Internationalizing Like China

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We empirically characterize how China is internationalizing the Renminbi by staggering the entry of different types of foreign investors into its domestic bond market and propose a dynamic reputation model to explain this strategy. Our framework rationalize China's strategy as trying to build credibility as an international currency issuer while reducing the cost of capital flight. We provide a sufficient statistic to measure countries' reputation over time and show that it can be estimated using micro data on foreign investors' portfolios. We use our framework to explore how countries compete to become a reserve currency provider.

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With the third largest domestic bond market in the world behind the United States and the European Union, China is often described as a possible future international currency provider. However, unlike the U.S. and Eurozone bond markets, the Chinese bond market has been largely closed to foreign investors, severely limiting the use of the Chinese Renminbi (RMB) as an international currency. Over the last decade, that has begun to change and China has progressively opened its domestic bond market to foreign investment. While the internationalization process is in its early stages, the size of the market and the ongoing opening-up process makes the evolution of China's bond market an important dynamic at the core of the international monetary system. This paper empirically characterizes the Renminbi's internationalization and the changing nature of foreign investment and provides a tractable framework to shed light on the gradual strategy that the Chinese government is pursuing in the internationalization of the Renminbi.

We begin our analysis by providing a comprehensive characterization of foreign investment in China's domestic bond market (see also Amstad and He (2020) and Amstad, Sun and Xiong (2020)). We show that after being largely segmented from global capital markets, foreigners have now started investing in Renminbi-denominated bonds. The initial increase in foreign investment was driven by central banks while the more recent increase has been driven by private investors.

We demonstrate that this pattern of early investment by stable investors like central banks followed by flightier private investment was driven by deliberate policy choices of the Chinese government aimed at selecting the investor base. By introducing a series of foreign investment schemes with varying quotas, lock-up periods, and registration requirements, China was able to stagger the entry of different investor types into its domestic market. China began by allowing in more stable, long-term investors, such as central banks, sovereign wealth funds, and non-profits. After creating this stable investor base, China gradually loosened its array of restrictions to increasingly allow in flightier foreign investors such as passive and active mutual funds, exchange traded funds (ETFs), and some hedge funds.

The patterns documented above raise many interesting questions on how a large economy can or should internationalize its currency, what is the rationale for gradualism and selecting the investors base, and the effect of Chinese capital market liberalization on other bond markets around the world and interest rates. We develop a theoretical framework to make sense of the above facts and provide a way to think about these issues. The framework has three core ingredients: governments that are potentially opportunistic and may want to capture foreign capital in crises, heterogeneous foreign investors with varying degrees of flightiness, and slow building of reputation of issuing governments in the eyes of foreign investors.

We interpret the policy choices of China as trading off building reputation as a country capable of providing the global store of value and risking a disruptive foreign capital flight. Letting in foreign investors helps build reputation for the issuer in global capital markets, but letting in too many foreign investors, particularly flighty ones, can be counterproductive by exacerbating crises as the investors pull out in times of stress. Crises are costly both directly because they lead to costly liquidations, and also indirectly because attempts to limit a flight of capital via ex-post capital controls on outflows lead to a loss of reputation. In our model, the reputation of a government in the eyes of foreign investors is the perceived probability that the government will not impose ex-post capital controls. This captures investors' fears of repatriation risk, the possibility that they will not be able to "get their money out of the country." The aim of the government is not to lower overall repayment to foreigners, as in a sovereign default, but instead to temporarily lock-in foreign capital to prevent costly unwinding of positions.

To capture the gradual opening up of markets to different type of investors, we introduce two classes of investors in the model. One class, stable investors, is less flighty in a crisis, in the sense of requiring less collateral in a crisis to roll over the debt. We view this class as capturing the behavior of central banks, sovereign wealth funds, but also some private investors that have particularly long horizons and stable funding (e.g. endowments and other non-profit institutions). The other class, flighty private investors, captures the majority of private investors like mutual funds, ETFs, and hedge funds.

We develop a dynamic reputation model in which a country, like China, chooses which classes of foreign investors to allow into its domestic bond market and how much to borrow from each type it lets in. In a crisis, foreign investors demand high collateral to roll over existing debt, forcing some assets to be liquidated to repay debt that cannot be rolled over due to insufficient collateral. Liquidating assets is costly, and the government is tempted to introduce ex-post capital controls to limit the flight by foreigners. However, the expectation that these controls might be imposed is precisely the reputational problem of the country: the more foreigners expect the country to impose the controls ex-post, the worse the terms of credit are ex-ante. This mechanism helps to shed light on how a country begins the process towards becoming an international currency (see also Bahaj and Reis (2020)).

Consistent with our empirical findings, the government only gradually opens the domestic bond market to foreigners. At low levels of reputation, the government chooses to only borrow from stable investors. At this stage of the internationalization process, the flighty private investors are too costly to allow into the domestic market. If the government does not institute ex-post capital controls on existing stable investors, then reputation increases over time and the interest rate schedule subsequently offered by foreigners becomes more attractive, increasing the government's desire to borrow more from foreigners. As reputation endogenously builds up, the value of letting more foreigners in becomes sufficiently high that the government allows flighty private investors into the domestic market. Importantly, the action of letting in private flighty investors itself increases the government's reputation, since it is a disproportionately expensive action to take for a government intending to impose ex-post controls.

Establishing reputation as an international currency issuer, like the U.S., is a slow and arduous process (Eichengreen et al. (2017)). Throughout modern history, many would-be contenders, like Japan or the Eurozone, have failed to displace the dominance of the dollar. Sargent (2012) stressed the importance and difficulty in building a reputation for the newly created United States in the 1780s and the newly created Euro Area in the 2000s. Whether or not the Renminbi will become a international currency is also uncertain. Our model offers a cautionary tale to optimistic views that China might quickly or straightforwardly emerge as an international currency provider. The stationary distribution of the model shows that countries endogenously spend most of the time at low levels of reputation and instituting policies that indeed confirm such low reputation is warranted. Governments that impose controls lose their reputation with investors, resetting their reputation cycle. At low levels of reputation, the cost of losing the existing reputation is also low, thus providing smaller incentives to building a better reputation.

Furthermore, reputation can only be built in the fire of a crisis. In normal times, when foreigners do not flee from the country's debt, the government is not tempted to tamper with foreign debt holdings. The lack of temptation also means that no reputation is built. Since crises are infrequent, so are opportunities to build reputation. In this respect, the behavior of a government during crises is a salient moment for investors to update their beliefs on the type of government they are facing. This updating is particularly strong for a country like China at the beginning of the internationalization process, because investors are unsure whether China will resist the temptation to impose controls on capital outflows in the face of a capital flight. As reputation builds, and investors assign higher probability that a government will not impose capital controls, it becomes more difficult to build it further and some governments decide that further gains in reputation are too small to justify not imposing capital controls in the next crisis.

Measuring reputation in the data is a notoriously difficult problem. Based on the model, we derive a sufficient statistic to track countries' reputation over time and estimate it in nearly real-time using micro data on foreign investors' portfolios. Intuitively, we track whether foreign investment funds that own RMB bonds are specialists in investing in emerging market or developed market bonds. Formally, we estimate at each point in time the correlation among investment funds between the share of the foreign portfolio invested in RMB bonds and the remaining share invested in a reference set of safe developed countries government bonds. We show that this measure can be estimated for all countries, not just China. Based on the model, a higher correlation points to a country's reputation closer to the reference set (countries of highest reputation). Consistent with the model, we find high positive correlations for countries such as the U.S. and Eurozone, and negative correlations for countries such as Brazil and South Africa. We find that China's reputation is in between emerging markets and developed countries. As predicted by the model, China's measured reputation increased as it opened up to flighty investors.

The model is tractable and can help make sense not only of new situations, like China's internationalization, but also the behavior of established players like the U.S. and their past trajectory. To better understand the interaction among countries competing to be a reserve currency, we develop a model of competition among issuing countries. Competition has a deep interaction with reputation building since countries' choices feature an interesting complementarity: if a country's competitors impose capital controls today and reset their reputation, then that country has higher incentives not to do so since tomorrow at a higher level of reputation it will capture a larger share of the market (face a better residual demand curve). We show that competition lowers the incentives to build a higher reputation by limiting the future benefits of becoming a reserve currency. In the extreme, committed governments could provide such high levels of competition as to deter any attempt by opportunistic governments to build reputation. More generally, we show that competition induces countries like China, currently at low levels of reputation, to spend more time (in a stationary distribution sense) at low levels of reputation. An established reserve currency issuer, like the US, can deter an up and coming competitor like China by issuing more safe debt to foreigners, thus satiating world demand more and leaving little space for the competitor (see also Farhi and Maggiori (2018), Choi, Kirpalani and Perez (2022)).

Finally, we extend the model to include two-way capital flows. Both gross foreign assets and liabilities grow in reputation, and crises with losses of reputation feature two-way retrenchment, a sharp contraction in both gross assets and liabilities. A country like China can start as a large net foreign creditor at low levels of reputation. Even if the country has a high saving rate so that in equilibrium it is a net foreign creditor, its government chooses to borrow from foreigners while at the same time investing abroad in order to build reputation. Reputation is like a pledgable asset, it is valuable because one can borrow against it. The higher its value, the more the country wants to lever against it. As reputation builds, the net foreign assets position deteriorates and established reserve currency issuer tend to be net foreign debtors.

Related Literature. The internationalization of the Renminbi is an important global macroeconomic development that has attracted much policy attention but surprisingly little formal analysis, either empirically or theoretically. Our focus is related to the literature on China's bond and currency market reforms like Song and Xiong (2018), Cerutti and Obstfeld (2018), and papers included in the handbook by Amstad, Sun and Xiong (2020).[1] Xiong (2018) and Brunnermeier, Sockin and Xiong (2022) focus on China's gradualistic approach to managing the financial system and issues with local government financial leverage. Song et al. (2011) document a number of stylized facts about the nature of China's economic growth strategy and provide a theoretical framework consistent with the observed patterns.

There is a recent theoretical literature on the international monetary system, mostly focusing on established international currencies like the U.S. Dollar and Euro (Farhi and Maggiori (2018), He et al. (2019), Chahrour and Valchev (2021), Gopinath and Stein (2021), Drenik, Kirpalani and Perez (2021), Choi, Kirpalani and Perez (2022)). An important exception is Bahaj and Reis (2020) who focus on the early process of jump-starting the Renminbi as an international currency. They focus on the unit of account and payments role of a currency and examine the role of the introduction of PBoC swap lines in leading the Chinese Renminbi to be adopted in the global payments system. We share a focus on competition among possible reserve currencies with Choi, Kirpalani and Perez (2022).

Our model of dynamic reputation is related to foundational work by Kreps and Wilson (1982), Milgrom and Roberts (1982), and Barro and Gordon (1983). Diamond (1989, 1991) mixes dynamic reputation and adverse selection to study the dynamics of reputation acquisition in financial markets and the choice between bond and loan financing. Our modeling of reputation builds on the strand of literature that considers changes in type over time (Mailath and Samuelson (2001), Cripps et al. (2004), Phelan (2006), and Mailath et al. (2006)).[2] Our paper is related to the literature examining how reputational incentives can help sustain debt repayment by governments as in Amador and Phelan (2021) and Fourakis (2021).

Finally, our focus on the temptation that governments face in imposing ex-post capital controls and the presence of stable and flighty investors is related to the literature studying fire sales, liquidity, and heterogeneous investor bases (Caballero and Simsek (2020), Clayton and Schaab (2022), Coppola (2021)).

[1] See also: Prasad (2017), Mo and Subrahmanyam (2020), and Lai (2021).

[2] See also Tadelis (1999) and Lu (2013).

1 Background on China's Bond Market

We begin by providing a brief overview of China's bond market. For more comprehensive introductions to the market, see Amstad and He (2020) in Amstad, Sun and Xiong (2020), or Schipke and Zhang (2019). Today, China's market is the third largest in the world, behind only the United States and the Euro Area. Appendix Figure A.II shows the remarkable growth in China's bond market over the last 15 years, the value approaching nearly $20 trillion at the end of 2020. In the last ten years, the size of China's bond market surpassed that of the U.K. and Japan. The other large markets in Figure A.II are the closest to the textbook case of free capital movement, thus making China an interesting outlier due to the combination of market size and segmentation from the rest of world capital markets.

China's central government had long been the largest issuer in domestic bond markets, with China Government Bonds (CGBs) used as the de facto proxy risk-free rate in local bond markets. The second most important category had long been policy-bank bonds, the bonds of the large Chinese state-affiliated policy banks (Agricultural Development Bank of China, China Development Bank, and the Export-Import Bank of China). The bonds of these banks are generally assumed to be implicitly guaranteed by the central government. Recently, both of these categories were supplanted by local government bonds (Xiong (2018)). The rest of the market, which is much smaller than the above three governmental or quasi-governmental set of issuers, is composed of bonds issued by firms, either State Owned Enterprises (SOEs) in the form of enterprise bonds, corporate bonds by private firms, or bonds issued by commercial banks.

Through much of its development, China's bond market was essentially closed to foreign investors. That began to change in the early 2000s. Rather than open its domestic bond market to all foreign investors at once, China instead pursued a gradual liberalization policy. China's policy of opening up began by allowing in foreign investors with strict limits on the size of investment via quotas and by regulating the type of investors that could enter through special programs with demanding application processes and often lengthy lock-up periods. Over the last 20 years, China reduced each of these barriers gradually, allowing larger investment scale, a greater variety of foreign investors, and increasingly allowing foreign investors to quickly take their money out of the country.

The liberalization process took a major initial step in 2002 with the introduction of the Qualified Foreign Institutional Investor (QFII) program.[3] Under this system, following a fairly onerous registration and application process, investors could gain access to domestic stock and exchange-traded bond markets. However, most of the foreign investment via QFII was in the Chinese stock market as the exchange-traded bond market is a small share of the overall bond market.[4] In these early stages, the quotas were small and only a narrow range of investors actually gained access to the market. Importantly, QFII investment was originally subject to a one-year lock up period. In 2009, this was lowered to three months for "pension funds, insurance funds, mutual funds, charitable funds, endowment funds, government and monetary authorities and open-ended funds" (ASIFMA (2021)).

[3]The Renminbi Qualified Foreign Institutional Investor (RQFII) was introduced in 2011, allowing investors to use RMB to enter the market rather than foreign currency. The programs were merged in 2020.

[4]Amstad and He (2020) note that 90% of foreign investment through these programs went to the stock market, with the small remaining share going to bonds.

In the 2010s, China significantly broadened direct access to the domestic bond market, allowing foreign participation in the China Interbank Bond Market (CIBM). The primary participants were central banks and other official investors, like sovereign wealth funds, and they could directly access the interbank market. In 2013, QFII and RQFII participants were allowed access to the interbank market (Guo (2019)). In 2015, the People's Bank of China (PBoC) allowed full access without a quota to the interbank bond market for long-term investors such as central banks and sovereign wealth funds (Amstad and He (2020)).[5] These reforms helped meet the requirements for the Renminbi's inclusion in the SDR (Special Drawing Rights) basket in 2016. Quota restrictions were removed for all investors with the launch of CIBM Direct in February 2016 (Guo (2019)), but this form of access still required direct access to China's bond markets with its accompanying regulatory and registration hurdles (Schipke et al. (2019)).

These hurdles were significantly lowered in 2017 with the introduction of Bond Connect. Unlike earlier programs, Bond Connect is based offshore in Hong Kong and can be accessed via standard trading platforms like Bloomberg without the registration requirements of QFII or CIBM Direct.[6] The ease of access into the Chinese market via Bond Connect was seen as an important reform to facilitate China's inclusion in global bond indices such as the Bloomberg Global Aggregate Index and the JP Morgan Government Bond Index - Emerging Markets (GBI-EM). In order to be included in these indices, bonds must be freely tradable, there cannot be substantial capital controls, and in some cases hedging instruments need to be available. In its 2018 press release announcing the inclusion of RMB bonds, Bloomberg wrote: "In order to be considered for inclusion in the Global Aggregate Index, a local currency debt market must be classified as investment grade and its currency must be freely tradable, convertible, hedgeable, and free of capital controls. Ongoing enhancements from the PBoC have resulted in RMB-denominated securities meeting these absolute index rules." While these criteria could arguably have already been met for official sector investors investing through CIBM Direct prior to Bond Connect, it was only recently that private investors were deemed to reach that level of access. Indeed, whether the Chinese bond market is freely investable for most foreign investors today is still a matter of contention. FTSE only added Chinese bonds to its World Government Bond Index (WGBI) in October 2021 and following this decision, for instance, Japan's Government Pension Investment Fund (the largest tracker of the WGBI) subsequently decided to track a version of the WGBI index excluding China, arguing that market access was still too incomplete

[5] The Chinese government was explicit that these relaxation of restrictions were only for long-term investors. PBC No. 220, July 14, 2015, the "Notice of the People's Bank of China (PBC) on Issues Concerning Investment of Foreign Central Banks, International Financial Institutions and Sovereign Wealth Funds with RMB Funds in the Inter-bank Market" writes "With a view to enhancing efficiency of foreign central banks or monetary authorities, international financial institutions, and sovereign wealth funds (hereinafter referred to as relevant overseas institutional investors) investing in the Chinese inter-bank market... Relevant overseas institutional investors shall act as long-term investors, and conduct trading based on reasonable needs for preserving or increasing the value of their assets. The PBC will, in accordance with the reciprocity principle and macro-prudential requirements, regulate trading behavior of relevant overseas institutional investors."

[6] In preparation for the launch of Bond Connect, PBC's Announcement [2016] No.3 extended the category of foreign institutional participants eligible to access the interbank bond market from the Foreign Central Bank-Type Institutions (including foreign central banks or monetary authorities, international financial organizations and sovereign wealth funds), QFIIs and RQFIIs to all qualified foreign institutional investors, including "other medium and long-term institutional investors" and changed the tone from "investors shall act as long-term investors" to "PBC encourages an overseas institutional investor to make medium and long term investments".

for them to invest (Sano and Galbraith (2019)).

While each step of these reforms has its own intricacies, one can understand China's bond market liberalization as beginning by allowing in a subset of long-term investors with restrictions on investment amounts and withdrawals, loosening these restrictions for subsets of investors over time, before moving toward free access to a range of global investors. This gradualism is consistent with the philosophy of "crossing the river by touching the stones," moving by incremental policy reforms to develop the economy while maintaining economic stability. As we document below, these reforms have overall been accompanied by inflows of foreign investment in Chinese bond markets, starting with official foreign investors and, more recently, growing amounts of private investment.

2 The Renminbi in International Portfolios

In this section, we document the rise of Renminbi-denominated bonds in international investment portfolios. From the beginning of 2014, foreign investment in onshore RMB bonds rose from under \$100 billion to nearly \$640 billion at the start of 2022. The largest increase came in 2020, when foreign holdings increased by nearly \$200 billion. Appendix Figure A.III plots the rise of foreign ownership of RMB-denominated bonds issued in onshore capital markets at a monthly frequency.

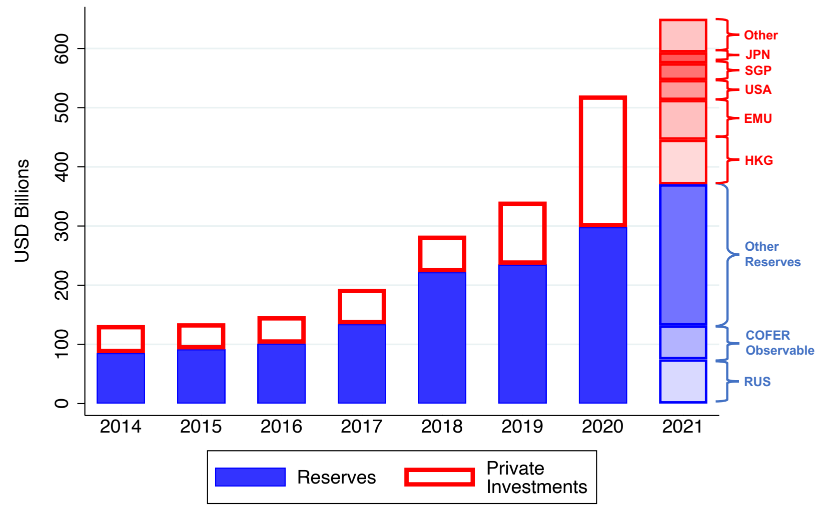
The process was gradual and featured some setbacks. There were two significant instances of foreign capital outflows over the last decade. The first occurred during the financial market turbulence of 2015-2016: between July 2015 and February 2016 the value of foreign holdings declined from \$128 to \$101 billion dollars, a 21% decline. This was a period of Chinese stock market volatility and depreciation of the Renminbi, and China intervened heavily in its financial markets. In particular, regulators introduced suspensions of share-trading following market drops and restricted domestic firms and investors from moving capital abroad. Despite the market turmoil and the sizable outflows, China did not introduce restrictions on foreign investors, including those in the bond market, from exiting the country.[7] In fact, government officials at the time publicly reinforced China's commitment to the opening up process and explicitly characterized capital controls as an unwanted regression in that process.[8] Some market participants, however, still argued that the possibility of future restrictions acted as a deterrent to foreign investment in China.[9] Inflows resumed and accelerated after this outflows episode. The most recent

[7]See, for instance, Danese (2016), who writes of the differential restrictions on outflows: "This is important since, as a result of capital outflows, Chinese authorities have been clamping down on all existing channels for moving capital out of the country. This has included suspending issuance of new quotas for outbound programmes, such as the qualified domestic institutional investor (QDII) scheme, as well as issuing window guidance to banks restricting how much foreign exchange (FX) corporates can remit out of the country. For CIBM, the rules did not include any such provisions, possibly in a bid to assuage concerns by index provider MSCI, which decided in June not to include A-shares in its emerging market index."

[8]See SAFE (2016) or SAFE (2015): "(...) the policy orientation of foreign exchange administration to support the development of the real economy and promote trade and investment facilitation remains unchanged. (...) While controlling abnormal capital flows, the SAFE has been dedicated to prudential management by economic and market means, and will continue to do so in the future. This way of administration will continue for ongoing and ex-post regulation, so as to build a macro-prudential management framework, rather than the traditional capital control model.".

[9]See Weinland (2017), who writes in the Financial Times, "China's restraints on capital outflows have started

Figure 1: Composition of Foreign Ownership of China-Issued RMB Bonds



Notes: Figure plots our estimated breakdown of foreign ownership of RMB denominated bonds into central bank reserves and private holdings. Data on reserves are from IMF COFER and private holdings are from IMF CPIS or from commercial data. See Appendix A.I.A for details.

period of outflows began in January 2022 and appears to be ongoing at the time of writing, with much of the data to analyze it still to be released.[10]

Figure 1 decomposes foreign ownership of Chinese Renminbi bonds issued by China-resident entities into two components, central bank reserves and private investment.[11] The initial rise in foreign investment is largely driven by central bank holdings. By far, the largest disclosed holder is the Central Bank of Russia. In 2017 and 2018, Russia dramatically cut its holdings of USD reserves and moved into RMB and EUR, apparently in response to U.S. sanctions and general wariness of relying on the dollar-based financial system. In particular, Russia increased its holding of RMB denominated bonds from under $1 billion in the second quarter of 2017 to around $67 billion in the second quarter of 2018. Reserve holdings themselves may also understate the true importance of the Renminbi as a reserve asset.[12]

It is only in 2019 and 2020 that we see a more substantial increase in private foreign investment in RMB bonds. For the latest year, 2021, the figure also displays the estimated private ownership of RMB bonds by investor country. We find that the investor base is broadly spread geographically with large private holdings of RMB bonds by the Euro Area, United States, Singapore, Japan, and Taiwan.[13]

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to discourage inbound investment into the country, the opposite of the intended effect of the measures."

[10] Market commentary mentions fears, after Russia's invasion of Ukraine, of sanctions spillover to China, but also deterioration in China's fundamentals and raising rates in the United States and other advanced economies.

[11] See Arslanalp, Eichengreen and Simpson-Bell (2022) for an analysis of the changing composition of global foreign exchange reserves.

[12] As discussed in Bahaj and Reis (2020) and Bahaj and Reis (2021), China has opened a number of swap lines with central banks around the world. Therefore, even if central banks do not hold Renminbi in their current reserves assets, they may be counting on Renminbi liquidity in a crisis.

[13] Appendix Figure A.I reports our estimates of the geographic breakdown of holdings for the full period. See Appendix Appendix A.I.A for details on the estimates. We note that the private investment estimates are based in

The aggregate investment pattern raises the question of what investors are actually purchasing within the class of RMB bonds. Using data from China Central Depository and Clearing, the top panel of Appendix Figure A.IV shows that China Government Bonds (CGBs) account for 67% of of foreign investment in China, with 30% of investment in Policy Bank Bonds (PBBs), even though these two classes only account for a combined 62% of the total bond market. Importantly, these are the two categories that are either direct liabilities (CGBs) or assumed to be implicitly guaranteed (PBBs) by the Central Government. By contrast, only 3% of foreign investment goes to the 38% of the market with significant private credit risk. These patterns highlight that, conditional on investing in RMB, foreign investors mostly hold the safer assets denominated in that currency. In Appendix Section A.I.D, we decompose private investment flows into RMB and show that it was driven by actual investment decisions and that flows into RMB were largely accounted for by sales of developed currency debt.

Foreign investment in RMB bonds is, of course, not the only way that foreign investors can lend to China. In Appendix A.I.B, we document the changing importance of offshore bond issuance in both RMB and foreign currency by Chinese entities. In particular, we show that for foreign mutual funds the share of investment in Chinese bonds denominated in RMB issued offshore (the CNH market) compared to total holdings (onshore plus offshore) fell from over 90% in 2013 to under 10% by 2020. Despite this rise in the importance of onshore relative to offshore RMB financing, Appendix Figure A.V shows that throughout the full sample period mutual funds continued to invest more in China in foreign currency via international capital markets than they did in the onshore RMB market. See Coppola, Maggiori, Neiman and Schreger (2021) and Eichengreen, Macaire, Mehl, Monnet and Naef (2022) for a more detailed exploration of foreign investment in China via the offshore bond market.

2.1 Selecting the Foreign Investor Base

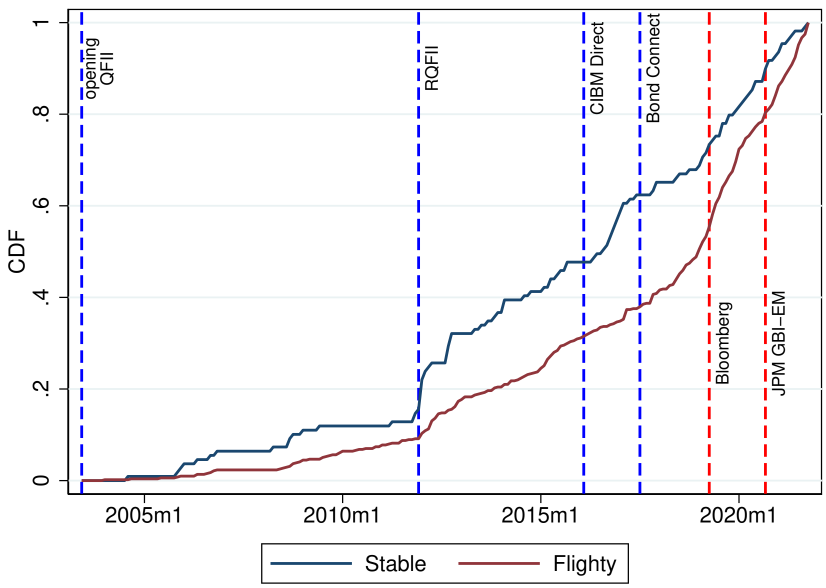
In the previous subsection, we documented the holdings of RMB bonds in China by reserve managers and foreign private investors. Here, we turn to understanding how China selected which type of investors would be able to invest in its bond market over time. To do so, we create a new monthly dataset of the investor composition of the four access methods to the Chinese bond market discussed in Section 1: QFII, RQFII, CIBM Direct, and Bond Connect. For each of the programs, the regulatory agency either directly reports the investor name and the month that particular investor gained access to the program, or they release a series of monthly reports of investors with access, and we infer the month of access based on the first appearance on the regulatory filing. Based on investor name, we merge these investor lists with Factset to collect investor information, such as country of residency, nationality, and industry classification. We then classify them as "Stable" investors, "Flighty" investors, or "Banks."[14]

Figure 2 displays the cumulative distribution function (CDF) of investors' entry into the Chinese bond

part on IMF CPIS data. These data exclude central bank holdings, but can include some public investment in the form of sovereign wealth funds, government pension funds, and state-owned enterprises. We confirmed, however, that for many countries the primary holders are mutual funds or insurance companies.

[14]"Stable" investors include central banks, legislative bodies, international organizations like the IMF, university endowments, non-profits, pension funds, and insurance companies. "Flighty" investors are those in the investment advice or portfolio management industry. "Banks" include investment banks, commercial banks, and broker dealers.

Figure 2: Entry into Domestic Markets



Notes: Figure plots the share of each investor type that had entered the market by a given date. The share is expressed as a fraction of investors by type that had entered by 2021.

market for Stable and Flighty investors from 2003 to 2021. It shows a striking difference between the entry pattern for the two types of investors, with Stable investors generally entering earlier in the sample period followed by a rapid increase in Flighty investors over the most recent years.[15] At the launch of RQFII and CIBM Direct, we observe increased entry of the Stable investors. By contrast, in the wake of the introduction of Bond Connect and China's inclusion in key bond indices, we observe a quicker entry of the Flighty investors.

We view these patterns as the result of conscious policy choices by the Chinese government that selected and grew its foreign investor base over the last two decades. As discussed above, the early entry and growth of the Stable investors was engineered via quota programs in which each investor separately applied for market access, while the later entry and growth of the Flighty investors is largely the result of more open and lightly regulated access programs like Bond Connect that allows access without any lock-up period. Our model, introduced in Section 3, both draws from this evidence in featuring two different classes of foreign investors, one stable and the other flighty, and provides an explanation of why China has followed this sequential opening up strategy to internationalize its bond market.

3 Reputation in the International Monetary System

We organize the empirical patterns documented above around stylized facts that inform our theory. First, the Chinese domestic bond market has progressively opened up to foreign participation. Second, this

[15] Appendix Figure A.VI repeats the exercise for each of the underlying categories. It shows the heterogeneous process followed by different sub-types of investors in entering this market. Appendix Figure A.VII breaks down Flighty investors into Mutual and Hedge Funds.

gradual opening up process was shaped by government policies aimed at selecting an investor base: starting with stable long-term investors and progressively letting in flightier private investors. We explain these facts via a dynamic model of a country internationalizing its bond market. We think of a country like China that has the potential to become the provider of a reserve currency, given its economic size or geopolitical importance, but that at an early stage does not have the reputation to provide a safe store of value. The model helps us think about how the country might build this reputation over time, the setbacks it might face, and the gradual policies it might choose.

3.1 Model Setup

The model is infinite horizon and time is discrete $t = 0, 1, \ldots$. Each date t is divided into a beginning, middle, and end of the date. Within each date we develop a financial intermediation model with costly liquidations, across dates we develop a dynamic reputation model. There is a country with a government and a representative financial intermediary, both of which are risk neutral. There are foreign investors who reside outside the country.[16] Investors live for one date and are risk neutral with a quadratic utility cost of lending to the country. There is measure one of *stable* foreign investors, $i = s$, and measure one of *flighty* foreign investors, $i = f$. Investor type is observable to the government and to intermediaries.

At the beginning of each date, the government's type is either *committed* or *opportunistic*. The government's type is not observable to foreign investors. We assume that the government controls all decisions within the country, so that we refer to the country level actions and objectives as if the government was implementing them directly. At the beginning of date t, governments make a financing decision for the country on behalf of its domestic intermediaries. Governments also make a strategic choice of whether or not to impose a capital control tax on outflows in the middle of date t, the tax has two levels denoted $\tau \in \{0, \overline{\tau}\}$. We assume that committed governments always choose $\tau = 0$.

We proceed as follows. We first describe payoffs to governments and investors. Next, we characterize the optimal strategy of the committed government. We then characterize strategies of opportunistic governments and study the dynamic reputation game. Figure 3 summarizes the timeline of date t and the actions taken at each point in time by each of the agents are described in detail below.

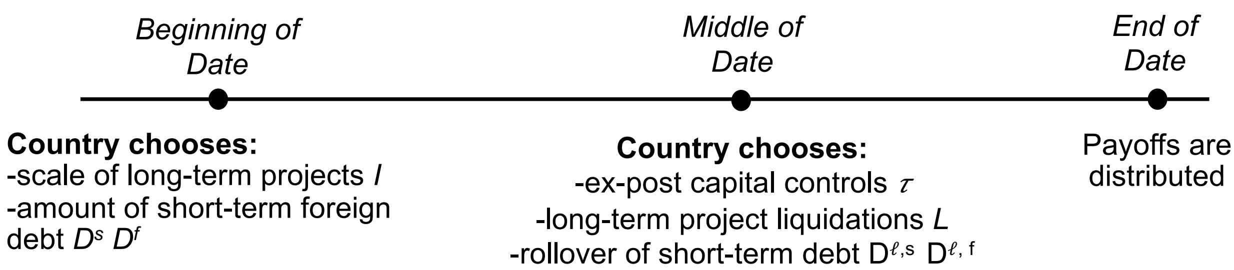
3.1.1 Payoff from Financial Intermediation

The government's payoff at date t is the final end of date equity payoff of the intermediary at end of t, denoted c_t. There is no consumption in the middle or beginning of the date. We derive this payoff below.

At the beginning of the date, the intermediary borrows short-term debt due in the middle of t denoted by amount $D_t^i \geq 0$, $i \in \{s, f\}$, from the two types of investors at endogenous interest rates R_t^i. Denote $D_t = D_t^s + D_t^f$ to be total foreign debt borrowed at the beginning of date t and $R_t = \frac{R_t^s D_t^s + R_t^f D_t^f}{D_t^s + D_t^f}$ the average interest rate on debt. The intermediary uses its debt D_t and an exogenous endowment of inside equity, $A \geq 0$, to undertake real projects of scale $I_t = A + D_t$.

[16] Our focus is on raising debt financing from foreign investors, we extend the framework to have a separately meaningful role for domestic investors/households in Appendix A.II.P.1 and Section 6.

Figure 3: Model Timeline Within Each Date



Notes: Figure displays the timing withing each date t of the financial intermediation model.

Real projects have a return $Q \geq 1$ if held to the end of the date. The projects yield no payoff in the middle of t, but can be liquidated at a discount $\gamma < 1$ per unit of final project payoff. Denote $L_t \leq QI_t$ the liquidations and γL_t the liquidation value that accrues to the intermediary.[17] Since there is no consumption in the middle of the date liquidations only occur to repay foreign debt.

The government can choose to roll over or repay the intermediary foreign debt in the middle of t. Denoting $D_t^\ell = D_t^{\ell,s} + D_t^{\ell,f}$ to be total debt that is rolled over, the intermediary's middle of t budget constraint is

$$D_t^\ell + \gamma L_t = R_t D_t. \tag{1}$$

The intermediary cannot discriminate between investor types in the middle of t, that is the intermediary must deliver the same terms to all investors. Denote R_t^ℓ the common (endogenous) interest rate for debt rollover. We assume that debt rollover is subject to a collateral constraint,

$$R_t^\ell D_t^\ell \leq (1 - h_t)(QI_t - L_t), \tag{2}$$

where $h_t \in (0, 1)$ is the haircut for debt rollover.

Final intermediary payoff is given by $c_t = QI_t - L_t - R_t^\ell D_t^\ell$, that is final payoff of the remaining projects minus repayment of debt that has been rolled over. We assume that the collateral constraint binds in the middle of t. Thus we can substitute equations 1 and 2 into the final payoff to write

$$c_t = \underbrace{\frac{h_t}{\gamma - \frac{1-h_t}{R_t^\ell}}}_{\text{Net Worth Multiplier}} \underbrace{\Big(\gamma QI_t - R_t D_t\Big)}_{\text{Liquidation Value of Inside Equity}}. \tag{3}$$

The final payoff c_t can be written as the product of a net worth multiplier and the liquidation value of the bank's inside equity. The net worth multiplier falls when the haircut is higher and when the the rollover interest rate R_t^ℓ is higher, because both tighten the collateral constraint and force more liquidations.

[17] Liquidations in our model are an actual unwinding of the real projects, not a sale of the project to some second best holders. Early liquidations occurs at a value below the value the projects would have yield if held to maturity.

3.1.2 Investor Preferences and Interest Rate Determination

Date t foreign investors are risk neutral but have a quadratic cost of lending to the intermediary at the beginning of the date. In the middle of the date, their preferences are linear. Investors do not discount payoffs between the beginning, middle, and end of t and are myopic. Stable and flighty investors have identical preferences over (monetary) payoffs and only differ in collateral demands (equation 4).

Investors at the beginning of t have wealth w, which they allocate between lending to the intermediary, D_t^i, at promised interest rate R_t^i, and allocating to an outside asset with exogenous expected return $\overline{R} > 0$. In the middle of the date, investors choose to roll over or repatriate their debt based on the promised rollover interest rate and on whether a capital control tax on outflows has been imposed by the government.

The haircut required for debt rollover depends on which investor type the country has borrowed from at the beginning of the date. In particular,

$$h_t = \begin{cases} h^s, & D_t^f = 0 \\ h^f, & D_t^f > 0 \end{cases} \tag{4}$$

where $h^f \geq h^s$, that is the required haircut is higher when borrowing from flighty investors. All investors are treated pari-passu and offered the same haircut, so that the presence of flighty investors raises the haircut for the entire market.[18]

An investor of type i with due debt repayment $R_t^i D_t^i$ pays a tax τ on net outflows $\max(R_t^i D_t^i - D_t^{\ell,i}, 0)$, where $D_t^{\ell,i}$ is the new debt and $\tau \in \{0.\overline{\tau}\}$ depends on whether the government has imposed a capital control. Withdrawn funds can be stored in an outside asset with unit return until the end of the date and then consumed. Investor i receives payoff R_t^ℓ per unit rolled over in the middle of t.

We solve the investor problem backwards starting from the rollover decision in the middle of the date. If the intermediary offers contracts that violate the required haircut, then no debt is rolled over $D_t^{\ell,i} = 0$. For contracts that offer sufficient collateral, investors maximize end of date payoff $c_t^{*,i}$:

$$\max_{D_t^{\ell,i} \geq 0} \quad c_t^{*,i} = (R_t^\ell - 1) D_t^{\ell,i} - \tau \max(R_t^i D_t^i - D_t^{\ell,i}, 0) + R_t^i D_t^i + \overline{R}(w - D_t^i)$$

The first order conditions imply: (i) indifference to any roll-over amounts $D_t^{\ell,i} \in [0, R_t^i D_t^i]$ if $R_t^\ell = 1 - \tau$; (ii) a corner solution at $D_t^{\ell,i} = 0$ for $R_t^\ell < 1 - \tau$; (iii) $D_t^{\ell,i} = R_t^i D_t^i$ if $R_t^\ell \in (1 - \tau, 1)$; (iv) indifference to any level of $D_t^{\ell,i} \geq R_t^i D_t^i$ for $R_t^\ell = 1$ (v) infinite lending for $R_t^\ell > 1$. Solutions (ii) to (v) cannot be an equilibrium, so that we restrict the attention to solution (i) and express the resulting interest rate schedule as:[19]

[18] This assumption helps us capture the market reforms that in practice allow a government to let in new types of investors. These reforms apply to the entire market, not just to the new investor type. We view this as capturing the spirit of the evidence in Section 1 and Section 2.1 documenting the gradual process by which China has progressively and selectively allowed different type of foreign investors into its domestic bond market, both by directly restricting the type of investors eligible for a given program, and by adopting policies like a fixed lock-up period which only certain types of investors can realistically agree to.

[19] Solution (v) in the aggregate violates the collateral constraint. Under solution (iv), both the intermediary and investors are indifferent between $D_t^{\ell,i} = R_t^i D_t^i$ and $D_t^{\ell,i} > R_t^i D_t^i$ for $R_t^\ell = 1$, and so we can rule it out by ruling

$$R_t^\ell = \begin{cases} 1, & \tau = 0 \\ 1 - \overline{\tau}, & \tau = \overline{\tau} \end{cases} \tag{5}$$

Thus, the capital control $\tau = \overline{\tau}$ reduces the interest rate for debt rollover. Each investor's total monetary payoff at the end of date t can therefore be written as

$$c_t^{*,i} = \overline{R}(w - D_t^i) + R_t^i R_t^\ell D_t^i = \overline{R}w + (R_t^i(1-\tau) - \overline{R})D_t^i,$$

which, all else equal, is lower when the capital control is imposed, $\tau = \overline{\tau}$.

We can now turn to the investor maximization problem at the beginning of date t. Investors have beliefs $\pi_t \in [0,1]$ that the government is committed at the beginning of t. We focus on strategies that are Markov in π_t throughout the paper. Investors have beliefs $m(\pi_t) \in [0,1]$ that if the government is opportunistic it will not impose capital controls in the middle of date t. Therefore, investors believe that the government will not impose capital controls with probability $M(\pi_t) = \pi_t + (1-\pi_t)m(\pi_t)$. We refer to $M(\pi_t)$ as the government's *reputation* and use the lighter notation M_t in the equations whenever the explicit reminder that M_t depends on π_t is not necessary for clarity.

At the beginning of t, investors take as given the promised interest rate R_t^i and and their belief M_t and solve the following problem:

$$\max_{D_t^i \geq 0} \quad \overline{R}w + (R_t^i E[1-\tau] - \overline{R})D_t^i - \frac{1}{4}\frac{b}{\omega(M_t)} D_t^{i2},$$

where the first term is the expected monetary payoff at the end of the date $E[c_t^{*,i}] = \overline{R}w + (R_t^i E[1-\tau] - \overline{R})D_t^i$ and $E[1-\tau] = M_t + (1-M_t)(1-\bar{\tau}) = 1 - (1-M_t)\bar{\tau}$. The last term is a utility holding cost of investing, with $b > 0$ a slope coefficient, and $\omega(M_t) > 0$ an exogenous cost/taste function that we assume to be continuous and weakly increasing in government reputation. For most of the paper, we think of $\omega(M_t)$ as being constant at 1, but an increasing function allows us to also capture the disproportionally higher demand faced by issuers of very safe bonds (high M). In Section 4, we show how $\omega(M_t)$ arises from aggregation in a model with investors with heterogeneous tastes for countries of different reputations.

Given R_t^i and M_t, investor i's optimal choice of debt purchases D_t^i is given by the first order condition:

$$R_t^i = \frac{\bar{R} + \frac{1}{2}\frac{b}{\omega(M_t)} D_t^i}{1 - (1-M_t)\overline{\tau}}. \tag{6}$$

This interest rate schedule has a lower intercept and slope the lower the probability capital controls are imposed ex-post (even when taking $\omega(M_t)$ to be constant). A higher reputation M_t corresponds to a interest rate schedules that start lower and increase slower as the amount of debt increases.

out $D_t^{\ell,i} = R_t^i D_t^i$. We can rule out (iv) by noting that (i) with $R_t^\ell = 1 - \tau \leq 1$ sustains $D_t^{\ell,i} = R_t^i D_t^i$ at lower borrowing cost to the intermediary. We can rule out (iii) by the same argument. Finally, (i) is weakly preferable to (ii) because the intermediary is indifferent between no rollover with $R_t^\ell = 1 - \tau$ and no rollover with $R_t^\ell < 1 - \tau$.

3.2 Optimal Debt Policy of the Committed Type

The solution of the model can be analyzed by first determining what the committed type of government optimally chooses to do in each date. Opportunistic types then decide to either mimic the committed type or deviate. Therefore, we start by analyzing the problem of debt issuance at the beginning of date t by a committed government.

The committed government chooses its debt policies at date t to maximize lifetime utility. As in much of the literature, the committed government chooses its policies taking the entire path of reputation $\{M(\pi_t), \pi_t\}$ as given, that is not internalizing the impact of its borrowing decisions on the behavior of the opportunistic government. The committed government's decision is therefore a repeated static problem of choosing policies at date t to maximize its date t payoff (with $\tau = 0$), taking current reputation M_t as given. The committed government internalizes the impact of its borrowing decisions on its interest rate schedule and required haircut.

Formally, the problem of the committed government at date t is to choose debt policies (D_t^s, D_t^f) in order to maximize its date t objective (equation 3 with $R_t^\ell = 1$, that is $\tau = 0$), subject to the interest rate schedules of stable and flighty investors (equation 6) and to the haircut determination (equation 4), taking its reputation M_t as given. The proposition below characterizes the optimal policy choices of a committed government.

Proposition 1 *There exists a unique opening up threshold $M^* \in [0,1]$ such that optimal policies of a committed government are*

$$D^s(M_t) = \frac{\omega(M_t)}{b}\left[\gamma Q(1-(1-M_t)\overline{\tau}) - \bar{R}\right]$$

$$D^f(M_t) = \begin{cases} 0, & M_t \leq M^* \\ D^s(M_t), & M_t > M^* \end{cases}$$

and the resulting interest rate is $R(M_t) = \frac{1}{2}\frac{\bar{R}}{1-(1-M_t)\overline{\tau}} + \frac{1}{2}\gamma Q$, and $R(M_t) = R^s(M_t) = R^f(M_t)$.

The proof is in Appendix A.II.B. This proposition proves that there is a unique threshold M^* below which a committed government only borrows from stable investors, and above which it borrows from both stable and flighty investors.[20]

The policy rules for debt and the resulting equilibrium interest rate are intuitive. Consider first the case of $M_t \leq M^*$, in which a committed government only borrows from stable investors. If the government acted as a competitive borrower, taking the interest rate as given, then the interest rate would equal the liquidation value of the project $R_t = \gamma Q$. Instead, the government takes into account the impact of its borrowing on the interest rate: it equates marginal benefit and marginal cost of borrowing. As a result, it borrows less than in the competitive case and faces lower interest rates. As is common in monopolist problems of this (functional form) type, it borrows half as much as in the competitive case and the

[20] Appendix A.II.P.2 generalizes Proposition 1 by providing more general conditions on investor preferences under which this form of staggered opening up occurs.

equilibrium interest rate is an arithmetic average of the competitive rate γQ and the rate that would have been paid on the first unit of debt $\frac{\bar{R}}{1-(1-M_t)\overline{\tau}}$.

The key property of Proposition 1 is the opening up threshold M^*, below which the government does not borrow from flighty investors and above which the government borrows equally from both types. The intuition follows a typical fixed cost problem, which can be best visualized by taking the log of the government's date t payoff,

$$\log c_t = \underbrace{\log \frac{h_t}{\gamma - (1 - h_t)}}_{\text{Net worth multiplier}} + \log\left(\gamma Q I_t - R_t D_t\right).$$

Intuitively, the net worth multiplier enters the government's objective separably from debt. This means that an increase in the haircut from $h_t = h^s$ to $h_t = h^f$ is a fixed cost to the committed government from the reduction in its net worth multiplier. The committed government is only willing to pay this fixed cost if the benefit from doing so is sufficiently high. In particular, the benefit the committed government receives is the ability to borrow from a second class of investors without increasing the marginal interest rate. This means that the government can double its debt issuance by setting $D_t^f = D_t^s$ while maintaining the same interest rate. As reputation M_t increases, the interest rate schedules R_t^i shift downwards and flatten. This means that at higher reputation, the government can raise more debt at lower interest rates. This makes the benefit of borrowing from a second class of investors increase in the government reputation. The threshold is the point M^* at which the benefit of increasing the debt by letting in the flighty investors exactly equals the fixed cost of the higher haircut. Appendix A.II.C provides a graphical illustration of this tradeoff.

We are now ready to define the indirect utility function of the committed government over the date t payoff as

$$V(M_t) = \frac{h(M_t)}{\gamma - (1 - h(M_t))} \quad \left(\gamma Q I(M_t) - R(M_t) D(M_t)\right) \tag{7}$$

which substitutes the policy functions from Proposition 1 into the objective function (equation 3) and sets $\tau = 0$. We have: $h(M_t) = h^s$ for $M_t \leq M^*$ and $h(M_t) = h^f$ for $M_t > M^*$; $I(M_t) = A + D(M_t)$; and $D(M_t) = D^s(M_t) + D^f(M_t)$.

3.3 Opportunistic Government Payoff and Strategies

An opportunistic government always mimics the debt issuance policy of a committed government at the beginning of each date to avoid revealing itself before any debt has been raised.[21] However, an opportunistic government additionally chooses whether to impose capital controls in the middle of date t.

If the opportunistic government does not impose capital controls at date t its payoff at the end of the date coincides with that of a committed government given by $V(M_t)$ in equation 7. If instead the

[21] We assume that investors hold off-path beliefs $\pi = M = 0$ for any government that does not mimic the issuance of a committed government. Appendix A.II.D briefly verifies that these beliefs are sufficient in equilibrium to ensure the opportunistic type always mimics issuance.

opportunistic government imposes capital controls, then the payoff is given by $g(M_t)V(M_t)$ for $g(M_t) > 1$ a function derived below. We, therefore, define the end of date payoff for an opportunistic government as:

$$V^{Opp}(M_t, \tau) = \begin{cases} V(M_t), & \tau = 0 \\ g(M_t)V(M_t), & \tau = \bar{\tau} \end{cases} \tag{8}$$

where

$$g(M_t) = \frac{\gamma - (1 - h(M_t))}{\gamma - \frac{1-h(M_t)}{1-\bar{\tau}}}. \tag{9}$$

Where g is a decreasing function of $h(M_t)$, that is higher haircuts lower the proportional gains from imposing capital controls. Equation 9 is derived by substituting the policy functions from Proposition 1 into the objective function (equation 3) and considering separately the case of $\tau = 0$ and $\tau = \bar{\tau}$.

We study strategies of the opportunistic governments that are Markov in the beginning-of-period probability π_t that foreign investors assign to the government being the committed type. We define a strategy for the opportunistic government to be a probability $m^o(\pi_t) \in [0, 1]$ that it will not impose capital controls in the middle of the date when investors hold beliefs π_t and $M(\pi_t)$ at the beginning of that date. Values of $m^o = 0$ and $m^o = 1$ correspond to the pure strategies of deviating for sure (certainty of capital controls) or mimicking for sure (certainty of no capital control), respectively. Interior values of m^o correspond to mixed strategies. Within a date for given investor beliefs, the opportunistic government does not suffer from time inconsistency. It sets the strategy $m^o(\pi_t)$ at the beginning of the date and then randomizes accordingly when deciding whether to impose capital controls in the middle of the date.

Reduced Form Game. It is convenient to collect the results so far into a reduced-form representation of the date t game. Investors believe that the government is committed at the beginning of date t with probability π_t. Consider strategies that are Markov in π_t. Let $\tau \in \{0, \bar{\tau}\}$ denote a capital control decision by the government. A committed government sets $\tau = 0$ by assumption. Denote $m(\pi_t)$ to be investors' belief about the probability that an opportunistic government sets $\tau = 0$. Define $M(\pi_t) = \pi_t + (1 - \pi_t)m(\pi_t)$ to be the government's *reputation* for setting $\tau = 0$. A committed government follows an exogenous debt policy $D^i_t = D^i(M(\pi_t))$, $i \in \{s, f\}$, as given by Proposition 1. Given interest rate R_t, the payoff to the committed type is $c_t = n_t(QA + (Q - R_t)D_t)$, where $n_t = n^s > 0$ if $D^f_t = 0$ and $n_t = n^f$ (where $0 < n^f \leq n^s$) if $D^f_t > 0$. The opportunistic government mimics the debt policy of the committed government (see Appendix A.II.D). The opportunistic government receives payoff c_t if it sets $\tau = 0$ and $g_t c_t$ if $\tau = \bar{\tau}$, where $g_t = g^s$ if $D^f_t = 0$ and $g_t = g^f$ if $D^f_t > 0$, with $g^s \geq g^f \geq 1$. Investor i receives payoff from lending equal to $R^i_t D^i_t$ if $\tau = 0$ and $(1 - \bar{\tau})R^i_t D^i_t$ if $\tau = \bar{\tau}$, and her beginning of period expected utility is $\bar{R}w + (R^i_t E[1 - \tau] - \bar{R})D^i_t - \frac{1}{4}\frac{b}{\omega(M_t(\pi_t))}D^{i2}_t$. The interest rate is $R_t = R(M(\pi_t))$, given by Proposition 1. An opportunistic government's strategy is the probability $m^o(\pi_t) \in [0, 1]$ of setting $\tau = 0$.

3.4 Dynamics of Reputation Building

We now study the dynamic game of reputation building, and characterize optimal strategies and equilibrium. We assume that at the end of date t, after payoffs have been distributed, the government may be dissolved. Committed governments are dissolved with probability $\epsilon^C > 0$ while opportunistic governments are dissolved with probability $\epsilon^O > 0$, with $\epsilon^C + \epsilon^O < 1$. Governments that are dissolved are replaced by the opposite type government, and place no value on their successor. Investors know these switching probabilities but actual changes in government are not observable to them. Let $\beta^* < 1$ be the government discount factor, then define $\beta \equiv \beta^*(1-\epsilon^O)$ to be the effective opportunistic government discount factor that accounts for switching probability. We build on Phelan (2006) and Amador and Phelan (2021) by analyzing the implications of exogenous government type-switching. This plays an important role in the dynamics of reputation in our model even for small probabilities of types switching.

Investor posterior beliefs at the end of date t (i.e., prior beliefs at the beginning of $t+1$) about the government type are formed from Bayes rule. If a government did not exercise the capital control in the middle of t, then

$$\pi_{t+1} = \epsilon^O + (1-\epsilon^C-\epsilon^O)\frac{\pi_t}{M(\pi_t)}. \tag{10}$$

If on the other hand a government exercised the capital control, then $\pi_{t+1} = \epsilon^O$, reflecting that the government revealed itself as opportunistic but may have died and switched types.

It is natural in this model to index strategies and beliefs with respect to the number of dates passed without the capital control having been imposed, which we term "steps" and denote by n. Note that $\pi_0 = \epsilon^O$. Henceforth we will focus on steps n rather than calendar dates t.

At step n, the opportunistic government takes as given investor belief $M(\pi_n)$ and chooses its own strategy m^o. This decision is characterized by the Bellman equation,

$$W(\pi_n) = \max_{m_n^o \in [0,1]} m_n^o \Big(V^{Opp}(M(\pi_n), 0) + \beta W(\pi_{n+1}) \Big) + (1-m_n^o)\Big(V^{Opp}(M(\pi_n), \bar{\tau}) + \beta W(\pi_0) \Big). \tag{11}$$

A mixed strategy $m_n^o \in (0,1)$ requires indifference between exercising and not exercising the capital control, that is,

$$V^{Opp}(M(\pi_n), 0) + \beta W(\pi_{n+1}) = V^{Opp}(M(\pi_n), \bar{\tau}) + \beta W(\pi_0).$$

By contrast, a pure strategy of exercising the control, $m_n^o = 0$, requires a weak preference for the capital control, whereas a pure strategy of not exercising the capital control, $m_n^o = 1$, requires a weak preference for not exercising it. We can now define a Markov equilibrium of the model.

Definition 1 *A Markov equilibrium of the model is a path of debt issuance of the committed government $\{D_n^s, D_n^f\}$, a path of debt purchases of stable and flighty investors such that debt markets clear at interest rates $\{R_n\}$, a path of strategies $\{m^o(\pi_n)\}$ of the opportunistic government, and a path of investor beliefs about government type $\{\pi_n\}$ and strategies $\{m(\pi_n)\}$, such that:*

1. *Debt issuances are optimal for the committed government*
2. *Debt purchases are optimal for investors*
3. *$m^o(\pi_n)$ is an optimal strategy of the opportunistic government at step n*
4. *π_n is consistent with Bayes' rule in equation 10 with $\pi_0 = \epsilon^O$*

5. *Investor beliefs are rational about government strategies:* $m(\pi_n) = m^o(\pi_n)$

Consistent with Phelan (2006), we conjecture and solve for an equilibrium that takes the form of a cycle, $n = 0, ..., N$ for $N \geq 0$. Opportunistic governments play a mixed strategy, $m(\pi_n) \in (0,1)$ at dates $n < N$. At N, opportunistic governments play a pure strategy of exercising the capital control, $m(\pi_N) = 0$. As in the previous literature, we refer to N as the "graduation step," at which a *committed* type government gains the highest possible beliefs and reputation. Committed types that continue to each step $n > N$ either switch types and play the pure strategy $m(\pi_n) = 0$, or remain committed and continue at the constant beliefs and reputation, $\pi_n = M_n = 1 - \epsilon^C$. We refer to this form of equilibrium as a graduation step Markov equilibrium.

An important step in the cycle is the earliest step N^* at which the government lets in flighty investors, that is $M_n < M^*$ for $n < N^*$.[22] We verify that $M_n \geq M^*$ for $n \geq N^*$, that is an economy that opens up stays open. We refer to N^* as the "opening up step", since the government is opening up to a new class of investors.

3.5 Paths of Reputation Building

In our conjectured equilibrium, the government plays either a mixed strategy or a pure strategy of exercising the capital control at every step. Recalling the notation $M_n = M(\pi_n)$, we must have

$$W(\pi_n) = g(M_n)V(M_n) + \beta W(\pi_0), \tag{12}$$

for all n. Focusing in particular on the first step $n = 0$, we have

$$W(\pi_0) = \frac{1}{1-\beta} g(M_0)V(M_0). \tag{13}$$

This condition says that the lifetime value that accrues to a specific opportunistic government at the beginning of the cycle under the optimal strategy is equal to the value it would achieve if it followed the strategy of imposing the capital control at every date forever.

As characterized above, a mixed strategy requires the indifference condition $V(M_n) + \beta W(\pi_{n+1}) = g(M_n)V(M_n) + \beta W(\pi_0)$. We can therefore substitute equations 12 and 13 into this indifference condition to obtain the representation

$$V(M_{n+1}) = \frac{g(M_n)}{g(M_{n+1})}\rho(M_n)V(M_n) + \frac{g(M_0)}{g(M_{n+1})}V(M_0) \tag{14}$$

where we have defined $\rho(M_n) = \frac{1}{\beta}\frac{g(M_n)-1}{g(M_n)}$. Equation (14) characterizes the indifference path of our conjectured equilibrium in terms of indirect utility $V(M_n)$, rather than in terms of the value function W_n. It tells us, for a given initial reputation M_0, opening up step N^*, and graduation step N, what

[22] As long as $\epsilon^O \leq M^* < 1 - \epsilon^C$, such a step exists in the conjectured equilibrium of this form. Note that it is possible for $N^* = 0$, that is opening up happens immediately, or for $N^* = N + 1$, that is opening up happens after graduation.

the path of reputation $M_1, ..., M_N$ must be to sustain a mixed strategy by the opportunistic government up until the graduation step. This path is characterized by an AR(1) process in indirect utility $V(M_n)$. However, as we describe in detail below, the coefficients of the AR(1) process change when the government opens-up due to the change in investor composition. We build more intuition for this equation below as we decompose its dynamics in the different regions. To simplify notation, we denote $\rho^s = \rho(M_n)$ and $g^s = g(M_n)$ for $M_n \leq M^*$ so that $h(M_n) = h^s$. Correspondingly, we denote $\rho^f = \rho(M_n)$ and $g^f = g(M_n)$ for $M_n > M^*$ so that $h(M_n) = h^f$. Note that $\rho^f < \rho^s$ since $g^f < g^s$.

Equation (14) governs the dynamics for $n < N$. To complete the argument, a pure strategy of $m_N = 0$ requires that $V(M_N) + \beta W(1-\epsilon^C) \leq g(M_N)V(M_N) + \beta W(\pi_0)$. An opportunistic government also plays a pure strategy at $n > N$, meaning that $W(1-\epsilon^C) = g(1-\epsilon^C)V(1-\epsilon^C) + \beta W(\pi_0)$.[23] Combining these conditions with equation 12 yields

$$V(1-\epsilon^C) \leq \frac{g(M_N)}{g(1-\epsilon^C)}\rho(M_N)V(M_N) + \frac{g(M_0)}{g(1-\epsilon^C)}V(M_0). \tag{15}$$

Equation (15) parallels equation (14). Intuitively, it states that graduation occurs once the required indirect utility V to sustain a mixed strategy exceeds the upper bound on indirect utility $V(1-\epsilon^C)$ attainable in the conjectured equilibrium. Once the transition path exceeds this threshold, indifference can no longer be maintained and graduation occurs. Observe that graduation cannot occur at a prior point on the indifference path. If we conjectured an earlier graduation step, equation (14) implies there is an indirect utility $V \leq V(1-\epsilon^C)$ that makes an opportunistic government indifferent between imposing and not imposing the capital control. But this means the opportunistic government strictly preferences continuation to reputation $1-\epsilon^C$, rather than graduation, a contradiction.

3.6 Model Equilibrium

To build intuition for the model dynamics, we consider first the simpler case in which foreign investors are homogeneous.

Homogeneous Investors. We set $h^s = h^f$ so that the haircut is identical across the two investor groups. The transition dynamics of equation (14) simplify to:

$$V(M_{n+1}) = \rho^f V(M_n) + V(M_0). \tag{16}$$

[23] If $N^* < N+1$, then equation 15 is a sufficient condition for a pure strategy $m_n = 0$ for $n > N$ to be optimal. If $N^* = N+1$, then the equilibrium also must satisfy $\Big(1-(1-\beta)g(1-\epsilon^C)\Big)V(1-\epsilon^C) \leq \beta g(M_0)V(M_0)$, which guarantees optimality of pure strategy after graduation. In general, we approach the model by solving for an equilibrium of the model not subject to this constraint, and then verifying that this constraint holds if the conjectured equilibrium has $N^* = N+1$.

Finally, note that in the homogeneous haircuts case, $N^* = 0$ and therefore a pure strategy at N implies a pure strategy at $n > N$.

The transition path of indirect utility $V(M_n)$ follows an AR(1) with a constant coefficient, $\rho^f = \frac{1}{\beta}\frac{g^f-1}{g^f}$. The rate of convergence decreases in the discount factor β, reflecting that as opportunistic governments become more patient they require smaller increases in reputation to be willing not to impose the capital control. It increases in the value g^f of imposing the capital control, reflecting that a higher value increases the foregone benefits of imposing the control today and so requires a larger increase in reputation to maintain indifference. Similarly, the analog of the graduation condition (15) is[24]

$$V(1-\epsilon^C) \leq \rho^f V(M_N) + V(M_0). \tag{17}$$

In our conjectured equilibrium, the graduation step N is determined, starting from the initial reputation M_0, as the first step N at which condition (17) is satisfied.[25] The proposition below characterizes this equilibrium.

Proposition 2 *If investors are homogeneous $h^s = h^f$, there exists a unique graduation step Markov equilibrium.*

Proposition 2 (see proof in the Appendix) verifies that a graduation step Markov equilibrium does in fact exist, and that it is the unique equilibrium of this form. Intuitively, uniqueness arises because the path of reputation described by equation (16) and the path of beliefs described by equation (10) have different responses to a change in the initial government reputation M_0. An increase in initial reputation M_0 means that all future reputations M_n must be higher to maintain the indifference condition. By contrast, a higher initial reputation means that posterior beliefs π_1 are lower, as more opportunistic governments are not imposing the capital control. This means that the future path of beliefs is also everywhere lower. In other words, the path of reputation M_n increases at every n in the initial reputation M_0, whereas the path of beliefs π_n determined by Bayes' rule falls at every n in the initial reputation M_0. This gives rise to a crossing point of these two paths at any conjectured graduation step N. The terminal condition of graduation, equation (17), then pins down the step N at which these two paths not only cross, but also graduation is feasible, giving rise to existence. At this point, a lower initial reputation would be required to graduate at a later step, due to the indifference path. However, a lower initial reputation implies that beliefs build faster, and so overshoot reputation. This gives rise to uniqueness. Appendix A.II.P.4 illustrates a numerical solution of this model.

Heterogeneous Investors. We now analyze the model with heterogeneous investor types. As discussed above, we assume that $\epsilon^O < M^* < 1-\epsilon^C$, so that a committed government with reputation ϵ^O would not open up whereas a committed government with reputation $1-\epsilon^C$ would open up. This ensures that our conjectured equilibrium has a well defined open up step $0 \leq N^* \leq N+1$.

If $N^* = 0$, then the economy is always open and the transition dynamics and graduation condition are given by equations (16) and (17). We now characterize the case $0 < N^* \leq N+1$. The transition dynamics

[24] As noted above, equation 17 also guarantees that $m_n = 0$ is optimal for $n > N$.

[25] If $\rho^f > 1 - \frac{V(\epsilon^O)}{V(1-\epsilon^C)}$, the proof of Proposition 2 additionally shows that it must be the case that $N < \infty$.

of equation (14) can be written separately in two regions (some of which may be empty in equilibrium). As characterized below, there is a lower region of low reputation and a fast rate of convergence. There is an upper region of high reputation and a slow rate of conversion. At the boundary between the two regions, an upward jump occurs in the transition dynamics.

The lower region is the (possibly empty) set of cycle steps $\mathcal{N}_1 \equiv \{n|n+1 < N^*\}$. For any $n \in \mathcal{N}_1$, the economy has not yet opened up to flighty investors at either n or $n+1$, and so the haircuts are $h_n = h_{n+1} = h^s$. As a result, the transition dynamics in equation (14) reduce to

$$V(M_{n+1}) = \rho^s V(M_n) + V(M_0). \tag{18}$$

The dynamics in this region carry the same intuition as the dynamics in the homogeneous investor model.

The boundary between the lower region and the upper region is the step prior to opening up, $N^* - 1$. When $N^* > 0$, this step always exists in our conjectured equilibrium. This is the unique step n of our conjectured equilibrium such that the economy is not open to flighty investors at $n-1$ but is open to flighty investors at n. This means that $h_{N^*-1} = h^s$ but $h_{N^*} = h^f$. Therefore if $N^* < N+1$, the transition dynamics of equation (14) reduce to:

$$V(M_{N^*}) = \frac{g^s}{g^f}\Big(\rho^s V(M_{N^*-1}) + V(M_0)\Big). \tag{19}$$

The opening up step N^* has the same transition dynamics as before opening up, but is scaled by the relative value g^s/g^f of imposing the capital control before and after opening up. We have that $g^s > g^f$: for a given inside equity, imposing capital controls before rather than after opening up increases the government utility more. Intuitively, this occurs because flighty investors are more inelastic (require a higher haircut) in their debt rollover decisions, thus making imposing capital controls ex-post less advantageous for the government.

Opening up is a disproportionately expensive action for the opportunistic types to take. In reputation games, taking this type of expensive action comes with a jump up in reputation. Formally, this manifests as a larger increase in the indirect utility $V(M_{N^*})$ at opening up N^* relative to the dynamics before opening up. Capital inflows jump up on opening-up for two reasons: (i) flighty investors are let in for the first time and due to the fix-cost nature of this decision there is a lumpy capital inflow (see Proposition 1); (ii) both stable and flighty investors respond to the endogenous jump up in the country's reputation by increasing their lending.

The upper region is the (possibly empty) set of cycle steps after the economy has opened up but before graduation, $\mathcal{N}_2 \equiv \{n|N^* \leq n < N\}$. In this region, the economy is open at both n and $n+1$, so that $h_0 = h^s$ and $h_n = h_{n+1} = h^f$. As a result, the transition dynamics of equation (14) reduce to

$$V(M_{n+1}) = \rho^f V(M_n) + \frac{g^s}{g^f} V(M_0). \tag{20}$$

Intuitively, a government that imposes the capital control at n also benefits from the higher proportional value of imposing the capital control when it resets to reputation M_0. This leads to the scaling of $V(M_0)$

by g^s/g^f. The rate of convergence also shifts from ρ^s to ρ^f, reflecting that the smaller proportional value of imposing the capital control slows the required increases in reputation needed to make the government willing not to impose the capital control today.

Finally, opportunistic governments must be willing to graduate at N, that is equation (15) must hold at N. As in the one investor model, graduation occurs when reputation implied by the indifference path exceeds the highest possible reputation $1-\epsilon^C$. If $N^* < N+1$, then the graduation condition is

$$V(1-\epsilon^C) \leq \rho^f V(M_N) + \frac{g^s}{g^f} V(M_0).$$

If instead $N^* = N+1$, then the graduation condition is

$$V(1-\epsilon^C) \leq \frac{g^s}{g^f}\left(\rho^s V(M_{N^*-1}) + V(M_0)\right).$$

Relating back to the intuition behind equation (19), the loss in value of the capital control may be sufficiently large that the opportunistic government cannot be incentivized to play a mixed strategy at the date prior to opening up. In this case, opening up occurs after graduation.

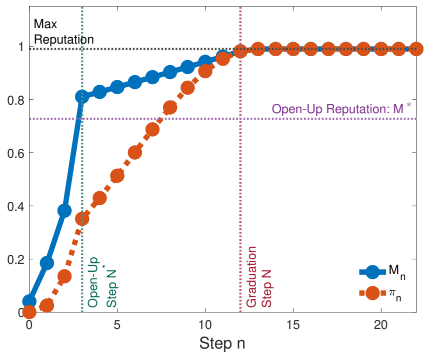
The proposition below characterizes this equilibrium.

Proposition 3 *There is at most one graduation step Markov equilibrium associated with an opening up step N^*.*

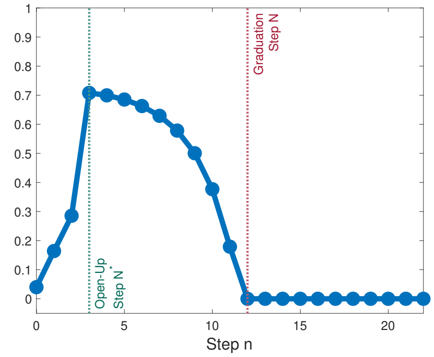
The model with heterogeneous investors might feature multiple equilibria with different opening-up steps, but given an opening-up step there is at most one equilibrium of this form associated with that step. In some sense, the logic of uniqueness of the equilibrium in the special case of homogeneous investors carries over to this set-up with multiple classes once the opening up step is fixed. The multiplicity, if present, arises from setting two different opening up steps. Technically, the possibility of multiple equilibria arises from the fact that reputation grows faster before opening up, but the jump up of reputation upon opening up is smaller the longer opening up is postponed. Intuitively, at a conjectured opening up date there might be two possible outcomes. The first is that the economy opens up and reputation experiences a larger jump according to equation (19), carrying it to $M_{N^*} > M^*$. This then rationalizes the decision of committed governments to open up at N^*. However, it can also be possible that if there were no jump and equation (18) governed the dynamics, we would have $M_{N^*} < M^*$. This in turn rationalizes the decision of committed governments not to open up.

Numerical Illustration. Figure 4 provides a numerical example of the equilibrium. Our model is intentionally stylized and qualitative, so all figures depicting equilibria of the model are to be taken as pure illustration without a quantitative focus. In this case, the economy opens up at $N^* = 3$ and graduates at $N = 12$. The upper left panel plots the evolution of reputation M_n and beliefs π_n. Beliefs and reputation start low at $n = 0$ because, at this point, investors are relatively sure that the government is opportunistic; in this example, prior beliefs at $n = 0$ are $\pi_0 = \epsilon^O = 0.001$. Intuitively, most governments at $n = 0$ are

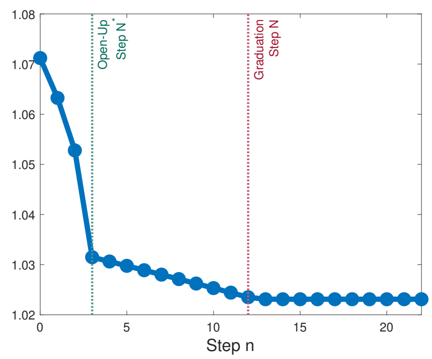
Figure 4: Equilibrium Reputation Cycle: Heterogeneous Foreign Investors



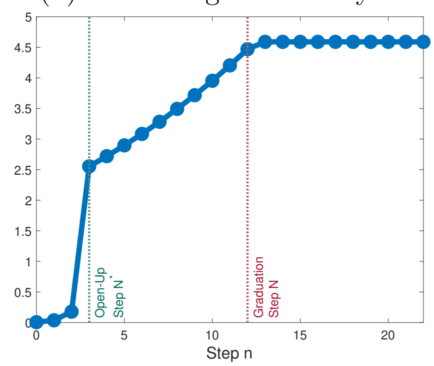
(a) Reputation M and Beliefs π



(b) Mimicking Probability m



(c) Interest Rate R



(d) Debt Issuance D

Notes: Numerical illustration of the equilibrium of the model when foreign investors are heterogeneous. The N^* dashed-green and N dashed-red lines are the opening up and graduation steps, respectively.

those that exercised capital controls last period, thus revealing themselves to be opportunistic, and the only uncertainty about their type this period is due to the exogenous switching probability. At low levels of reputation letting in the flighty investors is sub-optimal since total desired borrowing is small. As reputation builds further and consequently the interest rate schedule shifts downwards, both because of the direct effect of reputation and because we set $\omega(M)$ to increase in M, desired borrowing increases to the point that the government decides to let in the flighty investors. As discussed above, the decision to open up endogenously causes a jump up in reputation since it is disproportionately expensive for the opportunistic governments to mimic this decision. Reputation build-up slows down substantially after opening up as seen in the top left panel of Figure 4. The bottom right panel of Figure 4 confirms the intuition that the government upon opening up to flighty investors wants to borrow a lot more. Part of the increase is due to the “fixed cost" nature of letting in the flighty investors, part of the increase is due to the endogenous jump up in reputation. The bottom left panel shows that the equilibrium interest rate falls together with the debt increase.

After opening up, foreign debt continues to increase and interest rates continue to fall, but the movements are much less pronounced since further build up of reputation occurs slowly. At higher reputation the government contemporaneously sustains more foreign debt and lower interest rates, which is intuitive since higher reputation is a shift downward in the interest rate schedule. Eventually the economy reaches a level of debt and reputation at which further gains would be too small and all opportunistic governments decide to impose capital controls if a crisis occurs, thus restarting the reputation cycle. The presence of stable investors, rather than just one homogeneous class of flighty ones, allows the country to grow reputation faster before opening-up. After opening-up, the growth rate of reputation is the same as the homogeneous model. Appendix A.II.P.5, provides further numerical examples allowing for heterogeneous parameters in investor demand curves, a cap on the size of the stable investors, and variation in the taste for safe assets (the weights $\omega(M)$).

Discussion of Modeling Choices and Results. The model captures salient empirical features documented in Sections 1 and 2. Foreign entry into the Chinese market is a slow building process. In the model, investors "experiment" with this new market: they start with a cautious view ascribing a low reputation to the country. They then test the country commitment: they pull out their capital and pay attention to the reaction of the Chinese government and the well functioning of the bond market. If during these crises the Chinese government lets foreigners take their money out unimpaired, foreign investors positively update on the future prospects of investing in Chinese bonds. The model makes sense of the 2015-16 v-shape episode of capital outflows, visible in Appendix Figure A.III. In the midst of economic and financial turmoil in China, foreigners liquidated more than 20% of their Chinese bond holdings without the Chinese government locking the gates to foreign capital.[26] As the crisis passed, foreign capital flows returned to China with the overall foreign bond holdings increasing well past their pre-2015 peak.[27] In 2022 foreigners are again pulling out of China and it is an open question what the Chinese policy response is going to be.

The model highlights the importance of building the investor base, starting with stable investors, in the early phases of internationalizing the bond market of what could become an international currency. We think of the demand for the country's bonds by stable investors even at low levels of reputation as a special characteristic of countries that could become a reserve currency, like China. Most other countries, like many emerging markets, do not have this option and instead open up directly facing flighty investors. At each point in history only a handful of countries are possible contenders for a reserve currency role and researchers have long debated these countries' necessary characteristics such as size, importance in trade, military power, institutional quality, and fiscal capacity (Eichengreen, Mehl and Chitu (2017), Ilzetzki, Reinhart and Rogoff (2022)). The model captures this idea in reduced-form as the presence of these characteristics for China (e.g. size, and military power) is why the stable investors are demanding the bonds even at low levels of reputation, and instead focus on the endogenous build up of reputation.

The model captures the idea that reputation as an international currency issuer can only be built in

[26] In fact, the Chinese government decided to intervene by blocking domestic savers from exporting capital. A decision that we view, in part, as being motivated by fears that restrictions on foreigners would have damaged China's reputation in global markets at a time when China was actively pushing for internationalization.

[27] The simplicity of the model implies that the level of holdings is purely a function of reputation. This can be relaxed by making the outside option $\bar{R}$ or the slope of the demand curve b time varying, thus allowing for changes in the demand for Chinese bonds that do not depend solely on reputation.

the "fire" of severe crises. In normal times, there is little that investors learn about the government type and how it would behave in a future crisis. One can think of a step in our model as a crisis, with calendar time between two steps being "good times" of stochastic (potentially long) length. Appendix A.II.P.3 makes this formal by introducing a high and low state within each date. No reputation is built in the high state. The model presented in the main text only features the low/crisis state.

Alternative Policies and Mechanisms. The model shows how hard it is to build a reputation toward being a reserve currency. At a basic level, the rule of law and financial market development are important characteristics, on which China still has much progress to make. But being an international currency goes even further, it is a promise to foreign investors of a store of value in a crisis. Many government actions, such as ex-post capital controls, but also currency depreciation and/or inflation, can impair such a promise without constituting a deviation from the rule of law per se. Investors buying an international currency do so for its safety and liquidity and we think of these characteristics as being very sensitive to the reputation of the government. This view drives the focus of the paper on foreign investment in domestic currency bonds, rather than equity or foreign direct investment (FDI) where there is no expectation of stable returns regardless of the level of financial development or reputation. China also also opened up its equity (Stock Connect programs) and FDI markets to foreigners, and in many respects those liberalizations came earlier but do not load as heavily on policy commitments.

We focus on the uncertainty that investors face about a country like China and abstract from uncertainty that the country might have about investor behavior. In practice, we believe China can observe the behavior of large investors, like foreign central banks or large investment management groups, in many other countries that receive foreign portfolio investments. Investors, on the other hand, face the unique situation of a very large country beginning to open up its markets under the shadow of substantial political risk and a lack of transparency. Therefore, while China has a myriad of ways to learn about investors' tendencies in related contexts, it is hard to see how investors can assess what the Chinese government is likely to do in a future crisis other than by observing how it acted in past and current crises. It is this uncertainty and learning that our model focuses on.

We chose to model the willingness to impose ex-post capital controls as the defining characteristic of an opportunistic government because it captures a salient feature of foreign investors' fears about investing onshore in China: the ability to "get the money out" in a future crisis. Outright default, and inflation or exchange rate depreciation are other ways to alter repayments to foreign bondholders that also carry reputational losses. As detailed in Appendix A.I.G, foreign investors in the Chinese bond market emphasize uncertainty over "repatriation risk" or whether China will "lock the gates" in bad times.[28] While of course there are the standard currency and interest rate risks of investing in RMB, a salient risk in the context of China is the possibility that investors will not be able to get their money out in bad times. We

[28]For instance, a number of funds discuss concerns over the custodian or beneficial ownership arrangement of their bonds purchased via Bond Connect or CIBM Direct. With these untested markets, investors are not sure they will actually be able to sell the bonds they own in all market conditions. Another concern is generally referred to as a "suspension of trading." Although adopted more frequently so far in equity markets, investors in Chinese bond markets report fears that in times of market stress, China will halt trading on the bond market, making them unable to repatriate their capital.

model this as the risk that China institutes an ex-post capital outflow tax, although it could be re-framed as a quantity restriction on outflows.

Allowing the committed type to take into consideration its market impact has two advantages for us. First, it connects to the economics of reserve currencies as special assets whose issuers receive an exorbitant privilege via monopoly rents and opens up the possibility of studying competition among issuers (Farhi and Maggiori (2018); Choi, Kirpalani and Perez (2022)), something we return to in Section 5. Second, it allows for some degree of ex-ante macro-prudential policy to have already taken place in the model, sharpening the difference between ex-ante prudential measures and ex-post capital controls. Ex-ante capital controls do not carry the same reputational stigma because they are known at the time of investment.[29] Intuitively, a competitive intermediary sector would issue too much debt and reach the competitive interest rate, not internalizing its impact on the equilibrium borrowing rate. The government behaves as a monopolist and imposes ex-ante controls on intermediary borrowing in order to force them to internalize the price impact of borrowing (Lorenzoni (2008); Bianchi (2011); Guerrieri and Lorenzoni (2017); Bianchi and Lorenzoni (2021)).[30]

In general, governments have a number of other ex-post policies that would interact with ex-post capital controls. Bailout policy, either financed by ex-post taxes or ex-ante reserve accumulation, is a particularly relevant one since the government could prevent liquidations by bailing out the intermediation sector, formally bypassing the collateral constraint. Such bailouts have fiscal costs and can induce future moral hazard, so that there is a policy trade off. For example, one can think of the U.S. bailing out its financial intermediaries during the 2008 financial crisis while not tampering at all, and in fact supporting, the payoff and market access to U.S. Treasuries by foreigners. One possible extension of the model is to allow for reserve accumulation as a mechanism to "build" reputation.

Earlier Episodes of Countries Building a Reserve Currency Status. It is also interesting to reflect on how the model speaks to earlier episodes of countries building reputation toward becoming a global reserve currency. In this respect, we think of Alexander Hamilton's policy, when he was the first U.S. Secretary of the Treasury, of having the newly created federal government assume the debt of the states. The policy aimed at building a solid reputation as a borrower for the newly created United States (Sargent (2012)).[31] Similarly, we think of the later efforts by New York Federal Reserve Governor Benjamin Strong to build

[29] In a paper reviewing the IMF policy stance on capital controls over time Ostry (2022) writes: "the poor reputation of outflow controls is widespread in both academic and policy circles (and is not confined to the IMF). Indeed, the bad name of capital controls historically stems more from the reputation of outflow controls than inflow measures. The former are often seen as tantamount to expropriation of foreign investors, of changing the rules of the game after the money has already entered the country. And those concerns are legitimate."

[30] In the model, liquidations happen at an exogenous price γ. If we made the price a decreasing function of the size of liquidation ($\gamma(L_t)$), then the model would feature pecuniary externalities in the spirit of the macro-prudential literature. In our baseline, instead, the desire of the government to limit borrowing ex-ante compared to the competitive equilibrium is driven by the monopoly rents.

[31] Hamilton (1790) extols the virtues of governments that maintain their promises to creditors: "States, like individuals, who observe their engagements, are respected and trusted: while the reverse is the fate of those, who pursue an opposite conduct. [...] The credit of the United States will quickly be established on the firm foundation of an effectual provision for the existing debt." Chernow (2004)[pg 298] remarks: "With this huge gamble, Hamilton laid the foundations for America's future financial preeminence".

an investor base for the trade-bills (bankers acceptances) market in dollar in New York to rival the liquid and safe markets for these bills in sterling in London. Such efforts were instrumental into making the dollar a reserve currency (Eichengreen (2011); Broz (2018)). The need to maintain reputation was also a motivation behind England's misguided return to the gold standard at the pre-war exchange rate level in the 1920s.[32]

Countries have, at various times, suffered losses of reputation as providers of reserve currencies. England suffered a blow to its reputation with the sudden devaluation of the pound in 1931 and never recovered its role as a reserve currency provider. The U.S. went off gold in 1933 and then again in 1972. In particular, the Nixon administration in 1971 reneged on a promise of free convertibility of the dollar into gold, restricting this ability only to official ("stable") investors and excluding the private ("flighty") investors. Immediately after 1973 there was an attempt by foreign investors to diversify away from the dollar, but, perhaps due to the lack of viable alternatives, the dollar quickly regained and maintained its status.

4 Measuring Reputation

Measuring reputation empirically is a notoriously difficult task. In this section we derive a model-implied sufficient sufficient statistic for reputation. We then empirically implement this new measure of reputation with detailed micro data on foreign investors' bond holdings. We begin by deriving the measure theoretically and then estimate it in the data.

4.1 Investor Specialization and a Theoretical Measure of Reputation

We generalize the reputation model considered so far to allow for investors who specialize in countries of varying levels of reputation. We assume that there is a unit continuum of identical countries. Countries are identical in the sense that they have the same fundamentals, but may be at different investor beliefs π and reputation levels M. In this section, to sharpen the focus on investors, we assume that a measure one of issuing countries play the reputation game while having no interactions with each other. Section 5 removes this simplification and studies competition in becoming a reserve currency among the countries.

We focus on the case of homogeneous investors in terms of haircut ($h^s = h^f$) but allow instead specialization in the cost function, $\omega(M_t)$. We return to calendar time t because countries are at the same date t rather than the same step n.

A unit continuum of countries $j \in [0,1]$ are of equal measure. There are a set of investor specialists, $i \in \{1, ..., \mathcal{I}\}$, with each specialist having a continuum of identical investors of total measure $\frac{2}{\mathcal{I}}$.[33] We refer to investors by their specialization. Investors have identical information sets and have identical beliefs π_{jt} about the probability that government j is committed at date t. We restrict attention to Markov

[32] The Cunliffe Committee, charged in 1918 with studying the possible international monetary arrangements after WWI, stated in in its interim report: "The uncertainty of the monetary situation will handicap our industry, our position as an international financial centre will suffer and our general commercial status in the eyes of the world will be lowered." A strong dissenting voice was John Maynard Keynes (Keynes (1923)) who argued that these concerns were overblown compared to the economic cost of return to gold at a deflationary peg.

[33] We assume total measure of 2 to maintain consistency with the baseline model.

equilibria that are symmetric in π_{jt}, that is committed and opportunistic governments j and k play the same strategy at date t if $\pi_{jt} = \pi_{kt}$. Denote M_{jt} the beliefs of investors that government j will not exercise the capital control at date t.

Investor i has identical preferences to the baseline model, except that she can invest in the entire portfolio of debt. Her holding costs are separable across countries, meaning her preferences can be written separably as[34]

$$\overline{R}w_i + \int_j \left[E[R_{jt}(1-\tau_{jt}) - \overline{R}]D^i_{jt} - \frac{1}{4}\frac{b}{\omega_i(M_{jt})}D^{i2}_{jt} \right] dj. \tag{21}$$

The weights $\omega_i(M_{jt})$ are investor specific and akin to taste (higher or lower holding cost) for particular assets of varying reputation levels. It is the heterogeneity in the function $\omega_i(M_{jt})$ that we refer to as specialization. For example, investors who specialize in high reputation debt have an increasing ω_i.

Given i's beliefs M_{jt} and interests rates R_{jt}, investor i chooses her debt purchase D^i_{jt} to maximize her utility in equation (21). Since the investor's utility is separable across countries, optimal debt choice is also separable and given by

$$R_{jt} = \frac{\overline{R} + \frac{1}{2}\frac{b}{\omega_i(M_{jt})}D^i_{jt}}{1-(1-M_{jt})\overline{\tau}} \tag{22}$$

This demand curve is identical to that of the baseline model (equation (6)), up to the investor-specific reputation taste $\omega_i(M)$. For example, an investor i that specializes in reputation M has a higher taste $\omega_i(M)$, and hence has a flatter interest rate schedule for debt of that reputation level.

Representative Investor Aggregation. The model features a simple aggregation to a representative investor. Consider the problem of a committed government j with reputation M_{jt}. The decision problem of the committed government mirrors that of the baseline model. Since the haircut is identical across investors, the committed government borrows from every investor type. At the optimal issuance, the equalization of the demand schedules of investor 1 and investor $i > 1$ implies that relative issuance is given by $\omega_i(M_{jt})^{-1}D^i_{jt} = \omega_1(M_{jt})^{-1}D^1_{jt}$ for all i. A country of reputation M_{jt} raises different debt amounts from different investors only to the extent that their holding costs $\omega_i(M_{jt})$ differ. The total amount borrowed by a country of reputation M_{jt} is given by $D_{jt} = \frac{2}{\mathcal{I}}\sum_i D^i_{jt}$. Substituting in optimal relative issuance, we obtain for all i

$$\frac{1}{2}\omega(M_{jt})^{-1}D_{jt} = \omega_i(M_{jt})^{-1}D^i_{jt}. \tag{23}$$

where we define the average holding cost $\omega(M)$ among investors as

$$\omega(M) = \frac{1}{\mathcal{I}}\sum_i \omega_i(M). \tag{24}$$

[34]The investor problem is analogous to our baseline model, including the effect of ex-post capital controls. In the interest of brevity we do not restate the entire solution by backward induction starting from the rollover decision. We assume that governments cannot discriminate between investor types.

Finally, we can substitute equation (23) back into the interest rate schedules to obtain an aggregate demand schedule relating aggregate debt to the interest rate,

$$R_{jt} = \frac{\overline{R} + \frac{1}{4}\frac{b}{\omega(M_{jt})}D_{jt}}{1-(1-M_{jt})\overline{\tau}}. \tag{25}$$

The aggregate demand schedule therefore is identical to the one studied in the previous sections when summed over investors but here we have provided a tractable disaggregation of the investor specialization in assets with different reputation M given by equation (24). Given the aggregate demand for debt, the decision problem of the committed government is identical to the baseline model, so we can use Proposition 1 to characterize the committed government's strategy. We can then also apply the existence and uniqueness results of Proposition 2.

A Rank Measure of Reputation. We now characterize what types of investors hold a country at a given point in its reputation cycle. From the demand curves derived above, we have $D_i(M_{jt}) = \frac{1}{2}\omega_i(M_{jt})\omega(M_{jt})^{-1}D(M_{jt})$. Consider a country j with reputation M_{jt}. The (infinitesimal) portfolio share of investor i in that country is given by

$$\alpha_i(M_{jt}) = \frac{\frac{1}{2}\omega_i(M_{jt})\omega(M_{jt})^{-1}D(M_{jt})}{w_i}.$$

We take the debt issued by countries with the highest reputation, $\bar{M}$, to be a reference set. We show below that the correlation of portfolio shares across investors between the portfolio share in debt j and the debt of this reference set $\bar{M}$ reveals the correlation between investor taste $\omega_i(M_j)$ and $\omega_i(\bar{M})$. As long as investors are heterogeneous in this taste, i.e. they specialize in debt of varying reputation, the rank of these correlations reveals the issuers' reputation rank.[35] The proposition below formalizes this measure.

Proposition 4 *The correlation of investors' portfolio shares in the debt issued by country j of reputation M_{jt} with a reference set of debt issue by countries with reputation $\bar{M}$ measured at a point in time across investors is*

$$corr_i(\alpha_i(M_{jt}), \alpha_i(\bar{M})) = corr_i\left(\omega_i(M_{jt}), \omega_i(\bar{M})\right).$$

Let $\omega_i(M_{jt}) \approx \phi_0^i + \phi_1^i(M_{jt} - M^r)$ be a first order Taylor approximation around point M^r and define $\sigma_0^2 = Var_i(\phi_0^i)$, $\sigma_1^2 = Var_i(\phi_1^i)$, and $\rho_{0,1} = corr_i(\phi_0^i, \phi_1^i)$. Provided a sufficiently small approximation error, if $\sigma_0^2 > 0$, $\sigma_1^2 > 0$, and $|\rho_{0,1}| < 1$, then we have for any two countries j, k:

$$M_{jt} > M_{kt} \quad \iff \quad corr_i(\alpha_i(M_{jt}), \alpha_i(\bar{M})) > corr_i(\alpha_i(M_{kt}), \alpha_i(\bar{M}))$$

Intuitively, Proposition 4 says that if investors specialize in the debt of issuers with different reputation

[35] We assume that portfolio shares are invariant to the size of the fund w_i. In the model this can be done by assuming w_i to be constant across funds or by defining the taste functions ω_i up to a multiplicative constant w_i so that their ratio is independent of i. We also assume w_i is sufficiently high that there is positive investment in the outside asset.

and there is a set of issuers for which the reputation level is known to the the highest, then all other issuers' reputation can be ranked by checking how similar are the portfolio shares in those issuers compared to the reference set. We show below that this measure can be taken directly to the data. We note that the measure does not require knowing the parameters of the function $\omega_i(M)$, is valid even if the aggregate $\omega(M)$ is constant, and does not require observing the universe of investors or relying on market clearing.

This measure is particularly useful in the context of a new asset, like China bonds, for which time-series evidence on returns is of limited use or in situations when reforms or crises (like a default or imposition of controls) are likely to have changed the countries' reputation.[36] By using portfolio quantities among many heterogeneous funds, it provides a cross-sectional estimate of what the investors believe about the asset (see also Koijen and Yogo (2019)).

4.2 Empirical Implementation

The idea behind Proposition 4 is that heterogeneity in investor portfolios is driven by different relative preferences for investing in countries of various reputation levels. While we cannot observe this characteristic directly, if we know a set of countries to have a high reputation, then we can infer the relative ranking of other countries by seeing which other assets funds that own high reputation government debt also buy. In order to take this idea to the data we need: (i) a sufficiently large and heterogeneous (in terms of reputation focus) set of portfolio investors for which we observe their complete portfolio, and (ii) a choice of reference set. We take the reference set $\bar{M}$ in Proposition 4 to be a set of developed countries (DM) government bonds denominated in their local currency.[37] We think of this reference set as having a high reputation $\bar{M}$.

4.2.1 Portfolio Holdings

We use micro-data on portfolio investment from foreign investors via mutual funds and ETFs from around the world. Investment funds are a useful set of investors for our purposes because: (i) they tend to specialize in specific markets, (ii) high quality data is available at the security level for many countries, and (iii) they are substantial private holders of foreign debt security.[38] Our data include global mutual fund and exchange traded fund (ETF) holdings provided by Morningstar for each fund at the security level. We supplement it with information on the asset class, currency, market of issuance, nationality and residency of the issuer and its ultimate parent company, and other security characteristics.[39]

For each fund and currency, we calculate the share of the fund's total foreign currency bond investment in DM local currency bonds and the remaining share in a selected currency (with that currency omitted

[36] Appendix A.I.E reviews the price-based evidence on Chinese bonds.

[37] The complete list of countries is in Appendix A.I.C.

[38] For many large developed countries mutual funds and ETFs are the largest foreign bond investors, usually followed by insurance companies, pension funds, and non-financial corporations. Our focus is on keeping the type of investor constant across many domiciles, so we use mutual funds and ETFs for which high quality data is available for many countries.

[39] See Maggiori, Neiman and Schreger (2020) and Coppola, Maggiori, Neiman and Schreger (2021) for details on the data and the many sources combined in assembling it.

from the DM calculation if relevant).[40] In our baseline sample, we omit holdings of domestic currency bonds and any equities from the calculations because equities do not have a clear nominal currency component and domestic currency bonds play a special role for each country (see Maggiori et al. (2020)). We measure the correlation between the share of a foreign-currency bond portfolio invested in that currency with the share of the remaining foreign-currency bond portfolio invested in DM currencies across the universe of mutual funds and ETFs. More formally, for each fund i and currency c, we compute the share of the foreign-currency bond portfolio in that currency:

$$\alpha_{c,i} = \frac{\sum_{b \in B_c} \mathrm{MV}_{b,i}}{\sum_{c \in FC_i} \sum_{b \in B_c} \mathrm{MV}_{b,i}},$$

where $\mathrm{MV}_{b,i}$ is the market value of holdings (measured in USD) that fund i has in bond b, B_c denotes the set of bonds denominated in currency c, and FC_i the super-set of bonds in foreign currency from the perspective of fund i. The denominator, therefore, is the value of holdings of foreign currency bonds by fund i. In addition, for each fund i and currency c we compute the share of the remaining foreign-currency bond portfolio in DM currencies as

$$\alpha_{DM,c,i} = \frac{\sum_{d \in \{DM_i/c\}} \alpha_{d,i}}{(1 - \alpha_{c,i})}.$$

We exclude currency c if it is a developed currency, so that $\{DM_i/c\}$ is the set of developed currencies excluding c. We re-scale shares by $(1 - \alpha_{c,i})^{-1}$ so that they reflect the composition of the remaining portfolio excluding currency c.[41] Finally, we compute the summary statistic of interest: the correlation across funds of the share invested in currency c and the remaining share invested in (other) developed currencies

$$\rho_{c,DM} = corr_i\left(\alpha_{c,i}\ , \alpha_{DM,c,i}\right), \tag{26}$$

where the notation $corr_i$ emphasizes that the correlation is cross-sectional over funds i at a point in time.

In bringing the model to the data, we make two further refinements. First, in our baseline analysis we restrict the focus to the government bonds[42] of the country issuing each particular currency. For example, for the dollar we restrict the attention to U.S. government bonds and exclude bonds denominated in dollar but issued by other sovereigns. The focus on local-currency sovereign bonds in our baseline empirical analysis follows the rationale of our model since, as discussed above, these assets are the most directly sensitive to the reputation of a government (as opposed to corporate bonds and equity, for example). Appendix A.I.C provides more details on the procedure and highlights the impacts of expanding the types of assets included.

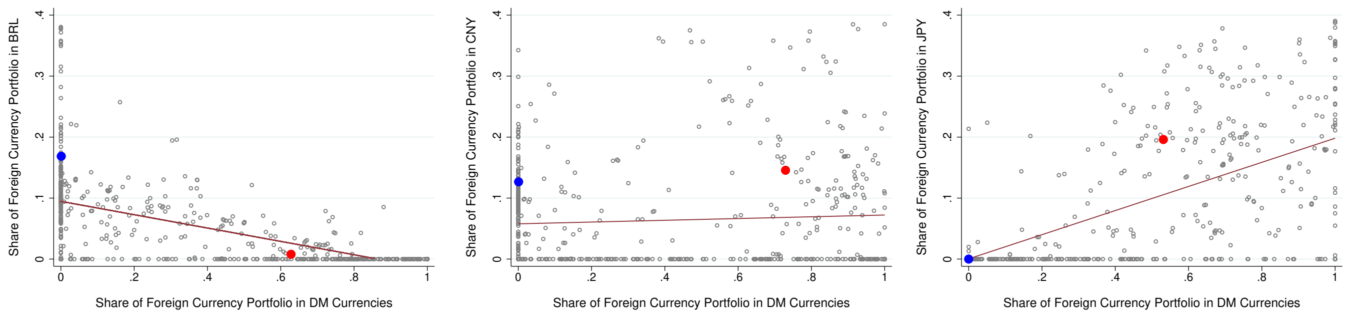
Second, we exclude from our analysis funds that specialize in any particular currency, which we define

[40] We define domestic currency to be the currency of the country in which the fund is domiciled. In the Appendix we explore robustness of this choice by also excluding the currency in which the fund reports its returns.

[41] This re-scaling maps the estimates closer to the theory since there the composition of the residual portfolio is unaffected by the size of the share in bonds issued by country j given the assumption of a continuum of issuers each of measure zero.

[42] In the case of China we classify Policy Banks' bonds as government debt, as these are assumed to be implicitly guaranteed by the central government.

Figure 5: Portfolio Shares by Currency, December 2020



(a) BRL (b) CNY (c) JPY

Notes: In each panel, observations are the portfolio holding shares of a particular fund in December 2020. The vertical axis is the portfolio share in BRL in the left panel, CNY in the middle panel, and JPY in the right panel. The horizontal axis in all panels in the portfolio share of in developed markets currencies. In each panel, the blue dot represents the holdings of the PIMCO Emerging Markets Local Currency and Bond Fund and the red dot represents the holdings of the T. Rowe Price International Bond Fund.

as funds that have more than 50% of their foreign-currency bond portfolio in a single currency. We do so because these funds are most likely to have too specific a mandate to reliably contribute to the correlation estimation. We also leave out funds with a small foreign currency portfolio, i.e. less than \$20 million of foreign currency investment, since these small investments are more likely to be noisy and reflect residual positions. Based on our focus on foreign-currency bonds and sample cleaning, the resulting dataset includes approximately 600 investment funds, adding up to just over a trillion dollar of assets under management. As we show below, this is a large sample with substantial investment heterogeneity and Appendix A.I.C provides further sample summary statistics.

4.2.2 Heterogeneous Investment Portfolios and Country Reputation

Figure 5 illustrates our estimates of this correlation measure. We plot the portfolio shares for bonds in three currencies: the Brazilian Real (BRL) in Panel (a), the RMB in Panel (B), and the Japanese Yen (JPY) in Panel (c). Each observation represents the holdings of a particular fund in December 2020, with the share of the fund's foreign bond holdings invested in DM currencies on the x-axis and the share invested in the government bonds of the selected currency on the y-axis.

In Panel (a), we see a negative relationship between the DM currency share and the share in BRL. In Panel (c), we see precisely the reverse pattern for the Yen, with funds investing more in JPY putting a higher share of their non-JPY funds in other DM currencies. In Panel (b) China lies in the middle between these two extremes, with no strong relationship between the DM share and holdings of RMB. This shows that RMB-denominated Chinese government bonds are held together with developed and emerging market government bonds in global portfolios, while Brazilian government bonds are mostly held by EM focused funds, and Japanese mostly held by DM focused funds.[43]

In each panel, we also highlight two specific funds to help illustrate how heterogeneity in investor portfolios is driven by different relative preferences for investing in countries of various reputation levels.

[43] Appendix Figure A.VIII plots this underlying data for all currencies in our sample.

The first fund (red dot) is the T. Rowe Price International Bond Fund: it reports the Bloomberg Global Aggregate ex-USD Bond Index as its benchmark and it describes its investment objective as "seeking the above-average total return potential from international bonds." This fund largely focuses on DM currency debt, with these bonds accounting for almost 65% of its FC portfolio. The second fund (blue dot) is the PIMCO Emerging Markets Local Currency and Bond Fund: it reports the J.P. Morgan Government Bond Index-Emerging Markets as its benchmark and it describes its investment objective as "tapping into opportunities for higher yields and currency appreciation through an actively managed portfolio of local currency-denominated emerging markets (EM) debt." This fund has less than 1% of its portfolio in DM currencies. In Panels (a) and (c) these two funds are at opposite extremes, reflecting their different specializations, but in Panel (b) their holdings of RMB are somewhat similar.

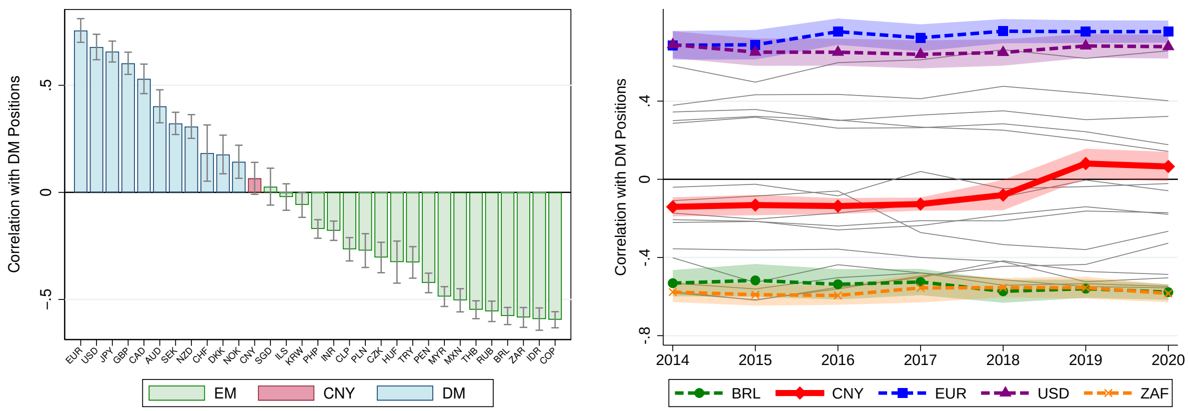
To illustrate more systematically the relation between DM currencies shares and holdings of each one of the currencies, Figure 6 Panel (a) reports the estimated correlations using December 2020 holdings data for all emerging and developed markets in our sample. We find that the Chinese RMB ranks in between emerging market and developed market currencies in terms of its correlation with DM bond portfolio shares. In particular, China ranks close to the most developed among emerging markets issuers: Singapore, Israel and South Korea. As one would expect, emerging markets' currencies have low and negative correlation with DM shares. Similarly, major DM currencies, like the Euro and the U.S. Dollar, have a positive and high correlation. These patterns in the data reflect the specialization of investors, with some funds more emerging market and some funds more developed market focused.

Through the lens of our model, tracking the correlation measure over time allows us to infer the evolution of a country's reputation rank. While the time series for China is relatively short, Figure 6 Panel (b) shows that China's portfolio correlation with developed markets has increased and so has its reputation rank in our model-implied measure. This jump in reputation provides support for a key prediction of our model: a country that opens up to flighty investors should experience a (larger than normal) jump up in reputation. We see such an increase in 2019 for China, the year of the largest inflows from setting up the Bond Connect program, while there is little movement in the correlation measure for the US and Eurozone, both with high and stable correlations' rank, and Brazil and South Africa, both with low and stable correlations' rank. Appendix Figure A.XI provides the estimated correlations time-series for a broader set of countries.

In the appendix, we demonstrate that this pattern of China lying in between the EM and DM currencies broadly holds across specifications. We consider U.S. Treasuries as the sole high reputation reference set, weight the observations by fund assets under management, exclude index funds, consider different fund size and fund specialization thresholds and find the results are broadly similar to our baseline with the Chinese RMB lying somewhat in between EM and DM currencies.

We also show the result is robust to controlling for other typical determinants of fund-level portfolios. While our model is univariate, with country reputation the only relevant characteristic, in practice many other characteristics may influence funds' allocations. In Appendix Table A.III, we control for other common drivers of portfolios, in particular so-called gravity variables such as the distance between the domicile of the fund and the issuing country, a common legal system between them, and the weight of the

Figure 6: A Rank Measure of Reputation: Sovereign Issuers in Local Currency



(a) Cross-Section of Estimates in 2020

(b) Time Series

Notes: Figure reports the correlation between the foreign-bond portfolio shares invested in government bonds in each currency and in a reference set of Developed Markets (DM) local-currency government bonds. Panel (a): reports cross-sectional estimates at the end of year 2020. Panel (b): reports time series for selected countries' estimates. Each line, including the ones in gray, corresponds to a specific currency. We label select currencies for ease of comparison. 95% confidence intervals are computed via bootstrapping.

issuing country in total exports/imports of the country's domicile and find similar results.

5 Reserve Currency Competition

An important feature of becoming an international currency is that a country at the beginning of the cycle faces competition from both other "aspirants," those at the same low level of reputation, and from countries that are already established, those at high levels of reputation. For example, China is entering now, but faces competition from the U.S. as an established reserve currency issuer. Theoretically, the interaction between reputation building and competition is an interesting area due to complementarities. For example, the value to a country of future higher reputation increases if current competitors lose reputation but decreases if entrenched players issue more. Both occur because the actions of others affect the residual demand curve that the country faces for its debt at future levels of reputation.

Our theoretical framework allows us to study competition among potential reserve currency issuers in a simple and tractable manner. We maintain a set-up nearly identical to Section 4 and briefly outline the differences before formalizing them below. The main difference is that investors now have holding costs/tastes that are no longer separable across countries. This introduces a motive for competition among the issuers: issuance by one country pushes up holding costs for other countries' debt. For tractability, we also introduce an asset S that is in fixed supply $\overline{S}$ and that is sold competitively. Its endogenously determined return is R_t^S. This asset serves as a common factor across investors.

5.1 Asset Demand and Aggregation

As in Section 4, there is a set of investor types, $i \in \{1, ..., \mathcal{I}\}$, with a continuum of investors of type i with total measure $\frac{2}{\mathcal{I}}$. There is a unit continuum of countries $j \in [0, 1]$. Investor i forms beliefs (π_{jt}, m_{jt}) about country j's type, strategy, and reputation at date t, with $M_{jt} = \pi_{jt} + (1 - \pi_{jt})m_{jt}$, and takes interest rates R_{jt} and the return R^S_t as given. She chooses her debt portfolio, D^i_{jt}, and asset holdings, S^i_t, in order to maximize her utility,

$$\overline{R}w_i + (R^S_t - \bar{R})S^i_t + \int_j E[R^i_{jt}(1 - \tau_{jt}) - \bar{R}]D^i_{jt}dj - \frac{1}{8}b\left(S^i_t + \int_j \omega_i(M_{jt})^{-1}D^{i2}_{jt}dj\right)^2 \tag{27}$$

Equation (27) is analogous to equation (21), except that investor i can now trade asset S, and i's holding costs are no longer independent across its holdings. The entire cost function is raised to the power of 2, so that the marginal cost of holding any asset depends on the other asset holdings in the portfolio. This interdependency of holding costs across countries gives rise to interconnected demand curves and a role for issuer competition.

Demand Curves for Assets. The maximization of utility in equation (27) with respect to S^i_t is given by the first order condition:

$$R^S_t - \bar{R} = \frac{1}{4}b\left(S^i_t + \int_j \omega_i(M_{jt})^{-1}D^{i2}_{jt}dj\right).$$

Recall that market clearing for asset S is given by $\frac{2}{\mathcal{I}}\sum_i S^i_t = \overline{S}$. We sum this equation over all investors and impose market clearing for asset S to write

$$R^S_t - \bar{R} = \frac{1}{8}b\left(\overline{S} + \frac{2}{\mathcal{I}}\sum_i \int_j \omega_i(M_{jt})^{-1}D^{i2}_{jt}dj\right). \tag{28}$$

The above equation shows that at the optimal portfolio the average portfolio holding costs across investors equal $R^S_t - \bar{R}$. This common factor across investors induces much tractability, as it will become clear below.[44] For simplicity, we set $\overline{S} = 0$, so that asset S is in zero net supply. We define the average portfolio holding cost b^*_t to be:

$$b^*_t = 4(R^S_t - \bar{R}) = b\int_j \left[\frac{1}{\mathcal{I}}\sum_i \omega_i(M_{jt})^{-1}D^{i2}_{jt}\right]dj. \tag{29}$$

The maximization of utility in equation (27) with respect to D^i_{jt} is given by the first order condition:

$$R_{jt} = \frac{\bar{R} + \frac{1}{2}b^*_t\omega_i(M_{jt})^{-1}D^i_{jt}}{1 - (1 - M_{jt})\overline{\tau}} \tag{30}$$

[44] An analogy might be drawn with money in the utility function frameworks and the cashless limit; a modeling tool that has proved very tractable in macro theory.

This demand curve has the same form as in equation (22), except that b_t^* replaces b as the slope of the demand curve.

As in Section 4, the model features a very tractable aggregation to a representative investor. By the same steps as in that section, we can define the average holding cost $\omega(M) = \frac{1}{\mathcal{I}} \sum_i \omega_i(M)$ as in equation (24), and define total holdings of debt issued by country j as $D_{jt} = \frac{2}{\mathcal{I}} \sum_i D_{jt}^i$. We substitute equation (23) into equation (29) to write:

$$b_t^* = b \int_j \frac{1}{4} \omega(M_{jt})^{-1} D_{jt}^2 dj \tag{31}$$

We finally obtain the representative investor demand curve:

$$R_{jt} = \frac{\bar{R} + \frac{1}{4} b_t^* \omega(M_{jt})^{-1} D_{jt}}{1 - (1 - M_{jt})\overline{\tau}}. \tag{32}$$

Again, this is analogous to equation (6) and equation (22), but now the slope b_t^* is endogenous. When other countries increase issuance to the investors, the residual demand curve faced by a specific country for its debt worsens (steepens). The effect occurs through a common component, b_t^*, to which countries of varying reputation M_{jt} are heterogeneously exposed via the taste $\omega(M_{jt})$. Countries at levels of reputation that investors on average find less attractive, a high $\omega(M_{jt})^{-1}$, are more exposed to increases in b_t^*.

5.2 Equilibrium and Stationary Distribution

We restrict our analysis to Markov strategies of committed and opportunistic government that are symmetric in investor beliefs π_{jt}: governments j and k of the same type play the same strategy if $\pi_{jt} = \pi_{kt}$.

Committed Government. A committed government j at date t takes as given the entire path of its own reputation $\{M_{jt}\}$, the reputation paths and issuance strategies $\{M_{it}, D_{it}\}_{i \neq j}$ of all other countries, and the path of returns on the outside assets $\{R_t^S\}$. Because committed government j is small, it therefore takes the path of slopes $\{b_t^*\}$ as given. The path of $\{b_t^*\}$ is sufficient information on the issuance by other countries for the committed government to solve its decision problem at date t.

As in the baseline model, the decision problem of committed government j is a repeated static problem in which at date t it faces reputation M_{jt} and slope b_t^*. Proposition 1 with homogeneous haircuts applies to this set-up and characterizes the committed government's strategy, with b_t^* replacing b.

Opportunistic Government. As in the baseline model, an opportunistic government mimics the debt issuance of the committed government to avoid revealing itself at the beginning of date t. The opportunistic government strategy is the choice of probability $m_t^o(\pi_{jt})$ of not imposing the capital control and the end of date payoff is still given by equation (8), where indirect utility V now depends on both M_{jt} and b_t^* but is otherwise defined analogously.

The decision problem of an opportunistic government can be defined analogously to the baseline model,

$$W_t(\pi_{jt}) = \max_{m^o_{jt}\in[0,1]} m^o_{jt}\Big(V^{Opp}(M_t(\pi_{jt}), b^*_t, 0)+\beta W_{t+1}(\pi_{j,t+1})\Big)+(1-m^o_{jt})\Big(V^{Opp}(M_t(\pi_{jt}), b^*_t, \bar{\tau})+\beta W_{t+1}(\epsilon^0)\Big). \tag{33}$$

where the value function W_t now also depends on time t variables like b^*_t and their future evolution.

Definition of Equilibrium. We now define an equilibrium of the model with competition.

Definition 2 *An equilibrium of the competition model is a path of debt issuances of committed governments $\{D_{jt}\}$, a path of debt and outside asset purchases $\{S^i_t, D^i_{jt}\}$ of investor i such that debt markets and asset markets clear at interest rates $\{R_{jt}, R^S_t\}$, a path of strategies $m^o_t(\pi_{jt})$ of opportunistic governments, a path of investor beliefs about government types $\{\pi_{jt}\}$, opportunistic government strategies $\{m_t(\pi_{jt})\}$, and government reputation $\{M_t(\pi_{jt})\}$, and a path of slopes $\{b^*_t\}$ such that: (1) Debt issuances are optimal for the committed government; (2) Debt and asset purchases are optimal for investors; (3) $m^o_t(\pi_{jt})$ is an optimal strategy of opportunistic government j at date t; (4) π_{jt} is consistent with Bayes' rule in equation (10); (5) Investor beliefs are consistent with the opportunistic government optimal strategy, (6) $m_t(\pi_{jt}) = m^o_t(\pi_{jt})$; (7) Slope b^*_t is consistent with equation (31).*

For given constant slope b^*, the equilibrium Definition 2 is identical to that in the baseline model with homogeneous haircuts (Definition 1).

Steady State Symmetric Equilibrium. We focus on characterizing a steady state of the model which features a symmetric graduation step Markov equilibrium. A steady state of the model is an equilibrium with a path of constant slopes: $b^*_t = b^*$.

We construct an equilibrium proceeding as follows.[45] First, consider the model of Section 3 with homogeneous haircuts. For any given b^* in the model with competition, define $b' = b^*$ to be the value of the slope of investor demand in the model without competition. Then by Proposition 2 there exists a unique graduation step Markov equilibrium of the model without competition. Imagine a unit mass of countries each separately in a Markov equilibrium without competition. Denote $\mathbf{M}(b^*) = \{M_0(b^*), ..., M_N(b^*), 1-\epsilon^C\}$ to be the reputation cycle associated with the unique graduation step Markov equilibrium without competition when the slope is $b' = b^*$. Parts (1)-(5) of the Definition 2 hold in this conjectured equilibrium. What remains to verify is that condition (6) also holds: given conjectured equilibrium issuance D_{jt} and reputation cycle $\mathbf{M}(b^*)$ the right hand side of equation (31) indeed equals the conjectured value of b^*.

Given the reputation cycle $\mathbf{M}(b^*)$, the steady state distribution μ_{b^*} over reputation levels $[0,1]$ is atomic with atoms at each point in $\mathbf{M}(b^*)$ and with no mass at any subset of $[0,1]$ that is disjoint with $\mathbf{M}(b^*)$.[46] We can rewrite equation (31) as

$$b^* = b\int_M \frac{1}{4}\omega(M)^{-1}D(M,b^*)^2 d\mu_{b^*}, \tag{34}$$

[45] As in the baseline model, we restrict attention to cases where the collateral constraint binds. We provide a sufficient condition on primitives for the collateral constraint to bind in the proof of Proposition 5.

[46] Appendix A.II.O provides a formal characterization of this stationary distribution μ_{b^*}.

where we employed a Lebesgue integral over μ_{b^*} and $D(M, b^*) = 2\frac{\omega(M)}{b^*}\left[\gamma Q(1-(1-M)\overline{\tau}) - \bar{R}\right]$ as in Proposition 1 with homogeneous haircuts. Thus, an equilibrium exists if there is a b^* such that the above condition holds. The proposition below formalizes existence of our conjectured equilibrium, which we refer to as a steady state symmetric graduation step Markov equilibrium.

Proposition 5 *There exists a steady state symmetric graduation step Markov equilibrium of the competition model.*

5.3 Effects of Competition

Competition affects the dynamics of the model both by affecting the optimal debt policy for a given reputation path and by affecting the path of reputation itself. Intuitively, competition lowers the value of becoming a reserve currency because, in the presence of competitors, the residual demand curve for debt is not as attractive (steeper) for the issuer. Most potential candidate countries stay at low levels of reputation, that is they do not become reserve currencies, and even those that emerge as reserve currencies find being one less valuable than in the absence of competition. To unpack these effects it is useful to consider some special cases before turning to the full effect of competition on the stationary distribution.

We consider first the special case of no inside equity, so that all projects are fully debt financed.

Proposition 6 *Assume that inside equity is zero, $A = 0$. Then, there exists a unique steady state symmetric graduation step Markov equilibrium of the model with competition. The reputation vector $\boldsymbol{M}$ and distribution μ are the same as those in the unique graduation step Markov equilibrium in the model without competition and slope b. Competition lowers the optimal debt issuance but does not affect the evolution of reputation.*

In this limiting case, competition lowers equilibrium debt issuance but has no direct impact on the reputational dynamics. The reason is that absent inside equity, the entire value of the government comes from debt issuance. Because b^* has the same proportional impact on the demand curves of all reputation levels, it drops out of the transition dynamics absent inside equity, leading to the limiting result.

In the general case with $A \geq 0$, the transition dynamics are

$$V(M_n) = \rho v A \frac{b^* - b}{b} + \rho V(M_{n-1}) + V(M_0),$$

where V is the indirect utility function of the committed government in the model without competition and slope b, and where $v = \frac{h}{\gamma - \frac{1-h}{R^M}}\gamma Q$ is the marginal value of inside equity.[47] In the limiting case of $A = 0$, these transition dynamics collapse to those of the model without competition, as highlighted by Proposition 6. When $A > 0$, the above equation shows that reputation builds more quickly when competition is higher, that is b^* increases relative to b. Intuitively, the value of intermediation can be thought of as a combination of value from inside equity and value from external debt. As competition

[47]See the proof of Proposition 6 in the Appendix for the derivation.

becomes more fierce, the value of external debt declines relative to the value of inside equity, making it less costly for a government to forego its current reputation level (all else equal). This means that a larger reputational gain is required to induce the opportunistic government to be willing to forgo capital controls today, leading to a faster buildup of reputation.

The above observation gives rise to a second interesting limiting case: committed governments can provide sufficiently fierce competition to force immediate graduation by opportunistic governments.

Proposition 7 *There exists a threshold $\overline{b}^*$ such that if and only if $b^* > \overline{b}^*$, there is a crowd out equilibrium of the competition model in which $\boldsymbol{M} = \{\epsilon^W, 1-\epsilon^C\}$ and all opportunistic governments immediately graduate.*

Intuitively, competition in this case is sufficiently fierce that opportunistic governments cannot build sufficient value from reputation. As a result, they immediately impose capital controls and graduate. Proposition 7 expresses the result in terms of a threshold on the sufficient statistic b^*.[48]

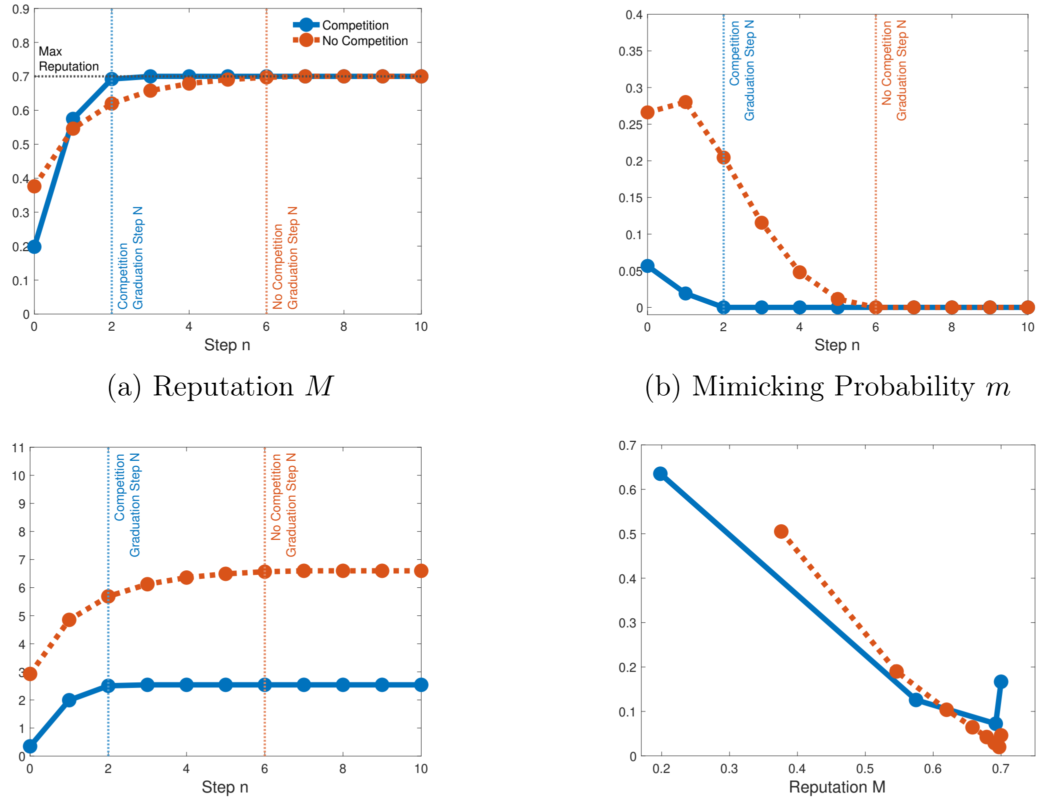
Numerical Illustration. We now turn to a numerical illustration of the general case. For simplicity, we assume $\omega(M)$ is constant in M. Figure 7 plots the equilibrium cycle and distribution of reputation for a country in the model under two configurations. This configuration is equivalent to the baseline model of Section 3.6, but with homogeneous haircuts. For this configuration, Figure 7 panel (d) plots the stationary frequency that the country spends at each level of reputation. The country spends most of the time at low levels of reputation highlighting how difficult it is to emerge as a reserve currency in the model.

In the second configuration, there is a unit mass of issuing countries. All parameters are otherwise identical to the first configuration, including b and $\omega(M)$. For this configuration, Figure 7 panel (d) plots the stationary frequency that a country, drawn at random ex-ante, spends at each level of reputation. Given the law of large numbers, this frequency also coincides with the stationary cross-sectional distribution μ. Compared to the first configuration, the country now spends more time at lower levels of reputation and graduates sooner.[49] Indeed, Panel (a) shows that reputation at $n = 0$ is lower under competition, but then grows faster leading to an early graduation. The faster growth is consistent with the lower mimicking probability at $n = 0$ under competition. A greater fraction of opportunistic types reveal themselves at $n = 0$ leading to a higher stationary mass point there (see Panel (d)). Panel (c) confirms that debt issuance per country falls due to competition. Overall, these features highlight that competition deters a country currently at a low level of reputation, like China, from building reputation up into being a reserve currency. Several of the key qualitative features of Figure 7 can be shown to be

[48]A similar expression holds in the model without competition and provides a restriction on a set of parameters, including the slope of the demand curve b, to induce immediate graduation ($N = 0$). In particular, the model without competition requires that $(1+\rho)V(\epsilon^O) \geq V(1-\epsilon^C)$ for immediate graduation to occur. If the model without competition features immediate graduation, then the model with competition also features immediate graduation.

[49]Both distributions feature an increase in mass at the highest reputation that is achieved after graduation. This level of reputation is identical in the two configurations and given by $1-\epsilon^c$. The graduation step is an absorbing state for committed types, so that a mass of probability builds up in the model at that level of reputation.

Figure 7: Competition and the Stationary Distribution



(a) Reputation M

(b) Mimicking Probability m

(c) Debt Issuance D

(d) Stationary Distribution μ

Notes: Numerical illustration of the model with or without competition. Panel (a) plots the reputation cycle M. Panel (b) plots the mimicking probability m. Panel (c) plots debt issuance. In panels (a), (b), and (c), the dashed-blue and dashed-red lines are the graduation steps of the model with competition and no competition, respectively. Panel (d) plots the stationary distribution μ of the two models.

generic properties of the model with competition. Generically, higher competition leads countries to start at a lower reputation level at $n = 0$, eventually build to a higher reputation level, and graduate faster. Higher competition always leads opportunistic governments to mimic less early in the reputation cycle. Equilibrium debt issuance is lower for any given reputation level.

How Can the U.S. Deter China From Becoming a Reserve Currency? In the model of competition we studied above, countries take the reputation cycle and distribution as given, in the spirit of monopolistic competition models. It is interesting to extend this set-up to consider the incentives of a country to manipulate the cycle, and the impact such a country has on the outcomes for its competitors. We provide here a brief leading example, relegating most of the details to Appendix A.II.M. Suppose there was a large country known to be committed forever, so that its reputation is $M = 1$ and constant. Assume that this country chooses issuance taking into consideration its effect on the reputational cycle $\mathbf{M}$, distribution μ, and other countries' issuance, that is its effect on b^*.

In terms of the model developed in this section, it is analytically convenient to make this country (the U.S.) the issuer of the outside safe asset S which we previously took as being supplied exogenously at $\bar{S}$.[50] This country faces the demand curve in equation (28). As it increases issuance S, the first term in the demand curve leads to the usual monopolist effect: the country internalizes that its own interest rate goes up as it issues more debt. As R^S increases, further issuance also has the effect of pushing up the slope of the demand curve, b^*, faced by its competitors. In turn, competitors' issuance decisions, affect the second term in equation (28), $\sum_i \int \omega_i (M_{jt})^{-1} D_{jt}^{i2} dj$, which falls if the competitors decrease their issuance. The country (U.S.) chooses higher issuance, all else equal, if this latter effect is indeed negative.

An interesting corollary of Proposition 7 is that this country (the U.S.) can choose sufficiently high issuance S such that all opportunistic competitors graduate immediately. Intuitively, the US flooding the market with safe assets diminishes the value of building reputation for an opportunistic competitor (say China) sufficiently to completely discourage it from building any reputation. More generally, we show that the probability that an opportunistic competitor, starting at the beginning of the reputation cycle (at step 0), goes through its next n crises without ever exercising the capital control declines for any $n > 0$ as the U.S. issues more safe debt. This means that the probability an opportunistic competitor builds to any reputation above the initial level declines. In this sense, increased issuance by the U.S. makes it harder for an emerging opportunistic competitor to establish itself as a competitor reserve currency. In practice, one important concern is that the U.S. issuing more debt to deter new entrants like China might risk a self-full-filling debt crisis in the U.S. itself (see Farhi and Maggiori (2018) and He et al. (2019)). This risk is absent here since we imposed common knowledge that the US is a committed type.

Formally, we define $\delta_n = \prod_{k=0}^{n-1} m_k$ to be the probability that a government that is opportunistic at step 0 and survives its next n crisis, does not exercise the capital control in any of those crises and reaches step n of its reputation cycle. We collect the result in the proposition below.

Proposition 8 *The probability that an opportunistic government (e.g. China) starting at step* 0 *reaches step n of its reputation cycle decreases in competition* b^* *for any $n \geq 1$, that is* $\frac{\partial \delta_n}{\partial b^*} < 0$.

In this set-up, the presence of an existing hegemon, like the U.S., makes it less likely that a multipolar international monetary system emerges. Much like in Stackelberg competition, the incumbent uses its dominant position to discourage entrance, in this case by oversupplying safe assets and shrinking the exorbitant privilege. To the extent that a multipolar system is desirable, this analysis opens up a role for multilateral policy agreements and points to the tools from the analysis of monopolies and competition as a way forward to analyze and reform the international monetary system.

6 Two-Way Capital Flows

The Chinese government is one of the largest holders of U.S. Treasuries and a major foreign investor in everything from direct financing of infrastructure projects to loans to emerging market economies. At the

[50] Taking the U.S. as being known to be committed, while we think of China as opportunistic, is purely for convenience and sharpens the focus on the key forces we want to highlight.

same time, it is letting foreigners participate in its domestic bond markets. In the model considered so far, we have focused on the decision to borrow from foreigners. We now consider the interrelated decision of letting domestic savers invest abroad. These two-way capital flows are important in understanding China's motivation for internationalizing its currency because they distinguish the current account and net foreign asset position (net borrowing at the country level) from the gross assets and liabilities positions and changes in gross positions (see also Obstfeld et al. (2010) and Dooley et al. (2008)).

We show that, as reputation builds, increased investment by foreigners in the domestic bond market coincides with increased foreign investment by domestic households (savers). On the one hand, the model clarifies that internationalizing a currency is not about net-borrowing per se, i.e. the current account or net foreign assets, but more liked to gross positions. On the other hand, it draws an equilibrium connection between internationalization and, all else equal, the net desire to borrow. In net, as reputation builds, the country becomes more of a borrower (or at least less of a creditor) from the rest of the world. For example, starting from a large creditor position at low levels of reputation, like China's present situation, there is a tendency toward becoming a debtor as reputation increases. Intuitively, reputation is like a pledgable asset, it is valuable because one can borrow against it. The more it becomes valuable, the more the country wants to use it to lever up.

We return to the baseline model of Section 3.6 with heterogeneous investors. We generalize that model by assuming that domestic households have an endowment W of liquid wealth at each date t. Households also own the intermediation sector, where $E_t \equiv V_t$ is the total value of the intermediation sector equity at date t. Thus, their total wealth position is $W + E_t$. At the beginning of each date, households can invest an amount K_t in illiquid foreign assets, which pay out R^K at the end of the date. Households invest the remainder $W - K_t$ in illiquid non-intermediary investments, and we normalize the return of these assets to 1 for simplicity.[51] In the main text we assume that shares in the intermediaries cannot be traded, since inside capital A is fixed and domestically held. In Appendix A.II.P.6, we relax this assumption and show that it generates a jump in both gross assets and liabilities that occurs at the opening up step.

Households have an adjustment cost for sending capital abroad based on their total wealth, given by $\Psi(k_t)(W + E_t)$, where $k_t = \frac{K_t}{W+E_t}$ is the fraction of their total wealth that they send abroad and where Ψ is increasing and convex. Given that households send a fraction k_t of their wealth abroad, their total welfare, including the value E_t of their intermediary equity, is given by: $\Big(R^K k_t - \Psi(k_t) + (1 - k_t)\Big)(W + E_t)$. The optimal private allocation of domestic savings to foreign investment k_t is constant, that is households always allocate a constant fraction of their total wealth to international investment. This optimal household allocation is given by $\Psi'(k) = R^K - 1$.

The government may encourage capital outflows by domestic savers to be higher or lower than the private optimum. On the one hand, the government may value investments that increase demand for the Renminbi as a global currency more so than individual households do, internalizing the benefits of a liquid market for its currency. The benefits might come in the form of a shift downward in the demand

[51] We assume that there is a very large penalty associated with $K_t > W$ and focus for simplicity on solutions in which this constraint does not bind.

curve of foreign investors, who have higher incentives to invest in Renminbi as a result of Chinese foreign investment. The benefits might also arise from gains in geopolitical importance or independence arising from building an international payment system in which the Renminbi is an accepted store of value and means of payment. On the other hand, individual savers may value exporting capital more than the government if they fear that capital held domestically will be captured by the government for its own private benefits. The government may have perverse incentives to restrict private outflows of capital if it can divert part of that capital to its private benefit.

To capture the wedge between private and government incentives, we assume that the government obtains a proportional benefit B from all savings kept at home, which yields a total benefit to the government of $B(1-k_t)(W+E_t)$. A value of $B>0$, can stand in for government corruption, or more benignly, benefits from keeping the savings domestic that are not internalized by households. A value of $B<0$, help us capture the extra value attributed by the government compared to households to investments abroad that help build the currency globally. Given the government's objective, its optimal allocation is $\Psi'(k_t) = R^K - (1+B)$. If $B>0$, then the government chooses to send less capital abroad than households would have privately chosen, and it imposes limits on domestic capital flowing abroad concurrently with the limits on inflows by foreigners (this latter part has been the focus of our model so far).[52]

Solving the model with two-way asset holdings follows the same steps as the model solution in Section 3.6. Since k_t is constant over time, the government's objective function is an affine transformation of $E_t = V_t$ generating similar dynamics. We further impose a realistic restriction that the marginal value of an additional unit of inside equity is less than two, so that the marginal return on an additional unit of inside equity is less than one hundred percent.[53] We summarize the dynamics in the proposition below.

Proposition 9 *In the model with two-way capital flows, both gross foreign assets and liabilities increase in reputation. The country's net foreign assets deteriorate as reputation improves.*

As reputation builds up, gross flows happen simultaneously: foreigners hold more of the domestic bond market and domestic capital flows abroad. Foreign assets, $K_t = k(W+E_t)$, increases in constant proportion ($k<1$) to the equity value of the intermediation sector. Intuitively, as reputation builds, the equity value of the intermediation sector also builds, and so does household net worth, making it more attractive to send more wealth abroad. Foreign liabilities D_t increase faster than the value of intermediation (see proof of Proposition 9 in the Appendix). The country is leveraging to extract the highest possible value out of its reputation, and becomes more levered as reputation increases. The net foreign asset position, therefore, deteriorates as reputation increases.

[52] In practice the government might simultaneously limit some forms of domestic capital outflows and incentivize others. For example, it might limit private holdings of foreign assets and, at the same time, invest abroad via state-owned entity projects that the government selects. In the case of China, for example, there are tight controls on private holdings of foreign securities, but at the same time entities like SAFE and AIIB make large investments abroad using domestic savings. This could be accommodated in our framework by introducing two types of foreign investments, one over which B is positive and one over which it is negative.

[53] See the proof of Proposition 9 in Appendix A.II.L for discussion of where this condition applies.

The model can make sense of a country like China that is a net foreign creditor at low levels of reputation: imagine that W is much larger than E_t at low levels of M. Even at low levels of reputation, and while being a net foreign creditor, the country chooses to borrow some capital from foreigners in order to start building future reputation. As that reputation is built, the desire for borrowing increases faster than the desire to invest domestic savings abroad, leading to a net foreign asset deterioration. The model captures the tendency of countries that are established reserve currency providers, like the U.S., to be net foreign debtors and characterizes their dynamic adjustment toward this position.

7 Conclusion

This paper characterizes China's strategy for internationalizing its currency through controlling the set of investors that can access its bond market. While the Renminbi has a long way to go to rival the U.S. Dollar as an international currency, China's real economic size and the size of its capital market could make the integration of its capital market into global financial markets a major shift in the international monetary system. We explain China's gradual approach to liberalizing capital inflows as balancing the desire to gain international currency status against the risks of sudden capital outflows that come with foreign investment. By beginning with allowing investment from more stable investors and only later allowing in flightier ones, China has put itself on a path towards becoming an international currency while trying to minimize the risks it faces on the transition path. Whether it is able to achieve this while avoiding costly episodes of capital flight and the imposition of capital outflow controls is an open question.

References

Amador, Manuel and Christopher Phelan, "Reputation and sovereign default," *Econometrica*, 2021, *89* (4), 1979–2010.

Amstad, Marlene and Zhiguo He, "Chinese bond markets and interbank market," *The Handbook of China's Financial System*, 2020, pp. 105–150.

Amstad, Marlene, Guofeng Sun, and Wei Xiong, *The Handbook of China's Financial System*, Princeton University Press, 2020.

Arslanalp, Serkan, Barry Eichengreen, and Chima Simpson-Bell, "The stealth erosion of dollar dominance and the rise of nontraditional reserve currencies," *Journal of International Economics*, 2022, p. 103656.

ASIFMA, "Foreign Institutional Investment in China: Various Access Channels," January 2021.

Bahaj, Saleem and Ricardo Reis, "Jumpstarting an international currency," 2020.

Bahaj, Saleem and Ricardo Reis, "Central bank swap lines: Evidence on the effects of the lender of last resort," *Review of Economic Studies*, 2021.

Barro, Robert J and David B Gordon, "Rules, discretion and reputation in a model of monetary policy," *Journal of monetary economics*, 1983, *12* (1), 101–121.

Bianchi, Javier, "Overborrowing and systemic externalities in the business cycle," *American Economic Review*, 2011, *101* (7), 3400–3426.

Bianchi, Javier and Guido Lorenzoni, "The Prudential Use of Capital Controls and Foreign Currency Reserves," Technical Report, National Bureau of Economic Research 2021.

Broz, J Lawrence, "The international origins of the Federal Reserve System," in "The International Origins of the Federal Reserve System," Cornell University Press, 2018.

Brunnermeier, Markus K, Michael Sockin, and Wei Xiong, "China's model of managing the financial system," *Review of Economic Studies*, 2022.

Caballero, Ricardo J. and Alp Simsek, "A Model of Fickle Capital Flows and Retrenchment," *Journal of Political Economy*, dec 2020, *128* (6), 2288–2328.

Carpenter, Jennifer N, Fangzhou Lu, and Robert F Whitelaw, "Government Bond Risk and Return in the US and China," 2022.
Cerutti, Eugenio M and Maurice Obstfeld, *China's Bond Market and Global Financial Markets*, International Monetary Fund, 2018.
Chahrour, Ryan and Rosen Valchev, "Trade Finance and the Durability of the Dollar," *Review of Economic Studies*, 2021.
Chernow, Ron, *Alexander Hamilton*, The Penguin Press, New York, 2004.
Choi, Jason, Rishabh Kirpalani, and Diego J Perez, "The Macroeconomic Implications of US Market Power in Safe Assets," 2022.
Clayton, Christopher and Andreas Schaab, "Multinational Banks and Financial Stability," *The Quarterly Journal of Economics*, 2022.
Conte, Maddalena, Pierre Cotterlaz, and Thierry Mayer, "The CEPII Gravity Database Highlights," 2022.
Coppola, Antonio, "In Safe Hands: The Financial and Real Impact of Investor Composition Over the Credit Cycle," 2021.
Coppola, Antonio, Matteo Maggiori, Brent Neiman, and Jesse Schreger, "Redrawing the map of global capital flows: The role of cross-border financing and tax havens," *The Quarterly Journal of Economics*, 2021, *136* (3), 1499–1556.
Cripps, Martin W, George J Mailath, and Larry Samuelson, "Imperfect monitoring and impermanent reputations," *Econometrica*, 2004, *72* (2), 407–432.
Danese, Paolo, "Small Print Won't Spoil CIBM Party," *Global Capital Euroweek*, July 2016.
Diamond, Douglas W, "Reputation acquisition in debt markets," *Journal of political Economy*, 1989, *97* (4), 828–862.
Diamond, Douglas W, "Monitoring and reputation: The choice between bank loans and directly placed debt," *Journal of political Economy*, 1991, *99* (4), 689–721.
Dooley, Michael, David Folkerts-Landau, and Peter Garber, "Asia, interest rates, and the dollar," *Deutsche Bank,*, 2008.
Drenik, Andres, Rishabh Kirpalani, and Diego Perez, "Currency choice in contracts," *The Review of Economic Studies*, 2021.
Du, Wenxin, Joanne Im, and Jesse Schreger, "The us treasury premium," *Journal of International Economics*, 2018, *112*, 167–181.
Eichengreen, Barry, *Exorbitant Privilege: The rise and fall of the Dollar and the Future of the International Monetary System*, Oxford University Press, 2011.
Eichengreen, Barry, Arnaud Mehl, and Livia Chitu, *How global currencies work*, Princeton University Press, 2017.
Eichengreen, Barry, Camille Macaire, Arnaud Mehl, Eric Monnet, and Alain Naef, "Is Capital Account Convertibility Required for the Renminbi to Acquire Reserve Currency Status?," Technical Report, CEPR, Discussion Paper 2022.
Farhi, Emmanuel and Matteo Maggiori, "A model of the international monetary system," *The Quarterly Journal of Economics*, 2018, *133* (1), 295–355.
Fourakis, Stelios, "Sovereign Default and Government Reputation," *Working Paper*, 2021.
Fund, International Monetary, "Survey on the Holdings of Currency in Official Foreign Currency Assets," 2015.
Gopinath, Gita and Jeremy C Stein, "Banking, trade, and the making of a dominant currency," *The Quarterly Journal of Economics*, 2021, (2), 783–830.
Guerrieri, Veronica and Guido Lorenzoni, "Credit crises, precautionary savings, and the liquidity trap," *The Quarterly Journal of Economics*, 2017, *132* (3), 1427–1467.
Guo, Kai, "Opening up China's bond market: Some considerations," *The Future of China's Bond Market*, 2019, p. 197.
Hamilton, Alexander, "Report Relative to a Provision for the Support of Public Credit," *The Papers of Alexander Hamilton*, 1790, pp. 1961–1987.
He, Zhiguo, Arvind Krishnamurthy, and Konstantin Milbradt, "A model of safe asset determination," *American Economic Review*, 2019, *109* (4), 1230–62.
Ilzetzki, Ethan, Carmen M. Reinhart, and Kenneth S. Rogoff, *Rethinking Exchange Rate Regimes*, Vol. 6, Elsevier: North Holland, 2022.
Keynes, John Maynard, *A tract on monetary reform*, London: Macmillan, 1923.
Koijen, Ralph SJ and Motohiro Yogo, "A demand system approach to asset pricing," *Journal of Political Economy*, 2019, *127* (4), 1475–1515.
Kreps, David M and Robert Wilson, "Reputation and imperfect information," *Journal of economic theory*, 1982, *27* (2), 253–279.

Lai, Edwin L-C, *One Currency, Two Markets: China's Attempt to Internationalize the Renminbi*, Cambridge University Press, 2021.

Liu, Becky and Terry Chan, "Foreign investment in China bonds – Who buys what," *Standard Chartered Global Research*, October 2019.

Lorenzoni, Guido, "Inefficient credit booms," *The Review of Economic Studies*, 2008, *75* (3), 809–833.

Lu, Yang K, "Optimal policy with credibility concerns," *Journal of Economic Theory*, 2013, *148* (5), 2007–2032.

Lustig, Hanno, Nikolai Roussanov, and Adrien Verdelhan, "Common risk factors in currency markets," *The Review of Financial Studies*, 2011, *24* (11), 3731–3777.

Maggiori, Matteo, Brent Neiman, and Jesse Schreger, "International currencies and capital allocation," *Journal of Political Economy*, 2020, *128* (6), 2019–2066.

Mailath, George J and Larry Samuelson, "Who wants a good reputation?," *The Review of Economic Studies*, 2001, *68* (2), 415–441.

Mailath, George J, Larry Samuelson et al., *Repeated games and reputations: long-run relationships*, Oxford university press, 2006.

Milgrom, Paul and John Roberts, "Predation, reputation, and entry deterrence," *Journal of economic theory*, 1982, *27* (2), 280–312.

Mo, Jingyuan and Marti G Subrahmanyam, "What Drives Liquidity in the Chinese Credit Bond Markets?," *NYU Stern School of Business*, 2020.

Obstfeld, Maurice, Jay C Shambaugh, and Alan M Taylor, "Financial stability, the trilemma, and international reserves," *American Economic Journal: Macroeconomics*, 2010, *2* (2), 57–94.

Ostry, Jonathan, "The IMF's Journey on Capital Controls: What Is the Destination?," 2022.

Phelan, Christopher, "Public trust and government betrayal," *Journal of Economic Theory*, 2006, *130* (1), 27–43.

Prasad, Eswar, *Gaining currency: The rise of the renminbi*, Oxford University Press, 2017.

SAFE, "Foreign Exchange Receipts and Payments for the First Three Quarters of 2015 Press Conference Transcript," November 2015.

SAFE, "SAFE Spokesperson Answers Press Questions on Foreign Exchange Receipts and Payments in 2015," February 2016.

Sano, Hideyuki and Andrew Galbraith, "Japan's GPIF to shun Chinese govt bonds even after benchmark inclusion," September 29 2019.

Sargent, Thomas J, "Nobel lecture: United states then, europe now," *Journal of Political Economy*, 2012, *120* (1), 1–40.

Schipke, Alfred, Markus Rodlauer, and Zhang Longmei, "China's Bond Market: Characteristics, Prospects, and Reforms," *The Future of China's Bond Market*, 2019.

Schipke, Alfred, Rodlauer-Markus and Longmei Zhang, *The future of China's bond market*, International Monetary Fund, 2019.

Song, Zheng and Wei Xiong, "Risks in China's financial system," *Annual review of financial economics*, 2018, *10*, 261–286.

Song, Zheng, Kjetil Storesletten, and Fabrizio Zilibotti, "Growing like china," *American economic review*, 2011, *101* (1), 196–233.

Tadelis, Steven, "What's in a Name? Reputation as a Tradeable Asset," *American Economic Review*, 1999, *89* (3), 548–563.

Weinland, Don, "China's capital controls dent inbound investment," 2017.

Xiong, Wei, "The mandarin model of growth," Technical Report, National Bureau of Economic Research 2018.

Online Appendix for "Internationalizing Like China"

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A.I Further Details on Data and Estimates

This Appendix contains further details on the data sources and estimates underlying the empirical results of the paper.

A.I.A Aggregate and Bilateral Bond Holdings

This section outlines the methodology for estimating the breakdown between central bank reserves and private holdings of RMB bonds, as well as their split by country of holder. Before detailing the methodology, we first define some concepts that will be useful throughout this entire section to understand data on bond markets. Some characteristics describe the issuer of the bond: country of residency of the immediate issuer of a bond (*residency*), country of residency of the ultimate parent entity controlling the immediate issuer of a bond (*nationality*), and the sector of the issuer (*corporate, government, etc...*). Some characteristics describe the bond itself: the currency of the bond (*CNY, CNH, foreign currencies*), the market of issuance (*onshore or international/offshore*). Some characteristics describe the holder of the bond: domestic or foreign investors, the sector of the holder (*central bank, other official investors, private investors*). The characteristics illustrated above are not exhaustive and the aim here is not to review them in detail, but just to use them to guide the reader thought this appendix. Our main focus is on bonds denominated in RMB, issued onshore by Chinese resident entities (also by nationality), and held by foreign investors.

One of our main data sources is the IMF's Coordinated Portfolio Investment Survey (CPIS). These data includes the bond portfolio holdings of each foreign country in China. More precisely, the issuers are domiciled in China (resident in China irrespective of nationality); the bonds can be issued in any market and denominated in any currency; the bonds include all bond types by sector (government, corporate, etc...); and the holder in each country excludes the central bank. CPIS data is a proxy for private holdings. It does, however, include the holdings of some state entities, for example the sovereign "oil fund" of Norway. Non-private investors are, in this section, mainly central banks. In the specific case of China, these portfolio holdings are most likely to be concentrated in bonds denominated in RMB, issued onshore by Chinese resident entities (also by nationality). An assumption that we maintain throughout and for which the next subsection provides some supporting evidence.

CPIS also contains additional information on Currency Breakdown of Investment by asset class (CPIS Table 2). These data are at the same investor and asset class level as the data above, but the issuers are now the universe of all issuers. For example, RMB denominated bond holdings of the US include: bonds denominated in RMB issued by any entity (Chinese resident or otherwise) and held by investors domiciled in the US. This is a superset of the RMB-denominated bonds held by each investor country onshore in China.

We start our analysis by collecting and combining different data sources to estimate the RMB holdings by central banks. The main source comes directly from the IMF Currency Composition of Official Foreign Exchange Reserves (COFER), which includes data on foreign reserve holdings of RMB. COFER data are reported to the IMF on a voluntary basis, but data for individual countries are strictly confidential. At present there are 149 COFER reporters, i.e. countries disclosing the currency composition of their holdings to the IMF. This subset of countries accounts for the "Allocated Reserves" and (for this subset) it is possible to directly observe their combined aggregate holdings in RMB since the fourth quarter of 2016. Prior to that date, holdings of RMB were aggregated into "Other Currencies". Based on a 2015 ad-hoc survey of the IMF (Fund (2015)) we obtained that 0.57% and 0.95% of foreign currency reserves were held in Renminbi in 2013 and 2014 respectively. Overall, this provides us with the level and share of COFER reserve holdings in RMB from 2013 to the present, except for 2015, a year for which we interpolate the data based on the 2014 and 2016 data.

While most countries only report their holdings to COFER on a confidential basis such that the underlying bilateral data is not disclosed, some countries are also Special Data Dissemination Standard (SDDS) Plus adherents and disclose their positions denominated in RMB. In addition, and in order to obtain the most detailed breakdown by country of official holdings in RMB, we separately collected the currency breakdown directly from central banks' documents for non SDDS reporters.[1] Using these combined data sources, we were able to observe the country breakdown for almost 40% of the total RMB official holdings in 2020.

There is a subset of countries that report their total reserve holdings in the International Financial Statistics (IFS), but do not report the currency breakdown to COFER. These countries are classified as "Unallocated Reserves" in COFER. By the end of 2020, about 6.6% of total reserves reported to IFS were from non-COFER reporters and therefore "Unallocated Reserves." We estimate the RMB holdings for these countries by multiplying their total reserves by the share of RMB in total "Allocated Reserves" excluding China. China became a COFER reporter between 2015 and 2018 (Arslanalp et al. (2022)) but does not disclose what share of its reserves it reported to COFER at any point in time during the transition. We assume that it increased its disclosure share at a constant rate between 2015 and 2018 (25% at end of 2015, 50% at end of 2016, 75% at end of 2017, 100% at end of 2018). Since we assume the PBoC does not hold any RMB denominated assets as reserves, we then remove China's reserves from the IMF's Allocated and Unallocated reserve totals to calculate the share of RMB in Allocated reserves excluding China. We estimate this share to be 3.1% in 2020. We then use this share of RMB to estimate the level of RMB holdings in Unallocated reserves to be $ 26 billion. Figure 1 labels as "Other Reserves" the sum of: "Allocated Reserves" for which the country of holder cannot be inferred and our estimate of

[1] The non-SDDS countries for which documentation was manually collected are: Czech Republic, Italy, Kazakhstan, Romania, South Africa, Spain, Tanzania and United Kingdom.

the RMB portion of "Unallocated Reserves."

For private holders, we distinguish three group of countries depending on data availability. The first group are countries that report in CPIS Currency Breakdown of Investment by asset class (CPIS Table 2) the RMB bond holdings. The second group are countries for which the CPIS dataset only includes portfolio holdings into China but does not provide a currency breakdown, but for which we can provide an estimates based on commercial micro data. The third group is the same as the second, except that micro data does not provide sufficient coverage of bond holdings.

For countries in the first group we obtain the CPIS Currency Breakdown of Investment by asset class (CPIS Table 2), which allows us to directly identify bond holdings in RMB by investor country[2]. As explained above, these data include all bonds denominated in RMB irrespective of the issuer. In this case, we assume that all RMB holdings are onshore. The next subsection provides some supporting evidence for this assumption.

For countries in the second group, we build an estimate by multiplying the level of bond holdings in China from CPIS (which includes bonds denominated in all currencies) with the percentage that we estimate to be RMB-denominated using micro data. We estimate this percentage using commercial security-level data on the positions of mutual funds and ETFs from Morningstar. We merge these data with CUSIP Global Services and Bloomberg FIGI security level master files that include the currency of denomination information as well as the residency of the immediate issuer. The combined dataset was previously used and is described in detail in Maggiori et al. (2020) and Coppola et al. (2021). In order to use the commercial data when the CPIS data on currency breakdown is unavailable, we require that we observe in the micro data at least 20% of the country's bond investment in China (residency) as reported in CPIS. In sum, for these countries we measure in each year the fraction of bond investment in China on a residency basis that is denominated in RMB and apply this fraction to the total bond holdings in CPIS. The countries with largest holdings in this second group are Luxembourg and Ireland[3]. We estimate that these two alone held about $35 billion in RMB bonds in 2020.

For countries in the third group, the coverage in the micro-data is not sufficiently high to estimate the share of investment in China that is RMB-denominated. For these countries, our estimate of the fraction of bonds in RMB is simply the average share of countries in group one and two above. More precisely, we compute the average fraction of bond investment in China (residency) that is denominated in RMB in each year across the countries in the first and second groups. We then multiply this average fraction by the level of bond holdings in China from CPIS (which, again, includes bonds denominated in all currencies) for each country of the third group to obtain the estimate of RMB-denominated bond holdings. Results are similar when we instead use the aggregate share (i.e. total RMB holdings over total investment in Chinese bonds).

Finally, we impose the restriction that the sum of central bank and private holdings (which we call the disaggregated total) has to sum to total foreign holdings. For total foreign holdings, we combine data from Chinese official sources (Bond Connect, CEIC) on onshore holdings with data from the BIS Debt Securities

[2]For the U.S. in 2020, we use Treasury International Capital (TIC) data instead of IMF CPIS data.

[3]The set of countries in the second group changed over time depending on data availability. In 2020, the countries in this group were CHE, DKK, IRL, LIE, LUX, MUS, NZL and TWN.

Statistics for obtaining the internationally issued RMB debt outstanding from Chinese issuers in a given year. Bond Connect foreign holdings refer to the total onshore foreign holdings including but not limited to holdings through Bond Connect.[4] From the BIS, we collect the total amount of international debt securities (IDS) issued by Chinese residents outside the local market of the country where the borrower resides (China) in RMB (about $ 16 billion by the end of 2020). This assumes that internationally issued RMB bonds that are classified as China by residency are entirely owned by foreign investors. In matching total foreign holdings in RMB from Bond Connect plus BIS IDS with the holdings we have obtained above from COFER, CPIS, and IFS, (the disaggregated total) there is an approximation error due to mismatches in the concepts of residency of the issuer, currency, and market of issuance, in each of the datasets used.[5] For most of the years in our analysis, the disaggregated total is greater than the sum of Bond Connect and BIS IDS Chinese international issuance in RMB. We then compute the share of each country-investor type as percent of a given year disaggregated total and apply those percentages to total foreign holdings obtained as the sum of Bond Connect and BIS IDS series. By doing so, we obtain an estimate for the breakdown between central bank reserves and private holdings of RMB bonds, and their split by country of holder as shown in Figure 1.

A.I.B Offshore Issuance

In this subsection we explore foreign investor holdings of Chinese bonds along several dimensions discussed in the previous subsection. We begin by classifying every bond issued in RMB into whether it was issued in onshore Chinese markets or offshore in international capital markets. To do so we classify any security denominated in CNH (offshore Chinese Yuan) as being issued offshore. However, in order to avoid relying entirely on the reported currency, we combine use open-source data from FIGI and additionally classify bonds with a security type of Eurobond or Global from FIGI as being issued offshore. We then merge this mapping of all RMB securities into onshore/offshore with the Morningstar data on bond holdings by mutual funds and ETFs. We measure the dollar value of end-of-year holdings of foreign funds[6] in onshore and offshore bonds, and calculate the share issued offshore in foreign holdings. Appendix Figure A.Va, documents a substantial decrease in the share of foreign-owned RMB denominated bonds that were issued offshore: from more than 90% in 2012 to less than 10% in 2020. Recall that the level of overall RMB (onshore or offshore) holdings was minimal in 2012 and much larger in 2020. This result provides support for the (imperfect) assumption in the previous subsection that all bonds in RMB held from foreign investors are assumed to be onshore.

Additionally, we classify all bonds issued by a Chinese entity on a nationality basis by the source of issuance on a residency basis according to whether it was issued by a Chinese resident entity or an international entity (based in Hong Kong, tax havens, or any other country) and utilize the residency-to-nationality algorithm of Coppola et al. (2021) to measure the foreign investors holdings of bonds that

[4] Bond Connect data is publicly available online and corresponds to the sum of foreign holdings through the Shanghai Clearing House (SHCH) and the China Central Depository Clearing (CCDC).

[5] For example, this misclassifies any foreign ownership of onshore bonds issued by non-China resident issuers (so-called "Panda" bonds) or bond issued offshore by non-China entities (so-called "Dim Sum" bonds).

[6] We consider foreign all funds excluding those domiciled in China or Hong Kong.

on an ultimate-parent nationality-basis are issued by a Chinese entity or were issued in RMB. Appendix Figure A.Vb shows for foreign mutual funds and ETFs: (i) the largest holdings are foreign currency issued by entities not resident in China but controlled by a Chinese entity (i.e. foreign by residency, but China by nationality); (ii) the holdings of onshore RMB have increased substantially in recent years; (iii) the holdings of onshore bonds issued by China resident entities in foreign currency are small; (iv) the holdings of offshore issued RMB are small. This analysis provides support for the (imperfect) assumption in the previous subsection that all bonds issued by China-resident entities and held from foreign investors are assumed to be denominated in RMB.

The analysis, furthermore, shows the importance of the offshore issuance in foreign currency by foreign resident entities that are ultimately controlled by a Chinese entity. These holding are not the focus of the current paper. Coppola et al. (2021) show that they are mostly bonds issued in dollar (or other major currencies) by affiliates domiciled in tax havens (like Cayman Islands and British Virgin Islands) of Chinese technology groups (Alibaba, Tencent), real estate groups (Evergande), or state owned enterprises.

A.I.C Empirical Implementation: Reputation Measure

In this subsection we provide details and additional specifications for the correlation measure introduced in Section 4, our proxy for a country's reputation. As discussed in the main text, the idea behind the empirical measure is to inspect what other type of foreign-currency bonds (DM or EM) funds holding bonds in a particular currency are likely to hold. Our focus is on the foreign currency (FC) portion of the portfolios, which we define as holdings in a currency that is not the currency of the country where the fund is domiciled. We restrict our sample to funds that have at least $20 million in FC holdings in local-currency government bonds and exclude specialist funds in any particular currency, which we define as funds that have more than 50% of their foreign currency bond portfolio in a single currency. As shown in Appendix Table A.I, in 2020 our sample after all the restrictions are applied contains 599 funds with an average of $1.8 billion in assets under management each, although with considerable dispersion. Of total AUM, 76% on average is in FC assets and on average 58% of the FC assets are government bonds in the local currency of the issuing country (for example, Brazilian government bonds in BRL). The major fund domiciles are the United States and the Eurozone. As is well known, funds in the Eurozone are heavily concentrated in Luxembourg and Ireland as domiciles, and then distribute to the rest of the Eurozone (as well as outside the Eurozone). In Table A.I, of the 318 funds domiciled in the EMU, 206 are domiciled in Luxembourg and 76 in Ireland. The sample focuses on funds that have major investments in foreign-currency government bonds, and while this is clearly a small subset of the universe of funds (which includes equity funds, and funds that only invest in particular currencies), it is a sufficiently large and heterogeneous sample for our estimation purposes.

Next, we classify all currencies (except the RMB) with at least $1 billion in foreign investments in Morningstar in December 2020 as either developed market (DM), emerging market (EM), or frontier market currency. We take a narrow definition of DM currencies to be those issued by G10 countries. Frontier and emerging markets are classified according to the MSCI's list. We conduct our analysis focusing on DM and EM currencies, leaving out frontier currencies since funds investing in those usually have a very specific mandate.[7]

Complementing the analysis in the main-text, we recalculate our measures for a number of different subsets of the data. The subsets considered are:

(a). **US Treasuries as Reference Asset:** taking U.S. Treasury debt as the sole high reputation reference asset ($\bar{M}$ from the theory).

(b). **Weighting by FC AUM of the funds:** weighting funds' portfolio shares by their foreign currency investment holdings in computing the correlation.

(c). **Excluding Index Funds:** leaving out funds classified as index funds in Morningstar (variable index_fund flag equal to "Yes" indicating a "pure index fund").

(d). **Intensive Margin:** including only funds with strictly positive holdings in a particular currency in computing the correlation for that currency.

(e). **Higher Specialist Threshold:** defining as specialist funds that have more than 98% of their foreign currency bond portfolio in any single currency, rather than 50% in our baseline analysis.

(f). **Alternative Minimum FC AUM:** including funds with at least $10 million in holdings of FC government bonds issued in their own currency.

(g). **Alternative Foreign Currency Definition:** excluding the currency in which the fund reports its returns (as opposed to excluding the currency of the country in which the fund is domiciled).

We summarize the results of these alternative specifications in Appendix Table A.II. For each alternative specification, we sort the estimated correlations in descending order and compute the average rank of DM and EM currencies, as well as the ranking of the CNY. Appendix Table A.II shows that, while there is clearly substantial variation in the estimates, the baseline result extends to these specifications in the sense that the Chinese RMB ranks between EM and DM currencies. The number of funds in subsets (c), (e), (f) and (g) changes due to the different selection criteria for the sample. Excluding index funds (e) reduces the sample size in about 10%, to 547 funds, while the alternative foreign currency definition (g) increases it in about 10% to 664 funds. Cases (e) and (f) impose less restrictive criteria than baseline resulting in larger sample sizes: 719 and 1107 funds, respectively. In Appendix Figure A.IX we report the cross-section estimates of these alternative specifications.

While our theory has only differences in reputation as drivers of differences in portfolios, there are, of course, other factors determining global portfolios. To evaluate the robustness of our conclusions about differences in perceived reputation, we additionally control for other determinants of fund-level portfolios that the literature has found to be important. In particular, we control for gravity variables commonly used in the literature to explain differences in bilateral cross-border investments between the domicile of the fund (investor origin) and the country issuing currency c (destination of the investment). We define:

[7] DM currencies are AUD, CAD, CHF, DKK, EUR, JPY, NZD, NOK, GBP, SEK, USD. EM currencies are BRL, CLP, COP, CZK, HUF, IDR, ILS, INR, KRW, MXN, MYR, PEN, PHP, PLN, RUB, SGD, THB, TRY, ZAR.

- $DIST_{Dom_i,c}$: Log Distance between the domicile country of fund i and the country issuing currency c.

- $TRADE_{Dom_i,c}$: Absolute sum of imports and exports between country of domicile of fund i and the country issuing currency c as a share of the investor country GDP. A measure of the bilateral trade dependency.

- $LEGAL_{Dom_i,c}$: Dummy that is 1 if the country of domicile of fund i and the country issuing currency c have same legal system origin.

All three type of variables are measured using data from the CEPII Gravity database based on the work in Conte et al. (2022). We treat the Eurozone and the EUR as a single location, and so if the investor country or the destination of the investment belongs to the EMU we apply variables calculated with respect to the Eurozone.

Using our baseline sample, we run the following cross sectional regression in each year:

$$\begin{aligned}\alpha_{c,i} = &\beta_{DM}^{AUD}\,\text{DMShare}_{AUD,i} + \beta_{DM}^{BRL}\,\text{DMShare}_{BRL,i} + \ldots + \beta_{DM}^{ZAR}\,\text{DMShare}_{ZAR,i} + \\ &+ \beta_{DIST} DIST_{Dom_i,c} + \beta_{LEGAL} LEGAL_{Dom_i,c} + \beta_{TRADE} TRADE_{Dom_i,c} + \epsilon_{c,i}\end{aligned}$$

where

$$\text{DMShare}_{k,i} = \begin{cases} \alpha_{DM,k,i}, & \text{if currency} \quad k = c \\ 0, & \text{otherwise} \end{cases}$$

Recall that, as defined in Section 4.2.1

$$\alpha_{c,i} = \frac{\sum_{b \in B_c} \text{MV}_{b,i}}{\sum_{c \in FC_i} \sum_{b \in B_c} \text{MV}_{b,i}},$$

is the share of the foreign-currency bond portfolio in currency c for fund i. Similarly,

$$\alpha_{DM,c,i} = \frac{\sum_{d \in \{DM_i/c\}} \alpha_{d,i}}{(1 - \alpha_{c,i})}.$$

is the share of the remaining (once we exclude currency c) foreign-currency bond portfolio in DM currencies.

In Appendix Table A.III we report the regression coefficients from the gravity regressions using our baseline sample and the year 2020. As expected, countries that are geographically closer, that trade more goods, and have a common legal system all tend to increase portfolio holdings between two countries. More importantly, we find that including gravity variables to the regression version of our analysis do not meaningfully change the relative ranking of China. To facilitate exposition in the table, instead of reporting the estimate for each currency we report β_{DM} for selected currencies (BRL, CNY, and JPY). β_{DM}^{BRL} is negative and statistically significant at the 1% confidence level, meaning that funds that have a higher share in BRL have a lower share of their remaining portfolio allocated to bonds denominated in DM currencies. β_{DM}^{JPY}, on the other hand, is positive and statistically significant at the 1% confidence level, meaning that funds that have a higher portfolio share in JPY allocate a higher portion of the rest of their portfolio in other DM currencies. β_{DM}^{CNY} is slightly positive, and its estimated beta is significantly different than that of both the BRL and JPY. Unlike classic EM and established DM currencies, the Chinese RMB is present in both EM and DM focused portfolios. Similarly to our baseline correlation estimates, β_{DM}^{CNY} is in between the EM and DM currencies after controlling for gravity variables. In Appendix Figure A.Xa we plot the estimated coefficients using the most complete specification (column (8) of Appendix Table A.III) for each currency. The coefficients in these regressions will not correspond to our correlations because the regression betas and correlations differ by the ratio of the variances. Nevertheless, we see that the ordering continues to be largely preserved.

To account for the fact that our dependent variable ($\alpha_{c,i}$) is censored between 0 and 1, we also evaluate the gravity regressions using a Tobit model. Appendix Figure A.Xb shows that this does not qualitatively change the relative position of the Chinese RMB.

In Figure A.XI, we plot the time series of portfolio correlations with DM for the 31 countries reaching the thresholds for inclusion. The estimated correlations are overall stable within countries over time, which is consistent with the idea that reputation is slow-moving. Aside from China, there are a few other currencies that display notable movement in sample. For instance, see the Korean Won increase its correlation with DM portfolios. By contrast, the Chilean Peso decreases its correlation with DM portfolios around the time its weight in the JP Morgan GBI Index increased significantly.

Finally, we calculate our correlation for two additional asset classes: USD-denominated corporate bonds (Appendix Figure A.XIIa) and equities (Appendix Figure A.XIIb). In both cases we conduct the analysis by the nationality of the issuer. For corporate bonds, we focus on USD-denominated bonds to avoid capturing the disparity in holdings by foreigners in local versus hard currency. We focus on foreign bonds holdings which means bonds issued by firms that are not (by nationality) based in the same country as the domicile of the fund. Interestingly, in both cases Chinese securities behave more like those of emerging markets in a contrast to our results for local currency government bonds. In other words, Chinese USD-denominated corporate bonds and equities are more frequently held by investors that own more emerging market rather than developed market securities. We view this as consistent with two observations we made in the main paper: (i) that foreign investors largely do not buy corporate bonds issued domestically in China, and (ii) that foreign investor do buy bonds issued by Chinese firms via subsidiaries in offshore financial centers. This might reflect foreign investors uncertainty and low-reputation beliefs for bankruptcy procedures and shareholder/bondholder rights in China's domestic courts.

A.I.D Flows Decomposition

In this section, we examine what assets private investors substituted away from as they started to move into RMB starting in 2018. We focus on the active component of portfolio changes in this analysis, holding asset prices and fund assets under management fixed. For fund i at time t the within-fund flow to or from a specific bond b is measured by

$$F_{t,i,b}^{Within} = \widetilde{AUM}_{i,t}\left(\widetilde{\omega}_{t,i,b} - \omega_{t-1,i,b}\right)$$

where ω is the share of asset b in the portfolio of fund i and AUM denotes the fund's assets under management. Importantly, all components are measured using period $t-1$ prices, with the notation $\widetilde{x}_t$ denoting that the variable x_t is measured using period $t-1$ prices. While this within, or active, component of rebalancing is only a part of the change in the dollar value of investment in China, in Appendix Figure A.XIV we show that it accounts for the majority of the increase in foreign holdings in 2019 and 2020.[8]

Aside from controlling for price changes, an important benefit of focusing on the within component of flows is that, at the fund level, the within-fund active rebalancing component sums to zero (as portfolio shares need to sum to 1). This allows us to write $F_{t,i,CNY}^{Within} + \sum_{b \neq CNY} F_{t,i,b}^{Within} = 0$. By zooming in on this component, Figure A.XIII documents which assets funds purchasing RMB bonds sold. We find that in 2019 and 2020, funds that purchased RMB bonds tended to sell bonds issued in developed market currencies. In 2019, funds purchasing RMB slightly increased their holdings of emerging markets currencies, while in 2020 a small amount of the RMB purchases came from sales of emerging market currency bonds. Overall, the substitution towards RMB bonds in private foreign portfolios came from movements out of developed market debt.

In Appendix Section A.I.F, we explore how much of the inflows to RMB bonds were driven by index inclusions. We use data on the index that funds report as their benchmark, and find that inclusion in the Bloomberg Global Aggregate is associated with more inflows than the 2020 inclusion in the JP Morgan GBI Index. Since the Bloomberg Global Aggregate is more tilted towards developed country currencies than the EM-currency-focused GBI, the rebalancing of funds benchmarked to the Bloomberg index may help explain why the purchases of RMB were largely financed with sales of DM currencies, with sales of EM currencies to buy RMB only beginning in 2020. The inclusion of China in both a major global and EM-focused bond index may help explain why it occupies an intermediate position between DM and EM currencies in terms of the portfolio correlations.

This subsection describes our procedure for decomposing the change in investment positions into a number of economically interpretable components and its implementation. Using data at the fund-security level, we compute for each security b, fund i and time t, the change in the amount owned by a fund as the change in market value of the holdings between $t-1$ and t.

We decompose the change in investment positions into a number of economically interpretable components. The change in the dollar value of investment $\Delta MV_{t,i,b}$ of a particular asset b between time t and $t-1$ by fund i can be split into the within-fund portfolio shift towards that asset $\left(F_{t,i,b}^{Within}\right)$, the increase or decrease in investment in that asset driven by fund-level inflows or outflows $\left(F_{t,i,b}^{Between}\right)$, valuation effects $(VE_{t,i,b})$, newly created funds purchasing that bond $(F_{t,i,b}^{NewFunds})$, and a residual $\left(F_{t,i,b}^{Residual}\right)$. We

[8] In 2019 the second largest component was the flow coming from new funds launched that year, predominately new Taiwanese ETFs that invest solely in Chinese RMB. Liu and Chan (2019) describe how reforms in the Taiwanese insurance industry drove inflows into RMB bond ETFs.

write this decomposition as:

$$\Delta MV_{t,i,b} = F_{t,i,b}^{Within} + F_{t,i,b}^{Between} + VE_{t,i,b} + F_{t,i,b}^{NewFunds} + F_{t,i,b}^{Residual}. \tag{A.1}$$

Figure A.XIV displays the decomposition of flows into RMB bonds into the five components as in equation (A.1). These changes in positions can themselves be expressed in terms of the price of the individual bond $P_{t,b}$ and quantity owned by a given fund $Q_{t,i,b}$. The change in the amount owned by a fund is then the change in market value between $t-1$ and t :

$$\Delta MV_{t,i,i} = P_{t,i}Q_{t,i,i} - P_{t-1,b}Q_{t-1,i,b} \tag{A.2}$$

where $P_{t,i}$ is the market price of the security b at time t and $Q_{t,i,b}$ the quantity owned by a given fund i.

Since we do not observe the actual transaction price at which funds buy or sell securities within a period, but only the level of holdings at the beginning end end of each period, we need to make an assumption about the time at which the securities are purchased. Our baseline analysis assumes that all transactions occur at last period's prices. In this case, we can write the valuation effects on the portfolio as the price change times the quantity owned at time t:

$$VE_{t,i,b} = \left(P_{t,b} - P_{t-1,b}\right) Q_{t,i,b}$$

The term that is particularly important for our analysis is what we call the within-fund portfolio flow: $F_{t,i,b}^{Within}$. It measures net purchases of a particular security, holding fixed the size of the investment portfolio, so it captures the extent to which a fund actively rebalances its portfolio towards security b. We measure this component as

$$F_{t,i,b}^{Within} = \widetilde{AUM}_{i,t}\left(\widetilde{\omega}_{t,i,b} - \omega_{t-1,i,b}\right)$$

where $\omega_{t-1,i,b}$ is the share of asset b in the portfolio of fund i at time $t-1$: $\dfrac{P_{t-1,i,b}Q_{t-1,i,b}}{\sum_k P_{t-1,i,k}Q_{t-1,i,k}}$. The notation $\widetilde{x}_t$ denotes a variable x_t measured using last period's prices.

The within-fund component multiplies the change in the portfolio weight of an asset $(\widetilde{\omega}_{t,i,b} - \omega_{t-1,i,b})$ coming entirely from changes in asset holdings (Q) by the AUM of the fund measured at last period's prices. Importantly, the sum of all within-fund flows is zero by construction at the fund level. Therefore, if we observe positive within-fund flows to RMB bonds, then within-fund flows are negative for other asset types, indicating active rebalancing away from some assets and towards RMB bonds. This allows us to measure which assets funds are substituting away from when they purchase RMB bonds.

The next component is the between-fund component of flows, $F_{t,i,b}^{Between}$, the increase in holdings of security b by fund i that would occur for a given amount of overall portfolio inflows (positive or negative) at the fund level. We define this term as

$$F_{t,i,b}^{Between} = \omega_{t-1,i,b} \cdot Inflow_{t,i} \tag{A.3}$$

where $Inflow_{t,i}$ is the net inflow of new money to fund i between period $t-1$ and t. This term captures the market value of an asset a fund would be expected to purchase or sell in response to flows into or out of the fund if it chose to purchase assets in proportion to their existing portfolio weights and thereby keep the portfolio weights unchanged at constant prices.

Finally, $F_{t,i,b}^{NewFunds}$ measures the amount of security b held by funds at the end of the period that did not exist the previous period. This term is of particular interest in the case of investments in China since new specialist funds are being created with the sole investment objective of holding RMB bonds.

In order to implement the decomposition in equation (A.1) we use three types of data. First, portfolio holding data from Morningstar and NAICS insurance filings for the US give us the market value at the security level at the monthly, quarterly, or annual frequency. Second, we use security prices for each of the holdings in the dataset, $P_{t,i}$. We collect the universe of prices of assets held by funds that ever invest in Chinese RMB. Third, we use inflows data into funds at the same frequency as the holding data. We use $Inflow_{t,i}$ as directly reported at the fund level in Morningstar Direct.[9]

Under our assumption that all trading occurs at last period's prices $P_{t-1,k}$, an alternative measure of inflows is the change in asset quantities measured at constant prices:

$$\widetilde{Inflow}_{t,i} = \sum_{k \in K} P_{t-1,k} \left(Q_{t,i,k} - Q_{t-1,i,k} \right)$$

In practice, the two measures differ because trading occurs at different points in time over each observation interval. Therefore, in our benchmark analysis, the residual captures the error induced by the assumption that all new purchases or sales occur at price P_{t-1} and possible other mismeasurement in flows or positions:

$$F_{t,i,b}^{Residual} = \omega_{t-1,i,b} \left(Inflow_{t,i} - \widetilde{Inflow}_{t,i} \right)$$

One should expect a sizable residual, especially when annual data is used. However, this timing assumption and the accompanying residual should not effect the measurement of the Within component.

A.I.E Price Evidence

Evidence on bond returns is hard to provide given the short sample, the likelihood of peso problems (crisis out-of-sample), and the possible endogeneity of return dynamics to the size of foreign holdings. We provide here a brief analysis focusing on government bonds (see also Carpenter et al. (2022)).

We estimate bond return loadings on risk factors that are commonly used in the literature. We begin our sample in 2010, the year when China's peg against the U.S. dollar was first relaxed. We measure quarterly dollar returns of holding a three-month tenor bond in currency i as $R_{i,t+1} = i_t - i_t^* - \Delta e_{t+1}$. We then regress the returns $R_{i,t}$ on a risk factor f_t to estimate the currency-specific loading on the factor, β_i, from a linear regression $R_{i,t} = \alpha_i + \beta_i f_t + \epsilon_{i,t}$.

Figure A.XV reports the regression coefficient β_i for a range of countries. We consider two risk factors. The first factor, HML, follows the work of Lustig, Roussanov and Verdelhan (2011) and constructs the return of investing in the currencies in the top 25% of currencies in terms of their interest rate and shorting

[9]We use the variable "estimated fund-level net flow" in Morningstar Direct.

the bottom 25%. The bottom panel runs the same regression but uses the quarterly log change in the VIX as the factor. Since an increase in HML occurs in good times and a spike in VIX in bad times, the rankings in the top and bottom panels are roughly reversed. In both cases, we find that RMB bonds in sample are estimated to be among the safest, if not the safest, returns. Of course, much of the measured safety of RMB come from the fact that the exchange rate was managed against the U.S. Dollar (and a basket of other currencies) throughout the sample period, making it among the least volatile currencies in the world. It is important to emphasize that both the portfolio quantity and price evidence are statements about the market behavior over a short sample in which internationalization was starting to occur. As the model in the next section emphasizes, market beliefs about safety of these assets might turn out to be quite wrong ex-post when crises occur and China could decide to either directly or indirectly penalize foreign investors. Obviously, should those events materialize the return dynamics of the bonds would look dramatically different.

A.I.F Index Inclusion and Shifting Portfolio Investment

One of the key drivers of the increase in private investment in 2019 and 2020 was the inclusion of Chinese bonds in major bond indexes. In particular, in April 2019 Chinese RMB bonds were added to the Bloomberg Global Aggregate Bond Index and in February 2020 Chinese RMB bonds were added to the JP Morgan Government Bond Index - Emerging Markets (GBI-EM). These index inclusions were not sudden decisions of the index providers, but rather the result of a series of significant reforms to market access discussed in Section 1. Restrictions on entry and exit from Chinese bond markets for private investors had long meant that it would be uncertain whether foreign investors could actually achieve the returns of any potential bond index. For instance, if there were quotas and lockup periods, it was not certain whether a fund could make the investments need to follow any index, or whether it could liquidate the investments as needed to satisfy investor redemption demands. The decisions of index providers to include Chinese RMB bonds in their indices came with an assessment that these barriers had been sufficiently removed.

In Figure A.XVI, we demonstrate the striking effect of index inclusion on holdings of RMB by funds benchmarked to various indices. Prior to 2019Q1, funds that benchmark to the Bloomberg Global Aggregate Index owned approximately no Chinese RMB bonds. There is a steady rise in holdings of RMB by funds that benchmark to this index over the subsequent years, consistent with Bloomberg's announcement of a 20-month phase-in period, with portfolio weights scheduled to increase 0.30% per month.[10] By contrast, the FTSE World Government Bond Index (WGBI), a major competitor for the Bloomberg index, did not include Chinese RMB bonds in the index until October 2021. Therefore, while one might be concerned that the increase in holdings of RMB bonds by funds that benchmark to the Bloomberg index might not be the causal effect of index inclusion (i.e. the funds were responding to a policy reform or demand shock for Chinese RMB bonds that also caused the index inclusion), in that case we would expect funds that benchmark to the FTSE WGBI to also increase their RMB bond holdings. The fact

[10] Pensions & Investments.

that they do not demonstrates that the increase in holdings by the funds that benchmark to Bloomberg is caused by the index inclusion decision.[11]

Aside from the benchmark driven rebalancing, the inclusion of China in benchmark indices appears to also account for a large extent of the other inflows. Table A.IV lists the largest 25 fund holdings of RMB bonds at the end of 2020. The largest position at 6.32bn dollars is held by the iShares China Bond ETF. While this fund does not benchmark against the Bloomberg Global Aggregate, it actually tracks the Bloomberg China Treasury and Policy Bank Index. This index was introduced in November 2016, and the fund itself was launched in July 2019, shortly after the inclusion of China in the Bloomberg Global Aggregate. As of December 2021, it had nearly doubled its AUM to $12.1 billion, making it the second-largest European exchange traded fund.[12] This is one sense in which above and beyond the flows to China driven by index inclusion, since the creation of country-specific indices appears to be tied to inclusion in the broader world indices, the rise of ETFs and funds that specialize in investing in RMB bonds is also linked to China's inclusion in global bond indices.

A.I.G Investor Discussion of Risk of Capital Outflow Restrictions

While in the theoretical framework, we model capital outflow controls as a tax on repatriation, as discussed in Section 3.1 there are a number of ways in practice that the Chinese government could restrict capital outflows by foreign investors. In this subsection, we document a number of instances in which important foreign investors explicitly flag the risk of not being able to get their capital out of China. We primarily rely on the discussion of risks in the "Statement of Additional Information" (SAI) that fund managers file to the SEC. Investors in China frequently feature a separate section of risk disclosures related to China.

In the SAI of the Blackrock Strategic Global Bond Fund, Blackrock discusses risks in China in its 2022 SAI and is quite explicit about how it fears repatriation risks of the kinds we model. They write "The Renminbi ('RMB') is currently not a freely convertible currency and is subject to foreign exchange control policies and repatriation restrictions imposed by the Chinese government. The imposition of currency controls may negatively impact performance and liquidity of the Funds as capital may become trapped in the PRC. The Funds could be adversely affected by delays in, or a refusal to grant, any required governmental approval for repatriation of capital, as well as by the application to the Funds of any restrictions on investments." (Page II-41). Blackrock's SAI continues to discuss a number of additional risks.

- Under the heading "Risk of Investing in the China Interbank Bond Market through Bond Connect," Blackrock writes "The precise nature and rights of a Fund as the beneficial owner of the bonds traded in the China Interbank Bond Market through CMU as nominee is not well-defined under PRC law. There is a lack of a clear definition of, and distinction between, legal ownership and beneficial ownership under PRC law and there have been few cases involving a nominee account structure in

[11] We find a similar pattern for funds that benchmark to JP Morgan GBI-EM when the index starts to include China. Unlike our analysis above of the Bloomberg index inclusion, we could not identify a rival local currency EM bond index to the JP Morgan one to use as a control group.

[12] The Financial Times, "Bond ETF inflows slump to lowest level since start of pandemic", December 17, 2021.

the PRC courts. The exact nature and methods of enforcement of the rights and interests of a Fund under PRC law are also uncertain." (Page II-43)

- "In the event that the relevant authorities suspend account opening or trading on the China Interbank Bond Market, a Fund's ability to invest in the China Interbank Bond Market will be adversely affected and limited. In such event, the Fund's ability to achieve its investment objective will be negatively affected and, after exhausting other trading alternatives, the Fund may suffer substantial losses as a result. Further, if Bond Connect is not operating, a Fund may not be able to acquire or dispose of bonds through Bond Connect in a timely manner, which could adversely affect the Fund's performance." (II-44)

PIMCO writes of the risks of investing in China similarly. Its SAI has a section on "Investments in the People's Republic of China" and in the 2021 disclosure, they note

- "Chinese regulators may suspend trading in Chinese issuers (or permit such issuers to suspend trading) during market disruptions, and that such suspensions may be widespread. In addition, certain securities are, or may in the future become, restricted, and a Fund may be forced to sell such restricted security and incur a loss as a result." (Page 51)
- "In addition, there also exists control on foreign investment in the PRC and limitations on repatriation of invested capital. Under the FII program, there are certain regulatory restrictions particularly on aspects including (without limitation to) investment scope, repatriation of funds, foreign shareholding limit and account structure. Although the relevant FII regulations have recently been revised to relax certain regulatory restrictions on the onshore investment and capital management by FIIs (including but not limited to removing investment quota limit and simplifying routine repatriation of investment proceeds), it is a very new development therefore subject to uncertainties as to how well it will be implemented in practice, especially at the early stage... As a result of PRC regulatory requirements, a Fund may be limited in its ability to invest in securities or instruments tied to the PRC and/or may be required to liquidate its holdings in securities or instruments tied to the PRC." (Page 52)
- "Currency repatriation restrictions may have the effect of making securities and instruments tied to the PRC relatively illiquid, particularly in connection with redemption requests." (Page 53)
- Under the heading of "Investing through CIBM Direct," Pimco warns "The CIBM Direct Rules are relatively new and are still subject to continuous evolvement, which may adversely affect the Fund's capability to invest in the CIBM." (Page 53)
- Under the heading of "Investing Through Bond Connect," Pimco warns "In addition to the risks described under "Foreign Securities" and "Investments in the People's Republic of China," there are risks associated with a Fund's investment in Chinese government bonds and other PRC-based debt instruments traded on the CIBM through the Bond Connect program... Trading through Bond Connect is subject to a number of restrictions that may affect a Fund's investments and

returns...While the ultimate investors hold a beneficial interest in Bond Connect securities, the mechanisms that beneficial owners may use to enforce their rights are untested and courts in the PRC have limited experience in applying the concept of beneficial ownership. As such, a Fund may not be able to participate in corporate actions affecting its rights as a bondholder, such as timely payment of distributions, due to time constraints or for other operational reasons." (Page 54)

Similarly, Vanguard includes a section on "Foreign Securities—China Bonds Risk." They write

- "The Chinese legal system constitutes a significant risk factor for investors. The interpretation and enforcement of Chinese laws and regulations are uncertain, and investments in China may not be subject to the same degree of legal protection as in other developed countries. In the event account opening or trading is suspended on the CIBM, a fund's ability to invest in securities traded on the CIBM will be adversely affected and may negatively affect the fund. Furthermore, if Bond Connect is not operating, a fund may not be able to acquire or dispose of bonds through Bond Connect in a timely manner, which could adversely affect the fund's performance." (Page B-12)
- "Bond Connect trades are settled in RMB, which is currently restricted and not freely convertible. As a result, a fund's investments through Bond Connect will be exposed to currency risk and incur currency conversion costs, and it cannot be guaranteed that investors will have timely access to a reliable supply of RMB." (Page B-13)

A.II Proofs and Further Details on the Theory

A.II.A Derivation of c_t

Here we provide a step by step derivation of c_t and other key variables. Recall that the intermediary collateral constraint in the middle of date t is

$$R_t^\ell D_t^\ell \leq (1-h_t)(QI_t - L_t)$$

and the intermediary budget constraint in the middle of date t is

$$D_t^\ell + \gamma L_t = R_t D_t.$$

The intermediary collateral constraint binds and liquidations are positive when

$$(1-h_t)QI_t < R_t^\ell R_t D_t,$$

that is the total cost of rolling all debt exceeds the collateral value of projects. Given that $I_t = A + D_t$, this can be rearranged to

$$A < \left[\frac{R_t^M}{(1-h_t)Q} R_t - 1\right] D_t,$$

which provides an upper bound on inside equity (equivalently, a lower bound on leverage) such that the collateral constraint binds. This upper bound is positive so long as h^s is sufficiently large, $h^s > 1 - \frac{R_t^\ell}{(1-h_t)Q} R_t$. Thus, in our numerical illustrations, we restrict parameters so that h^s is sufficiently large and inside equity is below the threshold such that the collateral constraint binds.

Under the conjecture that the collateral constraint binds, we have

$$D_t^\ell = \frac{(1-h_t)}{R_t^\ell}(QI_t - L_t).$$

From here, we can substitute into the budget constraint and rearrange to obtain project liquidations,

$$L_t = \frac{R_t D_t - \frac{(1-h_t)}{R_t^\ell} QI_t}{\gamma - \frac{(1-h_t)}{R_t^\ell}}.$$

Finally, we know that the final payoff to the intermediary at the end of date t is

$$c_t = QI_t - L_t - R_t^\ell D_t^\ell$$

Substituting in, we have

$$\begin{aligned}
c_t &= QI_t - L_t - R_t^\ell \frac{(1-h_t)}{R_t^\ell}\Big(QI_t - L_t\Big) \\
&= h_t\Big(QI_t - L_t\Big) \\
&= \frac{h_t}{\gamma - \frac{1-h_t}{R_t^\ell}}\Big(\gamma QI_t - R_t D_t\Big)
\end{aligned}$$

which gives the result for c_t.

A.II.B Proof of Proposition 1

Take as given a reputation level M_t. The objective of the committed government is:

$$\max_{D_t^s, D_t^f} \quad c_t = \frac{h_t}{\gamma - (1-h_t)}\Big(\gamma QI_t - R_t D_t\Big)$$

subject to the haircut determination

$$h_t = \begin{cases} h^s, & D_t^f = 0 \\ h^f, & D_t^f > 0 \end{cases}$$

and subject to the interest rate schedules (when borrowing from investors of type i)

$$R_t^i = \frac{\bar{R} + \frac{1}{2}\frac{b}{\omega(M_t)} D_t^i}{1 - (1-M_t)\overline{\tau}}.$$

Where the project funding constraint is $I_t = A + D_t$, the total debt definition is $D_t = D_t^s + D_t^f$, and the average interest rate is $R_t = \frac{R_t^s D_t^s + R_t^f D_t^f}{D_t^s + D_t^f}$. Note that the objective reflects that the committed government sets $\tau = 0$ and so $R_t^\ell = 1$.

It is convenient to denote $n(h) = \frac{h}{\gamma - (1-h)}$ to be the net worth multiplier when the haircut is h. We have

$$c_t = n(h_t)\Big(\gamma Q I_t - R_t D_t\Big)$$

Note that we have $n(h^s) \geq n(h^f)$, that is the net worth multiplier is larger when there are only stable investors.

The proof strategy proceeds as follows. We first find the optimal strategy if borrowing only from stable investors and the optimal strategy if borrowing from both investor types. We then find the maximum between the two to complete the characterization.[13]

Borrowing only from stable investors. If the committed type only borrows from stable investors, the net worth multiplier is a positive constant and hence the committed type can equivalently maximize the liquidation value of inside equity, $\gamma Q I_t - R_t D_t$. Given only borrowing from stable investors, $R_t = R_t^s$. Given the interest rate schedule, the first order condition is

$$\gamma Q = R_t + \frac{\partial R_t}{\partial D_t^s} D_t^s$$

Given $\frac{\partial R_t}{\partial D_t^s} = \frac{1}{2}\frac{b}{\omega(M_t)}\frac{1}{1-(1-M_t)\overline{\tau}}$, substituting in and rearranging obtains

$$D^s(M_t) = \frac{\omega(M_t)}{b}\Big(\gamma Q(1-(1-M_t)\overline{\tau}) - \bar{R}\Big).$$

From here, substituting into the interest rate schedule, we obtain

$$R(M_t) = \frac{1}{2}\frac{\overline{R}}{(1-(1-M_t)\overline{\tau})} + \frac{1}{2}\gamma Q$$

Finally, we can substitute into the objective function to obtain

$$V^s(M_t) = n(h^s)\Big(\gamma Q A + \Big(\gamma Q - R(M_t)\Big)D^s(M_t)\Big)$$

Borrowing from stable and flighty investors. If the committed type also borrows from flighty investors, then as before the net worth multiplier is a constant, and we can equivalently maximize the liquidation value of inside equity. Noting that we have

$$\gamma Q I_t - R_t D_t = \gamma Q A + \sum_{i \in \{s,f\}} (\gamma Q - R_t^i) D_t^i$$

[13] Note that it is never optimal to borrow only from flighty investors and not from stable investors.

then we have that the committed type optimally borrows the same amount from each investor type, $D^s_t = D^f_t = \frac{1}{2}D_t$ and $R^s_t = R^f_t = R_t$. Thus the objective function is equivalent to $2(\gamma Q - R^s_t)D^s_t$, and so optimal policy sets $D^s(M_t)$ and $R^s(M_t)$ as before, and moreover sets $D^f(M_t) = D^s(M_t)$ and $R^f(M_t) = R^s(M_t)$. Therefore, $D(M_t) = 2D^s(M_t)$, and so indirect utility is

$$V^f(M_t) = n(h^f)\Big(\gamma QA + 2\Big(\gamma Q - R(M_t)\Big)D^s(M_t)\Big).$$

Choosing what type of investor to borrow from. Note that the policies D^s and R have already been characterized in accordance with the proposition. All that remains in the proof is to characterize whether the committed government borrows from only the stable investors, or also from the flighty investors. The committed type only borrows from stable investors when $V^s(M_t) \geq V^f(M_t)$, or equivalently when $\Delta(M_t) \equiv V^s(M_t) - V^f(M_t)$ is positive. We show that $\Delta(M_t)$ generally has a single crossing condition. By Envelope Theorem, we have

$$\Delta'(M_t) = -n(h^s)\frac{\partial R^s_t}{\partial M_t}D^s_t + n(h^f)\sum_{i\in s,f}\frac{\partial R^i_t}{\partial M_t}D^i_t$$

where $\frac{\partial R^i_t}{\partial M_t}$ is the partial derivative at fixed debt. Given identical policy functions at the same reputation, then debt D^s_t and the interest rate derivative $\frac{\partial R^s_t}{\partial M_t}$ factor out, and hence

$$\Delta'(M_t) = \Big[-n(h^s) + 2n(h^f)\Big]\frac{\partial R^s_t}{\partial M_t}D^s_t(M_t).$$

Lastly, note that $\frac{\partial R^s_t}{\partial M_t} < 0$ as $\omega(M_t)$ is nondecreasing. Therefore, Δ' is monotone.

Recall that $n(h^f) \leq n(h^s)$. If $n(h^s)/n(h^f) = 1$, then opening up always dominates not opening up (no haircut difference) and opening up is immediate. Hence we can define $M^* = 0$ and the result follows.

If $1 < n(h^s)/n(h^f) < 2$, then $\Delta' < 0$, and hence we have a single crossing property in M_t. Hence we can define an opening up threshold M^*. In this case, the value of higher borrowing grows in reputation relative to the haircut difference, leading to opening up once reputation is sufficiently high. Appendix A.II.P.2 further generalizes this idea and shows how it results from investors' preferences featuring increasing differences in (D^i_t, M_t).

If $n(h^s)/n(h^f) \geq 2$, then we can return to the characterization of Δ to write

$$\Delta(M_t) = \Big(n(h^s) - n(h^f)\Big)\gamma QA + \Big[n(h^s) - 2n(h^f)\Big]\Big(\gamma Q - R(M_t)\Big)D^s(M_t) \leq 0,$$

and hence we can define $M^* = 1$ (the economy never opens up).

In sum, there exists a unique crossing point M^* such that optimal policies are

$$D^s(M_t) = \frac{\omega(M_t)}{b}\Big[\gamma Q(1 - (1 - M_t)\overline{\tau}) - \bar{R}\Big]$$

$$D^f(M_t) = \begin{cases} 0, & M_t \le M^* \\ D^s(M_t), & M_t > M^* \end{cases}$$

$$R(M_t) = \frac{1}{2}\frac{\bar{R}}{1-(1-M_t)\overline{\tau}} + \frac{1}{2}\gamma Q$$

This proves the result.

A.II.C A Graphical Representation of the Opening-Up Decision

In Figure A.XVII, we present a graphical representation of the government's opening up decision. The figure is split into 3 panels. In Panel (a), the government has a low reputation, defined by $M < M^*$. In Panel (b), the government has an intermediate reputation, $M = M^*$. In Panel (c), the government has a high reputation, defined by $M > M^*$. For illustration purposes we take an interior value $M^* \in (0, 1)$.

We begin by describing Panel (a) in which the government has a low reputation. The solid black line – h^s indifference curve – is the pairs of (total) debt D_t and interest rate R_t that give the same payoff to the committed government when the haircut is h^s. Given haircut h^s, payoff increases as the interest rate falls and debt increases, that is as the government is able to select points towards the bottom right corner of the graph. The solid red line, denoted by R^s, is the interest rate schedule available to the government if it borrows only from stable investors. The point A is the point (D, R) where the stable-only interest rate schedule is tangent to the h^s indifference curve, and so represents the optimal borrowing decision when only borrowing from stable investors.

To visualize the opening up decision, we ask whether the government can achieve higher utility by borrowing from flighty investors and incurring the higher haircut. The black dashed line is the indifference curve of pairs (D, R) that deliver the same payoff to the committed government when the haircut is h^f, as pairs on the solid black indifference curve did at the lower haircut h^s.[14] The h^f indifference curve lies everywhere below and to the right of the h^s indifference curve, reflecting that either a higher debt level or lower interest rate is required to compensate for the higher haircut.

The final part of the graph is the solid blue line, which is the interest rate schedule available to the government it if borrows from both stable and flighty investors.[15] This line has a flatter slope than the red line, reflecting the additional borrowing from flighty investors. At low reputation M, the blue line lies above the h^f indifference curve: that is, no points on the h^f indifference curve are attainable to the government even when borrowing from both investor types. This tells us that the government obtains lower payoff by opening up, reflected in that the optimal borrowing decision from both types, point B, lies above and to the left of the h^f indifference curve. This rationalizes the government's decision to only borrow from stable investors.

Panel (b) displays the same exercise, but conducted at a threshold M^*. As reputation increases, the interest rate schedule of borrowing from both types (solid blue line) flattens, and eventually becomes

[14] In other words, the black and black dashed indifference curves are a single indifference curve in the (D, R, h) space, $h \in \{h^s, h^f\}$, that is projected down into the (D, R) space.

[15] Here, we already imposed the optimality condition that, if it borrows from both investors, the government borrows the same amount from both investors, equalizing the interest rate it pay across the two investor types.

tangent to the h^f indifference curve.[16] At this reputation M^*, both the red and blue lines are, respectively, tangent to the h^s and h^f indifference curves. This reflects that at M^*, the government achieves the same optimal payoff regardless of whether or not it opens up. The government is indifferent to opening up or not at M^*.

Panel (c) displays the same exercise, but for reputation higher than M^*. At higher reputation, continual flattening of the blue line means that it now intersects but is not tangent to the h^f indifference curve. At this point, the government can achieve a point on the h^f indifference curve by opening up, but can also achieve points downward and to the right of the h^f indifference curve. The point B reflects the optimal borrowing decision when borrowing from both types, which lies downward and to the right of the h^f indifference curve. The government is therefore strictly better off by opening up.

Comparing across the three panels of Figure A.XVII, we can clearly see how higher reputation changes the borrowing incentives of the government. As reputation increases, the interest rate schedules are both shifting downwards and flattening. With the optimal borrowing amount from both investors always double what the government would borrow from stable investors alone, and the different haircut levels acting as a fixed cost, the government switches to borrowing from both types of investors as its reputation increases because it has a more favorable interest rate schedule at these higher reputation levels. The benefit of borrowing from both investors increases in the desired amount of borrowing, and so we see that the shift in the budget sets (interest rate schedules) generates an endogenous opening up threshold. Of course, these figures alone only show the possibility of a unique opening up threshold. Proposition A.XVII proves that the intuition provided by these figures is indeed general, with M^* as the unique opening up threshold.

A.II.D Verifying Opportunistic Government Mimics Issuance

We now show that the off-path beliefs $\pi = M = 0$ under our conjectured equilibrium induce the opportunistic government to mimic issuance. Suppose that at step n, the opportunistic government deviated to an optimal issuance. Facing beliefs $\pi = M = 0$, the optimal issuance policy of an opportunistic government is actually the same as Proposition 1 with $M = 0$. It therefore receives indirect utility $V(0)$ if not imposing capital controls and $g(0)V(0)$ if imposing capital controls. Investors' posterior beliefs are $\pi = \epsilon^O$ regardless of its capital control strategy, so that the continuation value to the opportunistic government is $W(\epsilon^C)$. Therefore, the opportunistic government sets $m = 0$. Thus, the value from the deviation to the committed government is

$$g(0)V(0) + \beta W(\epsilon^C) < g(\epsilon^C)V(\epsilon^C) + \beta W(\epsilon^C) \leq g(M_n)V(M_n) + \beta W(\epsilon^C)$$

for any step n. But then the strategy of mimicking issuance and then deviation for sure ($m = 0$) dominates the strategy of deviating on issuance. Thus the opporutistic government mimics issuance.

[16] Note that because the red line also flattens, the h^s indifference curve that the red line is tangent to shifts downwards and to the right, so the h^f indifference curve also shifts downward and to the right.

A.II.E Proof of Proposition 2

We begin by making two observations about the behavior of a feasible candidate path $\pi_0, ..., \pi_N$ and $M_0, ..., M_N$. The first is that the transition dynamics (16) imply that every point $M_n, \ldots, M_N$ of the path of reputation increases in the initial reputation $M_0(\pi_0)$ (henceforth M_0). The second is that Bayes' rule (10) implies that the evolution of beliefs $\pi_1, ..., \pi_N$ decreases in M_0, because π_{n+1} increases in π_n and decreases in M_n.[17]

It is convenient to define a candidate equilibrium in terms of the initial reputation M_0, with the path of reputation M_n defined from the transition dynamics and the path of beliefs π_n defined from Bayes' rule. Moreover, given a candidate initial reputation M_0, we can also pin down the graduation step N as follows.[18]

Lemma 1 *The graduation step N associated with an initial reputation M_0 is given by*[19]

$$N = \sup\left\{ n \middle| \frac{1-(\rho^f)^{n+1}}{1-\rho^f} V(M_0) < V(1-\epsilon^C) \right\}$$

Proof of Lemma 1. *Suppose that we conjectured a graduation step $N' < N$. Then, at the conjectured graduation step N', the value of waiting one step and then imposing the capital control, rather than imposing it at the current step, is*

$$\begin{aligned}
\frac{W^0_{N'} - W^{\overline{\tau}}_{N'}}{\pi_L} &= V(M_{N'}) - g^f V(M_{N'}) + \beta\Big[W_{N'+1} - W_0\Big] \\
&= \Big(1-g^f\Big)V(M_{N'}) + \frac{\beta g^f}{1-\pi_H\beta}\Big[V(1-\epsilon^C) - V(M_0)\Big] \\
&= \frac{\beta}{1-\pi_H\beta} g^f \Big[V(1-\epsilon^C) - \rho^f V(M_{N'}) - V(M_0)\Big] \\
&> 0
\end{aligned}$$

so that the opportunistic type prefers not to graduate. The form of $V(M_n) = \sum_{x=0}^{n}(\rho^f)^x V(M_0) = \frac{1-(\rho^f)^{n+1}}{1-\rho^f}V(M_0)$ used in the supremum is obtained in a standard manner by iterating the AR(1) process forward.[20] *QED*

[17] To see this, note that Bayes' rule is $\pi_{n+1} = \epsilon^O + (1-\epsilon^C-\epsilon^O)\frac{\pi_n}{M_n}$. Thus if M_0 increases, given $\pi_0 = \epsilon^O$ is fixed we have that π_1 decreases. Then consider the inductive step. Since M_0 increases, M_n increases for all n (equation 16). Thus if π_n decreases, then π_{n+1} also unambiguously decreases, completing the induction.

[18] By convention, Lemma 1 defines $N = +\infty$ if no such n exists, or if convergence happens to $V(1-\epsilon^C)$ only in limit.

[19] Note that this definition embeds a tiebreaking rule: if there is a step $N+1$ such that $\frac{1-(\rho^f)^{(N+1)+1}}{1-\rho^f}V(M_0) = V(1-\epsilon^C)$, then both N and $N+1$ are valid graduation steps of our model (i.e., a measure zero set of opportunistic governments can be incentivized to mimic at step N). This tiebreaking rule is embedded through the inequality in the supremum. We adopt the convention that N is the graduation step in this case. Note also that this finite series is well defined for $\rho^f > 1$ and $\rho^f < 1$. In the knife edge case of $\rho^f = 1$, we have to instead define the finite series by the usual sum.

[20] Conjecturing that $V(M_n) = \sum_{x=0}^{n}(\rho^f)^x V(M_0) = \frac{1-(\rho^f)^{n+1}}{1-\rho^f}V(M_0)$, we have $V(M_0) = \sum_{x=0}^{0}(\rho^f)^x V(M_0) =$

Lemma 1 implies that once we have a conjecture for M_0, we also have a graduation step. We now show that if the terminal condition $m_N = 0$, that is $\pi_N = M_N$, holds, then all intermediate conditions $\pi_n \leq M_n \leq 1 - \epsilon^C$ also hold.

Lemma 2 *If $M_N = \pi_N$ for $N < \infty$, then $\pi_n < M_n < 1 - \epsilon^C$ for all $n < N$.*

Proof of Lemma 2. *The proof proceeds by induction. By Lemma 1, we have $\pi_N = M_N < 1 - \epsilon^C$. Suppose that at date $n+1$, $\pi_{n+1} \leq M_{n+1}$. Then by Bayes' rule $\pi_{n+1} = \epsilon^O + \frac{1-\epsilon^O-\epsilon^C}{M_n}\pi_n$, we have*

$$\frac{M_n}{\pi_n} = \frac{1-\epsilon^O-\epsilon^C}{\pi_{n+1}-\epsilon^O} \geq \frac{1-\epsilon^O-\epsilon^C}{M_{n+1}-\epsilon^O} \geq \frac{1-\epsilon^O-\epsilon^C}{M_N-\epsilon^O} > \frac{1-\epsilon^O-\epsilon^C}{1-\epsilon^C-\epsilon^O} = 1.$$

The induction is then completed by the terminal condition $M_N/\pi_N = 1$, completing the proof. QED

Given these preliminary results, we can form a candidate equilibrium from an initial reputation M_0, which then has a graduation step, path of reputation, and path of beliefs as outlined. For our candidate to consistitute an equilibrium of the model, it must be the case that it also satisfies the terminal condition $\pi_N = M_N$ for graduation, in which case it also satisfies all intermediate conditions (Lemma 2) and so constitutes an equilibrium of the model. We are now ready to prove uniqueness and existence. We begin with uniqueness, and then prove existence.

Given we are defining candidate equilibrium from M_0 (implicitly, $M_0(\pi_0)$, that is the step 0 strategy $m_0(\pi_0)$), we will abuse notation and write $M_n(M_0)$ and $\pi_n(M_0)$ to make clear how a change in the initial conjectured reputation (implicitly, initial strategy/beliefs m_0) affects later parts of the path. One can equivalently think of this exercise as defining π_1 from $(\pi_0, M_0(\pi_0))$ using Bayes' rule and $M_1(\pi_1)$ from the transition equation, and so on. Doing so implicitly defines the strategies $m_n(\pi_n)$.

A.II.E.1 Uniqueness

Suppose that M_0^* is an equilibrium with associated graduation step $N < \infty$. Any equilibrium of the model must satisfy $\Delta(N, M_0) = \pi_N(M_0) - M_N(M_0) = 0$. Notice that holding fixed N, $\Delta(N, M_0)$ is a decreasing function of M_0, since π_N decreases in M_0 whereas M_N increases in M_0 due to the transition dynamics and Bayes' rule. Therefore, there is no other equilibrium with the same graduation step. Thus any other equilibrium must have a different graduation step. It suffices to show that there cannot be an equilibrium with a higher graduation step.

Suppose that there were another equilibrium with a higher graduation step. At the candidate equilibrium M_0^{**} with graduation step $N^{**} > N$, note that we must have $M_0^{**} < M_0^*$ from Lemma 1. We also

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$V(M_0)$ and, by induction,

$$V(M_{n+1}) = \rho^f V(M_n) + V(M_0) = \sum_{x=0}^{n+1} (\rho^f)^x V(M_0) = \frac{1-(\rho^f)^{n+2}}{1-\rho^f} V(M_0),$$

giving the form of $V(M_n)$ used in the supremum definition.

recall that π_n is a decreasing function of M_0 from Bayes rule. Thus, we have for $M_0^{**} < M_0^*$

$$\pi_{N+1}(M_0^{**}) > \pi_{N+1}(M_0^*) = \epsilon^O + (1 - \epsilon^C - \epsilon^O)\frac{\pi_N(M_0^*)}{M_N(M_0^*)} = 1 - \epsilon^C$$

where the last equality follows from $\pi_N(M_0^*) = M_N(M_0^*)$, since M_0^* was an equilibrium with graduation step N. But then $\pi_{N+1}(M_0^{**}) > 1 - \epsilon^C$, contradicting that M_0^{**} is an equilibrium. Thus, if there is an equilibrium, it is unique.[21]

A.II.E.2 Existence

The proof strategy for existence will proceed as follows. We will partition the M_0 set into intervals associated with graduation steps. We will then show that for each possible graduation step, there must be a crossing point of M and π above $M_0 = \epsilon^O$. Finally, we will show that at one step, this solution must lie in the interval of graduation steps.

We begin with the possibility that $M_0 = \epsilon^O$. If we have

$$\rho^f \geq \rho^{f*} \equiv \frac{V(1-\epsilon^C)}{V(\epsilon^O)} - 1$$

then we have an equilibrium with graduation at $N = 0$ and are done.

Next, we show existence for $\rho^f < \rho^{f*}$. We will break this into two subcases as follows. We define a threshold value $\overline{\rho}^f$ by

$$V(\epsilon^O) = (1 - \overline{\rho}^f)V(1 - \epsilon^C),$$

which is the threshold rate of convergence such that there is a finite graduation step for any M_0 when $\rho^f > \overline{\rho}^f$. Note that $\overline{\rho}^f < 1$ necessarily.

Existence when $\rho^{f*} > \rho^f > \overline{\rho}^f$.

The first case is the case where $\rho^f > \overline{\rho}^f$, that is $V(\epsilon^O) > (1-\rho^f)V(1-\epsilon^C)$. In this case, we know there is a graduation step $\overline{N} < \infty$ associated with ϵ^O.[22] In other words, $\overline{N}$ is the largest possible date such that

$$\frac{1 - (\rho^f)^{\overline{N}+1}}{1 - \rho^f} V(\epsilon^O) < V(1 - \epsilon^C).$$

We now define the following indifferent points for each $n \leq \overline{N}$. We define M_0^n for $n \leq \overline{N}$ by

$$\frac{1 - (\rho^f)^{n+1}}{1 - \rho^f} V(M_0^n) = V(1 - \epsilon^C),$$

[21] For completeness, note that the above argument rules out $N = \infty$ if a finite equilibrium exists, and also note that if there were hypothetically an equilibrium at $N = \infty$ it must be unique and associated with $\frac{1}{1-\rho^f}V_0(M_0) = V(1 - \epsilon^C)$.

[22] If $\rho^f \geq 1$ then this follows trivially, while if $\overline{\rho}^f < \rho^f < 1$ it follows since the limit of the finite series is $\frac{1}{1-\rho^f}V(\epsilon^O) > V(1 - \epsilon^C)$.

that is to say M_0^n is the highest value of M_0 such that graduation occurs at date n. Because we have analogously defined M_0^{n+1} as the solution to

$$\frac{1-(\rho^f)^{n+2}}{1-\rho^f}V(M_0^{n+1}) = V(1-\epsilon^C),$$

then we know that the interval $\mathbf{M}_n = [M_0^{n+1}, M_0^n]$ is the set of values M_0 such that graduation occurs at date n. By convention, we define $M_0^{\overline{N}+1} = \epsilon^O$, since all $M_0 \in [\epsilon^O, M_0^{\overline{N}}]$ lead to graduation at $\overline{N}$ (and since any feasible equilibrium must have $M_0 \geq \epsilon^O$).

We know there is not an equilibrium with graduation at $N = 0$ (given $\rho^f < \rho^{f*}$), and so we start at $N = 1$. Note that by construction, we have $M_1(M_0^1) = 1-\epsilon^C$ since $V(M_1(M_0^1)) = V(1-\epsilon^C)$. However, because $M_0^1 > \epsilon^O = \pi_0$, we have

$$\pi_1(M_0^1) = \epsilon^O + \left(1-\epsilon^C-\epsilon^O\right)\frac{\pi_0}{M_0^1} < 1-\epsilon^C = M_1(M_0^1).$$

Given we know that M_1 increases in M_0, π_1 decreases in M_0, and $\pi_1(\epsilon^O) = 1-\epsilon^C > M_1(\epsilon^O)$, then by continuity there exists $M_0^{1*} \in [\epsilon^O, M_0^1]$ such that $M_1(M_0^{1*}) = \pi_1(M_0^{1*})$. If $M_0^{1*} \geq M_0^2$, then $M_0^{1*} \in \mathbf{M}_1$ and so is a feasible graduation step. In this case, we have found an equilibrium. If not, then we have $M_0^{1*} < M_0^2$ and can proceed as follows.

The proof proceeds iteratively from here. Suppose that at N we have not yet found an equilibrium for any $n < N$. By definition, we have $M_N(M_0^N) = 1-\epsilon^C$. Taking the solution $M_0^{(N-1)*} < M_0^N$ from the previous step, we have

$$\pi_{N-1}(M_0^N) < \pi_{N-1}(M_0^{(N-1)*}) = M_{N-1}(M_0^{(N-1)*}) < M_{N-1}(M_0^N),$$

and therefore we have from Bayes' rule that $\pi_N(M_0^N) < 1-\epsilon^C$. Since $\pi_N(\epsilon^O) \geq 1-\epsilon^C \geq M_N(\epsilon^O)$, then there exists a crossing point M_0^{N*} at N. If $M_0^{N*} \in \mathbf{M}_N$ then we are done, and if not we continue. Finally, observe that at $N = \overline{N}$ we have $\mathbf{M}_{\overline{N}} = [\epsilon^O, M_0^{\overline{N}}]$. Thus if we find an equilibrium before $\overline{N}$ we are done. If we have not found an equilibrium at $\overline{N}$, then we have $M_0^{\overline{N}*} \in \mathbf{M}_{\overline{N}}$ and we have found a valid equilibrium. Therefore, an equilibrium exists if $\rho^{f*} > \rho^f > \overline{\rho}^f$.

Case of $\rho^f \leq \overline{\rho}^f$

In this case, define the point M_0^∞ as the solution to $\frac{1}{1-\rho^f}V(M_0^\infty) = V(1-\epsilon^C)$. The point M_0^∞ is the starting point such that $M_n \to 1-\epsilon^C$ as $n \to \infty$. Now, consider the infinite sequence generated by starting point M_0^∞. We have evolution of reputation

$$\pi_n = \epsilon^O + (1-\epsilon^C-\epsilon^O)\frac{\pi_{n-1}}{M_{n-1}}.$$

Given the limiting behavior of M_n, the limiting fixed point of beliefs is $\pi_\infty = 1-\epsilon^C$. This tells us that $M_n(M_0^\infty) \to 1-\epsilon^C$ and $\pi_n(M_0^\infty) \to 1-\epsilon^C$ as $n \to \infty$, so that beliefs and reputation converge to one another in limit. We now prove a result on how this convergence happens.

Lemma 3 *Suppose that $M_0 = M_0^\infty$. Then if $\pi_n > M_n$ for some n, then $\pi_{n+s} > M_{n+s}$ for all $s \geq 0$.*

Proof of Lemma 3. *If $\pi_n > M_n$, then we have*

$$\pi_{n+1} = \epsilon^O + (1 - \epsilon^C - \epsilon^O)\frac{\pi_n}{M_n} > 1 - \epsilon^C > M_{n+1}$$

where the last line follows since M_{n+1} converges to $1 - \epsilon^C$ from below. From here the argument follows immediately for all $s > 1$ from the same step. QED

Lemma 3 tells us that there are only two possible manners of convergence of π_n to π_∞. The first is convergence from below, in which case $\pi_n \leq M_n$ for all n. If it happens to be the case that convergence happens from below, then we would have an equilibrium with $N = \infty$.

Otherwise, suppose that convergence is from above. We denote $\underline{N}$ to be the first date at which $\pi_{\underline{N}}(M_0^\infty) \geq M_{\underline{N}}(M_0^\infty)$ (note the deliberate weak inequality in this definition). This crossing point must satisfy $\pi_{\underline{N}}(M_0^\infty) < 1 - \epsilon^C$, since by definition of $\underline{N}$ we have $\pi_{\underline{N}-1}(M_0^\infty) < M_{\underline{N}-1}(M_0^\infty)$.

Note that it is not possible for an equilibrium to occur at any $M_0 < M_0^\infty$. To understand why, for any such point the limiting behavior of the transition dynamics is $M_\infty(M_0) < M_\infty(M_0^\infty) = 1 - \epsilon^C$, but the limiting behavior of beliefs lies above $1 - \epsilon^C$. Thus, we can restrict attention to $M_0 \geq M_0^\infty$.

First, we note that it cannot be the case that graduation occurs for $N < \underline{N}$. To understand why, by definition of $\underline{N}$ we have we have $\pi_N(M_0) < \pi_N(M_0^\infty) \leq M_N(M_0^\infty) \leq \pi_N(M_0)$ for $N < \underline{N}$ and $M_0 \geq M_0^\infty$.

Now, let us take the date $\underline{N}$. Suppose first that we have a strict inequality, $\pi_{\underline{N}}(M_0^\infty) > M_{\underline{N}}(M_0^\infty)$. We know that $\pi_{\underline{N}}(1 - \epsilon^C) < M_{\underline{N}}(1 - \epsilon^C)$, so we know there exists a crossing point $M_0^{\underline{N}*} \in [M_0^\infty, 1 - \epsilon^C]$. We additionally know that this crossing point satisfies $M_0^{\underline{N}*} < M_0^{\underline{N}}$, where $M_0^{\underline{N}}$ is the threshold for graduation at $\underline{N}$ as defined in the previous part of the proof. To understand why this is the case, note that by definition $M_{\underline{N}}(M_0^{\underline{N}}) = 1 - \epsilon^C$ and $\pi_{\underline{N}}(M_0^\infty) < 1 - \epsilon^C$, so because $M_{\underline{N}}$ is increasing in M_0 and $\pi_{\underline{N}}$ is decreasing crossing must happen below $M_0^{\underline{N}}$. If $M_0^{\underline{N}*} \in \mathbf{M}_{\underline{N}}$, then we have found an equilibrium and are done. If $M_0^{\underline{N}*} < M_0^{\underline{N}+1}$, then we can proceed as follows. Define $\overline{N} > \underline{N}$ to be the graduation step associated with $M_0^{\underline{N}*}$, define $\mathbf{M}_n$ in the usual way for $\underline{N} + 1 \leq n \leq \overline{N} - 1$, and define $\mathbf{M}_{\overline{N}} = [M_0^{\underline{N}*}, M_0^{\overline{N}}]$. We have that $\pi_n(M_0^{\underline{N}*}) \geq 1 - \epsilon^C > M_n(M_0^{\underline{N}*})$ for all $\underline{N} \leq n \leq \overline{N}$. Because $M_0^{\underline{N}*} < M_0^{\underline{N}+1}$, then $\pi_{\underline{N}+1}(M_0^{\underline{N}+1}) < \pi_{\underline{N}+1}(M_0^{\underline{N}*}) = 1 - \epsilon^C = M_{\underline{N}+1}(M_0^{\underline{N}+1})$. Therefore, we have a single crossing point $M_0^{(\underline{N}+1)*}$ From here, the argument proceeds as in the previous case, where we note that the condition $\pi_{\overline{N}}(M_0^{\underline{N}*}) \geq 1 - \epsilon^C > M_{\overline{N}}(M_0^{\underline{N}*})$ tells us that if we have not found an equilibrium by date $\overline{N}$, then we must have $M_0^{\overline{N}*} \in \mathbf{M}_{\overline{N}}$, yielding a valid equilibrium.

It now remains only to handle the case where $\pi_{\underline{N}}(M_0^\infty) = M_{\underline{N}}(M_0^\infty)$. We note that although these paths cross, this is not a valid equilibrium because $\underline{N}$ is not the graduation step of M_0^∞. In this case, we know that $\pi_{\underline{N}+1}(M_0^\infty) = 1 - \epsilon^C > M_{\underline{N}+1}(M_0^\infty)$. Therefore, let us consider a point $M_0^\epsilon = M_0^\infty + \epsilon$. For sufficiently small ϵ, by continuity we have $1 - \epsilon^C = M_{\underline{N}+1}(M_0^{\underline{N}+1}) > \pi_{\underline{N}+1}(M_0^\epsilon) > M_{\underline{N}+1}(M_0^\epsilon)$ and, since $M_0^\epsilon < M_0^{\underline{N}+1}$, we have $\pi_{\underline{N}+1}(M_0^{\underline{N}+1}) < \pi_{\underline{N}+1}(M_0^\epsilon)$. Therefore, we have a crossing point

$M_0^{(\underline{N}+1)*} \in [M_0^\epsilon, M_0^{\underline{N}+1}]$. If $M_0^{(\underline{N}+1)*} \in \mathbf{M}_{\underline{N}+1}$ we are done. Otherwise, we define $\overline{N}$ as the graduation step associated with $M_0^{(\underline{N}+1)*}$ and define $\mathbf{M}_{\overline{N}} = [M_0^{(\underline{N}+1)*}, M_0^{\overline{N}}]$. From here the proof proceeds exactly as before.

Therefore, we also have an equilibrium for $\rho^f \leq \overline{\rho}^f$. This completes the existence proof.

A.II.F Proof of Proposition 3

The proof is essentially the same as the uniqueness proof of Proposition 2. Fixing an opening up step $N^* \geq 0$, suppose that M_0^* is an equilibrium with associated graduation step $N \geq N^*$. As in the proof of Proposition 2, any equilibrium of the model must satisfy $\Delta(N, M_0) = \pi_N(M_0) - M_N(M_0) = 0$ and moreover π_N decreases in M_0 while M_N increases in M_0, meaning that there cannot be another equilibrium at N. It again suffices to show there cannot be another equilibrium with a higher graduation step.

We can construct the graduation step associated with a pair (M_0, N^*) as

$$N = N^* + \sup\left\{ n \middle| \left(\frac{1-(\rho^f)^n}{1-\rho^f} + (\rho^f)^n \frac{1-(\rho^s)^{N^*+1}}{1-\rho^s} \right) \frac{g^s}{g^f} V(M_0) < V_0(0, 1-\epsilon^c) \right\}$$

where the proof follows from the same argument as Lemma 1. Therefore, higher M_0 is associated with a lower graduation step. Therefore, as in the proof of Proposition 2, a higher candidate graduation step $N^{**} > N$ has a candidate initial reputation $M_0^{**} < M_0^*$. From here, the contradiction proceeds from exactly the same steps as in the proof of Proposition 2.

A.II.G Proof of Proposition 4

Given that we have $\alpha_i(M_{jt}) = \frac{\frac{1}{2}\omega_i(M_{jt})\frac{1}{\omega(M_{jt})}D(M_{jt})}{w_i}$ and taking $w_i = w$ to be constant, then we have

$$corr_i(\alpha_i(M_{jt}), \alpha_i(\overline{M})) = corr_i\left(\frac{1}{2}\omega_i(M_{jt})\frac{\omega(M_{jt})^{-1}D(M_{jt})}{w}, \frac{1}{2}\omega_i(\overline{M})\frac{\omega(\overline{M})^{-1}D(\overline{M})}{w}\right) = corr_i\left(\omega_i(M_{jt}), \omega_i(\overline{M})\right)$$

given that $\frac{\omega(M_{jt})^{-1}D(M_{jt})}{w}$ and $\frac{\omega(\bar{M})^{-1}D(\bar{M})}{w}$ are constant across i. This gives the first part of the result.

Now to the second part of the result. Employing a Taylor series approximation around M^r, we have

$$\omega_i(M_{jt}) = \omega_i(M^r) + \omega_i'(M^r)(M_{jt} - M^r) + \mathcal{O}(M_{jt} - M^r)^2.$$

Denote $\phi_0^i = \omega_i(M^r)$, $\phi_1^i = \omega_i'(M^r)$, and $\mathcal{O}_{ijt}$ to be the approximation error. Denote $\mathcal{O}_t = \sup_{i,j} \mathcal{O}_{ijt}$ and $o_{ijt} = \mathcal{O}_{ijt}/\mathcal{O}_t \leq 1$ then

$$\omega_i(M_{jt}) = \phi_0^i + \phi_1^i(M_{jt} - M^r) + o_{ijt}\mathcal{O}_t.$$

Thus as $\mathcal{O}_t \to 0$,

$$corr_i(\omega_i(M_{jt}), \omega_i(\overline{M})) \to corr_i\Big(\phi_0^i + \phi_1^i(M_{jt} - M^r), \phi_0^i + \phi_1^i(\overline{M} - M^r)\Big).$$

We now look to show that the correlation is strictly increasing in M as the approximation error converges to zero. Denote $\hat{\omega}_i(M_{jt}) = \phi_0^i + \phi_1^i(M_{jt} - M^r)$ the first order approximations. Then, the correlation applied to $\hat{\omega}_i$ is

$$\rho(M_{jt}) = corr_i(\hat{\omega}_i(M_{jt}), \hat{\omega}_i(\overline{M})) = \frac{\text{cov}_i(\hat{\omega}_i(M_{jt}), \hat{\omega}_i(\overline{M}))}{\sqrt{var_i(\hat{\omega}_i(M_{jt}))var_i(\hat{\omega}_i(\overline{M}))}}.$$

Differentiating the correlation, we have

$$\begin{aligned}\frac{\partial\rho(M_{jt})}{\partial M_{jt}} &= \frac{\frac{\partial \text{cov}_i(\hat{\omega}_i(M_{jt}),\hat{\omega}_i(\overline{M}))}{\partial M_{jt}}\sqrt{var_i(\hat{\omega}_i(M_{jt}))} - \frac{\text{cov}_i(\hat{\omega}_i(M_{jt}),\hat{\omega}_i(\overline{M}))}{2\sqrt{var_i(\hat{\omega}_i(M_{jt}))}}\frac{\partial var_i(\hat{\omega}_i(M_{jt}))}{\partial M_{jt}}}{var_i(\hat{\omega}_i(M_{jt}))\sqrt{var_i(\hat{\omega}_i(\overline{M}))}} \\ &= \frac{\frac{\partial \text{cov}_i(\hat{\omega}_i(M_{jt}),\hat{\omega}_i(\overline{M}))}{\partial M_{jt}}var_i(\hat{\omega}_i(M_{jt})) - \frac{1}{2}\text{cov}_i(\hat{\omega}_i(M_{jt}),\hat{\omega}_i(\overline{M}))\frac{\partial var_i(\hat{\omega}_i(M_{jt}))}{\partial M_{jt}}}{var_i(\hat{\omega}_i(M_{jt}))^{3/2}var_i(\hat{\omega}_i(\overline{M}))^{1/2}}\end{aligned}$$

We have the covariance and variance

$$cov_i(\hat{\omega}_i(M_{jt}), \hat{\omega}_i(\overline{M})) = \sigma_0^2 + \sigma_1^2(M_{jt} - M^r)(\overline{M} - M^r) + \sigma_{01}(M_{jt} + \overline{M} - 2M^r)$$

$$var_i(\hat{\omega}_i(M_{jt})) = \sigma_0^2 + \sigma_1^2(M_{jt} - M^r)^2 + 2\sigma_{01}(M_{jt} - M^r)$$

where $\sigma_0^2 = var_i(\phi_0^i)$, $\sigma_1^2 = var_i(\phi_1^i)$, and $\sigma_{01} = cov_i(\phi_0^i, \phi_1^i)$. Therefore, we have

$$\frac{\partial cov_i(\hat{\omega}_i(M_{jt}), \hat{\omega}_i(\overline{M}))}{\partial M_{jt}} = \sigma_1^2(\overline{M} - M^r) + \sigma_{01}$$

$$\frac{\partial var_i(\hat{\omega}_i(M_{jt}))}{\partial M_{jt}} = 2\sigma_1^2(M_{jt} - M^r) + 2\sigma_{01}$$

Substituting these expressions back into the derivative of the correlation,

$$\begin{aligned}\frac{\partial\rho(M_{jt})}{\partial M_{jt}} &= \frac{\sigma_1^2\Big[(\overline{M} - M^r)var_i(\hat{\omega}_i(M_{jt})) - \text{cov}_i(\hat{\omega}_i(M_{jt}), \hat{\omega}_i(\overline{M}))(M_{jt} - M^r)\Big]}{var_i(\hat{\omega}_i(M_{jt}))^{3/2}var_i(\hat{\omega}_i(\overline{M}))^{1/2}} \\ &+ \frac{\sigma_{01}\Big[var_i(\hat{\omega}_i(M_{jt})) - \text{cov}_i(\hat{\omega}_i(M_{jt}), \hat{\omega}_i(\overline{M}))\Big]}{var_i(\hat{\omega}_i(M_{jt}))^{3/2}var_i(\hat{\omega}_i(\overline{M}))^{1/2}}\end{aligned}$$

Now, using the formulas for variance and covariance, we have

$$var_i(\hat{\omega}_i(M_{jt})) - \text{cov}_i(\hat{\omega}_i(M_{jt}), \hat{\omega}_i(\overline{M})) = -(\overline{M} - M_{jt})\Big[\sigma_1^2(M_{jt} - M^r) + \sigma_{01}\Big]$$

$$(\overline{M} - M^r)var_i(\hat{\omega}_i(M_{jt})) - \text{cov}_i(\hat{\omega}_i(M_{jt}), \hat{\omega}_i(\overline{M}))(M_{jt} - M^r) = (\overline{M} - M_{jt})\Big[\sigma_0^2 + \sigma_{01}(M_{jt} - M^r)\Big]$$

Substituting these expressions into the derivative of the correlation gives

$$\begin{aligned}\frac{\partial \rho(M_{jt})}{\partial M_{jt}} &= \frac{\sigma_1^2(\overline{M}-M_{jt})\Big[\sigma_0^2+\sigma_{01}(M_{jt}-M^r)\Big]-\sigma_{01}(\overline{M}-M_{jt})\Big[\sigma_1^2(M_{jt}-M^r)+\sigma_{01}\Big]}{var_i(\hat{\omega}_i(M_{jt}))^{3/2}var_i(\hat{\omega}_i(\overline{M}))^{1/2}}\\ &= (\overline{M}-M_{jt})\frac{\sigma_1^2\sigma_0^2-\sigma_{01}^2}{var_i(\hat{\omega}_i(M_{jt}))^{3/2}var_i(\hat{\omega}_i(\overline{M}))^{1/2}}\\ &= (\overline{M}-M_{jt})\frac{\Big(1-\rho_{01}^2\Big)\sigma_1^2\sigma_0^2}{var_i(\hat{\omega}_i(M_{jt}))^{3/2}var_i(\hat{\omega}_i(\overline{M}))^{1/2}}\end{aligned}$$

where $\rho_{01}=\frac{\sigma_{01}}{\sigma_0\sigma_1}$ is the correlation between ϕ_0^i and ϕ_1^i. Thus, we have $\frac{\partial\rho(M_{jt})}{\partial M_{jt}}>0$ provided that: (i) $\overline{M}>M_{jt}$; (ii) $|\rho_{01}|<1$; (iii) $\sigma_0^2,\sigma_1^2>0$.

Finally, provided that $\frac{\partial\rho(M_{jt})}{\partial M_{jt}}>0$, then as $\mathcal{O}_t\to 0$ we have that $corr_i(\alpha_i(M_{jt}),\alpha_i(\overline{M}))$ increases in M_{jt}. Therefore, $M_{jt}>M_{kt} \iff corr_i(\alpha_i(M_{jt}),\alpha_i(\overline{M}))>corr_i(\alpha_i(M_{kt}),\alpha_i(\overline{M}))$, and hence the portfolio correlation rank also ranks countries by reputation. This concludes the proof.

A.II.H Proof of Proposition 5

For given b^*, Proposition 2 tells us there exists a unique graduation step Markov equilibrium, and Appendix A.II.O derives its stationary distribution μ_{b^*}. To prove existence, we need to verify that there is some b^* such that the consistency condition holds, that is

$$\Delta(b^*)\equiv b^*-b\int_M \frac{1}{4}\omega(M)^{-1}D(M,b^*)^2 d\mu_{b^*}=0.$$

This equation depends on b only through b itself, since all other elements are functions of b^*.

The proof strategy has two steps. First, we show that there is an interval of values of b^*, denoted $[\underline{b},\bar{b}]\subset(0,\infty)$, such that $\Delta(\underline{b})<0$ and $\Delta(\bar{b})>0$. We then prove that Δ is continuous over this interval. This proves that Δ has a zero on this interval and hence an equilibrium exists.

Step 1: Interval Bounds

We first show there is a lower point $\underline{b}>0$ such that $\Delta(\underline{b})<0$. From Proposition 1, we have

$$\frac{1}{4}\omega(M)^{-1}D(M,b^*)^2=\frac{1}{b^{*2}}\omega(M)\Big[\gamma Q(1-(1-M)\overline{\tau})-\bar{R}\Big]^2.$$

Since $\omega(M)$ is a nondecreasing function of M, then we have for all M

$$\frac{1}{4}\omega(M)^{-1}D(M,b^*)^2\geq\frac{1}{b^{*2}}\omega(0)\Big[\gamma Q(1-\overline{\tau})-\bar{R}\Big]^2>0.$$

Therefore, we can write

$$\Delta(b^*) \leq b^* - b\frac{1}{b^{*2}}\omega(0)\Big[\gamma Q(1-\overline{\tau}) - \bar{R}\Big]^2.$$

Observe that $\Delta(0+) \to -\infty$, so that we have a $\underline{b} > 0$ such that $\Delta(\underline{b}) < 0$.

Next we construct an $\overline{b} > 0$ such that $\Delta(\overline{b}) > 0$. We have for all M

$$\frac{1}{4}\omega(M)^{-1}D(M,b^*)^2 \leq \frac{1}{b^{*2}}\omega(1)\Big[\gamma Q - \bar{R}\Big]^2.$$

Therefore, we can write

$$\Delta(b^*) \geq b^* - b\frac{1}{b^{*2}}\omega(1)\Big[\gamma Q - \bar{R}\Big]^2.$$

Observe that the RHS is positive for $b^* > \left(b\omega(1)\Big[\gamma Q - \bar{R}\Big]^2\right)^{1/3}$, thus we can define any $\overline{b} > \left(b\omega(1)\Big[\gamma Q - \bar{R}\Big]^2\right)^{1/3}$. Take in particular $\overline{b} \downarrow \left(b\omega(1)\Big[\gamma Q - \bar{R}\Big]^2\right)^{1/3}$.

Collateral Constraint. For completeness, we provide a sufficient condition on parameters such that $\overline{b}$ is consistent with the collateral constraint binding. The requirement for the collateral constraint to bind was for all M and for any $\tau \in \{0, \overline{\tau}\}$

$$A < \left[\frac{1-\tau}{(1-h_t)Q}R_t - 1\right]D_t.$$

Combining this requirement with the definition of $\overline{b}$ and recalling that D_t falls in $\overline{b}$ while R_t is invariant to $\overline{b}$ at given M, then we can write

$$A < \inf_{M\in[0,1]} \frac{1}{\left(b\omega(1)\Big[\gamma Q - \bar{R}\Big]^2\right)^{1/3}}\left[\frac{1-\tau}{(1-h_t)Q}R_t(M) - 1\right]2\omega(M)\Big[\gamma Q(1-(1-M)\overline{\tau}) - \overline{R}\Big].$$

Equivalently rearranging,

$$Ab^{1/3} < \inf_{M\in[0,1]} \frac{1}{\left(\omega(1)\Big[\gamma Q - \bar{R}\Big]^2\right)^{1/3}}\left[\frac{1-\tau}{(1-h_t)Q}R_t(M) - 1\right]2\omega(M)\Big[\gamma Q(1-(1-M)\overline{\tau}) - \overline{R}\Big].$$

This tells us that either A or b must be sufficiently low for $\overline{b}$ to be associated with a binding collateral constraint. We assume this is the case.

Therefore, we have constructed an interval $[\underline{b}, \overline{b}]$ with $\Delta(\underline{b}) < 0$ and $\Delta(\overline{b}) > 0$. It remains to prove that Δ is continuous on this interval, and hence there is a zero.

Step 2: Proof of Continuity

The proof that $\Delta(b^*) = b^* - \overline{D}(b^*)$ is continuous amounts to a proof that $\bar{D}(b^*) \equiv b \int_M \frac{1}{4}\omega(M)^{-1} D(M, b^*)^2 d\mu_{b^*}$ is continuous in b^*.

Let $\{M_0(b^*), ..., M_N(b^*)\}$ be the equilibrium reputation cycle of the graduation step Markov equilibrium without competition and with slope b^*. It is helpful to define the extended path $\{M_n(b^*)\}$ for all $n \geq 0$, where $M_n(b^*) = 1 - \epsilon^C$ for all $n > N$.[23]

We break the proof of continuity of $\overline{D}(b^*)$ into two steps. First, we prove that for every n in the extended path, M_n is continuous in b^*. We then use this result to prove that $\overline{D}(b^*)$ is continuous.

Lemma 4 *For every $n \geq 0$ of the extended path, $M_n(b^*)$ is continuous in b^*.*

Proof of Lemma 4: *We begin by showing that if $M_0(b^*)$ is continuous, then $M_n(b^*)$ is continuous for all $n > 0$. Recall that the path M_n for $n > 0$ is generated in equilibrium by the transition equation*

$$V(M_n) = \rho v A \frac{b^* - b}{b} + \rho V(M_{n-1}) + V(M_0)$$

for $0 < n \leq N$, and by $M_n = 1 - \epsilon^C$ for $n > N$. Define $\underline{V} = V(\epsilon^O)$ and $\overline{V} = V(1 - \epsilon^C)$. Define the hypothetical path of indifference-sustaining utilities as

$$V_n^* = \rho v A \frac{b^* - b}{b} + \rho V_{n-1}^* + V_0^*$$

with $V_0^* = V(M_0)$. Define V^{-1} the inverse function of V, which is continuous and well defined on $[\underline{V}, \overline{V}]$. Thus we can define the path of reputation as

$$M_n = \begin{cases} V^{-1}(V_n^*), & V_n^* \leq \overline{V} \\ 1 - \epsilon^C, & V_n^* > \overline{V} \end{cases}$$

Since V_n^* is a continuous function of (b^*, V_0^*), since V_0^* is a continuous function of M_0, and since $V^{-1}(\overline{V}) = 1 - \epsilon^C$, then a sufficient condition for M_n to be a continuous function of b^* for any $n > 0$ is that M_0 is a continuous function of b^*. It thus remains to prove that M_0 is a continuous function of b^*.

The proof that M_0 is continuous proceeds by contradiction. Suppose, hypothetically, that M_0 were not a continuous function of b^*. We have already proven that M_0 is a decreasing function of b^* (Lemma 6), so the discontinuity must be downward. Hence, a discontinuity implies there is some $b_1^* \in [\underline{b}, \overline{b}]$ such that $M_0(b_1^*-) > M_0(b_1^*+) + \delta$ for some $\delta > 0$, where $M_0(b_1^*-)$ and $M_0(b_1^*+)$ denote the left and right limits respectively. We have also proven that N is a nonincreasing function of b^* (Lemma 6). Therefore, we must have either $N(b_1^*-) = N(b_1^*+)$ or else $N(b_1^*-) > N(b_1^*+)$.

[23] The extended path is useful because it allow us to define the stationary distribution over all steps $n \geq 0$ of governments, including after the graduation step, rather than defining it over reputation at each step. This has the advantage that the set of steps $n \in \{0, \ldots\}$ of the extended path is invariant to b^*, which eases proof of continuity by avoiding discrete changes in graduation steps, which change discretely the number of atoms in the stationary distribution over reputation.

Suppose first that $N(b_1^*-) = N(b_1^*+) \equiv N$, that is the graduation step is continuous at the discontinuity. But since the transition dynamics determining M_n are continuous in b^* for given M_0 (V_0^*), then we have $M_n(b_1^*-) > M_n(b_1^*+)$ for all $n \leq N$. But then from Bayes rule, we have

$$\pi_N(b_1^*-) < \pi_N(b_1^*+),$$

contradicting that both $M_n(b_1^*-) = \pi_N(b_1^*-)$ and $M_n(b_1^*+) = \pi_N(b_1^*+)$, and hence contradicting that N is the graduation step of both. Thus, we cannot have $N(b_1^*-) = N(b_1^*+)$ at a discontinuity.

Suppose, then, that the discontinuity is accompanied with a discontinuity in the graduation step, $N(b_1^*-) > N(b_1^*+)$. By the same argument as above, the transition dynamics imply $M_n(b_1^*-) > M_n(b_1^*+)$ for all $n \leq N(b_1^*-)$. But then since $N(b_1^*-) > N(b_1^*+)$,

$$M_{N(b_1^*+)+1}(b_1^*+) < M_{N(b_1^*+)+1}(b_1^*-) \leq 1 - \epsilon^C$$

contradicting that $N(b_1^*+) < N(b_1^*-)$. Therefore, a discontinuity in M_0 also cannot be accompanied by a discontinuity in the graduation step.

Therefore, $M_0(b^*)$ is continuous. This completes the proof of this lemma.

Having proven that $M_n(b^*)$ is continuous for all $n \geq 0$ on the extended path, we are now ready to prove that $\overline{D}(b^*)$ is continuous and hence $\Delta(b^*)$ is continuous. It is helpful to redefine the stationary distribution over steps, $\mu_n(b^*)$, rather than over reputation levels, so that we can make use of the extended path. Under this definition, we can rewrite for any b^*

$$\bar{D}(b^*) = \frac{1}{4}\sum_{n=0}^{\infty} \omega(M_n(b^*))^{-1} D(M_n(b^*), b^*)^2 \mu_n(b^*).$$

Now, we can define the stationary distribution analogous to its definition in Appendix A.II.O, except that we no longer have an absorbing state. Therefore defining $\delta_0^*(b^*) = 1$ and defining

$$\delta_n^*(b^*) = \prod_{k=0}^{n-1} M_k(b^*)$$

for all $n > 0$. Note that mass at steps $n > N$ captures committed types that have not switched type. Given this definition of $\delta_n^*(b^*)$, we have the stationary distribution over steps

$$\mu_n(b^*) = \frac{\delta_n^*(b^*)}{\sum_{k=0}^{\infty} \delta_k^*(b^*)}.$$

Thus substituting in above, we can write

$$\bar{D}(b^*) = \frac{\sum_{n=0}^{\infty} \frac{1}{4}\omega(M_n(b^*))^{-1} D(M_n(b^*), b^*)^2 \delta_n^*(b^*)}{\sum_{n=0}^{\infty} \delta_n^*(b^*)}$$

Observe that the numerator and denominator are continuous functions of the path $\{M_n(b^*)\}$ and the slope b^*, and that the denominator is strictly positive and bounded away from zero since $\delta_0^*(b^*) = 1$. Therefore, $1/\sum_{n=0}^{\infty} \delta_n^*(b^*)$ is also a continuous function of $\{M_n(b^*)\}$. Therefore, $\overline{D}(b^*)$ is the product of two functions that are continuous is $(\{M_n\}(b^*), b^*)$, and so is itself continuous. Therefore since by Lemma 4 $M_n(b^*)$ is continuous in b^* for every n, then $\overline{D}$ is continuous. This completes the proof of continuity.

Summarizing Argument

We have shown that there is an interval $[\underline{b}, \bar{b}]$ such that $\Delta(\underline{b}) < 0$ and $\Delta(\bar{b}) > 0$ (Step 1). We have further shown that $\Delta(b^*)$ is continuous on $[\underline{b}, \bar{b}]$ (Step 2). Therefore, there is a value $\hat{b} \in [\underline{b}, \bar{b}]$ such that $\Delta(\hat{b}) = 0$. Therefore, an equilibrium of the competition model, as described, exists.

A.II.I Proof of Proposition 6

The transition dynamics of the equilibrium of this model are identical to those of the model without competition but slope $b' = b^*$. Thus we can write

$$V(M_n, b^*) = \rho V(M_{n-1}, b^*) + V(M_0, b^*).$$

Recall that we can write

$$V(M_n, b^*) = \frac{h^f}{\gamma - (1 - h^f)} \Big(\gamma Q A + \Big(\gamma Q - R(M_n) \Big) D(M_n, b^*) \Big)$$

Using the issuance solutions, we have

$$D(M_n, b^*) = 2 \frac{\omega(M_n)}{b^*} \Big[\gamma Q (1 - (1 - M_n) \overline{\tau}) - \bar{R} \Big] = \frac{b}{b^*} D(M_n)$$

where $D(M_n)$ is defined as in the baseline model without competition and slope b. Thus, substituting in we can write

$$V(M_n, b^*) = \frac{h^f}{\gamma - (1 - h^f)} \Big(\gamma Q A + \Big(\gamma Q - R(M_n) \Big) D(M_n) \frac{b}{b^*} \Big) = \nu \gamma Q A \frac{b^* - b}{b^*} + \frac{b}{b^*} V(M_n).$$

From here, we can substitute in to the transition equation and rearrange to obtain

$$V(M_n) = \rho \frac{h^f}{\gamma - (1 - h^f)} \gamma Q A \frac{b^* - b}{b} + \rho V(M_{n-1}) + V(M_0)$$

Finally, suppose that $A = 0$. Then, this transition equation is exactly the same as the transition equation in the model without competition and slope b. Thus, we obtain the same graduation step Markov equilibrium $\mathbf{M}$ and the same stationary distribution μ. However, issuance is affected since we have $D(M_n, b^*) = \frac{b}{b^*} D(M_n)$.

A.II.J Proof of Proposition 7

Recall that the transition equation is

$$V(M_n) = \rho v A \frac{b^* - b}{b} + \rho V(M_{n-1}) + V(M_0)$$

and that there is a unique graduation step Markov equilibrium associated of the model without competition and slope b^*. Conjecture an equilibrium with immediate graduation, $N = 0$. This means that $M_0 = \epsilon^O$ and that

$$V(1 - \epsilon^C) \leq \rho v A \frac{b^* - b}{b} + (1 + \rho)V(M_0)$$

Rearranging, we have

$$\left(1 + \frac{V(1 - \epsilon^C) - (1 + \rho)V(M_0)}{\rho v A}\right) b \leq b^*$$

which gives the result.

A.II.K Proof of Proposition 8

We begin with intermediate results needed to prove the result. It is important to recall that the transition equation implies that reputation builds faster from a starting point M_0 when b^* is higher.

It is helpful to define $M_n(b^*)$ to be the equilibrium path of reputation that results from the model without competition and slope b^* for all $n = 0, 1, ...$ Note that for $n > N$, we have $M_n(b^*) = 1 - \epsilon^C$. The extended definition is helpful for comparing paths with different graduation steps.

We begin with an initial Lemma establishing a notion of monotonicity.

Lemma 5 *Let $b_1^* > b_2^*$. If $M_n(b_1^*) \geq M_n(b_2^*)$, then $M_{n+s}(b_1^*) \geq M_{n+s}(b_2^*)$ for all $s \geq 0$.*

Proof of Lemma 5. Suppose that $M_n(b_1^*) \geq M_n(b_2^*)$. Recall we can write the transition equation as

$$V(M_n) = \rho V(M_{n-1}) + B^* + V(M_0)$$

where for notational compactness we have defined $B^* = \rho v A \frac{b^* - b}{b}$. Note that $B_1^* > B_2^*$ when $b_1^* > b_2^*$. Suppose first, by way of contradiction, that $B_1^* + V(M_0(b_1^*)) \leq B_2^* + V(M_0(b_2^*))$. Since $B_1^* > B_2^*$, then $M_0(b_1^*) < M_0(b_2^*)$. Then, we have

$$V_1(M_1^*) = B_1^* + V(M_0(b_1^*)) + \rho V(M_0(b_1^*)) < B_2^* + V(M_0(b_1^*)) + \rho V(M_0(b_2^*)) = V_2(M_1^*).$$

By induction, if $B_1^* + V(M_0(b_1^*)) \leq B_2^* + V(M_0(b_2^*))$ and $V(M_n(b_1^*)) < V(M_n(b_2^*))$, then

$$V(M_n(b_1^*)) = \rho V(M_{n-1}(b_1^*)) + B_1^* + V(M_0(b_1^*)) < V(M_n(b_2^*))$$

for all n, a contradiction. Therefore if $M_n(b_1^*) \geq M_n(b_2^*)$ for some n, then $B_1^* + V(M_0(b_1^*)) > B_2^* + V(M_0(b_2^*))$. But then by induction, $M_{n+s}(b_1^*) \geq M_{n+s}(b_2^*)$ for all $s \geq 0$. This completes the proof.

Lemma 5 allows us to prove the next result.

Lemma 6 *The following comparative statics are true in the model without competition and slope b^*:*

(a) *The graduation step N is weakly decreasing in b^*.*

(b) *Take $b_1^* > b_2^*$ such that $N(b_2^*) > 0$. Then, there exists $n' > 0$ such that $M_n(b_1^*) < M_n(b_2^*)$ for $n < n'$ and $M_n(b_1^*) \geq M_n(b_2^*)$ for $n \geq n'$.*

(c) *The path of beliefs $\pi_n(b^*)$ is nondecreasing in b^*.*

Proof of Lemma 6.

(a) Take slope b_2^*, and let $N_2 \equiv N(b_2^*)$ be the graduation step and $M_n(b_2^*)$ be the path of reputation associated with b_2^*. Now consider $b_1^* > b_2^*$. Suppose by way of contradiction that $N_1 \equiv N(b_1^*) > N(b_2^*)$. From Lemma 5, we know we must have $M_{N_2}(b_1^*) < M_{N_2}(b_2^*)$ to avoid graduation at N_2. From Lemma 5, we know that $M_n(b_1^*) < M_n(b_2^*)$ for all $n \leq N_2$. But then Bayes' rule implies that

$$M_{N_2}(b_1^*) < M_{N_2}(b_2^*) = \pi_{N_2}(b_2^*) < \pi_{N_2}(b_1^*)$$

meaning that beliefs exceed reputation at N_2, a contradiction. Therefore, $N_1 \leq N_2$, and the graduation step is non-increasing in b^*.

(b) First, note that Lemma 5 implies that if there is some n' such that $M_{n'}(b_1^*) \geq M_{n'}(b_2^*)$, then $M_n(b_1^*) \geq M_n(b_2^*)$ for all $n > n'$. We therefore necessarily have some such $n' \leq N_2 + 1$. From part (a), we know that $N_1 \leq N_2$. Now, suppose that we had $n' = 0$, and hence we had $M_n(b_2^*) < M_n(b_1^*)$ for all $n \leq N_1$. But then, from Bayes' rule we have

$$M_{N_1}(b_2^*) < M_{N_1}(b_1^*) = \pi_{N_1}(b_1^*) < \pi_{N_1}(b_2^*)$$

a contradiction. So, $M_0(b_1^*) < M_0(b_2^*)$, giving the result for some $n' > 0$.

(c) Let $b_1^* > b_2^*$. From part (a), we know that $N_1 \leq N_2$. From part (b), we know that there exists an $n' > 0$ such that $M_n(b_1^*) < M_n(b_2^*)$ iff $n < n'$. Therefore, from Bayes' rule the result holds trivially for $n \leq n'$ (recall that $\pi_{n'}$ is determined from $M_0, ..., M_{n'-1}$). If $n' \geq N_2$ then we have finished the proof. Suppose instead that $n' < N_2$ and consider $n > n'$. We know that at $n = N_2$,

$$\pi_{N_2}(b_2^*) = M_{N_2}(b_2^*) \leq M_{N_2}(b_1^*) = \pi_{N_2}(b_1^*),$$

so we also have beliefs that are higher at N_2.[24] Now recall Bayes' rule,

$$\pi_n = \epsilon^C + (1 - \epsilon^C - \epsilon^O)\frac{\pi_{n-1}}{M_{n-1}}.$$

[24]Note that if $N_1 < N_2$, the above equation holds because $M_{N_2}(b_1^*) = \pi_{N_2}(b_1^*) = 1 - \epsilon^C$.

From Bayes' rule, we know that if $\pi_n(b_1^*) \geq \pi_n(b_2^*)$ and $M_{n-1}(b_1^*) \geq M_{n-1}(b_2^*)$, then it must be the case that $\pi_{n-1}(b_1^*) \geq \pi_{n-1}(b_2^*)$. Therefore, by induction we have $\pi_n(b_1^*) \geq \pi_n(b_2^*)$ for all $n > n'$. This completes the proof.

Having proved Lemma 6, we are now ready to return to the main part of the proof of the proposition. Define $\delta_n = \Pi_{k=0}^{n-1} m_k$. Note that since $m_n(b_1^*) = 0$ for all $n \geq N_1$, the result holds trivially for all $N_1 \leq n \leq N_2$ and we can restrict attention to $n < N_1$.

Starting with δ_1 ($n = 1$). We know from part (b) of Lemma 6 that M_0 declines in b^*, so m_0 also declines in b^* given that initial beliefs are $\pi_0 = \epsilon^O$. Therefore, $\delta_1 = m_0$ declines in b^*.

We now consider δ_n for $n > 1$. Reputation is given by $M_n = \pi_n + (1 - \pi_n)m_n$ and beliefs are given by $\pi_{n+1} = \epsilon^O + (1 - \epsilon^C - \epsilon^O)\frac{\pi_n}{M_n}$. Using the first equation to write $m_n = \frac{M_n - \pi_n}{1-\pi_n}$ and the second to write $M_n = \frac{(1-\epsilon^C-\epsilon^O)\pi_n}{\pi_{n+1}-\epsilon^O}$, we can substitute the second equation into the first to obtain

$$m_n = \frac{\pi_n}{1 - \pi_n} \frac{1 - \epsilon^C - \pi_{n+1}}{\pi_{n+1} - \epsilon^O}.$$

From here, we can substitute into δ_n to obtain

$$\delta_n = \prod_{k=0}^{n-1} \frac{\pi_k}{1 - \pi_k} \frac{1 - \epsilon^C - \pi_{k+1}}{\pi_{k+1} - \epsilon^O}.$$

Taking logs and regrouping terms, we can write

$$\log \delta_n = \log \frac{\pi_0}{1 - \pi_0} + \sum_{k=1}^{n-1} \log \frac{\pi_k}{1 - \pi_k} \frac{1 - \epsilon^C - \pi_k}{\pi_k - \epsilon^O} + \log \frac{1 - \epsilon^C - \pi_n}{\pi_n - \epsilon^O}$$

$$\log \delta_n = \log \frac{\pi_0}{1 - \pi_0} + \sum_{k=1}^{n-1} \left[\log \frac{\pi_k}{\pi_k - \epsilon^O} + \log \frac{1 - \epsilon^C - \pi_k}{1 - \pi_k} \right] + \log \frac{1 - \epsilon^C - \pi_n}{\pi_n - \epsilon^O}$$

To complete the proof, we show that every term on the RHS is weakly decreasing in b^*. The first term, $\log \frac{\pi_0}{1-\pi_0}$, is constant since $\pi_0 = \epsilon^O$. Every component in the sum declines, since beliefs are weakly increasing in b^* and since we have

$$\frac{\partial}{\partial \pi_k} \left[\frac{\pi_k}{\pi_k - \epsilon^O} \right] = \frac{-\epsilon^O}{(\pi_k - \epsilon^O)^2} < 0$$

$$\frac{\partial}{\partial \pi_k} \frac{1 - \epsilon^C - \pi_k}{1 - \pi_k} = \frac{-\epsilon^C}{(1 - \pi_k)^2} < 0$$

The last term is also weakly decreasing in b^*, since

$$\frac{\partial}{\partial \pi_n} \left[\frac{1 - \epsilon^C - \pi_n}{\pi_n - \epsilon^O} \right] = \frac{-(1 - \epsilon^C - \epsilon^O)}{(\pi_n - \epsilon^O)^2} < 0$$

where the inequality follows since $1 - \epsilon^C - \epsilon^O > 0$ by assumption. Therefore, we obtain the result for all

n, concluding the proof.

A.II.L Proof of Proposition 9

The increases in gross assets and liabilities follows immediately from the fact that E_t and D_t both increase in reputation. For the latter part of the proposition, we have

$$NFA_t = k(W + E_t) - D_t.$$

Adopting notation $E_t = n_t\Big[\gamma Q I_t - R_t D_t\Big]$, where $n_t = \frac{h_t}{\gamma-(1-h_t)}$ is the net worth multiplier, we can define $v_t = n_t\gamma Q$ as the marginal value of an additional unit of inside equity. Using the Envelope Theorem, we have

$$\frac{\partial E_t}{\partial M_t} = -n_t \frac{\partial R_t}{\partial M_t} D_t = \frac{v_t}{\gamma Q} R_t D_t \frac{1}{1-(1-M_t)\overline{\tau}}\overline{\tau}$$

Now, we split the proof up into the regions $M_t < M^*$ and $M_t \geq M^*$.

For $M_t < M^*$, the economy has not yet opened up, and we have

$$\frac{\partial NFA_t}{\partial M_t} = \left[k\frac{v_t}{\gamma Q}\frac{R_t D_t}{1-(1-M_t)\overline{\tau}} - \frac{1}{b}\gamma Q\right]\overline{\tau}.$$

From here, we note that

$$\frac{\partial^2 NFA_t}{\partial M_t^2} = k\frac{v_t}{\gamma Q}\frac{\partial}{\partial M_t}\left[\left(\frac{1}{2}\gamma Q + \frac{1}{2}\frac{\bar{R}}{1-(1-M_t)\overline{\tau}}\right)\frac{1}{b}\left(\gamma Q - \frac{\bar{R}}{1-(1-M_t)\overline{\tau}}\right)\right]\overline{\tau} = \frac{1}{b}k\frac{v_t}{\gamma Q}\frac{\bar{R}^2}{(1-(1-M_t)\overline{\tau})^3}\overline{\tau}^2 > 0$$

so that if $\left.\frac{\partial NFA_t}{\partial M_t}\right|_{M_t=1} < 0$, then NFA is everywhere deterioriating as reputation builds. NFA is deteriorating at $M_t = 1$ if $k\frac{v_t}{\gamma Q} b R_t D_t - \gamma Q < 0$. Substituting in for R_t and D_t and rearranging, we have the sufficient condition

$$k < \frac{2}{v_t}\frac{(\gamma Q)^2}{(\gamma Q)^2 - \bar{R}^2}$$

Finally, note that $\frac{(\gamma Q)^2}{(\gamma Q)^2 - \bar{R}^2} > 1$, so the result holds provided that $v_t < 2$.

Next, note that at $M = M^*$, we have continuity in E_t but an upward discontinuity in D_t. Therefore, NFA discretely deteriorates at M^*.

Finally for $M_t > M^*$, we can repeat the same steps to get

$$\frac{\partial NFA_t}{\partial M_t} = \left[k\frac{v_t}{\gamma Q}\frac{R_t D_t}{1-(1-M_t)\overline{\tau}} - \frac{2}{b}\gamma Q\right]\overline{\tau}.$$

From here, note that we have $k\frac{v}{\gamma Q}\frac{R_t D_t}{1-(1-M_t)\overline{\tau}} - \frac{2}{b}\gamma Q < k\frac{v}{\gamma Q}\frac{R_t D_t}{1-(1-M_t)\overline{\tau}} - \frac{1}{b}\gamma Q$, and so the same argument as before applies, completing the proof.

A.II.M Set-up For: "How Can the U.S. Deter China From Becoming a Reserve Currency?"

A large incumbent country (the US) is known to be committed forever and so has constant reputation $M = 1$. It faces measure 1 of entrants (potential new reserve currencies like China) going through the reputation game. We consider the problem of the incumbent (leader) choosing its debt issuance, accounting for the impact of its debt issuance on the entire equilibrium outcome (debt issuance, reputation cycle, and stationary distribution) of the entrant countries. To simplify the problem, we abstract away from any transition dynamics and focus solely on the stationary point ("steady state"). As a result, the problem is static from the perspective of the incumbent (entrants converge instantly to the stationary distribution).

Formally, the incumbent's payoff function is

$$V^* = \nu^* \Big(\gamma^* Q^* I^* - R^S \overline{S} \Big)$$

where γ^* and Q^* are the liquidation value and return of the project (respectively), ν^* is the incumbent's net worth mutliplier and where $I^* = A^* + \overline{S}$. Now that we are no longer setting $\overline{S} = 0$, we have

$$R^S - \overline{R} = \frac{1}{8} b \Big(\overline{S} + \frac{2}{\mathcal{I}} \sum_i \int \omega_i(M)^{-1} D_i(M)^2 d\mu(M) \Big).$$

As before, we can define $b^* = 4(R^S - \overline{R})$, which now gives the slope of investor i's demand curve as

$$b^* = \frac{1}{2} b \overline{S} + b \int \frac{1}{\mathcal{I}} \sum_i \omega_i(M)^{-1} D_i(M)^2 d\mu(M) \Big).$$

Investor aggregation applies in the same way as before, so that we have

$$\int \Big[\frac{1}{\mathcal{I}} \sum_i \omega_i(M)^{-1} D_i(M)^2 \Big] d\mu(M) = \int \frac{1}{4} \omega(M)^{-1} D(M, b^*)^2 d\mu_{b^*}.$$

Thus, substituting back in we can write

$$b^* = \frac{1}{2} b \overline{S} + b \int \frac{1}{4} \omega(M)^{-1} D(M, b^*)^2 d\mu_{b^*}.$$

Because the reputation cycle, debt issuance, and stationary distribution of entrants depends on b^*, it is helpful to rewrite the incumbent's payoff over b^*, and to describe the implementability conditions for an incumbent to implement that choice of b^*. We can rewrite the payoff function of the incumbent as

$$V^* = \nu^* \gamma^* Q^* A^* + \nu^* (\gamma^* Q^* - R^S(b^*)) \overline{S}(b^*)$$

with corresponding implementability conditions

$$\overline{S}(b^*) = \frac{2}{b} \Big(b^* - b \int \frac{1}{4} \omega(M)^{-1} D(M, b^*)^2 d\mu_{b^*} \Big) \tag{A.4}$$

$$R^S(b^*) = \overline{R} + \frac{1}{4}b^* \tag{A.5}$$

Intuitively, the first implementability condition (equation A.4) describes the slack in market clearing for $\overline{S}$ that results from a given choice of b^* that must be filled by the incumbent, and hence determines $\overline{S}(b^*)$. The second implementability condition (equation A.5) gives the promised yield $R^S(b^*)$ that is required to incentivize investors to buy $\overline{S}(b^*)$ along with their debt purchases from entrants. Formally, the incumbent promises a return $R^S(b^*)$ to investors, which results in demand $\overline{S}(b^*)$ for incumbent debt and a slope b^* for entrants. Equations (A.4) and (A.5) therefore summarize the manner in which the incumbent implements a choice of b^*.

The focus of the this leading example in main text is on implementable allocations. Formally, Proposition 7 provides a minimum value $\overline{b}^*$ to crowd out opportunistic entrants, which is implemented by the incumbent with a promised yield $R^S(\overline{b}^*)$ and corresponding issuance $\overline{S}(\overline{b}^*)$ (or any larger choice $R^S(b^*)$ with $b^* > \overline{b}^*$). Proposition 8 illustrates the impact of the incumbent changing policy to achieve an increase in b^*, which is again achieved through adjustment in $\overline{S}(b^*)$ (equation A.4) and through an adjustment in $R^S(b^*)$ (equation A.5).

A.II.N Competition Solutions

The following proposition associates solutions of the model with competition with the no-competition models that generate them.

Proposition 10 *For every b^*, there exists a unique b (holding all other parameters fixed) such that there is an equilibrium of the model with competition that generates slope b^*.*

Proposition 10 provides a simple way of mapping a model with competition back into the parameters of the model without competition that generates it, in particular the original slope b. To understand Proposition 10, begin with a choice of b^*. From Proposition 2, we obtain the unique graduation step Markov equilibrium and cycle $\mathbf{M}$. From there, we obtain the stationary distribution μ over $\mathbf{M}$. Finally, we can rearrange the consistency condition to $b = \frac{b^*}{\int \frac{1}{4}\omega(M)^{-1}D(M)^2 d\mu(M)}$, which gives us the value of b. Given the graduation step Markov equilibrium and its stationary distribution are both unique, b is also unique. From here, reversing the steps starting from b yields an equilibrium of the model with competition that generates slope b^*.[25]

A.II.N.1 Proof of Proposition 10

Take a given b^*, then from Proposition 2 we know there exists a unique graduation step Markov equilibrium of the model without competition. We can then find the stationary distribution of this equilibrium (see Appendix A.II.O). The consistency condition $b^* = b\int \omega(M)^{-1}\frac{1}{4}D(M)^2 d\mu(M)$ is a linear equation in

[25] Note that Proposition 10 shows that each b^* is uniquely associated with a b, but not that b uniquely maps into b^*.

b, and therefore has a single solution (given knowledge of b^* and the unique graduation date Markov equilibrium). Therefore, there is a unique b such that the proposition holds.

A.II.O Stationary Distribution

Consider the discrete set of reputations $\mathbf{M}$ that comes out of the unique graduation step Markov equilibrium of the model without competition with slope b^*. The stationary distribution μ over $\mathbf{M}$ from the reputation game is the atoms over $\mathbf{M}$, whose probabilities are $\{\mu_0, ..., \mu_N, \mu_{N+1}\}$, where μ_{N+1} is the measure of countries that have reached reputation $1-\epsilon^C$ (i.e., that were committed types at cycle step N). We can characterize the stationary distribution as follows. First consider any step $0 < n < N+1$. At step n, the mass μ_n of countries in the stationary distribution comes from countries at the prior step that do not exercise the capital control, $M_{n-1}\mu_{n-1}$. Observe that all countries at step n either move to step $n+1$ or revert to step 0, meaning that

$$\mu_n = M_{n-1}\mu_{n-1}.$$

Step $n = N+1$ is an absorbing state for committed governments that do not switch type. The flows of types are the same as at steps $0 < n < N+1$, except that the mass $1-\epsilon^C$ of committed types also remain at $N+1$. Therefore, we have μ_{N+1} given by $\mu_{N+1} = (1-\epsilon^C)\mu_{N+1} + M_N\mu_N$, which rearranges to

$$\mu_{N+1} = \frac{1}{\epsilon^C} M_N \mu_N.$$

Let us define $\delta_n^* = \prod_{k=0}^{n-1} M_k$ for $0 < n < N+1$, with $\delta_0^* = 1$ and $\delta_{N+1}^* = \frac{1}{\epsilon^C}\prod_{k=0}^{N} M_k^*$. δ_n^* is a cumulative unconditional probability that a government that starts at step 0 goes through its first n crises without exercising capital controls (with an adjustment at $N+1$ for the absorbing state).[26] From above, we have $\mu_n = \delta_n^*\mu_0$ for all n. Finally using that $\sum_{n=0}^{N+1}\mu_n = 1$, we obtain

$$\mu_0 = \frac{1}{\sum_{n=0}^{N+1}\delta_n^*}.$$

Thus, from here we can write for all $0 \le n \le N+1$

$$\mu_n = \frac{\delta_n^*}{\sum_{x=0}^{N+1}\delta_x^*}$$

This characterizes the stationary distribution that arises out of the dynamic reputation model.

[26]Note the close relationship with δ_n defined in the main text, which defines the same object but condition on being opportunistic at step 0.

A.II.P Model Extensions

A.II.P.1 Domestic Debt Issuance

Suppose that in addition to inside equity A, there is also an amount $D_t^d \leq \overline{D}^d$ available to borrow from domestic households. Households inelastically save domestically at the equilibrium interest rate R_t (equivalently, the government can apply a tax/subsidy on savings). Moreover, there is financial repression: domestic households are forced to maintain their investment in the bank at date 1 without collateral. It follows that from the government's perspective domestic household savings and inside equity are equivalent given financial repression, and that the model is equivalent to one in which inside equity is $A^* = A + \overline{D}^d$. Financial repression forces households to roll over $\overline{D}^d$ at interest rate R_t^ℓ, which gives final payoff to households of $R_t^\ell R_t \overline{D}^d$ and reduces final payoff to intermediaries by the same amount.

A.II.P.2 Investor Utility Functions and Opening Up

We now provide more general conditions on investor preferences under which staggered opening up occurs, that is generalizing Lemma 1. Each early generation investor $i \in \{s, f\}$ has the utility function $U(M_t, R_t^i, D_t^i)$, which has already internalized the budget constraint. If investor $i \in \{s, f\}$ is allowed into the country, then her first order condition for optimal debt purchase is

$$\frac{\partial U(M_t, R_t^i, D_t^i)}{\partial D_t^i} = 0,$$

which defines an optimal debt policy $D^i(M_t, R_t^i)$ as a function of reputation M_t and the promised yield R_t^i. Note that $D^s(M, R) = D^f(M, R)$ for all (M, R).

We make two key assumptions on the utility function U.

Assumption 1 *The utility function U satisfies $\frac{\partial^2 U}{\partial D_t^i \partial R_t^i} > 0$ and $\frac{\partial^2 U}{\partial D_t^i \partial M_t} > 0$.*

Assumption 1 implies increasing differences in (D_t^i, R_t^i) and (D_t^i, M_t), so that the optimal debt policy $D^i(M_t, R_t)$ increases in both the (promised) interest rate R_t^i and the reputation M_t. The former is an intuitive assumption that a higher yield (all else equal) attracts more foreign investment. The latter is important to ensuring that countries benefit from a higher reputation, as it implies they can borrow more at the same interest rate as reputation builds. Note that the investor preferences in the baseline model satisfy Assumption 1, resulting in a debt policy that increases in both R_t^i and M_t.

This environment allows us to prove the following generalization of Proposition 1 on staggered opening up by the committed type.

Proposition 11 *There exists a unique opening up threshold $M^* \in [0, 1]$ such that:*

(a). The interest rate policy $R(M_t)$ is the solution to

$$\Big[\gamma Q - R(M_t)\Big] \frac{\partial D^s(M_t, R(M_t))}{\partial R} = D^s(M_t, R(M_t))$$

(b). The stable investor debt policy is $D^s(M_t) = D^s(M_t, R(M_t))$

(c). The flighty investor debt policy is

$$D^f(M_t) = \begin{cases} 0, & M_t \leq M^* \\ D^s(M_t), & M_t > M^* \end{cases}$$

Proof of Proposition 11. The proof follows similar steps as the proof of Lemma 1. Taking as given reputation M_t, the objective of the committed government is to:

$$\max_{D_t^s, D_t^f} \quad c_t = \frac{h_t}{\gamma - (1-h_t)} \Big(\gamma Q I_t - R_t D_t \Big)$$

subject to the haircut determination

$$h_t = \begin{cases} h^s, & D_t^f = 0 \\ h^f, & D_t^f > 0 \end{cases}$$

and subject to the demand functions $D_t^i = D_t^i(R_t, M_t)$ when an investor class is allowed into the country, to $I_t = A + D_t$, to $D_t = D_t^s + D_t^f$, and to $R_t = \frac{R_t^s D_t^s + R_t^f D_t^f}{D_t}$. As in the proof of Proposition 1, we define $n(h)$ to be the net worth multiplier when the haircut is h, so that

$$c_t = n(h_t) \Big(\gamma Q I_t - R_t D_t \Big)$$

Note that we have $n(h^s) \geq n(h^f)$. As in the baseline model, conditional on a choice of which investors to borrow from, the optimal borrowing rule maximizes the liquidation value of inside equity $\gamma Q I_t - R_t D_t$.

The proof proceeeds as in the proof of Proposition 1: we first derive optimal issuance conditional on either borrowing only from stable or borrowing from both, and then we compare the two.

Borrowing only from stable investors. Given the demand function $D^s(M_t, R_t)$ of stable investors, the first order condition for the optimal promised interest rate $R_t = R_t^s$ (it is slightly more convenient to represent the equivalent decision problem of choosing the interest rate) is

$$\gamma Q \frac{\partial D^s(M_t, R_t)}{\partial R_t} = D^s(M_t, R_t) + R_t \frac{\partial D^s(M_t, R_t)}{\partial R_t}$$

This equation defines the optimal interest rate policy $R(M_t)$,

$$\Big[\gamma Q - R(M_t) \Big] \frac{\partial D^s(M_t, R(M_t))}{\partial R_t} = D^s(M_t, R(M_t)).$$

From here, the optimal debt policy associated with this interest rate policy is $D^s(M_t) = D^s(M_t, R(M_t))$.

From here, we can substitute back into utility to obtain the indirect utility function in reputation,

$$V^s(M_t) = n(h^s) \gamma Q A + n(h^s) \Big(\gamma Q - R(M_t) \Big) D^s(M_t, R(M_t)).$$

Finally, we note that by Envelope Theorem,

$$\frac{\partial V^s(M_t)}{\partial M_t} = n(h^s)\Big(\gamma Q - R(M_t)\Big)\frac{\partial D_t^s}{\partial M_t} > 0,$$

where for clarity we note that $\frac{\partial D_t^s}{\partial M_t}$ is the partial derivative in M_t at a fixed interest rate R_t. Intuitively, indirect utility increases in reputation because, holding the interest rate fixed, an increase in reputation increases demand by stable investors, so that the country can borrow more at the same interest rate. This highlights the significance of Assumption 1.

Borrowing from stable and flighty investors. If the committed type also borrows from flighty investors, then note the liquidation value of inside equity is $\gamma QA + \sum_i(\gamma Q - R_t^i)D_t^f(M_t, R_t^i)$. Therefore since $D^s = D^f$, we have $R_t = R_t^s = R_t^f$ given as above by $R(M_t)$. Intuitively, all debt-related components of the liquidation value of inside equity are simply scaled up by 2 relative to the previous case, leading to the same rule. Thus, we can write the indirect utility function as

$$V^f(M_t) = n(h^f)\gamma QA + 2n(h^f)\Big(\gamma Q - R(M_t)\Big)D^s(M_t, R(M_t)).$$

In this case, note that by Envelope Theorem we have

$$\frac{\partial V^f(M_t)}{\partial M_t} = 2n(h^f)\Big(\gamma Q - R(M_t)\Big)\frac{\partial D_t^s}{\partial M_t} > 0.$$

Choosing what type of investor to borrow from. We can now characterize what type of investors the committed government decides to borrow from. The committed type only borrows from stable investors when

$$V^s(M) \geq V^f(M).$$

Begin first with the case in which $n(h^s)/n(h^f) < 2$. We show that $\Delta(M) \equiv V^s(M) - V^f(M)$ is monotone decreasing in M, and hence there exists an $M^* \in [0,1]$ such that the result holds (where by convention, we denote $M^* = 0$ if the economy is always open and $M^* = 1$ is the economy if always closed). By Envelope Theorem we have

$$\begin{aligned}
\Delta'(M) &= \frac{\partial V^s(M)}{\partial M} - \frac{\partial V^f(M)}{\partial M} \\
&= n(h^s)\Big(\gamma Q - R(M_t)\Big)\frac{\partial D_t^s}{\partial M_t} - 2n(h^f)\Big(\gamma Q - R(M_t)\Big)\frac{D^s(R_t(M_t), M_t)}{\partial M_t} \\
&= \Big[n(h^s) - 2n(h^f)\Big]\Big(\gamma Q - R(M_t)\Big)\frac{\partial D_t^s}{\partial M_t} \\
&< 0
\end{aligned}$$

where the final inequality follows since $n(h^s)/n(h^f) < 2$, $R(M_t) < \gamma Q$, and $\frac{\partial D_t^s}{\partial M_t} > 0$. Hence, Δ is decreasing and we can define such an M^*, giving the result. Note that this highlights the importance of increasing differences, that is an increase in reputation increases investor borrowing for the same interest rate.

If instead $n(h^s)/n(h^f) \geq 2$, then note that we have

$$V^S - V^f = \left(n(h^s) - n(h^f)\right)\gamma QA + \left(n(h^s) - 2n(h^f)\right)\left(\gamma Q - R(M_t)\right)D^s(M_t) \geq 0$$

and hence the country never opens up and we define $M^* = 1$.

Finally if $n(h^s) = n(h^f)$, then $V^s - V^f \leq 0$, the economy is always open, and we define $M^* = 0$.

A.II.P.3 Adding a High State

We extend the model to incorporate the possibility of a "high" state in the middle of t, so that crises may occur only infrequently.

In the middle of t, the state is high with probability p and low with probability $1-p$. The low state is analogous to the baseline model, and we denote c_t^L its payoff. We assume that neither government type ever exercises a capital control in the high state.

In the high state, the economy is in a boom and the intermediary gains access to a more valuable investment project, which converts 1 unit of the consumption good in the middle of date t into $R_H > 0$ units of the consumption good at the end of date t. We assume that $\gamma R_H > 1$, so that the intermediary optimally redeploys all of its existing assets to the new project in the high state. In this state, foreign investors lend unlimited amounts at R_H, as we describe further below, so that the intermediary is indifferent to rolling over any debt at the interest rate R_H. We assume that $R_t D_t$ is rolled over without loss of generality. As a result, the intermediary final payoff at the end of date t if the high state was realized in the middle of the date is given by

$$c_t^H = R_H\left(\gamma Q I_t - R_t D_t\right). \tag{A.6}$$

As in the baseline model, payoff in the high state is a net worth multiplier, R_H, on the liquidation value of inside equity.

From here, we can define the expected payoff to the committed type as

$$c_t = pc_t^H + (1-p)c_t^L = \left(pR_H + (1-p)\frac{h_t}{\gamma - (1-h_t)}\right)(\gamma Q I_t - R_t D_t).$$

Proposition 1 is easily shown to hold, with the only change being the realized value of the threshold M^*.

As in the baseline model, define $V(M_t) = c(M_t)$ and analogously define V^{opp}, except that in place of the multiplier g we now have

$$G(M_t) = \frac{pR_H + (1-p)\frac{h(M_t)}{\gamma - \frac{(1-h(M_t))}{1-\overline{\tau}}}}{pR_H + (1-p)\frac{h_t}{\gamma-(1-h(M_t))}} \geq 1,$$

reflecting that the net worth multiplier is only inflated in the low state.

As in the baseline model, an opportunistic government strategy is a probability m_t^o of not exercising the capital control in the low state. The opportunistic government is assumed to never exercise it in the high state, analogous to the committed type.

We assume that a government that dies following the high state does not switch type. Thus no information is revealed to investors about government type in the high state, and the posterior beliefs π_{t+1} are the prior beliefs π_t following the high state. Therefore, the corresponding Bellman equation is

$$\begin{aligned} W(\pi_n) = \max_{m_n^o \in [0,1]} & m_n^o \Big(V^{Opp}(M(\pi_n), 0) + \beta \Big(pW(\pi_n) + (1-p)W(\pi_{n+1}) \Big) \Big) \\ & + (1 - m_n^o) \Big(V^{Opp}(M(\pi_n), \overline{\tau}) \Big) + \beta \Big(pW(\pi_n) + (1-p)W(\pi_0) \Big) \end{aligned}$$

under the new definition of V^{Opp}. Note that the contribution of $\beta p W(\pi_n)$ to continuation value does not depend on strategy m_n^o, so we can rearrange to obtain

$$W(\pi_n) = \frac{1}{1-\beta p} \max_{m_n^o \in [0,1]} m_n^o \Big(V^{Opp}(M(\pi_n), 0) + \beta(1-p)W(\pi_{n+1}) \Big) \Big) + (1-m_n^o) \Big(V^{Opp}(M(\pi_n), \overline{\tau}) + \beta(1-p)W(\pi_0) \Big).$$

We can now characterize the transition equation using analogous derivations to the baseline model. At step $n = 0$ we can use the weak preference for exercising the capital control to obtain

$$W(\pi_0) = \frac{1}{1-\beta} G(M_n) V(M_n).$$

Then using the indifference condition at any n where a mixed strategy is played, we have

$$W(\pi_{n+1}) = \frac{1}{\beta(1-p)} (G(M_n) - 1) V(M_n) + W(\pi_0).$$

Finally, using again the weak preference for exercising the capital control at any step $n + 1$, we have

$$V(M_{n+1}) = \frac{1-\beta p}{\beta(1-p)} \frac{G(M_n) - 1}{G(M_n)} \frac{G(M_n)}{G(M_{n+1})} V(M_n) + \frac{G(M_0)}{G(M_{n+1})} V(M_0),$$

where we have defined $\varrho(M_n) = \frac{1-\beta p}{\beta(1-p)} \frac{G(M_n)-1}{G(M_n)}$. Thus the transition equation is precisely the same form as in the main text up to the changes in definitions. If there is a single investor, it is the same equation with the new definition of rate of convergence and indirect utility, and the rate of convergence is lower if $G^f > g^f$. It is notable that it is no longer trivial that $G^f < G^s$. The reason is that $G^f > G^s$ given R_H is a positive constant, i.e. the proportional gains from the good state are higher when the haircut is larger. As long as the effect of proportional gains from imposing capital controls dominates this latter effect, we have the same jump dynamics as in the baseline model.

A.II.P.4 Numerical Solution of the Model with Homogeneous Investors

Section 3.6 discussed the equilibrium of the model with homogeneous investors $h^s = h^f$. We provide here the accompanying numerical solution. Figure A.XVIII presents a numerical example of the equilibrium. Since investors are homogeneous, the opening up date is $N^* = 0$ by definition. In this example, graduation occurs at $N = 16$. The upper left panel plots the evolution of reputation M_n and beliefs π_n. Beliefs and reputation start low at $n = 0$ because, at this point, investors are relatively sure that the government is opportunistic; in this example, prior beliefs at $n = 0$ are $\pi_0 = \epsilon^O = 0.001$. Intuitively, most governments at $n = 0$ are those that exercised capital controls last period, thus revealing themselves to be opportunistic, and the only uncertainty about their type this period is due to the exogenous switching probability. At $n = 0$ there is no reputational cost to imposing the capital controls because the posterior belief would coincide with the prior, and a large increase in reputation (M_1), and/or a much flatter future interest rate schedule (i.e. higher $\omega(M_1)$), is required for opportunistic governments to be willing to forgo imposing capital controls. In this example we set $\omega(M)$ to be a strictly increasing function of M. Furthermore, since the belief that the government is the committed type is very low, a small fraction of opportunistic governments mimicking generates a large increase in posterior beliefs (in percentage) and future reputation. This can be seen in the top left panel of Figure A.XVIII in which a large gain in reputation M_n occurs moving from $n = 0$ to $n = 1$. The top right quadrant shows that this is supported by a relatively low value of the mimicking probability m_0. As beliefs build, reputation exceeds beliefs as more opportunistic governments are willing to defer employing capital controls to capitalize on the higher reputation and higher future benefits of imposing capital controls. This willingness declines as graduation approaches, reflecting the exponential convergence of the reputation building process.

The bottom left panel of Figure A.XVIII shows the decline in the equilibrium interest rate R_n as the reputation of the government improves. The bottom right panel shows the corresponding increase in foreign debt as reputation improves. At higher reputation the government contemporaneously sustains more foreign debt and lower interest rates, which is intuitive since higher reputation is a shift downward in the interest rate schedule.

A.II.P.5 Further Heterogeneity in Demand Curves

Investor heterogeneity plays a crucial role in the dynamics of opening up. In this appendix we allow for further heterogeneity in terms of parameters of the demand curve, like slope and intercept, as well as capping the total amount of financing that can be obtained by stable investors.

We think of the demand for the country's bonds by stable investors even at low levels of reputation as a special characteristic of countries that could become a reserve currency, like China. Most other countries, like many emerging markets, do not have this option and instead open up directly facing flighty investors. We think of stable investors as cheaper than private flighty ones but also a smaller overall pool of capital.

Similarly we think that the pool of capital that a country can attract goes up as its reputation improves. Part of this occurs because investors tend to specialize and there are many more large(r) investors that target relatively safe debt. Part of this occurs, even within the same investor, because as reputation increases the riskiness (variance and covariance with crisis) of the debt decreases, leading to a less steep demand function for the bonds (i.e. returns do not have to increase as much to generate a given increase in holdings).

In the paper, we put emphasis on simplicity and tractability and made the investors classes only different in their haircut. In this appendix, we explore other ways to capture our view of investor heterogeneity discussed above.

Heterogeneous Intercept, Slope, and Cap to Investors Demand Curves. In addition to the lower haircut, we can extend the model such that stable investors are also preferable to flighty investors from the perspective of investor borrowing costs. However, stable investors are capacity constrained and can only lend $D_t^s \leq \overline{D}^s$. We express the preferability of stable investors by the assumption that they always provide debt at a cheaper rate than the flighty investors, up to their debt capacity. Formally, we assume $R^s + \frac{1}{2}b^s\overline{D}^s \leq R^f$. As with haircuts, we now assume that the country also cannot discriminate on promised interest rates, that is it must set a common interest rate R_t for all investors allowed entry. This means that the country chooses to borrow from flighty investors only if it wishes to borrow more than the stable investors' capacity. If it borrows more than $\overline{D}^s$, it borrows the full investment capacity of the stable investors, $D_t^s = \overline{D}^s$, and the rest from flighty investors, $D_t^f = D_t - \overline{D}^s$. For now, we take $\omega(M) = 1$ for all M for both types of investors, and turn to those weights further below. As a result, we can express the promised interest rate schedule as

$$R_t = \begin{cases} \frac{R^s + \frac{1}{2}b^s D_t}{\mathcal{M}_t}, & D_t \leq \overline{D}^s \\ \frac{R^f + \frac{1}{2}b^f (D_t - \overline{D}^s)}{\mathcal{M}_t}, & D_t > \overline{D}^s \end{cases} \tag{A.7}$$

where we are defining $\mathcal{M}_t = 1-(1-M_t)\overline{\tau}$. The interest rate schedule is discontinuous at $\overline{D}^s$ if $R^s + \frac{1}{2}b^s\overline{D}^s < R^f$, and has a kink in the slope at $\overline{D}^s$ if $b^f \neq b^s$. This interest schedule, together with the assumptions made in the main text on haircuts, embeds an additional "fixed cost" to opening up to flighty investors in that it makes the interest rate schedule (in addition to collateral requirements) jump up on all debt when flighty investors are allowed to participate in domestic markets.

We assume single crossing continues to hold to simplify the analysis. In particular, we assume that there exists a crossing point $M^* \in (0,1)$ such that optimal debt issuance $D_t(M)$ satisfies $D_t(M) \leq \overline{D}^s$ for $M \leq M^*$ and $D_t(M) > \overline{D}^s$ for $M > M^*$. Under this assumption there is a single crossing point at M^* where the government shifts from borrowing from only stable investors to also borrowing from flighty investors. Given single crossing, the policy rule of the committed government as a function of M_t can be determined by maximizing the liquidation value of the intermediary: $\gamma Q I_t - R_t D_t$. We also have that optimal policy maximizes $\gamma Q I_t - R_t D_t$ separately for $M_t \leq M^*$ and $M_t > M^*$.

First suppose that $M_t \leq M^*$ and so $D(M_t) \leq \overline{D}^s$. Then, we have $R_t = \frac{R^s + \frac{1}{2}b^s D_t}{\mathcal{M}_t}$, and therefore the FOC for optimal debt issuance at an interior solution $D_t < \overline{D}^s$ is

$$0 = \gamma Q - R_t - \frac{\frac{1}{2}b^s}{\mathcal{M}_t} D_t$$

$$D(M_t) = \frac{1}{b^s}\Bigg[\gamma Q \mathcal{M}_t - R^s\Bigg].$$

Substituting back into the interest rate schedule, we get

$$R(M_t) = \frac{1}{2}\frac{R^s}{\mathcal{M}_t} + \frac{1}{2}\gamma Q.$$

Finally, note that this is applicable only as long as the debt cap does not bind, so we have a threshold M_* such that if $M_* < M_0 \leq M^*$ then the cap binds. In this region, the interest rate is instead given by

$$R(M_t) = \frac{R^s + \frac{1}{2}b^s\overline{D}^s}{\mathcal{M}_t}.$$

Next, suppose that $M_t > M^*$ and so $D(M_t) > \overline{D}^s$. In this case, we have $R_t = \frac{R^f + \frac{1}{2}b^f(D_t - \overline{D}^s)}{\mathcal{M}_t}$, giving

$$0 = \gamma Q - R_t - \frac{\frac{1}{2}b^f}{\mathcal{M}_t}D_t$$

$$D(M_t) = \frac{1}{b^f}\Bigg[\gamma Q \mathcal{M}_t - \Bigg(R^f - \frac{1}{2}b^f\overline{D}^s\Bigg)\Bigg]$$

Finally substituting back into the interest rate schedule, we obtain

$$R(M_t) = \frac{1}{2}\frac{R^f - \frac{1}{2}^f\overline{D}^s}{\mathcal{M}_t} + \frac{1}{2}\gamma Q.$$

Taking this all together, we have that the optimal issuance decision is

$$D(M_t) = \begin{cases} \frac{1}{b^s}\Bigg[\gamma Q \mathcal{M}_t - R^s\Bigg], & M_t \leq M_* \\ \overline{D}^s, & M_* < M \leq M^* \\ \frac{1}{b^f}\Bigg[\gamma Q \mathcal{M}_t - R^f\Bigg] + \frac{1}{2}\overline{D}^s, & M > M^* \end{cases},$$

where $M_* \leq M^*$ is the point at which the capacity constraint begins to bind. The associated interest rate is

$$R(M_t) = \begin{cases} \frac{1}{2}\frac{R^s}{\mathcal{M}_t} + \frac{1}{2}\gamma Q, & M_t \leq M_* \\ \frac{R^s + \frac{1}{2}b^s\overline{D}^s}{\mathcal{M}_t}, & M_* < M \leq M^* \\ \frac{1}{2}\frac{R^f - \frac{1}{2}b^f\overline{D}^s}{\mathcal{M}_t} + \frac{1}{2}\gamma Q, & M > M^* \end{cases}$$

Given these optimal issuance rule of the committed type, the analysis of the opportunistic type behavior follows unchanged from the main text. Figure A.XIX provides a numerical illustration of this equilibrium. We chose a parameter configuration to emphasize the debt limit. Indeed, the country starts at $n = 0$ borrowing only from stable investors. By step $n = 1$ the country desire to borrow exceed the debt capacity of the stable investors, yet the country does not open-up to flighty investors. It instead borrow $\bar{D}^s$ and waits for reputation to increase further before opening up. The open up date N^* is step 3.

Compared to the model in the main text, this more general heterogeneity allows for a smaller jump in debt when the country opens up. The model in the main text features no difference, other than the haircut, among the investors. This means that upon opening-up debt at least doubles. It doubles because the flighty investors are completely untapped before that point, and upon opening up the country borrows exactly as much from them as it does from the stable ones. It more than doubles because opening-up makes reputation jump up, and the higher reputation induces more borrowing from any type of investors. In this extended model, instead, we assume that the first unit of debt raised from the flighty investors is more expensive than the last unit raised from the stable ones: $R^s + \frac{1}{2}b^s\overline{D}^s \leq R^f$. This means that while debt does jump up upon opening-up, because of the fixed cost nature of letting in flighty investors, the fraction of total debt that is raised by flighty investors is relatively low. This fraction then continues to raise for all steps until graduation $n \in [N^*, N]$. This capture the pattern in the data of private investors becoming quantitatively more important as the country reputation improves.

Investor Specialization and Taste for Different Levels of Reputation. In the main text we introduced the taste/holding cost function $\omega_i(M)$ to allow for individual investors i specialization in the debt of countries with varying level of reputation. In the main text, we kept the investor class aggregate taste $\omega(M)$ identical between stable and flighty investors. In this appendix, we discuss several possible extensions: allowing pairing between specific investors and countries, allowing aggregate taste to be different between stable and flighty investors, and the foundations and equilibrium effect of steeper or flatter parametrizations of $\omega(M)$.

In the main model, investors hold identical amounts of debt by all countries with the same level of reputation M. It is possible, however, to allow some investors to have preferences for particular countries while maintaining overall symmetry. For example, this would capture in reduced form that investors tend to prefer the debt of countries that are closer geographically, politically, and have stronger trade connections. Formally, we could introduce wedges in the portfolio shares $\alpha_i(M_j)$ while making sure that, due to the law of large numbers, the wedges cancel out at the country level so that all countries face identical demand curves (just from a different subset of the investors).

The model can also allow for the investor class to have a different taste function $\omega^s(M)$ and $\omega^f(M)$. For example, if the two functions are affine transformations of each other, then the analysis is similar to the once discussed above in which the investors' demand functions have heterogeneous intercepts and slopes.

Finally, it is interesting to discuss possible foundations and the equilibrium effect of a declining function $\omega(M)$. For illustration purposes, Figures A.XVIII and 4 are based on increasing $\omega(M)$ while Figure 7 is based on a constant one. An increasing $\omega(M)$ provides more incentives for countries not to impose capital controls, since at each future step n they face progressively better interest rate schedules. This capture the notion that countries want to establish themselves as a reserve currency to capture the "exorbitant privilege" of facing very high demand for their bonds once they have high reputation. A steeper, i.e., faster increasing $\omega(M)$ tends to generate longer graduation dates N. In the case of heterogeneous haircuts, if the increase in $\omega(M)$ is faster for relatively low values of M (e.g. the function is increasing and concave) this tends to delay opening up (higher N^*) since the interest rate schedule that the country faces from stable investors improves fast with reputation.

Foundations for an increasing $\omega(M)$ and heterogeneity in this function across investor classes could come from habitat theories of the investor population and market segmentation with endogenous investor entry in different segments.

A.II.P.6 Opening-Up Step and Two-Way Flows

In the main text analysis of two-way flows, the intermediation sector inside equity is fixed and capital sent abroad is drawn from other domestic investments. Foreign assets are a constant percent of domestic wealth. When the country opens up to flighty foreign investors there is a jump up in the total value of the intermediation sector which increases foreign assets via its effect on wealth. Here we allow households to extract some of the intermediation sector inside equity and redeploy the capital abroad. This leads to a more than proportional increase in foreign assets when the country lets in flighty investors. To focus solely on this effect, we assume, for simplicity, that any money kept in the domestic economy is invested in the intermediation sector.

The household now allocates its resources W each period between bank equity, A_t, and foreign investment, K_t, that is to say $A_t + K_t = W$. We define the wealth of the household to be $K_t + E_t$, accounting for its equity wealth and its foreign investment wealth. Given the adjustment cost of sending capital abroad, the welfare of the household can now be written as

$$R^K K_t - \Psi(k_t)\Big(K_t + E_t\Big) + E_t,$$

where $k_t = \frac{K_t}{K_t+E_t}$ is the fraction of wealth invested abroad. Notice that E_t depends on inside equity, $A_t = W - K_t$, and so is endogenous to K_t. Taking the optimality condition of the committed type government for foreign investment, we obtain the solution

$$-\frac{R^K - \Big(1 + \Psi'(k_t)\Big)}{\Psi'(k_t)k_t - \Psi(k_t) + 1} = -\underbrace{\left(\frac{h_t}{\gamma - (1-h_t)}\gamma Q - 1\right)}_{\text{Return on Inside Equity}} \tag{A.8}$$

Equation (A.8) shows that k_t depends on the return on intermediary inside equity.[27] The LHS increases in k_t, so that a *decrease* in the return on inside equity leads to an increase in foreign investment in percent terms, k_t. Since the marginal return on inside equity *falls* at opening up due to the higher haircut h_t, this means that foreign investment is a constant k^s before opening up and is a constant k^f at and after opening up, with $k^s < k^f$ indicating that there is a disproportionately large increase in outflows from the domestic economy after opening up.

Intuitively, opening up to flighty investors increases the overall value of the intermediation sector by

[27] If the (marginal) return on inside equity is one, then the RHS is zero and we obtain the same first order condition as the previous specification with constant inside equity.

increasing its scale, but the increase in scale also decreases its marginal returns. Domestic capital moves abroad for two distinct reason: a wealth effect and a rebalancing effect. The wealth effect we described in the model in the main text. Here, we add a marginal decision for domestic households between investing domestically in the intermediation sector or investing abroad. Since the marginal returns at home decrease, the households optimally rebalance by investing more of their savings abroad as a fraction of total wealth.

We discuss below how this affects the full dynamics of the reputation model. The opportunistic type must send the same amount K_t of capital abroad to mimic the committed type and retain the same inside equity stake $A_t = W - K_t$.[28] In particular, the new transition dynamics can be written as

$$V(M_{n+1}) = \frac{g(h_n)}{g^*(h_{n+1})}\rho(h_n)V(M_n) + \frac{g^*(h_0)}{g^*(h_{n+1})}V(M_0)$$

where we have defined $g^*(M_n) \equiv \frac{R^K k_n - \Psi(k_n)}{1-k_n} + g(M_n)$. The transition dynamics are the same as before, except for replacements of $g(M_n)$ with $g^*(M_n)$.[29] This change has two effects. The first effect is that it further dampens the slope of the AR(1) process both before and after opening up, since $g^*(h_n) > g(h_n)$ due to the added value from sending a fraction of wealth abroad. Intuitively, as the country begins deriving more value from sending wealth abroad, it needs smaller increases in the value of inside equity to compensate for greater reputation.

The second effect comes from the change in the coefficient on $V(M_0)$ to $\frac{g^*(h_0)}{g^*(h_{n+1})}$ from $\frac{g(h_0)}{g(h_{n+1})}$. This coefficient is still equal to one before opening up. After opening up, there are two competing effects that determine whether the intercept is amplified or muted relative to before. The first effect is that the value of imposing the capital control falls after opening up, which lowers not only net worth but also the gains from sending capital abroad. This pushes the constant further towards zero and inserts a negative wedge in the transition dynamics at and after opening up. This reflects the intuition that a country resets its reputation also benefits from a higher proportional value of inside equity in the good state. The second effect arises from the increase in capital sent abroad, $k^f > k^s$, after opening up. This effect is ambiguous on the constant. On the one hand, it dampens the constant because the average return on foreign capital, $R^K - \frac{1}{k_n}\Psi(k_n)$, falls as capital is sent abroad. On the other hand, it amplifies the constant because as more capital is sent abroad, less is retained at home, and so larger reputation changes are required to maintain indifference.

[28]For simplicity, we assume that the adjustment cost for the opportunistic type is determined based on the market value E_t that arises if the capital control is not imposed.

[29]Notice that the component $g(h_n)\rho(h_n)$ in the slope of the AR(1) is correct as before, because it comes from the indifference condition which depends on g. By contrast, the other terms come from the Bellman equation, which depends on g^*.

Appendix Figures and Tables

Table A.I: Fund Sample Summary Statistics: 2020

		Total AUM (USD mi)		Total FC AUM (USD mi)		Average Share of Total AUM in FC Assets	Average Share of FC Assets in LC Government Bonds
		Mean	Median	Mean	Median		
Funds	599	1,776	526	899	329	76%	58%
of which Domiciled in							
EMU	318	1,017	421	797	314	83%	54%
USA	133	4,411	985	1,198	297	45%	60%
Canada	51	991	520	744	338	81%	37%

Notes: This table reports summary statistics of the funds included in the baseline analysis in 2020. We report the mean and median total AUM of the these funds, the AUM in assets denominated in currencies that are not the currency of the country the fund is domiciled (FC), the average share of total AUM in these FC assets and the share of these FC assets that is allocated in government bonds in the local currency of the issuing country.

Table A.II: Summary of Rankings for Alternative Estimations

	CNY Rank	**Average DM Rank**	**Average EM Rank**
Baseline	12	6	22
(a) UST as Reference	7	5.9	21
(b) Weighted by FC AUM	11	6.3	21.9
(c) Excluding Index Funds	12	6	22
(d) Intensive Margin	4	8.2	21.2
(e). Alternative Specialist Threshold	14	6	21.9
(f). Alternative Minimum FC AUM	13	6	21.9
(g). Alternative FC Definition	5	7.6	21.4

Notes: This table compares the ranking of CNY to the DM and EM averages for each alternative subset of the data. To compute rankings we sort the estimated correlations in each case in descending order.

Table A.III: Gravity Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\alpha_{c,i}$	$\alpha_{c,i}$	$\alpha_{c,i}$	$\alpha_{c,i}$	$\alpha_{c,i}$	$\alpha_{c,i}$	$\alpha_{c,i}$	$\alpha_{c,i}$
β^{BRL}_{DM}					-0.108***	-0.107***	-0.108***	-0.108***
					(0.006)	(0.006)	(0.006)	(0.006)
β^{CNY}_{DM}					0.016*	0.015*	0.016*	0.015*
					(0.009)	(0.009)	(0.009)	(0.009)
β^{JPY}_{DM}					0.199***	0.199***	0.200***	0.199***
					(0.011)	(0.011)	(0.011)	(0.011)
Distance	-0.005***			-0.001	-0.005***			-0.004***
	(0.001)			(0.001)	(0.001)			(0.001)
Trade Flow		0.306***		0.283***		0.116**		0.054
		(0.059)		(0.064)		(0.049)		(0.055)
Legal System			0.002*	0.001			-0.001	-0.001
			(0.001)	(0.001)			(0.001)	(0.001)
Observations	17,970	17,970	17,970	17,970	17,970	17,970	17,970	17,970
R-squared	0.202	0.205	0.200	0.205	0.441	0.440	0.439	0.441
DM Share	No	No	No	No	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

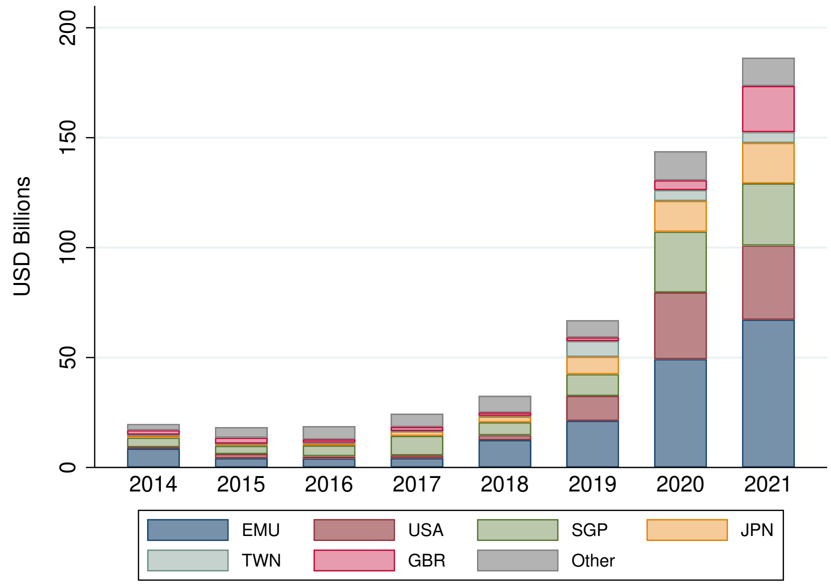
Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. This table reports the coefficient estimates of the gravity regressions. To simplify exposition instead of reporting all the β^{DM} (one for each currency) we only report estimates for the BRL, CNY and JPY estimates. All specifications include currency and fund domicile fixed effects. DM Share indicates whether the specification includes the variables $\alpha_{DM,c,i}$.

Table A.IV: Biggest Onshore RMB positions of Foreigners in Morningstar

Fund	Dom.	Benchmark (short)	RMB holdings (Bn USD) 2017	2018	2019	2020	Total % (2020)	(RMB hdgs) / (Total AUM), 2020
iShares China CNY Bond ETF	IRL	BBgBarc China Tsry+	0.000	0.000	0.170	6.320	13.10	1.00
Eurizon Bond Aggregate RMB	LUX	Bloomberg China Aggregate	0.000	0.547	0.938	2.448	5.07	1.00
PIMCO International Bond Fd (USD-Hedged)	USA	Bloomberg Gbl Agg	0.002	0.002	0.799	1.552	3.22	0.09
PIMCO Income Fund	USA	Bloomberg US Agg	0.000	0.000	0.000	1.381	2.86	0.01
Fuh Hwa China 5+ Yr Policy Bank Bond ETF	TWN	BBgBarc CHN Policy	0.000	0.000	1.418	1.174	2.43	1.00
Vanguard Total International Bd Idx Fund	USA	Bloomberg Gbl Agg	0.000	0.000	1.028	1.156	2.40	0.01
Cathay FTSE Chinese Policy Bk Bd5+YrsETF	TWN	FTSE Chinese Policy	0.000	0.000	1.453	1.083	2.25	1.00
PIMCO GIS Global Bond Fund	IRL	Bloomberg Global Aggregate	0.000	0.000	0.624	1.077	2.23	0.05
UBS (Lux) BS China Fixed Income (RMB)	LUX	Bloomberg China Aggregate	0.000	0.887	3.540	0.972	2.01	0.98
American Funds Capital World Bond Fund	USA	Bloomberg Global Aggregate	0.002	0.142	0.446	0.931	1.93	0.07
KGI China Policy Bank 3-10 Year Bond ETF	TWN	BBgBarc China Policy	0.000	0.000	0.869	0.894	1.85	1.00
Fubon China Policy Bank Bond ETF	TWN	BBgBarc China Policy	0.000	0.000	0.806	0.779	1.62	1.00
PIMCO GIS Income Fund	IRL	Bloomberg US Agg	0.000	0.000	0.000	0.742	1.54	0.01
PrivilEdge Income Partners RMB Debt	LUX	Bloomberg China Aggregate	0.000	0.009	0.011	0.679	1.41	0.91
iShares JPMorgan EM Local Govt Bond ETF	IRL	JPM GBI EM	0.000	0.000	0.000	0.663	1.37	0.10
BGF Fixed Income Global Opportunities Fd	LUX	Not Benchmarked	0.004	0.004	0.167	0.642	1.33	0.10
T. Rowe Price Intl Bd Fd (USD Hdgd)	USA	Bloomberg Gbl Agg	0.000	0.028	0.383	0.578	1.20	0.10
Shin Kong 10-Y China Trs Plc Bak Grn ETF	TWN	ChinaBond 10y Trsy&Plcy	0.000	0.000	0.827	0.499	1.04	1.00
American Funds Global Balanced Fund	USA	Composite with Bbg.Glb.Agg.	0.000	0.000	0.185	0.480	0.99	0.06
AB Global Bond Fund	USA	Bloomberg Global Aggregate	0.000	0.000	0.307	0.479	0.99	0.07
CSIF (CH) Bond Aggt Glb ex G4 ex CHF	CHE	Bloomberg Gbl Agg	0.000	0.000	0.188	0.469	0.97	0.43
iShares Core International Aggt Bd ETF	USA	Bloomberg Gbl Agg	0.000	0.000	0.161	0.429	0.89	0.13
Eastspring Inv China Bond Fund	LUX	Markit iBoxx ALBI	0.000	0.000	0.000	0.425	0.88	1.00
Western Asset Core Plus Bond Fund	USA	Bloomberg US Agg	0.065	0.064	0.066	0.408	0.85	0.01
SPDR® Blmbrg Bcly EM Lcl Bd ETF	IRL	Bloomberg EM Lcl	0.000	0.000	0.209	0.406	0.84	0.10

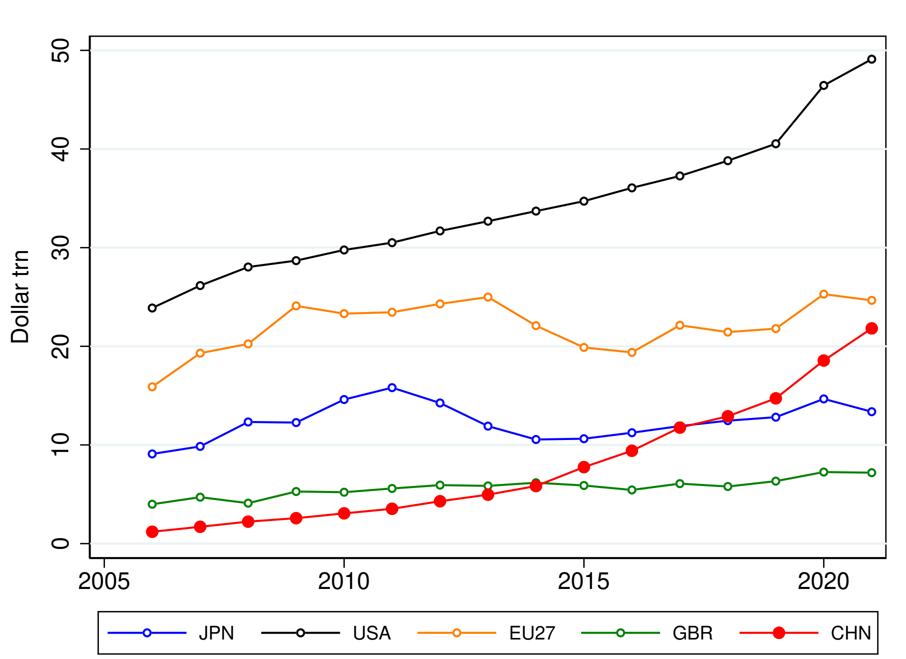
Notes: This table reports the funds with the largest investments in Morningstar in RMB in 2020Q4.

Figure A.I: Geography of Private Holders of Renminbi Bonds



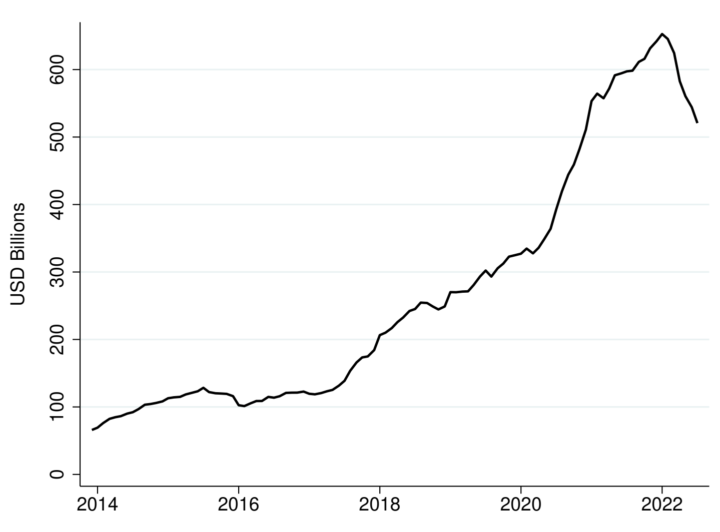
Notes: Figure reports identified private holdings of RMB bonds by investor country. When available, data from CPIS and TIC are used. When countries do not report the currency composition of their bond investment, data on fund holdings from Morningstar are used.

Figure A.II: The World's Largest Bond Markets



Source: Global Bond Market Outstanding from 2022 SIFMA Capital Markets Fact Book.

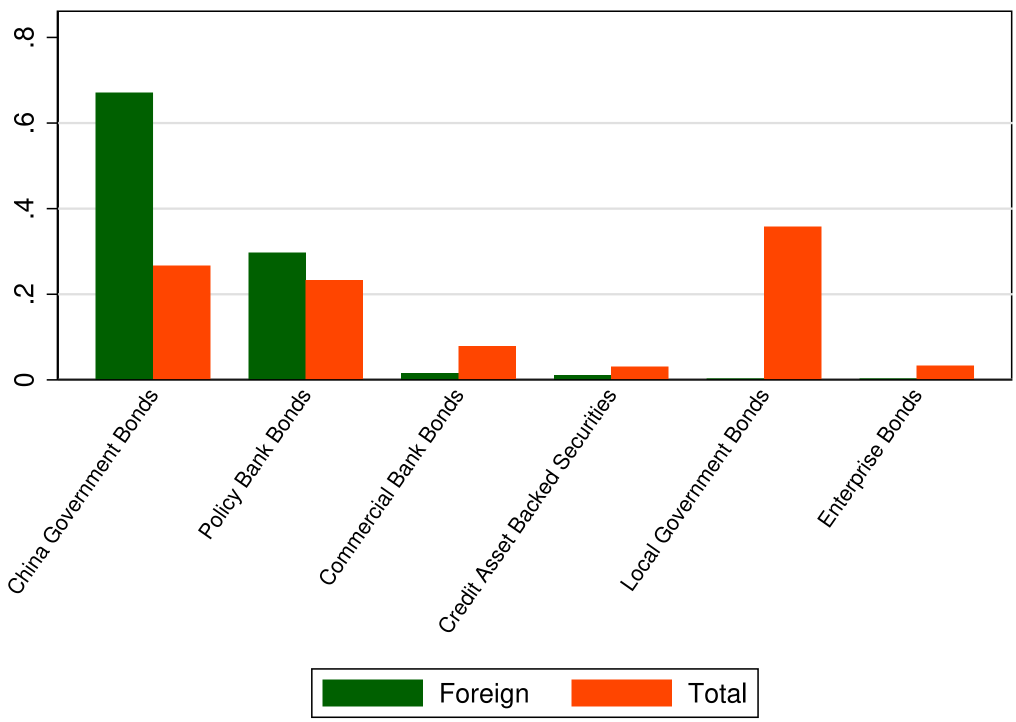
Figure A.III: Monthly Foreign Ownership of RMB-Denominated Bonds



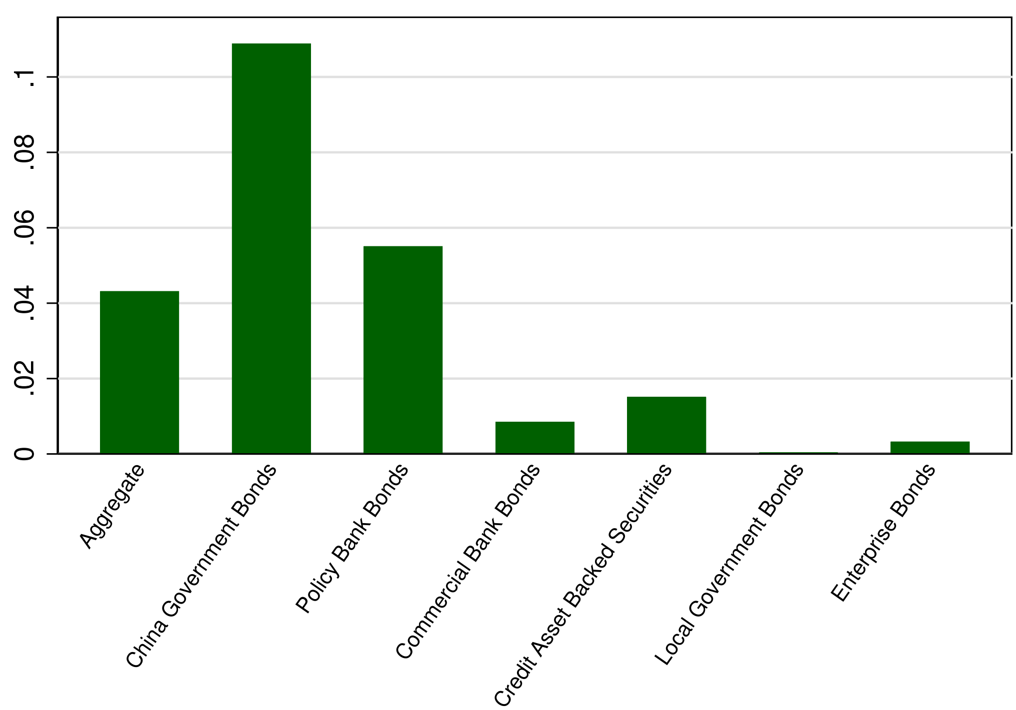
Source: Bond Connect, CEIC Data.

Figure A.IV: The Composition of Foreign Ownership of RMB Bonds

(a) Share of Foreign-Owned and Total Debt, 2021Q4



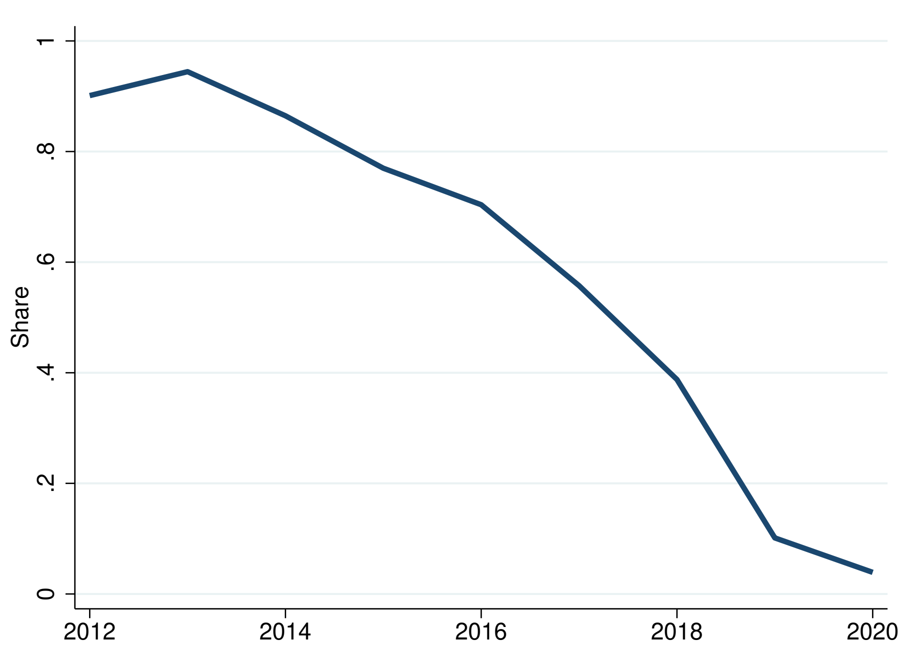
(b) Share of Outstanding Bonds Owned by Foreign Investors



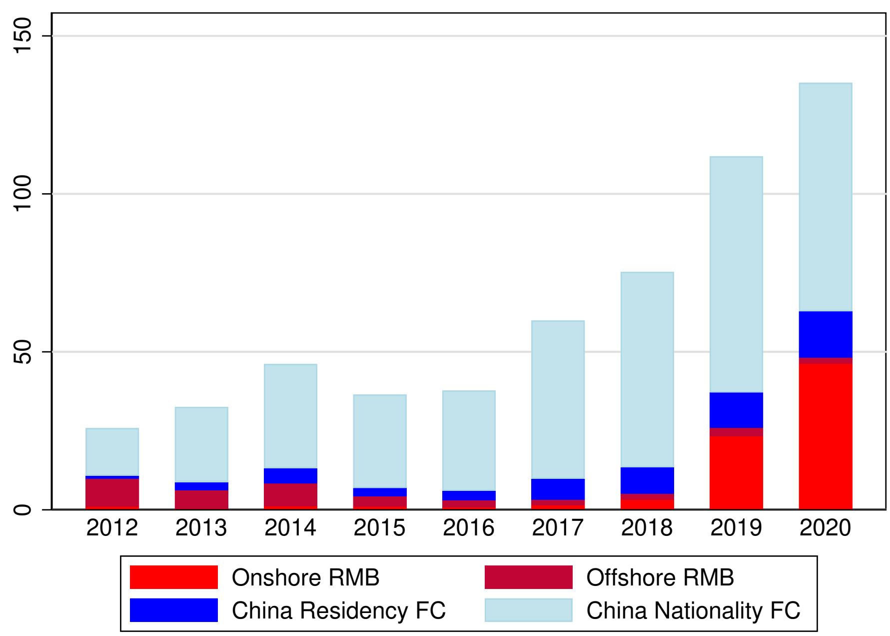
Notes: Data from China Central Depository & Clearing (CCDC). Top panel calculates the share of the foreign and total investment portfolio in each of the various categories of bonds. The bottom panel reports what share of each bond type is owned by foreign investors.

Figure A.V: Mutual Fund and ETF Investment in RMB

(a) Share of Foreign Investment in Offshore RMB

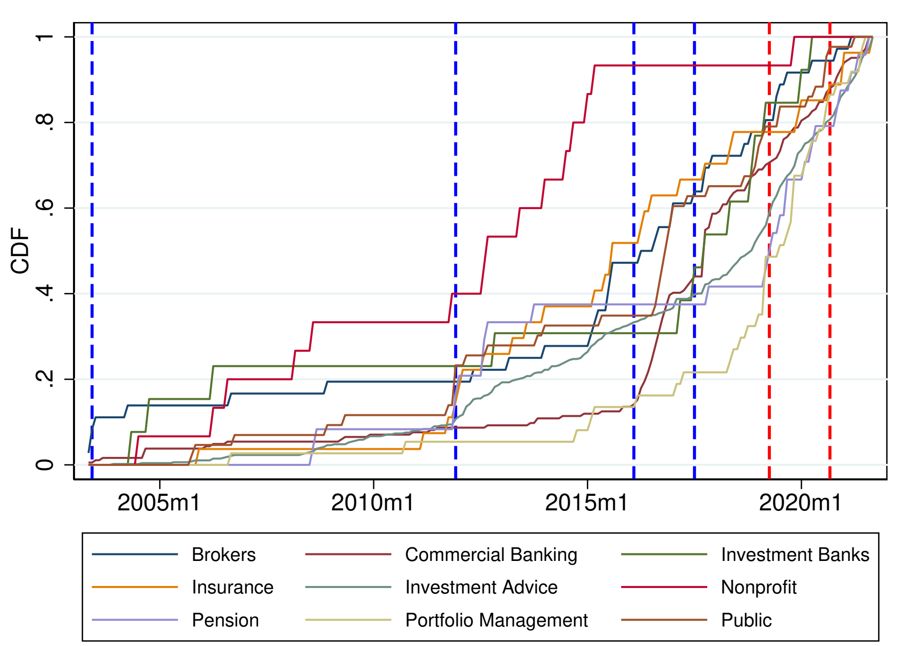


(b) Forms of Bond Investment in China and RMB



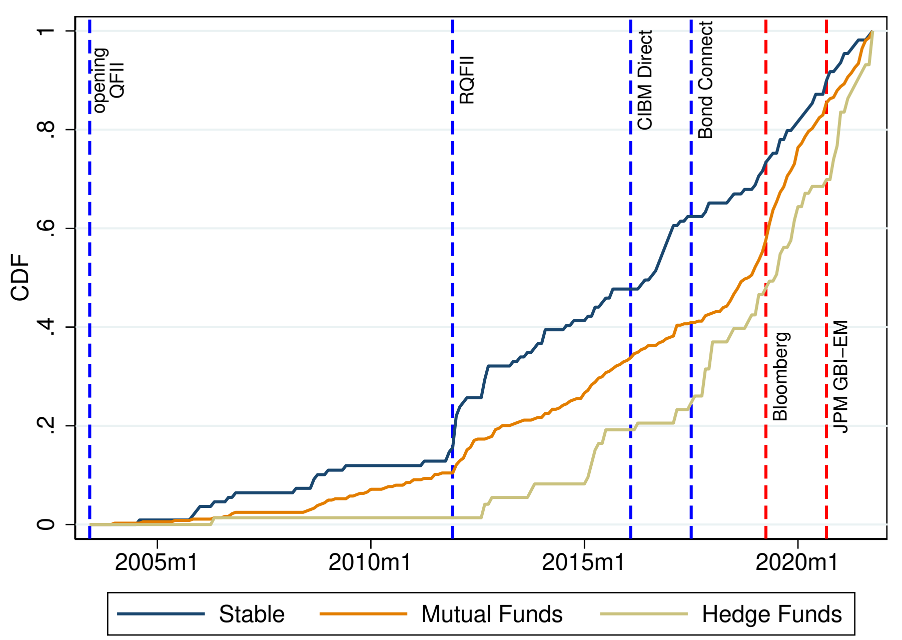
Notes: The top panel plots the share of foreign-owned RMB denominated bonds that were issued in onshore and offshore markets in global mutual fund and ETF portfolios. Offshore markets are defined as bonds classified as Eurobonds or Global by FIGI or bonds listed as being denominated in CNH. The bottom panel plots foreign ownership level of various types of Chinese bonds. China Residency FC refers to all bonds issued by a Chinese resident entity in a currency other than the RMB, and China Nationality FC refers to any foreign-owned foreign currency bonds issued by an entity that is Chinese on a nationality basis but not resident in China. Ownership data from Morningstar.

Figure A.VI: Foreign Investors' Entry in China's Domestic Bond Market



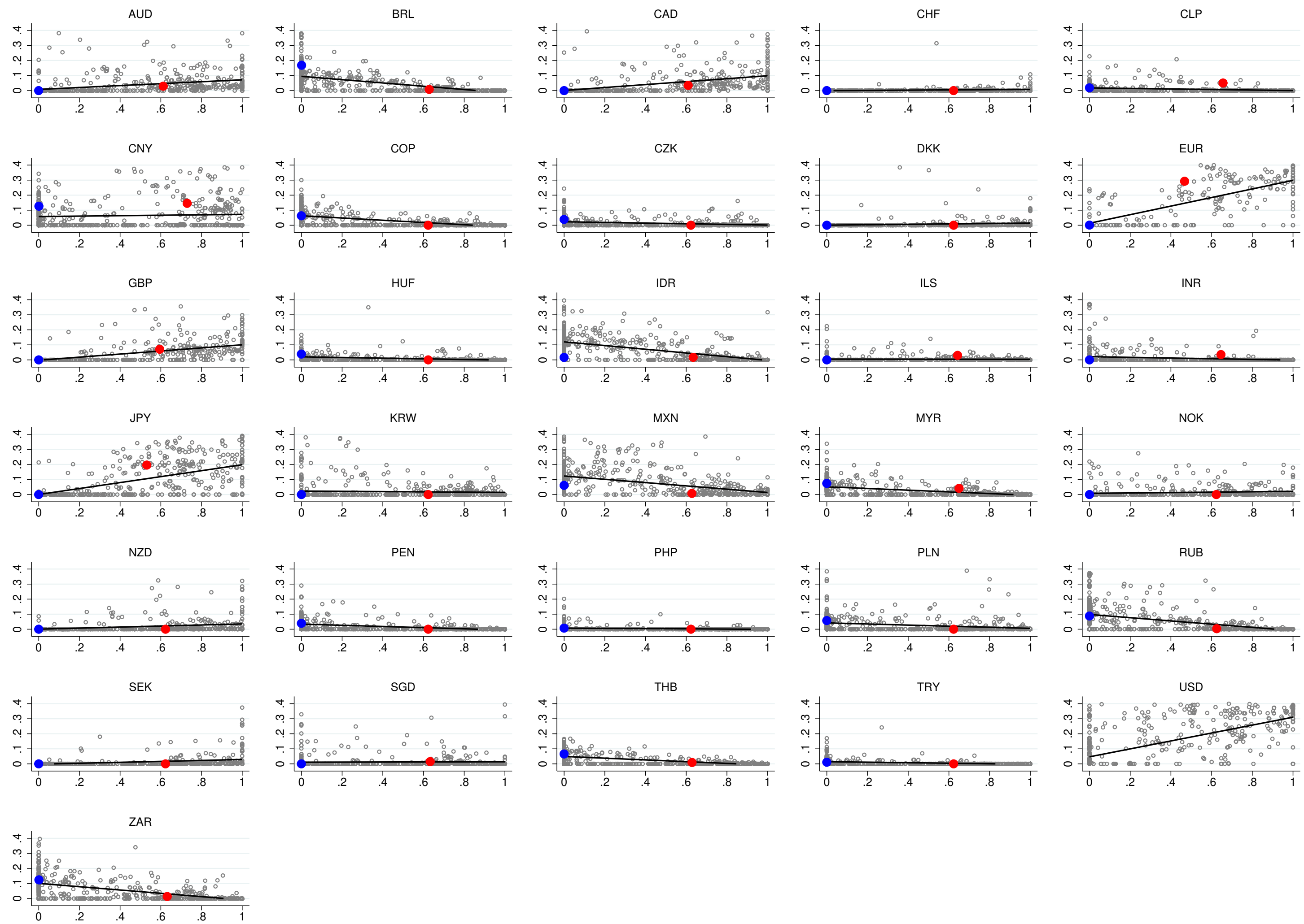
Notes: This figure plots the share of each investor type that had entered the market by 2021 at a given date at a more refined investor category.

Figure A.VII: Foreign Investors' Entry in China's Domestic Bond Market



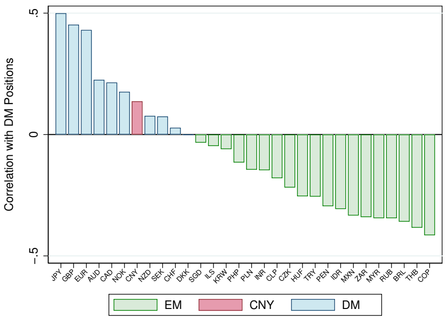
Notes: This figure plots the share of each investor type that had entered the market by 2021 at a given date breaking down Flighty investors into Mutual and Hedge Funds. We reclassified investors categorized as "portfolio managers" or "investment advice" companies according to the most frequent category among the subsidiaries.

Figure A.VIII: Portfolio Shares by Currency, 2020Q4

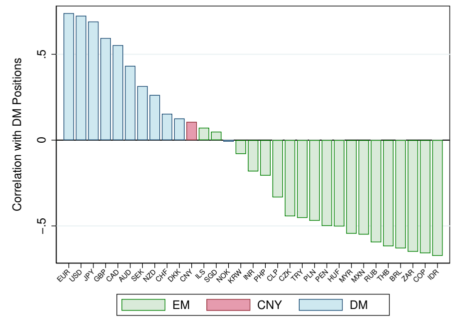


Notes: In each figure, an observation are the portfolio holdings a particular fund in the 4th quarter of 2020. The y-axis corresponds to the share of foreign currency portfolio holdings in a particular currency, and the x-axis to the share of the remaining (once we exclude this currency) foreign currency portfolio in DM currencies. In each panel, the blue dot represents the holdings of the PIMCO Emerging Markets Local Currency and Bond Fund and the red dot represents the holdings of the T. Rowe Price International Bond Fund. Notice the two funds are domiciled in the U.S. and, as explained in the text, their portfolio shares in USD are not considered for the analysis.

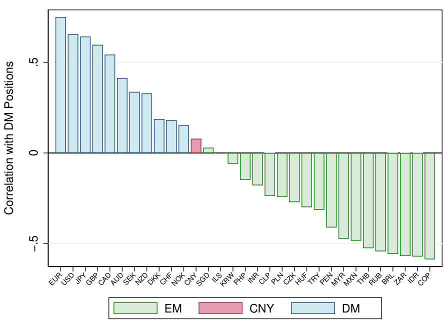
Figure A.IX: Cross-Section of Estimates in 2020: Alternative Specifications



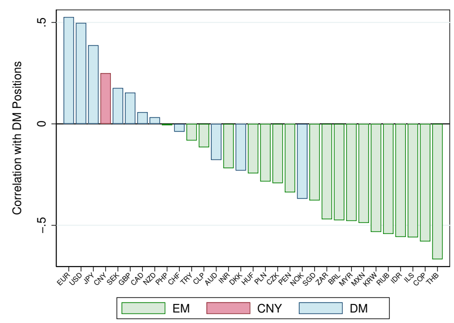
(a) UST as Reference



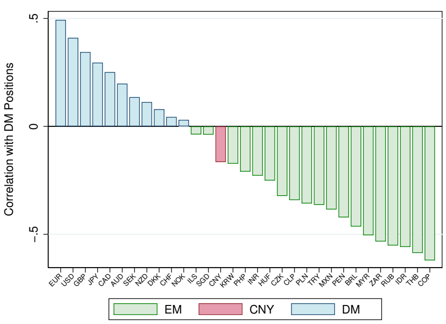
(b) Weighted by FC AUM



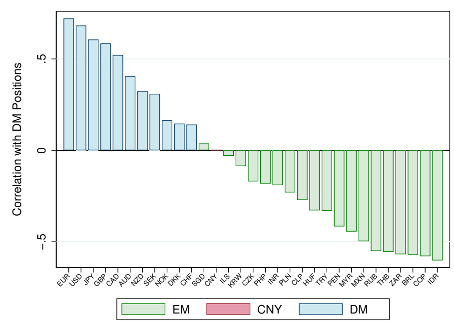
(c) Excluding Index Funds



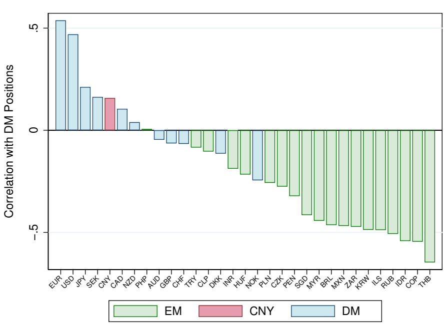
(d) Intensive Margin



(e) Alternative Specialist Threshold (98%)



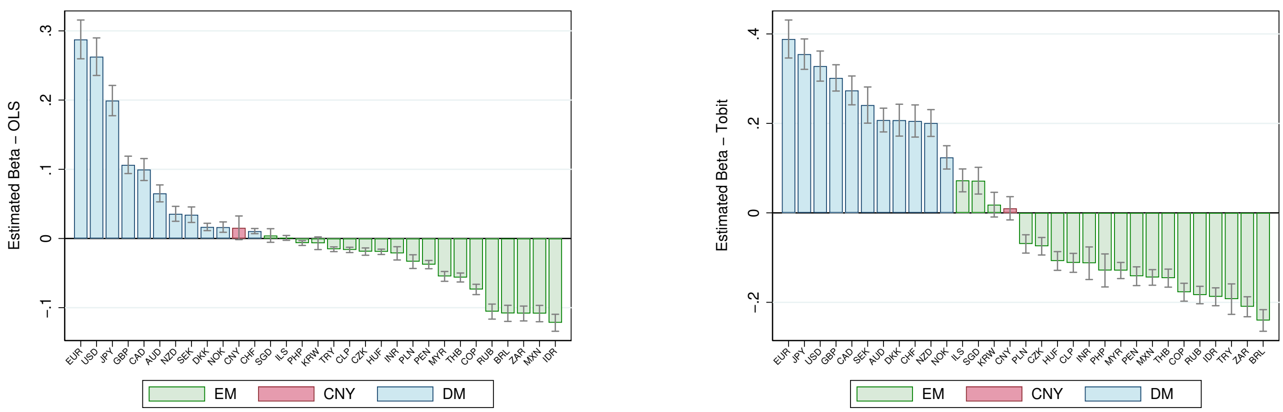
(f) Alternative Minimum FC AUM



(g) Alternative FC Definition

Notes: Figures report the correlation between the holdings of bonds in each currency and holdings in Developed Markets (DM) currencies for alternative specifications.

Figure A.X: Cross-Section of Beta Estimates in 2020

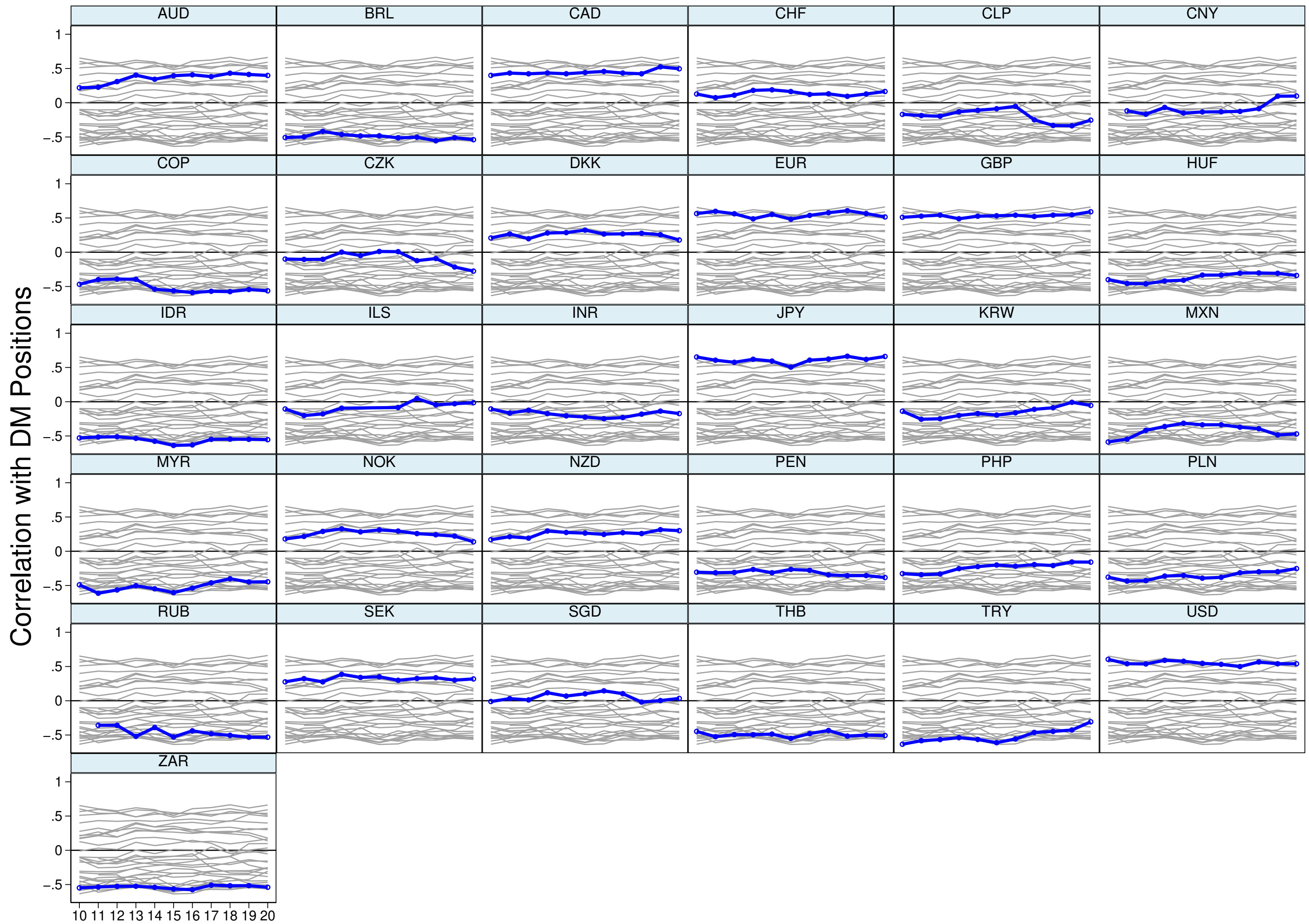


(a) OLS

(b) Tobit

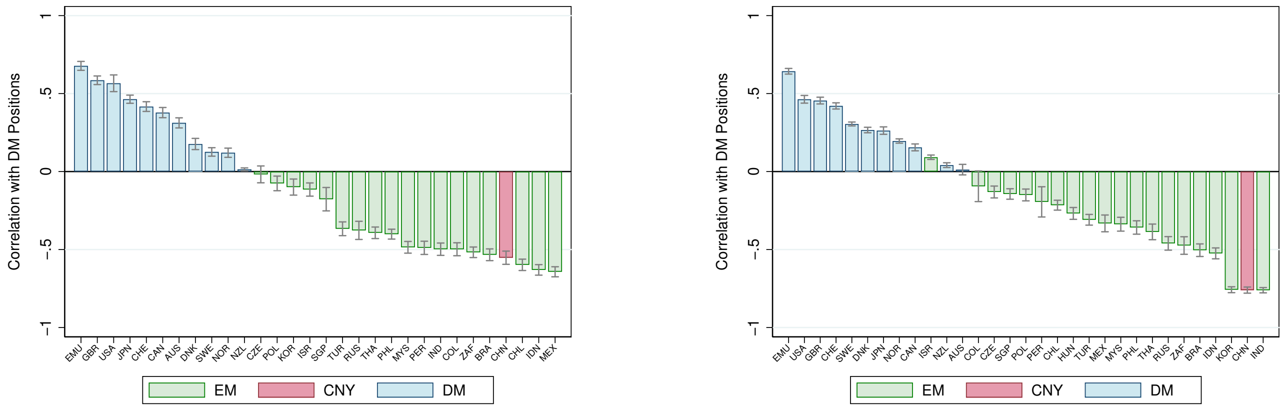
Notes: These figures plot the estimate β^c_{DM} in the gravity regressions including distance, trade flow and the common legal system dummy, as well as currency and fund domicile fixed effects. Confidence intervals are for 95%.

Figure A.XI: Portfolio Similarity with Developed Countries' Local-Currency Government Bonds: 2010 to 2020



Notes: Figure plots the evolution of the portfolio share correlation with DM Local-Currency Government Bonds. Gray lines correspond to the other currencies. We plot currencies that accounted for at least 0.3% of the total foreign currency investment in government bonds on average between 2010 and 2020. Missing observations correspond to years that the currency accounted for less than 0.1% of total foreign currency investment in government bonds.

Figure A.XII: Cross-Section of Correlation Estimates in 2020

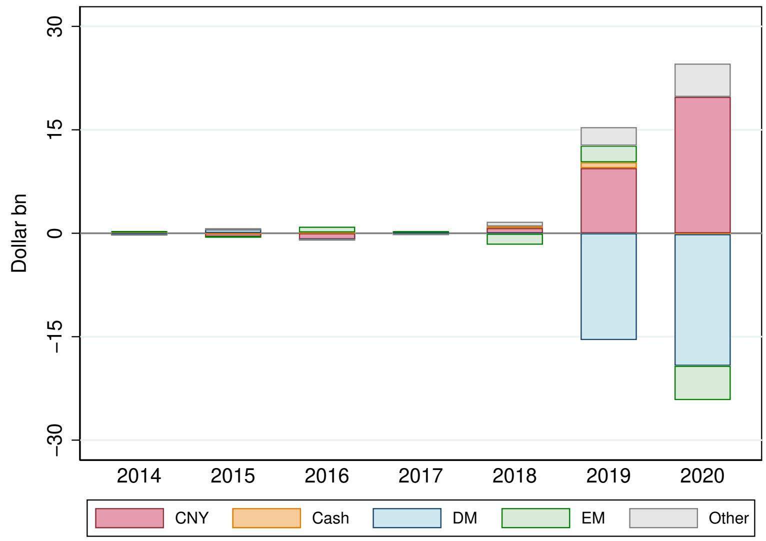


(a) USD Corporate Bonds

(b) Equities

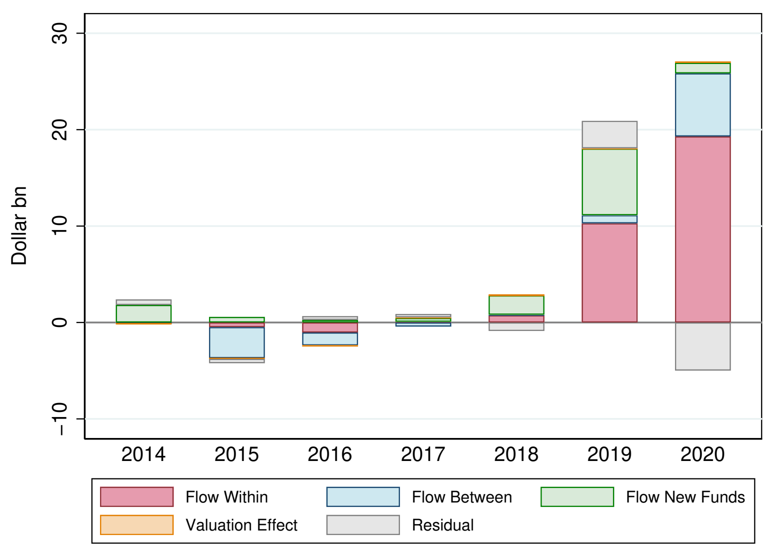
Notes: These figures report the correlation measure by nationality of the issuer for different types of assets. Confidence intervals are for 95%.

Figure A.XIII: Decomposition of Portfolio Shift by Currency Group



Notes: Figure implements the decomposition of the within component of flows. "CNY" refers to all assets denominated in Chinese Yuan. "Cash" refers to assets classified as so in Morningstar and U.S. Treasury Bills. "DM" refers to cross-border holdings of developed market currencies. "EM" refers to cross-border holdings of emerging market currencies. "Other" refers to other currencies and equities. This figure only consider funds that own some RMB assets.

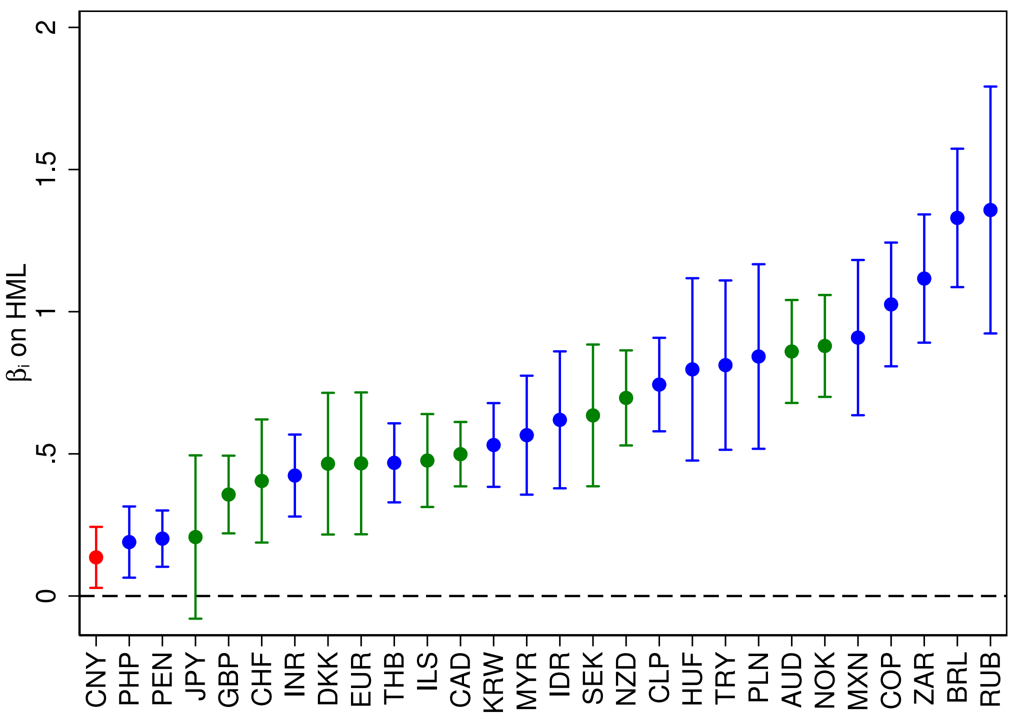
Figure A.XIV: Decomposition of Change in Renminbi Holdings by Type of Flow



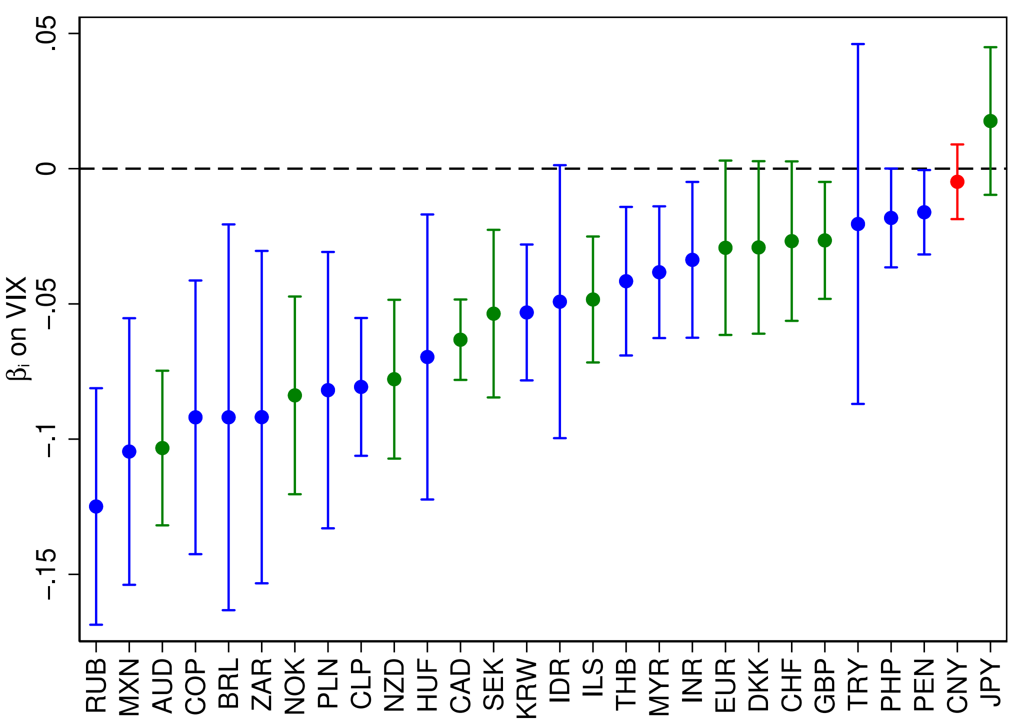
Notes: Figure implements the decomposition of flows into RMB bonds in equation A.1. Flow Within refers to increases in holdings of RMB assets holding fixed the size of funds. Flow Between refers to increases in holdings of RMB assets generated by inflows into funds that own RMB, holding prices and portfolio shares fixed. Flow New Funds refers to RMB bonds purchased by funds that were created in that year. Valuation Effect refers to the change in the market value of holdings coming from bond price and exchange rate changes. Residual includes measurement error and approximation residuals.

Figure A.XV: Returns on RMB relative to EM and DM Currencies

(a) HML

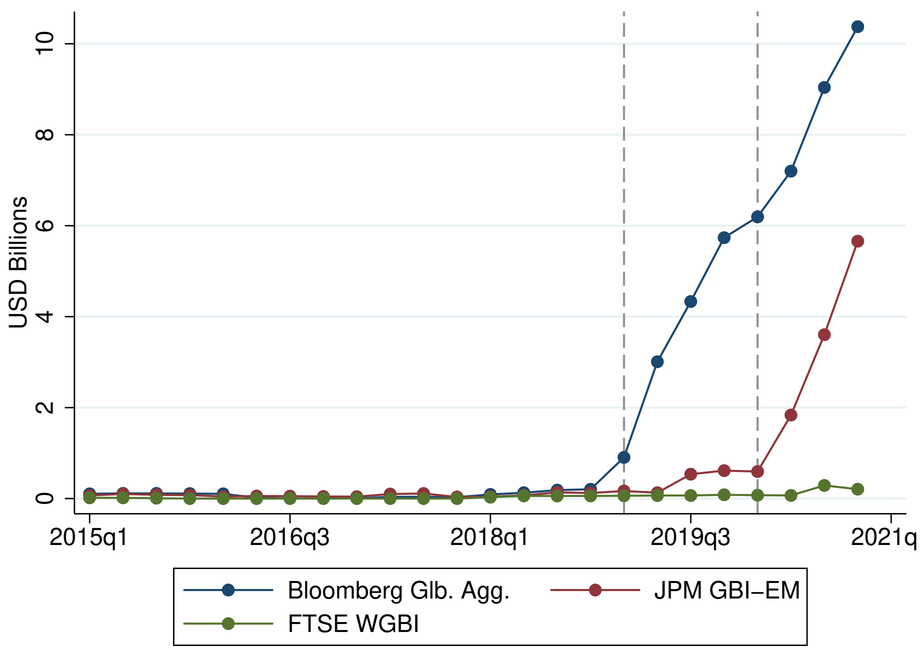


(b) VIX



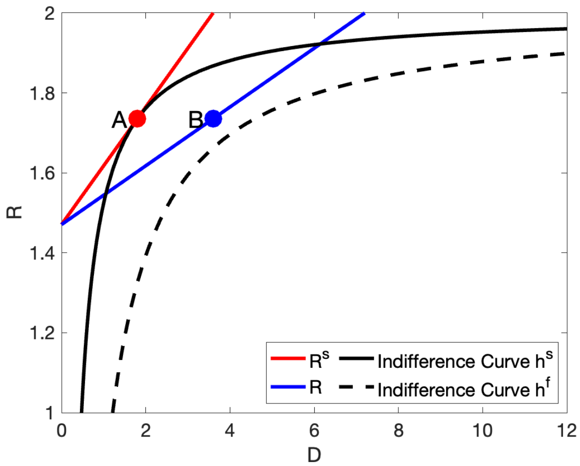
Notes: 2010-Present. Quarterly returns based on 3m Government bond yields. β_i estimated via univariate country-specific regressions of quarterly bond returns on the factor (HML in the top panel, and the log change in the VIX in the bottom panel. Data from Du et al. (2018).

Figure A.XVI: Index Inclusion and Foreign Investment in China

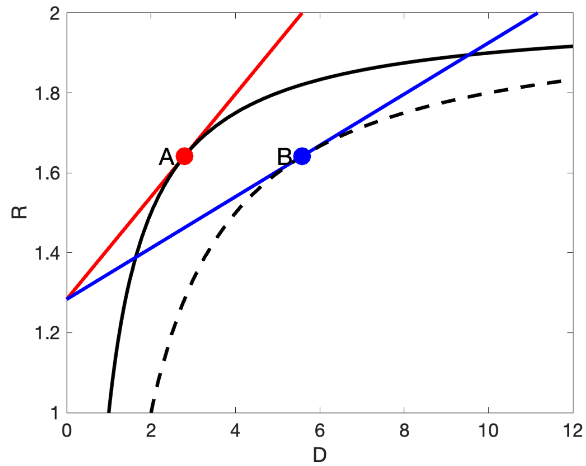


Notes: Figure shows the aggregate value of RMB holdings of funds benchmarked to the Bloomberg Global Aggregate Index, the JPMorgan GBI-EM Index, and the FTSE World Government Bond Index. Grey vertical lines denotes the dates of the inclusion of Chinese RMB bonds into the Bloomberg Global Aggregate (April 2019) and the JPMorgan GBI-EM (February 2020).

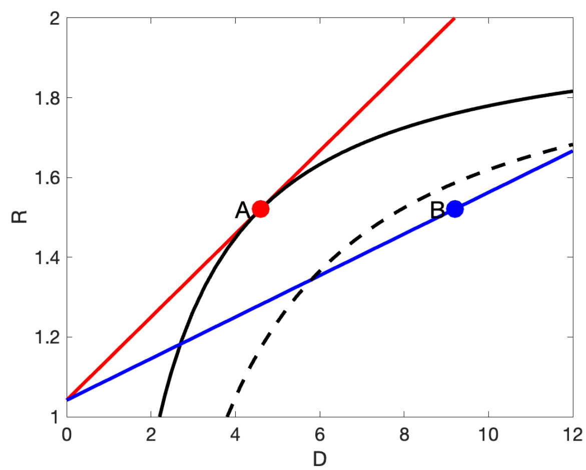
Figure A.XVII: Understanding the Opening-Up Decision



(a) Committed Gov. Issuance When $M < M^*$



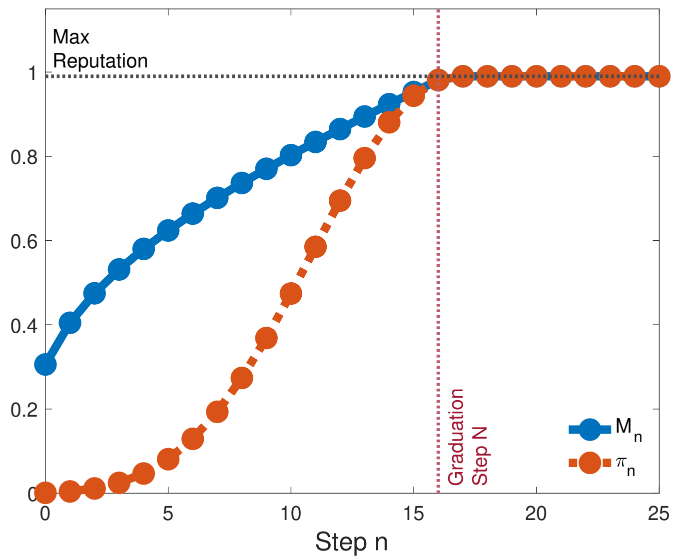
(b) Committed Gov. Issuance When $M = M^*$



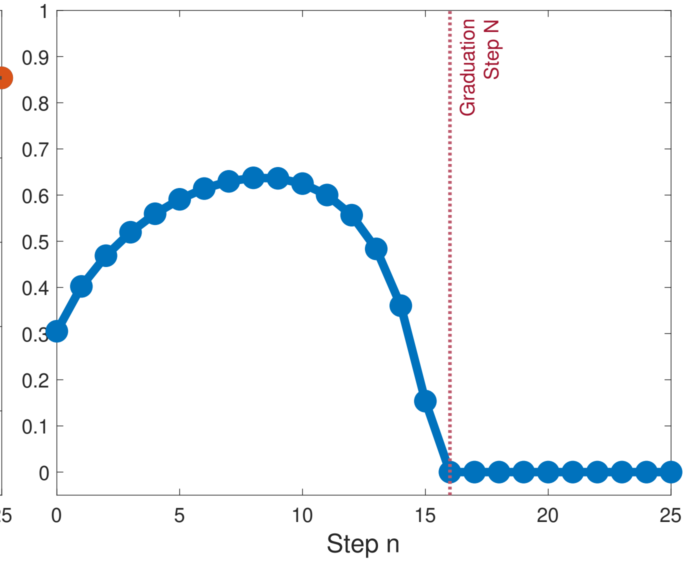
(c) Committed Gov. Issuance When $M > M^*$

Notes: These figures provide a graphical representation of the opening-up decision. Panel (a) plots the case of $M < M^*$, Panel (b) plots the case $M = M^*$, and Panel (c) plots $M > M^*$. In each plot the schedule R^s is the interest rate schedule available to the government if it borrows only from stable investors, and R the interest rate schedule if it borrows from both stable and flighty investors. Point A denotes the optimal debt issuance of the government conditional on only borrowing from stable investors, while Point B denotes the optimal debt issuance conditional on borrowing from both. The global optimal decision is given by the highest of the profits in point A and B. Indifference curve h^s denotes pairs of debt and interest rate that yield the same payoff to the committed government when the haircut is h^s. Indifference curve h^s denotes pairs of debt and interest rate that yield the same payoff as points on indifference curve h^s, but when the haircut rises to h^f.

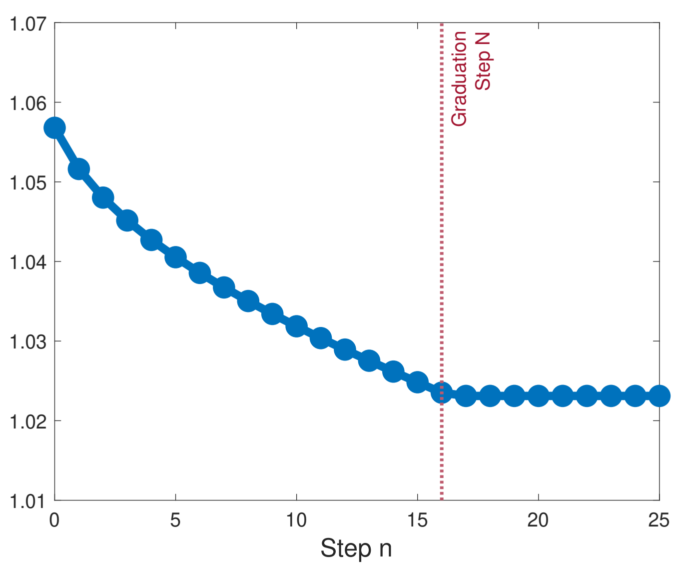
Figure A.XVIII: Equilibrium Reputation Cycle: Homogeneous Foreign Investors



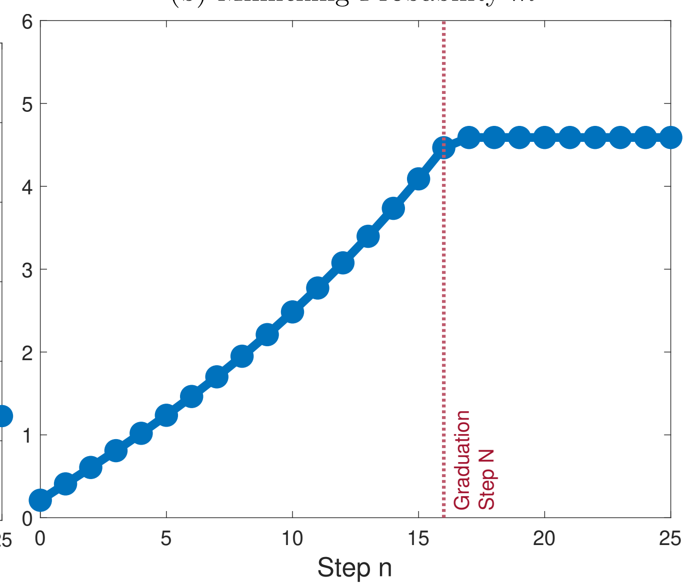
(a) Reputation M and Beliefs π



(b) Mimicking Probability m



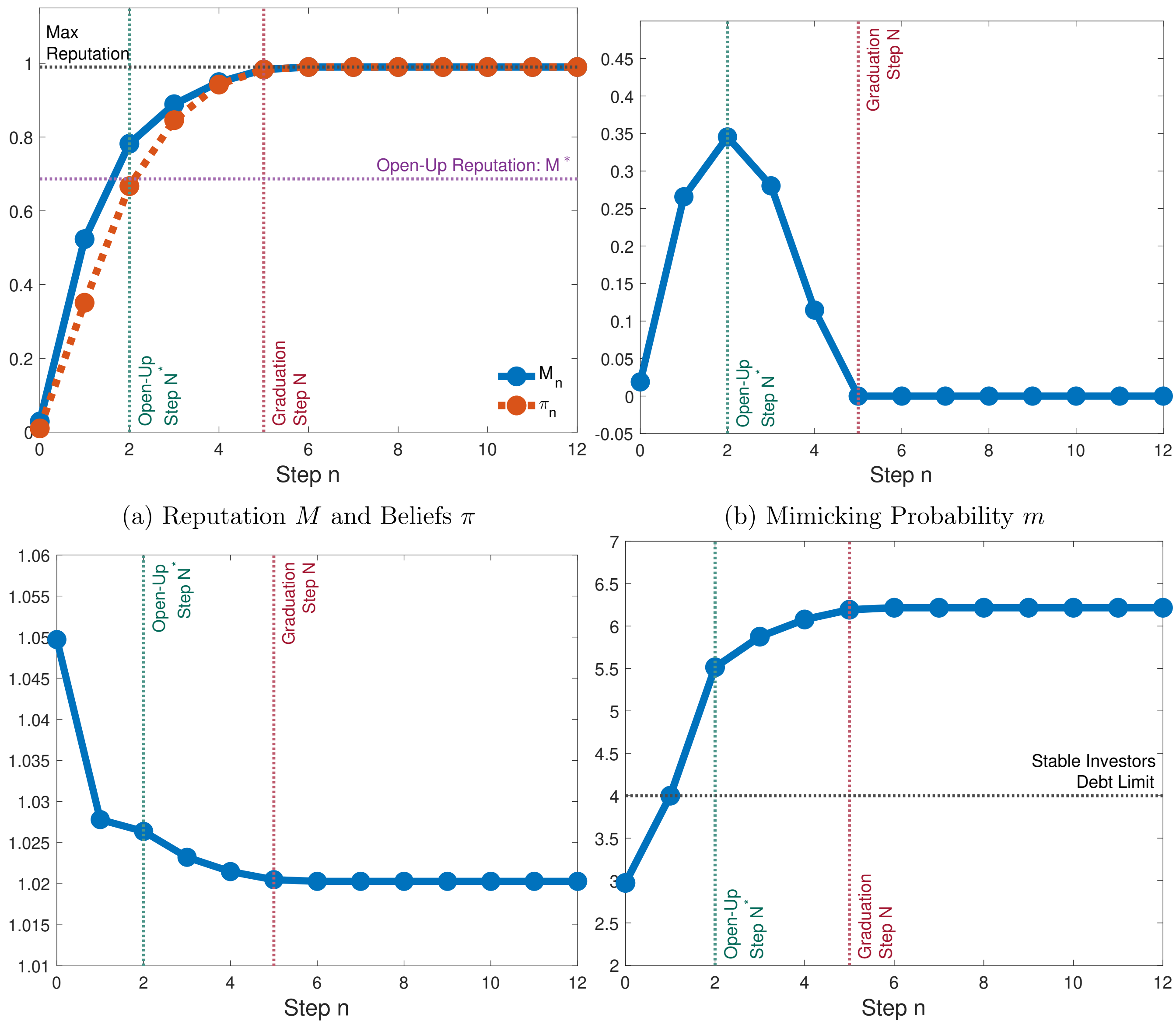
(c) Interest Rate R



(d) Debt Issuance D

Notes: Numerical illustration of the equilibrium of the model when foreign investors are homogeneous. The N dashed-red line is the graduation step.

Figure A.XIX: Equilibrium Reputation Cycle: Heterogeneous Foreign Investors Demand Curves



(a) Reputation M and Beliefs π

(b) Mimicking Probability m

(c) Interest Rate R

(d) Debt Issuance D

Notes: Numerical illustration of the equilibrium of the model when foreign investors are heterogeneous. The N^* dashed-green and N dashed-red lines are the opening up and graduation steps, respectively.