is lower than expected or who have greater investment opportunities. That is, there is a secondary market in liquid bonds that operates after the resolution of income uncertainty, but no such market exists for the other two types of loans. In the data, while all U.S. government debt appears to earn a convenience yield or liquidity yield relative to privately issued debt that is equally riskless or relative to government debt of other countries, the market considers short-term U.S. government debt to be more liquid than long-term debt. Our model captures the differing liquidity profile of loans by allowing some debt to be traded on secondary markets, while other government obligations are not.[5]

In our model, liquidity is valued because it provides flexibility as in the classic works of Hahn (1990) and Jones and Ostroy (1984). Savers in our model have two ways to smooth consumption across states. They can save more liquid assets, which they can sell in the event of a poor realization of endowment income. They can also lower the risk by reducing their savings in illiquid assets, which are not accessible when endowment income is realized. Since illiquid investments reduce income available for consumption in bad states, saving less in illiquid assets lowers risk. When the supply of liquid assets increases, their price is lower and the liquidity premium narrows. Investors react on both margins: they hold more liquid assets, which are now cheaper, and as they are better insured through liquid asset savings, they are willing to increase their illiquid investments, including loans to EMs. In essence, the liquidity premium of short-term U.S. government liabilities

[5] In the model, EMs have no need for the liquid bonds since their income path is known at the time of the initial portfolio choice, and, in fact, we assume that the time discount factor of EMs is sufficiently low that EMs always want to be borrowers and therefore have no demand for U.S. government bonds of either type.

reflects a risk premium: investors accept a lower return on liquid assets because these assets can be sold when facing low endowments, lowering the risk of low consumption.

We have empirically examined the effects of Federal Reserve quantitative easing (and subsequent quantitative tightening) on capital flows to emerging markets. In our baseline estimation, we examine the Fed's large purchases and sales of long-term Treasury bonds, treating T-bills and reserves as perfect substitutes and grouping them together as equally liquid assets. These interventions do not materially affect the overall debt of the consolidated government but change the liquidity of U.S. government obligations held by the public.[6] We make use of weekly data on bond flows to emerging markets from the Emerging Portfolio Fund Research (EPFR) dataset. We control for the credit default swap premium differential between each emerging market and the U.S. to mitigate the concern that results are driven by changes in credit risk.

We find that in weeks in which the Fed makes large purchases (sales) of longer-term Treasuries, there is a subsequent increase (decrease) in funds flowing to EMs. This effect is statistically significant out to a horizon of at least 52 weeks. We see these responses both in flows into and out of emerging markets, and in the total amount invested in EMs (which includes valuation changes). This empirical pattern is robust to controls for global conditions (VIX, 10-year U.S. Treasury bond yield, the weekly return on S&P 500 index) as well as recipient-country specific controls (money market rates, change in industrial production, change in the exchange rate relative to the dollar, and year-on-year CPI inflation).[7] We observe effects of a similar nature, though considerably more delayed, following news about QE and QT compared with the effects of actual long-term Treasury bond purchases and sales.

We then show how QE and QT affect the convenience yield on U.S. Treasuries, and how changes in the convenience yield in turn affect capital flows to emerging markets. We measure the convenience yield as the "Treasury basis", or the deviation from covered interest parity for government bonds of the U.S. relative to emerging market government bonds.[8] We first show that QE (QT) announcements lower (raise) the convenience yield, consistent with the prediction of our model that an increase (decrease) in the supply of liquid assets reduces (raises) the liquidity premium. We then use these announcement-induced changes in the convenience yield as a regressor for capital flows, and find that a decrease in the convenience yield leads to greater capital flows to emerging markets. The results are robust to alternative measures of covered interest parity deviations and to controls for global and country-level variables. Our study highlights the role of liquidity in linking QE and QT to capital flows to emerging markets.

[6] We ignore the fiscal effects that arise as interest rates on longer term debt differ from shorter term debt.

[7] The analysis is at the weekly frequency, and global variables are observed weekly, but most recipient-country specific controls are available at the monthly frequency.

[8] The Treasury basis measures the difference between the return on a foreign government bond converted into dollars using the forward exchange rate, relative to the return on a U.S. government bond. The literature widely uses this as a measure of the liquidity premium of U.S. Treasuries compared to other government bonds. See, for example, Jiang et al. (2021), Jiang et al. (2023), Engel and Wu (2023), Jiang et al. (2025), or Du et al. (2025).

QE, QT and Liquidity Composition

Under quantitative easing, the Federal Reserve buys less liquid debt of the government — medium- and long-term Treasury bonds and agency debt. It creates reserves held at the Fed. As Rogoff (2017, Ch. 8) argues, "pure" quantitative easing — where the Fed buys long-term Treasury bonds in exchange for money which creates reserves — is equivalent to changing the maturity and *liquidity* of U.S. government debt without changing the quantity outstanding. Since reserves pay interest (and in recent years, the interest rate on reserves has usually been nearly identical to the interest rate on 30-day Treasury bills), the Fed is in essence swapping short-term debt for long-term debt. The Fed's balance sheet is part of the consolidated U.S. government balance sheet, where the interest the Fed earns on its government bond portfolio is repatriated to the general Treasury account. Quantitative easing effectively alters the maturity structure of the outstanding Treasury debt held by the investors. In fact, Nagel (2016) refers to short-term T-bills as "near-money assets", implying that short-term T-bills and reserves are close substitutes. Reserves and short-term Treasury bills are prized for their high liquidity, as recent events such as the March 2020 "dash for cash" have verified.[9]

Table 1 presents a highly simplified and stylized representation of the Federal Reserve balance sheet. Quantitative easing involves a purchase of Treasury notes (medium-term bonds) and Treasury bonds (long-term bonds) from the financial sector. On the balance sheet, this shows up as an increase in "Medium-Term Notes and Long-Term Bonds" on the asset side, balanced by an equal increase in Reserves on the liability side. Quantitative tightening has the opposite effect. QE increases liquidity because it increases reserves, a liability of the Fed and a liquid asset held by the investors (specifically, banks in the Federal Reserve system). When the Fed injects liquidity into financial markets through QE by purchasing Treasury notes or bonds, the total amount of reserves plus Treasury bills in financial markets - which is our notion of *liquid* U.S. government assets held by the *investors* - rises, whereas the total amount of Treasury notes and bonds held by investors falls. Therefore, QE shifts the liquidity composition of U.S. government debt held by the investors. While the direct effect of QE is to increase the amount of reserves held by the banking system, ultimately this action affects total holdings of liquid U.S. government liabilities held by other actors in the private sector. For example, as a bank ends up with more reserves after QE, it might sell some of its T-bill holdings, thereby increasing the supply of liquid assets to the non-banking sectors of the economy.[10]

It is important to note that the Fed is not the only government institution that can perform QE. If the Treasury decides to change the mix of its debt issuance from long-term to short-term,

[9] See Vissing-Jorgensen (2021), Barone et al. (2022) and Cesa-Bianchi and Eguren Martin (2021).

[10] QE and QT do not generally involve buying or selling T-bills. If the Fed does buy or sell T-bills, this would have little effect on liquidity, since it is swapping one liquid asset held by the public (T-bills) for another liquid asset (reserves).

Table 1: Stylized Federal Reserve Balance Sheet

Assets	**Liabilities**
Short-term Government Bills	Currency
Medium-Term Notes and Long-Term Bonds	Reserves

it increases the liquidity held by the public. A decision by the U.S. Treasury to alter the mix of issuance short-term versus long-term bonds, in other words, is similar to the effects of QE and QT operations. QE increases reserves held by the public, not short-term bonds, and reduces the public's holding of long-term bonds, but reserves and short-term bonds are near perfect substitutes for the public and for the consolidated government balance sheet. As Rogoff (2017) argues, both QE and changing the tenor of Treasury debt issuance effectively achieve the same result — exchanging liquid short-term liabilities (such as reserves or T-bills) for long-term bonds. Miran and Roubini (2024) in fact refer to the shortening of the yield profile of Treasury debt in 2024 as "stealth QE." This alternative perspective is aligned with how our model portrays QE as a shift of the U.S. government debt issuance from less-liquid to more-liquid Treasuries.

Review of Literature

The key contribution of our paper is to document the liquidity channel through which QE and QT affect capital flows to emerging markets. In particular, we show how QE and QT affect the convenience yield on U.S. Treasuries, and then use these changes in the convenience yield as a regressor for capital flows to emerging markets. Our study thus highlights the role of liquidity in linking QE and QT to capital flows to emerging markets.

Our study is, therefore, related to work that has investigated the impact of quantitative easing/tightening (QE/QT) on reserves and bank lending. Many have centered on the ways in which domestic lending has been influenced.[11] Others have examined its impact on financial and macro variables in EMs, including a number of papers that have investigated the effects on capital flows to emerging markets. As Table 2 delineates, they differ from our contribution. Lim et al. (2014) finds large effects of QE on quarterly capital inflows to emerging markets and developing countries. Ahmed and Zlate (2014) find that large-scale asset purchases by the Federal Reserve lead to higher quarterly capital inflows to emerging market countries. Tillmann (2016) estimates a VAR in which surprise QE shocks are identified and finds a strong impact on U.S. monthly capital flows to emerging markets in Asia and Latin America. Duca et al. (2016) find that quarterly corporate bond issuance in emerging markets increases following QE. Anaya et al. (2017) use a large-scale structural global VAR, which identifies QE shocks using Fed balance sheet data, and find a significant impact on U.S. monthly capital flows to emerging markets. Bhattarai et al. (2021) estimate a

[11] Diamond et al. (2023), Kandrac et al. (2021), Kandrac and Schlusche (2021), Li et al. (2019), Rodnyansky and Darmouni (2017), Chakraborty et al. (2020) and Acharya and Dogra (2022).

Table 2: A Summary of Literature

Paper	Key Regressor	QE / QT	Freq.	Capital Flows
LMS	QE episodes	QE	Q	Aggregate
AZ	QE announcements, U.S. 10-year Treasury yields	QE	Q	Aggregate
T	QE announcements	QE	M	Aggregate
DNM	Fed's purchases of MBS and Treasuries	QE	Q	Corporate Bond
AHO	VAR-derived shock to Fed's total assets	QE	M	Bond & Equity
BCP	VAR-identified shock to securities held outright by the Fed	QE	M	Aggregate
CDL	Treasury futures yield changes on FOMC announcements	QE & Tapering	M	Bond & Equity
GJ	Asset prices surprises on FOMC announcements	QE	Q	Aggregate
FLS	QE announcements and Fed's Treasury purchases	QE	D	Bond & Equity
LE	Change in the Fed's weekly holdings of long-term Treasuries; QE and QT-induced changes in CIP deviations	QE & QT	W	Bond

Note: LMS stands for Lim et al. (2014), AZ for Ahmed and Zlate (2014), T for Tillmann (2016), DNM for Duca et al. (2016), AHO for Anaya et al. (2017), BCP for Bhattarai et al. (2021), CDL for Chari et al. (2021), GJ for Georgiadis and Jarocinski (2023), FLS for Fratzscher et al. (2018), and LE for this paper.

structural VAR for the U.S., then use the identified QE shocks from that VAR to examine the impact on macro variables for emerging markets. They find a large and persistent effect of QE in raising monthly capital inflows into these markets. Chari et al. (2021) use high-frequency identification to obtain a measure of unconventional U.S. monetary policy surprises using Treasury futures yield changes on FOMC event dates. Then, they use monthly data from the U.S. Department of Treasury International Capital (TIC) System on U.S. investor positions in foreign securities by country and asset type. They examine the effects of surprises during the QE and tapering periods on emerging markets. They find sizable effects on U.S. holdings of emerging market assets, with capital flows playing a larger role during the tapering period. Georgiadis and Jarocinski (2023) use high-frequency changes in asset prices to identify the effects of different unconventional U.S. monetary policy shocks, and find that QE triggers capital inflows to an aggregate of EMs. The empirical study closest to ours is Fratzscher et al. (2018). Using the high-frequency capital flow data from 2008 to 2012 on portfolio flows from EPFR, the study assesses the effects of QE announcements and the Fed's daily Treasury purchases on capital flows. Complementing their work, we pinpoint the liquidity channel through which both QE and QT affect capital flows to emerging markets.

On the theoretical front, Kolasa and Wesołowski (2020) build a calibrated structural model to explain how QE in the U.S. might lead to flows into purchases of EM's sovereign bonds. As returns on U.S. assets decline due to QE, investors find potential returns on EM sovereign bonds more attractive. Their analysis, which centers on default risk, complements our focus on liquidity. Kim (2023) builds a money-search model in which QE in a country such as the U.S., whose assets serve as collateral, can lead to capital flows to EMs.

However, none of these studies on QE and capital flows to emerging markets focuses on and identifies the liquidity channel through which QE and QT affect capital flows. There are two strands of closely related recent literature, but neither directly studies this question. One strand looks at the effects of QE or QT on CIP deviations: Viswanath-Natraj (2020) studies the effect of QE, and Du et al. (2024) study the impact of QT on CIP deviations, but neither links CIP deviations to capital flows to emerging markets.[12] Another strand examines the effects of CIP deviations on capital flows: Kubitza et al. (2025) examines the effects of CIP deviations on capital flows, but does not examine CIP deviations driven by QE or QT. Our study bridges these two strands, first showing how QE and QT affect the liquidity yield, and then using these changes as a regressor for capital flows to emerging markets. Additionally, very few papers look at the high-frequency changes in the Fed's holdings of long-term Treasuries, let alone interpreting them as a change in the liquidity composition of U.S. government liabilities.

Related are a large number of papers that examine spillovers of U.S. monetary policy more generally (that is, not specifically spillovers from quantitative easing or tightening) to emerging markets, including Rey (2016), Bruno and Shin (2015), Passari and Rey (2015), Aizenman et al. (2016), Georgiadis (2016), Kalemli-Ozcan (2019), Obstfeld et al. (2019), Iacoviello and Navarro (2019), Albagli et al. (2019), Miranda-Agrippino and Rey (2020), Avdjiev et al. (2020), Degasperi et al. (2020), Ca'Zorzi et al. (2020), Bräuning and Ivashina (2020), Ciminelli et al. (2022), Hoek et al. (2022), Obstfeld and Zhou (2022), and De Leo et al. (2024).[13]

Finally, our model assumes a special role for the U.S. dollar as the most important global provider of liquidity. The U.S. enjoys an "exorbitant privilege" by being able to borrow abroad at relatively low rates of interest, as Gourinchas and Rey (2007) and Gourinchas and Rey (2022) have noted. Recent studies that emphasize the special role of dollar liquidity include Ivashina et al. (2015), Jiang et al. (2021), Jiang et al. (2024), Bianchi et al. (2021) and Devereux et al. (2023). McGuire et al. (2009), Davies and Kent (2020) and Adrian and Xie (2020) document the dominant role of the dollar in liquid asset holdings of the global banking system, while Coppola et al. (2023) provide a historical perspective on how a currency becomes a dominant supply of liquidity.

Section 2 presents empirical evidence to support the claim that quantitative easing leads to increased capital flows to emerging markets. We show in Section 3 the evidence on covered interest parity deviations that accords with our model. Section 4 presents a model that helps explain this phenomenon, while Section 5 examines the model numerically. Section 6 concludes.

2 Liquidity of U.S. Government Liabilities and Capital Flows

Our empirical approach considers quantitative easing as an alteration of the maturity of government debt held by the investors. When the Federal Reserve buys long-term bonds, the Fed pays with money, increasing reserves of the banking system. QE changes the liquidity composition of

[12]See also Jiang and Sun (2024), who document shifts in the investor composition of the U.S. Treasury market during quantitative tightening and study the role of investor composition in shaping the transmission of QT to bond prices.

[13]Stedman and Hanson (2025) examine how spillovers from the European Central Bank monetary policy shocks to the U.S. yield curve depend on the convenience yield of U.S. Treasuries.

government debt in financial markets - the investors hold less long-term Treasury obligations and more short-term debt in the form of reserves. We are interested in how the shift in the liquidity composition of government debt has affected capital inflows to other countries.

2.1 Data Sources

We employ weekly bond flows data from the EPFR dataset. The EPFR dataset collects data on individual fund flows and fund allocations of mutual funds and exchange traded funds, and aggregates them to flows into and out of specific countries and sectors. The weekly capital flows and fund allocations are reported every Wednesday. Flows cover the total flows occurring over the past week. "Allocations" are their values as of every Wednesday.[14] Both flows and allocations are reported in units of the U.S. dollar.[15] Weekly capital flows cover mutual fund investors and exchange traded fund investors. We employ weekly *bond* flows and allocations at the country level.

With this EPFR data, we analyze how the weekly capital bond inflows to countries change following both sharp increases and decreases in the Fed's outright holding of U.S. Treasury securities from FRED. The country sample includes 16 emerging market countries: Brazil, Chile, China, Colombia, Hungary, India, Korea, Mexico, Malaysia, Israel, Peru, Philippines, Poland, Russia, Thailand, and Turkey. The sample period is from 01/01/2006—12/31/2018.[16]

Our identification of the dynamic effects on capital inflows to emerging markets after a large purchase or sale of government bonds by the Fed relies on high-frequency capital flow data. The EPFR is the most suited to our analysis given that the capital flow data are available at high frequency compared to other datasets such as the data from the U.S. TIC System or each country's balance of payments statistics. The investor coverage of the dataset is incomplete compared to the balance of payments data; nonetheless, the EPFR dataset is highly representative in capturing the aggregate flow data from the balance of payments data (see, for instance, Jotikasthira et al., 2012).

We also explore the capital flow dynamics to emerging markets after QE and QT announcements. We collect QE announcement dates from Fratzscher et al. (2018) and QT announcement dates from Du et al. (2024). QE and QT announcement dates that we employ are summarized in Table A2 in the Appendix.[17]

[14]Country weights for each fund are observed at a monthly frequency, whereas fund flows and allocations are observed weekly. EPFR imputes weekly flows to each country using the latest available country weights from the monthly data.

[15]We deflate allocations and flows such that they are in constant 2015 USD.

[16]The country-level weekly capital flow data from EPFR are available from May 2003.

[17]We employ a subset of QE announcements used by Fratzscher et al. (2018), which deliver a positive and direct message about an introduction or expansion of QE in the FOMC meetings. Moreover, the Maturity Extension Program (MEP) announcement dates are not included when flagging QE announcement dates, as they are not associated with meaningful increases in our liquidity supply measure, ΔLiq_t.

2.2 Capital Flow Dynamics

We first flag weeks when the weekly log change in the Fed's outright holding of U.S. Treasury securities excluding Treasury bills is larger than 1.331% and less than -0.288%. These cutoffs correspond to the 95th and 5th percentiles of the empirical distribution of weekly log changes in the Fed's outright holding of long-term U.S. Treasury securities in 12/18/2002-12/28/2022.[18] In the baseline specification, we treat reserves and U.S. Treasury bills as perfect substitutes.

We estimate the following weekly panel local linear projections (Jordà, 2005):

$$y_{i,t+k} = \alpha_{i,k} + \beta_k D_t + \gamma_k(CDS_{i,t} - CDS_{US,t}) + u_{i,k,t}, \tag{1}$$

where the dependent variables $y_{i,t+k}$ are (i) $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ and (ii) $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$. $BondFundAllocation_{i,t}$ refers to the value of bond fund assets allocated to country *i* on weekly date t in the EPFR data, aggregated across all bond funds tracked by EPFR, and the change in the bond fund allocation includes new allocations plus capital gains or losses. $BondFundFlow_{i,t}$ is the net flow of bond funds into country *i* over the past one week prior to weekly date t.[19] D_t is a dummy variable that is equal to one when, on the weekly date *t*, the Fed's holding of long-term U.S. Treasury securities increases more than 1.331% over one week, negative one when it falls below -0.288%, and zero otherwise.[20] Moreover, we also control for the difference between the emerging market country's one-year CDS premium and that of the U.S. $(CDS_{i,t} - CDS_{US,t})$ to mitigate the concern that the results may be driven by changes in credit risk premia rather than higher liquidity in the market for U.S. government liabilities.[21]

The coefficients of interest are β_k for $k = 0, \ldots, 52$, which trace the dynamic response of global bond fund allocations and flows to large Fed purchases or sales of long-term U.S. Treasuries. The first specification measures the cumulative change in bond fund allocations at horizon, relative to allocations one week prior to the large increase or decrease, while the second captures the evolution of weekly bond fund flows at horizon k, scaled by initial allocations.

We measure how global bond fund allocations to each country i are affected over k weeks, compared to the bond funds allocation one week before, after the Fed's large purchase or sale of long-term U.S. Treasury securities. We look at how each week's bond fund flow change*s* over k weeks, as a ratio of the bond funds allocation one week before, after a large increase in the Fed's

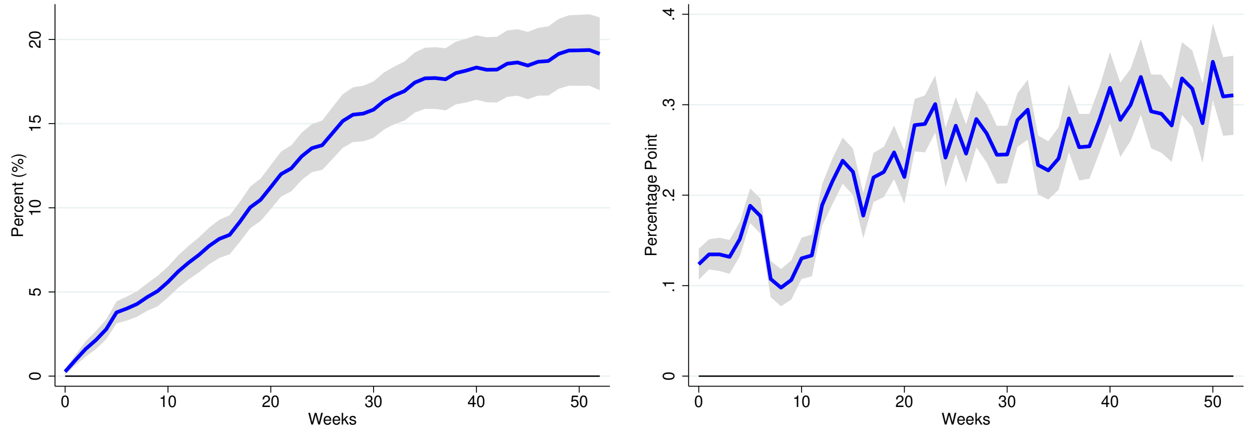
[18]The first observation is on 12/18/2002, and every Wednesday, the Fed reports its holdings of U.S. Treasury securities.

[19]As aforementioned, the country-level weekly bond flows are imputed with the latest available monthly country weights. Since we analyze the dynamic effects over 52 weeks, this imputation should be less of a concern.

[20]The results are robust to including two separate dummy variables capturing QE and QT. The average change in the Fed's holding of long-term U.S. Treasuries is 3% and -0.8% for $D_t = 1$ and -1, respectively.

[21]Our empirical results remain robust when the CDS differential is not included as a control.

Figure 2: Effect of Large Changes in the Fed's Holding of Long-term U.S. Treasuries on Capital Flows to EMs



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The left panel shows the response of bond fund allocations over 52 weeks following a large increase in the Fed's holding of long-term U.S. Treasury securities. The right panel shows the corresponding response of bond fund flows over 52 weeks. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

purchase of long-term Treasuries. We include country fixed effects in both specifications.[22]

Figure 2 shows the dynamic response of capital flows after a large increase in the Fed's holding of long-term Treasuries. In Figure 2, we see that the bond fund allocation increases by around 20% after a large purchase at the peak. In Figure 2, weekly capital inflows (as a ratio of the fund allocation before the large increase) increase by around 0.3 percentage points per week at the peak.

We perform additional robustness exercises. First, we standardize the weekly change in the Fed's holding of U.S. Treasury securities excluding Treasury bills and employ it as a regressor, ΔLiq_t.[23] We estimate the following weekly panel local linear projections (Jordà, 2005):

$$y_{i,t+k} = \alpha_{i,k} + \beta_k \Delta Liq_t + \gamma_k (CDS_{i,t} - CDS_{US,t}) + u_{i,k,t}, \tag{2}$$

where the dependent variables $y_{i,t+k}$ are (i) $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ and (ii) $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$. Shown in Figure 3, following a one standard deviation increase in the Fed's holdings of long-term U.S. Treasuries, bond fund allocations rise by about 10%, while weekly capital inflows increase by approximately 0.2 percentage points per week at the peak. These magnitudes are aligned with those in our baseline estimates shown in Figure 2.[24]

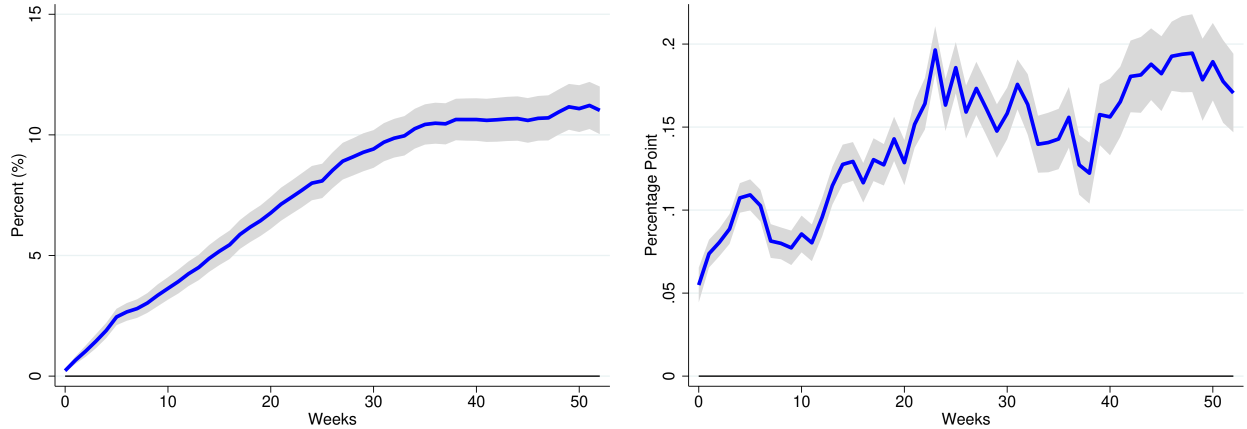
Second, we estimate the effects of QE and QT separately, allowing for potentially differential

[22] We exclude the top 1% and bottom 1% of the dependent variable in estimation.

[23] Figure A1 in the Appendix shows the time-series of ΔLiq_t.

[24] Roughly speaking, the large increases and decreases we identify correspond to changes of about *two* standard deviations from the mean.

Figure 3: Effect of Change in the Fed's Holding of Long-term U.S. Treasuries on Capital Flows to EMs



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The independent variable is the log change in the Fed's holding of long-term U.S. Treasuries, ΔLiq_t. The left panel shows the response of bond funds allocations over 52 weeks to a one standard deviation increase in the Fed's holdings of long-term U.S. Treasuries. The right panel shows the corresponding response of bond funds flows over 52 weeks. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

impacts on capital flows to emerging markets. Specifically, we include two dummy variables, D_t^{QE} and D_t^{QT},where the former equals one when $D_t = 1$ (i.e., a large increase in the Fed's holdings of U.S. long-term Treasuries) and the latter equals one when $D_t = -1$ (i.e., a large decrease in the Fed's holdings of U.S. long-term Treasuries). We then re-estimate regression (1) with two dummy variables. The results, reported in Figure A3 in the Appendix, show that capital flows to emerging markets rise following large increases in the Fed's holdings of long-term Treasuries and decline following large decreases.

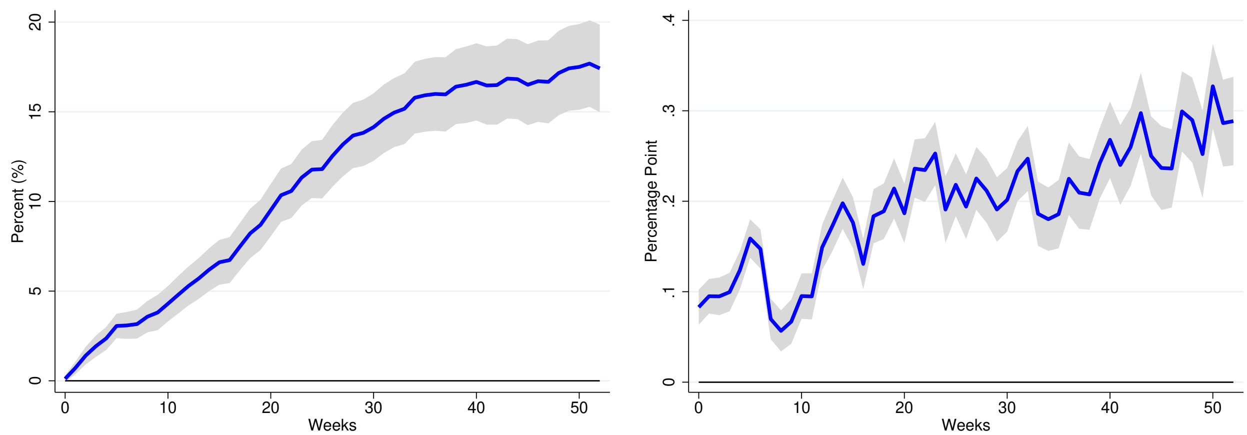
Third, we flag weeks when there are large increases or decreases in the Fed's holdings of U.S. Treasury securities across *all* maturities including U.S. Treasury bills. Under this specification, we treat reserves and U.S. Treasury bills as imperfect substitutes. Specifically, we construct an alternative dummy variable that equals one when, in week t, the Fed's outright holding of U.S. Treasury securities (including Treasury bills) increases by more than 1.302%, negative one if it falls by more than 0.519%, and zero otherwise.[25] We then re-estimate regression (1) using this alternative classification. Figure A4 in the Appendix shows that the results do not change when we flag the dates with large changes in the Fed's holding of U.S. Treasuries across all maturities, including Treasury bills.

Lastly, we add other global and country-level control variables to Equation 1.[26] Global variables at the weekly frequency include the weekly change in the log of the VIX index, the 10-year Treasury

[25]The cutoffs correspond to the 95th and 5th percentiles of the empirical distribution of weekly log changes in the Fed's outright holding of all U.S. Treasury securities in 12/18/2002-12/28/2022.

[26]The list of variables and their sources are summarized in Table A1 in the Appendix.

Figure 4: Dynamics of Capital Flows: Controlling for Global and Country-level Variables



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The left panel shows the response of bond fund allocations over 52 weeks following a large increase in the Fed's holding of long-term U.S. Treasury securities. The right panel shows the corresponding response of bond fund flows over 52 weeks. We control for global and country-level variables. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

bond yield, and the weekly return on S&P 500 index. We also control for the week-over-week changes in the log of bilateral nominal exchange rates against the U.S. dollar to show that the results are not driven by the exchange rate fluctuations. Other country-level controls are mostly at the monthly frequency: money market rates, month-over-month log changes in industrial production index, and year-over-year CPI inflation.[27] Figure 4 shows the results are robust to controlling for global and country-level variables.

We also examine the effects of QE and QT announcements on capital flows to emerging markets.[28] These results are qualitatively similar to those empirical patterns documented above but considerably more delayed and are summarized in Figures A9 and A10 in the Appendix.[29]

In sum, we show that the shift of the liquidity composition of U.S. government liabilities toward short-term liquid assets comes with larger capital inflows to emerging markets. Rationalizing this empirical pattern, we build a simple two-period model that features three different assets with different liquidity profiles and explain how a higher supply of liquid U.S. Treasuries insures investors and leads to more lending to other countries.

[27] For example, when data are available only monthly, in the regressions, we give each weekly observation the monthly value of the variable.

[28] We report the results with MEP announcements included as QE announcements, shown in Figures A12 and A13 in the Appendix. Moreover, we compare the dynamic estimates on MEP and QE announcements separately and show that MEP announcements have a positive effect on capital inflows to EMs, but the estimated effects are smaller in magnitude and noisier compared to those of QE announcements, shown in Figure A11 in the Appendix.

[29] Through the lens of our model, we provide a rationale for why the effects of QE and QT announcements may be more muted than the effects of their actual implementation. The discussion is presented in the Appendix.

3 Liquidity of U.S. Government Liabilities and CIP Deviations

We follow the literature in associating the convenience yield of short-term U.S. Treasury bills with the degree of liquidity these bills provide markets. Our hypothesis is that QE increases the supply of very liquid U.S. government assets to the public, and should reduce the convenience yield on T-bills. QT would have the opposite effect. Recent work that has examined the convenience yield on T-bills, and the Treasury basis, includes Krishnamurthy and Vissing-Jorgensen (2012), Krishnamurthy and Vissing-Jorgensen (2011), Nagel (2016), Vissing-Jorgensen (2021), Jiang et al. (2021), Obstfeld and Zhou (2022), Du et al. (2018), Du and Schreger (2022), Kalemli-Ozcan and Varela (2021), Du et al. (2023), Diamond and Van Tassel (2021), Tabova and Warnock (2021), Engel and Wu (2023), and Cerutti et al. (2021).

3.1 Data Sources

We explore how the convenience yields have changed after QE and QT announcements.[30] We measure the convenience yields following Du and Schreger (2016) and Du et al. (2018).[31] We quantify the convenience yield of the U.S. Treasuries and foreign government bonds by measuring the one-year CIP deviations, adjusted by the default risk using credit default swap (CDS) data, $\Phi_{i,t}$:

$$\Phi_{i,t} = (y_{i,t}^{Govt} - CDS_{i,t} - \rho_{i,t}) - (y_{US,t}^{Govt} - CDS_{US,t}),$$

where $y_{i,t}^{Govt}$ is the one-year local currency government bond yield in country i, $\rho_{i,t}$ is the one-year market-implied forward premium for hedging currency i against the U.S. dollar, and $y_{USD,t}^{Govt}$ is the one-year U.S. Treasury bond yield on weekly date t.[32] To account for the probability of government default, we adjust the CIP deviations by subtracting the difference between the emerging market country's one-year CDS premium and that of the U.S.[33] The CIP deviation captures the extent to which investors are willing to accept a lower yield on U.S. Treasuries as investors get non-pecuniary benefits from holding U.S. Treasuries.[34] We employ the same set of emerging market countries: Brazil, Chile, China, Colombia, Hungary, India, Korea, Mexico, Malaysia, Israel, Peru, Philippines, Poland, Russia, Thailand, and Turkey.

[30] Given that market prices of government bonds and swaps respond much more quickly to the news, we explore the dynamics of CIP deviations after the announcements, not after the actual change in the Fed's holding of U.S. Treasuries.

[31] We employ CIP deviation data from Du and Schreger (2016) and Du et al. (2018), and adjust for default risk using CDS data from Bloomberg Terminal and Markit.

[32] As shown in Section 3.2, the results are robust to using 3-month CIP deviations and 3-month interbank rate based CIP deviations.

[33] When CDS data on a weekly date t are missing, we replace them with the annual average for the corresponding year.

[34] See, for example, Jiang et al. (2021), Engel and Wu (2023), Jiang et al. (2024), Jiang et al. (2025) or Du et al. (2025) for recent studies that use the Treasury basis to measure the convenience yield on Treasuries.

3.2 Dynamics of CIP Deviations

We look at the dynamics of one-year CIP deviations following the QE and QT announcements.[35] We estimate the weekly panel local linear projection:

$$\Phi_{i,t+k} = \alpha_{QE,i,k} D_t + \alpha_{QT,i,k}(1 - D_t) + \omega_{k,QE} QE_t^{News} + \omega_{k,QT} QT_t^{News} + \epsilon_{i,k,t}, \quad (3)$$

where $\Phi_{i,t}$ captures the convenience yield of U.S. Treasuries over government bonds of country i on weekly date t in basis points.

The dummy variable QE_t^{News} (QT_t^{News}) is equal to one when, on the weekly date *t*, there was a QE (QT) announcement and zero otherwise. Given that market prices react quickly to news, we estimate the dynamic effect of QE and QT announcements over smaller windows to cleanly capture their impact on the liquidity yields. Each period spans two years before the *first* announcement of QE (or QT) and two years after the *last* announcement of QE (or QT): 2006–2014 for QE and 2015–2019 for QT. We define the dummy variable D_t equal to one for the years 2006–2014 and zero for 2015–2019. As aforementioned, announcement dates are fetched from Fratzscher et al. (2018) and Du et al. (2024), summarized in Table A2 in the Appendix. The coefficients of interest are $\omega_{k,QE}$ and $\omega_{k,QT}$ for $k = 0, \ldots, 52$.

Figures 5 and 6 summarize the results. The CIP deviations decrease after the QE announcements, while they increase after the QT announcements. As QE shifts the liquidity composition of U.S. government liabilities toward more liquid short-term assets, the market is flooded with short-term liquidity. Higher short-term liquidity lowers the liquidity and convenience yields. On the flip side, the QT lowers the supply of liquidity in the market, increasing the liquidity return. The quantitative magnitude of a fall in convenience yields after QE announcements is large, on average entailing a 1.3 percentage point fall in the convenience yield. The effect of QE on the convenience yield lasts more than 30 weeks. QT announcements in 2017 have come with a more muted change in convenience yields, around a half percentage point increase in the convenience yield lasting for around 15 weeks.[36]

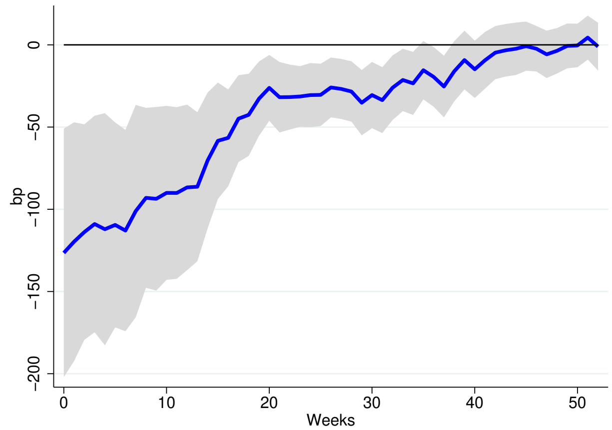
As a robustness check, we examine the effects of QE and QT announcements on the dynamics of *3-month* CIP deviations using an alternative measure of liquidity yield on U.S. Treasuries over emerging market government bonds. The results are shown in Figure A5 in the Appendix. The negative impact of QE announcements and the positive impact of QT announcements on CIP deviations remain intact.

Additionally, following Cerutti and Zhou (2024), we construct the CIP deviations using the

[35] We employ one-year CIP deviations as the CDS data are not readily available for those with tenor less than a year. The results are similar with the three-month CIP deviations.

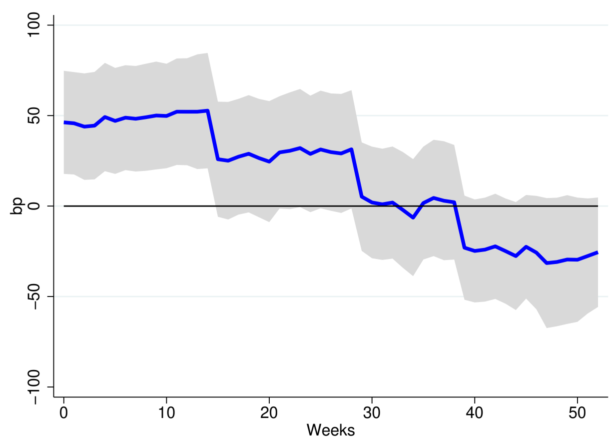
[36] Recently, Du et al. (2024) show that QT announcements lower the convenience yields on *long-term* U.S. Treasuries over foreign government bonds. We also find a similar pattern with the 10-year CIP deviations.

Figure 5: Effect of QE Announcements on CIP Deviations



Notes: The dependent variable is the one-year CIP deviation adjusted by default risk: $\Phi_{i,t} = (y_{i,t}^{Govt} - CDS_{i,t} - \rho_{i,t}) - (y_{US,t}^{Govt} - CDS_{US,t})$, where $y_{i,t}^{Govt}$ is the one-year local currency government bond yield in country i, $\rho_{i,t}$ is the one-year market-implied forward premium for hedging currency i against the U.S. dollar, and $CDS_{i,t}$ is the credit default swap premium on country i's government bond on weekly date t. The data are from Du and Schreger (2016) and Du et al. (2018). The shaded area represents the 90% confidence interval computed using heteroskedasticity-robust standard errors.

Figure 6: Effect of QT Announcements on CIP Deviations



Notes: The dependent variable is the one-year CIP deviation adjusted by default risk: $\Phi_{i,t} = (y_{i,t}^{Govt} - CDS_{i,t} - \rho_{i,t}) - (y_{US,t}^{Govt} - CDS_{US,t})$, where $y_{i,t}^{Govt}$ is the one-year local currency government bond yield in country i, $\rho_{i,t}$ is the one-year market-implied forward premium for hedging currency i against the U.S. dollar, and $CDS_{i,t}$ is the credit default swap premium on country i's government bond on weekly date t. The data are from Du and Schreger (2016) and Du et al. (2018). The shaded area represents the 90% confidence interval computed using heteroskedasticity-robust standard errors.

3-month interbank interest rates. The dependent variable is the 3-month interbank rate based CIP deviation:

$$\Phi_{i,t}^{IBOR} = (y_{i,t}^{3m,IBOR} - \rho_{i,t}^{3m}) - y_{US,t}^{IBOR},$$

where $y_{i,t}^{3m,IBOR}$ is the three-month interbank interest rate in country i, and $\rho_{i,t}^{3m}$ is the 3-month market-implied forward premium for hedging currency i against the U.S. dollar on weekly date t.[37] The results are very similar to what we have found in Figure A5 in the Appendix as well as those depicted in Figures 5 and 6.

In essence, the quantitative easing shifts the liquidity composition of U.S. government liabilities to more short-term liquid assets, decreasing the liquidity return of U.S. Treasuries relative to that of foreign government bonds. We would like to understand, through the lens of our model in Section 4, how this liquidity channel may affect investors' portfolio choices, specifically their lending to the emerging markets.

3.3 CIP Deviations and Capital Flows

In this section, we explore how the CIP deviations induced by QE and QT announcements affect capital flows to emerging markets. Using the estimates of $\hat{\omega}_{0,QE}$ and $\hat{\omega}_{0,QT}$ on CIP deviations from Equation 3, we compute $\frac{1}{100} \times (\hat{\omega}_{0,QE} \times QE_t^{News} + \hat{\omega}_{0,QT} \times QT_t^{News})$ $(\equiv \hat{\Phi}_{i,t})$. $\hat{\Phi}_{i,t}$ represents the CIP deviations in percentage points induced by QE and QT announcements. Then, with $\hat{\Phi}_{i,t}$, we estimate weekly panel local linear projections:

$$y_{i,t+k} = \alpha_{i,k} + \beta_k \hat{\Phi}_{i,t} + \gamma_k (CDS_{i,t} - CDS_{US,t}) + u_{i,k,t},$$

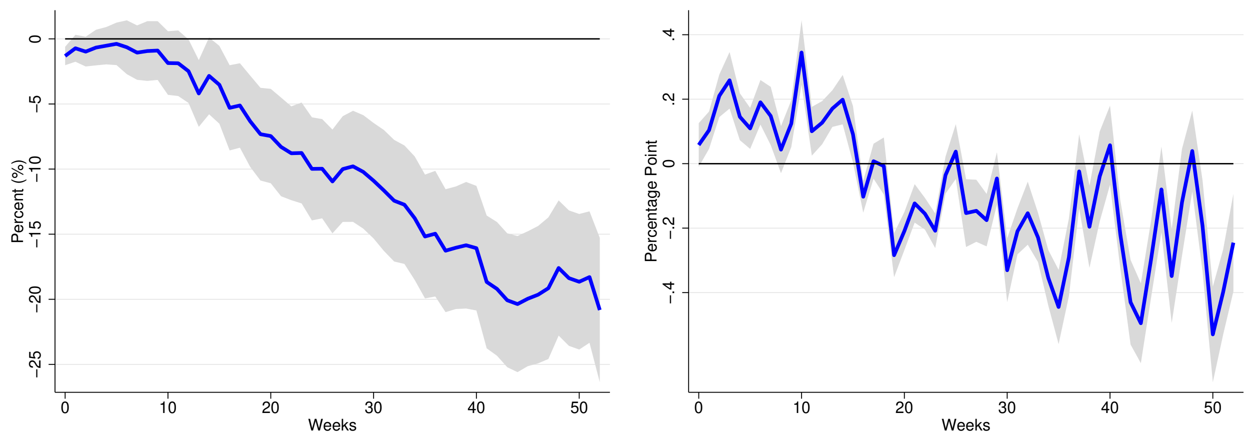
where the dependent variables $y_{i,t+k}$ are (i) $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ and (ii) $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$. We control for the difference between the emerging market country's one-year CDS premium and that of the U.S. We also include country fixed effects. The coefficients of interest are β_k for $k = 0, \ldots, 52$.

Figure 7 summarizes the estimation results of the dynamic panel local projections. When CIP deviations decrease after the QE announcements, capital flows to emerging markets increase. At their peak, a 100 basis point decrease in CIP deviations leads to a 20% increase in bond fund allocations and a 0.4 to 0.5 percentage point increase in bond fund flows as ratios of bond fund allocations at the pre-announcement level. We clearly observe that a shift in the liquidity yield of U.S. Treasuries vis-à-vis emerging market government bonds, induced by the QE and QT announcements, is followed by capital flowing into and out of emerging markets.

We perform several robustness checks. First, the results are robust to including the same set of global and country-level controls as in our baseline estimation in Section 2. Figure 8 shows

[37] We thank Haonan Zhou and Eugenio Cerutti for sharing their 3-month interbank rate based CIP measures with us. For details on the data construction, see Cerutti and Zhou (2024).

Figure 7: Effect of CIP Deviations on Capital Flows



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The dynamic effects of the CIP deviations induced by QE and QT announcements on capital flows to emerging markets are shown in both figures. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

empirical patterns similar to those depicted in Figure 7.

Second, the results are robust to using alternative measures of CIP deviations, computed with 3-month government bond rates and 3-month interbank rates. Figures A7 and A8 in the Appendix show estimation results consistent with the patterns illustrated in Figure 7.[38]

4 Model

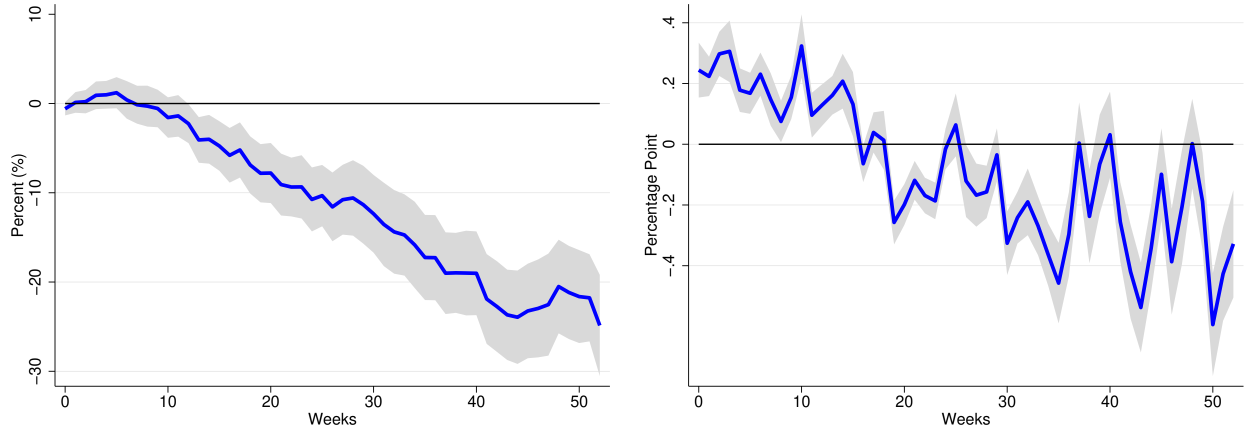
Our objective in this section is to provide a liquidity-based explanation to rationalize why lending to EMs increases with quantitative easing. We build a simple two-period model to illustrate how the changes in the liquidity profile of U.S. Treasuries affect investors' lending to EMs.

We are not interested in, and abstract from, the fiscal implications of the U.S. debt composition. That is, the timing of taxes is not the focus of our study. As the literature has noted, even in a setting with infinitely-lived representative agents, the presence of a liquidity return to government bonds breaks Ricardian equivalence. The particular fiscal policy that is optimal depends on the specifics of how liquidity interacts with private-market decisions, as well as the interdependence of fiscal and monetary policy.[39] The government of our model simply borrows and makes lump-sum

[38] Additionally, the results are largely unchanged when we include Maturity Extension Program (MEP) announcement dates in the construction of the QE announcement dummy. Figures A14–A16 in the Appendix show that the patterns documented in Figures 5, 6, and 7 are largely unchanged.

[39] See Azzimonti and Yared (2019), Bigio et al. (2019), Bassetto and Cui (2018), Bayer et al. (2023), Acharya and Dogra (2022), Krishnamurthy et al. (2018), Berentsen and Waller (2018) and Andolfatto and Martin (2018).

Figure 8: Effect of CIP Deviations on Capital Flows: Controlling for Global and Country-level Variables



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The dynamic effects of the CIP deviations induced by QE and QT announcements on capital flows to emerging markets are shown in both figures. We control for global and country-level variables. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

transfers, and the driver of U.S. current account deficits is government borrowing.[40]

Section 4.1 describes the environment: a two-period, three-country model in which U.S. and ROW households face income uncertainty and choose how to allocate savings across three types of assets that differ in their liquidity. Section 4.2 summarizes the key properties of the model. Section 4.3 contains the main analytical result that lending to EMs increases when the liquidity composition of U.S. government debt shifts toward more liquid assets.

4.1 Model Environment

There are two periods, 0 and 1. There are three countries, U.S., ROW and EM, each populated by a mass m^a of households, where $a = \{\text{US, ROW, EM}\}$. Each country's households may have different time discount factors, β^a, where $a = \{\text{US, ROW, EM}\}$. Each household exhibits constant relative risk aversion, parametrized by σ. We set up a model with three countries to allow for EMs to be borrowers, but to be consistent with the fact that the U.S. is also a net borrower on international markets. In our set-up, the U.S. is a borrower because of the government. Households in the U.S., under our parameter configuration, are savers and are lenders both to the U.S. government and to EMs. We take the amount of U.S. government debt B and the share of liquid U.S. Treasuries in total U.S. Treasuries η as exogenous. We vary η in our experiments to investigate the implications of the liquidity composition for lending to EMs.

[40] Although there are other reasons for the U.S. current account deficit in these models, Kekre and Lenel (2024) and Jiang et al. (2021) are examples of models in which the seigniorage from issuance of safe assets plays an important role in determining the U.S. deficit.

U.S. and ROW Households: Environment Period 0 is divided into two sub-periods. In the beginning of period 0, U.S. and ROW households receive a low endowment, $y_0^{a,L}$, but they face uncertainty about an additional income shock. With probability p, they will receive a positive shock in the second sub-period that raises their income to the high level $y_0^{a,H}$; with probability $1-p$, no shock occurs and their income remains at $y_0^{a,L}$. In period 1, U.S. and ROW households receive incomes of y_1^a , where $a = \{\text{US, ROW}\}$, regardless of their incomes in period 0.[41] U.S. and ROW households pay lump-sum taxes in periods 0 and 1, T_0^a and T_1^a, where $a = \{\text{US, ROW}\}$.

In the beginning of period 0, *before* learning their exact incomes, U.S. and ROW households decide how much to save in three different types of saving vehicles that offer different levels of liquidity: liquid U.S. Treasury bills $b_f^a \geq 0$, less-liquid U.S. Treasury bonds $\tilde{b}^a \geq 0$, and illiquid loans ℓ^a to EM for country $a = \{\text{US, ROW}\}$.[42] U.S. and ROW households buy liquid Treasuries forward b_f^a, and buy less-liquid Treasuries $\tilde{b}^a$ and make illiquid loans to emerging markets ℓ^a outright.[43]

In the second sub-period, households learn their exact incomes $y_0^{a,k}$. After their income levels are realized, the forward contract is settled: households buy liquid Treasuries from the government at a price $\frac{1}{R_b}$, resulting in the spot positions b^a in liquid Treasuries, such that $b_f^a = b^a$. After the income realization and the forward contract settlement, households can trade liquid Treasuries in the secondary market and adjust their liquid U.S. Treasuries holdings. Each household in country a of income type $k = \{H, L\}$ buys additional liquid Treasuries $b^{a,k}$ at the price $\frac{1}{R_{b,s}}$ (or sell if $b^{a,k} < 0$), after its income type k is obtained. The amount that they can sell at this point is restricted by how much the investors hold before the income shock is realized: $b^{a,k} \geq -b^a$. Absent other transaction costs, selling liquid bonds in the secondary market is equivalent to using them as collateral for very short-term loans in a repo market.[44]

Illiquid Treasuries cannot be sold and bought after income realizations. The difference between liquid and less-liquid Treasuries captures the ease of selling assets when needed. The price of illiquid bonds is $\frac{1}{R_{\tilde{b}}}$.

Illiquid loans to EM households also cannot be sold when the secondary market opens. They also require U.S. and ROW households to pay transaction costs as a function of the amount of loans: $f(\frac{\ell^a}{R_\ell})$, where ℓ^a is the amount of loans extended to EMs, at the price $\frac{1}{R_\ell}$, where $f' > 0$ and $f'' > 0$ for country $a = \{\text{US, ROW}\}$. This formulation for the transaction cost is intended as a

[41]The shocks to endowments can be reinterpreted as shocks to the amount of capital required for production in period 1, which households learn about only after their saving decisions are made. A simple framework with investment is presented in the Appendix.

[42]The time discount factors of U.S. and ROW households are much higher than EM households such that EM households want to borrow from the U.S. and ROW households.

[43]We assume that households buy liquid Treasuries forward so that their initial income levels (after-tax low income levels) are sufficient to finance optimal savings in less-liquid Treasuries and illiquid loans to emerging markets.

[44]After income shocks are realized, low-income households want to sell their liquid bills to increase consumption, while high-income households are willing to buy them. Alternatively, low-income households could borrow directly using T-bills as collateral; in the next period, the lending household simply sells the collateral. In the more complex real world, one important aspect of T-bill liquidity is their collateral value for very short-term loans. See Acharya and Laarits (2023), Gorton et al. (2022), Corsetti et al. (2023), and Diamond and Van Tassel (2021).

reduced form that might represent the cost of searching for acceptable projects to invest in. As the amount lent increases, the cost rises, and at an increasing rate to represent the increasing scarcity of acceptable projects for larger loans.

U.S. and ROW Households: Optimization Problem

Formally, before learning one's exact income $y_0^{a,k}$, each household in country a chooses a forward position on liquid U.S. Treasury bills $b_f^a \geq 0$, decides holdings of less-liquid U.S. Treasury bonds $\tilde{b}^a \geq 0$, and illiquid loans ℓ^a to EM, to maximize the expected utility from consumption in periods 0 and 1:

$$\max_{b_f^a \geq 0, \tilde{b}^a \geq 0, \ell^a} pU^{a,H} + (1-p)U^{a,L} + U(G_0^a, G_1^a), \text{ such that} \tag{4}$$

$$\frac{\ell^a}{R_\ell} + f(\frac{\ell^a}{R_\ell}) + \frac{\tilde{b}^a}{R_{\tilde{b}}} \leq y_0^{a,L} - T_0^a, \quad b_f^a = b^a$$

$$\text{and where } U^{a,k} = \max_{b^{a,k} \geq -b^a} \frac{(c_0^{a,k})^{1-\sigma}}{1-\sigma} + \beta^a \frac{(c_1^{a,k})^{1-\sigma}}{1-\sigma} \tag{5}$$

$$\text{and } c_0^{a,k} = y_0^{a,k} - T_0^a - \frac{\ell^a}{R_\ell} - \frac{b^a}{R_b} - \frac{\tilde{b}^a}{R_{\tilde{b}}} - \frac{b^{a,k}}{R_{b,s}} - f(\frac{\ell^a}{R_\ell}) \geq 0, \quad c_1^{a,k} = y_1^a - T_1^a + \ell^a + b^a + \tilde{b}^a + b^{a,k} \geq 0. \tag{6}$$

where $U^{a,H}$ and $U^{a,L}$ represent the utilities of households in country a with income type H and L, respectively. $U(G_0^a, G_1^a)$ is utility from public goods consumption, provided by each household's government in periods 0 and 1, and is separable from the utility from consumption for country $a = \{\text{US, ROW}\}$. Hence, it does not affect the optimal household saving choices.

After income realizations, households then choose to increase (or reduce if $b^{a,k} < 0$) their liquid Treasury holdings by $b^{a,k}$ to maximize their utility, subject to the constraint,

$$U^{a,k} = \max \frac{(c_0^{a,k})^{1-\sigma}}{1-\sigma} + \beta^a \frac{(c_1^{a,k})^{1-\sigma}}{1-\sigma}, \text{ such that} \tag{7}$$

$$b^{a,k} \geq -b^a \tag{8}$$

where $c_0^{a,k}$ and $c_1^{a,k}$ are the levels of consumption of income type k after learning their incomes in periods 0 and 1, respectively.

In sum, before learning one's exact income, each household in country a buys liquid U.S. Treasury bills forward b_f^a, and decides the holdings of less-liquid U.S. Treasury bonds $\tilde{b}^a$ and illiquid loans ℓ^a to EMs at the prices $\frac{1}{R_b}$, $\frac{1}{R_{\tilde{b}}}$, and $\frac{1}{R_\ell}$, respectively. Then, the household learns its income type k, receiving after-tax income $y_0^{a,k} - T_0^a$. The households then settle the forward positions resulting in the spot positions b^a in liquid Treasuries, such that $b^a_f = b^a$ and rebalance their liquid Treasuries by buying ($b^{a,k} > 0$) or selling additionally ($b^{a,k} < 0$) at the price $\frac{1}{R_{b,s}}$, and consumes $c_0^{a,k}$ in period 0. In period 1, each receives its after-tax income $y^a_1 - T^a_1$ and the payoffs from its lending: liquid U.S. Treasury bills $b^a + b^{a,k}$, less-liquid U.S. Treasury bonds $\tilde{b}^a$, and illiquid loans ℓ^a.

EM Households

For simplicity, we assume that EM households do not face income uncertainty in period 0, unlike U.S. and ROW households. y^{EM}_t denotes the income at time $t = 0, 1$ for EM households. The time discount factor for EM households is much lower than that of ROW and U.S. households, so that EM households borrow from ROW and U.S. households. EM households pay the transaction costs as a function of the total value of loans extended to them: $f(\frac{\ell^{EM}}{R_\ell})$. This cost is symmetric to the lender's cost for making the loan, and is meant to be a reduced-form representation of the two-sided problem of matching borrowers and lenders.

Given that both liquid and less-liquid Treasuries offer higher liquidity to savers, in equilibrium, the interest rates on these Treasuries are lower than that on illiquid loans.[45] EMs would not optimally choose to save in these lower interest-bearing Treasuries because they borrow via the most illiquid assets in equilibrium. It would be better for EM households to reduce borrowing than to borrow at high interest rates and save at low interest rates, therefore their saving in both liquid and illiquid U.S. Treasuries is zero.

EM households choose the amount of borrowing via illiquid loans ℓ^{EM} to maximize their utility from consumption in periods 0 and 1:

$$\max_{\ell^{EM}} \frac{(c_0^{EM})^{1-\sigma}}{1-\sigma} + \beta^{EM} \frac{(c_1^{EM})^{1-\sigma}}{1-\sigma}, \tag{9}$$

where c_0^{EM} and c_1^{EM} represent the consumption in periods 0 and 1, respectively. The budget constraints are given as:

$$c_0^{EM} = y_0^{EM} + \frac{\ell^{EM}}{R_\ell} - f(\frac{\ell^{EM}}{R_\ell}), \;\; c_1^{EM} = y_1^{EM} - \ell^{EM}.$$

In period 0, EM households receive endowments of y_0^{EM}, choose how much illiquid loans to take, ℓ^{EM}, at the price $\frac{1}{R_\ell}$, and the transaction costs, $f(\frac{\ell^{EM}}{R_\ell})$, and they consume c_0^{EM}. In period 1, EM households receive the endowment of y_1^{EM}, and pay back their loans ℓ^{EM}.

U.S. Government

The total amount of U.S. government debt is exogenously given as B. The share of liquid U.S. Treasuries in total U.S. Treasuries is exogenous and set as η. We vary η in our experiments to investigate the implications of the liquidity composition for lending to EMs. The U.S. government budget constraints in periods 0 and 1 are given as:

[45] We show this hierarchy in the interest rates formally in Lemma 1.

$$G_0^{\text{US}} = B(\frac{\eta}{R_b} + \frac{1-\eta}{R_{\tilde{b}}}) + m^{US}T_0^{US} \ \ and \ \ G_1^{US} = -B + m^{US}T_1^{US}.$$

U.S. government spending in period 0, G_0^{US}, is equal to the amount of borrowing in liquid and less-liquid U.S. Treasuries and the lump-sum tax collected from U.S. households, $m^{US}T_0^{US}$. We assume that G_0^{US} varies with η such that T_0^{US} is constant. This assumption allows us to abstract from effects of varying transfers and taxes on government revenues and borrowing as the liquidity composition of the U.S. government bonds changes. U.S. government spending in period 1, G_1^{US}, is equal to the lump-sum tax collected from U.S. households, $m^{US}T_1^{US}$ after paying back their government debt, B. As the total amount of U.S. government debt B is fixed as well as the lump-sum tax in period 1, T_1^{US}, U.S. government spending in period 1 is also a constant.

ROW Government

The ROW government runs a balanced budget. The budget constraints of the ROW government in periods 0 and 1 are given as:

$$G_0^{\text{ROW}} = m^{ROW}T_0^{ROW} \ \ and \ \ G_1^{ROW} = m^{ROW}T_1^{ROW},$$

where ROW government spending G_t^{ROW} in both periods is equal to the lump-sum tax collected from ROW households, $m^{ROW}T_t^{ROW}$, for $t = 0, 1$. The lump-sum tax collected from the ROW households in both periods is fixed.

Market Clearing Conditions

The market clearing conditions for liquid Treasuries, illiquid Treasuries, and illiquid loans are given as below:

$$m^{ROW}b^{ROW} + m^{US}b^{US} = \eta B,$$
$$m^{ROW}\tilde{b}^{ROW} + m^{US}\tilde{b}^{US} = (1-\eta)B, \ \text{ and}$$
$$m^{US}\ell^{US} + m^{ROW}\ell^{ROW} = m^{EM}\ell^{EM}.$$

The market clearing condition for rebalancing liquid Treasuries among households after their income realizations is given as:

$$m^{ROW}(pb^{ROW,H} + (1-p)b^{ROW,L}) + m^{US}(pb^{US,H} + (1-p)b^{US,L}) = 0.$$

4.2 Properties of the Model

In this section, we examine the mechanisms behind the equilibrium determination of interest rates and savings. Recall that households save in three vehicles: liquid Treasury bills b^a (tradable in the secondary market after income is realized), less-liquid Treasury bonds $\tilde{b}^a$, and illiquid loans to EMs

ℓ^a, at prices $\frac{1}{R_b}$, $\frac{1}{R_{\tilde{b}}}$, and $\frac{1}{R_\ell}$, respectively.

Households in country a, after they realize that their income type is k, adjust their holdings of liquid U.S. Treasuries by choosing $b^{a,k}$ (the additional amount of liquid Treasuries bought or sold in the secondary market) subject to the constraint $b^{a,k} > -b^a$ and the budget constraints 6, to maximize their utility shown in Equation 7. The first order condition (F.O.C) with respect to (w.r.t.) $b^{a,k}$ is given as:

$$-\frac{1}{R_{b,s}}(c_0^{a,k})^{-\sigma} + \beta^a(c_1^{a,k})^{-\sigma} + \mu^{a,k} = 0, \tag{10}$$

where we denote the Lagrangian multiplier on $b^{a,k} > -b^a$ as $\mu^{a,k}$.

Savers, at the beginning of period 0, before knowing their incomes, optimally choose their savings in liquid Treasuries $b^a \geq 0$, illiquid Treasuries $\tilde{b}^a \geq 0$, loans to EMs, ℓ^a, subject to the budget constraints 6 of incomes types $k = \{H, L\}$, to maximize their expected utility shown in Equation 4. The first-order conditions w.r.t b^a, w.r.t $\tilde{b}^a$, and w.r.t ℓ^a are, respectively:

$$p\big(-\frac{1}{R_b}(c_0^{a,H})^{-\sigma} + \beta^a(c_1^{a,H})^{-\sigma} + \mu^{a,H}\big) + (1-p)\big(-\frac{1}{R_b}(c_0^{a,L})^{-\sigma} + \beta^a(c_1^{a,L})^{-\sigma} + \mu^{a,L}\big) = 0, \tag{11}$$

$$p\big(-\frac{1}{R_{\tilde{b}}}(c_0^{a,H})^{-\sigma} + \beta^a(c_1^{a,H})^{-\sigma}\big) + (1-p)\big(-\frac{1}{R_{\tilde{b}}}(c_0^{a,L})^{-\sigma} + \beta^a(c_1^{a,L})^{-\sigma}\big) = 0, \text{ and} \tag{12}$$

$$-\big(\frac{1}{R_\ell} + \frac{1}{R_\ell}f'(\frac{\ell^a}{R_\ell})\big)\big(p(c_0^{a,H})^{-\sigma} + (1-p)(c_0^{a,L})^{-\sigma}\big) + p\beta^a(c_1^{a,H})^{-\sigma} + (1-p)\beta^a(c_1^{a,L})^{-\sigma} = 0. \tag{13}$$

Given this environment, we first derive a relationship between the interest rates summarized in Lemma 1. We show that the most liquid assets offer the lowest interest rates, and the interest rate on liquid Treasuries at the issuance is identical to that in the secondary market.

Lemma 1. $R_\ell \geq R_{\tilde{b}} \geq R_b = R_{b,s}$.

Proof. Using Equations 10 and 11, we can see that $R_{b,s} = R_b$. From Equations 11 and 12,

$$\big(\frac{1}{R_b} - \frac{1}{R_{\tilde{b}}}\big)\big(p(c_0^{a,H})^{-\sigma} + (1-p)(c_0^{a,L})^{-\sigma}\big) = p\mu^{a,H} + (1-p)\mu^{a,L} \geq 0$$

which implies that $R_{\tilde{b}} \geq R_b$. Using Equations 12 and 13, we find,

$$\frac{1}{R_{\tilde{b}}} = \frac{1}{R_\ell}(1 + f'(\ell^a))$$

Therefore, as long as $\ell > 0$ in equilibrium, $R_\ell > R_{\tilde{b}}$. □

Lenders get benefits other than interest rates from saving in more liquid assets, so they accept lower interest rates on more liquid assets. Lenders pay no transaction costs for both liquid Treasuries and less-liquid Treasuries, and moreover, they can sell liquid Treasuries when their income levels are realized. These perks make the most liquid assets offer the lowest interest rates.

The model assumes there are no shocks to aggregate income. Therefore, when the primary market opens, households know the equilibrium interest rate on liquid bonds traded in the secondary market. If the interest rates on the primary and the secondary market differ, each household can be better off by arbitraging between the primary and the secondary market. For instance, if the interest rate was higher in the primary market compared to that in the secondary market, a household could make a positive profit by purchasing additional liquid Treasuries in the primary market and selling them at a higher price in the secondary market. It follows that both the interest rate at the issuance and in the secondary market are the same.

We then show the amount of loans to EM is the same across lenders due to the presence of transaction costs.

Lemma 2. $\ell^{US} = \ell^{ROW}$.

Proof. Using Equations 12 and 13, we find,

$$\frac{1}{R_{\tilde{b}}} = \frac{1}{R_{\ell}}(1 + f'(\ell^a))$$

It can be trivially shown that $\ell^{US} = \ell^{ROW}$. □

This result arises because of the increasing cost of making loans. In equilibrium, the marginal cost of loans will be equal for both lenders, which then implies they will lend equal amounts.

Lastly, we show that the low income households sell all their liquid U.S. Treasuries in the secondary market when the interest rate on less-liquid Treasuries is higher than that on liquid Treasuries. The key insight is that the value of liquidity arises precisely because households can sell liquid Treasuries to smooth consumption when their income turns out to be low.

Proposition 1. *When the interest rate on less-liquid Treasuries is higher than that on liquid Treasuries, $R_{\tilde{b}} > R_b$, $b^{a,L} + b^a \geq 0$ binds while $b^{a,H} + b^a \geq 0$ does not bind. Low-income households sell all their liquid assets in equilibrium, while high-income households do not.*

Proof. When $R_{\tilde{b}} > R_b = R_{b,s}$, either $\mu^{a,H} > 0$ or $\mu^{a,L} > 0$ or both are positive. We show that $\mu^{a,H} = 0$ and $\mu^{a,L} > 0$ by showing that two other cases are not possible.

Case 1: $\mu^{a,H} > 0$ and $\mu^{a,L} = 0$.

Household budget constraints can be rearranged as $c_0^{a,H} = c_0^{a,L} + (y_0^H - y_0^L) - \frac{b^{a,H} - b^{a,L}}{R_b}$ and $c_1^{a,H} = c_1^{a,L} + (b^{a,H} - b^{a,L})$. And, $b^{a,H} = -b^a < b^{a,L}$ as the constraint only binds for high income households, and it implies that $b^{a,H} - b^{a,L} < 0$. As $y_0^H - y_0^L > 0$ and $b^{a,H} - b^{a,L} < 0$, using Equation 7, we can show that

$$\mu^{a,L} = \frac{1}{R_b}(c_0^{a,L})^{-\sigma} - \beta^a (c_1^{a,L})^{-\sigma} \qquad = 0$$

$$\mu^{a,H} = \frac{1}{R_b}\left(c_0^{a,L} + (y_0^H - y_0^L) - \frac{b^{a,H} - b^{a,L}}{R_b}\right)^{-\sigma} - \beta^a \left(c_1^{a,L} + (b^{a,H} - b^{a,L})\right)^{-\sigma} \quad < \mu^{a,L} = 0$$

Therefore, we cannot have $\mu^{a,H} > 0$.

Case 2: $\mu^{a,H} > 0$ and $\mu^{a,L} > 0$.

The constraints bind for both high and low incomes so $b^{a,H} = -b^a$ and $b^{a,L} = -b^a$. The two equalities cannot hold unless there is a zero supply of liquid Treasuries.

In sum, we conclude the constraint binds for low-income households but does not bind for high-income households. □

Proposition 1 shows that households save in *lower* interest-bearing liquid Treasuries and sell all of them when their income levels turn out to be low. The remainder of their saving is in illiquid Treasuries and loans to EMs. Lenders hold liquid assets, planning to sell them when their income is low in order to smooth consumption across states. These households do not hold more liquid U.S. Treasuries than the amount that they want to sell when their income levels turn out to be low because they could be better off by lowering their savings in liquid U.S. Treasuries and increasing their savings in less-liquid U.S. Treasuries. When income is realized, high income households buy all the liquid bonds of low income households and earn R_b. The high income households, ex-post, wish they had saved more, and are willing to purchase the liquid bonds and earn R_b.

4.3 Analytical Result: Liquidity Composition and Capital Flows to EMs

We next show analytically how capital flows to EM change as the liquidity profile of the outstanding U.S. Treasuries shifts toward more liquid assets. That is, we want to show how the total value of loans to EMs $\frac{\ell^{EM}}{R_\ell}$ changes when the share of liquid Treasuries in total U.S. government debt η varies.

In doing so, we assume that U.S. and ROW households are identical in that they share the same time discount factors and the same post-tax income profiles. That is, $\beta^{US} = \beta^{ROW}$, and $y_t^{US,k} - T_t^{US} = y_t^{ROW,k} - T_t^{ROW}$ for $t = 0, 1$. Without loss of generality, we also assume that $m^{US} + m^{ROW} = m^{EM} = 1$. For simplicity, we further assume that the cost for the U.S. and ROW households of lending to EM is zero, $f(\frac{\ell^{\text{US}}}{R_\ell}) = f(\frac{\ell^{\text{ROW}}}{R_\ell}) = 0$.

U.S. households choose $b^{US,L}$ and $b^{US,H}$, taking b^{US}, $\tilde{b^{US}}$, and ℓ^{US} as given. U.S. households choose $b^{US,k}$ to maximize their utility from consumption shown in Equation 7, given the constraints $b^{US,k} + b^{US} \geq 0$ for $k = \{H, L\}$ and the budget constraints in Equation 6. The F.O.C. w.r.t $b^{US,k}$ are:

$$-\frac{1}{R_{b,s}}(c_0^{US,H})^{-\sigma} + \beta^{US}(c_1^{US,H})^{-\sigma} = 0, \tag{14}$$

$$-\frac{1}{R_{b,s}}(c_0^{US,L})^{-\sigma} + \beta^{US}(c_1^{US,L})^{-\sigma} + \beta^{US}\mu_L^{US} = 0. \tag{15}$$

As we have shown in Proposition 1, the rebalancing constraint does not bind for the high income type: $b^{US,H} + b^{US} > 0$, i.e., $\mu_H^{US} = 0$.

In the beginning of period 0, before the income realizations, U.S. households choose their portfolios of liquid bills b^{US}, less-liquid bonds $\tilde{b}^{US}$, and illiquid loans ℓ^{US}, subject to the budget constraints in Equation 6 to maximize their expected utility shown in Equation 4, while assuming $f(\frac{\ell^{\text{US}}}{R_\ell}) = 0$. The F.O.C. w.r.t b^a, the F.O.C. w.r.t. $\tilde{b}^a$, and the F.O.C. w.r.t. ℓ^a are summarized below, respectively:

$$-\frac{1}{R_b}\left(p(c_0^{US,H})^{-\sigma} + (1-p)\,(c_0^{US,L})^{-\sigma}\right) + p\beta^{US}(c_1^{US,H})^{-\sigma} + (1-p)\,\beta^{US}\left((c_1^{US,L})^{-\sigma} + \mu_L^{US}\right) = 0 \tag{16}$$

$$p\left(-\frac{1}{R_{\tilde{b}}}(c_0^{US,H})^{-\sigma} + \beta^{US}(c_1^{US,H})^{-\sigma}\right) + (1-p)\left(-\frac{1}{R_{\tilde{b}}}(c_0^{US,L})^{-\sigma} + \beta^{US}(c_1^{US,L})^{-\sigma}\right) = 0 \tag{17}$$

$$p\left(-\frac{1}{R_\ell}(c_0^{US,H})^{-\sigma} + \beta^{US}(c_1^{US,H})^{-\sigma}\right) + (1-p)\left(-\frac{1}{R_\ell}(c_0^{US,L})^{-\sigma} + \beta^{US}(c_1^{US,L})^{-\sigma}\right) = 0 \tag{18}$$

EM households choose how much to borrow from the U.S. to maximize utility from consumption in periods 0 and 1. The F.O.C. w.r.t. ℓ^{EM} is:

$$\frac{1}{R_\ell}(c_0^{EM})^{-\sigma} - \beta^{EM}(c_1^{EM})^{-\sigma} - \frac{1}{R_\ell}f'\left(\frac{\ell^{EM}}{R_\ell}\right)(c_0^{EM})^{-\sigma} = 0. \tag{19}$$

Given that the ROW household decisions are identical to those of the U.S. households, the market clearing conditions now become:

$$b^{US} = \eta B, \tilde{b}^{US} = (1-\eta)B, \text{ and } \ell^{US} = \ell^{EM} = \ell.$$

We show that U.S. households extend more loans to EMs when the total amount of U.S. Treasuries is more tilted toward more liquid short-term Treasury Bills.

Proposition 2. *Define $x = \frac{\ell^{EM}}{R_\ell}$. Assuming $R_\ell + x\frac{dR_\ell}{dx} > 0$, U.S. households extend more loans to EMs when the liquidity composition of U.S. government debt shifts to more liquid short-term assets.*

That is, $\frac{dx}{d\eta} > 0$.

Proof. See the Appendix. □

The assumption is equivalent to $\frac{d\ell^{EM}}{dx} > 0$. That is, when the value of loans extended to EMs in period 0, x, increases, the loan repayment that lenders collect in period 1, ℓ^{EM}, increases as well. The equilibrium interest rate on loans R_ℓ does fall as x rises, but not by enough to offset the rise in x, so $\ell^{EM} = R_\ell x$ still rises.

Under this condition, holding total U.S. government debt constant, U.S. (and ROW) households increase their lending to EMs as the liquidity composition of U.S. Treasuries moves toward more liquid assets. The saver households lend more to EM households as they have more "insurance" against the possibility of having low income. They can sell their liquid Treasuries in the secondary market if facing lower income, in contrast to being locked in to illiquid assets. Therefore, lender households have a source of wealth to draw on when their incomes turn out to be low (or investment opportunities arise) since they can adjust their portfolios by selling liquid Treasuries.

Intuitively, suppose there is no additional cost of making loans to EMs, so that EM loans and illiquid Treasuries are perfect substitutes. The households allocate their portfolio between liquid and illiquid assets. Generally, investors would engage in precautionary saving because if their income turns out to be low, they can draw on their saving to supplement consumption. Liquid bonds play that role in our model. But there is another margin that investors can use to mitigate income risk. They can choose how much saving to put into illiquid assets. Since they commit an amount to illiquid saving, their income available once the income level is revealed is reduced in both states by the amount of their illiquid investment. Because utility is concave, increasing illiquid investments increases risk — investors leave less income available for consumption, which is especially bad in the low income state. So, ex-ante, they can reduce the risk of a bad outcome for consumption by choosing to put a lower amount of their portfolio holdings in illiquid assets.

Suppose the central bank provides more liquid assets. Households can, and will in equilibrium, choose to hold more liquid assets - that is, they can do more precautionary saving. The increase in the supply of liquid bonds lowers their price, so that in equilibrium the households choose to hold more. But knowing the central bank supplies more liquid assets, they can adjust on the other margin in the other direction - that is, they will marginally increase their investments in illiquid assets. In our model, the supply of illiquid investments is not fixed because households can increase loans to EMs. The higher illiquid investment raises risk, but that risk is offset by greater precautionary saving through liquid assets.

As our numerical exercises in the next section demonstrate, increasing income uncertainty reduces investments in the illiquid assets, holding the supply of liquidity constant. With higher income risk, in equilibrium households can mitigate ex-post consumption risk by tying up a smaller share of their saving in the inaccessible, illiquid assets.

5 Numerical Analysis

Our aim in this section is to perform a qualitative analysis for the general model that cannot be solved analytically: to explore the effects of increasing liquidity on interest rates, flows to emerging markets, and welfare, and to examine how the relationship between liquidity and flows to emerging markets is affected by income uncertainty. We estimate parameters for the model presented in Section 4 to match some key moments from 1980 to 2018, which pertain to the U.S. external balance and the interest rates across assets with different liquidity profiles. Section 5.2 presents the numerical results.

5.1 Calibration

One period in the model is one year. We choose parameters in the model to match moments in the data: the average ratio of the U.S. current account balance to GDP, the average U.S. saving rate, the average share of foreign investors' holdings of U.S. Treasuries, the average short-term and long-term interest rates on U.S. Treasuries, and the average interest rate on EM securities. The two-period model is not well-suited for a full quantitative dynamic analysis, but our calibrated model is useful in assessing the quantitative impact of QE/QT.

We assume that high and low after-tax income levels in period 0 ($y_0^{a,H} - T_0^a$ and $y_0^{a,L} - T_0^a$) obtained by the households of country a are $\Delta^a \times 100\%$ higher and lower, respectively, than the average period 0 after-tax income of country a, y_0^a. That is, $y_0^{a,H} - T_0^a = (y_0^a - T_0^a)(1 + \Delta^a)$, and $y_0^{a,L} - T_0^a = (y_0^a - T_0^a)(1 - \Delta^a)$, where $a = \{\text{US, ROW}\}$. We set the probability of high income to 0.5. The average incomes in period 0 for the U.S. and the ROW households then are normalized to one, i.e., $y_0^a - T_0^a = 1$. The period 1 after-tax income for households in the U.S. and the ROW is also set to one, assuming zero growth rates of incomes. EM households have a constant income across two periods, normalized to one. Assuming the same average incomes for both periods and across households, time discount factors govern how much each household wants to lend or borrow.[46] The functional form of the transaction cost of extending illiquid loans is $f(x) = \alpha \frac{x^\nu}{\nu}$, where α and ν are set to one and two, respectively. We compute the ratio of U.S. T-bills held by public to the total marketable U.S. public debt, both of which are collected from the U.S. Treasury Monthly Statement of the Public Debt (MSPD). η is set to 0.2, the value of this ratio in 2001–2018.[47]

[46] We could assume positive growth rates of incomes for all countries with a higher growth rate for EM. In the two period model, the difference in the size of the annual growth rates of GDP is not enough to generate the quantitatively sizable motive to borrow and lend from each other. Therefore, we assume zero growth rates of incomes over one period for all countries but calibrate time discount factors to match the key moments. The alternative specification, imposing the same discount factor for EM households as that of U.S. households while assuming a positive growth rate of endowments for EM households, produces qualitatively the same results, and the results are available upon request.

[47] When we add reserves held by depository institutions at the Federal Reserve to both the numerator and the denominator, η increases modestly by a few percentage points. For consistency with other moments in the data, we calibrate η using the share of short-term debt in total marketable U.S. Treasuries held by the public. The calibrated parameters change only slightly with a higher value of η, and our numerical results in Section 5 are unaffected quantitatively.

The rest of the parameter values are estimated by the simulated methods of moments. We target six moments. The first two moments are the average short-term and long-term interest rates of U.S. Treasuries, computed with monthly observations of 3-month and 10-year Treasury annual yields, respectively, in 1981–2018 and 1980–2018. The third moment is the average interest rate on EM securities, measured by the average of monthly ICE BofA emerging markets corporate plus index effective yields from December 1998–2018. The interest rate data are all from the FRED database. The fourth and the fifth moments are the average quarterly U.S. current account balance as a ratio of the U.S. quarterly GDP and the average monthly U.S. household saving rate from 1980 to 2018; both series are collected from the FRED database. Lastly, we compute the average share of foreign holdings of U.S. Treasuries in the total marketable U.S. Treasuries from December 2011–2018. The data are fetched from the U.S. MSPD. In sum, the six targeted moments are: (i) the mean interest rate on the U.S. short-term Treasuries (4%), (ii) the mean interest rate on the U.S. long-term Treasuries (6%), (iii) the mean interest rate on EM securities (10%), (iv) U.S. Current Account/GDP (-3%), (v) U.S. household saving rate (7%), and (vi) share of foreign holdings of the U.S. Treasuries (46%). We estimate time discount factors for three countries, the total supply of U.S. Treasuries B, and income fluctuations of lender households, $\Delta(= \Delta^{US} = \Delta^{ROW})$, and the constant relative risk aversion parameter σ to match moments (i)–(vi).

Although six parameters are jointly determined to match six moments, we can still offer a heuristic description of how each parameter is mostly inferred from an empirical moment. The time discount factor of EM households governs how much they want to front-load their consumption and hence the amount of borrowing and its interest rate, i.e., the interest rate on EM securities. The relative size of the discount factors of the U.S. and the ROW households to that of the EM households helps us to match the U.S. current account. The relative size of the time discount factor of the ROW to the U.S. captures how much they want to save for the next period, disciplining the share of foreign holdings of U.S. Treasuries. The total supply of Treasuries governs both the short-term and long-term interest rates of Treasuries while the size of income fluctuations affects saver households' desire to hold more liquid U.S. Treasuries, pinning down the difference in the short-term and long-term interest rates on U.S. Treasuries. The relative risk aversion of households regulates the saving rate.

We summarize the parameter values in Table 3, and the targeted moments in Table 4.

5.2 Numerical Results

With these parameters, we numerically solve the model summarized in Section 4.1. In particular, we are interested in how the equilibrium interest rates, loans to EMs and the welfare of households in each country vary with the share of liquid bonds in the U.S. Treasuries. Figures 9–12 depict the equilibrium outcomes against η, where an η fraction of total amount of U.S. Treasuries is liquid.

Table 3: Parameter Values

Parameters	Values	Descriptions
Normalized/Arbitrarily Chosen/Computed from Data		
$y_t^a - T_t^a$	1	Average Incomes in Periods 0 and 1
p	0.5	Probability of high-income households
ν	2	Transaction Costs of Illiquid Loans: $f(x) = \alpha \frac{x^\nu}{\nu}$
α	1	Transaction Costs of Illiquid Loans: $f(x) = \alpha \frac{x^\nu}{\nu}$
η	0.2	Share of U.S. T-bills in Marketable Treasuries
Estimated Parameters from Moment Matching		
β^{US}	1.0000	Time discount factor of U.S.
β^{ROW}	0.9971	Time discount factor of ROW
B	0.1054	Supply of U.S. Treasury bonds
β^{EM}	0.8451	Time discount factor of EM
Δ^{US}=$\Delta^{ROW} = \Delta$	0.0801	Income fluctuation of lenders
σ	0.4699	Relative risk aversion

Notes: The upper panel summarizes the parameters normalized or arbitrarily chosen. The lower panel summarizes the calibrated parameters by the simulated methods of moments.

Table 4: Targeted Moments

	Sample Period	Data Moments	Model Moments
Interest rate on U.S. short-term Treasuries	1981–2018	4%	4%
Interest rate on U.S. long-term Treasuries	1980–2018	6%	7%
Interest rate on EM securities	1998m12–2018	10%	9%
U.S. Current Account/GDP	1980–2018	-3%	-3%
U.S. household saving rate	1980–2018	7%	7%
Share of foreign holdings of U.S. Treasuries	2011m12–2018	46%	48%

Notes: We compute the historical average of variables of our interest from 1980 to 2018 if the data are available. The average short-term and long-term interest rates on U.S. Treasury are computed with 3-month and 10-year Treasury annual yields, respectively. The average of ICE BofA Emerging markets corporate plus index effective yields is used to compute the average interest rate on EM bonds. The share of foreign holdings of U.S. Treasuries is computed as foreign holdings of U.S. Treasuries over the total U.S. marketable Treasuries, where both data are from the U.S. Treasury Monthly Statement of the Public Debt (MSPD). All other data are from the St. Louis Fed's FRED database. The averages of monthly observations are reported for all variables except U.S. current account/GDP. For the average U.S. current account/GDP, we compute the mean of quarterly observations.

In Figure 9, as η increases, the supply of U.S. liquid Treasuries goes up, while that of U.S. illiquid Treasuries goes down. The increase in the liquidity composition of U.S. Treasuries increases the interest rate on liquid U.S. government bonds, while lowering that on illiquid U.S. government bonds. As the volume of liquidity increases, the liquidity yield declines, narrowing the gap between the yield on liquid U.S. government bonds and that on loans to emerging markets, consistent with what we have seen in Section 3.2, where the CIP deviations of U.S. short-term Treasuries fall after QE announcements.

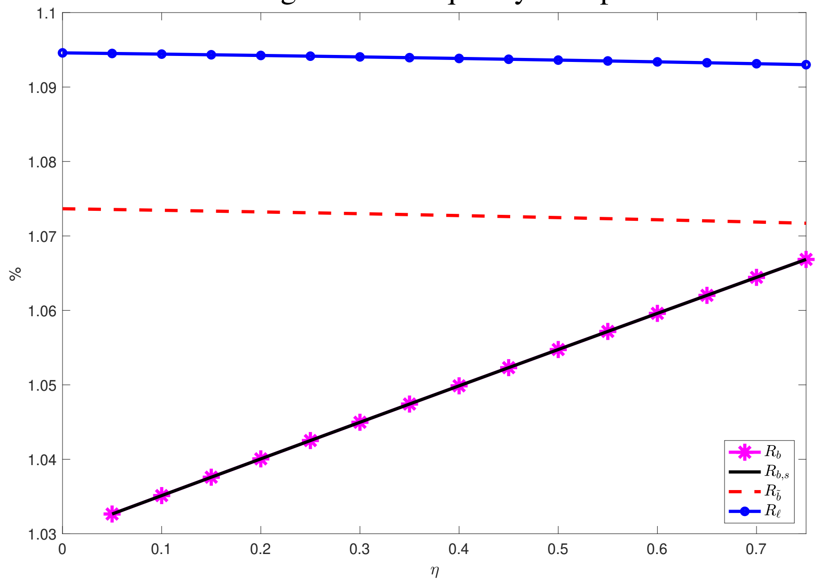
Since liquid bonds offer flexibility if the investor has lower income (or greater investment opportunities), U.S. and ROW households are willing to save more and lend more to EMs, shown in Figure 10. The interest rate on these loans falls as their demand increases, shown in Figure 9. Consequently, EM households benefit more as the liquidity composition of U.S. Treasuries shifts to more liquid assets, and therefore, their welfare increases with higher η, depicted in Figure 11.

Figure 11 also shows the ex-ante welfare in the U.S. and ROW as η increases. U.S. and ROW households have slightly lower welfare at low values of η. They also experience a much more subdued increase in welfare compared to EM households, even when η reaches a large value. This welfare result comes from the offsetting effects of an increase in the liquidity share on low-income and high-income households. Figure 12 shows that as the share of liquid U.S. Treasuries increases, low-income households in the U.S. and ROW benefit from higher liquidity in the market, insuring them against over-saving; however, high-income households become worse off. High-income households now face lower returns from their savings not only because the composition of Treasuries shifts to more liquid and hence lower interest-bearing assets, but because the interest rates on both less-liquid Treasuries and loans to EMs also fall slightly with a higher supply of liquid assets. These changes lead to a reduction in high-income households' average welfare initially. Nonetheless, when the share of liquid bonds is high enough, the interest gap between liquid Treasuries and less-liquid Treasuries narrows. Moreover, the positive effect from a higher value of loans to EMs, which yield the highest returns to households, outweighs the negative effects on the welfare of high income households.

We then explore how the total value of loans extended to EM changes with the liquidity composition of the U.S. Treasuries, while varying one parameter at a time from its baseline value. Specifically, we experiment with different parameter values of the transaction cost of extending illiquid loans α, the probability of high income p, and the income fluctuations of lender households Δ, that are 25% lower or higher than the baseline values, as shown in Figures A17 and A18 in the Appendix, and Figure 13, respectively. In all these figures, we see a positive relationship between the value of loans extended to EM and the share of liquid bonds in the U.S. Treasuries for the range of parameter values that we have explored. The numerical result is consistent with what we have shown analytically in Proposition 2.

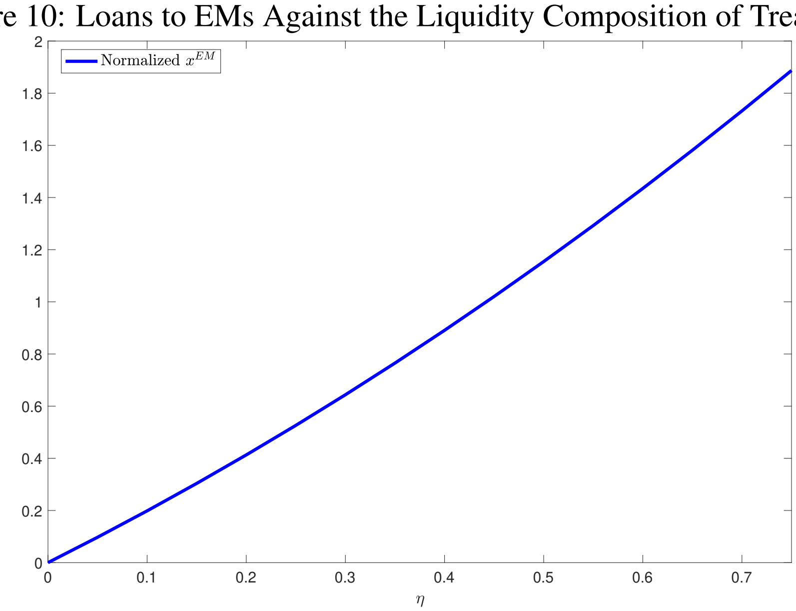
In Figure A17 in the Appendix, the value of illiquid loans to EMs is higher for every η when the

Figure 9: Interest Rates Against the Liquidity Composition of Treasuries



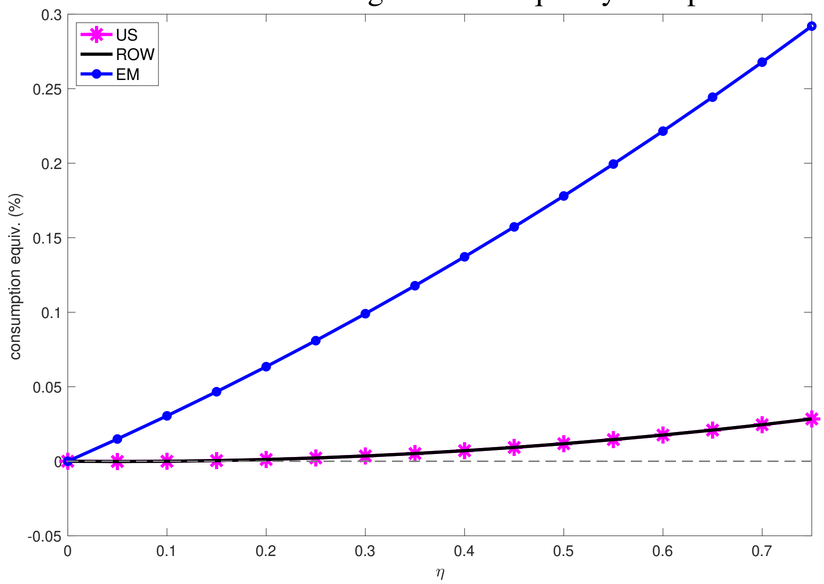
Notes: R_b, $R_{b,s}$, $R_{\tilde{b}}$, and R_ℓ represent the interest rate on liquid U.S. government bonds (pink starred line), their secondary market rate (black solid line), the interest rate on illiquid U.S. government bonds (red dashed line) and the interest rate on EM loans (blue dotted line). η is the share of liquid bonds in the U.S. government bonds.

Figure 10: Loans to EMs Against the Liquidity Composition of Treasuries



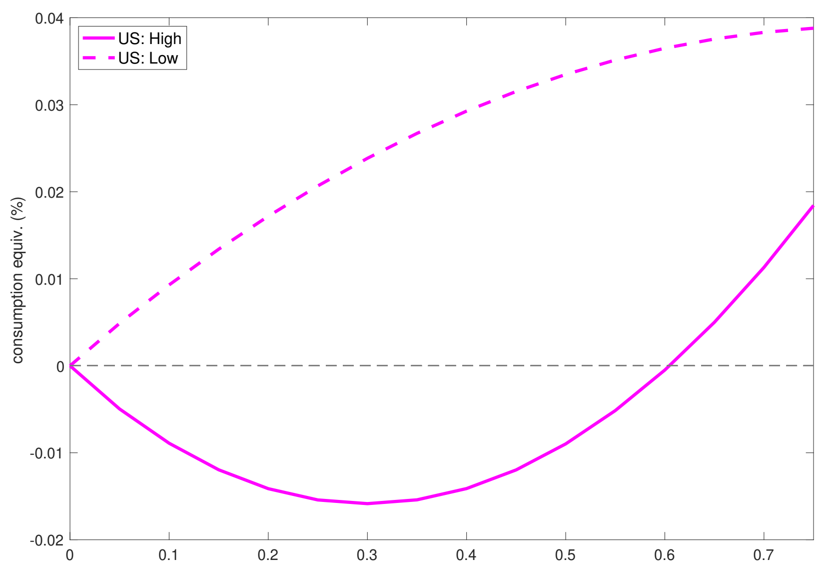
Notes: x^{EM} is the total value of loans to EM households: $\frac{\ell^{EM}}{R_\ell}$. Values are normalized as percentage changes relative to $\eta = 0$. η is the share of liquid bonds in the U.S. government bonds.

Figure 11: Welfare Across Countries Against the Liquidity Composition of Treasuries



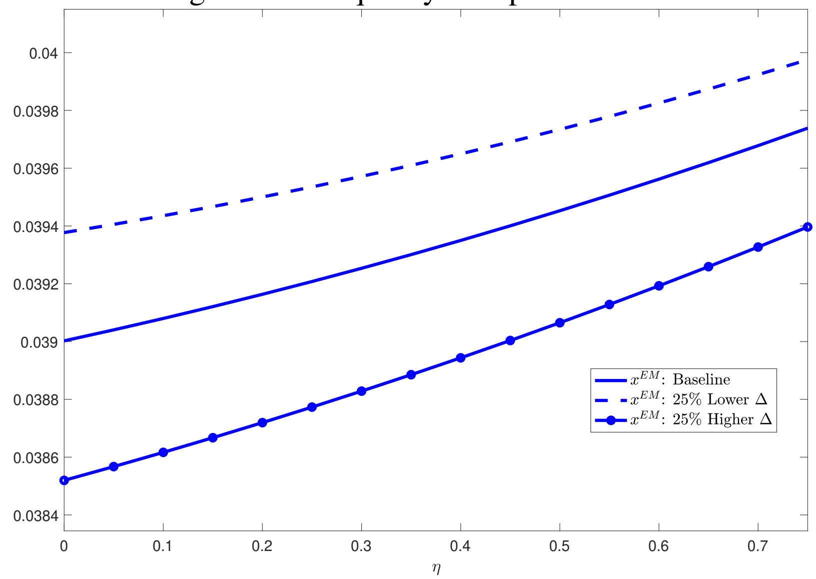
Notes: Welfare gain/loss is computed as a consumption equivalent (%). η is the share of liquid bonds in the U.S. government bonds. The welfare of the U.S. and the ROW households does not include the utility from the government spending.

Figure 12: Welfare of High vs. Low Income U.S. Households Against the Liquidity Composition of Treasuries



Notes: Welfare gain/loss is computed as a consumption equivalent (%). η is the share of liquid bonds in the U.S. government bonds. The welfare of the U.S. households does not include the utility from the government spending. The solid line is the U.S. high income households' welfare against η, and the dashed line is the U.S. low income households' welfare against η.

Figure 13: Loans to EMs Against the Liquidity Composition of Treasuries for Different Δ



Notes: x^{EM} is the total value of loans extended to EM households: $\frac{\ell^{EM}}{R_\ell}$. η is the share of liquid bonds in the U.S. government bonds. Δ governs the size of income fluctuations in period 0 for the U.S. and the ROW households. The total value of loans extended to EM households is plotted against η (i) with our baseline parameter values in a solid line, (ii) with 25% lower Δ in a dashed line, and (iii) with 25% higher Δ in a dotted line.

transaction cost of extending illiquid loans α is lower. With lower transaction costs that households need to pay when lending/borrowing via illiquid loans, they lend and borrow more from each other. The value of illiquid loans is larger for every η when the probability of high income p is higher, shown in Figure A18 in the Appendix. It is a consequence of having a higher average income in period 0 for the U.S. and the ROW households as the probability of having a high income is higher. As lender households have more average endowments in period 0, they lend more to the emerging markets.

Lastly, in Figure 13, saver households lend less when their income fluctuations are higher for a given level of η. When lender households face greater income uncertainty, they are less willing to lend to EMs for a given level of liquid Treasuries supplied, as they seek to smooth consumption against larger potential income shortfalls. However, an increase in loans extended to EMs, as η increases, is *larger* when the income dispersion in period 0 for lender households, Δ, is *higher*. Additional liquid Treasuries are most valuable to lender households when their income may fall significantly below the average. Therefore, while higher income uncertainty reduces the overall level of lending to EMs, it amplifies the effect of additional liquidity provision.

6 Conclusion

This paper identifies the liquidity channel through which Federal Reserve quantitative easing and quantitative tightening affect capital flows to emerging markets. Using weekly data on the Fed's purchases and sales of long-term U.S. Treasury securities, we find that large purchases lead to increased capital flows to emerging markets, while sales have the reverse effect. We then show further that QE lowers, and QT raises, covered interest parity deviations, and these induced changes in the convenience yield drive the capital flow responses. Our study thus highlights the liquidity channel through which U.S. monetary policy spills over to emerging economies.

We then offer a possible explanation for why changing the composition of these liabilities leads to greater lending to emerging markets. Quantitative easing shifts the composition of publicly held government debt toward more liquid assets, providing investors a greater buffer against the risk of low consumption. Better insured through liquid asset holdings, investors are willing to increase illiquid investments, including lending to emerging markets. Our numerical results further show that this channel is amplified during times of greater income uncertainty, as additional liquidity is most valuable precisely when investors face larger potential income shortfalls.

Emerging market policymakers, in turn, have an interest not only in the restrictiveness of U.S. monetary policy, but also in the policy toward liquidity provision. This perspective introduces another dimension to the observation of Rey (2016) concerning the supremacy of U.S. monetary policy decisions in the international transmission mechanism.

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Appendix

Additional Tables and Figures for Sections 2 and 3

List of Variables

Table A1: List of Control Variables

	Data Sources	Frequency
Global Variables		
Weekly Change in the Log of VIX	FRED Database	Weekly
10-year Treasury Bond Yield	FRED Database	Weekly
S&P 500 Index Weekly Returns	Yahoo Finance	Weekly
Country-Level Variables		
Changes in the Log of Exchange Rate (week-over-week)	BIS	Weekly
Interest Rates (Money Market Rates, Policy Rates)	IMF IFS	Monthly
Changes in the Log of Industrial Production Index (month-over-month)	IMF IFS	Monthly
CPI inflation (year-over-year)	IMF IFS	Monthly

Notes: When data are available only at the monthly frequency, each weekly observation in the regressions is assigned the corresponding monthly value. For countries where money market rates are unavailable, policy rates are used instead. Industrial production data are seasonally adjusted indices for all countries except Malaysia and China. For the Philippines and Peru, seasonally adjusted industrial production indices for the manufacturing sector are used due to data availability. Industrial production data are unavailable for Thailand, and interest rate data are unavailable for Hungary.

QE and QT Announcement Dates

Table A2 summarizes the QE and QT announcement dates that we employ.

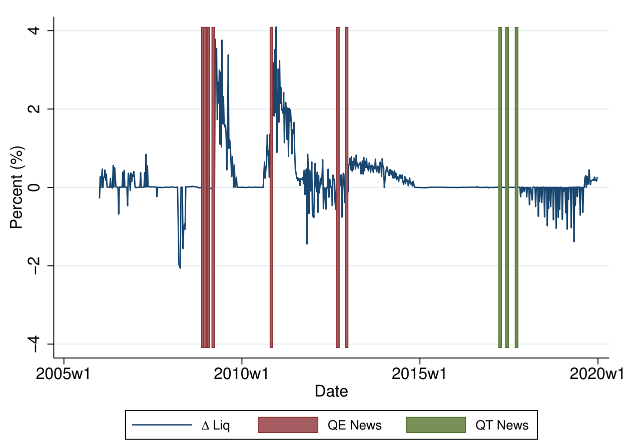
Table A2: QE and QT Announcement Dates

Date	Program	Source
25/11/2008	QE1	
16/12/2008	QE1	
28/01/2009	QE1	
18/03/2009	QE1	
03/11/2010	QE2	Fratzscher et al. (2018)
21/09/2011	MEP	
20/06/2012	MEP	
13/09/2012	QE3	
12/12/2012	QE3	
05/04/2017	QT1	
14/06/2017	QT1	Du et al. (2024)
20/09/2017	QT1	

Notes: For QE dates, we use the FOMC announcement dates from Table 1A in Fratzscher et al. (2018). The dates of QE announcements about a slowdown, contraction, and end of asset purchases are dropped. Only the dates of announcements conveying a strong signal of asset purchases and their expansion are included. In the baseline specification, we exclude Maturity Extension Program announcements because they generate little to no observable change in the Fed's holdings of Treasuries with maturities exceeding one year, which is our measure of liquidity provision. For QT, we employ the announcement dates from Du et al. (2024). The dates of main announcements and news are collected. The dates are in the form of DD/MM/YYYY.

Liquidity Measure, Unstandardized ΔLiq_t

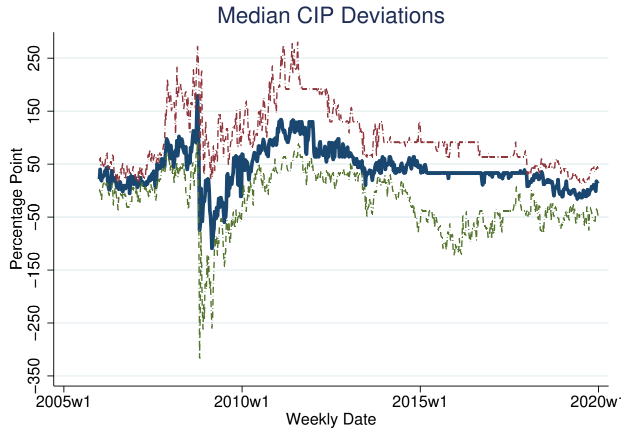
Figure A1: Weekly Change in the Fed's Holding of Long-term Treasuries



Note: The figure shows the log change in the Fed's holdings of long-term U.S. Treasuries, ΔLiq_t.

CIP Deviations, $\Phi_{i,t}$.

Figure A2: Median CIP Deviation



Notes: We quantify the convenience yield of the U.S. Treasuries and foreign government bonds by measuring the one-year CIP deviations, adjusted by the default risk using credit default swap (CDS) data, $\Phi_{i,t}$:

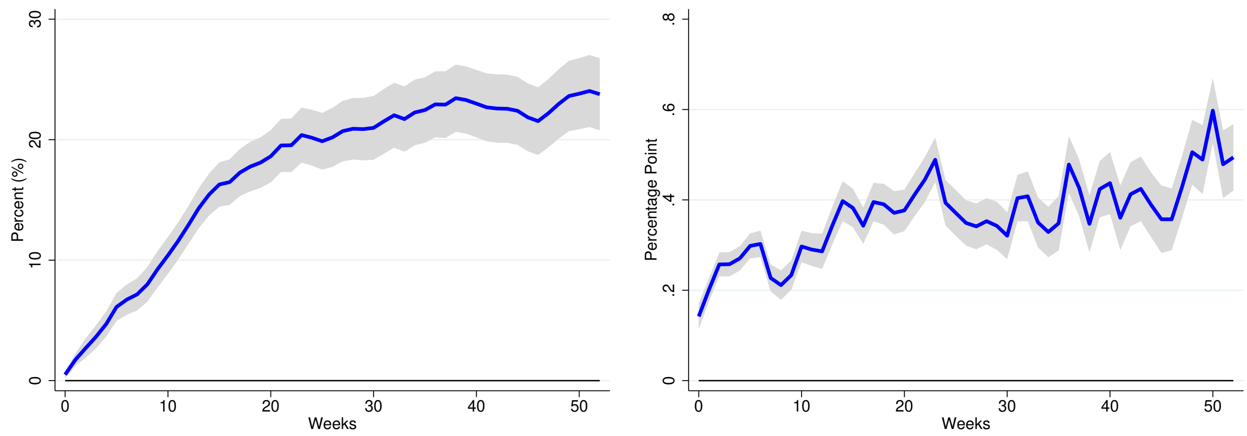
$$\Phi_{i,t} = (y^{Govt}_{i,t} - CDS_{i,t} - \rho_{i,t}) - (y^{Govt}_{US,t} - CDS_{US,t}),$$

where $y^{Govt}_{i,t}$ is the one-year local currency government bond yield in country i, $\rho_{i,t}$ is the one-year market-implied forward premium for hedging currency i against the U.S. dollar, and $y^{Govt}_{USD,t}$ is the one-year U.S. Treasury bond yield on weekly date t. To account for the probability of government default, we adjust the CIP deviations by subtracting the difference between the emerging market country's one-year CDS premium and that of the U.S. We plot its median value across emerging market economies in blue and the 25th and 75th percentiles in red and green dashed lines.

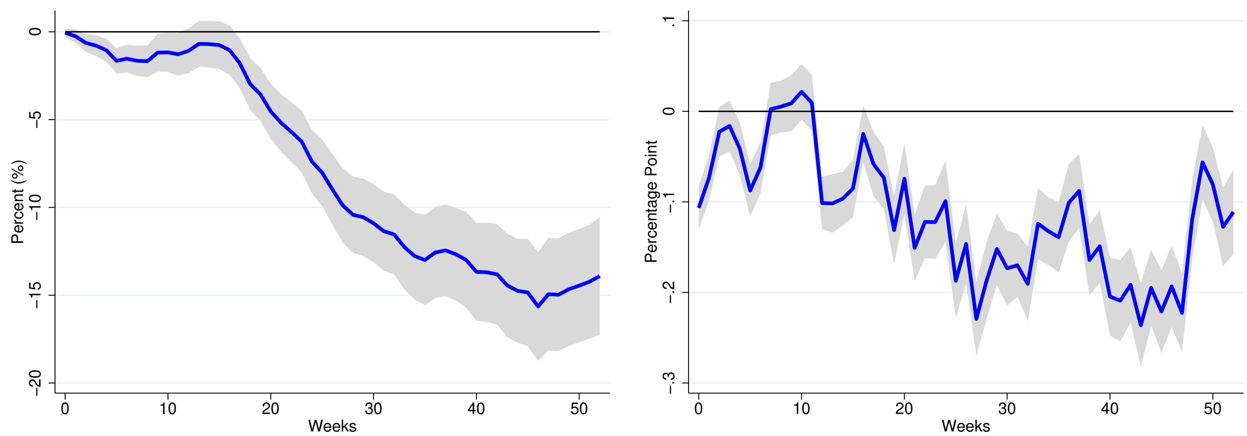
Robustness Checks: Section 2

Figure A3: Effect of Large Increases and Decreases in Fed's Holding of Long-term U.S. Treasuries on Capital Flows

After Large Increases In the Fed's Holding of Long-term U.S. Treasuries

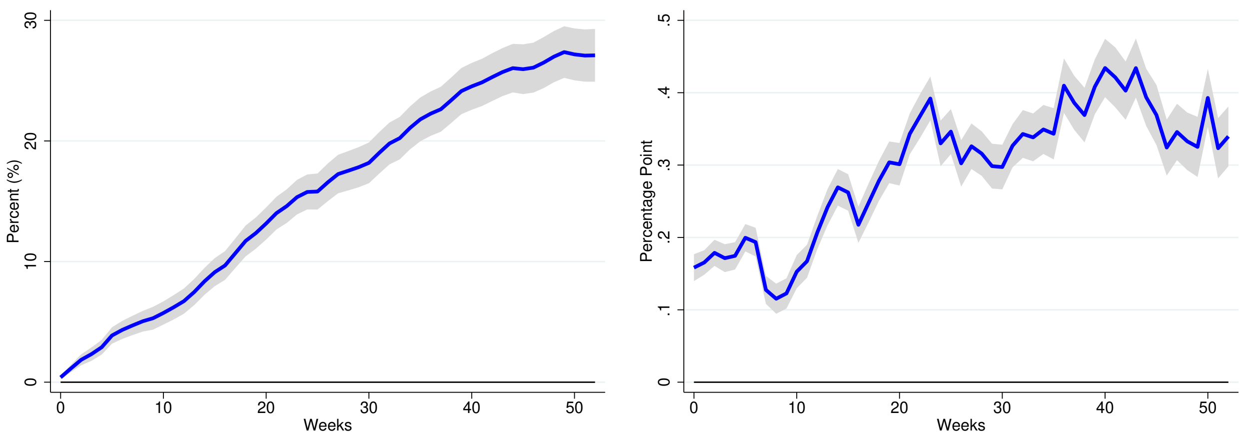


After Large Decreases In the Fed's Holding of Long-term U.S. Treasuries



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The upper panel shows the response of capital flows to bond funds over 52 weeks following a large Fed *purchase* of long-term U.S. Treasury securities. The lower panel shows the response of capital flows to bond funds over 52 weeks following a large Fed *sale* of long-term U.S. Treasury securities. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

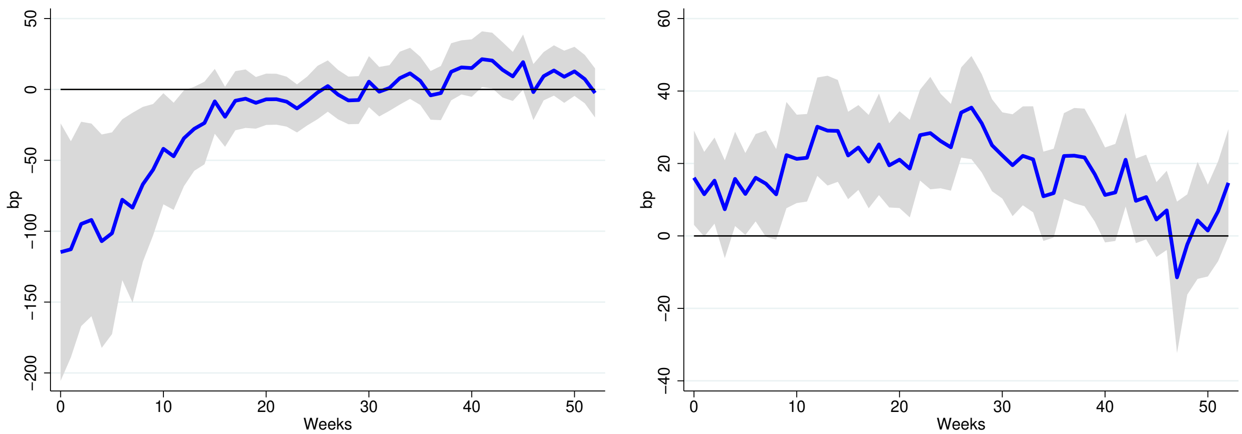
Figure A4: Dynamics of Capital Flows: Alternative Measure When Flagging Events



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The left panel shows the response of bond funds allocations over 52 weeks after a large increase in the Fed's holding of U.S. Treasury securities across all maturities. The right panel shows the corresponding response of bond funds flows over 52 weeks. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

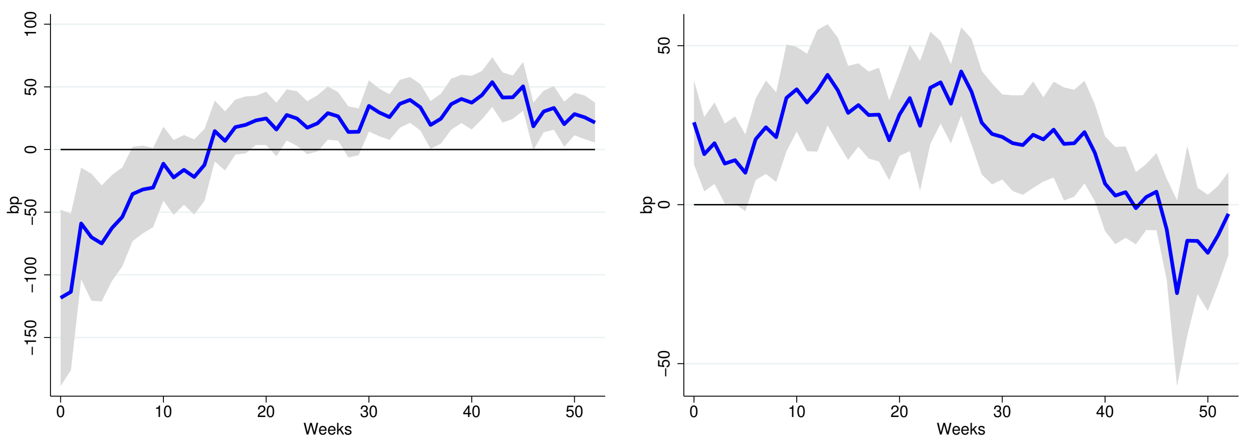
Robustness Checks: Section 3

Figure A5: Effect of QE and QT Announcements on 3-month CIP Deviations



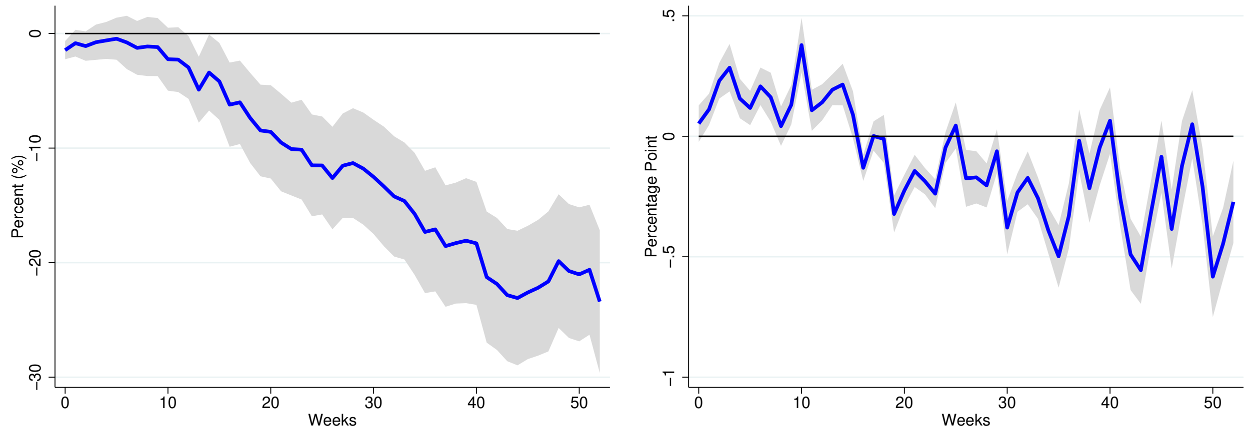
Notes: The dependent variable is the 3-month CIP deviation $\Phi_{i,t}^{3m} = (y_{i,t}^{3m,Govt} - \rho_{i,t}^{3m}) - y_{US,t}^{Govt}$,where $y_{i,t}^{3m,Govt}$is the three-month local currency government bond yield in country i, and $\rho_{i,t}^{3m}$ is the 3-month market-implied forward premium for hedging currency i against the U.S. dollar on weekly date t. The data are from Du and Schreger (2016) and Du et al. (2018). The shaded area represents the 90% confidence interval computed using heteroskedasticity-robust standard errors.

Figure A6: Effect of QE and QT Announcements on the Interbank Rate Based CIP Deviations



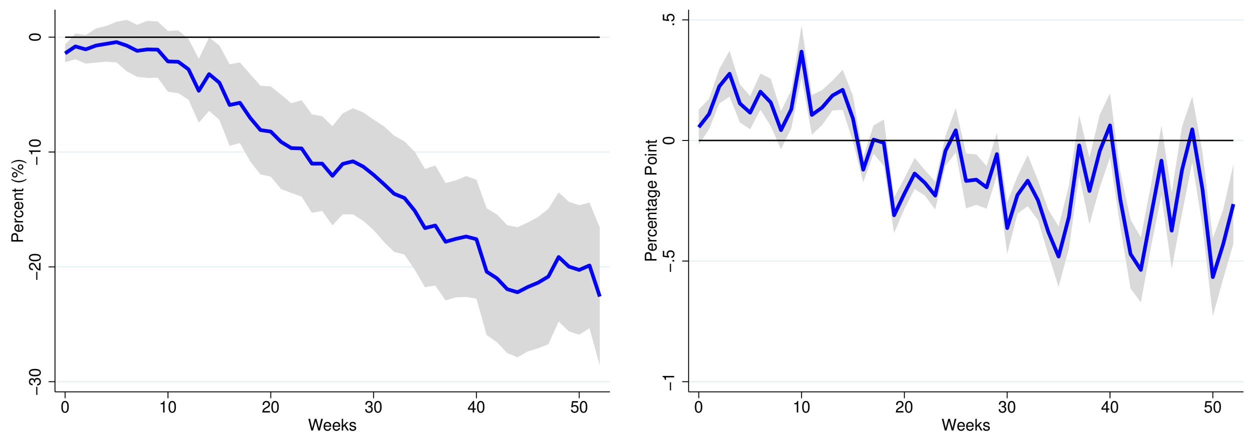
Notes: The dependent variable is the 3-month interbank rate based CIP deviation $\Phi_{i,t} = (y_{i,t}^{3m,ibor} - \rho_{i,t}^{3m}) - y_{US,t}^{ibor}$,where $y_{i,t}^{3m,ibor}$is the three-month interbank interest rate in country i, and $\rho_{i,t}^{3m}$ is the 3-month market-implied forward premium for hedging currency i against the U.S. dollar on weekly date t. The shaded area represents the 90% confidence interval computed using heteroskedasticity-robust standard errors.

Figure A7: Effect of CIP Deviations on Capital Flows: 3-month CIP deviations



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The dynamic effects of the 3-month CIP deviations induced by QE and QT announcements on capital flows to emerging markets are shown in both figures. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

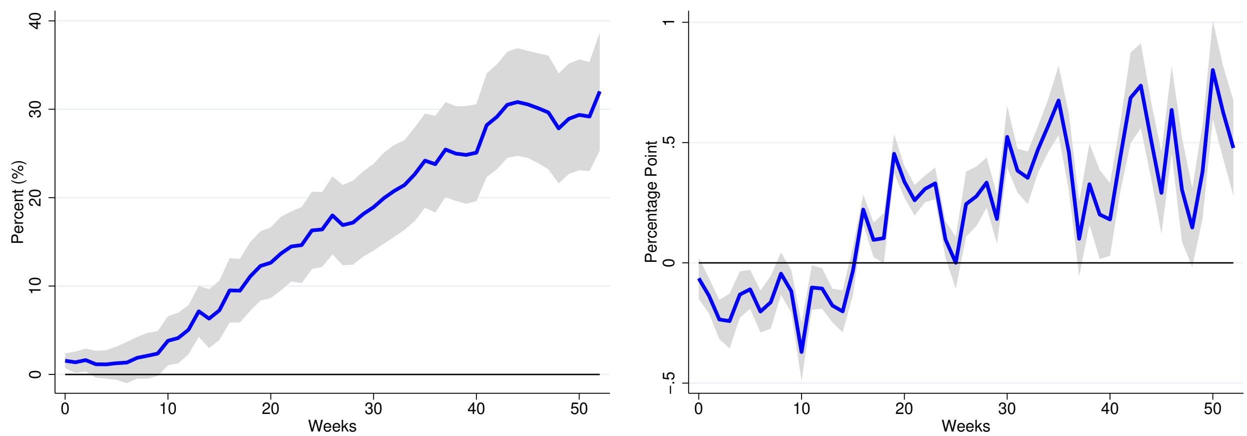
Figure A8: Effect of CIP Deviations on Capital Flows: 3-month interbank rate based CIP deviations



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The dynamic effects of the 3-month interbank rate based CIP deviations induced by QE and QT announcements on capital flows to emerging markets are shown in both figures. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

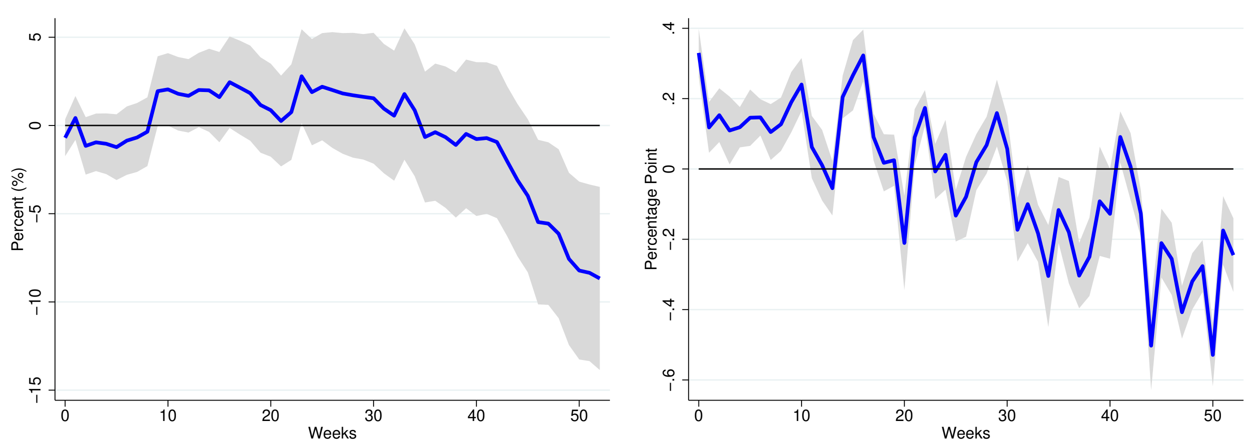
QE and QT Announcement Effect on Capital Flows

Figure A9: Effect of QE Announcements on Capital Flows



Notes: We estimate the following weekly panel local linear projections:$y_{i,t+k} = \alpha_{i,k} + \beta_k QE_t^{News} + \gamma_k QT_t^{News} + u_{i,k,t}$, where the dependent variables $y_{i,t+k}$ are (i) $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ and (ii) $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$. The dummy variables QE_t^{News} and QT_t^{News} are equal to one when, on weekly date *t*, there was a QE or QT announcement, respectively, and zero otherwise. The sample period is 2006–2018. We include country fixed effects. The response shows how the bond funds allocations (on the left) and weekly bond fund flows (on the right) have changed over 52 weeks after the QE announcements. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

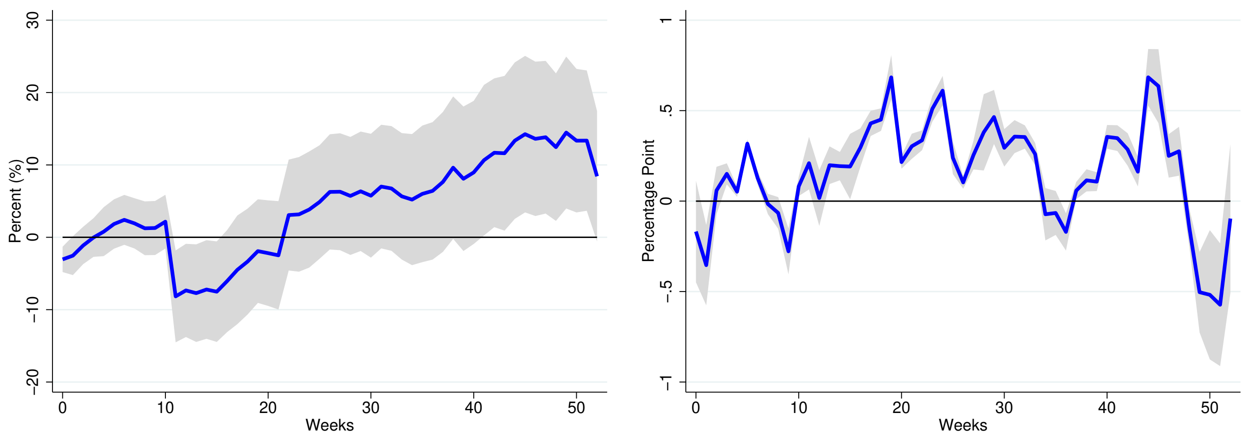
Figure A10: Effect of QT Announcements on Capital Flows



Notes: We estimate the following weekly panel local linear projections:$y_{i,t+k} = \alpha_{i,k} + \beta_k QE_t^{News} + \gamma_k QT_t^{News} + u_{i,k,t}$, where the dependent variables $y_{i,t+k}$ are (i) $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ and (ii) $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$. The dummy variables QE_t^{News} and QT_t^{News} are equal to one when, on weekly date *t*, there was a QE or QT announcement, respectively, and zero otherwise. The sample period is 2006–2018. We include country fixed effects. The response shows how the bond funds allocations (on the left) and weekly bond fund flows (on the right) have changed over 52 weeks after the QT announcements. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

Shown in Figures A9 and A10, we could see a positive effect on capital flows, around 10 weeks after QE announcement, and the negative effect on capital inflows to EMs surfaces around 40 weeks after QT announcements. We observe similar effects to those documented in Figure 2, though considerably more delayed, following news about QE and QT compared with the effects of actual long-term Treasury bond purchases and sales.[48]

Figure A11: Effect of MEP Announcements on Capital Flows



Notes: We estimate the following weekly panel local linear projections: $y_{i,t+k} = \alpha_{i,k} + \beta_k QE_t^{News} + \gamma_k QT_t^{News} + \theta_k MEP^{News} + u_{i,k,t}$, where the dependent variables $y_{i,t+k}$ are (i) $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ and (ii) $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$. The response shows how the bond funds allocations (on the left) and weekly bond fund flows (on the right) have changed over 52 weeks after the MEP announcements. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

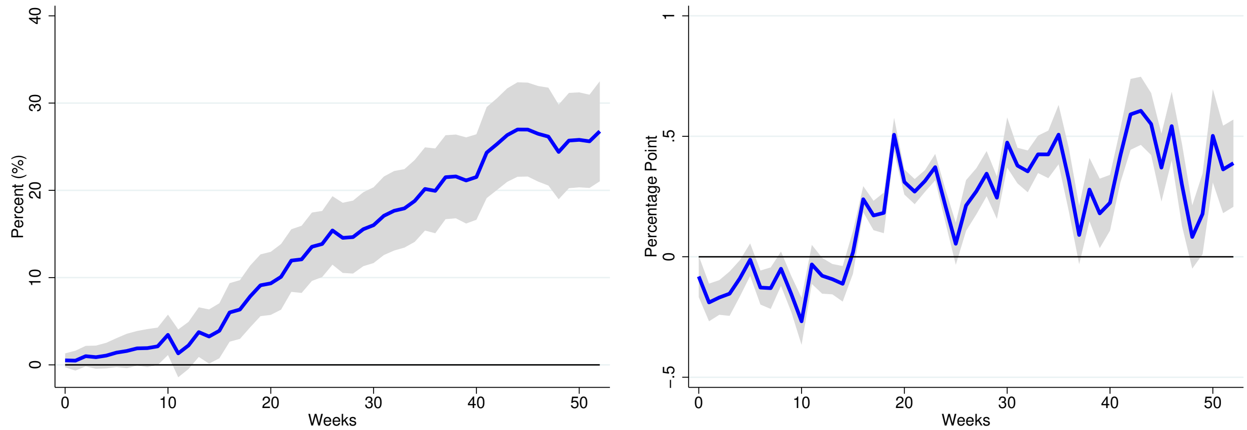
Figure A11 shows the estimated effects of MEP announcements on capital flows to emerging markets. The maturity extension program (MEP) swaps very long-term bonds (3–30 years) for shorter-term ones (1–3 years). The MEP therefore alters the liquidity composition of U.S. government liabilities, but to a lesser degree than QE, which replaces long-term bonds with reserves.

We find that MEP announcements have a positive effect on capital inflows to EMs, but the estimated effects are smaller in magnitude and noisier compared to those of QE announcements shown in Figure A9 .

[48]When we include the CDS differential as a control, the effects of QE and QT announcements appear in an even more delayed fashion.

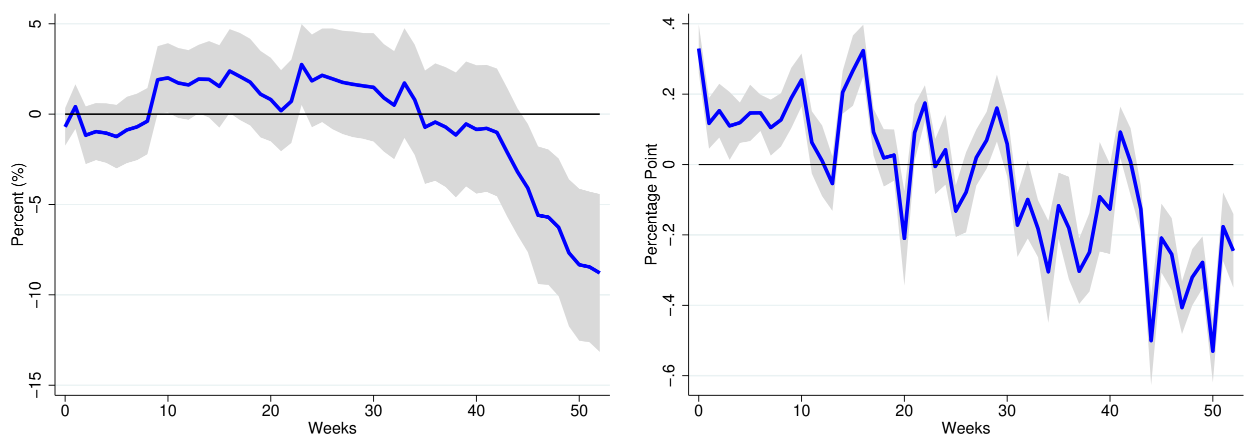
Robustness Checks: QE Announcements Including MEP Announcements

Figure A12: Effect of QE Announcements on Capital Flows, Including MEP



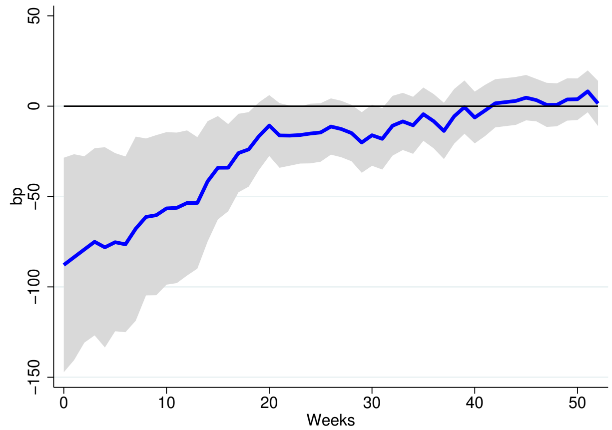
Notes: We estimate the following weekly panel local linear projections:$y_{i,t+k} = \alpha_{i,k} + \beta_k QE_t^{News} + \gamma_k QT_t^{News} + u_{i,k,t}$, where the dependent variables $y_{i,t+k}$ are (i) $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ and (ii) $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$. The dummy variables QE_t^{News} and QT_t^{News} are equal to one when, on weekly date *t*, there was a QE or QT announcement, respectively, and zero otherwise. MEP announcements are now included in QE announcements. The sample period is 2006–2018. We include country fixed effects. The response shows how the bond funds allocations (on the left) and weekly bond fund flows (on the right) have changed over 52 weeks after the QE announcements. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

Figure A13: Effect of QT Announcements on Capital Flows, Including MEP



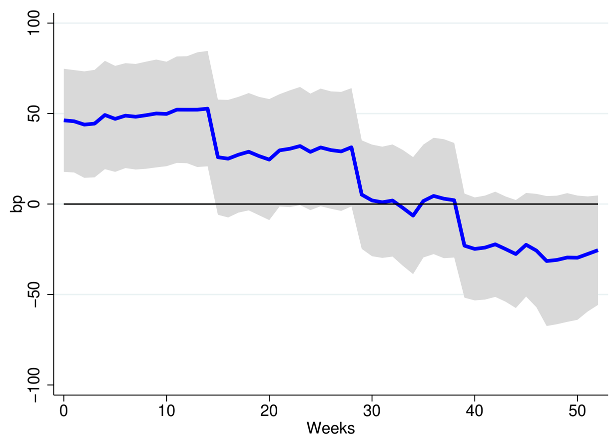
Notes: We estimate the following weekly panel local linear projections:$y_{i,t+k} = \alpha_{i,k} + \beta_k QE_t^{News} + \gamma_k QT_t^{News} + u_{i,k,t}$, where the dependent variables $y_{i,t+k}$ are (i) $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ and (ii) $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$. The dummy variables QE_t^{News} andQT_t^{News} are equal to one when, on weekly date *t*, there was a QE or QT announcement, respectively, and zero otherwise. MEP announcements are now included in QE announcements. The sample period is 2006–2018. We include country fixed effects. The response shows how the bond funds allocations (on the left) and weekly bond fund flows (on the right) have changed over 52 weeks after the QT announcements. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

Figure A14: Effect of QE Announcements on CIP Deviations, Including MEP



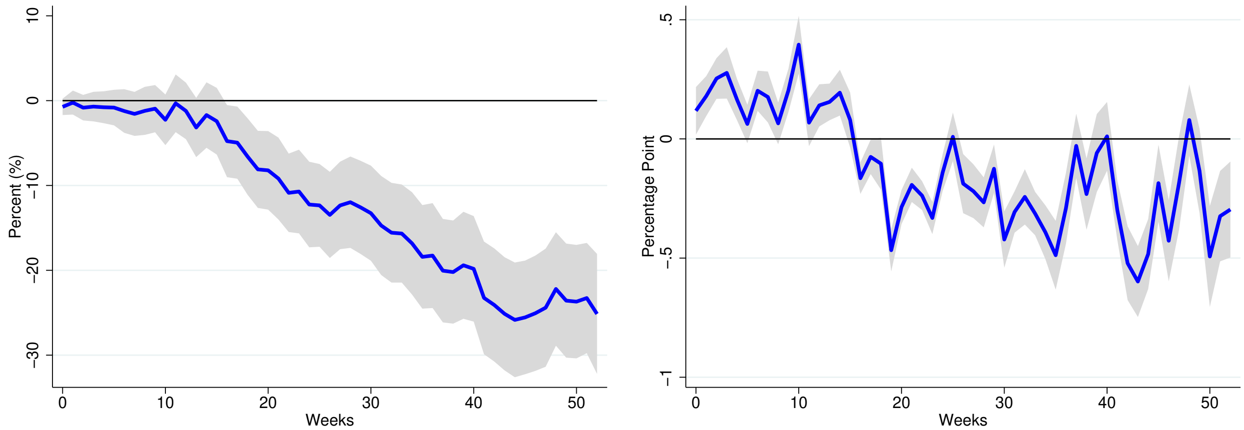
Notes: The dependent variable is the one-year CIP deviation adjusted by default risk: $\Phi_{i,t} = (y_{i,t}^{Govt} - CDS_{i,t} - \rho_{i,t}) - (y_{US,t}^{Govt} - CDS_{US,t})$, where $y_{i,t}^{Govt}$ is the one-year local currency government bond yield in country i, $\rho_{i,t}$ is the one-year market-implied forward premium for hedging currency i against the U.S. dollar, and $CDS_{i,t}$ is the credit default swap premium on country i's government bond on weekly date t. The data are from Du and Schreger (2016) and Du et al. (2018). The shaded area represents the 90% confidence interval computed using heteroskedasticity-robust standard errors.

Figure A15: Effect of QT Announcements on CIP Deviations, Including MEP



Notes: The dependent variable is the one-year CIP deviation adjusted by default risk: $\Phi_{i,t} = (y_{i,t}^{Govt} - CDS_{i,t} - \rho_{i,t}) - (y_{US,t}^{Govt} - CDS_{US,t})$, where $y_{i,t}^{Govt}$ is the one-year local currency government bond yield in country i, $\rho_{i,t}$ is the one-year market-implied forward premium for hedging currency i against the U.S. dollar, and $CDS_{i,t}$ is the credit default swap premium on country i's government bond on weekly date t. The data are from Du and Schreger (2016) and Du et al. (2018). The shaded area represents the 90% confidence interval computed using heteroskedasticity-robust standard errors.

Figure A16: Effect of CIP Deviations on Capital Flows, Including MEP



Notes: The figures show the estimation results from weekly panel local linear projections with the dependent variables being $ln(\frac{BondFundAllocation_{i,t+k}}{BondFundAllocation_{i,t-1}})$ on the left and $\frac{BondFundFlow_{i,t+k}}{BondFundAllocation_{i,t-1}}$ on the right. The dynamic effects of the CIP deviations induced by QE and QT announcements on capital flows to emerging markets are shown in both figures. The shaded area represents the 90% confidence interval, computed using heteroskedasticity-robust standard errors.

Model: Announcement vs. Implementation of QE

Model With Credible Announcement

Suppose the liquid share of the U.S. government bonds is initially $\eta = \eta^0$. At the beginning of period 0, the U.S. government credibly announces that, *before the secondary market opens and before households in country a learn their income type k*, it will exchange less-liquid Treasuries for liquid Treasuries, so that the liquid share of government bonds becomes exactly $\eta^1 > \eta^0$. In aggregate:

$$\sum_a m^a S_1^a = B(\eta^1 - \eta^0),$$

where S_1^a is the amount of less-liquid Treasuries swapped for liquid Treasuries for households in country a. Each household in country a optimally chooses to sell S_1^a less-liquid Treasuries at price $\frac{1}{R_{\tilde{b}}}$ and purchase S_1^a liquid Treasuries at price $\frac{1}{R_b}$.

We denote the equilibrium portfolio allocations of liquid Treasuries, less-liquid Treasuries, and illiquid loans in this new environment as $\left(b_1^a, \tilde{b}_1^a,\ \ell_1^a\right)$. We would like to show that the optimal portfolio allocations of liquid Treasuries, less-liquid Treasuries, and illiquid loans after the exchanges $\left(b_1^a + S_1^a,\ \tilde{b}_1^a - S_1^a,\ \ell_1^a\right)$ in this new environment are identical to those in the baseline equilibrium $\left(b_{1,base}^a,\ \tilde{b}_{1,base}^a,\ \ell_{1,base}^a\right)$ with $\eta = \eta^1$, described in Section 4.

For an income type k household in country a, the household chooses $b_{new}^a, \tilde{b}_{new}^a,$ and ℓ_{new}^a to maximize the expected utility subject to the following budget constraints:

$$c_0^{a,k} = y_0^{a,k} - T_0^a - \frac{\ell_{new}^a}{R_\ell} - \frac{b_{new}^a + S_1^a}{R_b} - \frac{\tilde{b}_{new}^a - S_1^a}{R_{\tilde{b}}} - \frac{b_{new}^{a,k}}{R_{b,s}} - f(\frac{\ell_{new}^a}{R_\ell}) \tag{20}$$

$$c_1^{a,k} = y_1^a - T_1^a + \ell_{new}^a + b_{new}^a + S_1^a + \tilde{b}_{new}^a - S_1^a + b_{new}^{a,k} \tag{21}$$

We now define new variables, $b^a \equiv b_{new}^a + S_1^a$ and $\tilde{b}^a \equiv \tilde{b}_{new}^a - S_1^a$, and relabel ℓ_{new}^a and $b_{new}^{a,k}$ as ℓ^a and $b^{a,k}$. Then, the budget constraints can be rewritten as follows:

$$c_0^{a,k} = y_0^{a,k} - T_0^a - \frac{\ell^a}{R_\ell} - \frac{b^a}{R_b} - \frac{\tilde{b}^a}{R_{\tilde{b}}} - \frac{b^{a,k}}{R_{b,s}} - f(\frac{\ell^a}{R_\ell}), \tag{22}$$

$$c_1^{a,k} = y_1^a - T_1^a + \ell^a + b^a + \tilde{b}^a + b^{a,k}. \tag{23}$$

and the market clearing conditions are also the same as in the baseline model with $\eta = \eta^1$:

$$\sum_a m^a b^a = \sum_a m^a (b_{new}^a + S_1^a) = B\eta^0 + B(\eta^1 - \eta^0) = B\eta^1. \tag{24}$$

$$\sum_a m^a \tilde{b}^a = \sum_a m^a (\tilde{b}^a_{new} - S^a_1) = B(1-\eta^0) - B(\eta^1 - \eta^0) = B(1-\eta^1). \tag{25}$$

Therefore, the optimization problem that households solve with $\eta = \eta^0$ initially, but with a credible announcement that η will increase to η^1, is the same as that in the baseline model with $\eta = \eta^1$. The portfolio allocations are identical: $\left(b^a_1 + S^a_1, \tilde{b}^a_1 - S^a_1,\ \ell^a_1\right) = \left(b^a_{1,base},\ \tilde{b}^a_{1,base},\ \ell^a_{1,base}\right)$. Hence, the amount of lending to emerging markets is identical in both cases.

Model with Non-Credible Announcement

Suppose now the government announces that it will increase the liquid share to η^1, but households believe that the new liquid share will be only η^2, where $\eta^0 < \eta^2 < \eta^1$ and η^0 is the pre-announcement liquid share of U.S. government bonds. Households believe that an amount S^a_2 of less-liquid Treasuries will be swapped for liquid Treasuries for households in country a, where S^a_2 satisfies

$$\sum_a m^a S^a_2 = B(\eta^2 - \eta^0).$$

We denote the equilibrium portfolio allocations of liquid Treasuries, less-liquid Treasuries, and illiquid loans in this new environment as $\left(b^a_2,\ \tilde{b}^a_2,\ \ell^a_2\right)$. If households believe the liquid share will be η^2, the amount of loans extended to emerging markets would be identical to that in the baseline model with $\eta = \eta^2$, as we have shown above.[49]

Since $\eta^2 < \eta^1$, the announcement that is only partially believed generates a strictly smaller effect on capital flows to emerging markets than either the fully credible announcement or the actual implementation of η^1.

[49] If the households' belief is indeed correct, $\left(b^a_2 + S^a_2,\ \tilde{b}^a_2 - S^a_2,\ \ell^a_2\right) = \left(b^a_{2,base},\ \tilde{b}^a_{2,base},\ \ell^a_{2,base}\right)$, where $\left(b^a_{2,base},\ \tilde{b}^a_{2,base},\ \ell^a_{2,base}\right)$ is the equilibrium portfolio allocation in our baseline model with $\eta = \eta^2$. If S^a_2 turns out to be higher or lower than what households believed, it will only affect the actual holdings of liquid and less-liquid U.S. government bonds after the exchanges, but not the amount of loans already extended to emerging market households.

Proof of Proposition 2

Proof. We use the following notation throughout: R_b and $R_{\tilde{b}}$ are the interest rates on liquid and less-liquid Treasuries, respectively;R_ℓ is the interest rate on illiquid loans to EMs; η is the share of liquid Treasuries in total U.S. government debt B; μ_L is the Lagrange multiplier on the constraint that low-income households cannot sell more liquid Treasuries than they hold; and $x = \frac{\ell}{R_\ell}$ denotes the total value of loans to EMs.

We multiply Equation 14 by p and Equation 15 by $1-p$, and compare to Equation 16 and we get the interest rates on liquid Treasuries are equal in the primary and in the secondary market: $R_{b,s} = R_b$. From Equation 18 and Equation 17, we get the interest rates on illiquid bonds and loans are the same, $R_\ell = R_{\tilde{b}}$ because illiquid bonds and loans to EM are equivalent for lenders, given the simplifying assumption that the U.S. does not bear the cost of lending to EM households. With these equilibrium conditions and $u'(c) = c^{-\sigma}$, we can write Equations 14–19 as

Then, the first-order conditions give us:

$$\beta^{US} R_b \left(c_1^{US,H}\right)^{-\sigma} = \left(c_0^{US,H}\right)^{-\sigma} \tag{26}$$

$$\beta^{US} R_b \left(c_1^{US,L}\right)^{-\sigma} + \beta^{US} R_b \mu_L = \left(c_0^{US,L}\right)^{-\sigma} \tag{27}$$

$$\beta^{US} p \left(\left(\frac{R_\ell - R_b}{R_\ell}\right)\left(c_1^{US,H}\right)^{-\sigma}\right) + \beta^{US}(1-p)\left(\left(\frac{R_\ell - R_b}{R_\ell}\right)\left(c_1^{US,L}\right)^{-\sigma} - \frac{R_b}{R_\ell}\mu_L\right) = 0 \tag{28}$$

$$\beta^{EM} R_\ell (c_1^{EM})^{-\sigma} + f'\left(\frac{\ell^{EM}}{R_\ell}\right)(c_0^{EM})^{-\sigma} = (c_0^{EM})^{-\sigma} \tag{29}$$

Combining Equations 27 and 28 , and we have,

$$\beta^{US} p \left(\left(\frac{R_\ell - R_b}{R_\ell}\right)\left(c_1^{US,H}\right)^{-\sigma}\right) + (1-p)\left(\beta^{US}\left(c_1^{US,L}\right)^{-\sigma} - \frac{1}{R_\ell}\left(c_0^{US,L}\right)^{-\sigma}\right) = 0 \tag{30}$$

Since we are interested in $\frac{dx}{d\eta}$, where $x^{US} = \frac{\ell^{US}}{R_\ell}$, $x^{EM} = \frac{\ell^{EM}}{R_\ell}$, $x^{US} = x^{EM} = x$, we replace ℓ^{US} with $R_\ell x$ and substitute back in the expressions for consumption, we get:

$$\left(y_0^{US,H} - \frac{1}{p}\frac{\eta B}{R_b} - x - \left(\frac{(1-\eta)B}{R_\ell}\right)\right)^{-\sigma} = \beta^{US} R_b \left(y_1^{US} + R_\ell x + B + \frac{1-p}{p}\eta B\right)^{-\sigma} \tag{31}$$

$$\begin{aligned} &\beta^{US} p (R_\ell - R_b)\left(y_1^{US} + R_\ell x + B + \frac{1-p}{p}\eta B\right)^{-\sigma} + \beta^{US}(1-p) R_\ell \left(y_1^{US} + R_\ell x + (1-\eta) B\right)^{-\sigma} \\ &= (1-p)\left(y_0^{US,L} - x - \left(\frac{1-\eta}{R_\ell}\right)\right)^{-\sigma} \end{aligned} \tag{32}$$

$$\left(y_0^{EM} + x - f(x)\right)^{-\sigma}(1 - f'(x)) = \beta^{EM} R_\ell \left(y_1^{EM} - R_\ell x\right)^{-\sigma} \tag{33}$$

Equation 31 becomes:

$$\left(y_0^{US,H} - \frac{1}{p}\frac{\eta B}{R_b} - x - \left(\frac{(1-\eta)B}{R_\ell}\right)\right) = \left(\beta^{US}R_b\right)^{-\frac{1}{\sigma}}\left(y_1^{US} + R_\ell x + B + \frac{1-p}{p}\eta B\right) \tag{34}$$

Now, totally differentiate Equation 32:

$$\begin{aligned}
&\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}(dR_\ell - dR_b) - \beta^{US}\sigma p\left(c_1^{US,H}\right)^{-\sigma-1}(R_\ell - R_b)\left(xdR_\ell + R_\ell dx + \frac{1-p}{p}Bd\eta\right)\\
&+\beta^{US}(1-p)\left(c_1^{US,L}\right)^{-\sigma}dR_\ell - \beta^{US}\sigma(1-p)\left(c_1^{US,L}\right)^{-\sigma-1}R_\ell\left(xdR_\ell + R_\ell dx - Bd\eta\right)\\
&= -\sigma(1-p)\left(c_0^{US,L}\right)^{-\sigma-1}\left(-dx + \frac{B}{R_\ell}d\eta + \frac{(1-\eta)B}{(R_\ell)^2}dR_\ell\right)
\end{aligned} \tag{35}$$

Then, from Equation 33,

$$-\sigma\left(c_0^{EM}\right)^{-\sigma-1}(1-f'(x))^2dx - \left(c_0^{EM}\right)^{-\sigma}f''(x)dx = \beta^{EM}\left(c_1^{EM}\right)^{-\sigma}dR_\ell + \beta^{EM}\sigma\left(c_1^{EM}\right)^{-\sigma-1}R_\ell\left(xdR_\ell + R_\ell dx\right)$$

Solving for dR_ℓ, we find:

$$\begin{aligned}
dR_\ell &= \frac{-\left(c_0^{EM}\right)^{-\sigma}f'' - \beta^{\text{EM}}\sigma(R_\ell)^2\left(c_1^{EM}\right)^{-\sigma-1} - \sigma\left(c_0^{EM}\right)^{-\sigma-1}(1-f'(x))^2}{\beta^{EM}\left(c_1^{EM}\right)^{-\sigma}\left(1+\sigma R_\ell x\left(c_1^{EM}\right)^{-1}\right)}dx\\
&\equiv \mathcal{A}dx, \text{where } \ \mathcal{A} < 0.
\end{aligned}$$

Then, totally differentiate Equation 34:

$$\begin{aligned}
&-\frac{B}{pR_b}d\eta + \frac{\eta B}{p(R_b)^2}dR_b - dx + \frac{B}{R_\ell}d\eta + \frac{(1-\eta)B}{(R_\ell)^2}dR_\ell\\
&= -\frac{1}{\sigma}\beta^{\mathbf{US}\frac{-1}{\sigma}}(R_b)^{\frac{-1-\sigma}{\sigma}}\left(c_1^H\right)dR_b + \left(\beta^{US}R_b\right)^{-\frac{1}{\sigma}}\left(R_\ell dx + xdR_\ell + \frac{1-p}{p}Bd\eta\right)
\end{aligned}$$

This can be simplified by noting that $\left(\beta^{US}R_b\right)^{-\frac{1}{\sigma}} = \frac{c_0^{US,H}}{c_1^{US,H}}$. We get:

$$\begin{aligned}
&-\frac{B}{p}d\eta + \frac{\eta B}{pR_b}dR_b - R_b dx + \frac{BR_b}{R_\ell}d\eta + \frac{(1-\eta)BR_b}{(R_\ell)^2}dR_\ell\\
&= -\frac{1}{\sigma}c_0^{US,H}dR_b + \frac{c_0^{US,H}}{c_1^{US,H}}R_b\left(R_\ell dx + xdR_\ell + \frac{1-p}{p}Bd\eta\right)
\end{aligned} \tag{36}$$

Now, plug in for dR_ℓ in Equations 35 and 36 and rearrange the terms,

$$\begin{aligned}
&\left[-\frac{1}{p} + \frac{R_b}{R_\ell} - \frac{c_0^{US,H}}{c_1^{US,H}}R_b\frac{1-p}{p}\right]Bd\eta + \left[-R_b + \frac{(1-\eta)BR_b}{(R_\ell)^2}\mathcal{A} - \frac{c_0^{US,H}}{c_1^{US,H}}R_b\left(R_\ell + x\mathcal{A}\right)\right]dx\\
&= -\left[\frac{1}{\sigma}c_0^{US,H} + \frac{\eta B}{pR_b}\right]dR_b
\end{aligned} \tag{37}$$

$$
\begin{aligned}
&\Bigg[\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}\mathcal{A}-\beta^{US}\sigma p\left(c_1^{US,H}\right)^{-\sigma-1}(R_\ell-R_b)(x\mathcal{A}+R_\ell)+\beta^{US}(1-p)\left(c_1^{US,L}\right)^{-\sigma}\mathcal{A}\\
&-\beta^{US}\sigma(1-p)\left(c_1^{US,L}\right)^{-\sigma-1}R_\ell(x\mathcal{A}+R_\ell)-\sigma(1-p)\left(c_0^{L}\right)^{-\sigma-1}\left(1-\frac{(1-\eta)B}{(R_\ell)^2}\mathcal{A}\right)\Bigg]dx\\
&+\left[\beta^{US}\sigma(1-p)\left(c_1^{US,L}\right)^{-\sigma-1}R_\ell B-\beta^{US}\sigma p\left(c_1^{US,H}\right)^{-\sigma-1}(R_\ell-R_b)\left(\frac{1-p}{p}\right)B+\sigma(1-p)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{B}{R_\ell}\right]d\eta\\
&=\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}dR_b
\end{aligned}
\tag{38}
$$

And, we can re-write Equations 37 and 38 as $A_1 d\eta + A_2 dx = A_3 dR_b$ and $B_1 dx + B_2 d\eta = B_3 dR_b$,where

$$
\begin{aligned}
A_1 &= \left(-\frac{1}{p}+\frac{R_b}{R_\ell}-\frac{c_0^{US,H}}{c_1^{US,H}}R_b\frac{1-p}{p}\right)B<0\\
A_2 &= -R_b+\frac{(1-\eta)BR_b}{(R_\ell)^2}\mathcal{A}-\frac{c_0^{US,H}}{c_1^{US,H}}R_b(R_\ell+x\mathcal{A})\\
A_3 &= -\frac{1}{\sigma}c_0^{US,H}-\frac{\eta B}{pR_b}<0\\
B_1 &= \beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}\mathcal{A}-\beta^{US}\sigma p\left(c_1^{US,H}\right)^{-\sigma-1}(R_\ell-R_b)(x\mathcal{A}+R_\ell)+\beta^{US}(1-p)\left(c_1^{US,L}\right)^{-\sigma}\mathcal{A}\\
&-\beta^{US}\sigma(1-p)\left(c_1^{US,L}\right)^{-\sigma-1}R_\ell(x\mathcal{A}+R_\ell)-\sigma(1-p)\left(c_0^{US,L}\right)^{-\sigma-1}\left(1-\frac{(1-\eta)B}{(R_\ell)^2}\mathcal{A}\right)\\
B_2 &= \left(\beta^{US}\sigma(1-p)\left(c_1^{US,L}\right)^{-\sigma-1}R_\ell-\beta^{US}\sigma p\left(c_1^{US,H}\right)^{-\sigma-1}(R_\ell-R_b)\left(\frac{1-p}{p}\right)+\sigma(1-p)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}\right)B\\
=&\beta^{US}\sigma(1-p)R_\ell\left[\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right]B\\
&+\beta^{US}\sigma\left(c_1^{US,H}\right)^{-\sigma-1}R_b(1-p)+\sigma(1-p)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}B>0\\
B_3 &= \beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}>0
\end{aligned}
$$

Given $A_1 d\eta + A_2 dx = A_3 dR_b$ and $B_1 dx + B_2 d\eta = B_3 dR_b$, we can derive:

$$
\frac{dx}{d\eta}=\frac{-B_2+B_3\frac{A_1}{A_3}}{B_1-B_3\frac{A_2}{A_3}}.
$$

A_2 and B_1 are negative as long as $(R_\ell + x\mathcal{A})$ is positive. Given this, $B_1 - B_3\frac{A_2}{A_3} < 0$. However, for the numerator, $-B_2 < 0$, while $B_3\frac{A_1}{A_3} > 0$.

We would like to show that $-B_2 + B_3\frac{A_1}{A_3} < 0$. That is,

$$
B_2 > B_3\frac{A_1}{A_3}
$$

$$\left(\beta^{US}\sigma\left(1-p\right)\left(c_1^{US,L}\right)^{-\sigma-1}R_\ell-\beta^{US}\sigma p\left(c_1^{US,H}\right)^{-\sigma-1}\left(R_\ell-R_b\right)\left(\frac{1-p}{p}\right)+\sigma\left(1-p\right)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}\right)B$$
$$>\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}\frac{\left(-\frac{1}{p}+\frac{R_b}{R_\ell}-\frac{c_0^{US,H}}{c_1^{US,H}}R_b\frac{1-p}{p}\right)B}{-\frac{1}{\sigma}c_0^{US,H}-\frac{\eta B}{pR_b}}$$
$$\iff\left(\frac{1}{\sigma}c_0^{US,H}+\frac{\eta B}{pR_b}\right)\left(\beta^{US}\sigma\left(1-p\right)\left(c_1^{US,L}\right)^{-\sigma-1}R_\ell-\beta^{US}\sigma p\left(c_1^{US,H}\right)^{-\sigma-1}\left(R_\ell-R_b\right)\left(\frac{1-p}{p}\right)+\right.$$
$$\left.\sigma\left(1-p\right)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}\right)>\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}\left(\frac{1}{p}-\frac{R_b}{R_\ell}+\frac{c_0^{US,H}}{c_1^{US,H}}R_b\frac{1-p}{p}\right)$$
$$\iff\beta^{US}c_0^{US,H}\left(1-p\right)R_\ell\left(\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right)+\beta^{US}c_0^{US,H}\left(c_1^{US,H}\right)^{-\sigma-1}R_b\left(1-p\right)$$
$$+c_0^{US,H}\left(1-p\right)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}+\frac{\beta^{US}\eta B\sigma\left(1-p\right)R_\ell}{pR_b}\left(\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right)$$
$$+\frac{\beta^{US}\eta B\sigma\left(1-p\right)}{p}\left(c_1^{US,H}\right)^{-\sigma-1}+\frac{\eta B\sigma\left(1-p\right)}{pR_bR_\ell}\left(c_0^{US,L}\right)^{-\sigma-1}$$
$$>\beta^{US}\left(c_1^{US,H}\right)^{-\sigma}-\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}\frac{R_b}{R_\ell}+\beta^{US}\left(c_1^{US,H}\right)^{-\sigma-1}c_0^{US,H}R_b(1-p)$$
$$\iff\beta^{US}c_0^{US,H}\left(1-p\right)R_\ell\left(\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right)+c_0^{US,H}\left(1-p\right)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}$$
$$+\frac{\beta^{US}\eta B\sigma\left(1-p\right)R_\ell}{pR_b}\left(\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right)+\frac{\beta^{US}\eta B\sigma\left(1-p\right)}{p}\left(c_1^{US,H}\right)^{-\sigma-1}+\frac{\eta B\sigma\left(1-p\right)}{pR_bR_\ell}\left(c_0^{US,L}\right)^{-\sigma-1}$$
$$>\beta^{US}\left(c_1^{US,H}\right)^{-\sigma}-\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}\frac{R_b}{R_\ell}$$

$$\iff\beta^{US}\left(c_0^{US,H}\left(1-p\right)R_\ell+\frac{\eta B\sigma\left(1-p\right)R_\ell}{pR_b}\right)\left(\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right)+c_0^{US,H}\left(1-p\right)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}$$
$$+\frac{\beta^{US}\eta B\sigma\left(1-p\right)}{p}\left(c_1^{US,H}\right)^{-\sigma-1}+\frac{\eta B\sigma\left(1-p\right)}{pR_bR_\ell}\left(c_0^{US,L}\right)^{-\sigma-1}-\beta^{US}\left(c_1^{US,H}\right)^{-\sigma}+\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}\frac{R_b}{R_\ell}>0$$
$$\iff\beta^{US}\left(c_0^{US,H}\left(1-p\right)R_\ell+\frac{\eta B\sigma\left(1-p\right)R_\ell}{pR_b}\right)\left(\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right)+c_0^{US,H}\left(1-p\right)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}$$
$$+\beta^{US}\frac{\eta B\sigma\left(1-p\right)}{p}\left(c_1^{US,H}\right)^{-\sigma-1}+\frac{\eta B\sigma\left(1-p\right)}{pR_bR_\ell}\left(c_0^{US,L}\right)^{-\sigma-1}-\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}-\beta^{US}(1-p)\left(c_1^{US,H}\right)^{-\sigma}$$
$$+\beta^{US}p\left(c_1^{US,H}\right)^{-\sigma}\frac{R_b}{R_\ell}>0$$

Using Equation 30,

$$p\left(\beta^{US}\left(\frac{R_\ell-R_b}{R_\ell}\right)\left(c_1^{US,H}\right)^{-\sigma}\right)+(1-p)\left(\beta^{US}\left(c_1^{US,L}\right)^{-\sigma}-\frac{1}{R_\ell}\left(c_0^{US,L}\right)^{-\sigma}\right)=0,$$

$$
\begin{aligned}
&\beta^{US}\left(c_0^{US,H}(1-p)R_\ell+\frac{\eta B\sigma(1-p)R_\ell}{pR_b}\right)\left(\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right)+c_0^{US,H}(1-p)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}\\
&+\frac{\beta^{US}\eta B\sigma(1-p)}{p}\Big(c_1^{US,H}\Big)^{-\sigma-1}+\frac{\eta B\sigma(1-p)}{pR_bR_\ell}\Big(c_0^{US,L}\Big)^{-\sigma-1}-\beta^{US}(1-p)\Big(c_1^{US,H}\Big)^{-\sigma}+\beta^{US}p\Big(c_1^{US,H}\Big)^{-\sigma}\frac{R_b-R_\ell}{R_\ell}>0\\
&\iff \beta^{US}\left(c_0^{US,H}(1-p)R_\ell+\frac{\eta B\sigma(1-p)R_\ell}{pR_b}\right)\left(\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right)+c_0^{US,H}(1-p)\left(c_0^{US,L}\right)^{-\sigma-1}\frac{1}{R_\ell}\\
&+\frac{\beta^{US}\eta B\sigma(1-p)}{p}\Big(c_1^{US,H}\Big)^{-\sigma-1}+\frac{\eta B\sigma(1-p)}{pR_bR_\ell}\Big(c_0^{US,L}\Big)^{-\sigma-1}-\beta^{US}(1-p)\Big(c_1^{US,H}\Big)^{-\sigma}\\
&+(1-p)\left(\beta^{US}\Big(c_1^{US,L}\Big)^{-\sigma}-\frac{1}{R_\ell}\Big(c_0^{US,L}\Big)^{-\sigma}\right)>0\\
&\iff \beta^{US}\left(c_0^{US,H}(1-p)R_\ell+\frac{\eta B\sigma(1-p)R_\ell}{pR_b}\right)\left(\left(c_1^{US,L}\right)^{-\sigma-1}-\left(c_1^{US,H}\right)^{-\sigma-1}\right)\\
&+(1-p)\frac{1}{R_\ell}\Big(c_0^{US,L}\Big)^{-\sigma}\left(c_0^{US,H}\Big(c_0^{US,L}\Big)^{-1}-1\right)\\
&+\frac{\beta^{US}\eta B\sigma(1-p)}{p}\Big(c_1^{US,H}\Big)^{-\sigma-1}+\frac{\eta B\sigma(1-p)}{pR_bR_\ell}\Big(c_0^{US,L}\Big)^{-\sigma-1}+\beta^{US}(1-p)\left(\left(c_1^{US,L}\right)^{-\sigma}-\left(c_1^{US,H}\right)^{-\sigma}\right)>0
\end{aligned}
$$

Since low income consumption in each period is no greater than high income consumption, all the elements are positive. We show that $\frac{dx}{d\eta}>0$. □

A Model with Investment

In this section, we show that the endowment shock in period 0 can map to a shock to investment needed for the production of outputs in period 1. The U.S. and the ROW households are endowed with K_0^a amount of capital and y_0^a amount of goods. Goods can be consumed or saved, while capital is used for production in period 1; capital cannot be produced from goods. At the beginning of period 0, households are not yet informed of the production technology of period 1, but they are aware that with probability p, production technology will be high-type and with probability $1-p$, it will be low-type. The production technology $F^{a,k}(K)$, where K is the amount of capital a household uses in production, $a \in \{US, ROW\}$ indexes the country, and $k \in \{H, L\}$ denotes the technology type, is:

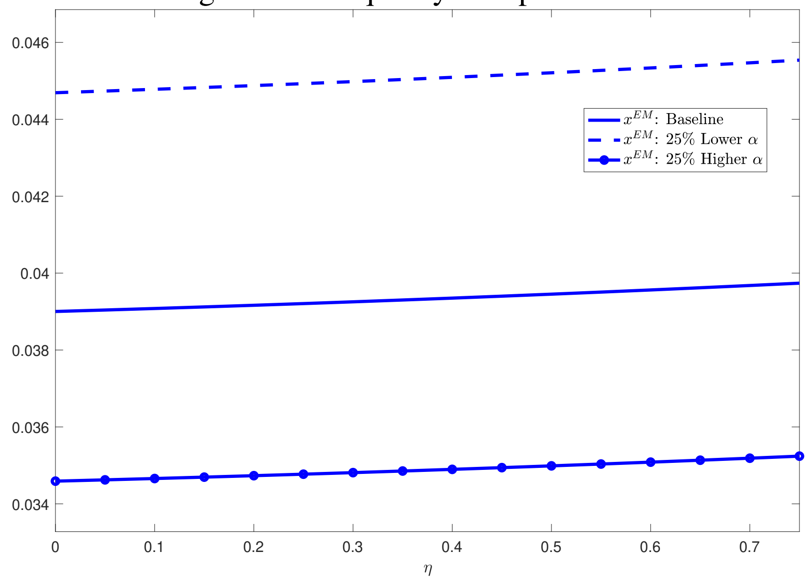
$$F^{a,H}(K) = \begin{cases} y_1^a & \text{if } K \geq K_0^a - \frac{1}{p} I_0^a \\ 0 & \text{if } K < K_0^a - \frac{1}{p} I_0^a \end{cases}$$

$$F^{a,L}(K) = \begin{cases} y_1^a & \text{if } K \geq K_0^a + \frac{1}{1-p} I_0^a \\ 0 & \text{if } K < K_0^a + \frac{1}{1-p} I_0^a \end{cases}$$

Once households learn their production technology, the high-type households will sell capital to the low-type households and low-type households will give goods in return. With this technology, the high-type households have higher "endowments" of goods, $y_0^a + \frac{1}{p} I_0^a$, while the low-type households have lower "endowments", $y_0^a - \frac{1}{1-p} I_0^a$. The value of liquidity then arises from the flexibility to adjust saving in U.S. liquid government bonds as needed for investment. That is, the effective period-0 endowments in this framework correspond to those in the baseline model: $y_0^{a,H} = y_0^a + \frac{1}{p} I_0^a$ and $y_0^{a,L} = y_0^a - \frac{1}{1-p} I_0^a$.

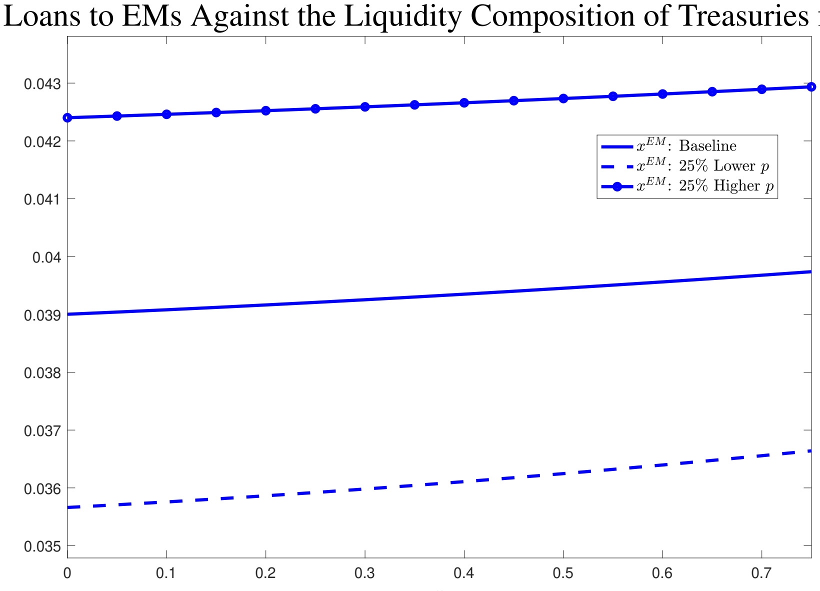
Additional Figures for Section 5

Figure A17: Loans to EMs Against the Liquidity Composition of Treasuries for Different α



Notes: x^{EM} is the total value of loans extended to EM households: $\frac{\ell^{EM}}{R_\ell}$. η is the share of liquid bonds in the U.S. government bonds. α governs the size of the transaction costs that households need to pay per one unit of loan lent/borrowed. The total value of loans extended to EM households is plotted against η (i) with our baseline parameter values in a solid line, (ii) with 25% lower α in a dashed line, and (iii) with 25% higher α in a dotted line.

Figure A18: Loans to EMs Against the Liquidity Composition of Treasuries for Different p



Notes: x^{EM} is the total value of loans extended to EM households: $\frac{\ell^{EM}}{R_\ell}$. η is the share of liquid bonds in the U.S. government bonds. p is the probability of having a high income in period 0 for the U.S. and the ROW households. The total value of loans extended to EM households is plotted against η (i) with our baseline parameter values in a solid line, (ii) with 25% lower p in a dashed line, and (iii) with 25% higher p in a dotted line.