Essays in International Finance

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Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I warrant that this authorisation does not, to the best of my belief, infringe the rights of any third party.

Statement of Conjoint Work

I confirm that Chapter 3 was jointly co-authored with dr. Gino Cenedese, Economist at the Bank if England. Each of us contributed equally to th creation, development and writing of the chapter.

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Introduction

This thesis contains three chapters. The first two chapters concentrate on the sovereign debt market and study how domestic holdings of government debt and financial intermediation influence yields and equilibrium debt levels. An innovative perspective emerges from these studies: Sovereign default risk and government yields crucially depend on the size of domestic debt and on its influence on the domestic credit market. This perspective surpasses the traditional view that exclusively relates sovereign default risk to the size of external debt and the economic cycle. The third chapter empirically investigates the functioning of international capital markets and the behavior of market participants. The chapter studies how the different return components of aggregate equity and bond markets influence mutual fund flows and vice-versa. Two interesting results emerge. Firstly, the non-contemporaneous correlation between flows and returns is found to be predictable at least in the short run. This result rejects the standard perfect market assumption in macro-models which implies that the correlation between flows and returns is strictly contemporaneous. Secondly, evidence is found that excess returns in the equity markets are driven by cash-flow news. This is in contrast with the typical finding in the literature that discount rates news is the main driver of excess returns.

Identifying determinants of government incentives to default is central to understand how equilibrium prices and quantities iare determined in sovereign debt markets. The scholarly literature has focused on two factors to explain default risk: the size of external debt and the fluctuation of the economic cycle. While these two dimensions are certainly important, another aspect seems equally important: the internal versus external composition of debt. Reinhart and Rogoff (2008) empirically investigate the importance of domestic debt for sovereign default episodes and conclude that there is a “forgotten history of domestic debt”. While domestic debt dynamics are relevant to understand sovereign default risk, very little research has been devoted to it. The first chapter of my thesis fills in the gap by incorporating domestic debt in a theoretical model of sovereign default. This extension leads to three contributions. The first is a positive one. While standard sovereign default models (i.e. Arellano, 2008 and Aguiar and Gopinath, 2006) assume exogenous output costs to default, the introduction of domestic debt allows me to illustrate an endogenous mechanism linking defaults and output contractions through the credit market which is consistent with the empirics. The second contributions is quantitative. The introduction of domestic debt helps to reproduce the high debt to GDP ratios and the low frequency of default that is found in the empirics. Finally the last contribution is normative. When domestic investors act competitively domestic debt levels are found to be inefficiently low. A case is made for the introduction of Pigouvian subsidies that subsidize domestic purchases of government debt.

Sovereign defaults and banking crises tend to come in pairs. Understanding the link between these two phenomena is relevant to understand how the risk of sovereign default is priced by financial markets. In the second chapter of the thesis I focus on the underlying mechanisms of contagion between public debt and bank's balance sheet. Using disaggregated banking data I analyze empirically the channels through which sovereign debt crises transmit to the banking sectors. I find that one of the main propagation mechanism operates through the collateral channel. When the default risk is high the price of government debt falls and the value of the asset that banks can pledge as a collateral on the wholesale market for liquidity contracts. Funding difficulties transmit thorough the balance sheet to the credit supply . The cyclicality of credit supply magnifies the negative impact of sovereign debt crises on output and consumption reducing the ex-ante incentives of issuing domestic debt. Lenders of last resort may mitigate the contraction of the credit supply in bad times offering liquidity in exchange for government debt. Following the monetary authority intervention the credit market recovers, sovereign yields fall and higher debt levels become sustainable.

The third chapter studies the functioning of international equity and bond markets and the behavior of its participant. The chapter focuses on the interaction between different return components of aggregate equity and portfolio flows. First, international equity and bond market returns are decomposed into changes in expectations of future real cash payments, interest rates, exchange rates, and discount rates. News about future cash flows, rather than discount rates, is the main driver of international stock returns. This evidence is in contrast with the typical results reported only for the US. Inflation news instead is the main driver of international bond returns. Next, the interaction between these return components and international portfolio flows is analyzed. Evidence consistent with price action, short-term trend chasing, and short-run overreaction in the equity market is found. International bond flows to emerging markets are found to be more sensitive to interest rate shocks than equity flows.

Contents

Chapter 1

Domestic Debt and Sovereign Defaults

1.1 Introduction

Understanding why countries default is central to studies about the sustainability of public finances. The scholarly literature has focused on two factors to explain default episodes: the size of external debt and the fluctuation of the economic cycle. While these two dimensions are certainly important, another aspect is equally important: the internal versus external composition of debt. Reinhart and Rogoff (2008) highlight the importance of domestic debt. They study the evolution of domestic debt from 1914 to 2007 in a sample of 64 countries and conclude that there is a “forgotten history of domestic debt”. While domestic debt dynamics are relevant to understand sovereign default episodes, very little research has been devoted to it. My paper fills in the gap by incorporating domestic debt in the sovereign default literature.

Four key empirical regularities demonstrate the importance of domestic debt. (i) Domestic debt is large and constitutes the largest fraction of government debt. (ii) Contrary to conventional wisdom, domestic investors are not strictly junior to external investors. Outright defaults on domestic debt happen and happen frequently. About 45% of the default episodes between 1980 and 2007 also involved domestic debt. (iii) Output contracts more around domestic default episodes rather than around external default episodes (iv) as does credit. Based on these regularities pertaining to domestic debt, I construct a dynamic stochastic general equilibrium model with endogenous default risk á la Eaton and Gersovitz (1981) that incorporates domestic debt and thereby rationalizes the four empirical regularities.

The theoretical model is composed of four sectors: a benevolent government, households (domestic investors), firms, and international investors. Households purchase domestic bonds and use them to store liquidity. As in Holmstrom and Tirole (1998) and in Gennaioli et al. (2014) liquidity from the maturing bonds is transferred from households (investors) to firms that are subject to a working capital constraint and require credit to finance a fraction of their wage payments. Finally, the price of government debt is determined by international investors that have access to both government debt and a risk-free asset. Within this framework, I show that the introduction of domestic debt has important positive and normative implications.

My main contributions are the following. First, while standard sovereign default models (i.e. Arellano, 2008 and Aguiar and Gopinath, 2006) assume exogenous output costs to default, the study of domestic debt allows me to illustrate an endogenous mechanism linking defaults and output contractions through the credit market which is consistent with the empirics.[1] The mechanism works as follows: Sovereign defaults weaken domestic investor's balance sheets causing a contraction of credit and a fall in output which is the stronger the larger the exposure towards domestic debt. Consequently, larger holdings of domestic debt discipline government and reduce incentives to default. The bigger the domestic holdings of government debt, the lower the probability of default and the larger the quantity of government debt that is sustainable in equilibrium.

Second, I calibrate the model to Argentina. Endogenous sovereign default models have difficulties matching simultaneously the high default rates and the high debt to GDP ratios. High default rates reduce debt to GDP ratios in equilibrium and vice-versa. The disciplinary force exerted by domestic debt reduces the tension between the size of government debt and the incidence of defaults. Thus, accounting for domestic debt helps to replicate the high debt to GDP ratios given the observed probability of default.

Third, the inclusion of domestic debt has important normative implications. Debt compo-

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[1] Theoretical sovereign default models have typically associated output losses to exogenous external forces (i.e. Arellano, 2008 and Mendoza and Yue, 2012): in retaliation to a default episode, lenders exclude countries from international financial markets and international trade causing output contraction. This view, however, has been challenged by several empirical works (i.e. De Paoli et al., 2009; Sandleris, 2012 and Borensztein and Panizza, 2009) showing that output contraction around defaults is actually explained by the contraction of domestic credit.

sition as well as debt size and cycle fluctuation matter to determining the default risk. In this paper, I investigate whether markets can autonomously replicate the efficient composition of debt. I find that, whenever domestic investors are small and take government debt prices as given, the competitive equilibrium is not efficient. Domestic investors consume too much and lend too little to the government: i.e. domestic holdings of government debt are sub-optimally low. The sub-optimality of debt composition introduces a pecuniary externality in the economy through the price of government debt. It follows that the management of the aggregate sovereign debt is also inefficient. Efficiency can be restored introducing a Pigouvian subsidy that incentivizes domestic purchases of government bonds.

My work is closely related to quantitative models of sovereign default that extend the seminal work of Eaton and Gersovitz (1981) (i.e. Arellano, 2008 and Aguiar and Gopinath, 2006). My paper also relates to the literature that studies the interplay between sovereign defaults, financial intermediaries and the credit market. Gennaioli et al. (2014), Bolton and Jeanne (2011), Brutti (2011) and Sosa Padilla (2014) build endogenous default models about the relation between domestic government debt and the banking sector.[2] My paper builds on this literature as it also relates sovereign default costs to the contraction of the credit market induced by losses incurred by domestic investors. I extend this literature studying domestic and external debt simultaneously.

My paper also relates to the work of Broner et al. (2010). This paper argues that the presence of complete secondary markets for government debt paired with the ability of the government to distinguish between domestic and foreign lenders can rationalize the existence of government debt even in the absence of default costs.[3] In my work I also emphasize the crucial role of domestic debt, in that domestic debt determines default risk and default costs. However, my paper departs from Broner et al. (2010) in that it does not aim to rationalize the existence of government debt but it aims to study the quantitative and normative implications of the existence of domestic debt.

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[2] Gennaioli et al. (2014) propose a stylized model relating default costs to the development of the domestic financial sector. More developed financial sectors sustain higher quantities of government debt. As sovereign defaults weaken the balance sheet of banks, greater exposure reduces the incentives to default. Similarly, Brutti (2011) proposes a stylized model where government debt is used to store liquidity and sovereign default causes a liquidity shortage. Finally Bolton and Jeanne (2011), Sosa Padilla (2014) also develop models that link default costs to banks holdings of government debt. In a recent paper Bocola (2014) also studies the relation between sovereign defaults and banking crises in a quantitative model where sovereign defaults are exogenous

[3] The argument is very intuitive. Efficient secondary markets can be used to transfer government bonds holdings from foreign lenders to domestic ones if the government decides to default. If this is the case, an altruistic government never defaults and the existence of government debt is justified.

Finally, my paper also relates to the literature about externalities in small open economies. Bianchi and Mendoza (2011) show that sudden stop episodes are explained by excessive borrowings. Agents fail to internalize the consequences of their own actions on borrowing costs and borrow too much. In this paper, I show that a similar mechanism applies to the sovereign debt market, but with different implications. Whenever domestic investors are too small to internalize the impact of their purchases on the price of government debt, domestic investors consume too much and lend too little to the government. Governments, thus, borrow too little and default too often. Efficiency can be restored with the introduction of subsidies that promote domestic holdings of government bonds.

The rest of the paper is organized as follows: Section 1.2 presents some stylized facts and narrative evidence about the relationship between sovereign defaults and internal debt. Section 1.3 introduces the quantitative model that I employ to study debt composition and its implication for default risk. Section 1.4 formally defines competitive equilibrium for the model economy. Section 1.5 defines the constraint efficient equilibrium and explains why in the model economy the competitive equilibrium is not achieve efficient. Section 1.6 calibrates the full quantitative model. Section 1.7 investigates the positive implications of introducing domestic debt in the framework, while Section 1.8 discusses the normative implications. Section 1.9 concludes the paper.

1.2 Stylized Facts

The sovereign default literature has concentrated on external debt dynamics while very little has been said about domestic debt. Reinhart and Rogoff (2008) review a large sample of default episodes and conclude that there is a “forgotten history of domestic debt”. Domestic debt has been greatly overlooked despite the existence of a vast empirical evidence suggesting that internal debt dynamics are important to assess the sustainability of public balances. In this section, I present some stylized fact about domestic debt confirming the crucial role of domestic debt .

Data about domestic holdings of government debt were gathered from a number of different data sources. Most of the data were collected from the Quarterly Public Sector Debt database (QPSD) compiled by the World Bank. As some countries with interesting debt dynamics were not surveyed (i.e. Argentina and Japan), I complemented QSPD data with data from the International Debt Statistics database (IDS) also compiled by the World Bank and the

Bruegel Sovereign Bond Dataset (BSBD). IDS contains yearly data for the external public debt. Internal debt is estimated as the difference between total debt and external debt. Total public debt figures are taken from Reinhart and Rogoff's "This time is different" website. Finally, BSBD collects quarterly data about public debt and its composition for the major European economies.

Domestic Debt Size

Figure 1 describes the composition of debt at the end of 2013 for a sample of emerging and developed economies. For every country in the sample, the share of domestic debt is large. The median internal to total debt ratio is roughly 0.6% meaning that internal debt the largest component of public debt. Even for small economies like Austria and Ireland the domestic to total debt ratio is above 0.25.

Default Incidence

According to the conventional view domestic debt is senior with respect to external debt. Episodes of outright defaults on domestic debt should therefore be rare. Empirical evidence, however, does not support this belief. Table 1 groups default episodes into different categories according to the jurisdiction of the debt titles involved.[4] About 55% of the default episodes since 1990 were non-discriminatory default on both domestic and external holdings of government debt. The case of Argentina is emblematic. Argentina defaulted three times since 1980. Once on domestic debt in 1989 and twice on both external and domestic debt in 1982 and 2001.

Defaults and Output Contraction

Countries typically incur in output losses around default episodes. Table 2 shows the evolution of normalized output around default. Defaults episodes are classified in two groups: default episodes that only involve the external component of debt and default episodes that also involve domestic holdings of government debt. Output contracts more around default episodes that also involve domestic holdings of government debt. External default episodes

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[4] The complete list of default episodes is reported in Table 2 in the Appendix.

Figure 1. Internal Debt Component

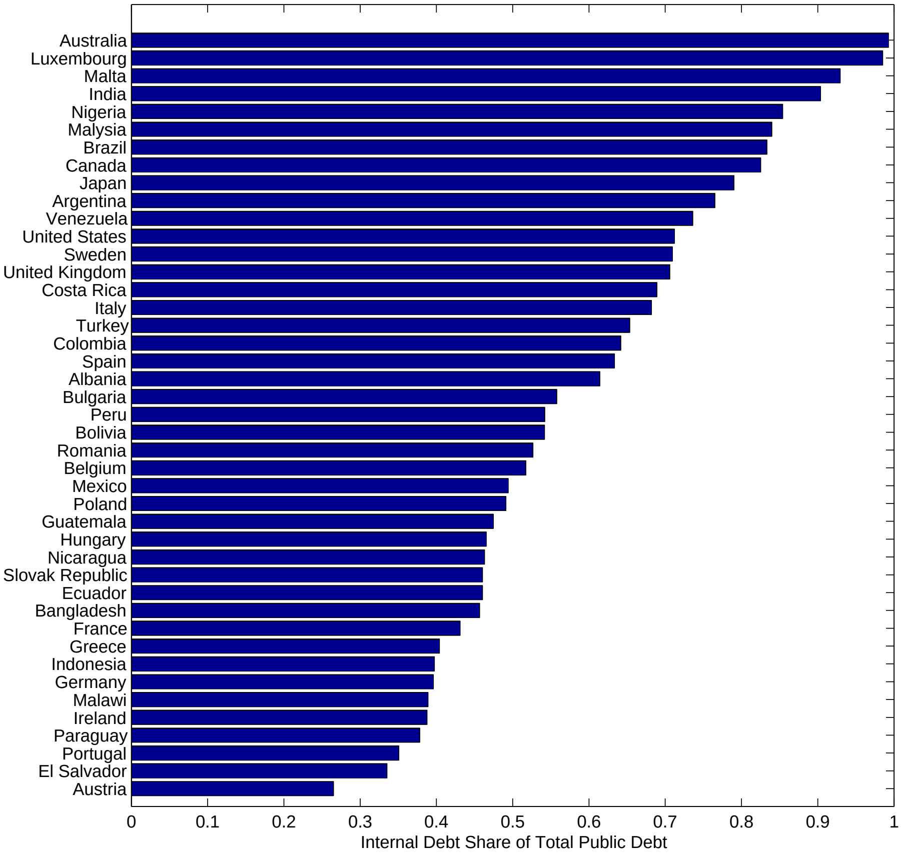

Figure 1 displays the domestic fraction of public debt for a sample of 43 countries. Data refer to the last quarter of 2013.

are associated with small contraction of output –about 2%– while defaults that also involve the domestic component are associated with a much larger contraction of output. Output contracts more than 13% on average. Reinhart and Rogoff (2008) also check for the differential response of output to domestic and external defaults and confirm that output fluctuation around default is smaller when default is limited to external debt.

Table 1. Incidence of Sovereign Defaults

Time	Non-Selective	Domestic	External
1990 - 2005	55%	18%	27%
1980 - 2005	25%	23%	52%

Table 1 displays the incidence of sovereign default episodes. Episodes are grouped according to the class of lenders that were involved in the default.

Table 2. Output Dynamics around Default

	Normalized Average Output Levels		
Time	Pure External	Also Domestic	T-test
t-3	105	94	1.37
t-2	107	99	1.21
t-1	100	100	0
t	98	87	1.90*
t+1	95	95	1.27
t+2	108	108	0.67
t+3	120	120	0.15

Table 2 describes the evolution of output around default episodes. The first two columns display the evolution of normalized output levels distinguishing between purely external defaults and defaults that also involve domestic holdings of government debt. Numbers are obtained averaging across default episodes. The third column presents the t-statics for the differences between the two series.

Defaults and Credit Contraction

Understanding why defaults on domestic debt are associated with greater output losses requires a deep understanding of the channels relating the sovereign bond market to the real economy. The theoretical literature has typically related output contraction to external factors such as the exclusion from trade and financial markets. However, this view has

Table 3. Credit Supply around Default

	Normalized Average Credit to GDP Ratio		
Time	Pure External	Also Domestic	T-test
t-3	93	92	0.21
t-2	96	97	0.17
t-1	100	100	0
t	100	93	1.31
t+1	99	82	1.78*
t+2	98	82	1.50
t+3	96	93	0.22

Table 3 describes the evolution of credit around default episodes. The first two columns display the evolution of normalized private credit to GDP ratios distinguishing between purely external defaults and defaults that also involve domestic holdings of government debt. Numbers are obtained averaging across default episodes. The third column presents the t-statics for the differences between the two series.

found little empirical support. Empirical studies (e.g. Sandleris, 2012) have shown that the reduction of trade volumes observed in the aftermath of sovereign default episodes is a consequence, not a cause, of output contraction. Similarly, the length of the exclusion time from financial markets is too short to explain the output fall.[5].

Recent developments in the empirical literature have underlined the importance of internal factors to determine the size of output contraction around sovereign default episodes (De Paoli et al., 2009). In particular, the contraction of internal (Albertazzi et al., 2014) and external (Arteta and Hale, 2008) credit appears to play a key role. Gennaioli et al. (2014) find that financial intermediaries reduce credit supply around default in a way which is proportional to their holdings of government debt. Intuitively, the greater the exposure towards government debt titles, the bigger the loss upon default. This finding is also confirmed by Sandleris (2012).

Table 3 displays the evolution of the credit to GDP ratio around default episodes.[6] Credit

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[5] The median exclusion length has dropped from four years in the eighties to two years in the nineties (Gelos et al., 2011)

[6] Data about the credit market is taken from the Financial Structure Dataset (FSD) created by Beck et al. (2009). A complete list of the episodes surveyed is contained in Table 2.

is measured as the loans supplied by financial intermediaries to the private sector.[7] Credit contracts by 9% in the two years following a domestic default episode and by only 2.5% in the aftermath of an external default.

1.3 Model

In this section I extend a standard quantitative sovereign default model to include both domestic and external debt. The economy is composed by four sectors: Firms, Domestic Households/Investors, External Investors and the Government.

1.3.1 Firms

Output y is produced by perfectly competitive firms employing labor N as the only input factor. Firms are subject to a productivity shock z and the production function is linear in labor.[8]

$$y = zN. \tag{1}$$

Firms are subject to a working capital constraint as in Mendoza and Yue (2012) and need to pay a fraction γ of labor costs before output is realized. Anticipated wage payments are financed with intra-temporal loans l that firms receive from domestic investors against the payment of an interest rate r^L. Firms' demand for credit l is determined by the working capital constraint:

$$l = \gamma w N. \tag{2}$$

Where w is the wage rate. Labor demand N is chosen to maximize profits:

$$\underset{N}{max} \left\{ zN - wN - r^L \gamma w N \right\} \tag{3}$$

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[7] Data about alternative sources of funding for firms –such as the private credit to the private sector– are scarce and incomplete. A few countries (i.e. Argentina) report information about alternative sources of credit. For these countries these alternative credit channels are small and can be neglected without undermining the overall picture we get from the data.

[8] The linearity of the production function ensures that the competitive equilibrium and the constraint efficient equilibrium defined in Sections 1.4 and 1.5 coincide for a given price of government debt.

The first order condition associated with the maximization problem of the firm is:

$$N: \; w = \frac{z}{1+\gamma r^L}. \tag{4}$$

Equation (4) relates wages to the marginal product of labor and to the conditions prevailing in the credit market. Higher loan rates r^L reduce the wage rates. Multiplying both sides of equation (4) by γN I obtain the loan demand function relating credit demand l to the interest rate on loans r^L:

$$l = \frac{z\gamma N}{1+\gamma r^L}. \tag{5}$$

1.3.2 Households

The economy is populated by a continuum i of households with mass one. Households value consumption c and dislike labor N according to the flow utility $U(c,N)$. Preferences are GHH:

$$U(c,N) = \frac{(c - \frac{1}{\omega}N^{\omega})^{(1-\sigma)}}{1-\sigma}. \tag{6}$$

The problem for the household is that of making contingent plans for consumption c, labor supply N, household's domestic bond holdings b'^H and fresh equity issuance $\mathcal{S}$ so as to maximize her lifetime utility. Households supply labor to firms and invest savings purchasing government bonds and supplying credit to firms. To ease the exposition, I discuss separately the labor supply decision which I name the worker's problem and the saving decision which I name the investor's problem.

Worker's Problem

Workers choose the optimal labor supply N on behalf of the household taking the income from investment π^I as given. In every period households receive wage payments wN from firms. A fraction γ of wage payments are anticipated by firms in the morning before output is realized. The remaining fraction $(1-\gamma)$ is paid in the afternoon after output is realized.

The maximization problem of the worker is:

$$\underset{c,N}{max} \frac{\left(c - \frac{N^{\omega}}{\omega}\right)^{(1-\sigma)}}{1-\sigma} \tag{7}$$

Subject to:

$$c = wN + \pi^{I} + T; \tag{8}$$

Workers choose labor supply N to maximize the utility of the households. The objective function does not contain the continuation value as the labor supply choice is strictly intratemporal. According to the budget constraint of the household (8) consumption is financed with labor income wN, investment profits π^{I} and a lump-sum transfer from the government T.[9] The first order condition associated with the labor supply decision is standard:

$$N: \; N^{\omega-1} = w. \tag{9}$$

Multiplying both sides of equation (9) by γN and rearranging the terms, I can express labor demand as a function of the credit supply l:

$$N = l^{\frac{1}{\omega}}. \tag{10}$$

Equations (5) and (10) jointly determine the equilibrium in the labor market as a function of the interest rate r^{L} prevailing in the credit market. Ceteris paribus, higher interest rates worsen the conditions in the labor market reducing wages and reducing equilibrium labor supply.

Investors

Investors observe workers choices and choose the optimal investment strategy on behalf of the households. Investors have access to two different markets: the market for government bonds b'^{H} and the market for credit to firms l. Investors behave competitively in the market for bonds while they enjoy a monopoly in the market for loans.[10] Monopolistic investors

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[9] Taxation is introduced in a lump-sum fashion for the sake of simplicity. A distortionary tax on labor would reduce the sustainability of government debt and increase the default frequency, but it would not alter the qualitative a normative implications of the model.

[10] This assumption is justified by the high level of concentration observed in the market for intermediated credit. Monopolistic competition is also introduced to ensure that the supply of credit in the competitive equilibrium and in the constrained efficient equilibrium defined in Sections 1.4 and 1.5 respectively coincide

internalize the impact of their choices on credit demand and behave accordingly.[11] Each period is divided in two interim times: morning and afternoon. I analyze each period separately.

In the morning investors receive liquidity from maturing bonds b^H. Liquidity is employed to produce loans l and purchase government bonds b'^H at the price q. Investors may also expand the resources available for investment issuing equity $\mathcal{S}$, which is purchased by workers. Investor's resource constraint at the beginning of the period is:

$$l + qb'^H = b^H + \mathcal{S}. \tag{11}$$

Using the balance sheet identity, equity after loans have been extended is defined as:

$$e \equiv l + qb'^H. \tag{12}$$

Combining equation (11) and (12), I obtain the equity equation:

$$e = b^H + \mathcal{S}. \tag{13}$$

Equity is the sum of domestic holdings of government debt b^H and the fresh equity $\mathcal{S}$.

Following a large body of the literature (i.e. Boz et al., 2014 and Angelini et al., 2012), it is assumed that investors are subject to a capital constraint:

$$e \geq (1 - \psi)\, l. \tag{14}$$

Equity needs to be larger than the risk-weighted value of investors'assets. This introduces a link between equity value and loan supply. $(1 - \psi)$ Is the risk weight assigned to the loans to the private sector. Financial regulations assign no risk to domestic government debt issued in domestic currency. This preferential treatment is captured in equation (14) by the absence of domestic debt on the right hand side of the equation. Combining equations (13) and (14) I obtain the credit supply function:

$$l \leq \frac{b^H + \mathcal{S}}{(1 - \psi)}. \tag{15}$$

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for a given price of government debt.

[11] Credit demand is jointly defined by equations (2), (5) and (10). Equations (5) and (10) define equilibrium quantities and prices in the labor market. Equation (2) relates credit demand and wage payments in the economy.

Equations (13) and (15) jointly describe the consequences of sovereign defaults on investors' balance sheet. Upon default investors' net worth falls and their ability to supply credit to the economy is reduced as the capital constraint becomes tighter. The capital constraint (15) is assumed to be always binding throughout the paper as it is always binding in the parameter space defined by the calibration exercise in Section 1.6.

The contraction of investors' balance sheet is bigger when their exposure to government debt is greater. Expanding the set of available investment opportunities to include foreign government bonds would not change the main mechanism highlighted above as long as domestic investors hold some domestic government bond. The size of investors' balance sheet contraction upon default, instead, crucially depends on the composition of the investment portfolio. Stylized facts presented in Section 1.2 suggests that domestic bond holdings are a large fraction of investor's assets. In the calibration exercise I choose parameter values that replicate the domestic investors exposure to government debt which is observed in the empirics.

In the afternoon investors receive gross interest payments $(1 + r^L)$ from firms for the intratemporal loans l. Following the tradition in the corporate finance literature it is also assumed that equity issuance $\mathcal{S}$ entails some additional costs which are paid in the afternoon. These costs are summarized by the quadratic cost function $\Phi(S) = I_{\mathcal{S}\geq 0}\left[\phi_0\mathcal{S} + \phi_1\mathcal{S}^2\right]$ as in Hennessy and Whited (2005).[12] Income from investment π^B net of equity contribution is:

$$\pi^I = \left(1 + r^L\right) l - \mathcal{S} - \Phi(\mathcal{S}). \tag{16}$$

Let $B^H \equiv \int_0^1 b^H \, di$ be the aggregate level of domestic bond holdings and $\hat{B}'^H = H(z, B, B^H)$ the forecasting rule adopted by the generic investor to predict the evolution of aggregate domestic bond holdings.[13] The maximization problem of each investor on behalf of the household is:

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[12] The calibration of the two parameters ϕ_0 and ϕ_1 is crucial. If bank recapitalization is costless, households can always compensate banks for the losses caused by a default. Parameters are therefore calibrated to replicate empirical moments.

[13] Government debt price depends on the evolution of aggregate domestic debt. As such it is necessary to define a forecasting rule that individual investor adopt to update their belief about the evolution of aggregate quantities of domestic bond holdings.

$$\underset{c,b'^H,\mathcal{S}}{max}\, V^H(z,B,B^H,b^H) = U\left(c,N\right) + \beta E\left(1-def'\right)V'^H(z',B',B'^H,b'^H|z) + \beta E def' V'^H\left(z',0,0,0|z\right). \tag{17}$$

Subject to:

$$c = wN + T + \pi^I; \tag{18}$$

$$\pi^I(z,B,B^H,b^H) = \left(1+r^L\right)l - \mathcal{S} - \Phi(\mathcal{S}); \tag{19}$$

$$l + qb'^H = b^H + \mathcal{S}; \tag{20}$$

$$l = \frac{b^H + \mathcal{S}}{(1-\psi)}; \tag{21}$$

$$l = \gamma w N; \tag{22}$$

$$r^L = \frac{zN}{l} - \frac{1}{\gamma}; \tag{23}$$

$$N = l^{\frac{1}{\omega}}. \tag{24}$$

$$\hat{B}'^H = H(z,B,B^H) \tag{25}$$

Equation (23) is obtained rearranging the loan demand function in equation (5). Equations (22), (23) and (24) jointly determine equilibrium conditions in the labor and credit market. They are included in the set of constraints faced by the domestic investors because of the monopolistic competition in the credit market. Combining equations (18), (19), (20), (22) and (23) the budget constrain of the household can be written more succinctly as:

$$c = zN + b^H - qb'^H - \Phi(\mathcal{S}) + T; \tag{26}$$

The first order conditions associated with the investor's problem are:

$$b'^H : \; q = \beta E \frac{U_c\left(c', N'\right)}{U_c\left(c, N\right)} \left[1 + z' \frac{\partial N'}{\partial b'^H}\right]; \tag{27}$$

$$\mathcal{S} : \; z\frac{\partial N}{\partial \mathcal{S}} = \frac{\partial \Phi(\mathcal{S})}{\partial \mathcal{S}}; \tag{28}$$

The right hand side of equation (27) states that the expected marginal gain of holding an additional unit of government debt is the marginal increase of future consumption and the marginal increase of future production. Equation (28) instead states that the marginal gain of issuing an additional unit of equity is a marginal increase in current levels of output (which is achieved through an improvement of the conditions in the credit market).

1.3.3 International Investors

International investors are risk neutral agents with deep pockets. They have access to two different inter-temporal investment opportunities. The first investment opportunity is a risk-free asset that pays the risk-free interest rate r^f in every possible contingency. The second investment opportunity is the risky government bond that pays 0 when the government defaults and 1 otherwise. As international investors are risk-neutral, the price of government bonds is derived by arbitrage and is equal to:

$$q(z, B', B'^H) = \frac{1 - P(def'|z)}{1 + r^f}. \tag{29}$$

The price q of government debt depends on the future probability of default and on the risk-free rate. The higher the probability of default, the higher the sovereign yields, as they need to compensate investors for the extra risk. Similarly, the higher the risk-free rate, the higher the government yields to ensure that the arbitrage condition is respected. The future probability of default depends on the realization of three factors: productivity z; government debt levels B'; and domestic debt levels B'^H. Low productivity and high government debt levels make the servicing of debt more expensive and increase the risk of default. Larger government debt levels, instead, reduce the risk of default as they imply higher output costs upon default.

Equation (29) defines the market clearing price of government bonds for international risk neutral investors. Under the assumption that the government cannot operate selective defaults, equation (29) defines the price for both the internal and external component of government debt.

1.3.4 Government

The optimal government policy is defined by the government borrowing rule $B'^*(z, B, B^H)$ and the default decision $def^*(z, B, B^H)$ that maximize the welfare of the economy. Government is subject to the following budget constraint:

$$T + B = q\left(z, B', B'^H\right) B'. \tag{30}$$

Transfers and bond payments are financed issuing new government debt.

In the non-default scenario, the optimal government borrowing rule $B'^*(z, B, B^H)$ maximizes the welfare of the household. The government solves the following maximization problem:

$$W^{nd} = \underset{B'}{max}\, V^{nd}\left(z, B, B^H\right)$$

Subject to:

$$V^{nd}(z, B, B^H) = U(c, N) + \beta E V^{nd}\left(z', B', B'^H | z\right); \tag{31}$$

$$c + q\left(B'^H - B'\right) - \left(B^H - B\right) = zN - \Phi(\mathcal{S}); \tag{32}$$

$$N = \left(\frac{B^H + \mathcal{S}}{(1-\psi)}\right)^{\frac{1}{\omega}}; \tag{33}$$

$$q\left(z, B', B'^{H}\right) = \frac{1 - P\left(def'\right)|z)}{1 + r^{f}}. \tag{34}$$

Equation (32) is the resource constraints of the economy which is derived combining equations (26) and (30). Equation (33) describes the equilibrium conditions in the labor market and it is obtained combining equations (21) and (24). The first order condition with respect to B' is:

$$B' : \; q + \frac{\partial q}{\partial B'}\left(B'^{H} - B'\right) = E\left[\beta \frac{U_{c'}(c', N')}{U_{c}(c, N)}\right]. \tag{35}$$

When the government decides to default it gets excluded from financial markets. However, it can be re-admitted with an exogenous probability λ. The welfare of the economy is thus expressed by the following equations:

$$W^{d} = V^{d}(z, 0, 0)$$

Subject to:

$$V^{d}(z, 0, 0) = U(c, N) + \beta^{H} E\left\{(1-\lambda)V^{d}(z', 0, 0|z) + \lambda V'^{nd}(z', 0, 0|z)\right\} \tag{36}$$

$$N = \left(\frac{0 + \mathcal{S}}{(1-\psi)}\right)^{\frac{1}{\omega}}; \tag{37}$$

$$c = zN - \Phi(\mathcal{S}); \tag{38}$$

The default decision is taken comparing households welfare in the default scenario and in the non-default scenario:

$$W(z, B, B^{H}) = \max_{def \epsilon \{0,1\}} (1 - def)W^{nd} + def W^{d}. \tag{39}$$

The government decides to default when the welfare of the household in the default scenario is higher than in the non-default scenario.

1.4 Competitive Equilibrium

The recursive competitive equilibrium is derived in three steps. First, I define the optimal saving and investment policy of the household. Second, I turn to the definition of the optimal government policy. Finally, I characterize the recursive competitive equilibrium.[14]

Saving and Investment Policy: The optimal individual saving and investment policy is a set of prices $\left\{w^{CE*}, r^{L,CE*}\right\}$ and individual and aggregate quantities $\left\{b'^{H,CE*}, B'^{H,CE*}\right\}$ with associated consumption, labor, equity, credit and production plans $\left\{c^{CE*}, N^{CE*}, \mathcal{S}^{CE*}, l^{CE*}, y^{CE*}\right\}$ such that for a given government policy $\{T, def\}$, for a given sovereign debt price $q\left(z, B', B'^H\right)$ and for a given forecasting rule $B'^H = H(z, B, B^H)$, prices and quantities solve the maximization problems of firms and households described in Section 1.3.1 and in Section 1.3.2 and the individual and aggregate quantities coincide: $B'^{H,CE*} = \int_0^1 b'^{H,CE*}\, di = b'^{H,CE*}$ and $L = \int_0^1 l^H\, di = l$.

Optimal Government Policy: The optimal government policy is defined by the government borrowing rule $B'^{CE*}(z, B, B^H)$ and the default decision $def^{CE*}(z, B, B^H)$ that maximize the welfare of the economy given the realized domestic holdings of government debt $B'^{H,CE*}$ and the associated labor and equity plans $\left\{N^{CE*}, \mathcal{S}^{CE*}\right\}$. The optimal government policy solves the maximization problem presented in Section 1.3.4.

Recursive Competitive Equilibrium: A recursive Competitive Equilibrium is a government borrowing and default rule $\left\{B'^{CE*}\left(z, B, B^H\right), def^{CE*}(z, B, B^H)\right\}$, and an individual saving rule $b'^{H,CE*}(z, B, B^H)$ with associated consumption, labor, equity, credit and production plans $\left\{c^{CE*}, N^{CE*}, \mathcal{S}^{CE*}, l^{CE*}, y^{CE*}\right\}$, equilibrium prices $\left\{w^{CE*}, r^{L,CE*}\right\}$ and equilibrium asset pricing equation $q^{CE}(z, B'^{CE*}, B'^{H,CE*})$ for sovereign bonds such that:

- The competitive equilibrium saving policy $b'^{H,CE*}(z, B, B^H, b^H)$ solves the maximization problem of the households and the representative firms for a given government

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[14] In this model investors behave competitively in the labor markets and in the bonds market, but they behave monopolistically in the credit market. Hence, the notion of "competitive" equilibrium is not entirely correct to describe the equilibirum. The equilibirum in the model economy would be more correctly defined as a "competitive equilibrium with monopolistic competition in credit market". For the sake of simplicity, with a small abuse of notation, I still define the equilibrium as "competitive".

policy $\left\{B'^{CE*}, def^{CE*}\right\}$, for a given price $q^{CE}(z, B'^{CE*}, B'^{H,CE*})$ and for a given forecasting rule $B'^{H,CE} = H(z, B, B^H)$.

- The individual and the aggregate saving decisions coincide: $B'^{H,CE*} \equiv \int_0^1 b'^{H,CE*}\, di = b'^{H,CE*}$.
- Individual and aggregate loan supply coincide: $L \equiv \int_0^1 g\left(b'^{H,CE*}, \mathcal{S}\right)\, di = l$.
- The borrowing rule $B'^{CE*}(z, B, B^H)$ and the default rule $def^{CE*}(z, B, B^H)$ solve the government decision problem 39, given given the realized domestic holdings of government debt $B'^{H,CE*}$ and the associated labor and equity plans $\left\{N^{CE*}, \mathcal{S}^{CE*}\right\}$.
- The asset pricing equation for government debt satisfies equation (29): $q = \frac{1-Pr(def')}{1+r^f}$.
- The credit market and the labor market clear at prices $\left\{w, r^L\right\}$.
- The taxation rule $T(z, B, B^H)$ satisfies the government budget constraint (30).

1.5 Recursive Constrained Efficient Equilibrium and Pecuniary Externality

The constrained efficient equilibrium is derived centralizing the problems of the household and the government. In the centralized version of the model the government takes the saving decision $B'^{H,EF*}$ on behalf of the household and simultaneously chooses the size of government debt B'^{EF*}. I show here that the existence of domestic debt introduces an externality in the economy. The competitive equilibrium characterized in Section 1.4 is not constraint efficient. First, I define the optimal government policy. I then characterize the recursive constrained efficient equilibrium.

Optimal Government Policy: The optimal government policy is defined by the government borrowing rule $B'^{EF*}(z, B, B^H)$, the optimal domestic saving rule $B'^{H,EF*}(z, B, B^H)$ and the default decision $def^{EF*}(z, B, B^H)$ that jointly maximize the welfare of the economy subject to the resource constraints of the economy and to the equilibrium conditions for the labor and the credit markets derived in the competitive equilibrium.

The optimal borrowing and domestic saving rules in the non-default scenario are solution to:

$$W^{nd} = \underset{B',B'^{H}}{max} V^{nd}(z,B,B^{H})$$

Subject to:

$$V^{nd}(z,B,B^{H},) = U(c,N) + \beta E\left(V'(z',B',B'^{H})|z\right); \tag{40}$$

$$c + q(B'^{H} - B') - \left(B^{H} - B\right) = zN - \Phi(\mathcal{S}); \tag{41}$$

$$N = \left(\frac{B^{H} + \mathcal{S}}{(1-\psi)}\right)^{\frac{1}{\omega}}; \tag{42}$$

$$q\left(z,B',B'^{H}\right) = \frac{1 - P(def'|z)}{1 + r^{f}}. \tag{43}$$

The first order conditions are:

$$B'^{H}: \ q - \frac{\partial q}{\partial B'^{H}}\left(B' - B'^{H}\right) = \beta E \frac{U_c\left(c',N'\right)}{U_c\left(c,N\right)}\left[1 + z'\frac{\partial N'}{\partial B'^{H}}\right]; \tag{44}$$

$$B': \ q - \frac{\partial q}{\partial B'}\left(B' - B'^{H}\right) = E\left[\beta\frac{U_{c'}(c',N')}{U_c(c,N)}\right]. \tag{45}$$

When the government decides to default it gets excluded from financial markets. The government may still be re-admitted to financial markets with an exogenous probability λ. The recursive problem of the government becomes:

$$W^{d} = V^{d}(z,0,0)$$

Subject to:

$$V^{d}(z,0,0) = U(c,N) + \beta E\left\{(1-\lambda)V^{d}(z',0,0) + \lambda V^{nd}(z',B',B'^{H})\right\} \tag{46}$$

$$c = zN - \Phi(\mathcal{S}); \tag{47}$$

$$N = \left(\frac{\mathcal{S}}{(1-\psi)}\right)^{\frac{1}{\omega}}; \tag{48}$$

The default decision is taken comparing households welfare in in the default scenario and in the non-default scenario:

$$W(B, z, B^H) = \underset{def\epsilon\{0,1\}}{max} (1 - def)W^{nd} + def W^d. \tag{49}$$

Constrained Efficient Equilibrium: A recursive constrained efficient equilibrium is a borrowing rule B'^{EF*}, a domestic saving rule $B'^{H,EF*}$ and a default rule $def^{EF*}(z, B, B^H)$ with associated household consumption, labor and equity plans $\left\{c^{EF*}, N^{EF*}, \mathcal{S}^{EF*}\right\}$ and equilibrium pricing equation q^{EF*} for sovereign bonds such that:

- The borrowing, saving and default rule solve the centralized problem of the government defined in Section 1.5.
- The price function for government debt satisfies equation (29): $q = \frac{1-Pr(def')}{1+r^f}$.
- The credit market, the labor market and the goods market clear.

1.5.1 Externality

Sovereign default models typically assume that the government is a large player that manages efficiently the entire stock of debt internalizing the consequences of its own action on prices. When domestic debt is introduced, the government retains control over the overall size of government debt, but has no control on its composition. Still, the composition of debt matters to determine the risk of default and the price of government debt. Atomistic domestic investor do not replicate the efficient allocation because they fail to internalize the impact of domestic purchases of government debt on sovereign yield.

The existence of a pecuniary externality distorting the allocation of domestic debt emerges comparing the first order conditions in equations (27) and (44). The externality is:

$$ext = -\frac{\partial q\left(z, B', B'^{H}\right)}{\partial B'^{H}}\left(B' - B'^{H}\right). \tag{50}$$

Two factors determine the magnitude of the pecuniary externality: the sensitivity of government debt price with respect to domestic debt $\frac{\partial q\left(z,B',B'^{H}\right)}{\partial B'^{H}}$ and the size external debt $\left(B' - B'^{H}\right)$. While the price of government debt is increasing in domestic debt levels, atomistic investors take prices as given. Domestic investors fail to understand that they can improve government borrowing terms by purchasing more domestic debt and therefore lend too little to the government. This explains the existence of the externality which is the bigger the more sensitive is government debt price to the size of domestic debt holdings. As the pecuniary externality alters government borrowing terms, the externality is greater when external debt is large. The inefficiency of domestic debt levels also affects the aggregate government debt management through the prices $q(z, B', B'^{H})$. Lower domestic holdings of government debt worsen government borrowing terms making lower government debt levels sustainable in equilibrium.

1.6 Calibration

Table 4. Calibration

Calibrated Parameter		Value	Target Statistics/Source
Discount factor	β^B	0.8	Standard in default Models
Re-entry probability	λ	0.2	Exclusion length = 1.25 years
Autocorrelation of TFP shocks	ρ	0.96	Standard RBC
Coefficient of relative risk aversion	σ	2	Standard RBC
Variance of TFP shocks	σ_z	0.034	Standard RBC
Frisch elasticity	ω	1.82	Standard RBC
Risk Free rate	r^f	0.017	US 5 year bond return
Working capital parameter	γ	0.353	Credit supply/Wage Bill: 0.353
Capital Adequacy Ratio	ψ	0.17	$0 - 0.8$ risk-weight on loans
Cost Parameter I	ϕ_0	-32	Investors exposure: 0.29
Cost Parameter II	ϕ_1	100	Investors exposure var: 0.017

Table 4 reports parameter values that are used for the calibration of the model and the associated target statistics

The production function and the utility function for the household are defined in equations (1) and (6) respectively. Productivity z follow a standard AR(1) process: $\log z_t = \rho \log z_{t-1} + \epsilon_t$, where $\epsilon_t \sim \mathcal{N}(0, \sigma_z)$ is a normally distributed productivity shock. The autocorrelation parameter ρ and the variance of the TFP shocks σ_z are calibrated using standard values adopted by the real business cycle literature to match the quarterly evolution of productivity.

Table 4 reports parameter values that were used to simulate the model and the corresponding target statistics. The calibration aims to replicate the behavior of the Argentinean economy from 1980 till 2001. Data sources for the target statistics are listed in Table 1 in the Appendix. The discount factor β is chosen to replicate the average default rate of Argentina. Argentina has defaulted on its debt 5 times since its independence in 1816, implying a default probability of 2.5%, which is our calibration target.[15] Re-entry probability λ is set equal to 0.2 which is consistent with the mean exclusion length of 1.25 years for Argentina found

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[15] While the value of the β is rather low for a quarterly calibration, it is in line with the discount rates that are calibrated in a similar fashion by Aguiar and Gopinath (2006)), Sosa Padilla (2014) and Mendoza and Yue (2012).

by Gelos et al. (2011). The risk-free rate is calibrated to the average quarterly yield of a 5 years US government bond and set equal to 0.017 as in Arellano (2008). The working capital parameter γ is set to match the average private credit to wage bill ratio 1980-2001: 35.3%.[16] Investors exposure is defined as the ratio between domestic debt and the value of financial assets held by financial intermediaries. In this model investors only hold two types of assets: domestic government bonds and loans to the private sector. According to equation (21), the larger is the size of equity $\mathcal{S}$, the bigger is the supply of loans and the smaller is domestic investor exposure to government debt. Parameters ϕ_0 and ϕ_1 regulate the size of equity $\mathcal{S}$ and are chosen to match the average exposure rate and its variance.[17] Finally ψ is set equal to 0.17 to mimic financial regulation requirements that prescribe a $0-0.8$ risk-weight on loans to the corporate sector. As the choice of 0.17 is somewhat arbitrary, I perform a sensitivity analysis in Section 1.7.3 to check how a set of key moments are affected by the choice of ψ.

1.7 Dynamics in the Competitive Equilibrium

1.7.1 Default Risk, Government Yields and Domestic Debt

With the introduction of domestic debt, output costs of default arise endogenously and they are determined by the size of domestic debt. The larger the size of domestic debt the greater is the loss that is placed on the domestic economy in the event of a default. Figure 2 describes the default set of the economy as a function of the states. Panel A shows that defaults happen when productivity is low and government debt is high. Panel B shows that the size of the default set is inversely proportional to the size of domestic debt.

The disciplinary role of domestic debt also affects the shape of the price function. Panel B of figure 3 describes the relation between sovereign debt price $q\left(z, B, B^H\right)$ and domestic holdings of government debt debt. The price of government debt is increasing in the size of domestic debt, meaning that the risk of default diminishes when domestic debt is large.

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[16] Credit is measured as the new credit supplied in every period by financial intermediaries. The wage bill is computed as the labor share of the GDP. Data about credit supply and the labor share of GDP are only measured at the yearly frequency. I therefore computed the yearly ratios and assumed that they are constant over quarters.

[17] Data for domestic exposure are yearly and they are only available starting from 1990

Figure 2. Defaults Set

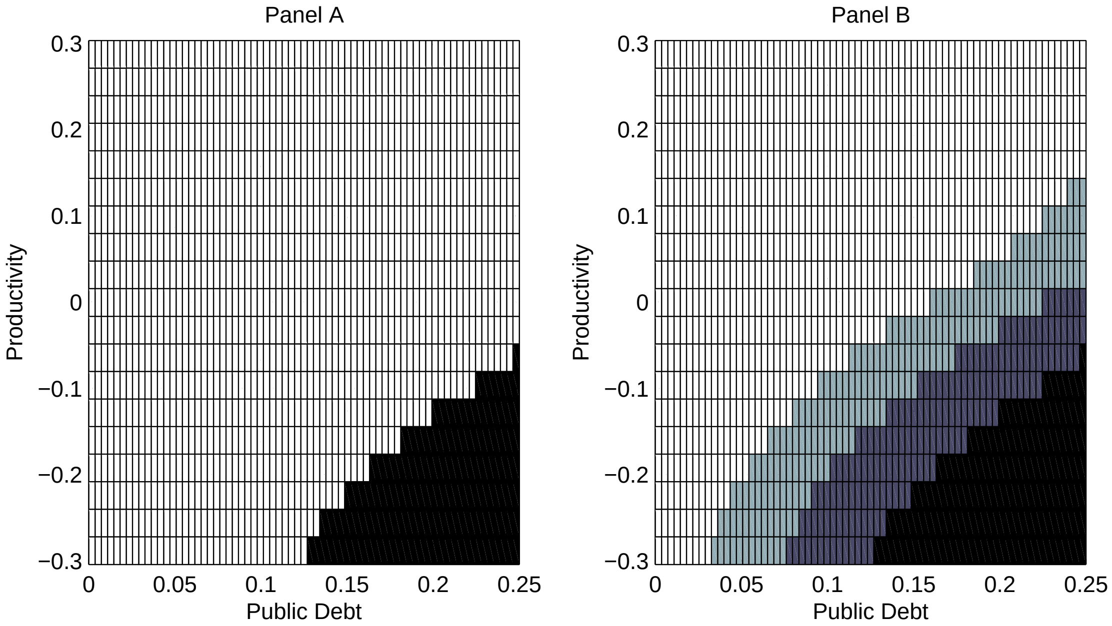

Figure 2 plots the default set for the model economy. Panel A draws the default set for a given level of domestic debt as a function of government debt (horizontal axis) and productivity (vertical axis). The black shaded area corresponds to combinations of productivity shocks and debt levels that trigger a default. Panel B draws the default set for three different levels of domestic debt. The default area in black is associated with high levels of domestic debt. The gray and the cyan areas are associated with intermediate and low levels of debt respectively. The default set expands as domestic debt becomes smaller

1.7.2 Simulations

The model is calibrated to reproduce the quarterly evolution of the Argentinean economy between 1980 and 2001. Results of the simulation exercise are summarized in the second column of Table 5.[18] Panel A compares data and simulated moments for statistics that were not directly targeted by the calibration exercise. Panel B, instead, reports results for moments that were directly addressed by the simulation exercise.

The model predicts an average default rate of 2.3% which is close to the 2.5% in the data.

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[18] Table 1 in Appendix lists data sources for each moment analyzed.

Figure 3. Public Debt Pricing Function

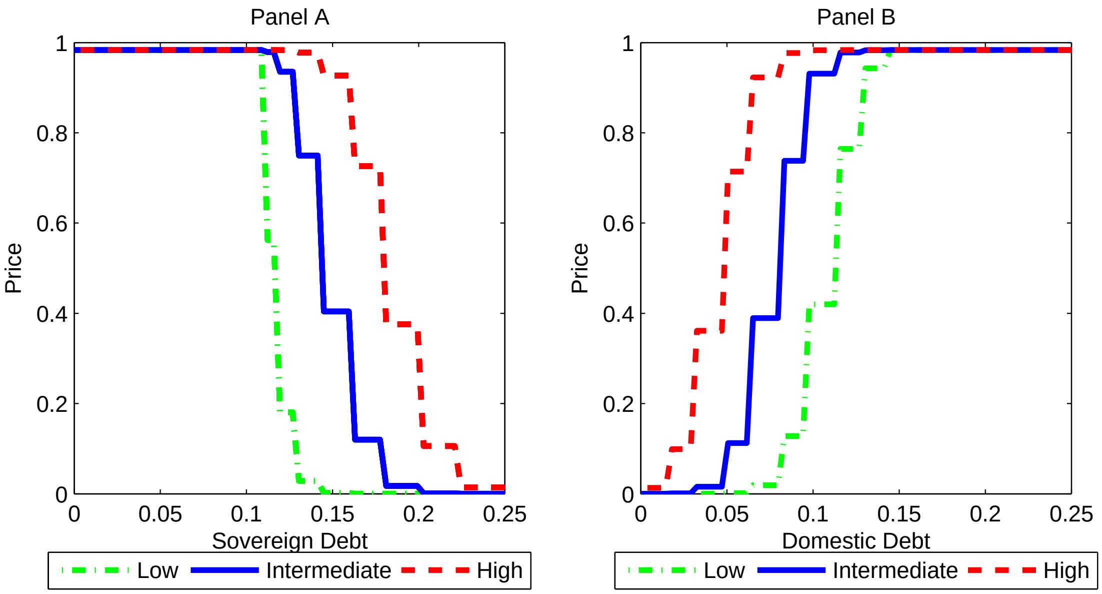

Figure 3 describes the price function for government debt in the model economy. Panel A draws prices as a function of government debt (horizontal axis) for three different productivity levels. Panel B draws prices as a function of domestic debt (horizontal axis) for three different productivity levels and for a given level of total government debt. Domestic debt is measured on the horizontal axis.

While the model underestimates the size of aggregate and domestic debt – 14% and 0.08% in the model respectively against the 48% and the 28% observed in the data–, the average internal vs. external composition of debt is predicted fairly well: 57% in the model and 58% in the data.[19] Turning to the second moments, the model matches broadly well the relative volatility of consumption and output and the negative quarterly correlation between the spread and both output and consumption. The model also captures the crowding-out effect

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[19] A key challenge in the sovereign default literature is to simultaneously match the high default frequency observed in the data and the high debt to GDP ratios. In quantitative models of sovereign defaults á la Eaton and Gersovitz (1981) there is a tension between the probability of default and government debt size. The higher is the former the lower has to be the latter. The introduction of domestic debt reduces the tension between default rates and debt to GDP ratios and improves the quantitative performance of the model with respect to benchmark models. Still, the predicted debt to GDP ratio are far from the observed one in this particular calibration of the model. Lower discount rates and generate debt levels that are closer to empirics

Table 5. Simulations

Panel A: Non Targeted Moments

	Data	Model CE	Model EF
Moments:			
Default Rate	2.5%	2.3%	1.8%
Debt/GDP ratio	0.48	0.14	0.20
Domestic Debt/GDP ratio	0.28	0.08	0.11
Internal/External Debt ratio	0.58	0.57	0.58
Spread	1,059	681	191
$\sigma(c)/\sigma(y)$	1.17	1.03	1.00
$\rho(spread, y)$	-0.64	-0.30	-0.55
$\rho(spread, c)$	-0.70	-0.25	-0.41
$\rho(L, spread)$	-0.28	-0.34	-0.60
$\rho(B^H/B, y)$	0.10	0.33	0.44
$\rho(B^H/B, spread)$	-0.63	-0.82	-0.86
Behavior around default:			
Mean GDP loss	-14%	-16%	-24%
Mean Credit contraction	-27%	-18%	-34%

Panel B: Targeted Moments

	Data	Model CE	Model EF
Moments:			
Credit supply/Wage bills	0.353	0.31	0.33
Domestic Investors Exposure	0.29	0.27	0.34

Table 5 reports moments obtained from model simulation. The first column reports empirical moments while the second and the third columns reports moments obtained from the model. Moments are obtained by simulating the model 100 times for 10,000 periods and averaging across the simulations

discussed by Ardagna et al. (2004) and Evans (1985). The correlation between government spreads and credit supply is negative.[20] The simulation exercise also replicates the negative correlation between spreads and the domestic to total debt ratio. Spreads are high when

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[20] The model also predicts that the quarterly correlation between the interest rates on domestic loans r^L and spreads is positive. This is consistent with empirical finding that borrowing costs rise for the private sector when spreads are higher. Finally, the correlation between output and r^L is negative when spreads are low meaning that absent the risk of default interest rates on credit are procyclical as suggested by Becker and Ivashina (2011).

domestic holdings of government debt are small. The model also accounts for more than half of the observed average spread between the Argentinean five year bonds and the 5-year treasury bills.

Finally, I evaluate the performance of the model at predicting the evolution of output and credit around default. In the first quarter of 2002, following the sovereign default episode of December 2001, the Argentinean economy contracted by 14% and credit supply contracted by 27%. The model matches these two regularities broadly well. Output drops by 16% in the year following the default episode, while credit contracts by 18%. Figure 1 in Appendix A.1 depicts the evolution of credit, output and other variables of interest around default.

1.7.3 Sensitivity Analysis

In this section I perform a sensitivity analysis to gain a better understanding of how a set of key moments in the baseline calibration react to changes in the underlaying parameters. Table 6 summarizes the findings of this exercise.

Firstly, I investigate how the model reacts to changes in the working capital parameter γ. Parameter γ regulates the demand for credit in the economy and is pivotal to determine the magnitude of the output contraction upon default. The bigger is γ the more dependent are domestic firms to credit. It is therefore not surprising that smaller levels of γ are associated with higher default risk. When γ is low defaults become more frequent but they hurt the economy less as the size of the domestic credit market is smaller. The average debt to GDP ratio decreases from 0.17 to 0.11 as smaller levels of debt are sustainable in equilibrium. When γ increases from 0.353 to 0.4, firms are more dependent on credit markets. Default is more expensive in terms of both output loss and credit contraction and the probability of default drops. Equilibrium debt to GDP ratio increases.

Secondly, the model response to changes in the re-entry probability λ. I find that results are not very sensitive to changes in λ. As λ increases from 0.2 to 0.25 the duration of the financial autarky decreases making the default option more appealing. Higher λ values generate higher default rates while lower λ values reduce the incidence of default. The size and the composition of debt are instead rather insensitive to changes in λ.

Finally, I check how the model reacts to changes of the parameters ϕ_0 and ϕ_1 in the cost function $\Phi(\mathcal{S})$. These two parameters crucially determine the substitutability between gov-

Table 6. Sensitivity Analysis

	Default Rate	B/Y	B^H/Y	B^H/B	L/Y	% GDP loss	% Credit fall
Data	2.5%	0.48	0.28	0.58	0.25	-14%	-27%
Benchmark	2.3%	0.14	0.08	0.57	0.31	-16%	-18%
W-K constraint. Benchmark value: $\gamma = 0.353$							
$\gamma = 0.3$	4.3%	0.09	0.05	0.57	0.27	-15%	-16%
$\gamma = 0.4$	1.1%	0.18	0.10	0.59	0.31	-21%	-26%
Re-entry Prob. Benchmark value: $\lambda = 0.2$							
$\lambda = 0.15$	2.4%	0.14	0.08	0.55	0.27	-18%	-20%
$\lambda = 0.25$	4.4%	0.13	0.07	0.59	0.31	-6%	-10%
Cost parameter. Benchmark value: $\phi_0 = -32$							
$\phi_0 = -29$	1.80%	0.17	0.09	0.56	0.31	-20%	-24%
$\Phi_0 = -35$	3.4%	0.10	0.06	0.58	0.31	-16%	-18%
Cost parameter. Benchmark value: $\phi_1 = -100$							
$\Phi_1 = 90$	3.2%	0.10	0.06	0.59	0.21	-17%	-18%
$\Phi_1 = 110$	1.8%	0.16	0.09	0.57	0.31	-21%	-25%
Capital Constraint Parameter. Benchmark value: $\psi = 0.17$							
$\psi = 0.05$	2.0%	0.17	0.10	0.58	0.31	-17%	-21%
$\psi = 0.2$	2.3%	0.14	0.06	0.55	0.31	-18%	-21%

Table 6 reports moments obtained from model simulation for a number of different parameters. Moments are obtained simulating the model over 10,000 periods and averaging across 100 simulations

ernment bond holdings and fresh equity. When bank recapitalization is cheap, meaning that ϕ_0 and ϕ_1 are low, households can easily compensate banks for the losses caused by a default. In this case default costs are smaller and incentives to default are higher. Lower debt levels are sustainable in equilibrium.

Figure 4. Domestic Debt: Policy Functions and Distributions

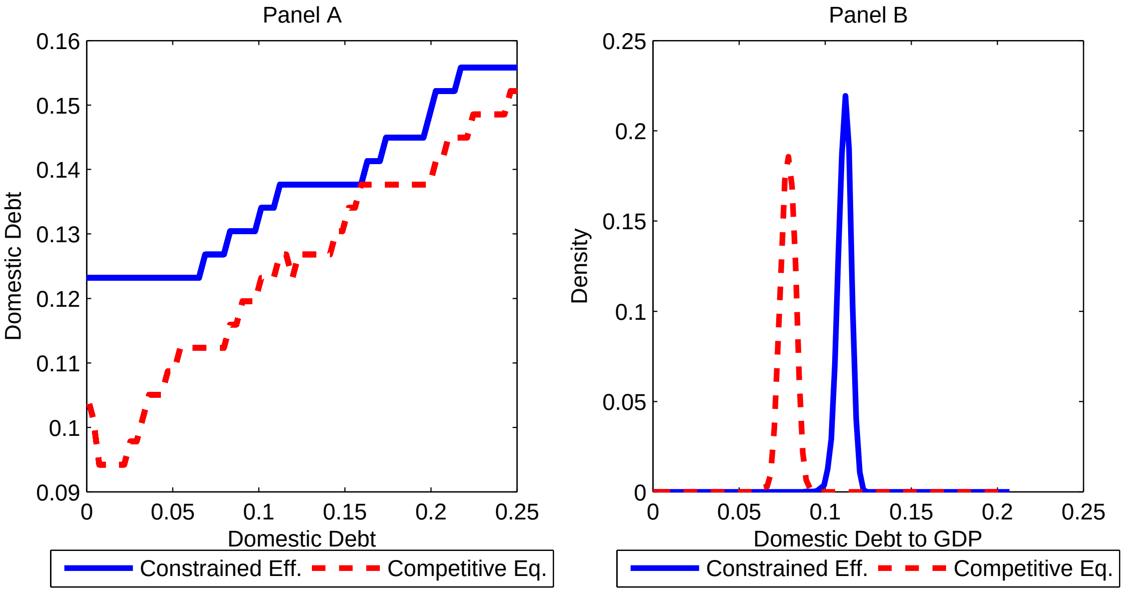

Figure 4 compares domestic debt levels in the competitive equilibrium and in the constrained efficient one. Panel A compares the domestic debt policy functions in the two equilibria as a function of outstanding domestic debt levels (horizontal axis). Panel B compares the distribution of domestic debt to GDP ratios in the competitive and in the constrained efficient equilibria.

1.8 Normative Analysis

1.8.1 Externality and Under-borrowing

Panel A in figure 4 compares policy functions for domestic holdings of government debt in the competitive equilibrium and in the constrained efficient equilibrium. Domestic holdings of government debt are inefficiently low in the competitive equilibrium. The inefficiency is caused by the existence of the pecuniary externality discussed in Section 1.5. Ceteris paribus, additional purchases of government debt by domestic investors improve government borrowing terms. In the competitive equilibrium domestic investors fail to internalize the consequences of their action on the price of government debt and domestic purchases of government bonds are inefficiently low. Panel B of figure 4 reproduces the predicted distributions of the domestic debt to GDP ratios which are obtained simulating the model over 10,000 periods. Domestic debt to GDP ratio is on average about 30% lower in the competitive equilibrium than in the efficient allocation.

The sub-optimal management of domestic debt leads to distorted borrowing terms for the government as suggested by equation (29). This pecuniary externality affects government borrowing levels that remain inefficiently low. Panel A in Figure 5 compares the policy functions for government debt in the competitive and in the constrained efficient equilibria. The government issues an inefficiently low quantity of debt in the competitive equilibrium. Domestic investors under-lending leads to under-borrowing in the sovereign debt market. This is also reflected in the distribution of the debt to GDP ratios which is reported in Panel B.

Figure 5. Government Debt: Policy Functions and Distributions

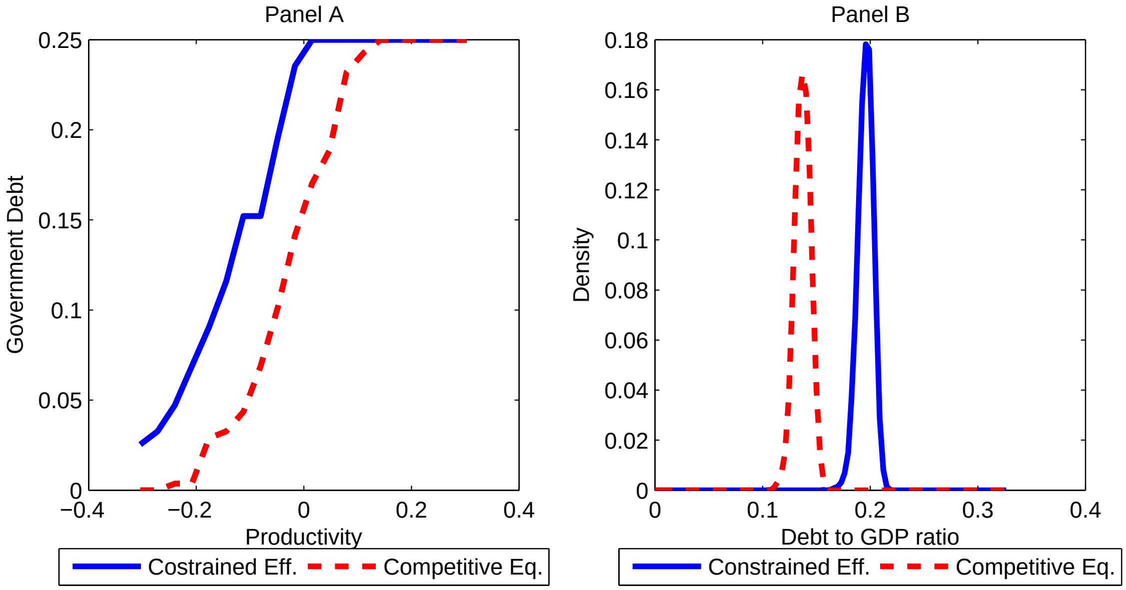

Figure 5 compares government debt levels in the competitive equilibrium and in the constrained efficient one. Panel A compares the government debt policy functions in the two equilibria as a function of productivity levels (horizontal axis). Panel B compares the distribution of debt to GDP ratios in the competitive and in the constrained efficient equilibria.

Column (3) of Table 5 displays moments that are obtained simulating the economy in the constrained efficient equilibrium and compares them with moments obtained in the competitive equilibrium. The optimal management of debt composition reduces default risk from 2.3% to 1.8%. The size of both the domestic and the external component of debt increase. The debt to GDP ratio increases from 14% to 20% in the efficient allocation,while the domestic debt to GDP ratio increases from 8% to 11%. The composition of debt instead remains almost unchanged and the domestic share of total government debt changes only from 57% to 58%. This result suggests that the correction of the externality greatly improves the borrowing ability of the government. As the borrowing terms improve, the government can expand external debt to nearly match the increase of the domestic debt. Lower default risk is also associated with lower spreads. The average spread falls from 681 base points to 191 base points.

While defaults happen at a lower frequency their consequences are more severe. The contractions of both output and credit upon default are sharper. This is explained by two concurrent factors. On the one side, governments are less prone to default and therefore defaults only happen with very bad productivity shocks. On the other side, higher domestic and external debt levels imply that defaults are bigger as the size of government debt itself is bigger. Figure 1 in Appendix A.1 describes the evolution of a number of relevant variables around default.

1.8.2 Optimal Pigouvian Subsidy

Domestic investors fail to achieve the social optimum as they fail to internalize the consequences of their own decision on the price q of government debt. Investors under-lending leads to government under-borrowing, high default rates and high government yields. Government intervention, however, can restore optimality by setting the correct incentives for domestic bond purchases. In particular, the government can introduce a Pigouvian subsidy scheme τ that restores efficiency.

Let τ be a Pigouvian subsidy on domestic holdings of government debt. Equation (26) becomes:

$$c = wN + r^L l + b^H - q\,(1-\tau)\,b'^{H,CE} - \phi(\mathcal{S}) + T. \tag{51}$$

Solving again the maximization problem of the household (17) replacing constraint (26) with

(51), the first order condition with respect to domestic bond holding B'^H becomes:

$$B'^H : \; q - \tau = \beta E \frac{U_c(c', N')}{U_c(c, N)} \left[1 + z' \frac{\partial N'}{\partial B'^H} \right]; \tag{52}$$

The optimal Pigouvan tax eliminating the externality is obtained comparing (44) and (52):

$$\tau = \frac{\partial q}{\partial B'^H} \left(B' - B'^H \right). \tag{53}$$

The optimal Pigouvan subsidy depends on the sensitivity of government debt prices to domestic bond holdings. When government yields are not influenced by the internal vs. external composition of debt the optimal Pigouvian subsidy is zero.

Table 7. Optimal Tax Rate: Simulations

	$mean(\tau)$	$\rho(\tau, y)$	$\rho(\tau, spread)$	W. Gain	max W. Gain
Model Simulations:	0.34	-0.13	0.49	1.4%	7%

Table 7 reports moments for the optimal tax rate τ. Moments are obtained simulating the model 100 times for 10,000 periods and averaging across the simulations.

Moments for the optimal prudential subsidy scheme and the associated welfare gains are summarized in Table 7. The average optimal subsidy rate is 0.34. Subsidies are more generous when the economy is doing badly and when the spreads are high. The average welfare gain of achieving the constrained efficient equilibrium is 1.4% measured in permanent units of consumption. Welfare gains of achieving the efficient allocation are typically small, while in this case they appear to be quite large.[21] The reason is that moving from the the competitive equilibrium to the efficient allocation the economy improves along three dimensions. First, consumption smoothing is improved. As the government gains better access to international financial markets it can smooth fluctuations in the business cycle more efficiently. Second, as the probability of default drops, the economy endures fewer sovereign debt crises. Finally, in the efficient allocation, domestic holdings of government debt are larger generating an expansion of both credit and output.

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[21] Bianchi (2011) for instance evaluates the welfare gains of eliminating over-borrowing in small open economies and finds that the average welfare gain is only 0.1%.

1.9 Conclusions

The academic and policy debate about the sustainability of government debt concentrate on debt size and on the economic cycle to quantify the risk of default. While these two dimensions are certainly crucial to determine the risk of default, the domestic versus external composition of debt is equally important. In particular empirical evidence suggests that (i) Domestic debt is big. (ii) Defaults on domestic debt do happen rather often. (iii) Output and (iv) credit contract more around episodes of domestic defaults compared to external defaults. Based on these regularities I construct a dynamic stochastic general equilibrium model with endogenous default risk á la Eaton and Gersovitz (1981) which also includes domestic debt.

I show that the composition of debt matters to assess the sustainability of public balances. Domestic debt, in particular, interacts with default costs and reduces government incentives to defaults. Consequently, I claim that the optimal management of government debt should not only be directed to the management of debt size and to the optimal default decision. Optimal debt management should also target debt composition. This is especially true in light of the finding that markets are not able to achieve the efficient debt composition autonomously as I show in Section 1.5.

Studying how the composition of debt influences government incentives to default is a promising area for future research. In this paper I focused on the nationality of bonds holders, but there are dimensions that are worth exploring and have not yet received the deserved attention. One is obviously the maturity structure and the currency denomination of debt (Arellano and Ramanarayanan, 2012). A second one would be the demographic and economic characteristics of sovereign bonds holders (D'Erasmo and Mendoza, 2013).

Appendix A

Appendices for Chapter I

A.1 Tables and Graphs

Table 1. Data Sources

Variable	Data Source
$\sigma(c)/\sigma(y)$	Sosa Padilla (2014)
$\rho(tb, y)$	Arellano (2008)
$\rho(spread, y)$	Arellano (2008)
$\rho(spread, c)$	Arellano (2008)
Default Rate	Arellano (2008)
Domestic Credit Provided by the Financial Sector	World Bank (World Development Indicators)
Government to GDP ratio	World Bank (World Development Indicators)
Exposure rate	Financial Structure Database
Equity/Assets ratio	Financial Structure Database: ROA/ROE
Gross Domestic Product	World Bank (World Development Indicators)
Total Debt	Reinhardt and Rogoff "This Time is Different" Database
External Debt	World Bank (International Debt Statistics)
Domestic Debt (Argentina)	Difference between internal and external debt
Wage share of GDP (Argentina)	INDEC (Instituto Nacional de Estadistica y Censos)
Spread	Arellano (2008)

Table 1 lists source database for the moments reported in the quantitative analysis

Table 2. Default Episodes

Country	Domestic Default	External Default	Credit Data
Argentina	1982,1989,2001	1982,2001	yes
Belize	2005	2005‘	yes
Bolivia	1983	1980,1986	yes
Brazil	1986,1990	1983	yes
Chile		1983	no
Costa Rica		1981	yes
Croatia	1993		no
Domenican Rep.	1982,2003	1982,2003	yes
Ecuador	1999,2005	1982,1999,2005	yes
El Salvador	1981		yes
Egypt		1984	yes
Grenada	2004	2004	yes
Guatemala		1986	yes
Indonesia		1998	yes
Jamaica		1981,1987	yes
Jordan		1989	no
Morocco		1983	yes
Mexico		1982	yes
Nigeria		1982	yes
Pakistan		1998	yes
Panama		1983	yes
Peru		1983	yes
Paraguay	2003	1986,2003	yes
Romania		1986	no
Russia	1998		yes
Trinidad & Tob.		1988	yes
Turkey		1982	no
Ukraine	1998	1998	no
Uruguay	2003	1984,1990,2003	yes
Venezuela	1995	1983,1990,1995,2003	no

Table 2 reports the list of default episodes observed between 1980 and 2005. Following Reinhart and Rogoff (2008) and Kohlscheen (2009), I adopt Standard and Poor's identification of defaults. Whenever two defaults are separated by less than three years, I consider them a single default

Figure 1. Dynamics around Default

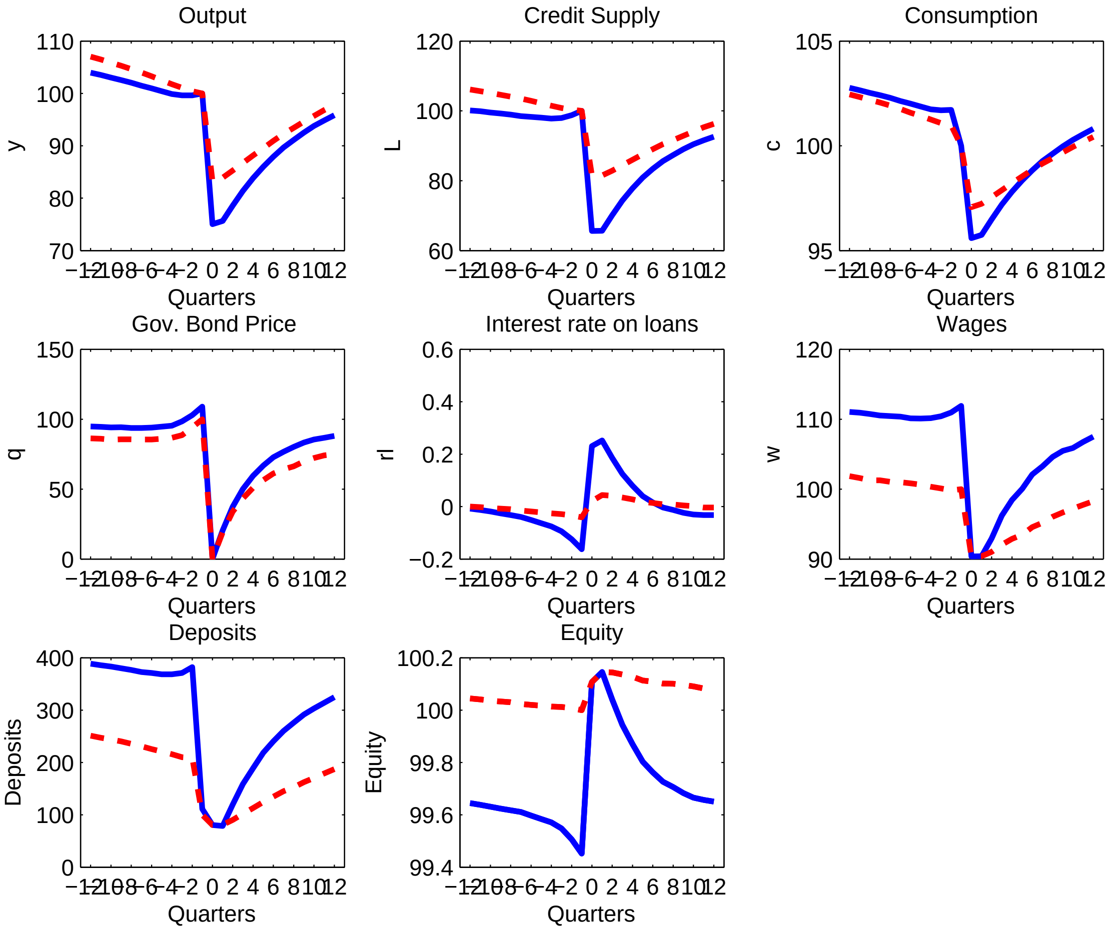

Figure 1 describes the evolution of a several variables around default in the competitive equilibrium (Blue solid lines) and in the constrained efficient equilibrium (red dashed lines). Time is on the horizontal axis and it spans from 12 quarter before to 12 quarters after a sovereign default episode.

A.1.1 Solution Algorithm

Following Hatchondo et al. (2010) equilibria are found iterating the finite model backwards till convergence. In the terminal period it is assumed that financial markets are closed as there is no need to transfer resources across time.

Competitive Equilibrium

1. Discretize the productivity shock z using a quadrature method as in Tauchen and Hussey (1991)
2. Set up the discrete grid reproducing the state space $\Omega = \left\{z \times B \times B^H \times b^H\right\}$.
3. Initialize household's value functions in the default scenario V^d and in the non default scenario V^{nd} evaluating household's utilities in the terminal period of each point of Ω.
4. Evaluate the default set in the terminal period comparing household's utilities in the default scenario and in the non default scenario. Initialize government debt price $q\left(z, B', B'^H\right)$ accordingly.
5. Arbitrarily initialize the forecasting rule $B'^H = H\left(z, B, B^H\right)$ which is constant over individual domestic debt levels b'^H.
6. For every possible government choice $\{B', def\}$, determine the household policy function policy function $b'^{CE,H*}\left(z, B, B^H, b^H\right)$ that maximizes household's value function given the forecasting rule $B'^H = H\left(z, B, B^H\right)$ and the government debt price $q\left(z, B', B'^H\right)$.
7. Update the forecasting rule imposing the equilibrium condition $b'^{CE,H*} = B'^{CE,H*} = H^{CE*}\left(z, B, B^H\right)$ assuring that individual and aggregate choices coincide.
8. Derive the optimal policy function for government debt B'^{CE*} which maximizes household's value function given the optimal choices of domestic agents $B'^{CE,H*}$ and the associated government debt price $q\left(z, B', B'^{CE,H*}\right)$.
9. Update the value functions of the household computing value functions at the optimum $V^d\left(z, B^{CE*}, B^{CE,H*}\right)$ and $V^{nd}\left(z, B^{CE*}, B^{CE,H*}\right)$.
10. Compare value function in the default and in the non-default scenarios and determine the default set. Update government debt $q\left(z, B'^{CE*}, B'^{EF,H*}\right)$ price accordingly.

11. Repeat steps 6 to 10 till value functions, government debt price and forecasting rule have converged. Tolerance values are set to $1e^{-6}$.

Constrained Efficient Equilibrium

1. Discretize the productivity shock z using a quadrature method as in Tauchen and Hussey (1991)
2. Set up the discrete grid reproducing the state space $\hat{\Omega} = \left\{z \times B \times B^H\right\}$.
3. Initialize household's value functions in the default scenario V^d and in the non default scenario V^{nd} evaluating household's utilities in the terminal period of each point of $\hat{\Omega}$.
4. Evaluate the default set in the terminal period comparing household's utilities in the default scenario and in the non default scenario. Initialize government debt price $q\left(z, B', B'^H\right)$ accordingly.
5. For every possible government choice $\{B', def\}$, determine the household policy function policy function $B'^{EF,H*}\left(z, B, B^H\right)$ that maximizes household's value function given the government debt price $q\left(z, B', B'^H\right)$.
6. Derive the optimal policy function for government debt B'^{EF*} which maximizes household's value function given the optimal choices of domestic agents $B'^{EF,H*}$ and the associated government debt price $q\left(z, B', B'^{EF,H*}\right)$.
7. Compare value function in the default and in the non-default scenarios and determine the default set. Update government debt $q\left(z, B'^{EF*}, B'^{EF,H*}\right)$ price accordingly.
8. Repeat steps 5 to 7 till the value functions, government debt price and forecasting rule have converged. Tolerance values are set to $1e^{-6}$.

Chapter 2

Sovereign Defaults, Wholesale Funding and Banking Crises

2.1 Introduction

Sovereign defaults and banking crises come in pairs. Reinhart and Rogoff (2014) review 80 episodes of sovereign default and find that in 90% of cases sovereign defaults happened either simultaneously or in close proximity to banking crises. Financial regulation assigns a preferential treatment to government bonds as they are assumed to bear nor risk. Banks are therefore greatly exposed to government debt as sovereign bonds are liquid, safe and they can be pledged as collateral in the market for funds. Italian banks, for instance, invest on average 60% (7%) of their investment portfolio (total assets) in Italian sovereign bonds. Banks' exposure to government debt, however, implies that banks are at the forefront when a sovereign debt crisis strikes. When governments default, banks incur in a capital loss and even when a default does not realizes banks are still exposed to the risk of downward corrections of bond prices.

Understanding the link between sovereign debt crises and banking crises is of utmost importance to assess the risks and the costs of sovereign debt crises and to suggest policy responses. In this work I focus on the underlying mechanisms of contagion between public debt and bank's balance sheet. I analyze balance sheet data of Italian banks and I study the evolution of the credit market and banks' funding during the sovereign debt crisis in 2011. I find that banks' funding became altogether more difficult during the crisis. In particular the secured wholesale market for liquidity, which extensively uses sovereign bonds as a collateral, froze. Difficulties on the funding side of banks' balance sheet transmitted to the credit market. Interest rates on loans increased and the credit supply contracted. I model the relation between sovereign risk and the banking sector developing a quantitative model of sovereign default á la Arellano (2008), which is extended to include a domestic banking sector. Following the example of Guerrieri et al. (2013) banks are modeled as risk neutral entrepreneurs that combine retail deposits and short-term wholesale funds to produce loans. Banks access to wholesale funds is determined by a collateral constraint that limits the size of wholesale funds to a fraction of the value of banks' assets. Banks purchase government bonds. When there are turbulences in the sovereign debt market, the value of banks assets declines making the access to the market for wholesale funds more difficult. As funding becomes more difficult, the supply of credit also contracts precipitating the economy in a recession. The model is calibrated to the Argentinean economy. Simulations replicate the interaction between sovereign debt market and the banking sector observed in the data. Banks' balance sheets contract during sovereign crises amplifying the consequences for the real economy. If a lender of last resort intervenes, the cyclicality of the credit supply is reduced and the consequences of a sovereign default are milder.

The empirical literature about the interaction between sovereign defaults and banking crises has evolved rapidly since the outbreak of the Euro area sovereign debt crisis. A first strand of this literature investigates the causal relation between sovereign defaults and banking crises. Reinhart and Rogoff (2014) suggest that sovereign default crises are often caused by banking crises. Governments rescue banks taking losses on their balance sheets and in doing so strain public finances. Borensztein and Panizza (2009) suggest that the causality flows in the reverse direction: sovereign defaults cause banking crises. They find that the probability of a banking crisis increases strongly when they condition on the events of a sovereign default. Conversely, the probability of a sovereign default increases only weakly conditioning on the events of a banking crisis . In my work I concentrate on sovereign default episodes that propagate from the government sector to the banking sector as it happened in Italy and Greece during the European sovereign debt crisis. The investigation of the reverse channel is a future step on my research agenda.

A second strand of the empirical literature explores the quantitative implication of sovereign debt crises for the banking sector. There is a general consensus in this literature that sovereign default episodes are associated with a contraction of the credit supply and a worsening of funding conditions. However, many papers (i.e. Albertazzi et al., 2014) use aggregate data and therefore cannot make a clear causal statement. In this paper I exploit a database containing information measured at the bank level to analyze the consequences of a stress in the sovereign debt market on the banking sector. I identify the following regularities. During a period of stress in the sovereign debt market banks funding becomes more difficult. In particular retail deposits become more expensive and the interbank market contracts. The secured segment of the interbank market, which typically uses government bonds as a collateral, is affected the most. Difficulties on the funding side transmit to the supply of credit. The supply of credit contracts and interest rates on loans increase.

The theoretical literature about sovereign debt crisis has also evolved rapidly recently. Gennaioli et al. (2014) set up a three periods model of sovereign defaults and banking and they derive a number of implications that are tested using empirical data. The main prediction of the model is that countries with more sophisticated financial markets should default less frequently. The model proposed by Gennaioli et al. (2014) also replicates the adverse impact of sovereign debt crises on credit markets observed in the empirics. In this paper I propose an endogenous model of sovereign defaults which analyses quantitatively the relation between the credit market and the sovereign debt market. Moreover I make the claim that government debt is pervasive in the balance sheet of financial intermediaries because it can be used as a collateral to access the wholesale markets for funds. Stresses in the sovereign debt market reduce the value of of government bonds and reduce the funding ability of financial intermediaries.

Bolton and Jeanne (2011) also develop a three periods model studying the relation between sovereign defaults and banking crises. Unlike Gennaioli et al. (2014) they introduce a role for interbank lending and borrowing. Interbank markets spread sovereign debt crises from one country to another. My paper relates to their paper as it also assigns a central role to the wholesale market for liquidity, but I extend their analysis to a fully specified dynamic stochastic general equilibrium model that is able to generate banking crises even when stresses in the sovereign markets do not lead to an outright default. Also, my paper does not focus on the international dimension of the contagion. I focus, instead, on the consequences of turbulences in the sovereign debt market for the domestic banking system and for the domestic credit market.

Sosa Padilla (2014) also studies the relation between sovereign defaults and banking crises. His paper is the first one to study these two phenomena in a fully specified quantitative model of sovereign defaults. Still, in his paper conditions in the sovereign debt market do not affect banks funding and the credit market unless a default happens. The model I present here instead proposes a channel through which the sovereign debt market and the credit market interact even in normal times through the price of government debt. The inclusion in the framework of the markets for banks funds also enable me to extend the analysis to the consequences of a sovereign default episode on the funding side of the banks' balance sheet. Finally this paper also contains an empirical analysis of the evolution of the Italian credit market and of the Italian market for bank's funds during the sovereign debt crisis in late 2011. This analysis is among the first ones to use data at the micro level to clearly quantify the causal effect of a sovereign debt crisis for the banking sector. The analysis also supports theoretical model about the interaction between the banking sector and the sovereign debt market.

The rest of the paper is organized as follows. Section 2.2 analysis balance sheet data of Italian banks during the 2011 sovereign debt crisis and outlines some key empirical facts. Section 2.3 presents the theoretical model. Section 2.4 formally defines the competitive equilibrium in the model economy. Section 2.5 explains the calibration of the model. Section 2.6 presents quantitative results. Section 2.7 introduces an application of the model which studies the consequences of a relaxation of collateral eligibility requirements. Section 2.8 concludes the paper.

2.2 Empirical Analysis

In this section I investigate the impact of high government yields on banks' funding conditions and on the credit supply. I choose Italy as a case study. Italy has a high debt to GDP ratio, but the careful management of the public accounts has maintained yields fairly low over the last decades. In the second half of 2011 however, concerns about the long run sustainability of government debt caused a sharp increase of government yields. In the same months other European economies such as Greece, Portugal, Spain and Ireland experienced sharp increases in government yields. I choose to focus on Italy for two reasons. Firstly in Italy the direction of the contagion went clearly from the sovereign debt market to the banking sector. Italian public finances were not strained by rescue packages aiming to support the financial sector. Secondly, I have access to a confidential database created by Banca d'Italia for supervisory reasons. This database contains monthly disaggregated balance sheet data for the entire population of banks operating in Italy. The detail pf the information contained in the database enables me infer causality using a diff-in-diff approach.

2.2.1 Identification Strategy

Figure 1. Italian Government Yields

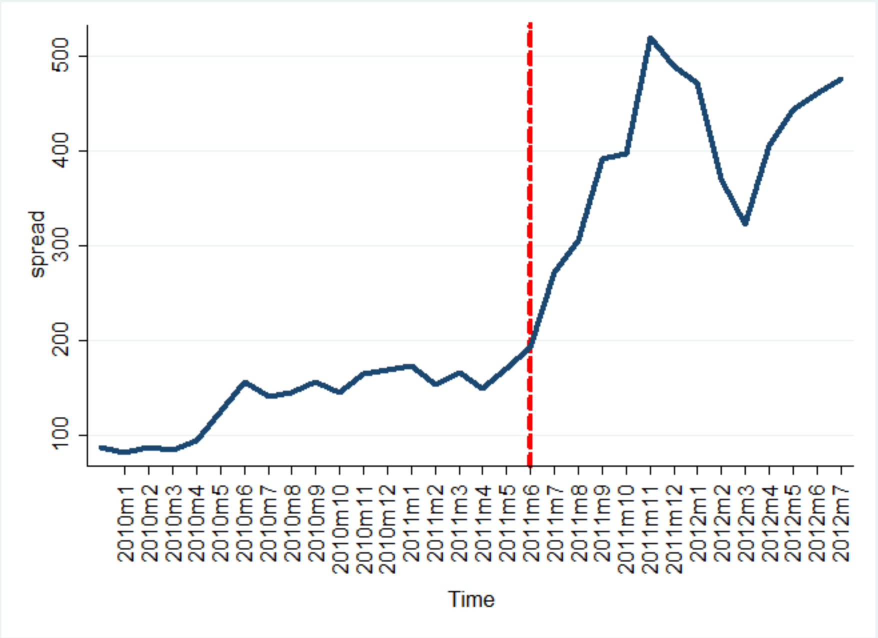

Figure 2.2.1 describes the evolution of the spread between the Italian and the German government bonds between 2010 and 2012

The sudden increase in Italian government bonds yields in the second half of 2011 is studied as natural experiment. Figure 1 plots the spread between Italian and German government bonds between January 2010 and July 2012. In this paper I concentrate on the 11 months between January 2011 and November 2011. During these months the spread increased from about 170 b.p. to more than 500 b.p.. The increase of the spread was concentrated in the second half of the year and policy makers responded slowly to it. The European Central Bank intervened only in December 2011 with a Long term Refinancing scheme (LTRO) that was designed to alleviate the stress in the sovereign debt markets. As no major policy interventions happened before December 2011, it is possible to compare dynamics in the banking sector in the five months between July and November 2011 with dynamics in the initial six months of the same year using a diff-in-diff approach to uncover the consequences of high government yields on the banking system.

Firstly, I define the dummy variable $crisis_t$, that identifies the crisis period. This variable is equal to 1 in the "treatment" sub-sample between July and November 2011 and it is equal to 0 in the "control" sub-sample between January and June 2011. Secondly, I define the variable exp_i measuring the average exposure of each individual bank i to Italian government bonds in the first six months of 2011.[1] Finally, I run the following specification:

$$\Delta y_{i,t} = \beta_1 crisis_t + \beta_2 crisis_t * exp_i + \beta_3 x_{i,t} + \beta_4 \nu_i + \varepsilon_{i,t}; \tag{1}$$

$y_{i,t}$ is the dependent variable. The coefficient β_1 measures the impact of the crisis period on the dependent variable, had the bank not been exposed to the sovereign debt risk.[2] Coefficient β_2 is the main coefficient of interest. It compares the pre-crisis and post-crisis pattern of banks that were affected differently by the crisis as a result of their different exposure. The vector of control variables $x_{i,t}$ contains: the ECB short term rate, a variable measuring the exposure of each bank to bonds issued in other "peripheral" countries, the average protfolio to asset ratio and the assets to liabilities ratio measuring banks capitalization.[3] Finally ν_i is a vector containing banks fixed effects. The inclusion of fixed effects justifies the absence of the exposure variable exp_i in the regression equation.[4]

The identification strategy crucially relies on the assumption that those banks holding a disproportionately high quantity of sovereign bonds do not differ from other banks in any dimension which is not controlled by control variables. In Table 1, reported in Appendix B.1 I report descriptive statistics for banks distinguishing between those banks that are highly exposed and those who are not. T-tests accept the null hypthesis that the means are the same in the two samples for our variables of interest.

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[1] Let $exp_{i,t} = \frac{GovtBonds_{i,t}}{Assets_{i,t}}$, be the ratio between holdings of Italian government and total assets for bank i at time t. The variable exp_i is the average value of $exp_{i,t}$ measured over the six months between January 2011 and June 2011

[2] A shock to the risk premium that affects uniformly all the banks would be captured for instance by β_1).

[3] Peripheral countries are Greece, Ireland, Portugal and Spain.

[4] Coefficients of equation (1) are estimated using panel regressions. Bertrand et al. (2004) point out that standard errors of difference-in-difference estimates may be downward biased when data are panel. To address this issue equation 1 is also estimated reducing the time-series dimension to two points in time. This is achieved computing the average values of each variable for the crisis period and for the non-crisis period. Coefficients for equation (1) are then estimated again using the newly created database which only contains two points in time.

2.2.2 Database and Variables

Data describing dynamics in the market for banks funds and in the credit market were obtained from a confidential database collected by Banca d'Italia for supervisory purposes. The database contains monthly snapshots of the balance sheet of each bank operating in Italy. Variables measuring the supply of credit to the private sector, the stock of retail deposits, the exposure of banks to sovereign debt risk and the exposure of banks to bonds issued in other Euro-Area peripheral economies are all contained in the database. Data about banks access to wholesale liquidity is obtained from variables measuring inter-bank claims. As suggested by Affinito (2011), inter-bank claims involving two banks belonging to same banking group were excluded as they respond do different incentives than extra-group transactions. Interbank claims are divided in two categories: the secured market and the unsecured market. Secured wholesale market operations are typically conducted using repurchase agreements (Repo) requiring an asset to be pledged as a collateral. No guarantees are instead involved in the unsecured transactions.[5]

Balance sheet variables only contain information about quantities. However, for the purpose of the analysis we are also interested in price dynamics. Information about interest rates on loans and on retail deposits is gathered, once again, from the supervisory database of Banca d'Italia. Balance sheet data are complemented with additional information containing time series for the average annual interest rate applied to loans and the average annual yield offered on deposits by each individual bank. The sample of banks reporting these figures only represents 14% of the overall population of Italian banks. It follows that self-selection issues cannot be excluded when analyzing price dynamics.

While it was not possible to find a database containing information about rates and prices in the secured market segment, data about interest rates in the unsecured wholesale market for funds were obtained from the e-Mid market. The e-Mid market is a trading platform designed in 1990 by Banca d'Italia to facilitate the exchange of liquidity on the interbank market. In 2006 17% of the Euro-area inter-bank transactions were settled through the e-Mid. During the crisis the importance of the unsecured market has declined. As a consequence it is not possible to assure that transactions recorded on the e-Mid are representative of inter-bank transactions as whole. Hence, I interpret the results about rates dynamics as merely suggestive.

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[5] Variables were normalized by the total value of assets of each bank. Normalization was required to ensure the secrecy of data during the analysis.

2.2.3 Banks Funding

Table 1. Retail Deposits

	(1) Δ Deposits	(2) Δ Deposits	(3) Δ Returns	(4) Δ Returns
$Crisis_t$	-0.0265	0.4494	77.5***	174.9***
	(0.0274)	(0.9133)	(14.9)	(17.3)
$Crisis_t * exp_i$	-0.00702	-0.0116	7.41***	10.1**
	(0.0104)	(0.0257)	(3.79)	(5.53)
Controls:				
ECB Rate	yes	yes	yes	yes
GIIPS holding	yes	yes	yes	yes
Banks FE	yes	yes	yes	yes
$Asset/Portfolio$	yes	yes	yes	yes
$Asset/Liabilities$	yes	yes	yes	yes
Bertrand-Duflo corr.	no	yes	no	yes

Table 1 analyzes the evolution of retail deposit funding around sovereign debt crises. Columns (1) and (2) analyze the evolution of quantities while columns (3) and (4) report the evolution of returns. Quantities are measured in logs and therefore coefficients for columns (1) and (2) express changes in the growth rate. Returns are expressed in base points.

Banks fund their operations collecting resources either from depositors or from other financial institutions thorough the wholesale market for funds. The retail market for funds is by far the most important source of funding for Italian banks. More than 13% of banks liabilities are retail deposits. The wholesale market for funds is composed of two segments: the unsecured market for funds and the secured market for funds. Secured wholesale market operations are typically conducted using repurchase agreements requiring an asset to be pledged as a collateral.

Table 1 contains estimates for coefficients β_1 and β_2 of equation (1) for dependent variables describing volumes and priced in the retail deposit market. Coefficients in columns (1) and (2) are not significant meaning that volumes in the retail deposit market were not affected by the sovereign debt crisis in 2011. Coefficients displayed in columns (3) and (4) instead suggest that the interest rate on retail deposit increased during the crisis and the increase was sharper for banks that were more exposed to government bonds.

I next turn to the analysis of the market for wholesale funds. I study the secured and the unsecured segment separately as the two may react differently to a stress in the sovereign debt

Table 2. Wholesale Market for Funds

	(1) Δ Secured	(2) Δ Secured	(3) Δ Unsecured	(4) Δ Unsecured	(5) Unsec. Rates
$Crisis_t$	-0.333***	-0.119‘	-0.273**	-0.272***	425***
	(0.084)	(0.913)	(0.125)	(0.124)	(97)
$Crisis_t * exp_i$	-0.266***	-0.663***	-0.0907**	-0.091***	162***
	(0.010)	(0.026)	(0.0377)	(.037)	(66)
Controls:					
ECB Rate	yes	yes	yes	yes	yes
GIIPS holding	yes	yes	yes	yes	yes
Banks FE	yes	yes	yes	yes	yes
$Asset/Portfolio$	yes	yes	yes	yes	yes
$Asset/Libilities$	yes	yes	yes	yes	yes
Bertrand-Duflo corr.	no	yes	no	yes	yes

Table 2 analyzes the evolution of wholesale deposit funding around sovereign debt crises. Columns (1) and (2) analyze the evolution of quantities in the secured wholesale market segment while columns (3) and (4) concentrate on the unsecured segment. Column (5) analyze changes in the interbank rate in the unsecured segment. Quantities are measured in logs and therefore coefficients for columns (1) to (4) express changes in the growth rates. Returns are expressed in base points.

market. The unsecured sector is very sensitive to risk as there are no guarantees to borrowing and lending. The secured market instead is less sensitive to changes in risk perception, but it typically uses bonds as a collateral for Repurchase Agreement (Repo) contracts. In the eve of the crisis, more than 60% of the Repo contracts in the wholesale market were using Italian government bonds as collateral before the onset of the crisis.

Results are reported in Table 2. Volumes fell both in the secured (columns 1-2) and in the unsecured market (columns 3-4). Contraction was sharper in the secured market segment. It is interesting to note that the estimated coefficient β_1 for the *crisis* variable is small in columns (1) and (2) compared to the β_2 coefficient. This suggests that the crisis did not have strong consequences on banks that were not exposed to the government bonds. Finally column (5) captures interest rates dynamics in the unsecured interbank market. Interest rates increased sensibly following the onset of the crisis.

Two regularities emerge from the empirical analysis of the dynamics in the funding market. During periods of stress in the sovereign debt market, funding through retail deposits becomes more expensive and funding through the wholesale market becomes altogether more difficult as quantities contract and, concurrently, returns increase.

2.2.4 Credit Market

The supply of credit is also influenced by conditions in the sovereign debt market. Table 3 analyzes dynamics in the credit market during the 2011 sovereign debt crisis.

Table 3. Credit Market

	(1) Δ Loans	(2) Δ Loans	(3) Δ Returns	(4) Δ Returns
$Crisis_t$	-0.0359***	-0.2422‘	57.10***	60.86***
	(0.0154)	(0.345)	(4.798)	(6.006)
$Crisis_t * exp_i$	-0.0118***	-0.0225***	4.08***	3.98**
	(0.0025)	(0.0089)	(1.204)	(2.164)
Controls:				
ECB Rate	yes	yes	yes	yes
GIIPS holding	yes	yes	yes	yes
Banks FE	yes	yes	yes	yes
$Asset/Portfolio$	yes	yes	yes	yes
$Asset/Liabilities$	yes	yes	yes	yes
Bertrand-Duflo corr.	no	yes	no	yes

Table 3 analyzes the evolution of the credit market around sovereign debt crises. Columns (1) and (2) analyze the evolution of quantities while columns (3) and (4) report the evolution of returns. Quantities are measured in logs and therefore coefficients for columns (1) and (2) express changes in the growth rate. Returns are expressed in base points.

Results in column (1) and (2) report coefficients obtained running a regression on equation (1) using the change in the credit supply as the dependent variable. β_1 Is negative and turns insignificant when the time dimension is reduced as suggested by Bertrand et al. (2004). Coefficients of the interaction term are instead negative and significant in both columns (1) and (2). These results confirm that the contraction of credit was more severe in banks that were more exposed to government bonds. Finally, columns (3) and (4) show that interest rates in the credit market were higher during the crisis and banks with large holdings of government debt were charging higher rates for credit.

Two regularities emerge from the study of the evolution of the credit market around a sovereign default episode. Firstly, the volume of credit reduces and, secondly, interest rates on loans increase.

2.3 Model

In this section I develop a sovereign default model that matches the empirical regularities observed in the credit market and in market for banks' funds. The model economy is composed of four sectors (households, banks, firms and government) and two agents (banks and households). The interaction between these four sectors determines quantities (such as consumption, output and labor) and prices in the economy.

2.3.1 Households

Households choose consumption c, labor supply N and savings d' to maximize their utility functions. Savings are deposited with a bank that pays a net return r^d. In this model I rule out the possibility of panics and bank runs a' la Diamond and Dybvig (1983). Deposits are safe as banks can never default on their liabilities towards households. The budget constraint of households is standard. Consumption, savings and lump-tax payments T are financed with labor income, and returns from past savings.[6]

$$\underset{c,d',N}{max}\, V^C(z,b,d) = U^C(c,N) + \beta^H EV^C(z',b',d')$$

$$s.t.\; c + d' + T = wN + \left(1 + r^d\right) d; \tag{2}$$

First order conditions associated with the household maximization problem are standard:

$$N: \; -\frac{U_N}{U_c} = w; \tag{3}$$

$$d': \; \frac{1}{1 + r'^d} = \beta^H \frac{U_{c'}}{U_c}. \tag{4}$$

---

[6] In an unreported exercise I extend the model to introduce distortionary taxation on labor. Distortionary taxes on labor reduce the sustainability of government debt and increase the default frequency, but do not alter the qualitative implications of the model.

2.3.2 Firms

Firms produce output y employing labor N as the only input factor. Firms are subject to a productivity shock z which follows a standard AR(1) process. The main departure from the standard framework is the introduction of a working capital constraint as in Mendoza and Yue (2012) and Sosa Padilla (2014) which rationalizes the presence of the credit market. Firms need to pay a fraction γ of wages before profits are realized. Banks provide intra-period loans to firms against the payment of an interest rate r^L. Firms' demand of loans is determined by the working capital constraint: $L = \gamma w N$ and it is increasing in the wage rate w and in the labor N. The supply function for loans is determined by the maximization problem of the bank and is derived in Section 2.3.3. Firms choose labor N to maximize profits:

$$\underset{N}{max} \left\{ zf\left(N\right) - wN - r^L L \right\};$$

$$s.t.\ L = \gamma w N. \tag{5}$$

The first order condition associated with the maximization problem of the firm is:

$$N:\ w = \frac{zf_N\left(N\right)}{1+\gamma r^L}. \tag{6}$$

Equation (6) relates wages to the marginal productivity of labor $zf_N\left(N\right)$ and to the interest rate r^L prevailing in the credit market. High interest rates depress wages.

2.3.3 Banks

The introduction of a banking sector raises several modeling issues as the literature proposes different frameworks to analyze bank's behavior. I choose to follow closely Guerrieri et al. (2013). Banks are modeled as risk neutral entrepreneurs that combine retail deposits d' and wholesale funds d^* to produce credit l which is then supplied to firms. The loan supply function is:

$$L = d' + d^*. \tag{7}$$

The size of retail deposits d' is determined by the household's consumption saving decision discussed in Section 2.3.1. Wholesale funds d^* are instead collected from abroad against the payment of an exogenous intra-temporal interest rate r^I.[7] Banks also have access to the market for government debt. In every period banks receive liquidity b from maturing bonds and purchase new bonds b' at the price q. Banks' access to the wholesale market for funds is constrained by value of bank's holding of government debt as in Kiyotaki and Moore (1997). More specifically wholesale funds d^* cannot exceed a fraction φ of the value of government debt holdings qb':

$$d^* \leq \varphi q b'. \tag{8}$$

Constraint (8) is meant to capture in a reduced form the functioning of the secured interbank market which is characterized by the widespread use of government bonds as a collateral for transactions between banks.[8]

Banks seek to maximize consumption choosing the optimal level of government bond holdings b', deposits d' and wholesale funds d^*. Banks maximization problem is:

$$\underset{c^B, b', d', d^*}{max} W^B(z, b, d) = c^B + \beta^B E W^B(z', b', d');$$

Subject to:

$$c^B = \left(1 + r^L\right) L + (b - qb') - \left(1 + r^d\right) d - (1 + r^I) d^*; \tag{9}$$

$$L = d' + d^*; \tag{10}$$

$$d^* \leq \varphi q b'. \tag{11}$$

Equation (9) defines bank's budget constraint. Consumption is financed with the revenues generated in the credit market and the revenues generated in the market for government debt minus the costs of accessing funds.

When the collateral constraint (11) is binding there is direct relationship between bond

---

[7] The interest rate r^I is left exogenous to capture the empirical regularity that interest rates in the international market for capital are primarily determined by factors that are external to the economy.

[8] Recall that in Section 2.2 evidence was found that the secured interbank market suffered the most during the sovereign debt crisis.

holdings and foreign borrowing hence the choice variable d^* drops from the maximization problem. The collateral constraint (11) is always binding when that the marginal revenues of foreign deposits are greater than the unit costs of wholesale funds:

$$r^L \geq r^I \tag{12}$$

For the calibrated parameters defined in Section 2.5, constraint (11) is always binding. In this paper I therefore restrict the analysis to the case in which the collateral constraint is always binding.

The first order conditions associated with the maximization problem of the bank are the following:

$$b' : \; q + \mu\varphi q + \beta^B E\left[1 - def'\right] = 0; \tag{13}$$

$$d' : \; 1 = \beta^B E\left[r'^d - r^L\right]; \tag{14}$$

$$d^* : \; r^L - r^I - \mu = 0; \tag{15}$$

$$\mu\left(d^* - \varphi q b'\right) = 0. \tag{16}$$

As the collateral constraint (11) is always binding equations (13) and (14) further simplify:

$$q = \beta^B \frac{1 - Pr(def')}{1 - \varphi(r^L - r^I)}; \tag{17}$$

$$r'^d = \frac{1}{\beta^B} + r^L. \tag{18}$$

Two forces determine the price of government bonds defined in equation (17).[9] The first one is the probability of default which appears in the numerator. The second component is the net marginal profits from wholesale deposits: $r^L - r^I$. When the marginal product of wholesale funds is high, banks expand their holdings of government bonds b' to produce more collateral. As the demand for government bonds increases the price of government

---

[9] Recall that the expected value of an indicator function equals the probability of the indicator being 1. That is E(1-def')=1-Pr(def').

bonds increases restoring the equilibrium in the market. This mechanism explains the inverse relation between the net marginal profits from wholesale deposits and the price of government debt.

Equation (18) establishes a positive relation between the interest rate on retail deposits r^D and the interest rates of loans r^L. When interest rates are high in the credit market, the marginal revenue generated by an additional unit of deposit is high. When this is the case, banks attempt to attract more deposits raising the interests rate they pay on deposits.

2.3.4 Government Policy

The government chooses whether to default or not and the optimal supply of government bonds b' that maximizes the weighted sum of the utilities of households and bankers subject to the conditions and constraints derived in the competitive equilibrium. The government also decides whether to default or not comparing the welfare of households and bankers in the default and in the non-default scenario.

The government is subject to the following budget constraint:

$$b = qb' + T. \tag{19}$$

The government finances the payment of maturing bonds b with lump-sum taxes T and issuing new bonds b' at the price q. Combining the government budget constraint in equation (19) with equations (2), (9) and (10) I derive the resource constraint of the economy:

$$c + c^b = zf\left(N\right) - r^I d^*. \tag{20}$$

As government debt is fully purchased by domestic investors in this model, the economy is closed and trade balance does not appear in the resource constraint of the economy. In the non-default scenario the government chooses b' that maximize the joint welfare of households and bankers. The recursive formulation of the maximization problem of the government is:

$$G^{nd} = \max_{b'} \left\{ \theta V^{C,nd}(z,b,d) + (1-\theta)\, W^{B,nd}(z,b,d) \right\};$$

subject to:

$$V^{C,nd}(z,b,d) = U^C(c,N) + \beta^H E V^{C,nd}(z',b',d'); \tag{21}$$

$$W^{B,nd}(z,b,d) = c^B + \beta^B E W^{B,nd}(z',b',d'); \tag{22}$$

$$c^B + r^d d + qb' + r^I d^* = b + d' + r^L L; \tag{23}$$

$$c + c^b = zf(N) - r^I d^*; \tag{24}$$

$$L = d' + \varphi q b'; \tag{25}$$

$$L = \gamma w N; \tag{26}$$

$$-\frac{U_N}{U_c} = w; \tag{27}$$

$$\frac{1}{1+r'^d} = \beta^H \frac{U_{c'}}{U_c}; \tag{28}$$

$$1 = \beta^B E\left[r'^d - r^L\right]; \tag{29}$$

$$r^L = \frac{zf_N}{L} - \frac{1}{\gamma}; \tag{30}$$

$$q = \beta^B \frac{1 - Pr(def')}{1 - \varphi(r^L - r^I)}. \tag{31}$$

θ Is the weight that the government assigns to the welfare function V of the household.

If the government decides to default it gets excluded from international financial markets but, it may be re-admitted with an exogenous probability ψ in every period. The welfare of the economy becomes:

$$G^d = \theta V^{C,d}(b,z) + (1-\theta)\, W^{B,d}(b,z)$$

subject to:

$$V^{C,d}(z,0,0) = U^{C}(c,N) + \beta^{H} E\left\{(1-\psi)V^{C,d}(z',0,0) + \psi V^{C,nd}(z',0,0)\right\} \tag{32}$$

$$W^{B,d}(z,0,0) = U^{B}(c^{B}) + \beta^{B} E\left\{(1-\psi)W^{B,d}(z',0,0) + \psi W^{B,nd}(z',0,0)\right\} \tag{33}$$

$$c^{B} + r^{d}d + r^{I}d^{*} = d' + r^{L}L; \tag{34}$$

$$c + c^{b} = zf\left(N\right) - r^{I}d^{*}; \tag{35}$$

$$L = d' + 0; \tag{36}$$

$$L = \gamma w N; \tag{37}$$

$$-\frac{U_N}{U_c} = w; \tag{38}$$

$$\frac{1}{1+r'^{d}} = \beta^{H}\frac{U_{c'}}{U_c}; \tag{39}$$

$$1 = \beta^{B} E\left[r'^{d} - r^{L}\right]; \tag{40}$$

$$r^{L} = \frac{zf_N}{L} - \frac{1}{\gamma}; \tag{41}$$

Finally the government decides whether to default or not comparing the welfare of the economy in the default scenario and in the non-default scenario:

$$G(z,b,d) = \max_{def\epsilon\{0,1\}} \left\{(1-def)G^{nd} + defG^{d}\right\}; \tag{42}$$

where:

$$G^{nd}(z,b,d) \equiv \theta V^{C,nd} + (1-\theta)\, W^{B,nd};$$

$$G^{d}(z,b,d) \equiv \theta V^{C,d} + (1-\theta)\, W^{B,d}.$$

The government decides to default when the welfare of the economy is higher in the default scenario thatn in the non-default scenario.

2.4 Recursive Competitive Equilibrium

Definition Recursive Competitive Equilibrium: A recursive competitive equilibrium is a borrowing and default rule $\left\{b'^{CE}, def^{CE}\right\}$ and a saving rule d'^{CE} with associated consumption, labor, production, funding and credit plans $\left\{c^{CE}, c^{b,CE}, N^{CE}, y^{CE}, d^{*,CE}, L^{CE}\right\}$ and equilibrium prices $\left\{q^{CE}, r^{d,CE}, r^{L,CE}\right\}$ such that:

- The consumption, saving, labor, production, funding and credit plans $\{c^{CE}, d'^{CE}, c^{b,CE}, N^{CE}, y^{CE}, d^{*,C}$ are solution to the maximization problems of the firms, households and banks, given the borrowing decision of the government and the associated default rule: $\left\{b'^{CE}, def^{CE}\right\}$.
- The borrowing and default rule $\left\{b'^{CE}, def^{CE}\right\}$ solve the problem of the government (42) given the first order conditions derived in the maximization problem of the household, firms and bankers.
- The asset pricing equation for government debt satisfies equation (31).
- The asset pricing equation for deposits satisfies equation (18).
- All markets clear.

2.5 Calibration

2.5.1 Functional Forms

There are two agents in this economy: households and banks. Standard GHH preferences over consumption and leisure are assumed for the Household:

$$U^C(c, N) = \frac{(c - \frac{N^\omega}{\omega})^{(1-\sigma)}}{1-\sigma}. \tag{43}$$

Recall that bankers are instead risk neutral and their utility function is linear in consumption.

$$U^B(c^B, N) = c^B \tag{44}$$

The production function for consumption goods employs labor N_t as the only input factor. The production function is chosen to display decreasing returns to scale:

$$y = zN^{1-\alpha}. \tag{45}$$

Productivity z follows a standard AR(1) process: $\log z' = \rho \log z + \epsilon_t$, where $\epsilon_t \sim \mathcal{N}(0, \sigma_z)$ is a normally distributed productivity shock.

2.5.2 Parameters

Table 4 reports parameter values used for the calibration. Values are standard for quarterly calibrations of the Argentinean economy. The discount factors β^H and β^B are chosen to replicate the average default rate of Argentina. Argentina has defaulted on its debt 5 times since its independence in 1816, implying a default probability of 2.5%, which is our calibration target.[10] Parameter φ has not been calibrated in before in the literature. I set the parameter arbitrarily high and equal to 0.8 to reflect the low haircuts in the wholesale market for liquidity. As the calibration of parameter φ is admittedly rather arbitrary I perform a sensitivity analysis on φ in Section 2.6.6.

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[10] While the values of the β^B and β^H are rather low for a quarterly calibration, they are in line with the discount that are calibrated in a similar fashion by Aguiar and Gopinath (2006)), Sosa Padilla (2014) and Mendoza and Yue (2012).

Table 4. Calibrations

Calibrated Parameter		Value	Target Statistics
Labor share final good production	α	0.35	Standard RBC
Discount factor Banks	β^B	0.8	Aguiar and Gopinath (2006)
Discount factor HH	β^H	0.8	Aguiar and Gopinath (2006)
Autocorrelation of TFP shocks	ρ	0.96	Standard RBC
Coefficient of relative risk aversion	σ	2	Standard RBC
Variance of TFP shocks	σ_z	0.034	Standard RBC
Working capital parameter	γ	0.4	Credit Supply/GDP = 24%
Re-entry probability	λ	0.1	Aguiar and Gopinath (2006)
Pledgeability Parameter	φ	0.8	
Autocorrelation of TFP shocks	ρ	0.95	Standard RBC
Weight of HH in planner's objective function	θ	0.5	Equal weights
Frisch elasticity	ω	1.455	Aguiar and Gopinath (2006)
Interest rates on interbank deposits	r^I	0.01	Binding coll. constraint

Table 4 contains parameter values that are used for the simulation of the model and the associated target statistic/source

The working capital parameter γ is set to match the average private credit to GDP ratio 1980-2001: 24%.[11] θ Is the weight that the government assigns to the welfare of the household when it chooses the default rule and debt levels to maximize the welfare of the economy. I set θ equal to 0.5 to assign equal weights to the two sectors of the economy.

2.6 Results

This section examines the performance of the model to replicate regularities presented in Section 2.2 and presents the main conclusions of the paper. I first focus on relation between government debt,credit market and funding conditions. Later I simulate the model and evaluate its quantitative performance. I conclude this section performing a sensitivity analysis over some of the key parameters of the model.

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[11] Credit is measured as the new credit supplied in every period by financial intermediaries. Credit supply is only measured at the yearly frequency. I therefore computed the yearly ratios and assumed that they are constant over quarters.

2.6.1 Default Region and Bonds Prices

Figure 2. Default Set

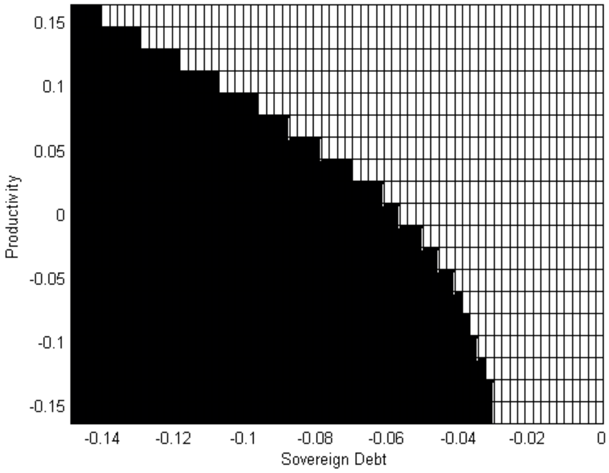

Figure 3. Default Set

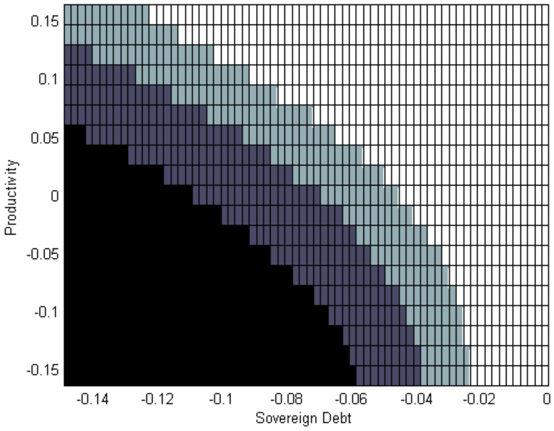

Figure 2 and Figure 3 plot the default set for the model economy.Figure 2 plots the default set for a given level of retail deposits d, while Figure 3 plot the default set for three different levels of retail deposits d

Figure 2 plots the default set of the government for every possible level of productivity (vertical axis) and debt (horizontal axis). The black shaded area is the default region while the white area is the non-default region. The black area becomes wider as we move towards the lower left corner of the figure. The risk of default increases when debt is high and when the productivity is low.[12] The quantitative model of sovereign default that I introduce here extends the standard framework 'a la Arellano (2008) adding a new state variable – household deposits– to the model. Figure 3 plots the default set for three different deposit levels. The size of the default set changes according to the different deposit level, but the shape remains broadly unchanged. Figure 1 in Appendix B.3 plots the relation between the size of the default set and deposits' level d. The relation is non linear. The default set is big for upper-intermediate levels of deposits and it shrinks for high and low deposit levels. This non-monotonic relation is determined by the simultaneous effect of two counteracting forces. On the one side, the greater the size of the deposits the greater is the incentive of the government to default. To make this point more intuitive, imagine that there were no deposits in the economy. In this case the only input left for the production would be government bonds. A sovereign default in this scenario would be extremely disruptive as it would completely stop the loan production. On the other side, there is a second force. As

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[12] Sovereign debt is defined as a negative quantity

bonds and deposits are perfect substitutes for the production of loans, the greater the size of deposits, the smaller the optimal quantity of bonds b' issued at time t. Hence, even when the outstanding quantity of bonds is high the probability of default is low as the future level of debt b' is predicted to be low.

Figure 4. Sovereign Bonds Price

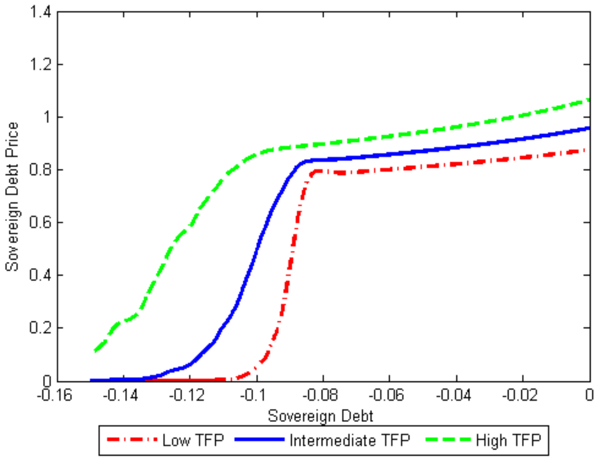

Figure 5. Sovereign Bonds Price

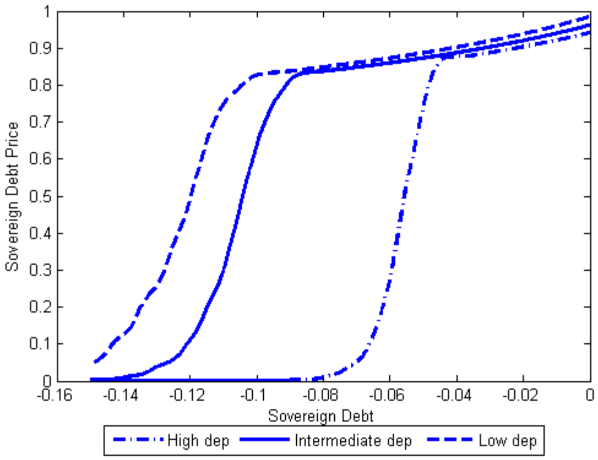

Figure 4 and Figure 5 draw government debt prices as a function of government debt. In Figure 4 each of the three lines corresponds to a different productivity draw. In Figure 5 each of the three lines corresponds to a different level of retail deposits.

According to equation (31) the price of sovereign debt is determined by the expected probability of a default and by the net marginal productivity of wholesale funds. Figure 4 plots the price of sovereign debt q for different values of debt and for three different productivity levels: high, intermediate and low. As sovereign debt increases the price of bonds first declines gently and then suddenly drops to zero. The sudden drop is explained by the risk of default. High levels of debt are associated with high risk of default and higher risk is rewarded with higher yields. The net marginal productivity of wholesale funds, instead, explains the gentle decline in prices for intermediate to low levels of debt. As debt supply increases banks expand their balance sheet using bonds as a collateral for wholesale funds. The marginal productivity of an additional unit of wholesale funds is declining and hence banks's propensity to buy additional government bonds is lower for higher levels of debt. The price of government bonds thus decreases to maintain the equilibrium in the sovereign debt market. Also productivity plays a role in determining government yields. High TFP draws are associated with higher bond prices as the probability of default is lower and, at the same time, the marginal productivity of government debt is higher.

Figure 5 describes the relation between the sovereign debt price q and deposits d. Higher deposit levels increase government incentives to default and are associated with higher government yields.

2.6.2 Market for funds

Figure 6. Wholesale Foreign Deposits

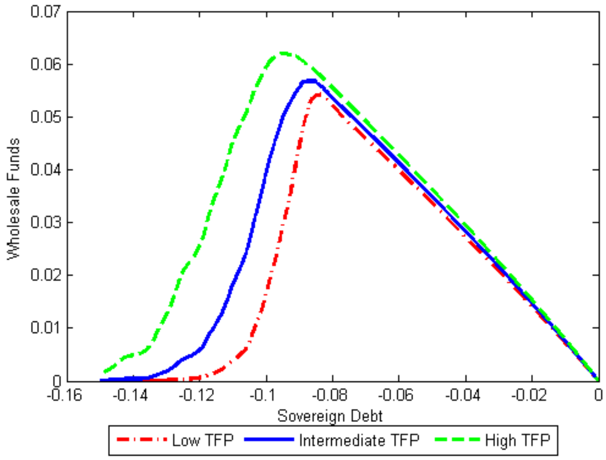

Figure 7. Retail Deposits

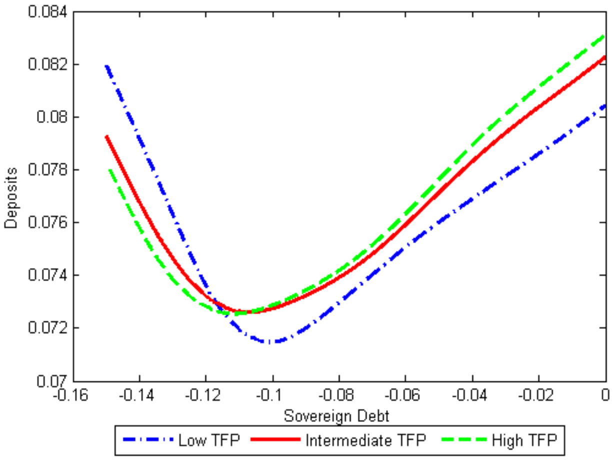

Figure 6 and Figure 7 plot wholesale and deposit levels as a function of of government debt levels. In both figures the different lines correspond to different productivity draws.

Banks collect funds from two different sources: retail deposits d and wholesale funds d^*. While the price of wholesale funds r^I is left exogenous, quantities are not. Banks' ability to attract wholesale funds depends on the value of the collateral that banks can offer. When the government supply of bonds increases, banks expand their balance sheet and attract more funds. The government, however, cannot commit to repay its debt. When debt expands above a certain threshold the default risk increases and debt price starts to contract reducing the overall value of the collateral. The hump-shaped line in Figure 6 describes this non-monotonic relation between the size of debt and wholesale fund levels.

From the perspective of banks household deposits d' and wholesale funds d^* are perfect substitutes in the production of loans. Hence, banks may raise returns r^d on deposits when wholesale funds are scarce in the attempt to attract more resources and to stabilize the production of loans. Figure 7 describes the relationship between household deposits and the size government debt. Deposits are large when the value of banks' holding of government debt qb' is small. This is the case when either government debt b' itself is small or when its price q is low. Comparing Figure 6 and Figure 7 it is evident that the two funding sources are substitutes. Banks attract more retail deposits when the wholesale ones are smaller.

2.6.3 Credit market

Figure 8. Loans to Private Sector

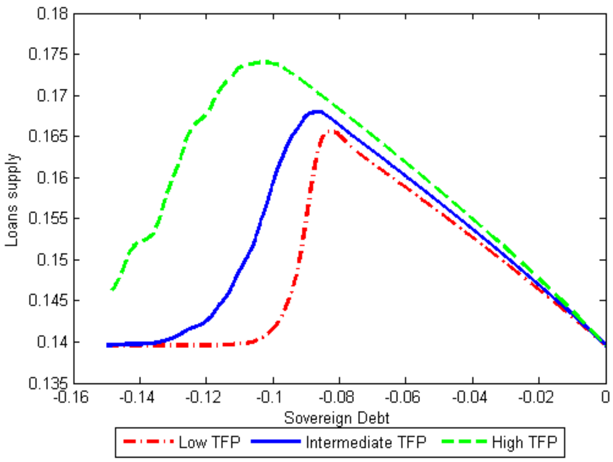

Figure 9. Interest Rates on Loans

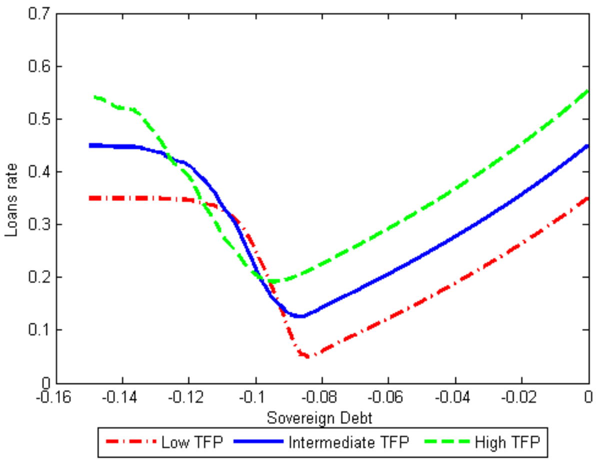

Figure 8 and Figure 9 describe the relation between the supply of credit and the interest rates on loans as a function of the government debt level. In both figures the different lines correspond to different productivity draws.

Banks ability to extend loans L is affected by turbulences in the sovereign bonds market. Figure 8 describes the behavior of loan supply as a function of government debt b for three different productivity levels. Loan supply increases together with the size of government debt up to the point in which the probability of default reduces the price of government debt, making funding more difficult and reducing the resources available for credit. Figure 9 plots the interest rate prevailing in the credit market for the three different productivity levels. The interest rate on loans r^L clears the credit market making the loan demand equal to the loan supply. Interest rate dynamics are inversely related to movements in the loan supply L. When the supply of credit is low, interest rates are high and vice versa.

2.6.4 Simulations

The model was simulated 100 times over $20,000$ periods to compute moments which are summarized in Table 5. The probability of default is 2.1% which is not too far from the

Table 5. Simulated Moments

Moments:	Model	Data
Sovereign Debt Market:		
Default probability	0.021	0.025
Domestic Debt/GDP ratio	0.28	0.28
Mean debt price	0.83	0.901
$\rho(q, y)$	0.47	0.89
Credit Market:		
Mean Credit/GDP ratio	0.26	0.24
Mean r^L	0.15	
$\rho(q, r^L)$	-0.30	
$\rho(q, L)$	-0.81	-0.28
Market for Funds:		
Deposit/GDP ratio	0.20	
Wholesale funds/GDP ratio	0.196	
$\rho(q, r^d)$	-0.87	

The table contains moments obtained simulating the model for for 100 time over 20,000 periods and averaging across the simulations

2.5% observed in Argentina from 1816 till now. The predicted mean debt to GDP ratio is 28% which matches perfectly the Argentinean domestic debt to GDP ratio.[13] The average yield of Argentinean government bonds is 10.1% in the data and it is 12.5% in the model.

The model also performs broadly well to reproduce key moments in the credit market. The average credit to GDP ratio is predicted to be 0.26, while it is found to be 0.24 in the date. The model also predicts a negative correlation between government debt price q and the interest rate on loans r^L as reported in Table 5. This is true however only in proximity of a default episode. When I compute the same correlation over periods that are at least 6 quarters away from a sovereign default episode, the correlation between r^L and q becomes positive. This is because in normal times productivity drives the credit market. When productivity is high, the marginal revenues of loans are high and the risk of a default is low. Hence the correlation between r^L and q is positive. However, when the risk of default is high, different forces are at play. With high default risk dynamics in the credit market are

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[13] Government debt is only domestic in this economy as it is entirely owned by domestic banks .

not driven by productivity shocks, but they are explained by changes in the supply of credit. Funding becomes more difficult and banks need to cut the credit supply triggering a credit crunch in the economy.

Finally, looking deposit rates r^D I find that they are negatively correlated with bond prices q. This inverse relation is induced by the substitutability between deposits d' and wholesale funds d^*. When government yields are low, banks enjoy an easy access to the wholesale market for funds and the demand for retail deposits is low. This in turn bids interest rates on of retail deposits down. The opposite happens when the access to wholesale markets becomes more difficult.

2.6.5 Dynamics around default

Figure 10. Loans to Private Sector

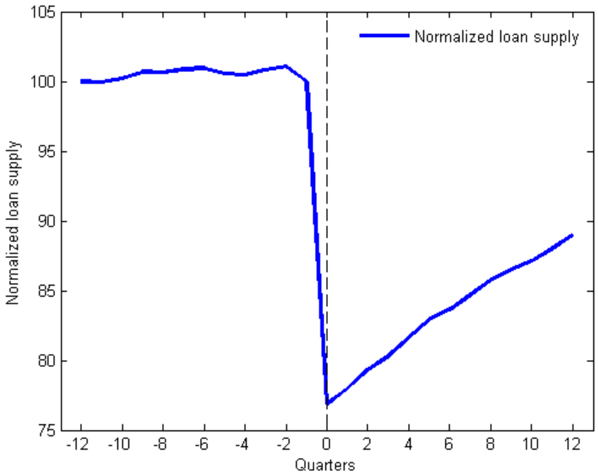


Figure 11. Interest Rate on Loans

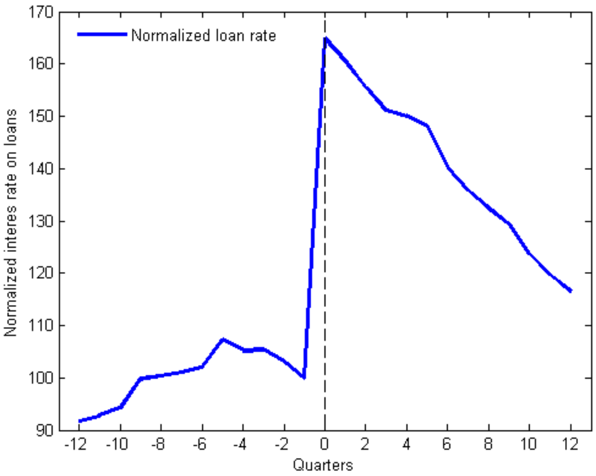


Figure 10 and Figure 11 respectively describe the evolution of the loan supply and the interest rate on loans around sovereign default episodes. Data are normalized by the value of the variable one quarter before the default happens.

Consequences of a sovereign default are severe. Figures 10 to 13 describe the simulated evolution of the credit market, output and other economic variables around a default episode. According to figure 10 loan supply starts to decline about a year before the actual default takes place. According to the model economy a default episode generates a contraction of the loan supply of about 23% which is not far from the 27% observed in Argentina in 2001. Loan supply only recovers slowly afterwards. Three years after the default the loan supply is still 10% smaller then it was before the crisis. The fall in the loan supply is mirrored by

Figure 12. Deposits

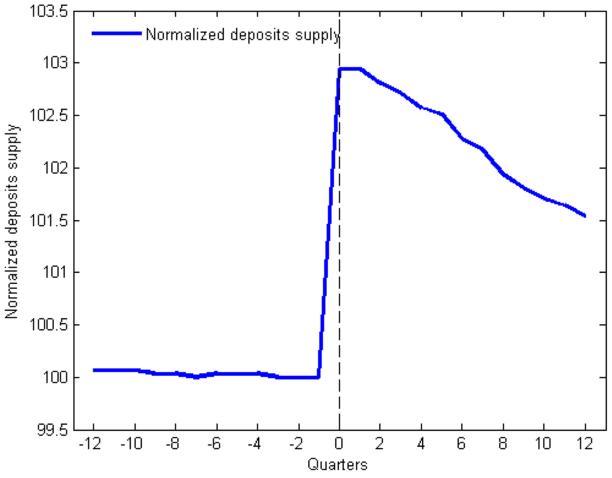


Figure 13. Output

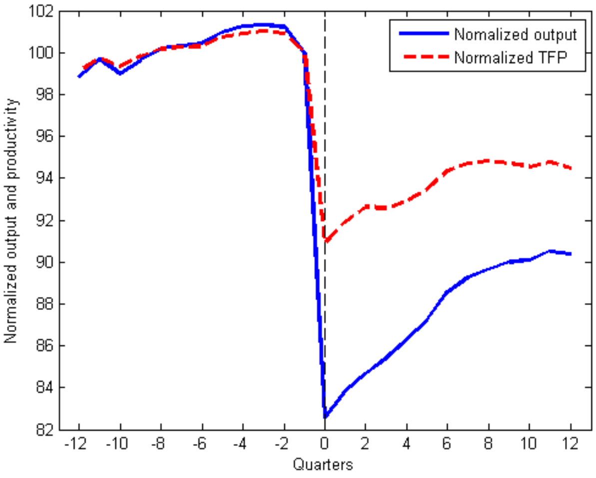


Figure 12 and Figure 13 respectively describe the evolution of retail deposits and output around sovereign default episodes. Data are normalized by the value of the variable one quarter before the default happens. The solid line in Figure 13 describes the evolution of output in the model economy. The dashed line instead describes the evolution of output in a similar model without financial frictions and the TFP is the only driver of the economy.

the surge in the interest rates on loan (Figure 11). r^L Increases by more then 60% around default.

In proximity of a sovereign default crisis the model predicts that the deposit rates r^D increase by 6% (Figure 3 in Appendix B.3) making households more willing to save. As a result retail deposits d' increase by 3% as reported in Figure 12. Deposit expansion is not large enough to off-set the concurrent contraction of wholesale funds. The contraction of the credit supply drives the economy into a recession. Higher credit rates increase the operating cost of firms. In equilibrium wage rates fall and the supply of labor also contracts causing a contraction of the output.(Figures 4 and 5 in Appendix B.3). According to the simulated model output falls by roughly 18%. Following the default in December 2001, Argentina experienced a 14% contraction of output in the first quarter of 2002.

To outline the role of the banking sector in figure 13, I compare the evolution of the output in the simulated model (solid line) with the evolution of output in the economy where there are no financial frictions (dashed line): that is $\gamma \to 0$. In this case there is no interaction between conditions in the credit market and conditions in the labor market.. Upon default the contraction of output and labor is only determined by the contraction of productivity. The presence of a banking sector, instead, amplifies the fluctuation of output upon default.

Labor and output not only contract because of the negative productivity shock. They also contract further as the credit supply becomes more difficult making labor more expensive for firms.

2.6.6 Sensitivity Analysis

Table 6. Sensitivity Analysis

	Default Rate	B/Y	% GDP loss	% Credit fall	Increase in r^L
Data	2.0%	0.28	-14%	-27%	
Benchmark	2.1%	0.28	-18%	-23%	0.6
			Pledgeability parameter: $\varphi = 0.8$		
$\varphi = 0.7$	2.9%	0.22	-15%	-22%	0.27
$\varphi = 0.9$	1.8%	0.29	-19%	-25%	0.8
			W-K constraint. Benchmark value: $\gamma = 0.4$		
$\gamma = 0.35$	2.4%	0.23	-16%	-18%	0.28
$\gamma = 0.45$	0.6%	0.37	-20%	-25%	0.75

This table reports moments obtained from model simulation for a number of different parameters. Moments are obtained simulating the model for 10,000 periods and averaging across 100 simulations

Parameter φ influences the exposure of the financial sector to the sovereign debt risk. When φ tends to zero the borrowing constraint (16) becomes more binding making wholesale funding more difficult. Clearly, the smaller φ, the smaller is the consequence of a default crises on the banking sector because wholesale funds are already small. Table 6 reports simulated moments for two different values of φ. When φ is low, the economy experiences defaults more frequently and smaller debt levels are sustainable in equilibrium.

I also perform a sensitivity analysis over the key parameter γ, which determines the extent to which production relies on credit from the banking sector. Taking inspiration from the work of Gennaioli et al. (2014) I interpret γ as the parameter describing the development of financial institutions. High values of γ imply that credit to the private sector is a pervasive feature of the economy and therefore financial system are well developed. On the contrary, low levels of γ are typical of less financially developed countries. Table 6 reports simulated moments for three different levels of γ: high, intermediate and low. When γ is high, defaults happen less frequently, but they more disruptive. The intuitions is straightforward. With high values of γ firms are more vulnerable to changing conditions in the credit markets. This fragility is internalized by the government that avoids defaults.

2.7 A Simple Model Application: Lender of Last Resort Intervention

In this section I present a simple application of the model. I study the consequences of the decision of the lender of last resort to accept government bonds as a collateral applying a fixed haircut to the face value. This policy resembles closely the non-conventional monetary policy adopted by the European Central banks to mitigate the impact of the sovereign debt crisis on the banking sector. While the analysis presented here is far from being exhaustive –as for instance the policy intervention is exogenously assumed–, it provides an example of how this model can be employed for the analysis of policy decisions.

Suppose that the lender of last resort announces that it will accept an unlimited quantity of government bonds b' as a collateral as long as the government issuing bonds is not defaulting. Suppose also that the central bank sets the value of the collateral to be equal to a fixed fraction υ of the face value of bonds. In this case it will always be possible for banks to convert b' bond holdings into $\upsilon b'$ wholesale funds as long as the government does not default. Asset pricing equation (31) becomes:

$$q = \begin{cases} \beta^B \frac{1-Pr(def')}{1-\varphi(r^L-r^I)} & if\ q > \upsilon \\ \beta^B\left(1-Pr(def')\right) + \varphi\upsilon\left(r^L - r^I\right) & if\ q \leq \upsilon \end{cases} \tag{46}$$

Table 7 compares simulated moments obtained from the standard model with those obtained replacing the government bonds pricing equation (31) with (46). Central bank intervention mitigates tensions in the credit market. The average interest rate applied on loans decreases from 15% to 13%. The intervention also improves conditions in the debt market. The probability of default decreases from 2.1% to 1.8% and the average price of sovereign debt increases. As refinancing constraints relaxes, the government can expand the supply of sovereign bonds and debt increases both in absolute terms and relative to the GDP. The central bank intervention, in other words, alleviates the pressure both on the credit market and on the sovereign debt market, and makes higher debt to GDP levels sustainable in equilibrium. As the debt to GDP ratio expands it may be difficult for the lender of last resort to repeal the policy without causing a shock to government finances.

Table 7. Simulated moments for model with Policy Intervention

Moments	Model (CB Intervention)	Model (Standard)	Data Data
Sovereign Debt Market:			
Default probability	0.018	0.021	0.020
Mean Debt/GDP ratio	0.30	0.28	0.28
Mean debt price	0.90	0.83	0.901
$\rho(q, y)$	0.53	0.47	0.89
Credit Market:			
Mean Loan/GDP ratio	0.25	0.26	0.24
Mean r^L	0.13	0.15	
$\rho(q, r^L)$	-0.33	-0.30	
$\rho(q, L)$	-0.83	-0.81	-0.28
Funds Market:			
Deposit/GDP ratio	0.20	0.20	
Wholesale funds/GDP ratio	0.22	0.196	
$\rho(q, r^d)$	-0.50	-0.87	

The table contains moments obtained simulating the model for for 100 time over 20,000 periods and averaging across the simulations

2.8 Conclusion

When a sovereign debt crisis hits the economy the banking sector is at the forefront. This paper identifies a mechanism that explains how sovereign debt crises propagate from public balances to the real economy. Banks balance sheets expand when debt increases and contract in proximity of sovereign defaults. The cyclicality in the banks balance sheet magnifies the consequences of a sovereign debt crisis. This magnification effect is greater in more developed financial systems and when firms are more dependent on bank loans.

In December 2011 the European Central Banks launched a long term refinancing program directed to mitigate the impact of sovereign market turbulences on the banking sector. In this paper I provide a theoretical framework for the analysis of this type of non non-conventional policies. My conclusions are that this intervention can reduce the tension both in the credit market and in the market for funds, but they also increase the indebtedness of the government.

The model presented in this paper can be extended in many directions. I believe that an interesting area for future research is the study of reverse relation between banks balance sheets and government debt. Sovereign debt crisis in countries like Ireland, Iceland and, to a certain extent, Spain originated first in the banking sector and later spread to the public sector. Banks were bailed out by governments and this caused an unexpected pressure on the public finances. This relationship is not captured yet in the model as the possibility for banks to default is ruled out by assumption. Introducing banks default would certainly enrich the model and improve our understanding of the relation between the banking system and government debt.

A second avenue for research relates to the study of the possible policy intervention to avoid contagion between public finances and banks balance sheet. In this paper I study the consequences of a central bank intervention in a stylized framework that assumes an exogenous central bank intervention. However, central banks typically face trade-offs when deciding whether to intervene or not. For instance, liquidity injection in the wholesale market for funds may lead to excessive risk taking and induce moral hazard in the banking sector. I believe that the introduction of a fully specified central bank problem could help to study the optimal design of financial regulation and monetary policy in presence of a default risk.

Appendix B

Appendices for Chapter II

B.1 T-tests

Table 1. T-test for the Means

Variable	Mean Low Exposure	Std.Dev Low Exposure	Mean High Exposure	Std.Dev High Exposure	t-test
Δ Deposits	-0.077	0.005	-0.071	0.009	-0.44
Deposit Interest Rates	519	11.3	494	34.6	0.78
Δ Secured Wholesale Dep.	0.212	0.052	0.253	0.49	-0.55
Δ Unsecured Wholesale Dep.	0.118	0.052	-0.050	0.079	1.74
Secured Interest Rates	941	19.6	916	38.7	0.59
Δ Credit Supply	0.001	0.0004	0.002	0.0005	-0.56
Loans Interest Rates	469	4.00	463	16.2	0.49

Columns 1 and 2 report means and standard deviations for the subset of banks whose sovereign debt holdings are below the median value. Columns 3 and 4 report means and standard deviations for the subset of banks whose sovereign debt holdings are above the median value. Finally the last column reports the value of the t-test comparing the two means

B.2 Solution Algorithm

The following algorithm solves the Ramsey problem presented in Section 3.

1. Discretize TFP shocks and create a vector of length Z containing all the possible productivity values.
2. Generate a vector of length D containing all the possible deposit values.
3. Generate a vector of length B containing all the possible values for debt.
4. Generate a grid for the household saving (deposit) choice. The grid contains B*B*Z*D rows and D columns. The first B refers to all the possible levels of debt that the government can choose in time t. The second B refers to the outstanding level of debt. Z is the vector of TFP shocks. D is the vector of outstanding deposit levels and the D columns contain all the possible choices for deposits.
5. Guess an initial value for the price of bonds q
6. Use the competitive equilibrium conditions to derive quantities and prices at each single point of the grid both in the default scenario and in the non-default case.
7. Compute the utility function of the Households at each point of the grid both in the default scenario and in the non-default case.
8. Iterate the value function of the Household till convergence in both scenarios.
9. Use the policy function of the Household to determine the optimal deposit choice for each choice of government debt b', each outstanding level of debt b and each shock z and outstanding level of deposit d.
10. Reshape the (B*B*Z*D)x(1) policy function for d' in to a (D*Z*B)*(B) matrix. Columns contain the optimal choice of b' for each state $\{d, z, b\}$ and each choice b'
11. Generate the (D*Z*B)*(B) grid for the government choice of debt b'
12. At each point of the (D*Z*B)*(B) grid compute Household utility and of Bank utility given the choice of d'
13. Compute the utility function of the Government as the weighted sum of the Government utility function both in the default scenario and in the non-default scenario

14. Iterate the value function of the Government until convergence

15. Compute the probability of default comparing value function in the default and in the non-default scenario and update the price of the sovereign bond using equation (31)

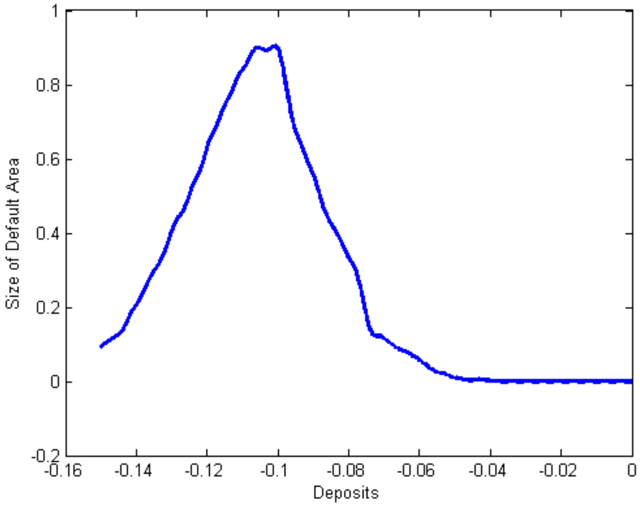
16. Reshape the (D*Z*B)*(B) matrix for q in to a (B*B*Z*D)*(D) matrix. Recall that households choice of deposit does not affect the price of debt.

17. Repeat steps 6-16 until q has converged.

B.3 Additional Tables and Figures

B.3.1 Default Region Size

Figure 1. Default Set Size

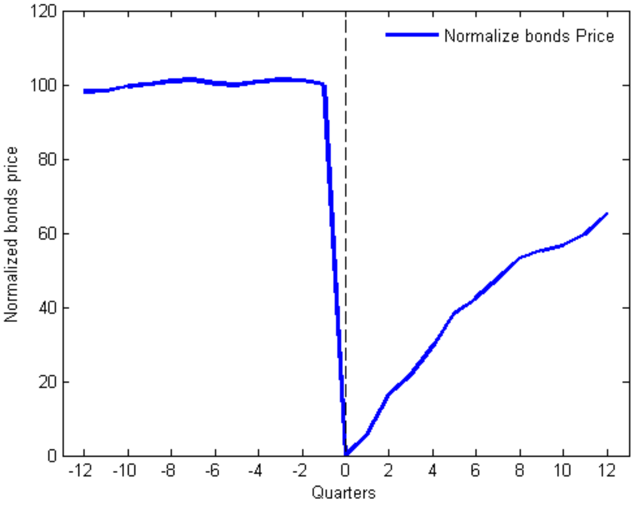


This figure describes how the size of the default set evolves as a function of the deposit levels

B.3.2 Simulations around default

Bonds Price around Default

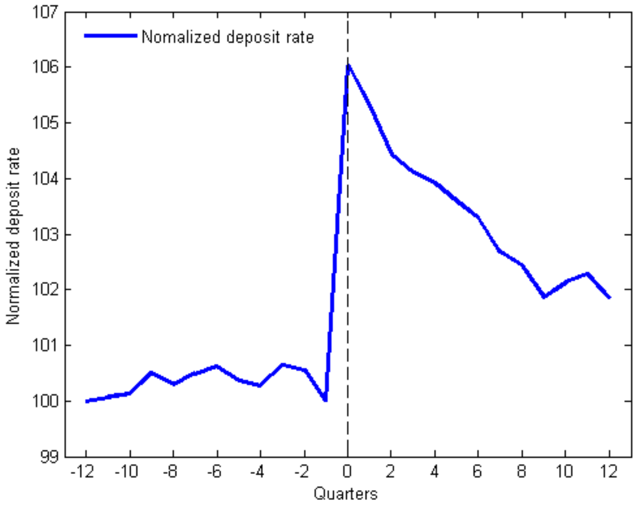
Figure 2. Sovereign Bonds Price



This figure describes the evolution of government bond price around a sovereign default episode. Data are normalized by the value of the variable one quarter before the default happens.

Interest rate on deposits around default

Figure 3. Interest Rate on Deposits



This figure describes the evolution of deposit rates around sovereign default episodes. Data are normalized by the value of the variable one quarter before the default happens.

Labor Market around default

Figure 4. Labor Supply

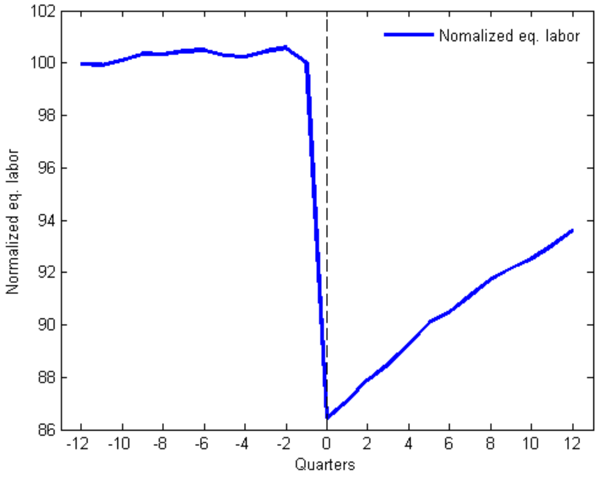


Figure 5. Wages

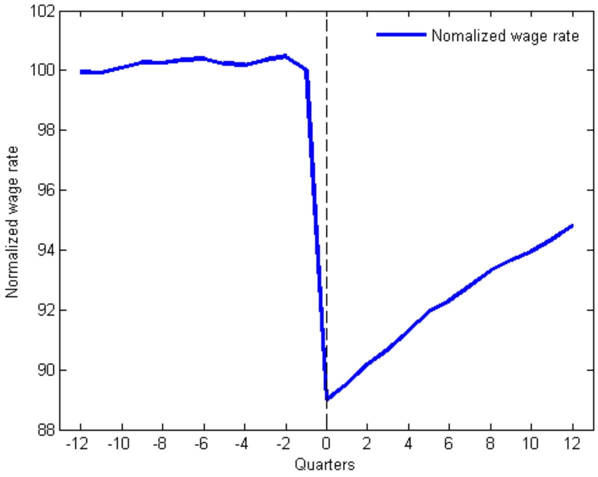


Figure 4 and Figure 5 describe the evolution of the labor supply and the wage rate around sovereign default episodes respectively. Data are normalized by the value of the variable one quarter before the default happens.

Chapter 3

What moves international stock and bond markets?

3.1 Introduction

The increased magnitude and volatility of cross-border capital flows have been a distinguishing feature of financial globalisation over the last two decades. The composition of these flows has also changed. International mutual funds play an increasingly important role in the landscape of international investment. These funds are progressively entering local-currency bond markets, and bond flows have increased their importance relative to equity flows and cross-border bank lending (International Monetary Fund, 2014).

The expanding size of the international mutual funds industry, together with its pro-cyclical behaviour during crises and its role in the international transmission of shocks (Jotikasthira et al., 2012; Raddatz and Schmukler, 2012), have recently attracted the interest of policymakers because of the associated risks for financial stability (Haldane, 2014). Therefore, the study of the behaviour of international mutual funds can inform policymakers on the optimal policy response to capital flows and the reform of the international monetary system. While there has been a considerable debate about the relationship between international (mostly equity) portfolio flows and asset prices,[1] surprisingly little is known about the relation between flows and the proximate drivers of these asset prices, such as news about discount

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[1] See, e.g., Bohn and Tesar (1996); Froot et al. (2001); Froot and Ramadorai (2008); Jotikasthira et al. (2012); Raddatz and Schmukler (2012).

rates and expected cash flows. This paper tries to fill this gap in the literature. First, we decompose international equity and bond market returns into changes in expectations of future dividends, inflation, interest rates, exchange rates, and discount rates, and study their relative importance in driving unexpected returns. Second, we analyse how these different components are associated with international mutual fund flows.

Our work is related to two literatures. First, there is an important literature that studies the joint dynamics of international capital flows and equity returns. A seminal paper is Bohn and Tesar (1996): they find that foreign investors are "return chasers," i.e. they provide evidence that foreign investors react to changes in expected returns. There are two related aspects of the trading behaviour of money managers: herding, i.e. the tendency of a group of managers to trade in the same direction; and momentum trading (also called positive-feedback trading), ie. buying past winners and selling past losers. Both aspects have been initially studied in the US market by Lakonishok et al. (1992). A number of recent papers (Froot et al., 2001; Froot and Ramadorai, 2008; Jotikasthira et al., 2012; Raddatz and Schmukler, 2012) find evidence for international funds that is consistent with this behaviour. Another view focuses on the impact of flows on returns. For example, Froot et al. (2001) find that equity inflows have a positive impact on stock market returns. Jotikasthira et al. (2012) show that international mutual funds' portfolio reallocations have a significant price effect. The increase in price due to inflows may be temporary, reflecting "price pressure," or permanent, such as in the case of information-driven flows (Kyle, 1985). Lou (2012) finds that flow-driven trading by mutual funds can explain return predictability, price pressure, and stock price momentum.

Our paper is also related to a second literature on empirical asset pricing. Mainstream research in empirical asset pricing asserts that discount-rate variation is its "central organizing question" (Cochrane, 2011).[2] This conclusion stems from the finding, mostly reported for the US equity market, that expected return shocks account for most of the variation of asset price returns, with little role for variation in expected cash flows.[3] However, a number of recent papers find more ambiguous results about the relative size of these two components. For example, Vuolteenaho (2002) finds that the cash-flow component always prevails when studying firm-level stock returns in the US. Phylaktis and Ravazzolo (2002), concentrating on a sample of countries in the Pacific-Basin region, find that the cash-flow shock component prevails over the expected-return component. More recently, Plazzi (2010) finds that

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[2] As in Cochrane (2011), in this paper we use the terms "discount rate," "risk premium," and "expected return" interchangeably.

[3] See also Cochrane (2008); Van Binsbergen and Koijen (2010); Koijen and Nieuwerburgh (2011) for the evidence on US aggregate stock market, Ang and Bekaert (2007) for the evidence on a small number of advanced economies, and Plazzi et al. (2010) for the evidence on US commercial real estate.

expected return shocks prevail over cash-flow shocks in the US, while the opposite is true in the UK. Rangvid et al. (2013) find that in a large number of non-US countries, dividend growth is predictable using the dividend yield as a predictor, which they interpret as evidence that news about future dividends is the main driver of return innovations.

We contribute to the two strands of the literature in three ways. First, we extend the analysis to 31 countries, including 18 advanced economies and 13 emerging markets. Second, we analyse both stock and bond markets in all these countries. With few exceptions, the literature has focused on the equity market. By looking at the bond market, we extend the analysis to a large share of global capital markets that has been perhaps under-represented in earlier studies. Third, we study the interaction between the return components and international portfolio flows.

We decompose the innovations in international asset returns into revisions in expectations of future real cash payments to investors, real interest rates, exchange rates, and discount rates. We find that news about future real cash payments is the main source of variation for bond and equity excess returns. Importantly, our findings are at odds with the evidence commonly found in the literature, reported mostly for the US equity market, that asset price movements are mainly due to innovations in expected returns, or equivalently to discount rate variation (e.g., Cochrane, 2011). News about exchange rate changes and real interest rate changes contributes little, if anything, to the variance of unexpected equity returns. This finding is consistent with that of Ammer and Mei (1996) and Phylaktis and Ravazzolo (2002) and it is also in line with the results of the cross-sectional asset pricing exercise of Cenedese et al. (2015), who find that returns on international equity markets are broadly unrelated to exchange rates.

Next, we explore the interaction between these return components and international portfolio flows. When markets are fully rational and complete and there are no information asymmetries nor any restrictions on capital movements, the relation between international portfolio flows and asset returns is of little interest. Returns react to changes in fundamentals and flows simply adjust to the new returns. On this basis, traditional macro models have largely neglected flows and concentrated on returns instead, and generally assume there is only contemporaneous relation between capital flows and asset returns.

A number of papers, however, have shown the existence of significant non-contemporaneous correlation between flows and returns. Using equity flow data for a large custodian bank, Froot et al. (2001) find that flows are affected by past returns and that inflows forecast future equity returns in emerging markets. Using similar data for the foreign exchange market, Froot and Ramadorai (2005) study the correlation between foreign exchange flows and currency returns and find that the contemporaneous correlation between flows and returns varies when it is calculated over different time horizons. They interpret this finding as evidence that either flows predict returns or vice-versa, or both. To the best of our knowledge, our paper is the first one to study the non-contemporaneous relation between portfolio flows and the proximate drivers of asset returns in the context of international equity and bond markets.

When return shocks are driven by cash-flow news, we find evidence of a short-term trend chasing pattern in the equity market. In the long run, instead, cash-flow news is associated with equity outflows. As Froot and Ramadorai (2005) note, if investors trend-chase mechanically, we should observe an inflow after an appreciation of asset prices, even when this appreciation is temporary as implied by a fall in the discount rates. To test for mechanical trend chasing, we evaluate investors' response to a negative discount rate shock, keeping the other news components constant.[4] We find that negative discount rate shocks predict equity outflows. International investors respond to a short-term transitory appreciation (i.e. a negative discount rate shock) by selling and to a permanent appreciation (i.e. a cash-flow shock) by buying. This evidence is stronger for institutional investors relative to retail investors, as for the latter group the results are not statistically significant. Real interest rate shocks and exchange rate shocks are not associated with equity flows.

Contrary to what we observe in the equity market, bond flows toward emerging economies are influenced by US real interest rate shocks. An upward revision of US interest rate expectations is associated with bond outflows in the short run. This result appears consistent with the view that debt flows to emerging markets are strongly correlated with policy interventions and the business cycle of developed economies; see, e.g., Ahmed and Zlate (2013). Discount rates shocks, inflation shocks, and exchange rates shocks instead are not associated with bond flows.

The rest of the paper is organised as follows: Section 3.2 describes the empirical methodology. Section 3.3 describes our database. Section 3.4 describes and comments on our empirical results. Section 3.5 concludes.

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[4] Remember that, holding the other components constant, a fall in expected future returns may be achieved only trough an increase in today's returns.

3.2 Empirical Methodology

3.2.1 International Equity Return Decomposition

Our analysis aims at studying the relation between capital flows and asset excess returns. A first step in this direction is to understand the dynamics that govern excess return movements. Campbell (1991) proposes an approximate present-value identity and shows how that equity return shocks can be decomposed into cash-flow shocks and expected-return shocks. An unexpected increase in excess returns today can be due to an increase in expected future cash flows (dividends), a downward revision of expected future excess returns (equivalently, a fall in risk premia), or both.

Ammer and Mei (1996) extend the Campbell (1991) decomposition to an international setting. We follow their methodology and decompose excess return shocks for foreign (non-US) stocks into four components: expected return shocks; cash-flow shocks; real interest-rate shocks; and real exchange rate shocks.

The approximate present-value relation for a foreign stock excess return:

$$f_{t+1} - E_t f_{t+1} = (E_{t+1} - E_t)\left(\sum_{j=0}^{\infty}\rho_e^j \Delta d_{t+1+j} - \sum_{j=0}^{\infty}\rho_e^j r_{t+1+j} - \sum_{j=0}^{\infty}\rho_e^j \Delta q_{t+1+j} - \sum_{j=1}^{\infty}\rho_e^j f_{t+1+j}\right), \quad (1)$$

where f is the log foreign equity return in excess of the risk-free rate, r is the real interest rate, d is the log real dividend paid, q is the log real exchange rate, and ρ_e is a constant of linearization that is slightly less than one.[5] We can write Equation (1) more succinctly to express the unexpected excess equity return $\tilde{f}$ as:

$$\tilde{f} = \tilde{f}_d - \tilde{f}_r - \tilde{f}_q - \tilde{f}_f, \quad (2)$$

where $\tilde{f}_d$ is the cash-flow news, $\tilde{f}_r$ is the interest-rate news, $\tilde{f}_q$ is the exchange rate news, and $\tilde{f}_f$ is the expected excess returns news.

Equation (2) is a dynamic accounting identity that imposes internal consistency on expectations: it is not a behavioural model. It says that, other things being equal, an upward

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[5] More specifically, the constant ρ_e is calculated as $\rho_e = \frac{1}{1+\exp(\overline{dp})}$, where $\overline{dp}$ is the sample mean of the log dividend-price ratio; in our sample, ρ_e averages 0.9972 across countries.

revision in forecast future dividends will have a positive impact on today's stock return. On the contrary, an increase in expected future excess returns that is not accompanied by revisions in forecast dividends, interest rates and exchange rates will lead to a fall in today's stock price so that higher future returns can be generated from the same cash flow. Similarly, positive news about future interest rates is negatively related to today's stock prices.

3.2.2 International Bond Return Decomposition

An equation analogous to (2) can be derived for the bond market. For international long-term coupon bonds, shocks to the foreign one-period log bond excess return x can be decomposed approximately as:

$$x_{t+1} - E_t x_{t+1} = (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho_b^j \left(-\pi_{t+1+j} - r_{t+1+j} - \Delta q_{t+1+j} - x_{t+1+j} \right), \tag{3}$$

where π is the log one-period inflation rate, and ρ_b is a constant of linearization that is slightly less than one.[6] We can write Equation (3) more succinctly to express the unexpected excess bond return $\tilde{x}$ as:

$$\tilde{x} = -\tilde{x}_\pi - \tilde{x}_r - \tilde{x}_q - \tilde{x}_x, \tag{4}$$

where $\tilde{x}_\pi$ is the inflation news, $\tilde{x}_r$ is the interest-rate news, $\tilde{x}_q$ is the exchange rate news, and $\tilde{x}_x$ is the bond expected excess returns news.

This decomposition says that positive unexpected excess bond returns are associated to either a negative change in expected inflation rates, or a decrease in expected future real interest rates or excess bond returns, or real exchange rates. Changes in expected inflation rates alter the expected real value of the fixed nominal payoff of the bond; even if the expected real bond returns are constant, a variation of expected inflation rates can generate capital gains or losses.

Campbell and Ammer (1993) derive a similar decomposition for unexpected excess returns on domestic n-period zero-coupon bonds. Unlike ours, their decomposition is exact, does not involve discounting, and sums up to $n-1$ instead of ∞. But given that our dataset consists of yields on international long-term coupon bonds, a different decomposition applies to our case. Engsted and Tanggaard (2001) build on Shiller and Beltratti (1992) to derive

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[6] More specifically, the constant ρ_b is calculated as $\rho_b = \exp\left(-\overline{Y}\right)$, where $\overline{Y}$ is the mean consol yield; in our sample, ρ_b averages 0.9961 across countries.

the decomposition for a domestic long-term coupon bond. The decomposition in Equation (3) extends that of Engsted and Tanggaard (2001) for international local-currency long-term coupon bonds.

3.2.3 VAR Specification

We can estimate the components of the decompositions in equations (1) and (3) by resorting to a vector autoregression (VAR) model. We derive expectations using forecasts from the VAR:

$$z_t = \sum_{j=1}^{p} A_j z_{t-j} + u_t, \tag{5}$$

where p is the number of lags that we include in our VAR.[7] The vector z includes the following state variables:

$$z = \left[f, \text{flows}_e, x, \text{flows}_b, r, \Delta q, \Delta i, dp, \Delta d, f_{US}, x_{US}, dp_{US}, \right]', \tag{6}$$

where f and x are respectively the log excess returns of the foreign equity market and the foreign bond market; r is the US real interest rate, Δi is the change in the nominal US T-bill rate, dp is the foreign dividend-price ratio, Δd is the log dividend growth, and Δq is the change in the log real exchange rate. These variables are among those most commonly suggested in the return predictability literature (see, e.g., Welch and Goyal, 2008; Rapach and Zhou, 2013). The inclusion of the dividend-price ratio is particularly important, not only because it is a potentially good forecaster of equity returns, but also because the equity return decomposition holds only conditional on an information set that includes prices (Campbell and Ammer, 1993; Engsted et al., 2012b). We include the US return and dividend-price ratios (f_{US} and dp_{US}) because they turn out to improve the return forecasts in our sample; this is in line with Rapach et al. (2013), who find that lagged US returns significantly predict returns in many non-US countries. Finally, we also include information about portfolio flows into the equity and bond markets (flows_e and flows_b), measured as the ratio of their dollar value to the relevant country's nominal GDP, because we want to study the interaction between returns and international investment flows.[8]

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[7] We select the optimal number of lags using the Akaike Information Criterion; this optimal number of lags turns out to be equal to one in our sample.

[8] A potential additional predictor for bond returns could be the Cochrane and Piazzesi (2005) factor based on forward rates. However, there are not enough data available to build this factor for our sample of 31

Innovations in equity excess returns and their components can now be obtained directly from the VAR. For instance, given that:

$$(E_t - E_{t-1})z_{t+j} = A^j u_t,$$

innovations to equity excess returns $\tilde{f}$ can be obtained directly as $\tilde{f} = e1' u_t$, where $e1 = (1, 0, \ldots, 0)'$ is a selection vector that picks out the innovation in equity excess returns. By the perpetuity formula, infinite-horizon cumulative innovations can be derived as $(E_t - E_{t-1}) \sum_{j=1}^{\infty} z_{t+j} = A(I - A)^{-1} u_t$. By the same token, we have that $(E_t - E_{t-1}) \sum_{j=1}^{\infty} z_{t+k+j} = A^{k+1}(I - A)^{-1} u_t$, so that the innovation in cumulative expected excess returns k periods forward, $(E_t - E_{t-1}) \sum_{j=1}^{\infty} (\rho_e^j f_{t+j} - \rho_e^{j+k} f_{t+k+j})$, can be derived as:

$$\tilde{f}_{f,t+k} = e1' \Phi(k) u_t,$$

where $\Phi(k)$ is the cumulative innovation matrix k periods forward:

$$\Phi(k) = \left(\Gamma - \Gamma^{k+1}\right) (I - \Gamma)^{-1},$$

with $\Gamma = \rho_e A$. We can retrieve the real rate component and the exchange rate component of the equity return decomposition in Equation (2) in an analogous fashion.

For innovations beginning at time t, the infinite-horizon cumulative matrix is $\Phi \equiv \Phi(\infty) = \Gamma(I - \Gamma)^{-1}$. The total impulse response function for the i-th shock $ei' \Psi u_t$ is defined as the sum of the infinite-horizon cumulative expected innovations and the shock itself: $ei' \Psi u_t = ei' \left(I + \Phi(\infty)\right) u_t$. For innovations beginning at time $t + k$, the infinite-horizon cumulative matrix is $\Phi - \Phi(k)$; when we include the shock itself, the infinite-horizon cumulative matrix is $\Psi - \Psi(k)$. In the presentation of the results in Section 3.4, we refer to the cumulative innovations beginning at time t and up to the first quarter ($k = 3$ using monthly data) as the "short-run" innovations. We refer to the infinite-horizon cumulative innovations beginning after the first quarter as the "long-run" innovations.

Finally, we can back out the expected cash-flow component $\tilde{f}_d$ by rearranging Equation (2)

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countries, which include both developed and emerging markets. Also, it is not obvious exactly which data (more specifically, which forward rates) to use to construct this factor in our framework, and particularly for them to be consistent with the dependent variable, i.e. bond returns. Our bond returns are derived from JP Morgan benchmark indices, which track the performance of a varied basket of fixed rate issuances, weighted by market capitalisation and whose inclusion in the index is subject to tradability, liquidity, credit rating and valuation criteria. This information is not publicly available.

to obtain:

$$\tilde{f}_d = \tilde{f} + \tilde{f}_r + \tilde{f}_q + \tilde{f}_f. \tag{7}$$

We estimate each of the components of the bonds excess returns in an analogous fashion. First we compute $\tilde{x}$, $\tilde{x}_r$, $\tilde{x}_q$ and $\tilde{x}_x$ from the residuals of the VAR. Then we estimate $\tilde{x}_\pi$ by rearranging equation (4). Chen and Zhao (2009) claim that this methodology is sensitive to the decision to estimate expected return news directly and treat news about real cash payments as a residual. However, Campbell et al. (2010) and Engsted et al. (2012b) show that this claim is incorrect. In a first-order VAR that includes the dividend price ratio and additional state variables that capture part of the predictability of returns and dividend growth not captured in the dividend price ratio, it does not matter which news component is treated as a residual and which ones are estimated directly (Campbell et al., 2010; Engsted et al., 2012b).[9] Of course, the estimation of the news components will depend on the selection of the state variables in the VAR model; this is naturally expected because the state variables will always be a subset of the full information set available to investors, and therefore may not capture the full time variation of the return components. The point here is that the relative importance of the news components will not depend on which of the components is treated as a residual. When we estimate the cash-flow news directly, our results indeed hold, confirming empirically the claims of Campbell et al. (2010) and Engsted et al. (2012b).

It is worth noting that we do not impose the same coefficients across all countries. We estimate the VAR coefficients using the mean group estimator, i.e. by running separate time-series regressions for each country and then averaging the coefficients over countries. Pesaran and Smith (1995) show that the mean group estimator leads to consistent estimates of the average coefficients in dynamic panel models like our VAR.

Standard errors of all the relevant statistics are calculated using the delete-1 jackknife method of Shao and Rao (1993). The jackknife is a non-parametric estimator that generates standard errors that are consistent even under cross-sectional dependence. The procedure starts by calculating an estimator θ from the entire sample of size T. Then, T new samples of size $T-1$ are recorded, omitting one cross section at a time. Next, one calculates the estimator $\theta_{[i]}$ from each one of the new i-th samples. Then, pseudo-values are calculated as T times θ less $T-1$ times the $\theta_{[i]}$. Finally, the variance of pseudo-values is the estimated variance

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[9] The only factor that could make the results differ is the approximation error in the underlying log-linear return approximation. This approximation error is generally found to be empirically small; see, e.g., Engsted et al. (2012a).

of the regression coefficient estimator. Vuolteenaho (2002) and Froot and Ramadorai (2005) apply the delete-1 jackknife to a panel VAR, similarly to our paper.

3.3 Data and Descriptive Statistics

Our dataset covers a total of 31 countries, which we divide in two subgroups. The first subgroup is what we call the Advanced Economies group, which includes 18 countries: Austria; Belgium; Canada; Switzerland; Germany; Denmark; Spain; Finland; France; Greece; Ireland; Italy; Japan; Norway; New Zealand; Sweden; the United Kingdom; and the United States. The second subgroup is what we call the Emerging Markets group (13 countries), and which consists of Czech Republic; Hong Kong; Hungary; Indonesia; India; Mexico; Malaysia; Philippines; Russia; Singapore; South Korea; Thailand; and South Africa.

For each of these countries we measure monthly equity market returns using MSCI equity index data at daily frequency obtained from Thomson Financial Datastream. We collect total return indices in US dollars. Yields on long-term coupon bonds are from Global Financial Data. Dividend yields data are also from the MSCI database. We proxy the risk-free rate with the one-month US T-bill rate, sourced from Kenneth French's website.

Monthly fund flows data are from EPFR, which tracks portfolio flows from both institutional and retail investors into financial products such as mutual funds, ETFs, and closed-end funds. Every month, EPFR collects data from each fund manager or administrator about the fund's total net assets, changes in net asset values, and country allocations.[10] From these data, flows (net of redemptions) into funds are calculated. Flows into individual countries are then estimated as follows: the average allocation to a given country from a fund group is multiplied by the total flows into that fund group; then, the same calculation is done across all fund groups, and these figures are added up to get the estimated total flows to that country. For example, flows to Brazilian equities are calculated as the sum of: (i) flows to Brazil-dedicated equity funds; (ii) the share of flows to Latin America-dedicated equity funds allocated to Brazil; (iii) the share of flows to so-called "Global Emerging Market"

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[10] EPFR also collects fund flows at a weekly frequency. However, in our analysis we prefer to use the data at the monthly frequency for three reasons: (i) country allocations are only available at the monthly frequency; (ii) funds that report at the weekly frequency are only a subset of those reporting monthly, so that the latter group covers a much larger number of funds and can give a more comprehensive view of funds' behaviour; and (iii) our dataset for bond yields, which we later match to the flow dataset, are only available at a monthly frequency for many countries.

equity funds allocated to Brazil; and (iv) the share of flows to global equity funds allocated to Brazil. These flows are correlated with the balance-of-payments gross portfolio inflows to a country as shown in Fratzscher (2011). We normalise flow data by their country's nominal GDP.

Table 1 displays descriptive statistics of these data. Monthly equity flows average about 4% of GDP across countries, whereas monthly bond flows average about 2% of GDP. Standard deviations are on average about 6% for equities and 3% for bonds. Flows tend to be strongly positively autocorrelated, with average first-order autocorrelations of about 0.4 for equities and 0.6 for bonds.

Exchange rates are calculated computing the difference between log equity returns in US dollars and log equity returns in local currency. We calculate monthly inflation data as the percentage change in CPI from IMF IFS database. The resulting database contains time series running from January 2004 to December 2013 for the 31 countries.

3.4 Results

3.4.1 Variance Decomposition of International Equity Returns

We use the VAR specification presented in Section 3.2.3 to calculate the proximate components of unexpected equity excess returns in Equation (2). The variance of excess returns can be decomposed as follows according to Equation (2):

$$\begin{aligned} \text{var}(\tilde{f}) = {} & \text{var}(\tilde{f}_d) + \text{var}(\tilde{f}_r) + \text{var}(\tilde{f}_q) + \text{var}(\tilde{f}_f) \\ & -2\text{cov}(\tilde{f}_d, \tilde{f}_r) - 2\text{cov}(\tilde{f}_d, \tilde{f}_q) - 2\text{cov}(\tilde{f}_d, \tilde{f}_f) \\ & +2\text{cov}(\tilde{f}_r, \tilde{f}_q) + 2\text{cov}(\tilde{f}_r, \tilde{f}_f) + 2\text{cov}(\tilde{f}_q, \tilde{f}_f). \end{aligned} \tag{8}$$

Panel A of Table 2 displays the contribution of each of the terms in Equation (8) to the overall variance of the unexpected equity excess return. We scale each component by the variance of the unexpected excess return $\text{var}(\tilde{f})$ so that they sum to one. Results are presented for the entire sample of countries and also for the sub-sample of advanced and emerging countries separately.

News about future dividends is the main sources of variation of unexpected equity returns.

More specifically, the variance of dividend news is the largest component of the variance of equity returns for both advanced and emerging economies. This findings is at odds with the evidence commonly found in the literature, reported for the Unites States, that asset price movements are mainly due to innovations in expected returns, or equivalently to discount rate variation (e.g., Cochrane, 2008, 2011). Cochrane (2008) reaches this conclusion as he finds absence of dividend growth predictability (equivalently, absence of variation in cash-flow expectations) for the aggregate US equity market via means of OLS regressions of the dividend growth on the dividend yield; this evidence implies that returns are predictable (equivalently, that discount rates are time-varying) to account for the observed time variation of dividend yields.[11] Results from our VAR, which pool information for many more countries, suggest the opposite. We find that dividend growth is predictable: the OLS coefficient on the dividend yield in the dividend growth equation is -0.05 and is statistically significant at the five per cent confidence level.[12]

A number of recent papers confirm our results about the relative size of the cash-flow and the excess return component. Plazzi (2010) finds that expected return shocks prevail over cash-flow shocks in the US, while the opposite is true in the UK. Vuolteenaho (2002) studies firm-level stock returns in the US and finds that the cash-flow component always prevails. Phylaktis and Ravazzolo (2002) concentrate on a sample of countries in the Pacific-Basin region and show that the cash-flow shock component prevails over the expected-return component. Finally, Rangvid et al. (2013) find that in a large number of non-US countries, dividend growth is predictable using dividend yields. They interpret this result as an evidence that news about future dividends is the main drivers of return innovations.

News about exchange rates changes contributes little, if anything, to the variance of unexpected equity returns. This finding is consistent with that of Ammer and Mei (1996) and Phylaktis and Ravazzolo (2002), who find that the exchange rate component does not contribute much to the variance of the UK and Asian equity markets. It is also in line with the results of the cross-sectional asset pricing exercise of Cenedese et al. (2015), who find that

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[11] Van Binsbergen and Koijen (2010), Plazzi et al. (2010), and Koijen and Nieuwerburgh (2011) argue that OLS regressions may miss substantial variation in expected cash flows and that structural R^2s—that is, the underlying variation in conditional expectations of the data generating process—may differ significantly from the OLS R^2. They propose present-value models, estimated via GMM or maximum likelihood, to capture the time variation in expected cash-flow growth that is not captured by OLS regressions. While the application of these present-value models in an international setting is a promising area, we leave this for future research. Our pooled VAR, which combines information from many countries, appears to capture already at least some of the time variation in expected cash flows.

[12] We don't report the full matrix of coefficients for brevity and ease of exposition. Another interesting result emerging from the analysis of the VAR coefficients is that lagged equity portfolio flows also help predict dividend growth (coefficient 0.029, significant at the 10 per cent confidence level).

returns on international equity markets are broadly unrelated to exchange rates.

The relatively large standard errors in Table 2 suggest that the contribution of the components is only imprecisely estimated. Also, the several covariance terms in the decomposition make results difficult to interpret. Therefore, we complement results in Table 2 with those obtained with an alternative methodology to assess the contribution of the different return components to the time variation of unexpected excess returns. First, we orthogonalise each component using a Cholesky decomposition. Then, we measure the R^2 values in regressions of unexpected excess returns on each of the orthogonalised components.[13] Table 3 reports these R^2 values. Estimates are now more precise, and are consistent with the results above: dividend shocks account for most of the time variation of unexpected excess returns in our sample.

3.4.2 Variance Decomposition of International Bond Returns

We use the VAR specification discussed in Section 3.2.3 to evaluate the contribution of each proximate component to the overall excess return in the bond markets. According to equation (4), the variance of excess returns can be decomposed as follows:

$$\begin{aligned} \text{var}\left(\tilde{x}\right) = {} & \text{var}\left(\tilde{x}_\pi\right) + \text{var}\left(\tilde{x}_r\right) + \text{var}\left(\tilde{x}_q\right) + \text{var}\left(\tilde{x}_x\right) \\ & + 2\text{cov}\left(\tilde{x}_\pi, \tilde{x}_r\right) + 2\text{cov}\left(\tilde{x}_\pi, \tilde{x}_q\right) + 2\text{cov}\left(\tilde{x}_\pi, \tilde{x}_x\right) \\ & + 2\text{cov}\left(\tilde{x}_r, \tilde{x}_q\right) + 2\text{cov}\left(\tilde{x}_r, \tilde{x}_x\right) + 2\text{cov}\left(\tilde{x}_q, \tilde{x}_x\right). \end{aligned} \tag{9}$$

Panel B in Table 2 contains the variance decomposition for international bond returns. Each component is normalised by the variance of the unexpected excess bond return $\text{var}(\tilde{x})$ so that they sum up to one.

News about future inflation and real interest rates account for most of the variation of unexpected bond returns. The importance of inflation news in explaining the variance of unexpected bond returns is in line with the results of Campbell and Ammer (1993) for the US bonds market and the results of Engsted and Tanggaard (2001) for the Danish bond market.

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[13] Following Engsted and Tanggaard (2001), the components are ordered as follows: dividend shocks $\tilde{f}_d$, real rate shocks $\tilde{f}_r$, exchange rate shocks $\tilde{f}_q$, and expected return shocks $\tilde{f}_f$. Our results are qualitatively robust to different orderings of the variables; ordering expected return shocks before dividend shocks actually reinforces the result, as dividend shocks now account for about 98 per cent of time variation of unexpected returns.

Estimates for bond returns are also imprecisely estimated as shown by their relatively large standard errors. To address this problem our results are complemented with an alternative methodology that measures the R^2 values in regressions of unexpected excess returns on each of the orthogonalised components.[14] Table 3 reports these R^2 values. Estimates are more precise, and are consistent with the results above: inflation shocks account for most of the time variation of unexpected bond returns in our sample.

3.4.3 Relation between asset return components and portfolio flows

International equity markets

We use the return decomposition contained in equation (2) to study the relation between news about portfolio flows and the proximate causes of excess returns. Table 4 summarises covariances between return components and portfolio flows for international equity markets. The table is divided into three panels. Panel A reports results for the entire sample of countries. Panel B reports results for advanced economies, while Panel C displays results for emerging market economies. Each cell contains estimates of the scaled covariances between the elements indicated in the row and column headings.[15] Covariances are normalised using the product of the standard deviation of unexpected excess returns and the standard deviation of unexpected flows to facilitate comparison across the elements of the table.

The first column in each of the panels contains normalised covariances between excess returns news and news about portfolio flows at different horizons. The contemporaneous covariance between flow and return news in cell (1,1) is positive and significant. This covariance term can be interpreted as an estimate of price impact. On impact, shocks to excess returns are positively associated with shocks to flows. Results are consistent across the three panels. The second and the third rows of column 1 explore flows reaction to an excess return shock in the short and in the long run. In the short run—cell (2,1)—flows react positively. This is

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[14] Following Engsted and Tanggaard (2001), the components are ordered as follows: inflation shocks $\tilde{x}_\pi$, real rate shocks $\tilde{x}_r$, exchange rate shocks $\tilde{x}_q$, and expected return shocks $\tilde{x}_x$. Our results are qualitatively robust to different orderings of the variables; ordering expected return shocks before inflation news changes the results somewhat significantly in quantitative terms, as inflation shocks now account for about 58 per cent of time variation of unexpected returns as opposed to 42 per cent in the case of expected return shocks.

[15] The decomposition of flows maps directly into the definition of the cumulated impulse response function. Unexpected flows a can be retrieved from the error term of the VAR. Total flows correspond to the infinite-horizon cumulated impulse response function. Short-run and long-run expected flows are obtained breaking down the infinite-horizon cumulated impulse response function in two parts.

consistent with investors chasing returns and increasing their exposure to stock markets that have experienced unexpectedly high returns. However, the trend-chasing behaviour is short lived. After one quarter, the covariance between expected flows and returns turns negative as reported in cell (3,1). The change of the covariance sign suggests that investors initially overreact to excess return shocks and reverse their positions afterwards. This finding is especially strong for emerging economies. Finally, the last row of Table 4 contains the covariance between the infinite-horizon cumulative flow innovation and the excess return shock. The positive and significant covariance reported in cell (4,1) suggests that the observed short-term positive correlation is not entirely offset by the long-term negative correlation.

Results in Table 4 are confirmed by the cumulated impulse response functions of the VAR. Figure 1 contains the cumulated impulse response function of equity flows following an excess return shock.[16] On impact international equity flows react positively to a return shock. Equity inflows remain positive for the first five months after the shock and slowly revert afterwards. The humped shape of the impulse response function confirms the initial overreaction which is corrected about one quarter after the initial shock.

We also investigate the existence of an anticipation effect. This is the comovement of expected future returns and portfolio flows (first row of Table 4). Cell (1,2) shows that unexpected positive flow shocks are associated with an upward revision in cumulated expected future returns. Investors anticipate future returns and invest in countries that display higher expected returns. Again evidence is found that the positive relation between flows and returns breaks down in the long run and the covariance between the two becomes negative as reported in cell (1,3). Figure 2 shows the cumulated impulse response function for excess returns following a portfolio flow shock. Following an unexpected flow shock equity returns tend to increase in the short run. However, after about five months equity returns begin to decline.

The fourth and the fifth columns of Table 4 display the covariances between portfolio flows and the real rate and the exchange rate component respectively. The contribution of these two components is modest and covariance terms are statistically insignificant. The last column displays the relation between portfolio flows and dividend news. Uncovering the relation between flows and the dividend component of returns is crucial as news about future

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[16] The shock is induced by setting the equity return shock in the VAR error vector equal to one standard deviations while the other elements of the VAR error vector are set equal to their conditional expectations, conditioning on the excess return component being equal to one standard deviation. For a similar approach in setting the impulse responses, see Vuolteenaho (2002), Cohen et al. (2002), and Froot and Ramadorai (2005).

dividends accounts for most of the variance in international equity returns. Dividend shocks are found to be followed by capital inflows on the impact and up to a quarter after the shock. This is especially true for emerging markets. In the long run the relation disappears and the covariance term turns negative and insignificant. The infinite horizon cumulated effect of a dividend shock—cell(4,6)—is positive and significant. Figure 3 displays the cumulative impulse response function of equity flows to a dividend shock.[17] Following the initial positive reaction, the covariance between flows and cash-flow news weakens as it is testified by the flattening of the impulse response function. While the dynamics appear to be similar in each of the three samples, the significance level is higher for emerging economies than for advanced economies.

The analysis conducted so far suggests that investors chase returns at least in the short run. The covariance terms in columns one and six of Table 4 suggest that investors increase their equity holdings following a positive excess return shock especially when this is induced by a revision in cash-flow expectations. However, according to equation (2), a positive excess return shock may also be triggered by a negative shock to expected returns.[18] In this case the resulting appreciation of return is only temporary, as the price must eventually fall so that future returns will be lower.[19] Figure 4 displays the cumulated impulse response function for equity flows following a negative shock to expected returns.[20] Countries experience equity outflows even in the presence of returns' appreciation. This implies that investors are able to discriminate between appreciations that are caused by an upward revision of expected future dividend growth and excess returns that are caused by a downward revision of expected future returns. In other words, international investors are not mechanical momentum traders and they respond to a short-term transitory appreciation by selling and to a permanent appreciation by buying.

The finding that flows react differently to different types of shocks is intriguing and suggests

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[17] The shock is induced setting the VAR error vector to a constrained maximum likelihood value, imposing the constraint that cash-flow shock equals one standard deviations and that the expected return shock is zero. For a similar approach in setting the impulse responses see Vuolteenaho (2002).

[18] Holding the other components constant, a fall in expected future returns may be achieved only trough an increase in today's returns. We abstract from exchange rate and real rate shocks in this part of the analysis because we find that they are not important drivers of equity flows when looking the impulse response function.

[19] Campbell (1991) return decomposition is related to the Beveridge-Nelson decomposition in the time-series literature, with the dividend shock corresponding to the nonstationary, permanent component and the expected return shock corresponding to the stationary, temporary component. See, e.g., Cohen et al. (2002).

[20] The shock is induced setting the VAR error vector to a constrained maximum likelihood value, imposing the constraint that the expected return shock equals one standard deviation and that all the other shocks are zero.

that investors behave rationally when taking investment decisions. A natural question is whether institutional investors behave differently from retail investors, as one might expect that the former group, mainly composed by professional portfolio managers, may react more rationally to shocks. We decompose fund flows into those coming from institutional and retail investors and run the same analysis above for these two different subsets. Figures 5 and 6 display the impulse response functions of institutional and retail equity flows, respectively, to a negative shock to expected equity excess returns. Institutional and retail investors react differently to this temporary equity appreciation: institutional flows are negative following such a shock, while retail flows are not statistically significant. This difference is consistent with institutional investors behaving more rationally than retail investors.

International bond markets

Table 5 summarises the relation between flows and returns in international bond markets in the same format as in Table 4. The first column reports the scaled covariance between unexpected bond excess returns and news about portfolio flows. Cell (1,1) displays the contemporaneous covariance between bond flows and bond returns and measures the price effect. The estimated price impact is positive but the result is only significant for the sample of emerging economies.

Cell (2,1) contains the covariance between the short-term expected flow news and unexpected excess returns. The covariance between flows and returns is positive and significant (with the exception of the developed economy sample) in the short run, while in the long run—cell (3,1)—it becomes insignificant. The impulse response function in Figure 7 confirms the positive short-term impact of an excess return shock on portfolio bond flows. As the time passes, the impulse response flattens confirming the transitory nature of the relation between excess return shock and flow changes.

We also assess the existence and the magnitude of an anticipation analysing comovements between flow shocks and expected future returns. Expected returns react weakly to unexpected flow shocks in the short run as shown in cell (1,2). In the long run instead—cell (1,3)—a negative relation between flows and returns emerges. Results are more significant for the sample of emerging economies. The impulse response in Figure 8 describes the unexpected excess return reaction to a flow shocks. Positive flow shocks predict negative excess returns in the medium and in the long run.

The risk-free rate component explains some of the covariance between flows and returns especially for emerging economies. An upward revision in expectations about the US risk-free rate causes bond outflow on the impact—cell (1,4)—and in the short run—cell(2,4). The negative covariance between bond flows and the risk free rate is (weakly) significant for emerging economies while it is not for advanced economies. This result is consistent with the view that debt flows to emerging markets are correlated with monetary policy interventions and the business cycle of developed economies as suggested for instance by Ahmed and Zlate (2013).[21] Finally, both inflation shocks and exchange rate shocks explain have little explanatory power for the comovements between flows and returns. Covariances are low and not significant for either component.

Figure 9 depicts the impulse response function describing flows reaction to an downward revision of expected bond returns. While in the equity market negative expected return shocks generate outflows, in the bond market we do not find the same result. The reaction of flows to expected future returns shocks is not significant. In unreported results, we find that the same statistically insignificant results hold when we analyse institutional and retail investors separately.

3.5 Conclusions

In this paper we study the relation between international mutual fund flows and the different return components of aggregate equity and bond markets. We decompose international equity and bond market returns into changes in expectations of future real cash payments, interest rates, exchange rates, and discount rates. We find that news about future dividend growth is the main source of variation for equity excess returns. Importantly, our findings are at odds with the evidence commonly found in the literature, reported mostly for the US

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[21] In May 2013, chairman Ben Bernanke announced that the Federal Reserve would start "tapering" (or slowing down) its programme asset purchases; large outflows from emerging-market-dedicated mutual funds followed suit (this episode has been named "taper tantrum" by the financial press). This episode suggests a sharp sensitivity of international capital flows to revisions of expectations about the US risk-free rate. While a formal analysis of the relation between international capital flows and US monetary policy goes beyond the scope of this paper, we computed the 12-month rolling correlation between risk-free rate shocks and emerging-market bond flows and analyzed its evolution over time. We found two main results. First, the comovement between emerging-market bond flows and interest rate shocks is strong and negative. Secondly, this comovement became stronger during the global financial crisis. During the "taper tantrum" episode in May 2013 the correlation between international bond flows and interest rate shocks was strongest than ever before in our sample. This finding suggests that changes in the expectations about risk-free rates may play a key role in explaining the large movements in the international bonds market observed around May 2013.

equity market, that asset price movements are mainly due to innovations in expected returns, or equivalently to discount rate variation. International bond returns instead are mainly driven by inflation news. News about exchange rates contributes little to the variance of unexpected equity and bond returns. When we analyse the relation between the proximate causes of excess returns and flows, we find evidence consistent with price action, short-term trend chasing, and short-run overreaction in equity markets. Finally we find that international bond flows to emerging markets are more sensitive to revisions in expectations about future interest rates relative to equity flows.

3.6 Tables and Figures

Figure 1. Impulse Response Function of Portfolio Equity Flows to an Excess Return Shock.

This figure shows the cumulated response of equity flows to a one standard deviation shock to excess returns. The response is shown at different return horizons (horizontal axis, scale in weeks). The solid line is the response of cumulated equity flows, while the dashed lines display ±2-standard-deviation bounds estimated using the delete-1 jackknife method. Data pool emerging markets and developed economies together.

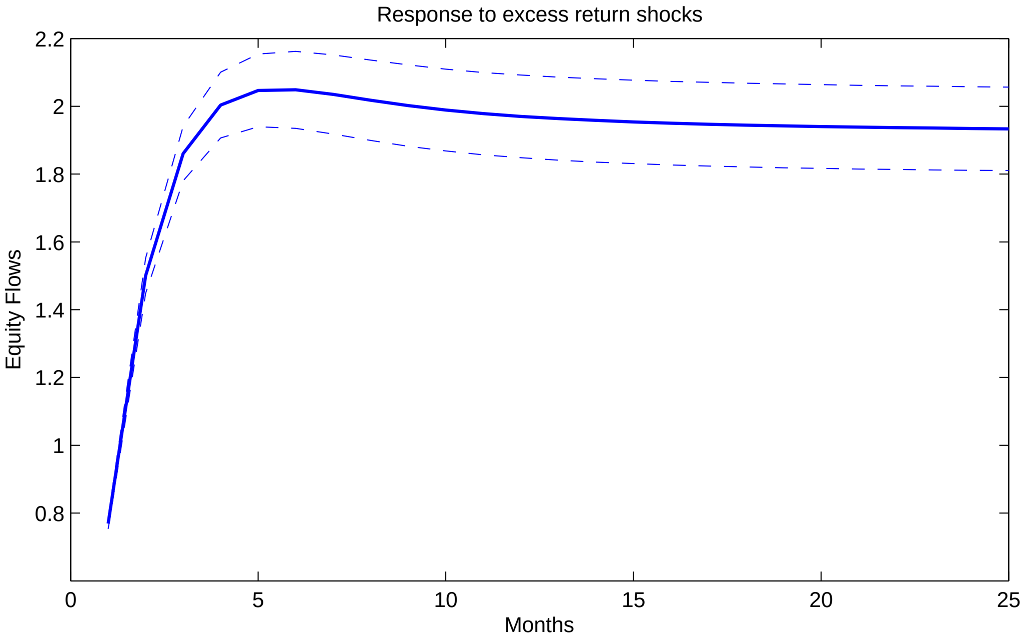

Figure 2. Impulse Response Function of Excess Return to an Equity Flow Shock.

This figure shows the cumulated response of equity excess returns to a one standard deviation shock to flows. The response is shown at different return horizons (horizontal axis, scale in weeks). The solid line is the response of cumulated equity excess returns, while the dashed lines display ±2-standard-deviation bounds estimated using the delete-1 jackknife method. Data pool emerging markets and developed economies together.

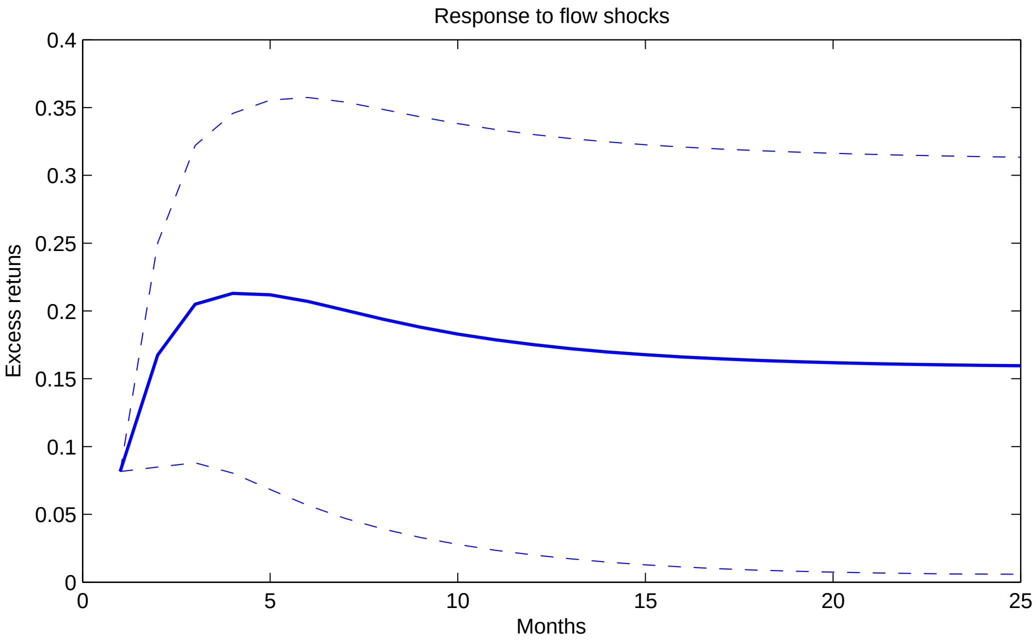

Figure 3. Impulse Response Function of Portfolio Equity Flows to a Cash-Flow Shock.

This figure shows the cumulated response of equity flows to a one standard deviation shock to cash-flow news. The shock is induced setting the VAR error vector to a constrained maximum likelihood value, imposing the constraint that cash-flow shock equals one standard deviations and that expected return news is zero. The response is shown at different return horizons (horizontal axis, scale in weeks). The solid line is the response of cumulated equity flows, while the dashed lines display ±2-standard-deviation bounds estimated using the delete-1 jackknife method. Data pool emerging markets and developed economies together

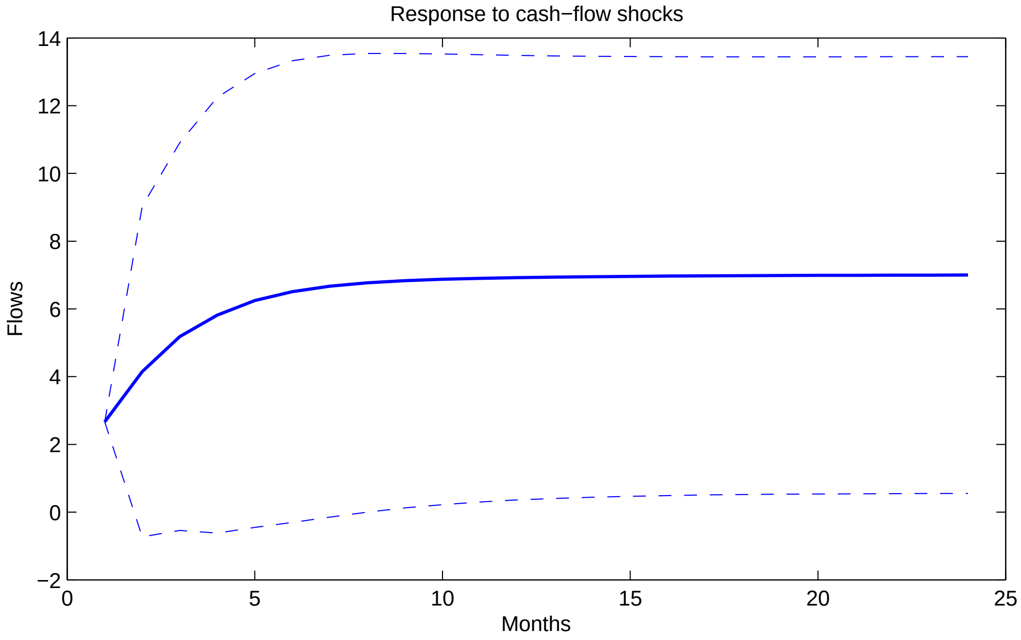

Figure 4. Impulse Response Function of Portfolio Equity Flows to a Negative Expected Return Shock.

This figure shows the cumulated response of equity flows to a one standard deviation negative expected returns shock. The shock is induced setting the VAR error vector to a constrained maximum likelihood value, imposing the constraint that excess return shock is equal to one standard deviations and that the expected cash-flow shock is zero. The response is shown at different return horizons (horizontal axis, scale in weeks). The solid line is the response of cumulated equity flows, while the dashed lines display ±2-standard-deviation bounds estimated using the delete-1 jackknife method. Data pool emerging markets and developed economies together

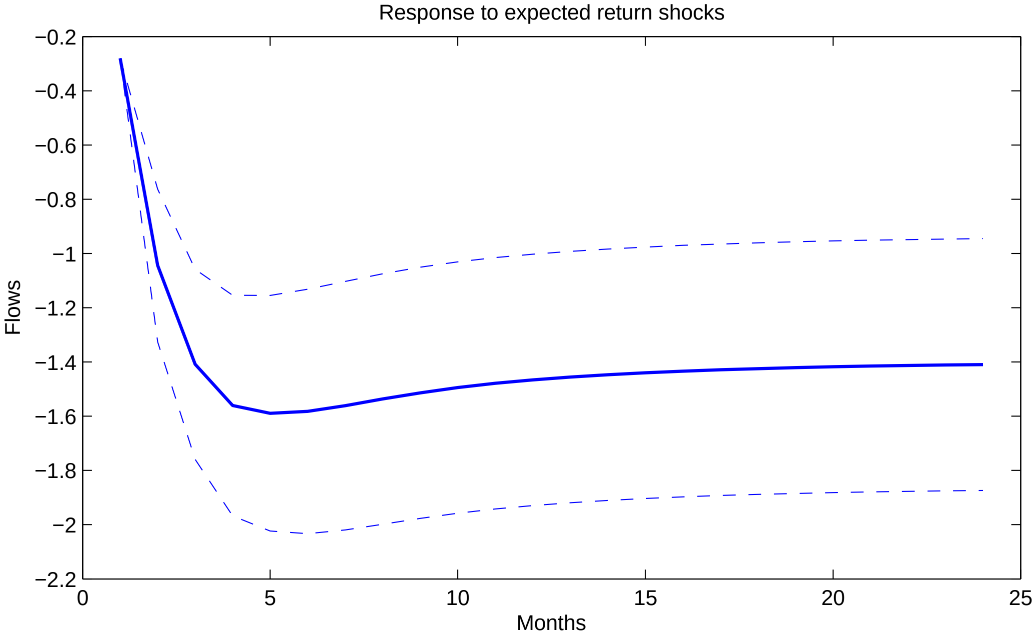

Figure 5. Impulse Response Function of Portfolio Equity Flows to a Negative Expected Return Shock: Institutional Investors

This figure shows the cumulated response of institutional investors equity flows to a one standard deviation negative expected returns shock. The shock is induced setting the VAR error vector to a constrained maximum likelihood value, imposing the constraint that excess return shock is equal to one standard deviations and that the expected cash-flow shock is zero. The response is shown at different return horizons (horizontal axis, scale in weeks). The solid line is the response of cumulated equity flows, while the dashed lines display ±2-standard-deviation bounds estimated using the delete-1 jackknife method. Data pool emerging markets and developed economies together

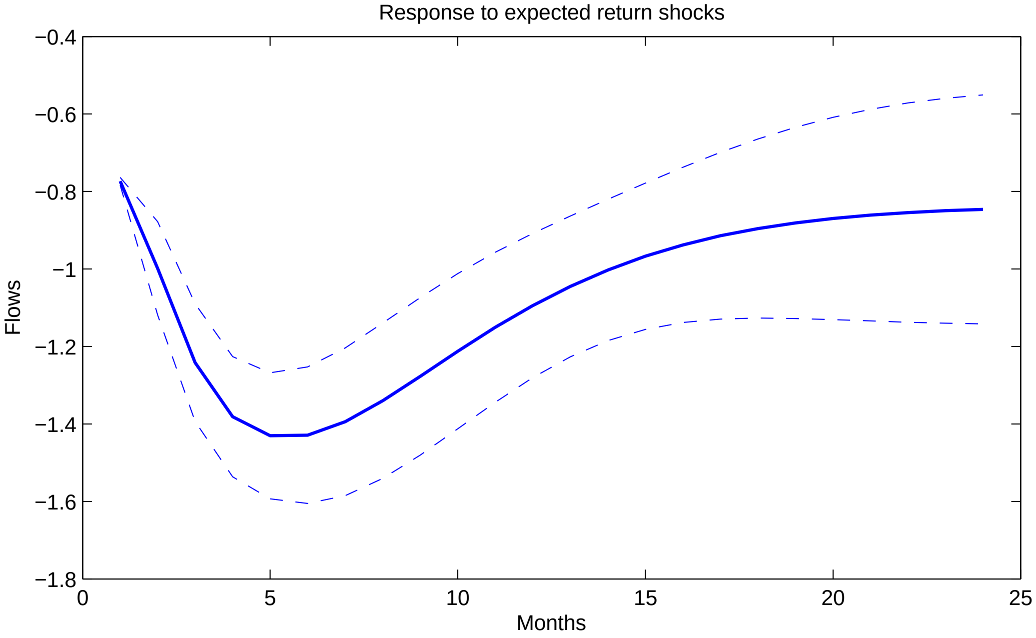

Figure 6. Impulse Response Function of Portfolio Equity Flows to a Negative Expected Return Shock: Retail Investors

This figure shows the cumulated response of retail investors equity flows to a one standard deviation negative expected returns shock. The shock is induced setting the VAR error vector to a constrained maximum likelihood value, imposing the constraint that excess return shock is equal to one standard deviations and that the expected cash-flow shock is zero. The response is shown at different return horizons (horizontal axis, scale in weeks). The solid line is the response of cumulated equity flows, while the dashed lines display ±2-standard-deviation bounds estimated using the delete-1 jackknife method. Data pool emerging markets and developed economies together

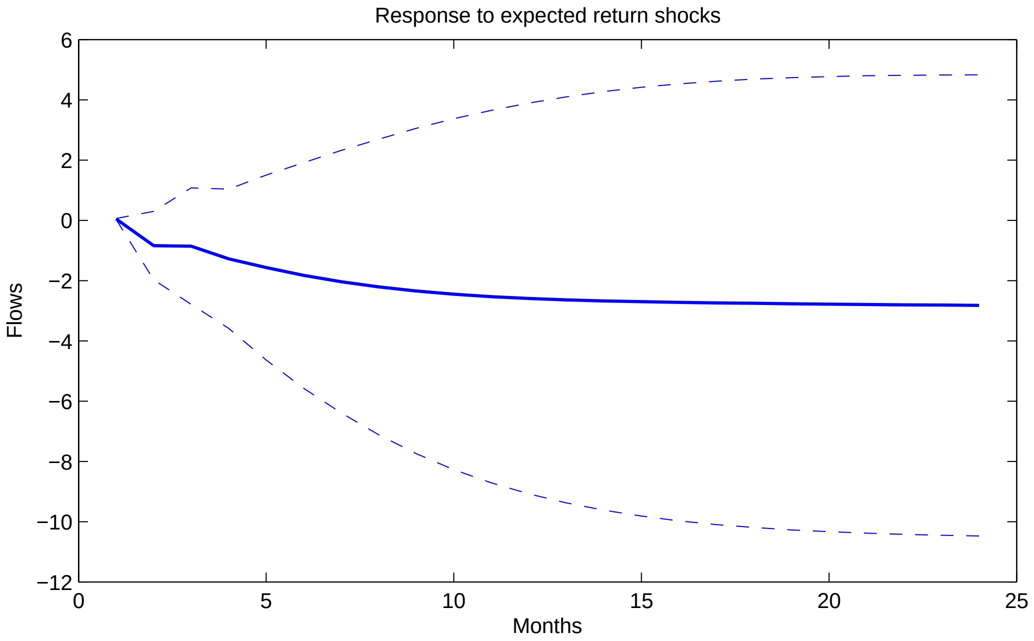

Figure 7. Impulse Response Function of Portfolio Bond Flows to an Excess Return Shock.

This figure shows the cumulated response of bond flows to one standard deviation shock to excess returns. The response is shown at different return horizons (horizontal axis, scale in weeks). The solid line is the response of cumulated bond flows, while the dashed lines display 2 standard deviations bounds estimated using the delete-1 jackknife method. Data pool emerging markets and developed economies together.

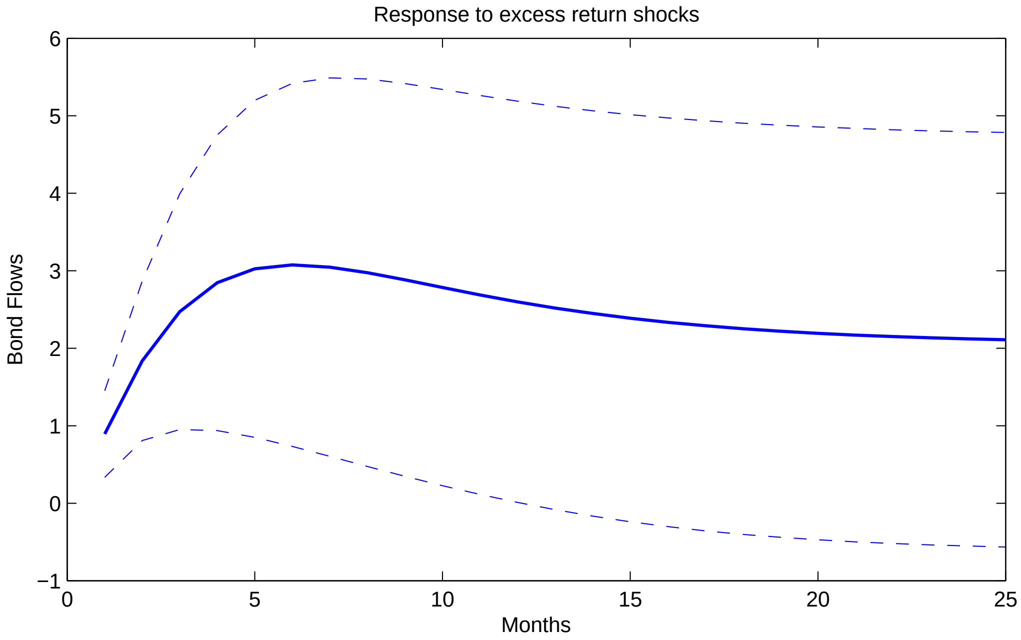

Figure 8. Impulse Response Function of Bonds Excess Return to a Bond Flow Shock.

This figure shows the cumulated response of bond excess returns to a one standard deviation shock to bond flows. The response is shown at different return horizons (horizontal axis, scale in weeks). The solid line is the response of cumulated bond excess returns, while the dashed lines display 2 standard deviations bounds estimated using the delete-1 jackknife method. Data pool emerging markets and developed economies together.

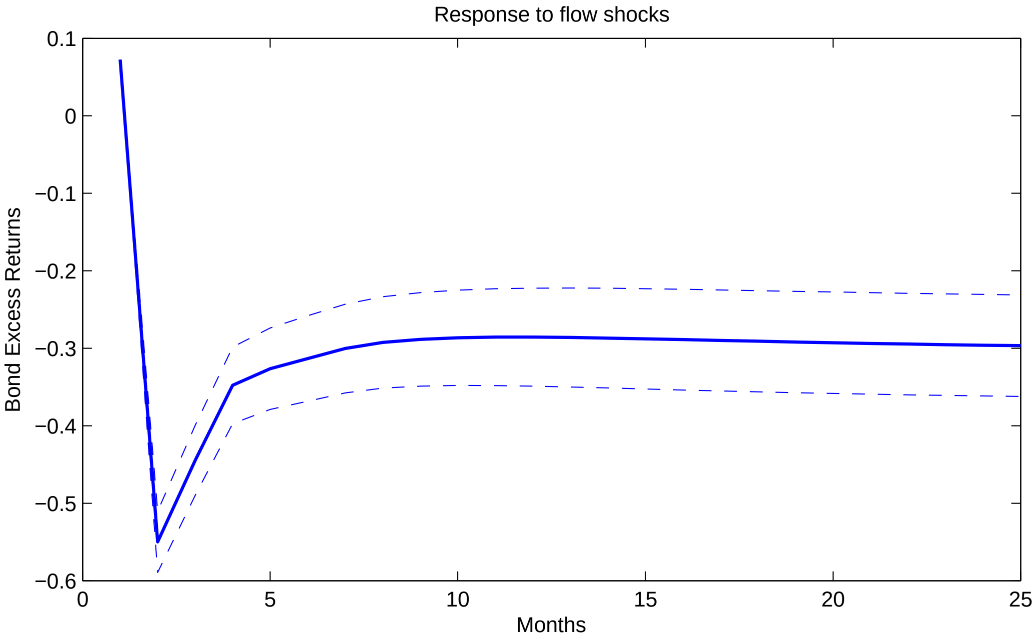

Figure 9. Impulse Response Function of Portfolio Bond Flows to a Negative Expected Return Shock.

This figure shows the cumulated response of bond flows to negative expected returns shock. The shock is induced setting the VAR error vector to a constrained maximum likelihood value, imposing the constraint that excess return shock equals one standard deviations and that the expected inflation shock is zero. The response is shown at different return horizons (horizontal axis, scale in weeks). The solid line is the response of cumulated equity flows, while the dashed lines display 2 standard deviations bounds estimated using the delete-1 jackknife method. Data pool emerging markets and developed economies together

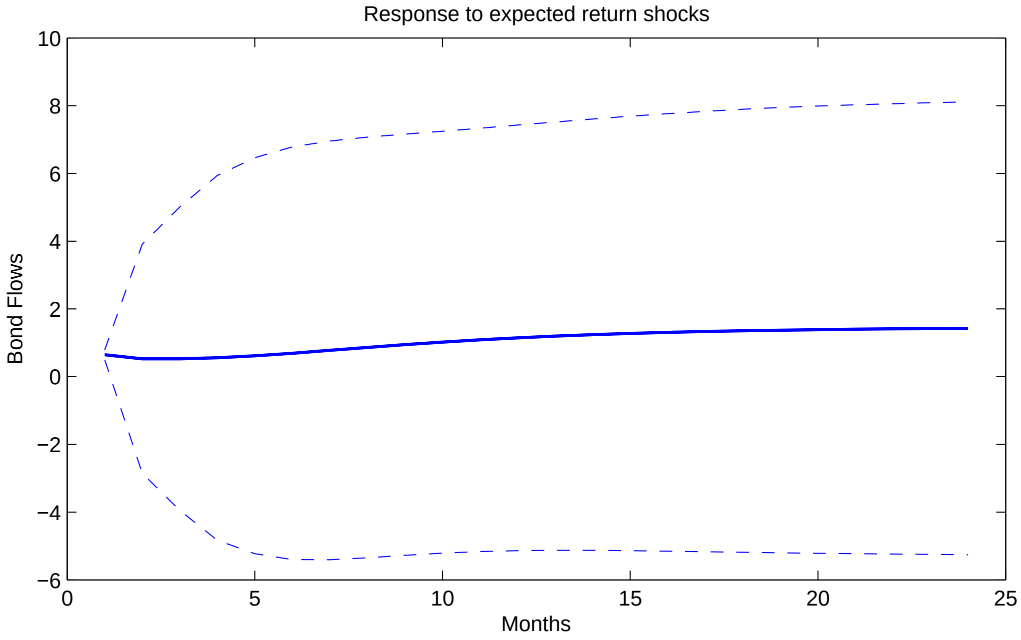

Table 1. Descriptive Statistics.

The table reports descriptive statistics for international equity and bond fund flows for the sample period of January 2004 to December 2013 for 31 countries. Flows are measured as the ratio of their dollar value to the relevant country's nominal GDP. AC(1) denotes the first-order autocorrelation.

	Equities			Bonds		
	Mean	St. dev.	AC(1)	Mean	St. dev.	AC(1)
Austria	0.018	0.024	0.204	0.012	0.019	0.463
Belgium	0.016	0.022	0.551	0.013	0.020	0.451
Canada	0.035	0.049	0.265	0.035	0.044	0.620
Czech Republic	0.025	0.039	0.381	0.007	0.011	0.616
Denmark	0.022	0.031	0.295	0.019	0.027	0.627
Finland	0.033	0.045	0.544	0.012	0.018	0.590
France	0.028	0.037	0.564	0.008	0.011	0.598
Germany	0.036	0.054	-0.064	0.012	0.016	0.726
Greece	0.014	0.023	0.561	0.007	0.013	0.465
Hong Kong	0.194	0.268	0.448	0.016	0.023	0.743
Hungary	0.044	0.075	0.347	0.069	0.086	0.788
India	0.045	0.058	0.356	0.002	0.002	0.739
Indonesia	0.028	0.035	0.509	0.020	0.028	0.547
Ireland	0.022	0.029	0.586	0.028	0.039	0.727
Italy	0.011	0.015	0.563	0.013	0.018	0.642
Japan	0.043	0.061	0.703	0.008	0.011	0.580
Korea	0.066	0.085	0.476	0.011	0.014	0.795
Malaysia	0.055	0.076	0.253	0.038	0.048	0.773
Mexico	0.028	0.036	0.313	0.025	0.032	0.782
New Zealand	0.004	0.006	0.489	0.030	0.036	0.813
Norway	0.022	0.029	0.587	0.016	0.020	0.760
Philippines	0.021	0.029	0.535	0.037	0.050	0.671
Russia	0.049	0.065	0.281	0.014	0.017	0.726
Singapore	0.100	0.138	0.517	0.016	0.022	0.693
South Africa	0.066	0.089	0.423	0.034	0.043	0.787
Spain	0.016	0.021	0.622	0.008	0.017	0.535
Sweden	0.036	0.047	0.500	0.023	0.036	0.565
Switzerland	0.118	0.176	0.080	0.017	0.040	-0.199
Thailand	0.060	0.082	0.385	0.011	0.016	0.730
United Kingdom	0.051	0.065	0.574	0.015	0.019	0.553

Table 2. Variance Decomposition.

The table reports the contribution of return components, as implied by the VAR, to the variance of the unexpected returns of international bond and equity markets. The table shows the variances and covariances of these components, normalised by the variance of the unexpected excess returns. Results displayed in the table refer to the period running from January 2004 to December 2013. Standard errors are calculated with the delete-1 jackknife method and reported within parentheses.

Panel A: Equities

	$(\tilde{f}_d)$	$(\tilde{f}_f)$	$(\tilde{f}_q)$	$(\tilde{f}_r)$	$-2(\tilde{f}_d, \tilde{f}_f)$	$-2(\tilde{f}_d, \tilde{f}_q)$	$-2(\tilde{f}_d, \tilde{f}_r)$	$2(\tilde{f}_f, \tilde{f}_q)$	$2(\tilde{f}_f, \tilde{f}_r)$	$2(\tilde{f}_r, \tilde{f}_q)$
All	1.518	0.425	0.000	0.004	-0.989	-0.001	0.043	0.000	-0.001	0.000
	(0.930)	(0.344)	(0.000)	(0.003)	(1.258)	(0.001)	(0.075)	(0.001)	(0.046)	(0.000)
Emerging Markets	1.508	0.312	0.000	0.006	-0.870	-0.001	0.041	0.000	0.004	0.000
	(0.751)	(0.300)	(0.000)	(0.006)	(0.897)	(0.001)	(0.127)	(0.000)	(0.109)	(0.000)
Advanced Economies	1.766	0.637	0.000	0.004	-1.453	-0.002	0.038	0.001	0.009	0.000
	(1.049)	(0.451)	(0.000)	(0.003)	(1.462)	(0.001)	(0.079)	(0.001)	(0.050)	(0.000)

Panel B: Bonds

	$(\tilde{x}_\pi)$	$(\tilde{x}_x)$	$(\tilde{x}_q)$	$(\tilde{x}_r)$	$2(\tilde{x}_\pi, \tilde{x}_x)$	$2(\tilde{x}_\pi, \tilde{x}_q)$	$2(\tilde{x}_\pi, \tilde{x}_r)$	$2(\tilde{x}_x, \tilde{x}_q)$	$2(\tilde{x}_x, \tilde{x}_r)$	$2(\tilde{x}_r, \tilde{x}_q)$
All	0.755	0.062	0.000	0.003	0.192	-0.001	-0.019	0.000	0.007	0.000
	(0.149)	(0.079)	(0.000)	(0.002)	(0.161)	(0.000)	(0.023)	(0.000)	(0.022)	(0.000)
Emerging Markets	0.893	0.048	0.000	0.006	0.043	-0.001	0.015	0.000	-0.004	0.000
	(0.260)	(0.104)	(0.000)	(0.006)	(0.321)	(0.001)	(0.047)	(0.001)	(0.047)	(0.000)
Advanced Economies	0.853	0.136	0.000	0.003	0.029	0.000	-0.026	0.000	0.006	0.000
	(0.286)	(0.160)	(0.000)	(0.002)	(0.423)	(0.000)	(0.037)	(0.000)	(0.028)	(0.000)

Table 3. Contribution of components using linear regressions.

The table reports the contribution of return components, as implied by the VAR, to the variance of the unexpected returns of international bond and equity markets. The table shows the R^2 values in regressions of unexpected excess returns on each of the orthogonalised components. We orthogonalise each of the components using a Cholesky decomposition. In the decomposition, equity return components are ordered as follows: dividend shocks $\tilde{f}_d$, real rate shocks $\tilde{f}_r$, exchange rate shocks $\tilde{f}_q$, and expected return shocks $\tilde{f}_f$. Bond return components are ordered as follows: inflation shocks $\tilde{x}_\pi$, real rate shocks $\tilde{x}_r$, exchange rate shocks $\tilde{x}_q$, and expected return shocks $\tilde{x}_x$. Results displayed in the table refer to the period running from January 2004 to December 2013. Standard errors are calculated with the delete-1 jackknife method and reported within parentheses.

	Panel A: Equities			
	$\tilde{f}_d$	$\tilde{f}_r$	$\tilde{f}_q$	$\tilde{f}_f$
All	0.728	0.033	0.003	0.236
	(0.095)	(0.066)	(0.012)	(0.092)
Emerging Markets	0.799	0.028	0.005	0.166
	(0.277)	(0.223)	(0.017)	(0.088)
Advanced Economies	0.631	0.076	0.006	0.285
	(0.128)	(0.111)	(0.026)	(0.136)
	Panel B: Bonds			
	$\tilde{x}_\pi$	$\tilde{x}_r$	$\tilde{x}_q$	$\tilde{x}_x$
All	0.939	0.020	0.002	0.038
	(0.104)	(0.064)	(0.018)	(0.056)
Emerging Markets	0.952	0.001	0.009	0.035
	(0.118)	(0.046)	(0.045)	(0.057)
Advanced Economies	0.855	0.013	0.018	0.112
	(0.169)	(0.057)	(0.046)	(0.129)

Table 4. Relations between Portfolio Flows and Returns in International Equity Markets.

The table reports scaled covariances between equity flow and return news as implied by the VAR. Each cell contains estimates of the covariances between the elements indicated in the row and column headings. We pick out the innovations in the variables by postmultiplying the appropriate selection vector by the unexpected shock u, the expected short-term (ST) innovation $\Phi(k)u$, the expected long-term (LT) innovation $(\Phi - \Phi(k))u$, and the total innovation Ψu. We set $k = 3$ months. Covariances are scaled by the product of the standard deviation of unexpected excess returns and the standard deviation of unexpected flows to facilitate comparison across the elements of the table. Standard errors are calculated with the delete-1 jackknife method and reported within parentheses.

Panel A: All Countries

	Return Innovation					
Portfolio flow innovation	Unexpected Excess Return	Expected ST return	Expected LT return	Real Rates	Exchange Rate	Dividends
Unexpected Flow	0.288	0.748	-0.474	-0.006	0.000	0.556
	(0.035)	(0.245)	(0.177)	(0.026)	(0.000)	(0.307)
Expected ST Flow	0.746	1.733	-1.087	-0.012	0.000	1.380
	(0.143)	(0.625)	(0.394)	(0.050)	(0.000)	(0.734)
Expected LT Flow	-0.315	-0.705	0.523	0.008	0.000	-0.489
	(0.136)	(0.302)	(0.307)	(0.024)	(0.000)	(0.260)
Total Flow	0.718	1.776	-1.038	-0.009	0.001	1.447
	(0.209)	(0.726)	(0.377)	(0.052)	(0.001)	(0.867)

Panel B: Advanced Economies

	Return Innovation					
Portfolio flow innovation	Unexpected Excess Return	Expected ST return	Expected LT return	Real Rates	Exchange Rate	Dividends
Unexpected Flow	0.254	0.737	-0.407	-0.009	0.000	0.575
	(0.066)	(0.288)	(0.199)	(0.031)	(0.000)	(0.359)
Expected ST Flow	0.653	1.584	-0.846	-0.010	0.000	1.382
	(0.191)	(0.647)	(0.415)	(0.057)	(0.001)	(0.772)
Expected LT Flow	-0.160	-0.432	0.413	0.010	0.000	-0.168
	(0.130)	(0.276)	(0.249)	(0.026)	(0.000)	(0.297)
Total Flow	0.747	1.889	-0.839	-0.009	0.001	1.789
	(0.266)	(0.819)	(0.428)	(0.065)	(0.001)	(1.046)

Panel C: Emerging Markets

	Return Innovation					
Portfolio flow innovation	Unexpected Excess Return	Expected ST return	Expected LT return	Real Rates	Exchange Rate	Dividends
Unexpected Flow	0.403	0.488	-0.444	-0.008	0.000	0.440
	(0.065)	(0.210)	(0.108)	(0.016)	(0.000)	(0.222)
Expected ST Flow	0.954	1.492	-1.165	-0.037	0.000	1.245
	(0.199)	(0.640)	(0.327)	(0.040)	(0.000)	(0.707)
Expected LT Flow	-0.492	-0.624	0.558	0.017	0.000	-0.541
	(0.150)	(0.331)	(0.250)	(0.028)	(0.000)	(0.328)
Total Flow	0.865	1.357	-1.051	-0.027	0.000	1.144
	(0.250)	(0.632)	(0.307)	(0.049)	(0.000)	(0.687)

Table 5. Relations between Portfolio Flows and Returns in International Bond Markets.

The table reports scaled covariances between bond flow and return news as implied by the VAR. Each cell contains estimates of the covariances between the elements indicated in the row and column headings. We pick out the innovations in the variables by postmultiplying the appropriate selection vector by the unexpected shock u, the expected short-term (ST) innovation $\Phi(k)u$, the expected long-term (LT) innovation $(\Phi - \Phi(k))u$, and the total innovation Ψu. We set $k = 3$ months. Covariances are scaled by the product of the standard deviation of unexpected excess returns and the standard deviation of unexpected flows to facilitate comparison across the elements of the table. Standard errors are calculated with the delete-1 jackknife method and reported within parentheses.

Panel A: All Countries

	Return Innovation					
Portfolio flow innovation	Unexpected Excess Return	Expected ST return	Expected LT return	Real Rates	Exchange Rate	Inflation
Unexpected Flow	0.137	-0.008	-0.151	-0.033	0.000	0.055
	(0.089)	(0.172)	(0.096)	(0.019)	(0.000)	(0.222)
Expected ST Flow	0.520	0.127	-0.545	-0.081	0.000	-0.022
	(0.169)	(0.346)	(0.276)	(0.050)	(0.001)	(0.466)
Expected LT Flow	-0.041	0.131	-0.006	0.026	0.000	-0.110
	(0.141)	(0.208)	(0.159)	(0.018)	(0.000)	(0.216)
Total Flow	0.616	0.250	-0.702	-0.087	0.000	-0.077
	(0.207)	(0.362)	(0.346)	(0.057)	(0.001)	(0.501)

Panel B: Advanced Economies

	Return Innovation					
Portfolio flow innovation	Unexpected Excess Return	Expected ST return	Expected LT return	Real Rates	Exchange Rate	Inflation
Unexpected Flow	0.038	-0.177	-0.061	-0.017	0.000	0.216
	(0.074)	(0.171)	(0.102)	(0.022)	(0.000)	(0.210)
Expected ST Flow	0.248	-0.253	-0.282	-0.041	0.000	0.328
	(0.227)	(0.406)	(0.295)	(0.048)	(0.001)	(0.474)
Expected LT Flow	-0.019	0.180	0.048	0.014	0.000	-0.223
	(0.070)	(0.175)	(0.103)	(0.020)	(0.000)	(0.213)
Total Flow	0.268	-0.250	-0.295	-0.043	0.000	0.320
	(0.252)	(0.445)	(0.315)	(0.052)	(0.001)	(0.512)

Panel C: Emerging Markets

	Return Innovation					
Portfolio flow innovation	Unexpected Excess Return	Expected ST return	Expected LT return	Real Rates	Exchange Rate	Inflation
Unexpected Flow	0.256	0.250	-0.274	-0.061	0.000	-0.171
	(0.090)	(0.199)	(0.156)	(0.035)	(0.000)	(0.270)
Expected ST Flow	0.845	0.907	-0.907	-0.159	0.001	-0.687
	(0.251)	(0.560)	(0.381)	(0.094)	(0.001)	(0.712)
Expected LT Flow	-0.062	-0.014	0.001	0.022	0.000	0.054
	(0.180)	(0.178)	(0.223)	(0.032)	(0.000)	(0.168)
Total Flow	1.039	1.143	-1.180	-0.198	0.001	-0.804
	(0.359)	(0.731)	(0.560)	(0.131)	(0.002)	(0.925)

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