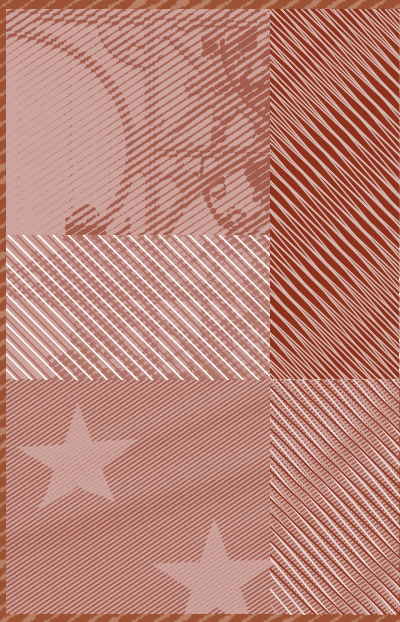
FINANCIAL INNOVATION IN SOVEREIGN BORROWING AND PUBLIC PROVISION OF LIQUIDITY

2015

Patricia Gómez-González



Documentos de Trabajo
N.º 1511

BANCO DE ESPAÑA
Eurosistema

FINANCIAL INNOVATION IN SOVEREIGN BORROWING AND PUBLIC PROVISION OF LIQUIDITY

FINANCIAL INNOVATION IN SOVEREIGN BORROWING AND PUBLIC PROVISION OF LIQUIDITY

Patricia Gómez-González (*)

BANCO DE ESPAÑA

(*) Banco de España. Alcala, 48. 2014 Madrid. Spain. Contact information: p.gomez@bde.es. I am indebted to Alp Simsek, Ivan Werning and George-Marios Angeletos for their invaluable guidance in this project. I also thank Daron Acemoglu, Henrique Basso, Nicolas Caramp, David Colino, Arnaud Costinot, Aitor Erce, Anna Gibert, Sara Hernandez, Luis Molina, Eva Ortega, Jonathan Parker, Pascual Restrepo, Matthew Rognlie, Jesse Schreger, Annalisa Scognamiglio, Daan Struyven, Carlos Thomas, Adrien Verdelhan, Yu Xu, an anonymous referee and participants in seminars at MIT, Federal Reserve Board, University of Maryland, Colby College, University of Illinois-Urbana Champaign, Ryerson University, The World Bank, Banco de España, The LSE Systemic Risk Centre, Universidad Carlos III de Madrid, European Winter Meeting of the Econometric Society and the XXXIX Simposio de la Asociación de Economía Española. Disclaimer: The views expressed herein are those of the author and not necessarily those of the Banco de España or the Eurosystem.

Documentos de Trabajo. N.º 1511

2015

ISSN: 1579-8666 (on line)

Abstract

This paper studies how financial innovation in sovereign debt markets can increase a country's level of private investment and welfare. I propose a model where public debt has a liquidity purpose for the domestic private sector and is demanded as a saving vehicle by more patient international investors. The public bond is risky, it has a low (high) return when the government's fiscal capacity is low (high), but the government cannot strategically default on it. The main result of the paper is that the government can increase private investment by increasing the number of assets supplied, tranching its fiscal capacity, and issuing a safe and a risky bond. The risky bond is held only by international investors and the domestic private sector demands the safe bonds. Safe bonds lower the cost of liquidity hoarding for the private sector which enables it to increase investment. I test the predictions of the model using a dataset on public debt and local currency sovereign debt ownership for a group of emerging economies. I find that domestic collateral constraints are key determinants of the shares held abroad of total public debt and especially of relatively riskier debt instruments (local currency debt).

Keywords: sovereign debt, financial innovation, liquidity.

JEL classification: F34, G21, G23, H63.

Resumen

Este artículo estudia cómo la innovación financiera en mercados de deuda soberana puede aumentar el nivel de inversión privada y el bienestar de un país. Propongo un modelo donde la deuda pública actúa como vehículo de provisión de liquidez para el sector privado doméstico y es demandado también como vehículo de ahorro por inversores internacionales más pacientes. El bono soberano es arriesgado, tiene un retorno bajo (alto) cuando la capacidad fiscal del gobierno es baja (alta), pero el gobierno no puede hacer impago estratégico. El resultado principal del artículo es que el gobierno puede aumentar la inversión doméstica privada si aumenta el número de activos, y emite un activo seguro y uno arriesgado. El activo arriesgado solo lo demandan los inversores internacionales. El sector privado doméstico demanda los activos seguros ya que disminuyen el coste de aprovisionarse de liquidez lo que le permite aumentar la inversión. Contrasto las predicciones del modelo usando una base de datos sobre base inversora de deuda pública y de deuda pública en moneda local para un grupo de economías emergentes. Encuentro que las restricciones crediticias a nivel doméstico juegan un papel clave en determinar la proporción de deuda pública total en manos de no residentes y especialmente de instrumentos de deuda más arriesgados (deuda en moneda local).

Palabras clave: deuda soberana, innovación financiera, liquidez.

Códigos JEL: F34, G21, G23, H63.

1 Introduction

The set of instruments that governments all over the world issue is large and has expanded over time. Governments issue debt with different maturities, bonds indexed to inflation or to some reference interest rate and some countries issue debt in different currencies. Financial innovation has transformed sovereign debt markets of advanced and emerging economies.

This process of financial innovation is still ongoing. To give some recent examples, the United States approved in July 2013 the issuance of Floating Rate Notes (FRNs) indexed to the 13-week US Treasury bill auction rate and the first auction of this type of securities was held in January 2014. Spain started issuing inflation indexed bonds in June 2014.

The timing, circumstances and country characteristics of governments introducing financial innovations in sovereign debt markets differ widely. For instance, inflation-indexed bonds are issued by emerging economies as well as advanced economies. Some of them started issuing them in the nineties and 2000s and others as early as the forties. Moreover there is no systematic distinction in the timing across advanced and emerging economies (Borensztein et al. (2004)). A big proportion of emerging markets' borrowing is done in foreign currency but several advanced economies also issue part of their debt in a foreign currency. See Appendix A for some examples.

Another relevant characteristic of sovereign debt markets is that they are open to a large variety of investors. A common distinction is made between domestic and foreign holders of debt and within each of these whether it is the official sector, mostly Central Banks; the financial sector or the non-financial sector. These investors might differ in their degree of patience or in their rationale to hold public debt: as a vehicle to save, as a way to store liquidity or as a policy tool.

This paper combines these two observations and studies how the composition of public debt investor base, in particular local vis-a-vis foreign debt holders, can shape the government's financial innovations in sovereign debt markets.

I propose a model where the local private sector uses public debt to hoard liquidity for a future and uncertain liquidity shock in the spirit of Holmstrom and Tirole (1998), Woodford (1990), Gennaioli et al. (2014b) or Angeletos et al. (2012). In contrast with these models, I assume that sovereign debt markets are open to more patient risk-neutral international investors who demand the public assets as a savings vehicle. Finally, I assume that the government's future fiscal capacity is uncertain which, absent financial innovation, renders public debt risky.

The main result of the paper is that the government can increase domestic investment if instead of issuing one bond which pays off its risky fiscal capacity in the next period, it

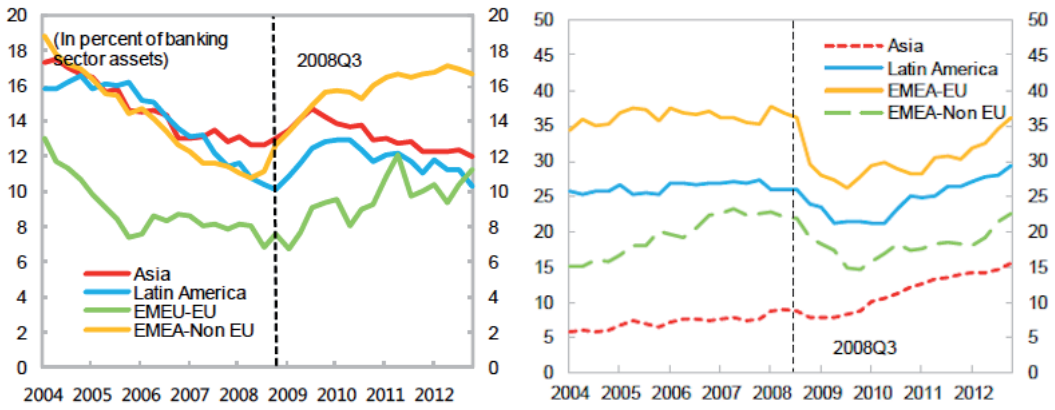


Figure 1: Share of own debt holdings (as % of banking sector assets) and share of sovereign debt held by foreign investors for emerging economies (Source: Arslanalp and Tsuda (2014))

tranches its fiscal capacity and issues two different assets. When the government is constrained by short-selling restrictions, the optimal asset combination is a safe and a risky asset. The intuition for this result is that the existence of a safe asset lowers the cost of liquidity hoarding for the private sector. This increases the equity multiplier, that is, the extent to which the private sector can leverage its own wealth which in turn increases domestic investment and welfare. The residual fiscal capacity is designed to attract risk-neutral international investors who do not have a liquidity motive for holding debt and are willing to hold riskier debt instruments.

The comparative statics of the model are consistent with recent changes in public debt ownership as a whole and differences in the investor composition for different debt instruments.

First, it is consistent with the increase in the holdings of own sovereign debt by financial institutions in all groups of emerging economies and the drop in the share of sovereign debt held by non-residents after the financial crisis as shown in figure 1 for several groups of emerging economies. Arslanalp and Tsuda (2012) and Merler and Pisani-Ferry (2012) report the same stylized fact for advanced economies.

Second, it is consistent with recent ownership shifts towards foreign investors of riskier debt instruments[1]. Recently emerging economies have experienced a surge in the share of local currency (LC) debt held by foreigners. Du and Schreger (2013) report that the share of LC debt in total emerging market offshore debt trading volume has increased from 35% in 2000 to 71% in the 2011. Figure 2 plots in blue the share of LC debt held by foreigners for years before and after the global financial crisis and in green a measure of collateral constraints. In particular I use the amount needed as collateral for a loan as percentage of

[1]For the purpose of this paper, riskier sovereign debt instruments are those whose payment is cyclical, that is, they pay more in good states of the world.

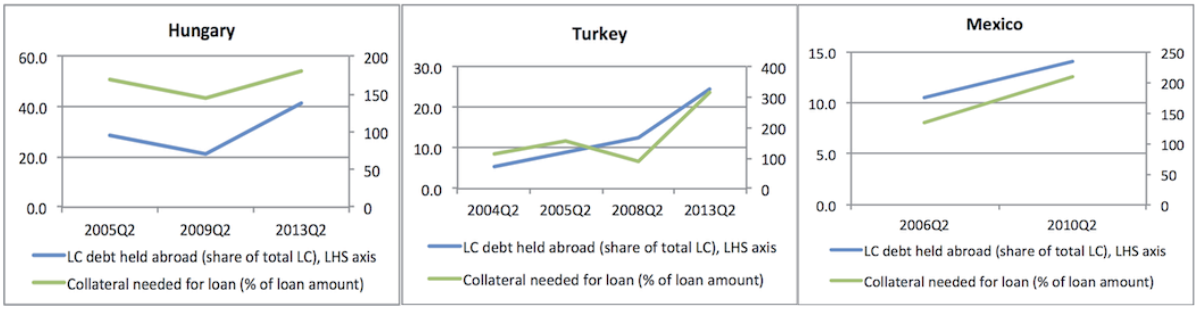


Figure 2: Share of LC debt held abroad and collateral constraints for celected countries (Data sources: Arslanalp and Tsuda (2014) and World Bank Enterprise Surveys)

the loan amount from the World Bank Enterprise Surveys. We see that the share of LC debt held by non-residents in recent years has increased and that it is closely correlated to the strength of collateral constraints in the domestic economy. Through the lens of the model a tightening of collateral constraints or a fiscal capacity drop will cause an increase in the share of domestic banks holdings of debt, decrease in the share held abroad, and increase in the share of LC debt held by foreigners.

Empirically I find that domestic financial conditions, more so than fiscal capacity, are a key determinant of the share of sovereign debt held abroad as well as the share of LC debt held by nonresidents. To do this, I use a panel dataset with quarterly data on sovereign debt ownership, measures of collateral constraints, fiscal capacity, and other controls for 21 emerging economies between 2004 and 2010.

The paper is organized as follows. The remainder of this section discusses the related literature. Section 2 introduces the model and presents the benchmark scenario with only one public bond. Section 3 presents the benevolent government's general financial innovation problem. This section also proposes the combinations of assets that implement the optimal allocation obtained in the planner's problem. Section 4 highlights the benefits of financial innovation in sovereign borrowing and its complementarities with financial integration. Section 5 presents some comparative statics results when the government issues more than one public asset. Section 6 tests empirically the comparative statics results from the benchmark model and the model with more than one public asset. Finally section 7 concludes.

1.1 Literature Review

This paper is related to several strands of the literature. First, the model I present builds upon the models about public provision of liquidity such as Holmstrom and Tirole (1998), Holmstrom and Tirole (2011) and Woodford (1990). It also relates to the models about

optimal provision of liquidity using public debt such as Aiyagari and McGrattan (1998), Guerrieri and Lorenzoni (2009) or Angeletos et al. (2012). However all the aforementioned papers have studied the optimal quantity of debt and have assumed away default risk or any constraints on fiscal capacity and have also ruled out multiple debt instruments. This paper, by contrast, abstracts from the quantity of debt and focuses on the fiscal capacity dimension and shows how the issuance of different debt instruments can improve liquidity provision for a given quantity of debt.

Second, in the spirit of Allen and Gale (1994) I study how financial innovation can decrease the cost of liquidity hoarding and hence increase investment. To the best of my knowledge there has been little work about financial innovation in sovereign borrowing. Gale (1990) studies the optimal design of public debt in an overlapping generations model and concentrates on risk-sharing. Papers such as Sandleris et al. (2011) and Hatchondo and Martinez (2012) study GDP-linked bonds and their relationship with sovereign debt sustainability, default incentives and risk-sharing benefits. However these models allow for sovereign default and consider a particular financial innovation, GDP-linked bonds, and their objective is not to solve a general financial innovation problem for the government. This paper instead does not allow for default and imposes commitment on the government's side but studies a general financial innovation framework. Also, contrary to the papers mentioned above, the model presented in this paper features domestic debt and a liquidity purpose of public debt.

This paper also contributes to the debate about financial innovation in public debt where there have been several proposals to make governments' securities more state-contingency which would improve risk-sharing between debtors and creditors. The most relevant ones have proposed to make debt contingent on commodity prices or another external variable relevant to the country (Caballero (2002, 2003)) or to create securities indexed to GDP (Shiller (1993, 2003)). In the model I present here, state-contigency is advisable for another reason: the existence of two types of investors with different motives to hold public debt, liquidity hoarding and saving.

This paper is also related to the literature on shortage of safe assets (Caballero and Krishnamurthy (2009), Caballero and Farhi (2013), Gourinchas and Jeanne (2012)). It is also closely related to the ESBies policy proposal by Brunnermeier et al. (2011) which points at a lack of safe assets as the source of problems in the European Union. In that paper they propose a European Debt Agency which would buy a portfolio of member nations sovereign bonds and issue senior and junior tranches of this portfolio. However in this paper the scope of application is a union and requires a supranational entity. My paper instead can be applied to a wider range of countries. I also solve the planner's general financial innovation problem and conclude that state-contingency can do better than safe assets. I also concentrate on

the investor base composition of the safe as well as the risky debt instrument. Finally, the model set-up in my paper allows me to perform comparative statics that are later brought to the data.

Finally this paper relates to recent papers on public debt ownership such as Broner et al. (2010), Erce (2012), Gennaioli et al. (2014b), Broner et al. (2014) and Brutti and Saure (2013). Most have concentrated on investor base composition and default incentives, especially regarding creditor discrimination. This paper instead focuses on how investor base composition can shape the introduction of heterogeneous debt instruments in sovereign debt markets. I will discuss in greater detail how the model presented in this paper compares to Broner et al. (2014) in the last section of the paper.

2 One Defaultable Bond

2.1 Set-up

We consider a three period economy with time indexed $t = 0, 1, 2$ and a single good. There are three types of agents: an entrepreneur, a consumer, and a foreign investor. All agents are risk-neutral and get utility from consumption in all three periods. The first two agents have a discount factor of $\beta = 1$ whereas the foreign investor's discount factor denoted by β^*, satisfies $\beta^* > 1$.

At date 0 the entrepreneur invests in a project of variable scale and chooses initial investment scale I. Her initial net worth equals A. The consumer has a big endowment that can lend to the entrepreneur. At date 1 the project is hit by a liquidity shock s which makes the project require an injection of s units of good per unit of initial investment to continue. The liquidity shock can take two values $\{s_H, s_L\}$, where $s_H > s_L$, with respective probabilities $\{\lambda, 1-\lambda\}$. After the project is hit by the liquidity shock the entrepreneur can decide the continuation scale of the project $i(s) \in [0, I]$. At date 2 the project gives a private return to the entrepreneur of $R > 1$ for each unit of investment that was carried through to date 2. From this return only $\rho < R$ is pledgeable to consumers.

The entrepreneur chooses initial investment $I > A$. Under $R > 1$ the project earns a higher return than the market rate. Therefore the entrepreneur wants to be a net borrower and invest more than her own wealth. At date 0 the entrepreneur borrows from consumers $I - A$ as well as the cost of insuring for the future liquidity shock. The foreign investor cannot lend to the domestic entrepreneur.

Assumption 1. *International investors cannot lend directly to domestic entrepreneurs. Only domestic consumers can do so.*

This assumption is a reduced form way to capture that domestic consumers have a comparative advantage in lending to domestic entrepreneurs with respect to foreign investors. Borrowing from abroad would be too costly for entrepreneurs. This might capture domestic consumers having better information about the entrepreneur's project or the domestic conditions in which the entrepreneur's project is carried out, better monitoring capacity or a stronger protection by domestic bankruptcy laws.

Admittedly this assumption is an extreme one. In the model borrowing from abroad is so costly that it becomes prohibitive for domestic entrepreneurs. This is typically not true for the entire private domestic sector in an economy. However, as long as a fraction of the domestic sector cannot tap international markets and the government can, the channels and results of the paper will survive.

At date 0 the government issues public bonds which give a return at date 1. The supply is fixed and normalized to one. The domestic entrepreneur will demand the bond as a way to insure against the future liquidity shock. Foreign investors also demand these bonds in an integrated sovereign debt market but they do not have a liquidity motive for holding debt. Instead, they buy bonds as a saving vehicle.

Assumption 2. *The only available security for the entrepreneur to insure against the liquidity shock is the public bond. The supply of the public bond is fixed and it is issued in an integrated debt market, where entrepreneurs compete for the asset with more patient foreign investors.*

The first part of this assumption acts only as a simplification. All the results of the model would still hold even if entrepreneurs had access to other assets as long as the value of the assets is not enough to fulfill the entrepreneur's liquidity needs.

This simplification is especially applicable to financial crises when other asset prices collapse and sovereign debt becomes a highly valued asset due to its safety and liquidity (IMF (2012), Krishnamurthy and Vissing-Jorgensen (2012)) or for less financially developed countries where alternatives are fewer as Gennaioli et al. (2014a) report.

The supply of bonds being fixed can be interpreted as the public borrowing needed to cover an exogenous and fixed level of government expenditures. The focus of this paper is the relative holdings of public debt between internationals and domestics and how the existence of both types of investors shapes the introduction of financial innovation in sovereign debt

markets. Thus, we are going to abstract from the bond supply decision and take it as exogenous and fixed.

The last part of assumption 2, the fact that international investors are more patient than domestics, should not be taken literally. It is a reduced form to capture a higher foreign willingness to hold sovereign debt. When performing comparative statics, an increase in the international discount factor can be interpreted as an increase in world risk or as an increase in the available income internationally to invest in sovereign debt.

The government issues the bond at date 0 and receives q units of good per bond which it transfers to consumers. It commits to repay and redeems the bond at date 1 by taxing consumers and repaying bond holders the face value of their bond. The government's taxation power or fiscal capacity at $t = 1$ is uncertain and perfectly correlated with the liquidity shock that hits the entrepreneur's project. In particular at date 1, the government can tax $\bar{\eta}$ when $s = s_L$ and $\underline{\eta}$ when $s = s_H$, where $\underline{\eta} < \bar{\eta} \leq 1$. Since the government commits to repay the bond issued at date 0, if the government only issues one bond the its payoff structure will be given by $(\underline{\eta}, \bar{\eta})$ in states (s_H, s_L) respectively.

Assumption 3. *The fiscal capacity shock and the private sector liquidity shock are perfectly correlated.*

According to this assumption, the return of the public bond is low when liquidity needs in the private sector are high. This contrasts with the assumption in Gennaioli et al. (2014b): they assume public bonds give a higher return when liquidity needs are high. In their model liquidity needs are high when investment opportunities are more profitable, which is when the government's incentive to repay the bonds is higher. The empirical evidence on the relationship between liquidity needs and sovereign debt spreads in emerging economies points in the direction of assumption 3. Papers such as Levy-Yeyati and Williams (2010) and Peiris (2010) find that tighter liquidity conditions, that is, higher liquidity needs are associated with higher country spreads in emerging economies. Higher country spreads are consistent with lower fiscal resources but are not with a higher incentive to repay government debt.

It is important to highlight, related to the above discussion, that this paper does not feature sovereign risk in the sense of willingness to repay as a lot of the sovereign debt literature has done. This paper models a government with commitment whose inability to repay because of low fiscal resources triggers low returns in one of the states of the world. It does not feature a government with inability to commit and strategic defaulting behavior. However the payoff structure of the bond with commitment but risky fiscal capacity is observationally

equivalent at date 1 to a model where the government issues one bond and imposes a haircut $\bar{\eta} - \underline{\eta}$ in one of the states of the world.

Assumption 3 is a reduced form way to capture the observed temporal connection between banking crises and sovereign debt crises reported in Reinhart and Rogoff (2009), Arellano and Kocherlakota (2012), Sosa-Padilla (2011), Balteanu and Erce (2012) and Borensztein and Panizza (2008). This reduced-form assumption makes the analysis of the model highly tractable and effective in capturing the empirical association between liquidity crises in the private sector and lower repayment of public debt. This comes at a cost, namely, I abstract away from strategic default and concentrate exclusively on ability to repay. In Appendix E I relax this assumption and study the case where the fiscal capacity and the private sector liquidity shock are positively but not perfectly correlated.

2.2 Demand from Investors

2.2.1 Demand from Domestic Investors

The entrepreneur maximizes her expected net return from the project. Since the entrepreneur wants to maximize the initial investment scale of the project it is optimal to assign all pledgeable returns ρ to consumers, keeping the illiquid return for helself: $R - \rho$ of the amount that is carried through.

Denoting by q the price of the liquid asset at $t = 0$, the entrepreneur's problem is given by:

$$\begin{aligned} max_{\{I, i(s_H), i(s_L), z\}} \quad & (R-\rho)(1-\lambda)i(s_L) + (R-\rho)\lambda i(s_H) \\ s.t. \quad & (\rho - s_L)(1-\lambda)i(s_L) + (\rho - s_H)\lambda i(s_H) + (\lambda\underline{\eta} + (1-\lambda)\bar{\eta})z \geq I - A + zq \\ & i(s_H)(s_H - \rho) \leq \underline{\eta} z \end{aligned}$$

where $i(s_L)$ and $i(s_H)$ are the continuation scales in both states and z is the amount of bonds bought at $t = 0$.

The first constraint is the entrepreneur's budget constraint by which the entrepreneur's initial investment scale plus the purchase of the assets qz need to be less or equal than the entrepreneur's initial wealth plus the expected net return from the project and the expected return from the asset. It corresponds to the consumer's participation constraint. In order for the consumer to be willing to lend to the entrepreneur at date 0 its expected return from the project must be at least what the entrepreneur borrowed at date 0, $I - A + zq$.[2]

[2]The contract between entrepreneur and consumer will always assign all liquid or pledgeable returns to the consumer in order to maximize the initial investment scale of the project. Thus, in state $s = s_L$ the consumer will get a repayment of $\bar{\eta}z + (\rho - s_L)i(s_L)$ and in state $s = s_H$ the consumer obtains $\underline{\eta}z + (\rho - s_H)i(s_H)$ which corresponds to the left hand side of the budget constraint.

The second constraint of the problem is the collateral constraint which imposes that the outside funds required for reinvestment in the high liquidity shock state are less or equal to the return from the liquid asset in that state of the world.

I assume that $s_L < \rho < s_H < R$ which implies that when the liquidity shock is low the project is self-financed and entrepreneur's inside liquidity is enough to withstand the liquidity shock. Instead when the liquidity shock is high the project needs prearranged financing. Thus in state L full continuation is always optimal, $i(s_L) = I$ while in state H full continuation might not be optimal. Denoting $\frac{i(s_H)}{I} \equiv \chi$ and $\lambda\underline{\eta} + (1-\lambda)\bar{\eta} \equiv \Pi$ we can rewrite the entrepreneur's problem as:

$$\begin{aligned} max_{\{I,\chi,z\}} \quad & (R-\rho)(1-\lambda+\lambda\chi)I \\ s.t. \quad & (\rho - s_L)(1-\lambda)I + \lambda\chi(\rho - s_H)I + \Pi z \geq I - A + zq \\ & \chi I(s_H - \rho) \leq \underline{\eta} z \end{aligned} \tag{1}$$

When $q > \Pi$, both constraints bind. Therefore, the collateral constraint expresses the amount of bonds demanded by entrepreneurs at $t = 0$ in terms of the initial investment scale I and the continuation scale χ as well as parameters:

$$z = \frac{\chi I(s_H - \rho)}{\underline{\eta}} \tag{2}$$

Intuitively the amount of bonds demanded is increasing in the continuation scale $i(s_H)$ and decreasing in the bond's repayment fraction in the high liquidity need state of the world, $\underline{\eta}$.

Using this expression for z in the budget constraint, the initial investment is given by:

$$I = \frac{A}{1 - (\rho - s_L)(1-\lambda) - \lambda\chi(\rho - s_H) + \frac{\chi(s_H - \rho)}{\underline{\eta}}[q - \Pi]} \tag{3}$$

From (3) we see that $I'(\chi) < 0$, so the entrepreneur faces a scale-liquidity trade-off as in Holmstrom and Tirole (1998). If the entrepreneur wants to hold more liquidity to withstand the future liquidity shock she has to choose a lower initial investment scale since both liquidity hoarding and initial investment scale are chosen at date 0.

Maximizing the expected return of investment is equivalent to minimizing the unit cost of investment

$$min_{\{\chi\}} \quad c(\chi, q, \underline{\eta}, \bar{\eta}, \lambda, \Theta) \equiv \frac{1 + s_L(1-\lambda) + s_H\lambda\chi + \frac{\chi(s_H - \rho)}{\underline{\eta}}[q - \Pi]}{1 - \lambda + \lambda\chi}$$

where $\Theta \equiv (s_H, s_L, \rho)$ is a vector of parameters regarding the project. The solution to this problem depends on the price of the bond q:

$$\chi(q, \underline{\eta}, \bar{\eta}, \lambda, \Theta) = \begin{cases} 1 & if \quad q \in [\Pi, q^{max}) \\ \in (0,1) & if \quad q = q^{max} \\ 0 & if \quad q > q^{max} \end{cases}$$

where q^{max} is given by $\frac{\partial c(\chi, q^{max}, \underline{\eta}, \bar{\eta}, \lambda, \Theta)}{\partial \chi} = \lambda\underline{\eta} + (1-\lambda)\bar{\eta} + \frac{\lambda(1+s_L(1-\lambda)-s_H)\underline{\eta}}{(s_H-\rho)(1-\lambda)}$.
Thus, the demand for liquidity from local investors is given below and it is denoted by z^L. It is decreasing in its price q:

$$z^L(q, \underline{\eta}, \bar{\eta}, \lambda, \Theta) = \begin{cases} 0 & if \quad q > q^{max} \\ \frac{\chi I(s_H-\rho)}{\underline{\eta}} & if \quad q = q^{max},\ where\ \chi \in (0,1) \\ \frac{I(s_H-\rho)}{\underline{\eta}} & if \quad q \in (\Pi, q^{max}) \end{cases}$$

where I is given by substituting the price q in (3).

2.2.2 Demand from International Investors

The demand from foreign investors, z^F, is given by their valuation of the bond, which is determined by their discount factor and the bond's expected payoff $\lambda\underline{\eta} + (1-\lambda)\bar{\eta} \equiv \Pi$. Their demand for bonds is perfectly elastic at $q = \beta^*\Pi$, they will demand any positive amount of bonds as long as $q = \beta^*\Pi$.

2.3 Market Clearing

Market clearing in the bond market at $t = 0$ implies that $z^L(q, \underline{\eta}, \bar{\eta}, \lambda, \Theta) + z^F(q, \underline{\eta}, \bar{\eta}, \lambda) = 1$. Necessarily $q \geq \beta^*\Pi$, otherwise the demand from international investors would be infinite. In this section we concentrate on the case where both types of investors hold part of the debt issued and the project is fully continued in both states of the world, $\chi = 1$. This is equivalent to making the following parametric assumptions about the fiscal capacity in the bad state of the world where the private sector is hit by the high liquidity shock:

$$\underline{\eta} > \frac{(s_H - \rho)\left(A - (1-\lambda)(\beta^* - 1)\bar{\eta}\right)}{1 - (\rho - s_L)(1-\lambda) + \beta^*\lambda(s_H - \rho)} \tag{4}$$

and about the foreign discount factor

$$\beta^* < 1 + \frac{\lambda\left(1 + s_L(1-\lambda) - s_H\right)\underline{\eta}}{(s_H - \rho)(1-\lambda)\Pi} \tag{5}$$

The first condition ensures that there is enough liquidity for both types of investors to hold the public debt and the second condition ensures that foreigners do not value public debt too much and crowd-out domestic demand for public debt and the liquidity hoarding motive. In Appendix B we characterize the equilibria for the cases where (4) and (5) do not hold.

When (4) holds international investors hold part of the supplied public bonds. Thus, their valuation pins down the price of debt: $q = \beta^*\Pi$. The bond is sold at a premium, that is, $q - \Pi > 0$, because $\beta^* > 1$. If (5) also holds then $q = \beta^*\Pi < q^{max}$. Thus, at date 0 the demand from international investors is given by the section of the domestic demand for bonds where $q \in (\Pi, q^{max})$. In that case $\chi = 1$, the project is fully continued. Substituting this and the price for the public asset in (3) we obtain the initial scale of investment which is given by

$$I = \frac{A}{1 - (\rho - s_L)(1-\lambda) - \lambda(\rho - s_H) + (s_H - \rho)(\beta^* - 1)(\lambda + (1-\lambda)\frac{\bar{\eta}}{\underline{\eta}})} \tag{6}$$

and is proportional to the entrepreneur's initial wealth A. It is multiplied by the equity multiplier $\frac{1}{\left[1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)+(s_H-\rho)(\beta^*-1)(\lambda+(1-\lambda)\frac{\bar{\eta}}{\underline{\eta}})\right]} > 1$ which defines the maximum the entrepreneur can leverage its own initial capital.

We see that the maximum leverage per unit of own capital is increasing in the pledgeable return ρ. It is decreasing in the total expected cost of the project $1 + s_L(1-\lambda) + s_H\lambda$. Most importantly, for the purposes of this paper, it is decreasing in the cost of liquidity hoarding for the private sector which is the given by last sumand in the denominator in (6).

Two points are worth highlighting regarding the cost of liquidity hoarding. First, for the liquidity hoarding to have an effect on the equity multiplier and decrease investment it is key that foreign investors are more patient than domestics. If β^* were to equal 1 the level of investment would equal $\frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)}$ and would not be affected by the demand and cost of liquidity. The intuition for this is that if foreign investors were as patient as domestics, since they do not demand public debt as a way to hoard liquidity but in order to save, they would drive the premium at which public debt is sold, $q - \Pi$, to 0. The domestic entrepreneurs would be able to buy liquidity at no cost. This would increase the level of investment.

Second, the novel relationship that this model delivers is that the investment level is decreasing in the ratio of fiscal capacities in the low and high liquidity need states. With only one public bond the $\frac{\bar{\eta}}{\underline{\eta}}$ ratio parametrizes the amount of wasted liquidity. Wasted liquidity is the amount of useless liquidity that the entrepreneur is forced to purchase when she does not need it ($\bar{\eta}$) for each unit of liquidity she buys for the state when she does need the return ($\underline{\eta}$). Equilibrium investment is decreasing in the wasted liquidity, the lower this quantity is, the higher investment. The intuition for this is that wasted liquidity increases the cost of liquidity hoarding which in turn allows the entrepreneur to leverage her intial wealth further. The amount of bonds demanded by local entrepreneurs is $\frac{I(s_H-\rho)}{\underline{\eta}}$ where substituting I for its expression (6) and rearranging we obtain:

$$z^L = \frac{A(s_H-\rho)}{\underline{\eta}\left[1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)\right]+(s_H-\rho)(\beta^*-1)\Pi} \tag{7}$$

which is decreasing in the asset returns $\underline{\eta}$ and $\bar{\eta}$.

At price $q=\beta^*\Pi$ international investors will demand any residual bonds not demanded by locals. By market clearing the quantity of bonds demanded by internationals is the following:

$$z^F = 1 - z^L \tag{8}$$

2.4 Comparative Statics

A number of comparative statics are interesting to understand the workings of the model and will be relevant for the empirical analysis. For the purpose of the comparative statics we can set $\bar{\eta}=1$. This implies that in the good state when liquidity needs are low the government can fully redeem the public bond by taxing consumers. In the bad state when private liquidity needs are high the government bond pays: $\underline{\eta}\equiv\eta<1$.

An increase in s_H and a decrease in s_L such that the total cost per unit of investment, $1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)$, remains constant brings about an increase in the amount of debt held by locals and by market clearing, a decrease in the amount of debt in the hands of international investors. An increase in s_H is akin to a tightening of domestic collateral constraints which increases the need for public liquidity, increasing the demand for bonds at home. Initial investment scale I decreases because of the scale-liquidity trade-off: the higher the reinvestment shock in bad times, the higher the liquidity provision that the entrepreneur must make at date 0 and thus the lower the initial investment scale the entrepreneur can

choose. Another way of seeing this is that an increase in s_H decreases the equity multiplier which in turn decreases the maximum the entrepreneur can leverage her own wealth.

An increase in the repayment fraction η decreases the amount of bonds held by domestics, since local demand for public bonds is decreasing in the amount the bonds repay. By market clearing the amount of debt held by international investors increases. Intuitively if each bond now gives a higher return, the entrepreneur will need less of them to save for the liquidity shock. The total amount of liquidity held by domestic entrepreneurs, ηz_L increases since

$$\eta z_L = \frac{A(s_H - \rho)}{1 - (\rho - s_L)(1 - \lambda) - \lambda(\rho - s_H) + (s_H - \rho)(\beta^* - 1)(\lambda + \frac{1-\lambda}{\eta})}$$

when $q = \beta^* \Pi$. This amount is increasing in η. Investment increases because of the wasted liquidity force described before. An increase in η implies a return at $s = s_H$ closer to 1 which lowers wasted liquidity purchased by the entrepreneur for state $s = s_L$.

Finally, an increase in the patience of international investors parametrized by an increase in β^* decreases the local demand for bonds and lowers domestic investment. A higher international discount rate increases the price of the public bond for domestic entrepreneurs too because debt markets are integrated. Domestic investment is also lower when international investors become more patient because the increase in β^* increases the effective cost of investment. The increased demand from international investors crowds-out domestic demand for bonds and domestic investment. The comparative statics with β^* is a reduced form way to capture an increase in the foreign demand for government provided liquidity.

The following proposition summarizes the comparative statics presented so far:

Proposition 1. *For a given level of expected cost of investment,* $1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)$*: (i)* $\frac{\partial z^L}{\partial s_H} > 0$, $\frac{\partial z^F}{\partial s_H} < 0$ *and* $\frac{\partial I}{\partial s_H} < 0$*; (ii)* $\frac{\partial z^L}{\partial \eta} < 0$, $\frac{\partial z^F}{\partial \eta} > 0$ *and* $\frac{\partial I}{\partial \eta} > 0$*; (iii)* $\frac{\partial z^L}{\partial \beta^*} < 0$, $\frac{\partial z^F}{\partial \beta^*} > 0$ *and* $\frac{\partial I}{\partial \beta^*} < 0$.

3 Financial Innovation

As we have seen domestic investment decreases with unused liquidity that the public asset provides. Therefore, the government has some room to improve its provision of domestic liquidity. It will do so by introducing multiple debt instruments. In this section I suppose that the government issues two assets and chooses payoffs (x_1^H, x_1^L) and (x_2^H, x_2^L) respectively in states $s = s_L$ and $s = s_H$ to maximize total welfare.

It is worth noting that the government does not make international competition for the assets dissappear. The government will sell both assets in integrated debt markets. Allowing

the government to segment markets and sell the risky public asset to both investors but at different prices is unrealistic, especially with the existence of secondary markets which allow trading among investors (Broner et al. (2010)). Furthermore, although banning all competition from abroad could potentially be implemented by imposing capital controls, this is not welfare-improving. See appendix C for details and for how the model in this paper compares to others where capital controls can be welfare-improving.

The crucial gain of financial innovation is the improvement of liquidity provision through the channel of unused or wasted liquidity. In this section we will see how.

3.1 Entrepreneur's Problem

To study the government's problem we first need to know what the behavior of the entrepreneur will be with two assets available as liquidity hoarding vehicles. The problem looks as follows and it is a generalization of Problem 1:

$$\begin{aligned} max_{\{\chi,z_1,z_2,I\}} \quad & (R-\rho)(1-\lambda+\lambda\chi)I \\ s.t. \quad & (\rho-s_L)(1-\lambda)I+\lambda\chi(\rho-s_H)I+\Pi_1 z_1+\Pi_2 z_2 \geq \\ & I-A+z_1q_1+z_2q_2 \\ & \chi I(s_H-\rho)\leq x_1^H z_1+x_2^H z_2 \end{aligned} \tag{9}$$

where Π_1 and Π_2 denote the expected payoffs of both assets: $\Pi_1=\lambda x_1^H+(1-\lambda)x_1^L$ and $\Pi_2=\lambda x_2^H+(1-\lambda)x_2^L$.

Proposition 2. *When $q_1>\Pi_1$ and $q_2>\Pi_2$ both constraints bind.*

Proof. To see this, note that $q_1\geq\Pi_1$ and $q_2\geq\Pi_2$. The price of the assets can never go below their expected values, otherwise consumers who are assumed to have a big endowment would want to postpone all their consumption to date 1. This would drive the price of the liquid assets to their date 1 values, which are the expected values. At this price consumers will be indifferent between buying the assets or not.

If $q_1>\Pi_1$ or $q_2>\Pi_2$, only entrepreneurs will demand the assets since they have a higher valuation for them. To see that if $q_1>\Pi_1$ and $q_2>\Pi_2$ the budget constraint binds, we rewrite it as:

$$\rho(1-\lambda+\lambda\chi)I-s_L(1-\lambda)I-s_H\lambda\chi I\geq I-A+(q_1-\Pi_1)z_1+(q_2-\Pi_2)z_2 \tag{10}$$

Since $\rho(1-\lambda+\lambda\chi)I$ enters negatively the entrepreneur's objective function, she will make this term as small as possible choosing to just satisfy the constraint. The collateral constraint binds for $q_1>\Pi_1$ and $q_2>\Pi_2$ because the entrepreneur will choose z_1 and z_2 just enough

to cover the liquidity needs in the high liquidity shock state. Demanding more than this amount would imply that the right-hand side of the budget constraint in (10) increases. Since the budget constraint binds this would increase $\rho(1-\lambda+\lambda\chi)$, which would lower the entrepreneur's objective function. □

Denote by ℓ the unit cost of liquidity. The entrepreneur will choose the asset that will minimize her unit cost of liquidity, that is: $\ell = min\left\{\frac{q_1-\Pi_1}{x_1^H}, \frac{q_2-\Pi_2}{x_2^H}\right\}$. Suppose for concreteness that asset j minimizes ℓ and that asset j provides enough liquidity in state $s = s_H$ to cover all reinvestment needs. In that case $z_{-j} = 0$ since the entrepreneur does not want to purchase the liquidity using the asset that provides it at a higher cost.

As before international investors demand any amount of the asset as long as $q_j \leq \beta^*\Pi_j$, with strict equality if international investors hold part of asset j. As long as fiscal capacity is big enough international investors hold partly or completely both assets and $q_j = \beta^*\Pi_j$ for both j[3]. Since $\beta^* > 1$ both constraints in the entrepreneur's problem bind as proven in Proposition 2.

Thus, from the collateral constraint I obtain the local demand for the relatively cheap asset:

$$\frac{\chi I(s_H-\rho)}{x_j^H} = z_j^L \tag{11}$$

The parametric assumption on fiscal capacity ensures that this asset is enough to cover liquidity needs for the entrepreneur. In that case $z_{-j}^L = 0$. Substituting in the budget constraint and solving for investment we obtain:

$$I = \frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda\chi(\rho-s_H)+\chi(s_H-\rho)\ell} \tag{12}$$

The entrepreneur's unit cost minimization problem is given below:

$$min_{\{\chi\}}\frac{1+s_L(1-\lambda)+s_H\lambda\chi+\chi(s_H-\rho)\ell}{1-\lambda+\lambda\chi} \equiv c(\ell,\chi)$$

The solution for the continuation scale χ is the following:

$$\chi = \begin{cases} 1 & if\ \ell \in (0,\ell^{max}) \\ \in (0,1) & if\ \ell = \ell^{max} \\ 0 & if\ \ell > \ell^{max} \end{cases}$$

[3] As in the benchmark model I concentrate on the case where the marginal buyer is the international investor for both types of assets. This is ensured as long as $\eta > A(s_H-\rho)/1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)+(s_H-\rho)\lambda(\beta^*-1)$.

where ℓ^{max} is a threshold value. To see that this is the schedule for the continuation scale note that problem (9) is linear in I. Therefore we only need to evaluate the utility levels corresponding to $\chi = 0$ (continuing only when the shock is low) and $\chi = 1$ (always continuing). The unit cost for $\chi = 0$, $c(\chi = 0, \ell) = \frac{1+s_L(1-\lambda)}{1-\lambda}$ and $c(\chi = 1, \ell) = 1 + s_L(1-\lambda) + s_H\lambda + (s_H - \rho)\ell$. Comparing these we obtain that $c(\chi = 1, \ell) < c(\chi = 0, \ell)$ if and only if

$$\ell < \frac{\lambda}{(1-\lambda)(s_H - \rho)} + \frac{(s_L - s_H)\lambda}{s_H - \rho} \equiv \ell^{max} \tag{13}$$

which equals $\frac{\partial c(\chi, \ell^{max})}{\partial \chi} = 0$. I will impose throughout that $\ell < \ell^{max}$ and the project is continued at full scale in both states of the world. In this case, investment as a function of ℓ is given by the following expression:

$$I(\ell) = \frac{A}{1 - (\rho - s_L)(1-\lambda) - \lambda(\rho - s_H) + (s_H - \rho)\ell} \tag{14}$$

From here we see that $\frac{\partial I(.)}{\partial \ell} < 0$: the investment level is decreasing in the unit cost of liquidity.

3.2 Planner's Objective and Constraints

Domestic welfare W is given by the utility of consumption enjoyed by entrepreneurs and consumers in the three periods. Both agents have linear utility of consumption and do not discount future payoffs. We assume for this section that the government always wants to fully continue in both states of the world $\chi = 1$.[4]

Entrepreneurs consume the expected rent from their investment at date 2. Consumers lend a part $A - I + q_1 z_1 + q_2 z_2$ of their endowment E to finance the project initially and for the entrepreneur to prearrange for the future liquidity need. They obtain a return of $x_1^L z_1 + x_2^L z_2 + (\rho - s_L)I$ when the liquidity shock is low and obtain $x_1^H z_1 + x_2^H z_2 + (\rho - s_H)I$ when the liquidity shock is high. Also, at date 0 they obtain the proceeds from the total asset issuance q_1 and q_2 and are taxed the face value of both assets at date 1.

Thus, the utility expressions respectively for entrepeneurs and consumers are given by:

$$\begin{aligned} U^E &= (R - \rho)I \\ U^C &= E + A - I - q_1 z_1 - q_2 z_2 + (\rho - s_L)(1-\lambda)I + (\rho - s_H)\lambda I \\ &\quad + (q_1 - \Pi_1) + (q_2 - \Pi_2) + \Pi_1 z_1 + \Pi_2 z_2 \end{aligned}$$

[4] As in section 2 for this to be optimal we impose an upper bound on the foreign discount factor β^* which will ensure that the prices of the public assets are not too high. In particular, if we assume $\beta^* - 1 < \frac{1+(s_L - s_H)(1-\lambda)}{(s_H - \rho)(1-\lambda)}$, $\chi = 1$ will be optimal for the two financial innovations problems that we study in this section.

Total welfare equals:

$$\begin{aligned} W &= E + A + [R(1-\lambda+\lambda\chi) - s_L(1-\lambda) - s_H\lambda\chi - 1]\, I \\ &\quad +(q_1-\Pi_1)(1-z_1) + (q_2-\Pi_2)(1-z_2) \end{aligned} \tag{15}$$

By market clearing $1-z_1$ equals the amount of asset held by international investors, z_1^F and similarly for asset 2. Therefore, welfare can be rewritten as:

$$\begin{aligned} W &= E + A + [R(1-\lambda+\lambda\chi) - s_L(1-\lambda) - s_H\lambda\chi - 1]\, I \\ &\quad +(q_1-\Pi_1)z_1^F + (q_2-\Pi_2)z_2^F \end{aligned} \tag{16}$$

This expression is intuitive. The government wants to maximize the total net suplus from the investment and the liquidity premia, $q_1-\Pi_1$ and $q_2-\Pi_2$ obtained from international investors. The liquidity premium paid by entrepreneurs to consumers is a transfer across agents which cancels out in the welfare calculation and only the premia coming from abroad matter for welfare in the economy.

The government is constrained by its fiscal capacity. The sum of the payoffs of both assets in each of the states of the world cannot be larger than the government's fiscal capacity in that state of the world:

$$x_1^L + x_2^L \leq 1 \tag{17}$$

$$x_1^H + x_2^H \leq \eta \tag{18}$$

3.2.1 Monotonicity Requirement

If payoffs satisfy monotonicity it must be the case that for both assets:

$$x^L \geq x^H \tag{19}$$

We start our analysis without considering this restriction in section 3.3. Then, we add the more realistic assumption that public assets pay less in the state of the world that fiscal capacity is low.

In our discussion of assumption 3 in the set-up of the benchmark model in section 2 we argued that the state where fiscal capacity is low and the private liquidity shock is high corresponds to a "twin crisis" state, meaning a simultaneous banking and sovereign debt crisis.

A sovereign debt crisis is typically resolved with a sovereign debt restructuring process which ends with haircuts on investors.[5] Allowing for violations of (19) would imply that haircuts on some debt instruments are negative. Although there is no systematic data about haircuts at the debt instrument level, this seems unrealistic. We can imagine assets affected differently after a sovereign debt restructuring. For example, we can expect long-term debt more affected than short-term. Long-term debt due date can be adjourned and the payments will be rescheduled. It is more likely that short-term will be paid-off quicker and hence experience no haircut or a small one. In any case, it seems unlikely that it will have a negative haircut and some assets will gain from the sovereign debt restructuring process.

Also bonds issued under different laws might differ in the final recouped investment. Those under local law are normally hit stronger by a sovereign debt restructuring than those issued under the UK or US law where creditor litigation has increased dramatically the amount of recouped investment (Schumacher et al. (2013)). Again, however, bonds under UK or US law do not recoup more than they invested after a sovereign debt restructuring process which would be the implication of violating (19).

3.3 Planner's Problem without Monotonicity Requirements

As a benchmark, I start the analysis with the problem without monotonicity constraints. The planner maximizes expected welfare (16) choosing the asset payoffs and the minimum cost of liquidity hoarding for the entrepreneur, ℓ. In doing so the government is subject to the fiscal capacity constraints and internalizes the effect that its choice has on investment, demand for the public assets and prices.

The government solves the following problem:

$$\begin{aligned} max_{\{x_1^H, x_1^L, x_2^H, x_2^L, \ell\}} \quad & W \equiv E + A + \left[R - s_L\left(1-\lambda\right) - s_H\lambda - 1\right] I(\ell) \\ & + (q_1 - \Pi_1)(1 - z_1(\ell)) + (q_2 - \Pi_2)(1 - z_2(\ell)) \end{aligned} \tag{20}$$

$$s.t.$$

$$x_1^L + x_2^L \leq 1 \tag{21}$$

$$x_1^H + x_2^H \leq \eta \tag{22}$$

$$I = \frac{A}{1 - (\rho - s_L)(1-\lambda) - \lambda(\rho - s_H) + (s_H - \rho)\ell} \tag{23}$$

$$\ell = min\left\{\frac{q_1 - \Pi_1}{x_1^H}, \frac{q_2 - \Pi_2}{x_2^H}\right\} \tag{24}$$

$$0 \leq z_j(\ell) \leq 1 \tag{25}$$

$$q_j \geq \beta^* \Pi_j \quad with\ inequality\ only\ if\ z_j(\ell) = 1 \tag{26}$$

[5] See Cruces and Trebesch (2013) for a haircut database of recent sovereign debt restructurings.

where $j = \{1, 2\}$ and Π_j are assets' expected payoffs defined above.

Constraints (21) and (22) are the fiscal capacity constraints. Equation (23) gives the expression for investment from the entrepreneur's problem which depends on the unit cost of liquidity ℓ which is defined in (24) and is also a constraint on the planner's problem.

Constraints (25) and (26) impose market clearing considerations in the planner's problem and short-selling constraints. Equation (25) imposes that the local demand for asset j, $z_j(\ell)$ which depends on the cost of liquidity, cannot be bigger than the total supply of asset j which is normalized to 1. Also, $z_j(\ell) \geq 0$ because agents cannot short-sell the public assets. Equation (26) is just saying that asset prices will be pinned down by international investors' valuation if they hold the asset, that is if $z_j(\ell) < 1$ and will be strictly above international investors' valuation only when all of the supplied asset j is held domestically ($z_j(\ell) = 1$).

The approach to solve this problem is to solve a slightly modified version with fewer constraints and a modified objective and then check that the solution obtained satisfies initial constraints and that the objective takes the same value in the original objective. Thus, we start by modifying the objective W.

From constraint (26) we see that the government is not free to choose any quantity for the liquidity premia coming from foreigners. The maximum the government can obtain from foreigners for each asset j is $(\beta^* - 1)\Pi_j$. A liquidity premium higher than that would imply that all the supplied assets are held domestically ($z_j(\ell) = 1$ for both assets) and the liquidity premia coming from foreigners goes to zero. Note also that $\Pi_j \leq 1$. This implies that we can bound the liquidity premia coming from international investors:

$$\begin{aligned} 0 \;\leq\; & (q_1 - \Pi_1)(1 - z_1(\ell)) + (q_2 - \Pi_2)(1 - z_2(\ell)) \\ & \leq (\beta^* - 1)(1 - z_1(\ell)) + (\beta^* - 1)(1 - z_2(\ell)) \end{aligned} \tag{27}$$

where the first inequality in (27) holds with equality only when $z_1 = z_2 = 1$.

Therefore we can write a slightly modified welfare objective $\tilde{W}$ which is an upper bound on W which is given by:

$$\begin{aligned} \tilde{W} \;\equiv\; & E + A + [R - s_L(1 - \lambda) - s_H\lambda - 1]\, I + \\ & (\beta^* - 1)(1 - z_1(\ell)) + (\beta^* - 1)(1 - z_2(\ell)) \end{aligned} \tag{28}$$

The constraint on asset prices contained in (25) also imposes a lower bound on the unit cost of liquidity ℓ, namely $\ell \geq \frac{(\beta^* - 1)\Pi_j}{x_j^H} = \frac{(\beta^* - 1)\Pi_j}{x_j^H} = (\beta^* - 1)\left(\lambda + (1 - \lambda)\frac{x_j^L}{x_j^H}\right)$ where I have used the definition of Π_j. The lower bound on ℓ is given by:

$$\ell \geq \lambda(\beta^* - 1) \tag{29}$$

with equality only when $x_j^L = 0$ for asset j.

Using the modified objective (28) and the lower bound on unit cost of liquidity (29) we can rewrite the planner's problem in terms of the implemented fiscal capacity allocations. After solving for these we will find the asset combination that implements them.

Denote fiscal capacity allocations by F. In $(F_D^L, F_F^L, F_D^H, F_F^H)$ superscripts denote state of the world and subscripts denote the holder. Then F_D^L denotes how much of the fiscal capacity in $s = s_L$ is allocated to domestics. F_F^L denotes how much of that capacity is allocated abroad in the good state of the world. Similarly for F_D^H and F_F^H. Finally denote (ℓ^L, ℓ^H) as the unit cost of liquidity in both states of the world.

$$
\begin{aligned}
max_{\{\ell^H, F_F^L, F_D^H, F_F^H\}} \quad & E + A + [R - s_L(1-\lambda) - s_H\lambda - 1]\, I + \\
& \lambda(\beta^* - 1)F_F^H + (1-\lambda)(\beta^* - 1)F_F^L \qquad (30) \\
s.t. & \\
I &= \frac{A}{1 - (\rho - s_L)(1-\lambda) - \lambda(\rho - s_H) + (s_H - \rho)\ell^H} \qquad (31) \\
F_D^H &\geq I(s_H - \rho) \qquad (32) \\
\ell^H &\geq \lambda(\beta^* - 1) \qquad (33) \\
F_D^H + F_F^H &\leq \eta \qquad (34) \\
F_D^L + F_F^L &\leq 1 \qquad (35)
\end{aligned}
$$

The planner's problem given by (30) above maximizes the returns from investment and the liquidity premia coming from abroad subject to the behavior coming from the entrepreneur's problem. In particular (31) gives the expression for investment in terms of parameters and the liquidity premium in state $s = s_H$. Constraint (32) rewrites the collateral constraint in terms of the new variables: it is just saying that the amount of fiscal capacity held by domestics in state $s = s_H$ has to be greater or equal than the reinvestment need in that state of the world. Constraint (33) gives the lower bound for the liquidity premium that we obtained above. Finally the government needs to satisfy the fiscal capacity constraints (34) and (35).

To solve this problem, first note that the objective function is increasing in investment I. Since $I'(\ell^H) < 0$ the planner chooses the minimum possible ℓ^H, that is: $\ell^H = \lambda(\beta^* - 1)$ from (33) with equality. This pins down investment $I = \frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)+(s_H-\rho)\lambda(\beta^*-1)} \equiv I^{**}$. Second, note that the planner's aim is to make F_D^H as small as possible. The reason for this is that increasing F_D^H, decreases F_F^H from (34). The planner wants to provide just the indispensable liquidity to entrepreneurs and maximize the financial flows coming from abroad. Then (32) holds with equality, $F_D^H = I^{**}(s_H - \rho)$ and $F_D^L = 0$.

Finally fiscal constraints and (35) hold with equality or else fiscal capacity would be wasted. The optimal fiscal capacity allocation without monotonicity constraints is given in the proposition below.

Proposition 3. *Without monotonicity constraints on asset payoffs, the optimal fiscal capacity allocation is given by:*

$$\begin{aligned} F_D^H &= I^{**}(s_H - \rho) \\ F_D^L &= 0 \\ F_F^H &= \eta - I^{**}(s_H - \rho) \\ F_F^L &= 1 \end{aligned}$$

where $I^{**} = \frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)+(s_H-\rho)\lambda(\beta^*-1)}$ *and it is the level of investment pinned down by* $I(\ell^H = \lambda(\beta^* - 1))$.

As I argued above, the allocation provides just enough liquidity domestically to attain the desired level of investment. When the government is not constrained by monotonicity it does not supply any liquidity to domestics in $s = s_L$ and $F_D^L = 0$. In that state of the world private liquidity covers reinvestment needs and all fiscal capacity is allocated abroad to maximize foreign capital flows.

Since $\beta^* > 1$ the premia coming from abroad are a positive income flow for consumers. They are taxed the expected payoffs when repayment is due at date 1 but obtain a flow higher than that at date 0 when assets are sold.

3.4 Planner's Problem with Monotonic Asset Payoffs

The problem when the planner is not subject to monotonicity requirements is simply (20) including a monotonicity constraint. To solve the problem in terms of fiscal capacity allocations we still solve a slightly modified version of the problem where we impose an upper bound welfare $\tilde{W}$ like in (28).

However the lower bound on unit cost of liquidity is now higher than (29). To see this note that $\ell \geq \frac{(\beta^*-1)\Pi_j}{x_j^H} = \frac{(\beta^*-1)\Pi_j}{x_j^H} = (\beta^* - 1)\left(\lambda + (1-\lambda)\frac{x_j^L}{x_j^H}\right)$ which under monotonicity requirements $x_j^L \geq x_j^H$ cannot be smaller than $\ell \geq \beta^* - 1$. This condition holds with equality when $x_j^L = x_j^H$. We see that when the government is constrained by monotonicity the minimum payoff in state $s = s_L$ it can choose is the same as in $s = s_H$, which increases the minimum unit cost of liquidity it can attain.

The problem in terms of fiscal capacity allocations is the following:

$$\begin{aligned} max_{\{\ell^H, F_F^L, F_D^H, F_F^H\}} \quad & E + A + [R - s_L(1-\lambda) - s_H\lambda - 1]\, I + \\ & \lambda(\beta^* - 1)F_F^H + (1-\lambda)(\beta^* - 1)F_F^L \end{aligned} \tag{36}$$

$$s.t.$$

$$I = \frac{A}{1 - (\rho - s_L)(1-\lambda) - \lambda(\rho - s_H) + (s_H - \rho)\ell^H} \tag{37}$$

$$F_D^H \geq I(s_H - \rho) \tag{38}$$

$$\ell^H \geq \beta^* - 1 \tag{39}$$

$$F_D^H + F_F^H \leq \eta \tag{40}$$

$$F_D^L + F_F^L \leq 1 \tag{41}$$

$$F_D^L \geq F_D^H;\ F_F^L \geq F_F^H \tag{42}$$

The planner's problem given by (36) is very similar to the one with no monotonicity requirements. The only differences are a higher upper bound on the liquidity premium (39) and the monotonicity constraints (42). They require the amount of fiscal capacity held by both types of agents, domestics and foreigners, in the low liquidity shock state be greater or equal to what they hold in the high liquidity shock state.

The reasoning to obtain the solution is also very similar to above. The government wants to minimize ℓ^H since $I'(\ell^H) < 0$. Thus the planner chooses the minimum possible that is: $\ell^H = \beta^* - 1$ from (39) with equality. This pins down investment $I = \frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)+(s_H-\rho)(\beta^*-1)} \equiv I^*$. The planner's aim is to make F_D^H as small as possible. From (40) we see that increasing F_D^H necessarily decreases F_F^H because fiscal capacity is limited and this lowers the objective function. Then (38) will hold with equality.

Also (42) for domestics must hold with equality $F_D^L = F_D^H$. The argument is similar to above, making F_D^L higher than just necessary would lower F_F^L from (41) which again lowers the objective function. As before fiscal constraints (40) and (41) hold with equality. Under this allocation the monotonicity constraint for foreigners is slack. The optimal fiscal capacity allocation is summarized in the following proposition.

Proposition 4. *Under monotonicity constraints, the optimal fiscal capacity allocations are:*

$$\begin{aligned} F_D^H &= F_D^L = I^*(s_H - \rho) \\ F_F^H &= \eta - I^*(s_H - \rho) \\ F_F^L &= 1 - I^*(s_H - \rho) \end{aligned}$$

where $I^* = \frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)+(s_H-\rho)(\beta^*-1)}$ *and it is the level of investment pinned down by* $I(\ell^H = \beta^* - 1)$.

The allocation is intuitive. As before the planner wants to provide just the indispensable liquidity to entrepreneurs. However in this case it is constrained by monotonicity and has to provide the same amount in the good state of the world even if the project is self-financed. As before, all residual fiscal capacity is allocated abroad to exploit the high willingness to pay for the domestic assets international investors have.

3.5 Assets that Implement Optimal Fiscal Capacity Allocations

A payoff structure that implements the fiscal capacity allocation under no monotonicity corresponds to the Arrow-Debreu securities given by:

$$\begin{aligned} x_1^H &= \eta,\ x_1^L = 0 \\ x_2^H &= 0,\ x_2^L = 1 \end{aligned}$$

in which fiscal capacity in each state of the world is supplied in the form of one asset.

Indeed this combination implements the fiscal capacity allocations given in subsection 3.3. The fiscal capacity allocated to domestics in both states of the world equals:

$$F_D^H = z_1 x_1^H + z_2 x_2^H \tag{43}$$

$$F_D^L = z_1 x_1^L + z_2 x_2^L \tag{44}$$

where $z_1$and z_2 is the demand coming from domestic for each asset.

Given these two assets the entrepreneur will choose to hold asset 1 since it is the only asset that provides liquidity in state $s = s_H$. The expected asset payoff $\Pi_1 = \eta\lambda$ which makes $\ell = \lambda(\beta^* - 1)$.

The domestic demand for asset 1 equals $z_1 = \frac{I^{**}(s_H-\rho)}{\eta}$ and $z_2 = 0$. The foreign demand for both assets equal $z_1^F = 1 - z_1 = 1 - \frac{I^{**}(s_H-\rho)}{\eta}$ and $z_2^F = 1$. Plugging these and the payoffs in (43) and (44) for both types of investors we obtain the optimal fiscal capacity allocations from Proposition 3.

Angeletos (2002) and Buera and Nicolini (2004) show that non-contingent debt of different maturities can implement any Arrow-Debreu allocation. In particular, with two states of the world the government can implement the Arrow-Debreu allocation issuing long-run bonds and holding short-run bonds. However, in the financial innovation problem I consider I do not allow the government to hold one of the assets, constraint (25) states that $z_j(\ell) \geq 0$.

This that appears as a constraint in the planner's problem emerges from the entrepeneur's problem. Looking at the collateral constraint in Problem 9 we see that the entrepreneur does not want to hold negative amounts of any asset because that would make her constraint more binding. International investors also do not want to sell any of the assets because they are patient investors who prefer a return at date 1 than an income flow at date 0.

Also, the problem I am interested in studies what is the optimal structure of the assets the government issues to maximize domestic investment and financial flows from abroad.

Furthermore as Debortoli et al. (2014) points out completing the market with bonds of different maturities as in Angeletos (2002) and Buera and Nicolini (2004) requires very large positions relative to the size of the economy. For these two reasons I consider the Arrow-Debreu allocation as a theoretical benchmark and will concentrate on the optimal financial innovation under monotonicity.

Under monotonicity the payoff structure that implements the fiscal capacity allocation is a safe and a risky asset:

$$\begin{aligned} x_1^H &= \eta,\ x_1^L = \eta \\ x_2^H &= 0,\ x_2^L = 1 - \eta \end{aligned}$$

In this case again the entrepreneur will again only demand asset 1 since it pays in state H. Its expected payoff $\Pi_1 = \eta$, and thus $\ell = \beta^* - 1$.

Since the entrepreneur does not buy asset 2, $z_2 = 0$. From the collateral constraint (11) $z_1 = \frac{I^*(s_H - \rho)}{\eta}$. The foreign demand for asset 2 is all the asset supplied $z_2^F = 1$ because domestics hold none of this asset and $z_1^F = 1 - z_1 = 1 - \frac{I^*(s_H - \rho)}{\eta}$. The fiscal capacity allocations that are attained with this combination of assets is exactly the optimal one from Proposition 4.

The ESBies proposal in Brunnermeier et al. (2011) implements a fiscal capacity allocation like this one for the European Union. In their proposal a European Debt Agency (EDA) would buy the sovereign bonds of member nations according to some fixed weights and issue a senior and a junior tranch on the portfolio of bonds. A similar implementation at the country level would have governments issuing senior and junior bonds. We have seen no financial innovation like this in sovereign debt markets.

The closest counterpart we observe in sovereign debt markets are bonds with different relative riskiness. For example, local and foreign currency debt. Local currency debt would be the relatively riskier debt instrument since devaluations and currency depreciations occur more frequently in bad times. Foreign currency debt would be the relatively safe asset. This will be the focus of the analysis in the empirical section of the paper.

4 The Benefits of Financial Innovation and Complementarities with Financial Integration

To start, it is worth noting that the planner problems given in subsections 3.3 and 3.4 were subject to the same fiscal capacity constraints as in the scenario with only one defaultable bond. Thus government revenues are identical in all scenarios. In the case with one bond the government revenues are given by $\beta^*(1-\lambda+\lambda\eta)$, which is identical to the level of government revenues in the other two scenarios when we add the revenues accruing from both assets. Despite keeping fiscal capacity constant the government is increasing domestic investment when it issues two different securities. In particular we find the following:

Proposition 5. *Let I^{**} denote the investment level with Arrow-Debreu securities. Let I^* denote the investment level with one safe and one risky bond. Finally let I denote investment with one risky bond. We have $I^{**} \geq I^* \geq I$ with strict inequality when fiscal capacity $\eta > \frac{(s_H-\rho)(A-(\beta^*-1)\lambda)}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)}$ for the first inequality and $\eta > \frac{(s_H-\rho)(A-(\beta^*-1))}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)}$ for the second.*

For the argument we concentrate on the case where the fiscal capacity conditions are met and thus both domestic and international investors hold part of the public asset held by domestics to hoard investment. In this case financial innovation increases investment. Furthermore, investment is highest when the government issues Arrow-Debreu securities and lowest one it issues only one defaultable bond.

The intuition for this result is that by issuing two different assets the government tranches its fiscal capacity and reduces the wasted liquidity, that is, the amount of uneeded liquidity the entrepreneur purchases per unit of outside liquidity required in the bad state of the world.

The lower the wasted liquidity, the higher the domestic investment because the local investors can leverage more their wealth. We see this by comparing the case with Arrow-Debreu securities and with one safe and one risky asset. In the former case, when the entrepreneur buys asset 1 she does not buy any wasted liquidity because the asset's payoff in that state of the world is 0. In the latter case, when the government is issuing a safe asset the entrepreneur has to buy some liquidity for the state she will not use it.

The cost of the wasted liquidity in this model comes from the existence of international investors. The model features a crowding-out effect coming from international investors' demand for public bonds. This high demand from foreign investors is captured by the higher discount factor abroad $\beta^* > 1$ and drives up the price of the public bond. The government

by tranching its fiscal capacity and decreasing wasted liquidity decreases the cost of liquidity hoarding for entrepreneurs without imposing capital controls[6].

Finally, financial innovation introduces assets especially designed to attract international investors who are risk-neutral and demand the assets as a savings vehicle.

It is worth noting that if the economy is in autarky then the following proposition holds:

Proposition 6. *Under autarky, investment denoted as I^{Aut} does not depend on the ratio of fiscal capacities $\bar{\eta}/\underline{\eta}$. Thus, investment and welfare are equal under financial innovation than without.*

In this model we see that the benefits of financial innovation arise when sovereign debt markets are integrated. In Appendix D we find the equilibria when foreign investors cannot buy public debt in sovereign debt markets. In both equilibria, with high and low fiscal capacity, investment would not be affected by financial innovation.[7]The government cannot improve the allocation by changing the payoff structure.

5 Comparative Statics

In this section I perform comparative statics for the scenario with one safe and one risky asset. The comparative statics regard the relative holdings of safe to risky asset for different types of investors.

An increase in s_H and a decrease in s_L such that the total cost per unit of investment, $1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)$, remains constant brings about an increase in the international relative holdings of risky to safe asset. The intuition for this is that the tightening of collateral constraints increases the domestic demand for the safe asset. By market clearing, the amount of safe asset held by international investors decreases. The international holdings of risky asset are always equal to the amount supplied. Thus, the relative holdings of risky to safe increase because the denominator decreases.

An increase in fiscal capacity η decreases the relative holdings of risky to safe asset. The reason for this is that an increase in η lowers the domestic demand for the safe asset because now every bond pays more. Thus international investors need to hold more of the safe asset which decreases the ratio of risky to safe assets held by foreigners.

[6]See Appendix C for a discussion on capital controls in this model.

[7]More broadly we can think of sovereign debt markets open to different types of investors with different motives to hold debt and with a higher demand for the public bond. In the model presented in this paper these are foreign investors. This is consistent with the empirical evidence that shows a steady increase in the share of debt held by foreigners for emerging and advanced economies (Arslanalp and Tsuda (2014) and Arslanalp and Tsuda (2012)).

An increase in the patience of international investors parametrized in an increase in β^* increases the foreign demand for the safe asset because being more patient they demand more of all assets. This decreases the ratio of risky to safe international holdings since as in the previous scenarios risky asset holdings are fixed and normalized to 1.

Proposition 7. *Let z_1^F denote the foreign holdings of the risky asset and z_2^F the foreign holdings of the safe asset. Then for a given level of $1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)$, (i) $\frac{\partial(z_1^F/z_2^F)}{\partial s_H}>0$, (ii) $\frac{\partial(z_1^F/z_2^F)}{\partial \eta}<0$, and (iii) $\frac{\partial(z_1^F/z_2^F)}{\partial \beta^*}<0$.*

6 Empirical Analysis

6.1 Objective and Data

In this section I test the comparative statics in propositions 1 and 7 regarding public debt ownership as a whole and ownership of relatively riskier sovereign debt instruments. To do this I construct a panel dataset of 21 emerging economies between 2004 and 2010. The countries included in the sample are emerging markets from Asia, Latin America, countries in Europe, Middle East and Africa (EMEA) that are in the European Union and others that are not. See Appendix F.1 for a complete list of countries included and data sources.

With this data I test the two sets of predictions. First, the ones regarding sovereign debt ownership. For this I use the share of sovereign debt held abroad. Second, I test the predictions regarding ownership of riskier debt instruments. For this I use the share of Local Currency (LC) sovereign debt held abroad because devaluations and currency depreciations occur more frequently in bad times. In other words, LC debt has a more cyclical payoff structure than foreign currency debt. For the purpose of the model, the asset with the cyclical payoff structure is the risky debt instrument.

Propositions 1 and 7 give predictions on the effect of tightening of collateral constraints, fiscal capacity, and foreign discount factor have on them.

For tightening of collateral constraints I use two measures. First, a measure of domestic availability of credit: private credit by deposit money banks and other financial institutions. This measure has been used extensively in the literature about credit market development and financial frictions (Gennaioli et al. (2014a), Gennaioli et al. (2014b), and Alfaro et al. (2008)). Second, I use an inverse measure of banks' leverage: banks' capital to assets. As we saw in subsection 2.4 an increase in s_H decreases the equity multiplier of the productive sector, the maximum the private sector can leverage its initial wealth. Therefore the leverage

ratio decreases which automatically implies that in the model the inverse leverage increases after an increase in s_H.

For fiscal capacity I use three different proxies used often in the development economics literature (Dincecco and Prado (2012), Baskaran and Bigsten (2013)). Tax revenues over GDP, direct tax revenues on income, profits, and capital gains as a percentage of government revenues or as a percentage of tax revenues. For all of them higher levels imply a higher fiscal capacity of the government or the economy's fiscal effort. Another way to capture fiscal capacity in the model is through sovereign debt spreads. The analysis before proposition 1 normalized fiscal capacity in good times to 1 and then performed comparative statics with fiscal capacity in bad times. Therefore an increase in fiscal capacity in bad times η captures a decrease in the riskiness in the returns of the public asset: payoffs of the public asset are more similar. Riskiness of sovereign debt is typically captured by the sovereign debt spread and it is an inverse measure of fiscal capacity.

Finally, as an inverse measure of the international discount factor I use the federal funds rate. Since interest rates are inversely related to discount factors, a lower federal funds rate implies a higher degree of world impatience. Another way of seeing this is that a low federal funds rate makes investors search for yield in other investments, which can rationalize a high willingness to hold sovereign debt.

I would like to highlight that this analysis does not make any causal claims. This section presents evidence using regression analysis consistent with the previous model. There could be other channels explaining the associations that I find in the data. To mitigate as much as possible these concerns, I control for several relevant variables as well as including time and country fixed effects to control for global shocks and for time-invariant country-specific characteristics. I will also discuss in the last subsection other possible channels.

6.2 Comparative Statics on Sovereign Debt Ownership

The specification used to test the comparative statics regarding sovereign debt ownership as a whole contained in proposition 1 are the following:

$$\%\, debt\, abroad_{it} = \alpha_i + \lambda_t + \beta_1 Collateral_{it} + \beta_2 Fiscal\, Capacity_{it} + \gamma X_{it} + u_{it} \quad (45)$$

$$\%\, debt\, abroad_{it} = \alpha_i + \beta_3 Federal\, Funds\, Rate_t + \gamma \tilde{X}_{it} + u_{it} \quad (46)$$

where the dependent variable is the share of total outstanding public debt held by international investors. The term α_i are country fixed effects, which control for time-invariant country-specific factors which can affect the share of sovereign debt held abroad (eg. insti-

tutions, perceived creditworthiness of a country). The coefficient λ_t are time fixed effects which capture shocks affecting all countries such as the world interest rate. Specification (46) does not contain time fixed effects precisely because we want to estimate the effect of the federal funds rate which is a common shock across countries.

Finally to deal with all time-variant country-specific factors which can affect the share of government debt held abroad I include X_{it}, a vector of controls. The vector $\tilde{X}_{it}$ of the specification with no time fixed effects is the vector X_{it} augmented by a variable of collateral constraints and a variable of fiscal capacity. In particular I include capital to asset ratio and sovereign spread. Including other measures such as local credit or some measure of tax revenues does not significantly change the coefficient for federal funds rate.

I include financial openness, percentage of public debt over GDP, and GDP real growth rate. We expect a more financially open economy or an economy with higher debt to have more sovereign debt held abroad regardless of collateral constraints and fiscal capacity. Also, a growing economy is more likely to have sovereign debt held by internationals because these expect a repayment more likely.

The regression equations also contain a measure of political risk and inflation. The political risk index compiled by the International Country Risk Guide measures the degree of political stability in a country (Comelli (2012)). A lower level of that index makes a country less attractive to foreign investors. Also inflation makes sovereign debt less attractive to foreign investors, since some of the debt is issued in local currency. More generally, inflation can be seen by international investors as a signal of poor monetary and fiscal policy.

Furthermore, I include a measure of credit ratings residual which captures the effect of credit ratings once we account for fundamentals and credit history. Good credit ratings will likely increase the share of sovereign debt held by international investors.

Finally, since part of the sovereign debt is issued in local currency, I include the nominal exchange rate to control for exchange rate risk. It is defined as local currency units per US dollar. Everything else equal, an increase in the nominal exchange rate makes the investment in LC debt less attractive for foreigners since the currency they are investing in is depreciating. As we see in Appendix F.2 only two of the countries in my sample have hard pegs as their exchange rate regimes over the whole period in my data and seven countries have free floating exchange rate regimes. Therefore the nominal exchange rates do contain information about exchange rate risk. For robustness I also use the annual change in the nominal exchange rate instead of the level. For all specifications I obtain very similar results and the variables that are significant with the level of the nominal exchange rate remain significant at the same level of confidence too.

		Share of debt abroad	Share of LC abroad
Collateral constraints (s_H)	Capital to assets ratio	-	+
	Local Credit	+	-
Fiscal capacity (η)	Tax revenues measures	+	-
	Sovereign debt spreads	-	+
International patience (β^*)	Fed Funds Rate	-	+

Table 2: Summary of variables and expected signs for comparative statics

The three variables of special interest in these specifications are the measure of collateral constraints, fiscal capacity, and federal funds rate. According to the model, $\beta_1 > 0$ if we use local credit as a measure of collateral constraints and $\beta_1 < 0$ if we use banks' capital to assets ratio; $\beta_2 > 0$ if we use the variables capturing tax revenues and $\beta_2 < 0$ if we use spreads, and $\beta_3 < 0$. For convenience, the following table summarizes these expected signs as well as the ones for the comparative statics on LC debt abroad.

The model predicts that a tightening of collateral constraints, lower local credit available or a higher capital to assets in the banking sector, implies a repatriation of sovereign debt, a lower share of debt held abroad. As we argued, bigger reinvestment needs increases the domestic demand of sovereign debt for those who purchase debt as a way to store liquidity.

An increase in fiscal capacity increases the share of debt held abroad. This happens because now each asset gives domestic investors now more return to cover reinvestment needs. This decreases their demand, increasing the share of debt held by internationals.

Finally, an increase in the federal funds rate implies a decrease in the international discount factor which brings about a decrease in the international demand for bonds.

The results are in Appendix F.3. Columns (1)-(5) contain the results for specification (45) with different measures for tightening of collateral constraints and fiscal capacity. Column (6) contains the results for specification (46). For all of them standard errors are clustered at the country level using bootstrap.

The data confirms the predictions of the model regarding the importance of collateral constraints as captured by the inverse of the leverage ratio. This effect is negative and significant in all except one specification. The results for local credit are inconclusive since the point estimate is not significant.

The evidence on fiscal capacity is not strong. The point estimates for the measures of tax revenues are positive and the point estimate of the sovereign debt spread is negative, all as predicted by the model, but these are only significant in one specification, column (2) when using tax reveues over GDP.

Finally, the coefficient on the federal funds rate is also inconclusive. It is non-significant but the point estimate contradicts the model since according to the model it had to be negative.

6.3 Comparative Statics on Local Currency Sovereign Debt Ownership

The specification used to test the comparative statics regarding ownership of relatively riskier public debt instruments contained in Proposition 7 are the following:

$$\%\, LC\, abroad_{it} = \alpha_i + \lambda_t + \beta_1^{LC} Collateral_{it} + \beta_2^{LC} Fiscal\, Capacity_{it} + \gamma X_{it} + u_{it} \quad (47)$$

$$\%\, LC\, abroad_{it} = \alpha_i + \beta_3^{LC} Federal\, Funds\, Rate_t + \gamma \tilde{X}_{it} + u_{it} \quad (48)$$

where the dependent variable is the share of local currency public debt held abroad. As before λ_t are time fixed effects and α_i are country fixed effects which in this set-up could capture for example the historical credibility in managing inflation. X_{it} is a vector of controls. As before, $\tilde{X}_{it}$ is the same vector of controls but augmented with a measure of collateral constraints and a measure of fiscal capacity. In particular here I use local credit and sovereign spread. As before, including other measures such as capital to assets ratio or some measure of tax revenues does not significantly change the coefficient for federal funds rate.

Most of the controls I included in (45) and (46) are included here. The channels through which they may matter are similar to the ones explained previously. I make only one change: substitute the share of public debt over GDP for the share of local currency debt over total debt. For the share of LC debt held abroad the relevant stock variable is the total amount of LC debt, as before we expect a country which issues more debt in LC to have more of it held abroad.

We now concentrate on the relevant variables for Proposition 7. The model predicts that $\beta_1^{LC} < 0$ if we use local credit and $\beta_1^{LC} > 0$ if we use banks capital to assets; $\beta_2^{LC} < 0$ if we use measures of tax revenues and $\beta_2^{LC} > 0$ if we use spreads, and $\beta_3^{LC} > 0$. These signs are summarized in table 2.

Regarding the coefficient for local credit, the model with two assets predicts that as collateral constraints become tighter at home the domestic demand for debt shifts towards the relatively safer debt instruments. This increases the ratio of risky to safe foreign ownership, which is

consistent with seeing increases in the foreign ownership of LC debt in the data. When tightening of collateral constraints is measured as a decrease in local credit the sign of β_1^{LC} is negative. If we measure tightening of collateral constraints as a decrease in the leverage ratio, and hence an increase in the capital to assets ratio, we expect $\beta_1^{LC} > 0$.

As we saw an increase in fiscal capacity implies a drop in the domestic demand of the safe debt instrument, because each asset now gives a higher return for liquidity hoarding at home. This implies an increase in the share of the safe instrument held abroad and a corresponding decrease in the ratio risky to safe owned by internationals.

Finally, an increase in the international discount factor crowds-out the domestic demand for safe asset. This causes a decrease in the share of risky to safe asset held abroad which is consistent with a decrease in the LC debt held abroad.

The results are Appendix F.4. As before, columns (1)-(5) contain the results for specification (47) and column (6) contains the result for equation (48). Standard errors are clustered at the country level using bootstrap.

The results for collateral constraints confirm the predictions of the model. The coefficients for local credit are negative and significant in all specifications as predicted by the model. The coefficient for the inverse of the leverage ratio is non-significant.

The evidence for the effect of fiscal capacity on the share of LC public debt held abroad is somewhat mixed. The coefficient for tax revenues over GDP confirms the prediction of the model as we see in column (2). However this finding is not robust to including local credit as a measure of collateral constraints. The other two measures of tax revenues are insignificant and their point estimates are positive. As far as spreads are concerned, the point estimate is positive as predicted by the model but it is not significant.

Finally, the data shows no evidence of a negative effect of the federal funds rate on the share of LC debt held abroad. The coefficient is insignificant.

6.4 The Global Financial Crisis and Sovereign Debt Ownership

From the previous analysis, liquidity conditions emerge as key in determining foreign ownership of sovereign debt. The global financial crisis offers a great setting to explore the effects a tightening of liquidity conditions had on sovereign debt ownership.

To explore this, I sutdy how sovereign debt ownership correlate with measures of credit conditions before and after the crisis. I mark the post period in the fourth quarter of 2008. I choose this period because the third quarter of 2008 corresponds to the federal takeover of Fannie Mae and Freddie Mac and when the Federal Reserve cut its federal funds rate from

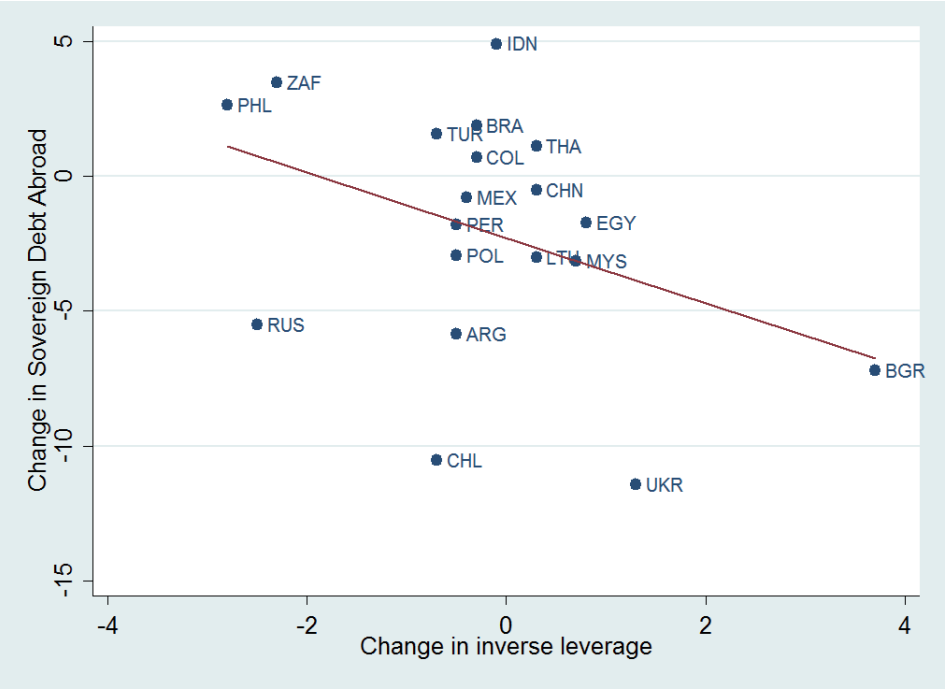


Figure 3: Tightening of collateral constraints and sovereign debt foreign ownership (Data sources: Arslanalp and Tsuda (2014) and World Bank Indicators)

1.94% to 0.51%. We can see this as a quasi-exogenous tightening of collateral constraints for the countries in my sample, since these were events happening in the US and with limited repercussions in emerging markets at this time. However I cannot claim I am gauging at causality since there could be many other relevant variables that I do not control for in this analysis.

According to the benchmark model in section 2 more severe tightening of collateral conditions causes a sovereign debt repatriation because domestics use sovereign debt as collateral. This causes bigger drops in the share of sovereign debt held abroad. Figure 3 shows a scatter plot for the 21 emerging economies in my sample. I plot the change in the share of sovereign debt held abroad between 2008Q4 and 2007Q4 against the change in banks' capital to assets ratio. As expected we see a negative relationship between these two variables. Indeed countries which experienced increases in capital to assets ratio in their banking sector experienced a decrease in banks' leveraging and thus a tightening of collateral constraints. According to the model these countries should experience a drop in the share of government debt held abroad.

6.5 Discussion of Other Possible Channels

The results regarding the effect of the banking sector capital to assets ratio on sovereign debt ownership is not driven by the automatic effect on banks balance sheets. In fact, the automatic effect goes in the opposite direction. Sovereign debt repatriation increases the assets' of the banking sector because part of the debt is bought by banks (Arslanalp and Tsuda (2014) for emerging economies and Arslanalp and Tsuda (2012) for advanced economies). This automatically decreases the capital to assets ratio of the banking sector, which would make us prone to find a negative instead of a positive association between the share of debt held abroad and the banks' capital to assets ratio. This goes against the results presented in the previous subsections: I find a negative effect as predicted by the model even though the effect on banks' balance sheets goes in the direction of dampening this negative association.

Broner et al. (2014) presents a model to explain similar stylized facts to the ones highlighted in this paper: increases in the share of sovereign debt held by the domestic private sector as sovereign spreads increased in some countries of the Euro Area, decreases in the share of debt held abroad, shifts of domestic credit from the private to the public sector, and increases in the borrowing costs for the private sector as sovereign spreads increased. In their model an increase in the risk of default, caused by a decline in the quality of institutions or by changes in investors' expectations, increases the expected return for domestic investors of debt. This happens because of their assumption of discrimination in favor of domestic creditors. In the presence of financial frictions this increase in domestic demand for sovereign debt displaces domestic investment.

The resulting connection between domestic demand for sovereign debt and investment is also present in my model. However, the channels I present are somewhat different. In my model there is no strategic sovereign default and thus no creditor discrimination in case of sovereign default either. Instead, a worsening of financial conditions or a deterioration of the government's fiscal capacity, increases the domestic demand for sovereign debt. This increased demand does not displace investment directly. The channels through which investment and thus welfare decrease are different in this model. A worsening of financial conditions decreases the equity multiplier directly, and thus the extent to which the private sector can leverage its own wealth. On the other hand, a deterioration of the government's fiscal capacity decreases the equity multiplier through its increase of the cost of liquidity hoarding for the private sector.

The drop in investment in Broner et al. (2014) comes from a portfolio decision from the private sector. An increase in the return of sovereign debt displaces other productive invest-

ment. In my model the drop in investment comes from a worsening of financial conditions or from an increase in the cost of liquidity hoarding for the private sector.

The key difference in the assumptions between both models is whether private sector investment and private sector purchases of sovereign debt are complements or substitutes. In Broner et al. (2014) both are substitutes in the presence of financial frictions and more so in what they call the "crowd-out region". In models where sovereign debt acts as collateral, both are complements. Example of this includes not only my paper but also among many others Holmstrom and Tirole (1998), Angeletos et al. (2012) and Gennaioli et al. (2014b). Ultimately this is an empirical question and it is beyond the scope of this paper to distinguish them.

7 Conclusion

This paper presents a model where public debt has a liquidity role, debt is risky because of government's risky fiscal capacity and sovereign debt markets are integrated by different investors who demand debt for different purposes. The paper shows that in this environment financial innovation in sovereign debt can increase domestic investment and domestic welfare. The key assumption behind this result is the liquidity role of public debt. Financial innovation can make liquidity cheaper for the private sector by changing the payoff structure of the public assets in a way that lowers wasted liquidity for domestic investors.. For this to be possible there must be other types of investors willing to hold the residual risk not allocated to domestics.

The implementation of the optimal sovereign debt structure are assets of different relative riskiness. The paradigm would be to have seniority clauses which render some bonds, senior bonds, safe and riskier or junior bonds. Another possible implementation that I have explored in the empirical analysis are local and foreign currency bonds.

The financial innovations proposed and the way of approaching the government's financial innovation problem have highlighted that the government can exploit the existence of different types of investors when designing assets. Especially the government can design assets taking advantage of the different degrees of patience in its investor base and the different rationales for holding public debt. The paper has shown that to provide liquidity optimally at home the government does not need to segment markets or tax foreigners: an appropriate asset design can result in market segmentation. The financial innovation problem has also highlighted that when there are investors willing to hold riskier tranches of the public fiscal capacity the government first allocates fiscal capacity to meet liquidity demands at

home and after that allocates the residual riskier fiscal capacity to those investors willing to hold it. Finally it has also highlighted the complementarities between financial innovation and financial integration showing that the benefits of financial innovation are higher when sovereign debt markets are more integrated.

The model presented in this paper has delivered comparative statics consistent with sizeable shifts public debt ownership as a whole that has been reported extensively in the recent years as well as shifts of relatively riskier debt instruments to foreigners. Moreover, data on sovereign debt ownership and local currency public debt ownership for a group of emerging economies points at the important relationship between sovereign debt investor base composition and tightness of collateral constraints in domestic markets.

The framework and results presented in this paper point to a number of promising avenues for future research. Looking at investor base composition and debt ownership at a smaller level of granularity regarding debt instruments and different types of investors. For instance, thinking about shifts of ownership between financial and non-financial types of investors or with different degrees of risk appetite. Introducing lack of commitment and allowing the government to default on its public debt can introduce relevant trade-offs in the planner's financial innovation problem which have been ignored in this paper.

References

Aghion, P., Bacchetta, P., Banerjee, A., 2001. Currency crises and monetary policy in an economy with credit constraints. European Economic Review 45 (7), 1121–1150.

Aiyagari, S. R., McGrattan, E., 1998. The optimum quantity of debt. Journal of Montary Economics 42, 44–69.

Alfaro, L., Kalemli-Ozcan, S., Volosovych, V., 2008. Why doesn't capital flow from rich to poor countries? An empirical investigation. Review of Economics and Statistics 90, 347–368.

Allen, F., Gale, D., 1994. Financial Innovation and Risk Sharing. MIT Press.

Angeletos, G.-M., August 2002. Fiscal policy with non-contingent debt and the optimal maturity structure. Quarterly Journal of Economics 117, 1105–1130.

Angeletos, G.-M., Collard, F., Dellas, H., Diba, B., 2012. Optimal public debt management and liquidity provision. mimeo.

Arellano, C., Kocherlakota, N., 2012. Internal debt crisis and sovereign defaults. Federal Reserve Bank of Minneapolis Research Department Staff Report.

Arslanalp, S., Tsuda, T., 2012. Tracking global demand for advanced economy sovereign debt. International Monetary Fund Working Paper (12/284).

Arslanalp, S., Tsuda, T., 2014. Tracking global demand for emerging market sovereign debt. International Monetary Fund Working Paper (14/39).

Balteanu, I., Erce, A., May 2012. Bank crises and sovereign defaults: Exploring the links. mimeo.

Baskaran, T., Bigsten, A., 2013. Fiscal capacity and the quality of government in sub-saharan africa. World Development 45, 92–107.

Beck, T., Demirguc-Kunt, A., Levine, R., May 2009. Financial institutions and markets across countries and over time: Data and analysis. World Bank Policy Research Working Paper 4943.

Borensztein, E., Chamon, M., Jeanne, O., Mauro, P., Zettelmeyer, J., 2004. Sovereign debt structure for crisis prevention. International Monetary Fund Occasional Paper (237).

Borensztein, E., Panizza, U., 2008. The costs of sovereign default. IMF Working Paper 08/238.

Broner, F., Erce, A., Martin, A., Ventura, J., 2014. Sovereign debt markets in turbulent times: Creditor discrimination and crowding-out effects. Journal of Monetary Economics 61, 114–142.

Broner, F., Martin, A., Ventura, J., September 2010. Sovereign risk and secondary markets. American Economic Review 100, 1523–1555.

Brunnermeier, M. K., Garicano, L., Lane, P. R., Reis, R., Santos, T., Thesmar, D., Nieuwerburgh, S. V., Vayanos, D., September 2011. European safe bonds (ESBies). mimeo.

Brutti, F., Saure, P., May 2013. Repatriation of debt in the euro crisis: evidence for the secondary markets theory.

Buera, F., Nicolini, P., April 2004. Optimal maturity of government debt without state contingent bonds. Journal of Monetary Economics 51, 531–554.

Caballero, R., November 2002. Coping with Chile's external vulnerability: a financial problem. mimeo.

Caballero, R., May 2003. The future of the imf. The American Economic Review. Papers and Proceedings of the One Hundred Fifteenth Annual Meeting of the American Economic Association 93 (2), 31–38.

Caballero, R., Farhi, E., 2013. A model of the safe asset mechanism (SAM): safety traps and economic policy. working paper.

Caballero, R., Krishnamurthy, A., December 2001. International and domestic collateral constraints in a model of emerging market crises. Journal of Monetary Economics 48 (3), 512–548.

Caballero, R., Krishnamurthy, A., November 2004. Smoothing sudden stops. Journal of Economic Theory 119 (1), 104–127.

Caballero, R., Krishnamurthy, A., 2009. Global imbalances and financial fragility. American Economic Review Papers and Proceedings 99 (2), 584–588.

Chinn, M., Ito, H., September 2008. A new measure of financial openness. Journal of Comparative Policy Analysis 10 (3), 309–322.

Comelli, F., August 2012. Emerging market sovereign bond spreads: Estimation and backtesting. IMF Working Paper No. 12/212.

Cruces, J. J., Trebesch, C., 2013. Sovereign defaults: The price of haircuts. American Economic Journal:Macroeconomics 5 (3), 85–117.

Debortoli, D., Nunes, R., Yared, P., June 2014. Optimal government debt maturity under limited commitment. mimeo.

Dincecco, M., Prado, M., 2012. Warfare, fiscal capacity, and performance. Journal of Economic Growth 17, 171–203.

Du, W., Schreger, J., July 2013. Local currency sovereign risk. Harvard University mimeo.

Erce, A., September 2012. Selective sovereign defaults. Federal Reserve Bank of Dallas Working Paper no. 127.

Gale, D., 1990. The Efficient Design of Public Debt. Vol. Public Debt Management: Theory and History.

Gennaioli, N., Martin, A., Rossi, S., July 2014a. Bank, government bonds, and default: What do the data say? IMF Working Paper No. 14/120.

Gennaioli, N., Martin, A., Rossi, S., April 2014b. Sovereign default, domestic banks and financial institutions. Journal of Finance 69, 819–866.

Gourinchas, P.-O., Jeanne, O., June 2012. Global safe assets. BIS Working Paper no. 399.

Guerrieri, V., Lorenzoni, G., 2009. Liquidity and trading dynamics. Econometrica 77, 1571–1790.

Hatchondo, J. C., Martinez, L., 2012. On the benefits of GDP-indexed government debt: Lessons from a model of sovereign defaults. Economic Quarterly 98 (2), 139–157.

Holmstrom, B., Tirole, J., February 1998. Private and public supply of liquidity. The Journal of Political Economy 106 (1), 1–40.

Holmstrom, B., Tirole, J., 2011. Inside and Outside Liquidity. MIT Press.

IMF, April 2012. Safe assets: Financial system cornerstone? Global Financial Stability Report.

Korinek, A., August 2011. The new economics of prudential capital controls. IMF Economic Review 59 (3), 523–561.

Krishnamurthy, A., Vissing-Jorgensen, A., 2012. The aggregate demand for treasury debt. Journal of Political Economy 120 (2), 233–267.

Levy-Yeyati, E., Williams, T., 2010. Us rates and emerging markets spreads. Universidad Torcuato di Tella, Business School Working Paper 02/2010.

Merler, S., Pisani-Ferry, J., February 2012. Who's afraid of sovereign bonds? Bruegel Policy Contribution 2012|02.

Peiris, S., 2010. Foreign participation in emerging markets' local currency bond markets. IMF Working Paper 10/88.

Reinhart, C., Rogoff, K., 2009. This Time is Different. Eight Centuries of Financial Folly. Princeton University Press.

Sandleris, G., Sapriza, H., Taddei, F., November 2011. Indexed sovereign debt: An applied framework. Collegio Carlo Alberto Working Paper No. 104.

Schumacher, J., Trebesch, C., Enderlein, H., June 2013. Sovereign defaults in court: The rise of creditor litigation. Mimeo.

Shiller, R. J., 1993. Macro Markets: Creating Institutions for Managing Society's Largest Economic Risks. Clarendon Press.

Shiller, R. J., 2003. The New Financial Order: Risk in the 21st Century. Princeton University Press.

Sosa-Padilla, C., February 2011. Sovereign defaults and banking crises. University of Maryland mimeo.

Woodford, M., 1990. Public debt as private liquidity. American Economic Review Papers and Proceedings 80 (2), 382–388.

A Financial Innovation in Sovereign Borrowing for Advanced Economies

Country	Different Maturities	Indexed to Inflation	Variable rate/ coupon	Different Currencies
Australia	✓	✓		
Austria	✓			
Belgium	✓		✓	
Canada	✓		✓	✓[1]
Czech Republic	✓			
Denmark	✓	✓		✓[2]
Finland	✓			✓[3]
France	✓	✓[4]	✓	
Germany	✓	✓		
Greece	✓			
Ireland	✓			
Italy	✓	✓[5]	✓	
Japan	✓	✓	✓	
Korea	✓	✓		✓[6]
Netherlands	✓			✓[7]
New Zealand[8]	✓	✓		
Portugal	✓			
Slovenia	✓			✓[9]
Spain	✓	✓[10]		
Switzerland	✓			
United Kingdom	✓	✓		
United States	✓	✓	✓	

Source: Debt Management Offices of each country

[1,3,6,7,9]Foreign currency: US dollars. [2]Foreign currency: euro. [4] Indexed to European and French Inflation. [5] Indexed to European and Italian Inflation. [8]Other: kiwi bond (retail stock).

[10]It started issuing them in June 2014, after the first version of this paper was out.

B Equilibrium characterization

First, we consider the case where $\underline{\eta} > \frac{(s_H-\rho)(A-(1-\lambda)\bar{\eta})}{1-(\rho-s_L)(1-\lambda)+\beta^*\lambda(s_H-\rho)}$ and $\beta^* > 1 + \frac{\lambda(1+s_L(1-\lambda)-s_H)\underline{\eta}}{(s_H-\rho)(1-\lambda)\Pi}$. When β^* is higher than this upper bound it is too expensive for the entrepreneur to hoard liquidity. Thus $z^L = 0$ and the project cannot continue when $s = s_H$, $\chi = 0$. The initial investment level is then given by

$$I = \frac{A}{1-(\rho-s_L)(1-\lambda)}$$

All public debt is held by foreigners, z^F and their valuation pins down the price of public debt $q = \beta^*\Pi$. As long as $\underline{\eta} > \frac{(s_H-\rho)(A-(1-\lambda)\bar{\eta})}{1-(\rho-s_L)(1-\lambda)+\beta^*\lambda(s_H-\rho)}$ international investors hold part of the public debt and $q = \beta^*\Pi$. In the knife-edge case where $\beta^* = 1 + \frac{\lambda(1+s_L(1-\lambda)-s_H)\underline{\eta}}{(s_H-\rho)(1-\lambda)\Pi}$, the continuation scale $\chi \in (0,1)$ and investment scale equals:

$$I = \frac{A}{1-(\rho-s_L)(1-\lambda)-\chi\lambda(\rho-s_H)+\chi(s_H-\rho)(\beta^*-1)(\lambda+(1-\lambda)\frac{\bar{\eta}}{\underline{\eta}})}$$

The domestic holdings of the public asset equal $z^L = \frac{\chi A(s_H-\rho)}{\underline{\eta}\left[1-(\rho-s_L)(1-\lambda)-\chi\lambda(\rho-s_H)+\chi(s_H-\rho)(\beta^*-1)(\lambda+(1-\lambda)\frac{\bar{\eta}}{\underline{\eta}})\right]}$ and international investors hold the rest $z^F = 1 - z^L$.

The last case to consider is the one where the return of the bond in $s = s_H$ is not big enough, that is when $\underline{\eta} \leq \frac{(s_H-\rho)(A-(1-\lambda)\bar{\eta})}{1-(\rho-s_L)(1-\lambda)+\beta^*\lambda(s_H-\rho)}$. Under this parametric condition if also the following condition on A holds

$$\frac{\underline{\eta}(1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H))}{s_H-\rho} < A < \frac{\underline{\eta}(1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H))}{s_H-\rho} + \frac{\underline{\eta}\lambda(1+s_L(1-\lambda)-s_H)}{(1-\lambda)(s_H-\rho)} \tag{49}$$

then the project is fully continued $\chi = 1$, $z^L = 1$ and $z^F = 0$.

The demand for bonds is given by $z^L = \frac{I(s_H-\rho)}{\underline{\eta}}$. Combining this expression with (3) and equating it to total supply of bonds we can solve the price of the bond in this equilibrium:

$$q = \Pi + A - \frac{\underline{\eta}(1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H))}{s_H-\rho} \tag{50}$$

The constraints on A given in (49) ensures that the price of the public bond (50) satisfies $\Pi < q < q^{max}$ where $q^{max} = \Pi + \frac{\lambda(1+s_L(1-\lambda)-s_H)\underline{\eta}}{(s_H-\rho)(1-\lambda)}$. Investment is given by:

$$I = \frac{\underline{\eta}}{s_H-\rho} \tag{51}$$

which as we see is increasing in $\underline{\eta}$ but not in the ratio of fiscal capacities as in the section 2. It is increasing in $\underline{\eta}$ because when $\underline{\eta}$ is low the entrepreneur is constrained and cannot hoard as much liquidity as she would want to. Therefore, the slacker this constraint is the higher attainable investment will be.

Proposition 8. *(a) An equilibrium in this model is given by a tuple (q, I, z^L, z^F), consisting on price of debt, initial investment scale and domestic and foreign holdings of the asset; (b) when $\underline{\eta} > \frac{(s_H-\rho)(A-(1-\lambda)\bar{\eta})}{1-(\rho-s_L)(1-\lambda)+\beta^*\lambda(s_H-\rho)}$ and $\beta^* < 1+\frac{\lambda(1+s_L(1-\lambda)-s_H)\underline{\eta}}{(s_H-\rho)(1-\lambda)\Pi}$, then the equilibrium is given by:*

$$\begin{aligned} q &= \beta^*\Pi \\ I &= \frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)+(s_H-\rho)(\beta^*-1)(\lambda+(1-\lambda)\frac{\bar{\eta}}{\underline{\eta}})} \\ z^L &= \frac{I(s_H-\rho)}{\underline{\eta}} \qquad z^F = 1-z^L \end{aligned}$$

(c) When $\underline{\eta} > \frac{(s_H-\rho)(A-(1-\lambda)\bar{\eta})}{1-(\rho-s_L)(1-\lambda)+\beta^*\lambda(s_H-\rho)}$ and $\beta^* = 1+\frac{\lambda(1+s_L(1-\lambda)-s_H)\underline{\eta}}{(s_H-\rho)(1-\lambda)\Pi}$, then the equilibria is given by for any $\chi \in (0,1)$

$$\begin{aligned} q &= \beta^*\Pi \\ I &= \frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda\chi(\rho-s_H)+\chi(s_H-\rho)(\beta^*-1)(\lambda+(1-\lambda)\frac{\bar{\eta}}{\underline{\eta}})} \\ z^L &= \frac{\chi I(s_H-\rho)}{\underline{\eta}} \qquad z^F = 1-z^L \end{aligned}$$

(d) When $\underline{\eta} > \frac{(s_H-\rho)(A-(1-\lambda)\bar{\eta})}{1-(\rho-s_L)(1-\lambda)+\beta^*\lambda(s_H-\rho)}$ and $\beta^* > 1+\frac{\lambda(1+s_L(1-\lambda)-s_H)\underline{\eta}}{(s_H-\rho)(1-\lambda)\Pi}$, then the equilibrium is characterized by:

$$\begin{aligned} q &= \beta^*\Pi \\ I &= \frac{A}{1-(\rho-s_L)(1-\lambda)} \\ z^L &= 0 \qquad z^F = 1 \end{aligned}$$

(e) When $\underline{\eta} \leq \frac{(s_H-\rho)(A-(1-\lambda)\bar{\eta})}{1-(\rho-s_L)(1-\lambda)+\beta^*\lambda(s_H-\rho)}$, then the equilibrium is as follows:

$$\begin{aligned} q &= \Pi + A - \frac{\underline{\eta}(1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H))}{s_H-\rho} \\ I &= \frac{\underline{\eta}}{s_H-\rho} \\ z^L &= 1 \qquad z^F = 0 \end{aligned}$$

C The Case of Capital Controls

As we have seen the equilibrium investment level with international investors given in (6) is decreasing in the international investor´s patience. A natural question is whether imposing capital controls which ban the arrival of international flows from abroad can increase welfare at home.

A first approximation to this question would be to calculate the consumption of both types of agents and compute domestic welfare as we discuss in section (3.2). Investment under open financial markets is given by (6). Under autarky since (4) holds the marginal buyer of the public bond is the domestic consumer which implies that the price of the bond has no liquidity premium, $q = \Pi$ and investment under autarky is simply given by $I = \frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)}$, since liquidity hoarding in autarky is costless. Thus, investment is higher under autarky. However consumers lose from remaining in autarky since they now do not get the premia coming from abroad, $q - \Pi$ which due to the higher patience abroad will always be greater than zero.

Now we allow for ex ante transfers between the entrepreneur and the consumer. The entrepreneur will transfer part of her initial wealth A to the consumer in order to make him indifferent between autarky and open financial markets. Then we will compute whether the final investment under autarky is higher than in open financial markets.

For convenience let´s denote by $\bar{R} \equiv R - s_L(1-\lambda) - s_H\lambda - 1$, the net return from the domestic investment and by $k \equiv 1 - (\rho - s_L)(1-\lambda) - (\rho - s_H)\lambda$. As in the comparative statics part we simplify notation by assuming $\bar{\eta} = 1$. Under open financial markets investment and the transfer to consumers from abroad are given by:

$$I^{Open} = \frac{A}{k + \frac{s_H-\rho}{\eta}(\beta^* - 1)(\lambda\eta + 1 - \lambda)} \tag{52}$$

$$T^{Open} = (\beta^* - 1)(\lambda\eta + 1 - \lambda)\left(1 - \frac{I^{Open}(s_H - \rho)}{\eta}\right) \tag{53}$$

For this to be an equilibrium (4) needs to hold, which we can rewrite in terms of the initial wealth A being below a threshold:

$$A < \frac{\eta k}{s_H - \rho} + (\beta^* - 1)(\lambda\eta + 1 - \lambda)$$

Therefore let assume that the entrepreneur transfers T^{Open} to consumers. After this transfer the consumer is indifferent between autarky and open financial markets. In autarky the

entrepreneur's investment choice after transfers is given by:

$$I^{Autarky,T} = \frac{\tilde{A}}{k} = \frac{A - T^{Open}}{k}$$

where the entrepreneur can leverage its initial wealth after transfers $\tilde{A} < A$ as much as $1/k$ since in the closed economy when (4) holds the consumer is the marginal holder of the asset who pins down the price. Thus, $q = \Pi$ and there is no cost of hoarding liquidity for the entrepreneur.

Proposition. *Under autarky the consumer is made worse-off, the entrepreneur is made better-off and total welfare is always smaller than under open financial markets. Open financial markets is also better than autarky when the entrepreneur makes a transfer to the consumer to make him indifferent between autarky and open financial markets.*

Proof. For the first part, we need to calculate total welfare $W = E+A+(R - s_L(1-\lambda) - s_H\lambda - 1)\, I+ (q - \Pi)z^F$ for both scenarios, open financial markets and autarky and show that $W^{Open} > W^{Autarky}$. Denote $\Pi = (\lambda\eta + 1 - \lambda)$.

Under open markets,

$$\begin{aligned} I^{Open} &= \frac{A}{k + \frac{s_H - \rho}{\eta}(\beta^* - 1)\Pi} \\ W^{Open} &= E + A + \bar{R}I^{Open} + (\beta^* - 1)\Pi\left(1 - \frac{I^{Open}(s_H - \rho)}{\eta}\right) \end{aligned}$$

where as we see W^{Open} welfare is comprised of the net return from investment and the financial flows from abroad. For this to be an equilibrium it must be that

$$\eta > \frac{(s_H - \rho)\,(A - (1-\lambda))}{1 - (\rho - s_L)(1-\lambda) + \beta^*\lambda(s_H - \rho)} \tag{54}$$

Investment and welfare in the autarkic economy is given by:

$$\begin{aligned} I^{Autarky} &= \frac{A}{k} \\ W^{Autarky} &= E + A + \bar{R}I^{Autarky} \end{aligned}$$

It follows directly from condition (54) that $I^{Autarky} > I^{Open}$. For $W^{Open} > W^{Autarky}$ it must be the case that

$$\bar{R}(I^{Autarky} - I^{Open}) < (\beta^* - 1)\Pi \left(1 - \frac{I^{Open}(s_H - \rho)}{\eta}\right) \tag{55}$$

Rearranging (55) we see that it always holds when $I^{Autarky} > I^{Open}$, that is when(54) holds. For the second part of the proposition we need to prove that $I^{Open} - I^{Autarky,T} > 0$. Substituting investment for their expressions we obtain that $\frac{A}{k + \frac{s_H - \rho}{\eta}(\beta^* - 1)\Pi} - \frac{\tilde{A}}{k} > 0$. Rearranging this expression and substituting $\tilde{A} = A - T^{Open}$ we obtain $(\beta^* - 1)\Pi \left(\frac{\eta - I^{Open}}{\eta}\right) \eta k > -k(s_H - \rho)(\beta^* - 1)\Pi$. Cancelling out terms this expression becomes $\eta + s_H - \rho > I^{Open}$. Using the expression for I^{Open} this is equivalent to $\frac{A}{\left(\eta k + \frac{s_H - \rho}{\eta}(\beta^* - 1)\Pi\right)(\eta + s_H - \rho)} < 1$ which can be rewritten as

$$A < \eta k + k(s_H - \rho) + (s_H - \rho)(\beta^* - 1)\Pi + \frac{(s_H - \rho)^2(\beta^* - 1)\Pi}{\eta}$$

This condition on A always holds when $A < \frac{\eta k}{s_H - \rho} + (\beta^* - 1)\Pi$, which is the initial condition for an equilibrium given in section (C). □

Capital controls which ban foreign investors from buying the public asset do not increase welfare in this model because there are no pecuniary externalities. A crucial ingredient for capital controls to be welfare-improving is that a relative price affects constrained individuals, either directly by tightening collateral constraints or by decreasing wealth of constrained individuals (Caballero and Krishnamurthy (2001), Caballero and Krishnamurthy (2004), Aghion et al. (2001), Korinek (2011)).

From the entrepreneur's problem (1) we see that this is not the case here. The price of the public debt affects the investment choice level I and in turn how much of the public bond available the entrepreneur demands but it does not affect how constrained the entrepreneur is directly nor by changing the entrepreneur's net worth.

D Autarkic equilibria: Sovereign Debt Markets Closed to Foreign Investors

In this section we derive the solution of the model in autarky. We start by analyzing the case when (4) holds: $\underline{\eta} > \frac{(s_H-\rho)(A-(1-\lambda)\bar{\eta})}{1-(\rho-s_L)(1-\lambda)+\beta^*\lambda(s_H-\rho)}$. In that case we know z^L coming from domestic entrepreneurs is lower than total supply of public bond. With integrated sovereign debt markets part of the bond would be held by foreign investors.

With sovereign debt markets only open to domestic agents, it will be consumers who will demand the public bond. Since they do not have a liquidity motive to hold debt and their discount factor $\beta = 1$ in equilibrium:

$$q^{Aut,I} = \Pi$$

When $q = \Pi$ the entrepreneur is indifferent between holding as much bonds as to cover liquidity needs and infinite: $z^L \in [\frac{I\chi(s_H-\rho)}{\underline{\eta}}, \infty)$. We assume that the entrepreneur just holds enough to cover liquidity needs. Since $q < q^{max}$ defined in appendix B, full continuation is optimal in both states $\chi = 1$ and liquidity needs are given by $\frac{I(s_H-\rho)}{\underline{\eta}}$. Plugging this and the price in the expression for investment (3) we obtain that the equilibrium level of investment is:

$$I^{Aut,I} = \frac{A}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)}$$

Therefore the level of investment is increasing in the level of entrepreneur's initial wealth and in the equity multiplier $\frac{1}{1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H)}$ which defines the maximum leverage per unit of own capital that the entrepreneur can obtain. As in section 2 it is decreasing in the expected cost of the project and increasing in the pledgeable return ρ.

However, under autarky when $\underline{\eta}$ is large enough, investment does not depend on the cost of liquidity hoarding. This is due to the fact that when $\underline{\eta}$ is large enough the marginal holder of the public bond is the domestic consumer who drives the liquidity premium to zero.

We now turn to the case when $\underline{\eta} \leq \frac{(s_H-\rho)(A-(1-\lambda)\bar{\eta})}{1-(\rho-s_L)(1-\lambda)+\beta^*\lambda(s_H-\rho)}$. In this case only the domestic entrepreneur will hold the bond. The analysis here will be identical to the case with integrated debt markets but $\underline{\eta}$ low derived in Appendix B. There we found that the price of the bond is given by:

$$q^{Aut,II} = \Pi + A - \frac{\underline{\eta}(1-(\rho-s_L)(1-\lambda)-\lambda(\rho-s_H))}{s_H-\rho}$$

and that the level of equilibrium investment is increasing in $\underline{\eta}$:

$$I^{Aut,II} = \frac{\underline{\eta}}{s_H-\rho}$$

E Financial Innovation under Positive Correlation

This appendix presents the optimal financial innovation under the following assumption:

Assumption. *3' The fiscal capacity shock and the private liquidity shock are positively correlated.*

which substitutes Assumption 3 in section 2.

According to this new assumption there are four states of the world, $s = \{HL,\ HH,\ LL,\ LH\}$ with probabilities denoted as $\{\lambda_{HL},\ \lambda_{HH},\ \lambda_{LL},\ \lambda_{LH}\}$. The first letter of each state denotes the government's fiscal capacity and the second denotes the liquidity shock. Thus, state HL corresponds to the state where the government's fiscal capacity is high and the private sector does not need outside liquidity because the liquidity shock is small s_L, and so on. To span all the states of the world the government will issue four assets.

E.1 Financial Innovation without Monotonicity Constraints

As we saw in section 3.3 the optimal innovation is to issue Arrow-Debreu securities. These securities must satisfy the fiscal capacity constraints. Labeling the assets from 1 to 4, this implies that:

$$\begin{aligned}
\sum_{j=1}^{4} x_{HL}^{j} &\leq 1 \\
\sum_{j=1}^{4} x_{HH}^{j} &\leq 1 \\
\sum_{j=1}^{4} x_{LL}^{j} &\leq \eta \\
\sum_{j=1}^{4} x_{LH}^{j} &\leq \eta
\end{aligned}$$

The assets will have the following payoffs: $(1,0,0,0)$, $(0,1,0,0)$, $(0,0,\eta,0)$ and finally $(0,0,0,\eta)$. The investor base composition of assets 1 and 3 will be only international investors for the same rationale as the main body of the paper: entrepreneurs do not want to purchase an asset which gives a return when the liquidity shock is small, s_L and prices are $q_1 = \beta^* \lambda_{HL}$ and $q_3 = \beta^* \lambda_{LL}$. The other two assets will be held by domestics and internationals and prices will be pinned down by international investors' valuations: $q_2 = \beta^* \lambda_{HH}$ and $q_4 = \beta^* \lambda_{LH}$.

E.2 Financial Innovation under Monotonicity Constraints

Under imperfect correlation, monotonicity implies that each asset pays more when the government's fiscal capacity is high. As in the main body of the paper the rationale for this is that the state with lower fiscal capacity corresponds observationally to a sovereign debt restructuring. This implies that:

$$\begin{aligned} x^j_{HL} &\geq x^j_{LL} \\ x^j_{HH} &\geq x^j_{LH} \\ x^j_{HL} &\geq x^j_{LH} \\ x^j_{HH} &\geq x^j_{LL} \end{aligned}$$

where j denotes the asset. The optimal asset combination is a safe asset and two Arrow-Debreu securities that satisfy the fiscal capacity constraints above: $(1-\eta, 0, 0, 0)$, $(0, 1-\eta, 0, 0)$ and (η, η, η, η). The investor base for the risky assets will only be international investors who will price the assets at $q_1 = \beta^* \lambda_{HL}(1-\eta)$ and $q_2 = \beta^* \lambda_{HH}(1-\eta)$. The safe asset will be held by both types of investors and its price will be $q_3 = \beta^* \eta$.

F Appendix to the Empirical Analysis

F.1 Data Sources, Definitions, and Sample

Variable	Description	Source	Range	Frequency
Nonres	Public debt held by non-residents over total outstanding debt (in %)	Arslanalp and Tsuda (2014)	2004-2010	Quarterly
Nonres LC	Public local currency debt held by non-residents over total outstanding local currency debt (in %)	Arslanalp and Tsuda (2014)	2004-2010	Quarterly
Local Credit	Private credit by deposit money banks other institutions over GDP (in %)	Beck et al. (2009)	2004-2010	Yearly
Capital to Assets	Bank capital to bank assets ratio (in %)	WB Indicators	2004-2010	Yearly
Fiscal Capacity	Tax revenues over GDP (in %)	WB Indicators	2004-2010	Yearly
Fiscal Capacity 2	Direct tax revenues on income, profits, and capital gains as a % of government revenues	WB Indicators	2004-2010	Yearly
Fiscal Capacity 3	Direct tax revenues on income, profits, and capital gains as a % of total tax revenues	WB Indicators	2004-2010	Yearly
Sovereign spread	EMBI sovereign debt spread. With respect to US with similar maturity.	JP Morgan	2004-2010	Quarterly
Financial Openness	Chinn-Ito Index	Chinn and Ito (2008)	2004-2010	Yearly
Political Risk	Political Risk Index (International Country Risk Guide)	Cruces and Trebesch (2013)	2004-2010	Quarterly

Data Sources, Definitions, and Sample (*continued*)

Variable	Description	Source	Range	Frequency
CPI Inflation	Consumer price inflation (yoy in %)	WB Indicators	2004-2010	Yearly
Nominal exchange rate	Official exchange rate (LCU per US $, period average)	WB Indicators	2004-2010	Yearly
GDP Real Growth	GDP real growth (yoy in %)	WB Indicators	2004-2010	Yearly
Total Debt GDP	Share of total public debt over GDP (in %)	Arslanalp and Tsuda (2014) and WB Indicators	2004-2010	Yearly
LC Debt	Share of local currency public debt over total public debt (in %)	Arslanalp and Tsuda (2014)	2004-2010	Quarterly
Rating Residual	Residual from regression of ratings on fundamentals and credit history	Cruces and Trebesch (2013)	2004-2010	Quarterly
Fed Funds	Effective federal funds rate	Federal Reserve Bank of St. Louis	2004-2010	Quarterly
* WB Indicators are World Bank Indicators				

Groups of countries	List of countries
Asia	China, Indonesia, Malaysia, Philippines, Thailand
Latin America	Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay
EMEA-EU	Bulgaria, Hungary, Lithuania, Poland
EMEA-Non EU	Egypt, Russia, South Africa, Turkey, Ukraine

F.2 *De facto* Exchange Rate Regimes for Countries in Sample 2004-2010

Country	2004	2005	2006	2007	2008	2009	2010
Argentina	2	2	2	2	2	2	2
Bulgaria	1	1	1	1	1	1	1
Brazil	3	3	3	3	3	3	3
Chile	3	3	3	3	3	3	3
China	1	1	1	1	2	2	2
Colombia	3	2	2	2	2	2	2
Egypt	2	2	2	2	2	2	2
Hungary	1	1	1	1	3	3	3
Indonesia	2	2	2	2	2	2	2
Lithuania	1	1	1	1	1	1	1
Mexico	3	3	3	3	3	3	3
Malaysia	1	1	2	2	2	2	2
Peru	2	2	2	2	2	2	2
Philippines	3	3	3	3	3	3	3
Poland	3	3	3	3	3	3	3
Russia	2	2	2	2	2	2	2
Thailand	2	2	2	2	2	2	2
Turkey	3	3	3	3	3	3	3
Ukraine	1	1	1	1	2	2	2
Uruguay	3	3	2	2	2	2	2
South Africa	3	3	3	3	3	3	3

Source: IMF Exchange Rate classification in yearly reports

1 = denotes hard peg (exchange arrangement with no separate legal tender or currency board arrangement), 2 = denotes soft peg (conventional peg agreement, stabilized arrangement, crawling peg, pegged arrangement within horizontal bands), 3 = denotes free floating

F.3 Share of Total Sovereign Debt held Abroad

	(1) nonres	(2) nonres	(3) nonres	(4) nonres	(5) nonres	(6) nonres
Capital to Assets		-1.365*	-1.399*	-1.442**	-1.004	-0.961
		(0.828)	(0.713)	(0.711)		
Local Credit	-0.0981					
	(0.108)					
Tax Revenues/GDP	0.585	0.978*				
	(0.509)	(0.594)				
Direct Taxes/Revenues			0.356			
			(0.293)			
Direct Taxes/Tax Revenues				0.294		
				(0.269)		
Sovereign Spread					-0.00289	-0.00272*
					(0.00233)	(0.00163)
Federal Funds Rate						0.203
						(0.225)
Openness	-1.240	0.0284	-0.106	0.0224	1.198	0.775
	(1.146)	(1.119)	(1.621)	(1.569)	(2.156)	(1.894)
Political stability	0.379	0.376	0.491**	0.500	0.0143	0.202
	(0.269)	(0.247)	(0.246)	(0.336)	(0.345)	(0.249)
GDP Real Growth	0.423	0.157	0.153	0.121	0.216	0.178
	(0.296)	(0.283)	(0.284)	(0.295)	(0.274)	(0.124)
CPI Inflation	0.266	-0.0461	-0.000873	0.0514	-0.0908	-0.224**
	(0.269)	(0.213)	(0.284)	(0.233)	(0.225)	(0.111)
Rating Residual	0.249	-1.195	-1.450	-1.626	-1.597**	-1.990**
	(1.078)	(0.935)	(1.109)	(1.210)	(0.785)	(0.895)
Debt/GDP	0.208	0.240	0.279	0.274	0.199	0.255*
	(0.182)	(0.183)	(0.191)	(0.180)	(0.165)	(0.142)
Nominal Exchange Rate	0.00768	0.00904	0.00698	0.00758	0.00630	0.00632
	(0.1000)	(0.0812)	(0.109)	(0.0256)	(0.107)	(0.101)
Time FE	Yes	Yes	Yes	Yes	Yes	No
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	408	456	456	456	501	501
No. Countries	20	20	20	20	20	20
r2	0.394	0.378	0.381	0.387	0.336	0.269

Standard errors in parentheses clustered at country level using bootstrap
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

F.4 Share of Local Currency Public Debt held Abroad

	(1) nonres_LC	(2) nonres_LC	(3) nonres_LC	(4) nonres_LC	(5) nonres_LC	(6) nonres_LC
Capital to Assets		-0.805				
		(1.298)				
Local Credit	-0.331***		-0.335**	-0.325***	-0.237**	-0.200***
	(0.0996)		(0.135)	(0.124)	(0.0975)	(0.0736)
Tax Revenues/GDP	-0.911	-1.732**				
	(1.008)	(0.750)				
Direct Tax/Revenues			0.234			
			(0.272)			
Direct Taxes/Tax Revenues				0.200		
				(0.418)		
Sovereign Spread					0.00281	0.00280
					(0.00533)	(0.00475)
Federal Funds Rate						0.376
						(0.502)
Openness	-0.343	-0.406	-0.0802	0.0491	2.624	2.080
	(2.184)	(1.718)	(1.157)	(1.507)	(2.301)	(2.187)
Political Stability	0.271	0.143	0.395	0.388	0.105	-0.314
	(0.335)	(0.406)	(0.376)	(0.359)	(0.343)	(0.390)
GDP Real Growth	0.265	0.531*	0.180	0.201	0.464*	0.392
	(0.325)	(0.287)	(0.238)	(0.370)	(0.252)	(0.297)
CPI Inflation	-0.773*	-0.602	-0.739*	-0.719**	-0.328	-0.337**
	(0.466)	(0.497)	(0.397)	(0.340)	(0.308)	(0.162)
Rating Residual	1.183	0.215	1.130	1.032	1.391	2.543***
	(1.528)	(1.818)	(1.474)	(1.547)	(1.122)	(0.974)
LC Debt/Total Debt	-0.106	-0.0794	-0.0878	-0.0814	-0.0950	0.0674
	(0.220)	(0.169)	(0.154)	(0.236)	(0.184)	(0.119)
Nominal Exchange Rate	-0.00355	0.000118	-0.00491	-0.00450	-0.00145	-0.00227
	(0.291)	(0.317)	(0.109)	(0.295)	(0.0994)	(0.0785)
Time FE	Yes	Yes	Yes	Yes	Yes	No
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
No. Obs.	339	363	339	339	368	368
No. Countries	18	18	18	18	18	18
R-Squared	0.467	0.327	0.461	0.463	0.342	0.219

Standard errors in parentheses clustered at country level using bootstrap
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

BANCO DE ESPAÑA PUBLICATIONS

WORKING PAPERS

1301 JAMES COSTAIN and ANTON NAKOV: Logit price dynamics.
1302 MIGUEL GARCÍA-POSADA: Insolvency institutions and efficiency: the Spanish case.
1303 MIGUEL GARCÍA-POSADA and JUAN S. MORA-SANGUINETTI: Firm size and judicial efficacy: evidence for the new civil procedures in Spain.
1304 MAXIMO CAMACHO and GABRIEL PEREZ-QUIROS: Commodity prices and the business cycle in Latin America: living and dying by commodities?
1305 CARLOS PÉREZ MONTES: Estimation of regulatory credit risk models.
1306 FERNANDO LÓPEZ VICENTE: The effect of foreclosure regulation: evidence for the US mortgage market at state level.
1307 ENRIQUE MORAL-BENITO and LUIS SERVEN: Testing weak exogeneity in cointegrated panels.
1308 EMMA BERENGUER, RICARDO GIMENO and JUAN M. NAVE: Term structure estimation, liquidity-induced heteroskedasticity and the price of liquidity risk.
1309 PABLO HERNÁNDEZ DE COS and ENRIQUE MORAL-BENITO: Fiscal multipliers in turbulent times: the case of Spain.
1310 SAMUEL HURTADO: DSGE models and the Lucas critique.
1311 HENRIQUE S. BASSO and JAMES COSTAIN: Fiscal delegation in a monetary union with decentralized public spending.
1312 MAITE BLÁZQUEZ CUESTA and SANTIAGO BUDRÍA: Does income deprivation affect people's mental well-being?
1313 ENRIQUE ALBEROLA, ÁNGEL ESTRADA and DANIEL SANTABÁRBARA: Growth beyond imbalances. Sustainable growth rates and output gap reassessment.
1314 CARMEN BROTO and GABRIEL PEREZ-QUIROS: Disentangling contagion among sovereign CDS spreads during the European debt crisis.
1315 MIGUEL GARCÍA-POSADA and JUAN S. MORA-SANGUINETTI: Are there alternatives to bankruptcy? A study of small business distress in Spain.
1316 ROBERTO RAMOS and ENRIQUE MORAL-BENITO: Agglomeration matters for trade.
1317 LAURA HOSPIDO and GEMA ZAMARRO: Retirement patterns of couples in Europe.
1318 MAXIMO CAMACHO, GABRIEL PEREZ-QUIROS and PILAR PONCELA: Short-term forecasting for empirical economists. A survey of the recently proposed algorithms.
1319 CARLOS PÉREZ MONTES: The impact of interbank and public debt markets on the competition for bank deposits.
1320 OLYMPIA BOVER, JOSE MARIA CASADO, SONIA COSTA, PHILIP DU CAJU, YVONNE MCCARTHY, EVA SIERMINSKA, PANAGIOTA TZAMOURANI, ERNESTO VILLANUEVA and TIBOR ZAVADIL: The distribution of debt across euro area countries: the role of Individual characteristics, institutions and credit conditions.
1321 BRINDUSA ANGHEL, SARA DE LA RICA and AITOR LACUESTA: Employment polarisation in Spain over the course of the 1997-2012 cycle.
1322 RODOLFO G. CAMPOS and ILIANA REGGIO: Measurement error in imputation procedures.
1323 PABLO BURRIEL and MARÍA ISABEL GARCÍA-BELMONTE: Meeting our D€STINY. A Disaggregated €uro area Short Term Indicator model to forecast GDP (Y) growth.
1401 TERESA SASTRE and FRANCESCA VIANI: Countries' safety and competitiveness, and the estimation of current account misalignments.
1402 FERNANDO BRONER, ALBERTO MARTIN, AITOR ERCE and JAUME VENTURA: Sovereign debt markets in turbulent times: creditor discrimination and crowding-out effects.
1403 JAVIER J. PÉREZ and ROCÍO PRIETO: The structure of sub-national public debt: liquidity vs credit risks.
1404 BING XU, ADRIAN VAN RIXTEL and MICHIEL VAN LEUVENSTEIJN: Measuring bank competition in China: a comparison of new versus conventional approaches applied to loan markets.
1405 MIGUEL GARCÍA-POSADA and JUAN S. MORA-SANGUINETTI: Entrepreneurship and enforcement institutions: disaggregated evidence for Spain.
1406 MARIYA HAKE, FERNANDO LÓPEZ-VICENTE and LUIS MOLINA: Do the drivers of loan dollarisation differ between CESEE and Latin America? A meta-analysis.
1407 JOSÉ MANUEL MONTERO and ALBERTO URTASUN: Price-cost mark-ups in the Spanish economy: a microeconomic perspective.
1408 FRANCISCO DE CASTRO, FRANCISCO MARTÍ, ANTONIO MONTESINOS, JAVIER J. PÉREZ and A. JESÚS SÁNCHEZ-FUENTES: Fiscal policies in Spain: main stylised facts revisited.

1409 MARÍA J. NIETO: Third-country relations in the Directive establishing a framework for the recovery and resolution of credit institutions.
1410 ÓSCAR ARCE and SERGIO MAYORDOMO: Short-sale constraints and financial stability: evidence from the Spanish market.
1411 RODOLFO G. CAMPOS and ILIANA REGGIO: Consumption in the shadow of unemployment.
1412 PAUL EHLING and DAVID HAUSHALTER: When does cash matter? Evidence for private firms.
1413 PAUL EHLING and CHRISTIAN HEYERDAHL-LARSEN: Correlations.
1414 IRINA BALTEANU and AITOR ERCE: Banking crises and sovereign defaults in emerging markets: exploring the links.
1415 ÁNGEL ESTRADA, DANIEL GARROTE, EVA VALDEOLIVAS and JAVIER VALLÉS: Household debt and uncertainty: private consumption after the Great Recession.
1416 DIEGO J. PEDREGAL, JAVIER J. PÉREZ and A. JESÚS SÁNCHEZ-FUENTES: A toolkit to strengthen government budget surveillance.
1417 J. IGNACIO CONDE-RUIZ, and CLARA I. GONZÁLEZ: From Bismarck to Beveridge: the other pension reform in Spain.
1418 PABLO HERNÁNDEZ DE COS, GERRIT B. KOESTER, ENRIQUE MORAL-BENITO and CHRISTIANE NICKEL: Signalling fiscal stress in the euro area: a country-specific early warning system.
1419 MIGUEL ALMUNIA and DAVID LÓPEZ-RODRÍGUEZ: Heterogeneous responses to effective tax enforcement: evidence from Spanish firms.
1420 ALFONSO R. SÁNCHEZ: The automatic adjustment of pension expenditures in Spain: an evaluation of the 2013 pension reform.
1421 JAVIER ANDRÉS, ÓSCAR ARCE and CARLOS THOMAS: Structural reforms in a debt overhang.
1422 LAURA HOSPIDO and ENRIQUE MORAL-BENITO: The public sector wage premium in Spain: evidence from longitudinal administrative data.
1423 MARÍA DOLORES GADEA-RIVAS, ANA GÓMEZ-LOSCOS and GABRIEL PÉREZ-QUIRÓS: The Two Greatest. Great Recession vs. Great Moderation.
1424 ENRIQUE MORAL-BENITO and OLIVER ROEHN: The impact of financial (de)regulation on current account balances.
1425 MAXIMO CAMACHO and JAIME MARTINEZ-MARTIN: Real-time forecasting US GDP from small-scale factor models.
1426 ALFREDO MARTÍN OLIVER, SONIA RUANO PARDO and VICENTE SALAS FUMÁS: Productivity and welfare: an application to the Spanish banking industry.
1427 JAVIER ANDRÉS and PABLO BURRIEL: Inflation dynamics in a model with firm entry and (some) heterogeneity.
1428 CARMEN BROTO and LUIS MOLINA: Sovereign ratings and their asymmetric response to fundamentals.
1429 JUAN ÁNGEL GARCÍA and RICARDO GIMENO: Flight-to-liquidity flows in the euro area sovereign debt crisis.
1430 ANDRÈ LEMELIN, FERNANDO RUBIERA-MOROLLÓN and ANA GÓMEZ-LOSCOS: Measuring urban agglomeration. A refoundation of the mean city-population size index.
1431 LUIS DÍEZ-CATALÁN and ERNESTO VILLANUEVA: Contract staggering and unemployment during the Great Recession: evidence from Spain.
1501 LAURA HOSPIDO and EVA MORENO-GALBIS: The Spanish productivity puzzle in the Great Recession.
1502 LAURA HOSPIDO, ERNESTO VILLANUEVA and GEMA ZAMARRO: *Finance for all:* the impact of financial literacy training in compulsory secondary education in Spain.
1503 MARIO IZQUIERDO, JUAN F. JIMENO and AITOR LACUESTA: Spain: from immigration to emigration?
1504 PAULINO FONT, MARIO IZQUIERDO and SERGIO PUENTE: Real wage responsiveness to unemployment in Spain: asymmetries along the business cycle.
1505 JUAN S. MORA-SANGUINETTI and NUNO GAROUPA: Litigation in Spain 2001-2010: Exploring the market for legal services.
1506 ANDRES ALMAZAN, ALFREDO MARTÍN-OLIVER and JESÚS SAURINA: Securitization and banks' capital structure.
1507 JUAN F. JIMENO, MARTA MARTÍNEZ-MATUTE and JUAN S. MORA-SANGUINETTI: Employment protection legislation and labor court activity in Spain.
1508 JOAN PAREDES, JAVIER J. PÉREZ and GABRIEL PEREZ-QUIRÓS: Fiscal targets. A guide to forecasters?
1509 MAXIMO CAMACHO and JAIME MARTINEZ-MARTIN: Monitoring the world business cycle.
1510 JAVIER MENCÍA and ENRIQUE SENTANA: Volatility-related exchange traded assets: an econometric investigation.
1511 PATRICIA GÓMEZ-GONZÁLEZ: Financial innovation in sovereign borrowing and public provision of liquidity.

BANCO DE **ESPAÑA**
Eurosistema

Unidad de Servicios Auxiliares
Alcalá, 48 - 28014 Madrid
E-mail: publicaciones@bde.es
www.bde.es