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International reserves and the maturity of external debt

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ABSTRACT

This paper studies how the level of international reserves affects the maturity structure of external debt. We show in an illustrative theoretical model that reserves lengthen the maturity of external debt via a flattening of the yield curve. Using data of 66 emerging and developing countries and applying different econometric approaches, we find robust evidence that reserves increase the share of long-term in total external debt. Results hold for private and public external debt individually. Taking reserves and their effect on the debt maturity structure together, they reinforce financial stability.

1. Introduction

This paper examines the effect of central banks' international reserves on the maturity structure of an economy's external debt. We show that, other things equal, an extended debt maturity is the endogenous response to the build-up of international reserves in emerging and developing economies. Thus, besides their direct effects on financial stability, international reserves tilt the maturity structure of external debt towards more LT debt, which further enhances financial stability.

The global financial crisis of 2008 wracked advanced economies and caused an exodus of capital. Emerging economies, on the other hand, withstood well the tide of the global financial tsunami (see IMF, 2010). They attracted substantial capital inflows thanks to a relatively stable macroeconomic environment, low debt levels and better prospects for economic growth compared to advanced economies. These capital inflows combined with government policies in favour of financial development have facilitated the growth of debt markets.

In the past, however, external debt flows to emerging and developing economies have caused economic turmoil. The level of external debt, its maturity composition, its currency denomination, and variable interest rates, among others, all potentially make emerging markets crisis-prone. Crises usually entail enormous output losses (Aizenman and Ito, 2014; Catão and Milesi-Ferretti, 2014; Gupta et al., 2007; Hutchison and Noy, 2005). Therefore, debt management has become a vital component of macroprudential policies.

These macroprudential policies have often been accompanied by the enormous build-up of international reserves at central banks (Fig. 1), which provide insurance against financial crises and help maintain a stable exchange rate and a resilient

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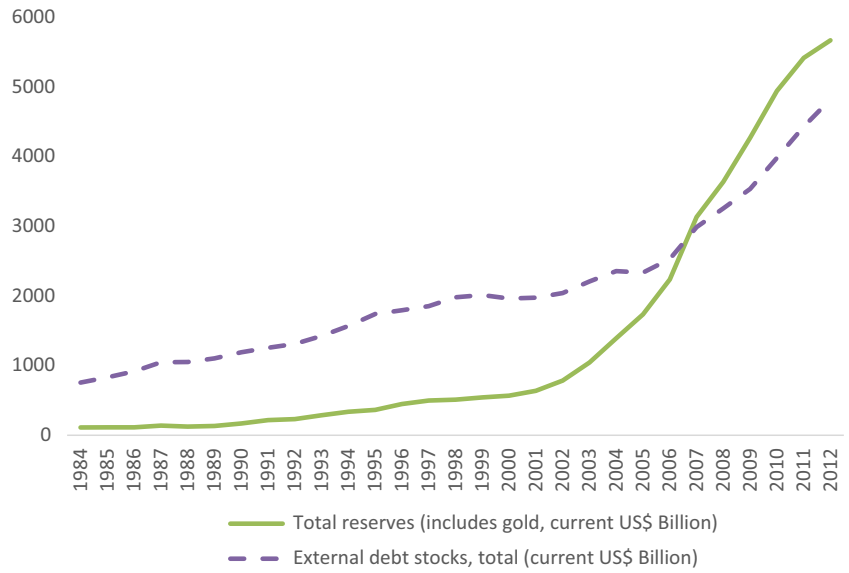

Fig. 1. International reserves and external debt in emerging and developing economies.

financial system. The stabilizing effect of reserves might operate through two channels: First, a higher level of reserves lowers the probability of a financial crisis (Aizenman and Marion, 2004; Cheung and Qian, 2009). It subsequently reduces the riskiness of an investment in the domestic economy because financial crises often entail exchange rate devaluations and cause recessions. Second, reserves create bailout expectations and reduce the costs if a crisis materialises (Aizenman et al., 2012). In a nutshell, reserve hoardings are perceived as an implicit insurance of foreign investors; therefore, they may enhance capital inflows to emerging markets.

This paper uncovers a hitherto disregarded effect of reserves: Their implicit insurance value might affect the maturity composition of external debt, measured by the ratio of long-term (LT) to overall external debt.[1] First, we examine the relationship between reserves and the maturity of external debt in a theoretical model that establishes the link between reserves and the yield curve. As a second step, we test our hypotheses empirically.[2]

ST external debt is less costly relative to LT debt (Broner et al., 2013), but it is a contributing factor to financial crises (Furman and Stiglitz, 1998; Reinhart and Calvo, 2000). In contrast, LT debt is more stable and resilient to crises, although it is more expensive due to higher default risk. When the trade-off between costs and crises-prevention benefit of different maturities of external debt is balanced, a county reaches its optimal debt maturity structure. International reserves, by reducing the crisis probability and creating bail-out expectations, reduce the cost (interest rate or yield) of LT debt relatively more than that of ST debt. For given benefits of LT and ST debt, reserves shift the optimal maturity composition of debt towards more LT investments.

We then confront our theory with the data: We analyse a panel data set of 66 emerging and developing economies over the period 1984–2012 using a variety of econometric methods, including fixed effect panel data regressions, System GMM, and a dynamic panel data vector autoregression (VAR). Careful attention is paid to the treatment of endogeneity issues. To account for possible differences between private and public debt, we split the data and investigate the maturity structures of public and private debt in the empirical section separately. To preview the results, we find that international reserves raise the share of LT relative to total external debt.

Our paper is one of the first that bridge the gap between the literature on the effects of international reserves and studies that determine the optimal maturity of external debt. There is a vast literature on the optimal maturity structure of corporate debt. Most papers study the maturity structure from the perspective of liquidity risk and information asymmetries. Borrowers that finance a LT project with ST debt are vulnerable to refinancing and interest rate risks. Premature liquidation hurts firms and investors because the value of assets is higher within the firm than outside (Hart and Moore, 1994). Diamond (1991) stresses that debt maturity is the result of a trade-off between liquidity risk and borrowers' preference for ST debt due to private information about the future credit rating.[3] Moreover, ST debt may serve as disciplining device to reduce moral hazard (Bolton and Scharfstein, 1990; Cheng and Milbradt, 2012).

[1] The definitions of LT and ST external debt follow the World Bank International Debt Statistics. LT debt is debt that has an original or extended maturity of more than one year; in all other cases debt is labelled ST.

[2] International reserves also affect the composition of foreign equity investment as shown by Qian and Steiner (2014).

[3] Diamond points out that investors who borrow ST are either high or low rated companies. While the former wait for the arrival of positive news, which allow for more favourable credit conditions, the latter have no access to LT financing.

Studies on the macroeconomic determinants of the maturity composition of debt are relatively few. In an influential paper, Rodrik and Velasco (2000) formulate a theoretical model for the determination of the maturity structure of external debt focussing on the liquidity risk of an investment project.[4] Empirically, they find that the share of ST debt is positively associated to GDP per capita and the size of the financial system of the recipient country but not to foreign trade activities. In addition, economic and political uncertainty may tighten the solvency constraints and subsequently tilt the debt profile towards ST debt (Bussière et al., 2004). Finally, a rat race towards shorter maturities might result from the strategic behaviour of individual creditors who have an incentive to shorten the maturity of their loans (Brunnermeier and Oehmke, 2013). The effect of international reserves has not been studied in this framework so far.

The paper is organized as follows: The next section develops the theoretical model to illustrate the link between international reserves, the yield curve and the optimal maturity structure of external debt. Section 3 is devoted to the empirical analyses including a variety of econometric methods and robustness checks. The policy implications of our findings are discussed in Section 4. The final section summarises our results and concludes.

2. Theoretical considerations: reserves and the maturity of external debt

This section presents a theoretical model that establishes the link between the level of reserves and the choice between ST and LT external debt. What are plausible channels through which international reserves might affect the maturity structure of external debt? We argue that the maturity choice may depend on the relative cost of debt instruments, that is, the term structure of interest rates; the latter, in turn, might be influenced by the level of international reserves.

International reserves are well-known to reduce the probability of a financial crisis and mitigate the output cost when a crisis cannot be prevented. If these benefits of reserves affect ST and LT debt contracts to varying degrees, reserves change the term structure of interest rates. As a result, the level of reserves affects the choice between ST and LT debt.

2.1. A model of the term structure of debt: theoretical setting

Our theoretical considerations are based on the model of the cost of external borrowing provided by Rodrik and Velasco (2000). This model determines the term structure of interest rates where the riskiness of different debt maturities determines their cost. The original model analyses the debt contract between a representative investor and foreign lenders. We add government as an additional actor to this setting: A government – represented by its central bank – may influence the debt contract through its hoarding and provision of international reserves.

Assume that a representative investor has access to a fixed-size investment project that lasts three periods: She prepares the project in period 0 and executes it in periods 1 and 2. An investment of k units of the single tradable good in period 0 yields Rk units of the good in period 2 with $R > 1$. The project may be dissolved partly in period 1 due to liquidity issues. However, premature liquidation is costly: Liquidation of an amount of $l \leqslant k$ in period 1 only yields ρl units, where $\rho < 1$.

The investor has no own resources, but may borrow from abroad. The required resources k can be split between ST borrowing (d) and LT borrowing (k-d). Assume for simplicity that the riskless world interest rate is zero for both ST and LT loans. ST loans have a maturity of one period, whereas LT contracts are made for two periods. Creditors may choose not to renew the contract in period 1 with probability p. If creditors refuse to roll-over ST debt, the investor is forced to partly liquidate the project.

The investor faces a trade-off between ST and LT debt: While ST debt is less expensive than LT one, uncertain roll-over makes it more expensive in expected value. From the point of view of a creditor, senior ST debt bears less risk. Its provision may be explained by agency problems and liquidity risk. In our model, creditors are indifferent between ST and LT debt while investors may choose an optimal maturity structure.

In our interpretation of the model, creditors decide not to roll-over their credits when the likelihood of a crisis in the host country is high. A macroeconomic crisis might depreciate the real value of the investment and increases the probability that the investor declares bankruptcy. Hence, we assume that the probability that investors refuse to roll-over debt (p) is a function of the probability of a financial crisis.

Since the model focuses on the term structure of interest rates – as opposed to their absolute level – the project-specific risk is irrelevant in our analysis. The project-specific risk affects ST and LT loans alike.

Depending on the size of ST debt relative to LT debt the results of the benchmark model may be summarised as follows[5]: If ST debt is small relative to LT debt, the project yields enough resources in period 2 to repay the entire stock of ST and LT debt. This statement even holds after premature liquidation of ST debt in period 1. Consequently, both ST and LT debt carry the world riskless interest rate. In the intermediate case, premature liquidation and repayment of ST obligations implicate that available resources in period 2 fall short of debt obligations. Hence, the investor defaults on her LT debt partly. Since under this scenario LT debt is riskier than ST debt, creditors will demand a risk premium which makes LT debt costlier than ST debt. In the worst scenario where the stock of ST obligations is large relative to LT debt, the investor defaults on her entire LT debt and repays only

[4] Diamond and Rajan (2001) study ST debt from the perspective of liquidity risk of an investment project.

[5] For the formal analysis refer to Rodrik and Velasco (2000).

part of her ST debt if there is no refinancing in period 1. Hence, while LT debt is still riskier than ST debt, ST debt contracts also carry a risk premium. This term structure of interest rates is depicted in Fig. 2.

2.2. Term structure of interest rates and international reserves

How do central banks' international reserves enter the model? Reserves affect the stability of the economy where the investment takes place. In particular, higher reserves reduce the risk of a financial crisis. They can be used to defend the local currency and to smooth the effects of a currency crisis if it cannot be prevented.

Financial instabilities reduce foreign creditors' willingness to invest in the economy. Under a mechanism of self-fulfilling crises, foreign creditors may suddenly stop renewing the debt contract such that capital reversals or capital flight take place and result in a full-blown financial crisis. Therefore, in a financial crisis financial constraints become tighter and foreign ST creditors do not renew their contracts. The negative repercussions of a financial crisis are aggravated by the reaction of foreign investors.[6] This leverage effect may be prevented by the presence and use of reserves.[7]

In the following, we examine the effect of reserves on the interest rate differential between LT and ST debt. Since this effect depends on the relative amount of ST debt, we distinguish several cases:

Case 1: $d \leqslant \rho k$

In this scenario, a crisis in period 1 does not affect ST creditors' returns: their claims on the borrower (d) are smaller than liquidable resources (ρk). Hence, there are always sufficient resources to service ST debt. The interest rate on ST debt equals the world riskless rate, namely $r_S = 0$. What about the LT interest rate r_L? There are two possible sub-cases:

Case 1a: $d \leqslant \left(\frac{R-1}{R-\rho}\right) \cdot \rho k$

Both ST and LT debt can fully be repaid. As a result $r_S = r_L = 0$ and the availability of reserves does not affect the term structure of interest rates.

Case 1b: $\left(\frac{R-1}{R-\rho}\right) \cdot \rho k < d < \rho k$

In this setting, after servicing all ST creditors, available resources in period 2 fall short of liabilities. In this case the interest rate on LT debt is determined by the condition that the expected return of a risky loan equals the world interest rate:

$$(1-p) \cdot (1+r_L) + pq_L(1+r_L) = 1 \tag{1}$$

where q denotes the probability of repayment in the case of a crisis.[8] q is assumed to equal the ratio of available resources to outstanding claims:

$$q_L = \min\left[\frac{R\left(k - \frac{d}{\rho}\right)}{(1+r_L)\cdot(k-d)}, 1\right] \tag{2}$$

After plugging (2) in (1), the LT interest rate can be expressed as

$$(1+r_L) = \left(\frac{1}{1-p}\right) \cdot \left[1 - \frac{pR\left(k - \frac{d}{\rho}\right)}{k-d}\right] \tag{3}$$

Along the lines of Aizenman and Marion (2004) we assume that the probability of a currency crisis increases in the level of external debt and falls in reserves (IR):

$$p = \phi + \alpha\frac{d}{IR}. \tag{4}$$

Hence, the derivative of p with respect to IR is negative ($p_{IR} < 0$). Analysing how IR affects the differential $(r_L - r_S)$ reduces to the effect of IR on r_L since r_s is constant:

[6] If the crisis does not have a global dimension, one might argue that foreign creditors prefer to move their resources to unaffected countries. They demand a higher risk premium such that credit costs exceed the return of the project.

[7] Reserves also reduce exchange rate risk. Exchange rate risk, however, does not affect the term structure of interest rates. Therefore, this effect is neglected in this section.

[8] q can be considered either as the probability of being repaid or as the recovery ratio if remaining resources are distributed among all creditors equally.

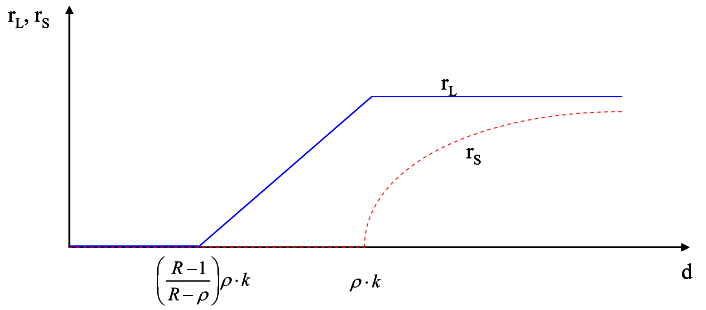

Fig. 2. Terms structure of interest rates as a function of the level of ST debt. Note: r_L (r_S) is the LT (ST) interest rate. The variable d (k) stands for the amount of ST (total) debt, R for the return of the investment project over two periods and ρ is the recovery ratio after early liquidation in period 1.

$$\frac{\partial(1+r_L)}{\partial IR} = -\frac{p_{IR}}{(1-p)^2}\left[\frac{R\left(k-\frac{k}{\rho}\right)}{(k-d)}-1\right] < 0$$

This expression is negative because $p_{IR} < 0$ and, by assumption for case 1b, $0 < \frac{R\left(k-\frac{d}{\rho}\right)}{k-d} < 1$. International reserves reduce the interest rate on LT debt. The interest differential between LT and ST debt decreases.

Case 2: $d > \rho k$

In this case, liquidation of the project in period 1 does not provide sufficient resources to cover all ST claims. The entire project has to be liquidated and after partially servicing ST debt there are no resources left to cover LT liabilities. The model assumes that LT debt is junior to ST debt. This assumption is in line with the observation by Berglöf and von Thadden (1994) that ST debt is usually repaid while creditors of junior LT debt may agree to a partial debt waiver.

The interest rate differential can be expressed as

$$(r_L - r_S) = \left(\frac{1}{1-p}\right)\left[\frac{p\rho k}{d}\right]$$

and the effect of reserves on the interest rate differential is given by

$$\frac{\partial(r_L - r_S)}{\partial IR} = \frac{p_{IR}\cdot\rho\cdot k}{(1-p)^2\cdot d} < 0$$

In this case, increasing reserves make LT debt contracts more attractive relative to ST debt because their relative cost decreases.

In sum, our model suggests that an increase in international reserves lowers the probability of a financial crisis, p, and any change in p has a stronger effect on r_L than on r_S since all LT debt is lost in case of premature liquidation, whereas part of ST debt will be repaid even in case of a crisis. Thus, international reserves affect the term structure of interest rate – higher reserves flatten the yield curve, making LT debt more attractive relative to ST debt due to the reduced relative cost. This, consequently, will induce domestic borrowers to adjust their portfolio toward more LT debt.

In general, debt maturity and the level of reserves affect each other simultaneously and are the joint outcome of a maximization problem. Our model focuses on the effect of a given level of reserves on the optimal maturity structure. Accordingly, we assume that an independent central bank chooses a level of reserves and borrowers react in their choice of debt maturity. In their model of sovereign debt and reserves, Bianchi et al. (2013) focus on the reverse causality by assuming an exogenous debt maturity. As such, both papers complement each other.

In their parametrised model, Bianchi et al. (2013) find that lower debt maturity increases the optimal amount of reserves.[9] In line with their model our crisis specification assumes that the default probability increases in the level of ST debt, which might be counterbalanced by higher reserves (see Eq. (4)). Our model differs in that we consider assets of different maturities and show that interest rates of LT debt are more elastic with respect to reserves than ST debt.

A key difference between private and public debt consists in their enforceability. If a private debtor is unable to service its liabilities, its project is liquidated and the proceeds are split between creditors. If, however, a public debtor stops servicing its debt, it is very difficult to seize collateral because there is no supranational authority that enforces the claims of international creditors. As a result, its willingness-to-pay has to be considered in addition to the creditors' willingness to roll-over.

[9] There are two opposing mechanisms at work: Lower maturity increases the vulnerability to rollover risk and raises the demand for reserves. Second, given that at low maturities the elasticity of the spread with respect to debt reductions is large, reserves are used to lower debt and the optimal reserve level falls.

Repayment by the public borrower can be ensured if the costs of default are sufficiently high. If we assume that the information set is such that default only affects LT debt, default risk increases the spread between LT and ST debt. The effect of reserves is ambiguous: On the one hand, higher reserves lower the probability of a default-inducing crisis and reduce the spread. On the other, reserves reduce the costs of default – they are a substitute for foreign borrowing in times of crisis, which increases the spread. If we assume that default costs are sufficiently large and that the first effect dominates, our model also holds for the special case of sovereign debt and reserves reduce the interest rate spread between LT and ST debt.

Existing models of sovereign debt either explain the maturity structure without making reference to reserves (e.g. Arellano and Ramanarayanan, 2012; Broner et al., 2013) or consider the joint presence of external assets and liabilities (e.g. Aizenman and Marion, 2004; Bianchi et al., 2013). The empirical puzzle of the simultaneous presence of reserves and sovereign debt – why do countries not use their reserves to lower debt levels? – has been explained by the fact that reserves can be used for consumption smoothing even after sovereign default (see Alfaro and Kanczuk, 2009; Corneli and Tarantino, 2016).

3. Empirical analysis

In this section, we use macroeconomic data to empirically test the hypothesis that international reserves affect the maturity structure of external debt. In addition to using aggregate external debt data, we split the data into private and public and publicly guaranteed debt. This allows us to examine whether the effects depend on the nature of the borrower. To account for the possible interdependence between private and public debt, we apply a panel data vector autoregression (VAR), which allows for dynamic interdependence among private debt, public debt, and international reserves, while controlling for cross-sectional heterogeneity.

3.1. The maturity composition of external debt – a panel data analysis

3.1.1. Aggregate external debt

We first consider the fixed effects panel data regression[10] on annual data for 66 countries (Appendix A) from 1984 to 2012. The sample size is determined by data availability. We estimate the following log-log model:

$$\ln\left(LT/totaldebt\right)_{i,t} = \alpha \cdot X_{i,t-1} + \beta \cdot Y_{i,t-1} + \gamma \cdot Z_{i,t-1} + \varepsilon_{i,t} \tag{E1}$$

where a log-transformation is applied to both dependent and independent variables. The dependent variable $(LT/totaldebt)_{i,t}$ measures the maturity composition of external debt, computed as the ratio of country i's stock of long-term (LT) to total external debt. i and t are country and year indices, respectively. External debt data is gathered from the World Bank International Debt Statistics. All independent variables are lagged by one period to cope with potential endogeneity and reverse causality.

We group the independent variables into three categories. $X_{i,t-1}$ contains macroeconomic factors, including the variable of interest, international reserves, measured as the ratio of international reserves to ST debt (IR/ST).[11] This measure captures the role of international reserves for crisis prevention and as insurance against roll-over debt crises.[12] According to our theory, we expect that international reserves positively affect LT relative to overall external debt. Moreover, given that the effect of international reserves might be non-linear, we add the squared term of IR/ST.

Apart from international reserves, we include M2 coverage and imports coverage. In theory, the level of M2 may have opposing effects on the maturity structure of debt: On the one hand, M2 is a measure of potential domestic capital flight or domestic drain (see Kaminsky and Reinhart, 1999; Obstfeld et al., 2010). Agents may withdraw domestic bank deposits and invest them in foreign assets. If this happens rapidly, it could lead to a bank run and precede a currency crisis (Obstfeld et al., 2010). This is especially likely in the absence of a large war chest of reserves. Thus, a high ratio of M2 to international reserves may signal potential vulnerabilities and reduce the average maturity of external debt. On the other hand, M2 measures the liabilities of monetary authorities and deposit money banks. As such it is a measure of the size of the financial sector, especially of its depth (see Beck et al., 2000). Deep domestic financial markets reduce domestic agents' need for external liquidity finance. This might especially lower the demand for external ST debt because "young" financial markets of emerging and developing countries typically offer rather ST than LT contracts. Thus, higher M2 may increase the share of LT relative to ST external debt. When the latter effect dominates, a high ratio of M2 is associated with a high share of LT debt in total external debt. We measure M2 coverage as the ratio of M2 to international reserves.

Imports coverage is defined as the value of imports relative to international reserves. The variable indicates the extent to which imports could be financed by reserves in a current account crisis and in a situation of lost access to foreign financial markets. The smaller the magnitude, the longer an adjustment in the current account can be postponed by the sale of

[10] The Hausman test rejects a random effects regression.

[11] Definitions for each variable and data sources are provided in Appendix B.

[12] We tested the robustness of our results using another widely applied measure for the adequacy of international reserves, reserves relative to GDP. It yields similar results to those reported in this paper. Results are available from authors upon request.

reserves. High values of imports coverage indicate a higher probability of crises. Therefore, we expect that it negatively affects the maturity of a country's external debt.

The productivity of the economy (GDP per capita) is also included. Rodrik and Velasco (2000) argue that increasing productivity raises the share of ST debt. Following their argument, we expect that GDP per capita has a negative coefficient indicating less LT debt.

$Y_{i,t-1}$ includes variables that are related to political uncertainty and institutional quality. In particular, we consider the change of government as a measure for political uncertainty (Jong-A-Pin and *de* Haan, 2011; Hausmann et al., 2005). In addition, we include two controls for institutional quality, namely the quality of bureaucracy and law and order from the International Country Risk Guide (ICRG). Citron and Nickelsburg (1987) and Ozler and Tabellini (1991) find that a country with frequent government changes and weak institutions faces difficulties in obtaining LT financing.

Finally, we include a few other relevant determinants of the maturity structure of debt in $Z_{i,t-1}$. The first one are capital control policies such as Chilean-type capital controls that directly alter the maturity composition of investors' portfolios. Although it is widely known that capital controls change the maturity composition of external debt, it is notoriously difficult to quantify all those regulations and policies (Montiel and Reinhart, 1999). For simplicity, we rely on a commonly used *de jure* measure, the Chinn-Ito Index, to quantify the strictness of a country's capital control policies. The Chinn-Ito Index takes smaller values when an economy has more capital account restrictions.[13] Macroprudential policies designed to reduce the risk of financial instabilities are another potential determinant of the debt maturity structure. In fact, the private sector might not internalize the impact of a higher ratio of ST debt over IR on the probability of a crisis, which implies that macroprudential instruments might be used as a second best policy to achieve the efficient maturity structure of debt. Aizenman et al. (2015) find macroprudential policies to complement reserve accumulation. In fact, limits on debt maturity mismatches are part of the macroprudential policy toolkit (Lim et al., 2013). We expect macroprudential policies to increase the share of LT in total external debt.

Finally, external and global factors may affect cross-border debt flows (Calvo et al., 1993; Chuhan et al., 1998; Montiel and Reinhart, 1999). We use the US interest rate yield spread as the world factor. Although decreasing, a significant share of external debt in emerging and developing economies is denominated in US Dollar. Hence, US interest rates have a direct effect on emerging economy debt. Indeed, tighter Federal Reserve monetary policy is found to drive up marginal funding costs of emerging and developing borrowers, typically by more than one-for-one (Arora and Cerisola, 2001; Hartelius et al., 2008; Uribe and Yue, 2006). US interest rate spreads are measured by the yield differential between 10-year and 1-year US Treasury securities. We expect that higher US interest rate spreads drive up the term spread between LT and ST interest rates in developing countries, resulting in a higher share of ST external debt. A time trending variable is also included in $Z_{i,t}$ to control for a possible trend in the time series.

The results of fixed effects panel data regressions using aggregate external debt data are reported in column (1) of Table 1. In line with our theory, international reserves are positively associated with the share of LT debt. In other words, a developing country may receive more LT relative to ST external debt if it has a higher level of international reserves. As the regression result suggests, an increase in international reserves over GDP by one percentage point is associated with 0.05% more LT relative to total external debt. In addition, the coefficient of the squared term of international reserves over ST debt turns out to be significantly negative (albeit small in absolute terms), indicating the existence of a non-linear effect – the marginal maturity-enhancing effect of larger international reserve holdings diminishes with increasing reserves. A country's productivity level (GDP per capita) is negatively associated with the share of LT debt, which is in line with the findings of Rodrik and Velasco (2000).

High M2 over international reserves is associated with more LT debt. This implies that the effect of more developed financial markets (more LT debt) dominates the effect of increased probability of financial crises (more ST debt) in the determination of the maturity structure.

In accordance with our priors, imports coverage negatively affects the maturity structure of debt. A lower coverage of imports by international reserves makes a country vulnerable to external shocks and current account crises. As a response, foreign creditors provide rather senior ST than junior LT financial resources, resulting in a lower share of LT debt.

Regarding institutional and political factors, the frequency of government change does not significantly affect the share of LT debt. Good bureaucratic quality can be a "shock absorber" that tends to minimize the impact from changes in policy and reduces the likelihood of crises. The positive and significant effect of bureaucratic quality and law and order suggest that better institutional and bureaucratic quality tend to attract a higher share of LT external debt.

As Montiel and Reinhart (1999), we find that a financially more open economy tends to have relatively less LT liabilities. We do not find a significant effect of macroprudential policies on the debt maturity structure. Regarding the world factor, a higher US interest rate spread negatively influences the share of LT debt. Indeed, due to investors' concern with respect to the Federal Reserve's exit from its quantitative easing (QE), there were a few episodes of drastic capital outflows from emerging and developing economies. This may reflect that rising US interest rates could reshape the structure of external debt in emerging and developing economies.

[13] The Chinn-Ito Index evaluates a country's overall capital controls without distinguishing controls on inflows and outflows, as well as controls on different types of capital flows, e.g. long-term versus short-term. A new capital control index (1995–2013) compiled by Fernández et al. (2016) provides separate indices for controls on different flow directions and capital types. We used their data and can confirm the robustness of our results. The results are available from the authors upon request.

Table 1
Determinants of the ratio of LT to total external debt.

	(1)	(2)
Int. reserves	0.048***	0.047***
	(0.00)	(0.00)
Int. reserves^2	−0.003***	−0.003***
	(0.00)	(0.00)
GDP per capita	−0.107***	−0.094***
	(0.02)	(0.03)
M2/int. reserves	0.076***	0.076***
	(0.01)	(0.01)
Imports coverage	−0.019	−0.023*
	(0.01)	(0.01)
Political instability	−0.001	0.003
	(0.01)	(0.01)
Bureaucracy	0.035***	0.035***
	(0.01)	(0.01)
Law and order	0.017***	0.014***
	(0.01)	(0.01)
Capital controls	−0.012***	−0.013***
	(0.00)	(0.00)
Macroprudential policy	0.014	0.019
	(0.02)	(0.02)
US treasury yield spread	−0.027***	−0.014*
	(0.01)	(0.01)
Mexican crisis		0.017
		(0.01)
Asian crisis		0.049***
		(0.02)
Global fin. crisis		0.014
		(0.03)
Trend	0.002**	−0.001
	(0.00)	(0.00)
Constant	1.386***	1.250***
	(0.17)	(0.17)
R-squared	0.18	0.19
# of observations	1482	1482
# of groups	64	64

Notes: Results are estimated from fixed effect panel data regressions. Dependent variable is the logarithm of LT debt/total external debt. All explanatory variables – except the crisis dummies – are lagged by one period.

The R-squared is relatively low – our basic model explains about 18% of the total variation in the maturity composition of external debt. Rodrik and Velasco (2000, p. 81) provide an explanation for the low explanatory power arguing that "it is difficult to quantify the myriad policies and regulations that directly affect short-term capital flows".

ST debt flows are typically considered to be "hot" – highly volatile. Being a leading indicator for financial crises (Kaminsky et al., 1998), a high proportion of ST debt exposes countries to the risk of self-fulfilling crises (Caballero and Krishnamurthy, 2006). Crises are usually coupled with a sudden stop of capital flows and a capital reversal. There is a plethora of discussions about the experience of sudden outflows of ST capital during crises in emerging and developing economies. We anticipate that during financial crises, there are substantial outflows of ST debt, while the amount of LT debt remains relatively stable.

Thus, we add three dummy variables for notorious financial crises to examine our anticipation and the robustness of our estimation results: Mexico 1994, East Asia 1997, and the global financial crisis of 2008. Such large-scale regional or global financial crises usually impose substantial contagion effects on countries outside the inflicted region.[14] Each crisis variable is set to 1 in the crisis year and all following years before the next crisis hits; and equal to 0 before the current crisis and after the next crisis has materialized. For instance, the crisis variable of the 1994 Mexican crisis is set to 1 from 1994 to 1997 (Asian financial crisis materialized), while it equals 0 before the year 1994 and after 1997.[15]

We report the regression results for the specification including crisis variables in column (2) of Table 1. While all three major crises have positive coefficients, only the East Asian crisis of 1997 raises the share of LT debt significantly. The insignificance of the 2008 global financial crisis may be explained by the fact that it affected primarily the advanced world; although emerging markets may have felt the crunch of capital flows due to soaring riskiness in global financial markets, they have not

[14] Frankel and Schmukler (1998) study the spillover effect of the Mexican crisis on Asian economies. IMF (1998) finds that the 1997 Asian crisis spread to other developing countries.

[15] In regressions not reported here, we added a country specific crisis variable. For example, a dummy that equals 1 if the annual exchange rate depreciation of the local currency exceeds 15% (Reinhart and Rogoff, 2011). However, such a crisis variable is highly correlated with international reserves. To avoid multicollinearity, we decided to drop it from the regressions. Alternatively, we use exchange rate volatility to proxy for currency crisis. The main results are robust and the estimates for exchange rate volatility itself are insignificant in all cases.

been forced to change their structure of assets and liabilities. Adding these three crisis variables does not affect other results, but raises the explanatory power of our model by 1 percentage point.

3.1.2. Private and public debt

In the previous section, we examine the relevant factors that affect the maturity composition of external debt using aggregate data. While this procedure provides a general picture of the determinants of debt maturity, it may obscure differences between public and private debt. Indeed, although both LT public and LT private debt trended upwards during the past three decades, private LT debt has a much faster pace – it increased more than 17 times from 1984 to 2012 (Fig. 3). This section tries to scrutinize those factors that explain the differences in public and private LT debt and that affect their maturity composition idiosyncratically.

There are common factors that affect the maturity structure of both public and private debt, possibly in different degree though. These common determinants may include the aforementioned macroeconomic and political factors. For the sake of consistency, in the regressions on public and private debt we first use the same basic set of independent variables as in Section 3.1.1.

In the specifications using private external debt we include an additional variable – the inflation rate. Private borrowers are more concerned about high inflation rates than sovereign borrowers that can print money out of debt. We expect that inflation affects the maturity structure of private debt because inflation reveals information about the expected real value of LT debt contracts denominated in domestic currency (Demirgüç-Kunt and Maksimovic, 1999).

Due to the unavailability of both public and private ST debt data, we cannot construct the maturity composition variable analogously to the case of aggregate debt, namely public (private) LT debt over total public (private) debt. Instead, the ratio of public (private) LT debt over total external debt is used as dependent variable. Tables 2 and 3 report the results. International reserves are found to significantly extend the maturity of both types of external debt.

The estimation for public debt (Table 2) yields results similar to those for aggregate debt, except that the R-squared increases substantially from 18% to 45%, indicating that the explanatory power of the model is much higher for public debt data than for aggregate data. International reserves increase the share of public LT debt and the size of this effect is almost twice as large as for aggregate debt. Being insignificant for aggregate data, macroprudential policies negatively affect the share of LT in total public debt. The implementation of macroprudential policies might be perceived as a bad signal about the vulnerability of the economy. This induces creditors to turn to ST contracts.

The estimation results for the maturity composition of private debt (Table 3) display some differences. First of all, while international reserves again positively affect the maturity of private debt, the magnitude of the effect is larger than for aggregate debt. Second, M2/IR turns insignificant. Third, GDP per capita becomes positive and significant, suggesting that private borrowers in more developed countries tend to borrow more in LT contracts. Fourth, changes of government become statistically significant and negative. Creditors might fear that frequent government changes acerbate the riskiness of local businesses and prefer ST contracts. Fifth, capital controls have significant, but opposite effects on private and public debt. While fewer controls (or more capital account openness) reduce the share of LT public debt, they raise the share of LT private debt. The reason might be linked to the lender's recovery ratio when default occurs. When firms in a financially open country

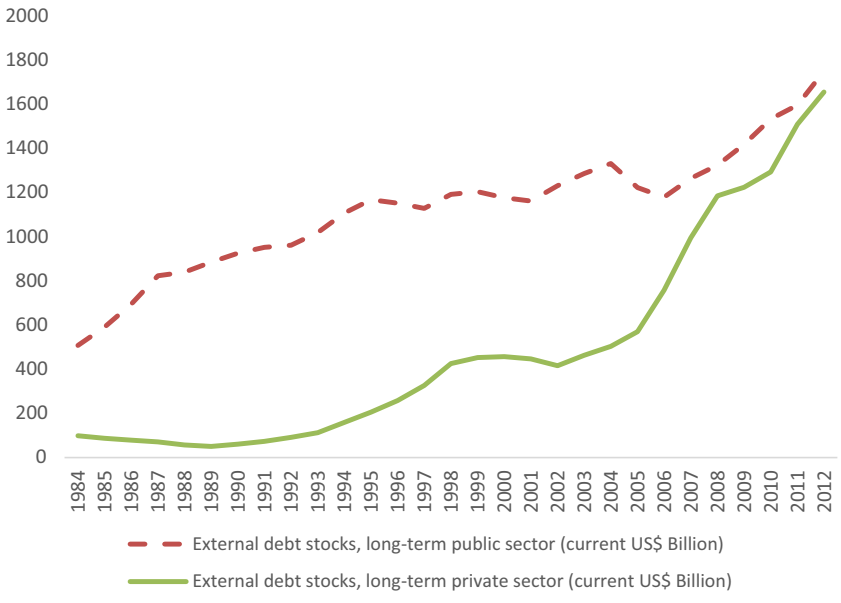

Fig. 3. Public and private long-term external debt in emerging and developing economies.

Table 2
Determinants of the share of LT public debt.

	(1)	(2)
Int. reserves	0.080***	0.078***
	(0.01)	(0.01)
Int. reserves^2	−0.007***	−0.007***
	(0.00)	(0.00)
GDP per capita	−0.286***	−0.265***
	(0.04)	(0.04)
M2/int. reserves	0.100***	0.100***
	(0.02)	(0.02)
Imports coverage	0.023	0.017
	(0.02)	(0.02)
Political instability	−0.015	−0.009
	(0.02)	(0.02)
Bureaucracy	0.015*	0.015*
	(0.01)	(0.01)
Law and order	0.043***	0.039***
	(0.01)	(0.01)
Capital controls	−0.054***	−0.056***
	(0.01)	(0.01)
Macroprudential policy	−0.213***	−0.205***
	(0.03)	(0.03)
US treasury yield spread	−0.007	0.014
	(0.01)	(0.01)
Mexican crisis		0.020
		(0.02)
Asian crisis		0.063**
		(0.02)
Global fin. crisis		−0.002
		(0.04)
Trend	0.001	−0.002
	(0.00)	(0.00)
Constant	3.607***	3.386***
	(0.24)	(0.24)
R-squared	0.45	0.46
# of observations	1537	1537
# of groups	64	64

Notes: Results are estimated from fixed effect panel data regressions. Dependent variable is the log of LT public debt/total external debt. All explanatory variables – except the crisis dummies – are lagged by one period.

default, more collateral assets are usually available for international lenders to confiscate, which reduces the cost of default incurred by lenders. However, if the sovereign defaults, there is no supranational institution that can hold a sovereign accountable, leading international lenders to prefer ST to LT debt investments. Sixth, macroprudential policies become insignificant in the private debt regression. Finally, in contrast to public debt, the 1994 Mexican crisis negatively affects the maturity of private external debt. Indeed, between the 1994 Mexican crisis and the Asian crisis of 1997, financial "over-lending" in ST credit was common particularly in East Asian economies, which eventually led to the devastating financial crisis (Corsetti et al., 1999). The 2008 global financial crisis is found to positively affect the maturity of private debt, whereas it is insignificant for public debt.

Regarding the additional variable included in private debt maturity regressions, high inflation is found to shorten the maturity of private debt,[16] which is in line with the findings of Boyd et al. (2001) and Rousseau and Wachtel (2002).

Overall, the explanatory power of our regression model for the maturity of private debt is much higher than that of aggregate debt – it explains about 45% of the variation in the maturity of private debt.

3.2. Robustness check

In this section, we check the robustness of our empirical results: First, we apply a System GMM dynamic panel regression approach to account for possible endogeneity, second, utilize an alternative measure for the maturity composition, then split the sample into emerging markets and other developing economies, and finally test our results using additional control variables.

Endogeneity: Endogeneity is present if central banks adjust their reserve policies in response to the maturity structure of external debt. In previous sections we used predetermined variables lagged by one period to deal with endogeneity; how-

[16] To check robustness, we also included the inflation rate in the public debt estimation; coefficients are insignificant however.

Table 3
Determinants of the share of LT private debt.

	(1)	(2)
Int. reserves	0.089*	0.098**
	(0.05)	(0.05)
Int. reserves^2	−0.001	−0.002
	(0.01)	(0.01)
GDP per capita	1.661***	1.522***
	(0.27)	(0.27)
M2/int. reserves	0.132	0.095
	(0.11)	(0.11)
Imports coverage	−0.175	−0.114
	(0.12)	(0.12)
Political instability	−0.265***	−0.305***
	(0.10)	(0.10)
Bureaucracy	0.165***	0.176***
	(0.05)	(0.05)
Law and order	0.090**	0.141***
	(0.04)	(0.04)
Capital controls	0.193***	0.201***
	(0.04)	(0.04)
Macroprudential policy	0.074	0.042
	(0.13)	(0.13)
US treasury yield spread	0.019	0.002
	(0.06)	(0.06)
Inflation	−0.074**	−0.060*
	(0.03)	(0.03)
Mexican crisis		−0.259**
		(0.11)
Asian crisis		0.195
		(0.15)
Global fin. crisis		0.573***
		(0.22)
Trend	0.025***	0.005
	(0.01)	(0.01)
Constant	−16.587***	−15.062***
	(1.75)	(1.80)
R-squared	0.43	0.45
# of observations	912	912
# of groups	48	48

Notes: Results are estimated from fixed effect panel data regressions. Dependent variable is LT private debt/total external debt. All explanatory variables – except the crisis dummies – are lagged by one period.

ever, if variables are persistent over time, this approach is unable to remove endogeneity concerns. For this reason, we use dynamic panel data System GMM, which is particularly helpful in dealing with the persistent data (e.g. autocorrelation) and independent variables being not strictly exogenous (Blundell and Bond, 1998). As reported in Table 4, international reserves are found to significantly increase the maturity of aggregate external debt and public debt. The magnitude of the effect is comparable to that found in the previous section. We do not find a significant effect of international reserves in the private debt regression.

Alternative measurement of maturity: The International Debt Statistics of the World Bank provide data of the weighted average maturity (in years) on new external debt commitments for public and publicly guaranteed external debt. Weights are given by the amounts of the loans. The effect of international reserves on the maturity composition is expected to evolve slowly over time because reserves cannot change the maturity of outstanding debt, but only affect the chosen maturity of new credit contracts. This variable has the virtue that it focuses on this latter measure. For example, Argentina had a weighted average public external debt maturity of about 10.4 years in 1986 and it extended this maturity to 24.8 in 2012. Although only available for public debt, we use this average maturity as alternative dependent variable to check whether international reserves have an effect on the maturity of new debt contracts.

As shown in Table 5, international reserves lengthen the weighted maturity of public debt in both a fixed effect panel regression (Column 1) and System GMM specification (Column 2). The coefficient values are comparable to those in Table 2. Interestingly, two of three major financial crises seem to shorten the weighted maturity. Overall, the explanatory power is rather poor – the R-squared is as low as 3%.

Country subsamples: We split the data into two subsamples – emerging markets and developing economies – to study the robustness of our results. As a prior, we expect that emerging markets have more developed financial markets than developing countries, which allows borrowers to better interact with foreign investors. In developing countries international reserves may serve as a substitute for developed financial markets and hence impose stronger effects on the maturity struc-

Table 4
Determinants of external debt maturities: System GMM.

	All	Pub	Priv
Lagged dep. variable	0.468***	0.449***	0.367***
	(0.12)	(0.07)	(0.11)
Int. reserves	0.053***	0.080***	−0.003
	(0.01)	(0.01)	(0.10)
Int. reserves^2	−0.003**	−0.004***	0.006
	(0.00)	(0.00)	(0.01)
GDP per capita	0.001	−0.161**	1.287*
	(0.06)	(0.07)	(0.65)
M2/int. reserves	0.023	0.023	0.181
	(0.02)	(0.02)	(0.14)
Imports coverage	0.035**	0.079***	−0.239
	(0.02)	(0.02)	(0.15)
Political instability	−0.002	−0.013*	0.016
	(0.01)	(0.01)	(0.07)
Bureaucracy	0.022	0.001	0.077
	(0.02)	(0.01)	(0.14)
Law and order	0.006	0.008	0.045
	(0.01)	(0.01)	(0.08)
Capital controls	0.002	−0.008	0.067*
	(0.01)	(0.01)	(0.03)
Macroprudential policy	−0.011	−0.049***	−0.015
	(0.02)	(0.02)	(0.07)
US treasury yield spread	−0.008	0.007	−0.104**
	(0.01)	(0.01)	(0.05)
Inflation			−0.004
			(0.07)
Trend	0.000	−0.001	0.007
	(0.00)	(0.00)	(0.02)
Constant	0.855*	2.705***	−12.697***
	(0.45)	(0.62)	(4.05)
Hansen	56.46	52.77	35.97
AR(1)	−2.40	−2.28	−1.98
AR(2)	0.83	0.75	0.47
Instruments	125	125	125
Obs.	1536	1536	889

Notes: Results are estimated from System GMM regressions. The dependent variables in columns All, Pub, and Priv are LT debt/total external debt, public and publicly guaranteed external debt/total external debt and private external debt/total external debt, respectively.

ture of debt. Indeed, as shown in Table 6, international reserves are found to extend the maturity of external debt across country samples. In private debt regressions their effect is only significant in developing countries.

Concessional debt: Our results could be driven by the presence of multilateral and bilateral concessional debt (usually in public and LT form), especially in developing countries, where concessional debt accounts for about 30% of total external debt. Concessional debt could simultaneously lengthen the maturity of external debt and increase the level of international reserves, resulting in an endogeneity issue. To address this point, we purge concessional debt from our external debt data, re-run regressions and check if our original results persist. An additional variable, the share of concessional debt in total debt, is also added to control for potential crowding out of market debt by concessional debt. We report the results in Table 7, which shows that for emerging markets results are virtually the same as those reported in Table 6. In developing countries, the salient difference is that international reserves affect private, but not public debt.

Additional control variables: To further check the robustness of the results, we tested how a number of additional control variables affect our regressions. We discuss them here briefly; detailed result tables might be found in the supplementary material, which accompanies the online publication of this article.

(1) *Default episodes:* The regression covers the 1980s, a period when many Latin American but also other countries defaulted on their debt. In the aftermath of default, their access to external borrowing was limited, especially to LT one. We therefore control for periods of default by a dummy variable, which includes debt restructurings with the Paris Club and debt restructurings with private banks or bondholders. Without concrete information about for how long a default limits a country's borrowing ability, we experimented with different time windows of two, three and four years. The effect is insignificant though and does not affect our qualitative results.
(2) *Regional effects of crises:* The effects of the included dummy variables for the Mexican crisis 1994 and the East Asian crisis 1997 could be rather regional than global and the impact vastly different for different regions. To test this hypothesis, we divide our country sample into three regional groups, namely Asia, Latin America and other countries,

Table 5
Determinants of the weighted maturity (years) of new external public debt commitments.

	(1)	(2)
Lagged dep. variable		0.157**
		(0.07)
Int. reserves	0.034***	0.051*
	(0.01)	(0.03)
Int. reserves^2	0.000	−0.004
	(0.00)	(0.01)
GDP per capita	−0.301***	−0.293**
	(0.02)	(0.13)
M2/int. reserves	−0.068**	−0.044
	(0.03)	(0.12)
Imports coverage	0.085***	0.091
	(0.03)	(0.11)
Political instability	−0.034	−0.051
	(0.03)	(0.07)
Bureaucracy	0.010	0.019
	(0.02)	(0.06)
Law and order	0.012	−0.034
	(0.01)	(0.04)
Capital controls	0.030***	0.026
	(0.01)	(0.04)
Macroprudential policy	0.186***	−0.225
	(0.04)	(0.29)
US treasury yield spread	0.004	−0.016
	(0.02)	(0.02)
Mexican crisis	−0.072**	−0.077*
	(0.04)	(0.04)
Asian crisis	−0.081*	−0.061
	(0.05)	(0.06)
Global fin. crisis	−0.064	−0.013
	(0.07)	(0.07)
Trend	0.004	0.011*
	(0.00)	(0.01)
Constant	5.362***	5.391***
	(0.21)	(0.88)
R-squared	0.03	
# of observations	1475	1448
# of groups	64	64

Notes: Results are estimated using the log of the weighted average maturity (years) of public and publicly guaranteed external debt as dependent variable. Column (1) reports the results of a standard random effect panel regression, since the Hausman test does not reject the Null. Column (2) reports results based on System GMM. All explanatory variables in Column (1) – except the crisis dummies – are lagged by one period.

and run regressions for each subsample. According to the results the Mexican crisis 1994 and East Asian Crisis 1997 do not affect the maturity structure in their region. Both crises, however, positively affect the debt maturity structure in developing countries outside their region. It seems that capital flight from the crisis-ridden regions has positive spillovers for other regions where the capital is invested in more LT projects than before.

(3) *Capital flow reversals and sudden stops:* A third factor might be responsible for the positive correlation between the level of international reserves and the maturity structure of external debt: capital flow reversals and sudden stops. We therefore generate a sudden stop dummy variable, which takes on the value 1 if a fall in the financial account exceeds twice the country-specific standard deviation of the financial account. For the duration of the effect we consider time windows of two, three and four years. Sudden stops turn out to be insignificant. More importantly, their inclusion does not change the other results qualitatively.

In sum, using a System GMM regression approach, an alternative measure for the maturity composition, different country samples and additional controls, we are able to validate the robustness of our empirical results; and once again confirm our theoretical postulation.

3.3. The interactions between the maturity composition of public and private debt

Thus far, our empirical exercises assume that public and private debt evolve independently of each other. However, the debt literature suggests that there are two possible interactions between public and private debt. The first one is the "crowding out" effect of public debt with respect to private debt, which is usually found in the context of advanced economies. The

Table 6
Determinants of external debt maturities: emerging vs. developing economies.

	Emg	Emg-pub	Emg-prv	Dev	Dev-pub	Dev-prv
Int. reserves	0.048***	0.173***	0.000	0.046***	0.060***	0.144**
	(0.02)	(0.02)	(0.05)	(0.00)	(0.01)	(0.06)
Int. reserves^2	0.004	−0.002	0.015	−0.003***	−0.005***	−0.013
	(0.01)	(0.01)	(0.02)	(0.00)	(0.00)	(0.01)
GDP per capita	−0.462***	−0.601***	1.185***	0.069**	0.053	0.990**
	(0.06)	(0.08)	(0.22)	(0.03)	(0.04)	(0.46)
M2/int. reserves	−0.087***	0.036	−0.205**	0.092***	0.088***	0.136
	(0.03)	(0.04)	(0.10)	(0.01)	(0.02)	(0.15)
Imports coverage	0.110***	0.203***	−0.082	−0.037***	−0.001	−0.025
	(0.03)	(0.05)	(0.11)	(0.01)	(0.02)	(0.17)
Political instability	−0.034	−0.043	0.098	0.008	0.013	−0.452***
	(0.03)	(0.04)	(0.08)	(0.01)	(0.01)	(0.14)
Bureaucracy	0.024*	0.006	−0.011	0.033***	0.007	0.341***
	(0.01)	(0.02)	(0.04)	(0.01)	(0.01)	(0.09)
Law and order	0.040***	0.056***	0.215***	0.008*	0.033***	0.126**
	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.06)
Capital controls	0.015*	−0.029**	0.069**	−0.032***	−0.083***	0.230***
	(0.01)	(0.01)	(0.03)	(0.00)	(0.01)	(0.06)
Macroprudential policy	−0.005	−0.119***	0.136*	0.033	−0.232***	0.568*
	(0.02)	(0.03)	(0.08)	(0.03)	(0.04)	(0.32)
US treasury yield spread	−0.006	0.053**	−0.085*	−0.017**	−0.005	0.043
	(0.02)	(0.02)	(0.05)	(0.01)	(0.01)	(0.09)
Inflation			−0.107***			−0.037
			(0.03)			(0.05)
Mexican crisis	−0.034	−0.042	0.074	0.037***	0.058***	−0.507***
	(0.03)	(0.04)	(0.09)	(0.01)	(0.02)	(0.17)
Asian crisis	0.110***	0.010	0.721***	0.039**	0.082***	−0.108
	(0.04)	(0.05)	(0.12)	(0.02)	(0.03)	(0.21)
Global fin. crisis	0.155***	0.075	0.384**	−0.033	−0.058	0.782**
	(0.05)	(0.08)	(0.17)	(0.03)	(0.04)	(0.32)
Trend	−0.001	0.003	−0.022*	0.000	−0.002	0.021
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.02)
Constant	3.609***	8.482***	−7.183***	0.168	0.712***	−9.512***
	(0.41)	(0.54)	(1.44)	(0.19)	(0.27)	(3.04)
R-squared	0.44	0.75	0.82	0.24	0.39	0.40
# of observations	348	362	350	1134	1175	562
# of groups	14	14	14	50	50	34

Notes: Results are estimated from fixed effect panel data regressions. The results for the sample of emerging economies are reported in columns "Emg, Emg-pub, and Emg-prv". Columns "Dev, Dev-pub, Dev-prv" report results for other developing countries. For both samples, the first dependent variable is the ratio of LT debt/total external debt, while in the next columns follow LT public debt/total external debt and LT private debt/total external debt as dependent variables. All explanatory variables – except the crisis dummies – are lagged by one period.

theoretical conjecture is that increasing public debt drives up the interest rate and negatively affects the borrowing abilities of firms and households. At the same time, Ricardian equivalence suggests that households restrict their demand for debt as public debt increases. The empirical evidence, however, is ambiguous (Aschauer, 1989; Evans, 1987). In the developing world, the prevailing view is that public debt can be a substitute for private debt in that borrowers in emerging and developing economies are usually subject to borrowing limits due to credit rationing. Governments, which are less credit constrained, can relax private borrowing limits by issuing public debt (Caballero and Krishnamurthy, 2006; Holmström and Tirole, 1998; Woodford, 1990). Moreover, the development of the sovereign bond market may serve as a catalyst for the development of the corporate bond market (Dittmar and Yuan, 2008).

Against these theoretical backdrops, we augment our empirical exercise by potential interactions between public and private debt. Panel data vector autoregressions (VAR) provide a straightforward way to control for these interactions. However, the normal VAR estimator for panel data with lagged dependent variables as explanatory variables may be biased and inconsistent (Anderson and Hsiao, 1981). To address this issue, we turn to the System Generalized Method of Moments (GMM) estimator by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). Additionally, System GMM panel data VAR offers supplementary benefits, e.g. accounting for autocorrelation and cross-sectional heterogeneity.

The dynamic panel data VAR is specified as a three-equation system with international reserves and the maturities of private and public debt as endogenous variables. As exogenous variables we include the set of controls from the previous sections. The number of dynamic lags for each endogenous variable is determined on the basis of the Bayesian Information Criterion (BIC).

Fig. 4 presents impulse-response functions and the 5% error bands generated by Monte Carlo simulations (1000 repetitions). They reveal information of how shocks in one endogenous variable affect the other endogenous variables and how this effect evolves dynamically. Fig. 4 shows that both the maturity of public and private debt respond positively to an innovation in international reserves. There are, however, different dynamic patterns in each response. The share of LT private

Table 7
Determinants of external debt maturities controlling for concessional debt – emerging markets vs. developing countries.

	Emg	Emg-pub	Emg-prv	Dev	Dev-pub	Dev-prv
Int. reserves	0.059***	0.164***	0.021	0.039**	0.005	0.254***
	(0.02)	(0.04)	(0.05)	(0.02)	(0.02)	(0.07)
Int. reserves^2	0.012*	−0.004	0.022	0.001	−0.001	−0.019**
	(0.01)	(0.01)	(0.02)	(0.00)	(0.00)	(0.01)
GDP per capita	−0.528***	−0.975***	1.053***	0.245**	0.406***	0.447
	(0.08)	(0.12)	(0.22)	(0.10)	(0.11)	(0.45)
M2/int. reserves	−0.106***	−0.006	−0.174*	0.049	0.020	0.119
	(0.04)	(0.07)	(0.10)	(0.04)	(0.05)	(0.14)
Imports coverage	0.140***	0.242***	−0.121	−0.005	0.045	0.087
	(0.04)	(0.07)	(0.11)	(0.04)	(0.05)	(0.17)
Political instability	−0.039	−0.042	0.077	0.098***	0.133***	−0.424***
	(0.04)	(0.06)	(0.08)	(0.04)	(0.04)	(0.13)
Bureaucracy	0.056***	−0.002	0.004	0.022	0.025	0.248***
	(0.02)	(0.03)	(0.04)	(0.02)	(0.03)	(0.09)
Law and order	0.051***	0.058***	0.216***	−0.030	−0.009	0.132**
	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)	(0.06)
Capital controls	0.026**	−0.032*	0.070**	−0.030*	−0.075***	0.197***
	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)	(0.06)
Macroprudential policy	−0.007	−0.154***	0.122	0.199*	−0.245*	0.896***
	(0.03)	(0.05)	(0.08)	(0.12)	(0.13)	(0.32)
US treasury yield spread	−0.011	0.054	−0.096*	−0.058**	−0.070**	0.041
	(0.02)	(0.03)	(0.05)	(0.03)	(0.03)	(0.09)
Concessional debt share	−0.111***	−0.020	0.002	−0.204***	−0.069*	−0.223*
	(0.03)	(0.05)	(0.07)	(0.04)	(0.04)	(0.13)
Inflation			−0.118***			−0.046
			(0.03)			(0.05)
Mexican crisis	−0.025	−0.017	0.068	0.070	0.109**	−0.406**
	(0.04)	(0.06)	(0.09)	(0.05)	(0.05)	(0.16)
Asian crisis	0.109**	0.046	0.708***	−0.056	0.011	−0.064
	(0.05)	(0.08)	(0.12)	(0.06)	(0.07)	(0.21)
Global fin. crisis	0.145**	0.157	0.357**	−0.285***	−0.395***	0.584*
	(0.07)	(0.12)	(0.18)	(0.09)	(0.11)	(0.31)
Trend	−0.002	0.005	−0.020*	−0.005	−0.016***	0.042**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Constant	3.922***	11.094***	−16.185***	−1.568**	−2.184***	−4.058
	(0.51)	(0.83)	−1.429	(0.68)	(0.76)	−2.983
R-squared	0.45	0.67	0.82	0.17	0.34	0.41
# of observations	331	344	332	1108	1153	562
# of groups	13	13	13	49	49	34

Notes: Same as in Table 6, except that, for both samples, the first dependent variable is the ratio of total LT debt excluding concessional debt/total debt excluding concessional debt, while the next columns display regressions for LT public debt excluding concessional debt /total debt excluding concessional debt and LT private debt/total debt excluding concessional debt as dependent variables.

debt (see first panel in second row of Fig. 4) immediately increases by about 0.03% in response to a 1 S.D. shock in international reserves. The response slowly gets stronger as time evolves and reaches its peak (0.108%) 6 years after the shock before gradually fading out. Public debt maturity, in turn, shows a different response (first panel in third row of Fig. 4). It initially responds positively (0.023%), but then diminishes quickly over time. In fact, it dies out in less than three years. Comparing the peak impact, 0.108% in private debt versus 0.023% in public debt, shows that the maturity of private debt is more sensitive to international reserves than that of public debt.

Besides the insights in the dynamic process, the VAR approach provides a couple of new findings: First, the maturities of public and private debt do not affect international reserves. That is, central banks' reserve policies do not actively react to changes in the maturity composition of debt. The variation in reserves is almost exclusively explained by its own history. Indeed, as shown by the variance decomposition in Table 8, about 99% of IR variation is explained by itself.

Second, with respect to the question whether public LT debt crowds-out private LT debt or substitutes it, our results seem to be in line with the substitution theory. As shown in Fig. 3, both public and private LT debt of emerging and developing economies have substantially increased during the last three decades. But private LT debt has increased much faster than public one. Apparently, public debt has not been "crowding out" private debt in emerging and developing economies. Moreover, according to the impulse-response analysis in Fig. 4, the maturity of public debt negatively responds to a shock in the maturity of private debt. A plausible interpretation is that, with decades of stable economic growth and deepening bond markets in emerging and developing economies, private LT debt is less credit constrained, which makes substitution by public debt unnecessary.

Table 8 reports the variance decomposition, which measures the percentage of variation of each endogenous variable that is explained by other endogenous variables. While international reserves are shown to be positively related to the maturity composition of both public and private debt, reserves are only one of many factors that determine the debt maturity struc-

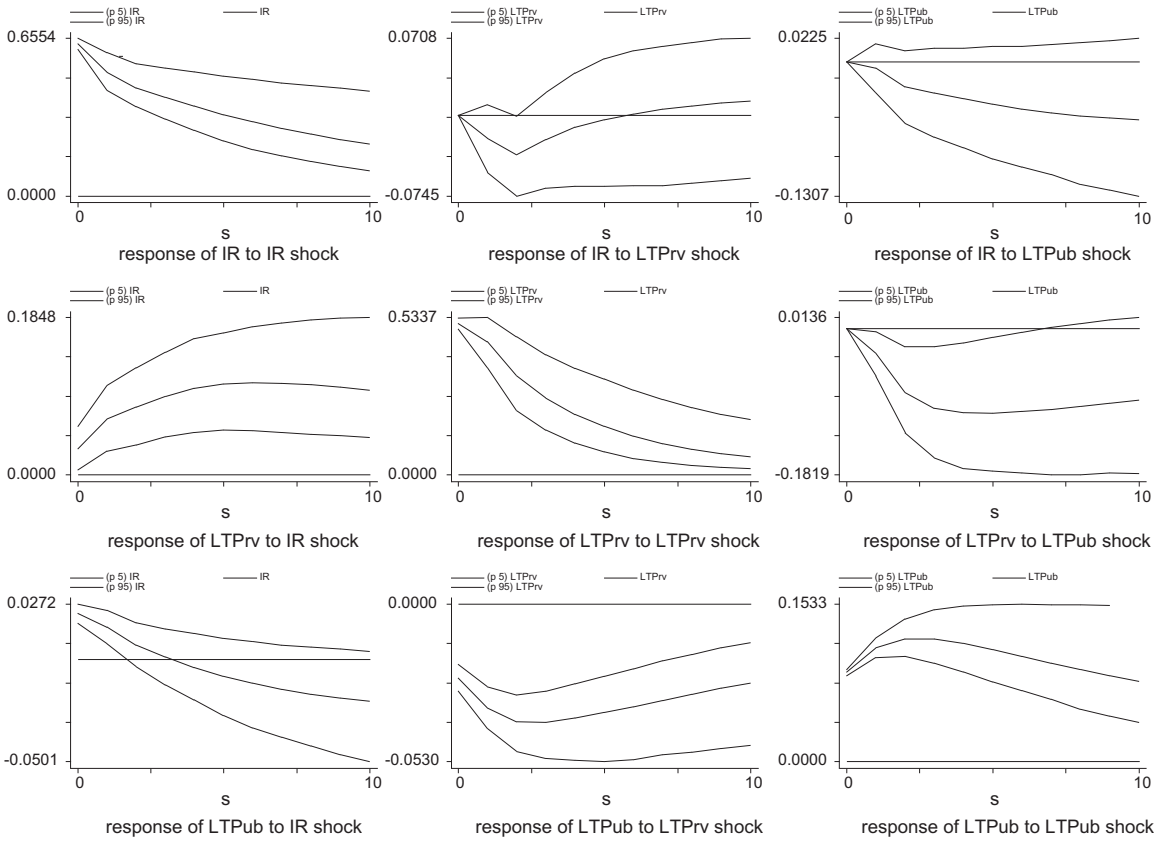

Fig. 4. Impulse response of international reserves and the maturity compositions of private and public debt to 1 Cholesky S.D. shock.

Table 8
Variance decomposition.

	IR	Priv.	Pub.
IR	0.99	0.00	0.01
Priv.	0.09	0.82	0.08
Pub.	0.02	0.10	0.89

Note: This table reports variance decompositions – the percentage of variation in the row variable explained by the column variable.

ture. In fact, international reserves explain 9% and 2% of the variation of the maturities of private and public debt, respectively. The major part of the variations is explained by their own history, namely the lagged dependent variables. This shows that the maturity composition of external debt is relatively persistent over time.

Overall, using robust dynamic panel data VAR, we validate the robustness of our hypothesis that international reserves lengthen the maturity of external debt in emerging and developing economies. Further, this approach reveals how this effect evolves over time. While international reserves affect the maturity of debt, the analysis shows that there are many other factors that determine the debt maturity, especially its own history.

4. Discussion

Our theoretical and empirical analyses suggest that international reserves affect the maturity composition of a country's external debt: Higher reserves increase the ratio of LT to ST external debt for both private and public debt. Given that countries' vulnerability to financial crises decreases as they rely more on LT debt, reserves help countries to preserve financial stability. We call this the reinforcement effect of reserves for financial stability. This section elaborates on these issues.

The literature distinguishes two main motives for reserve holdings: a mercantilist and a precautionary one. According to the mercantilist approach, reserve accumulation may be part of an export-led growth strategy because it depreciates the

exchange rate and makes export prices more competitive. The precautionary motive emphasizes reserves' role in defending the exchange rate and in coping with external shocks.

There is ample evidence that reserves provide precautionary services, both empirical studies and theoretical models coincide in the finding that reserves reduce the probability and severity of financial crises. In the presence of productivity shocks reserves allow to smooth consumption intertemporally (Aizenman and Marion, 2004) and mitigate the output effects of liquidity shocks (Aizenman and Lee, 2007). Mourmouras and Russell (2009) find that the effect of negative shocks on worker welfare might be attenuated by international reserves. Li and Rajan (2009) show in a theoretical model that high reserves may prevent speculative attacks on the currency by compensating for the negative effect of weak fundamentals.

On the empirical side, the literature on early warning indicators for currency crises generally includes reserves – scaled by GDP, M2 or ST external debt – as an important indicator. Frankel and Saravelos (2012) summarize more than 80 papers of this literature in a meta-analysis and identify low reserves as the most reliable warning indicator. This also holds for the crisis of 2008–2010. De Gregorio and Lee (2004) and Aizenman et al. (2012) show that reserves reduce the output costs of crises. For the crisis of 2008–2010, Obstfeld et al. (2009) and Fratzscher (2009) note that countries with low reserves are associated with larger depreciations.

In addition to this direct effect on financial stability, our analysis points to an indirect effect of reserves, which has not been considered by the literature so far: By increasing the average maturity of external debt, reserves make countries more resilient to volatile capital flows and help to maintain domestic financial stability.

On theoretical grounds, ST debt makes borrowers more vulnerable to the risk that creditors do not roll-over their loans. This may lead to the costly liquidation of projects and the default of the debtor (as described in the theoretical model and the papers cited in Section 2). In the case that debtors default because creditors have refused to roll-over maturing debt, creditor runs become self-fulfilling.

The same literature on early warning indicators finds that countries are more vulnerable to crises if their level of external ST debt is high (see Frankel and Saravelos, 2012, and IMF, 2000, for general treatments). Rodrik and Velasco (2000) conclude that "countries with short-term liabilities to foreign banks that exceed reserves are three times more likely to experience a sudden and massive reversal in capital flows" and that "greater short-term exposure is associated with more severe crises when capital flows reverse". Indicators of vulnerability include ST debt as a share of total external debt (positively associated with crisis incidence) and international reserves as a share of ST external debt (negatively associated with crisis incidence). The latter reveals the double dividend of reserves: First, high reserves directly raise the indicator value by increasing its numerator. Second, for a given amount of external debt, they lower the denominator by shifting external obligations from short to long-term maturities. Hence, reserve hoardings provide a reinforcement effect for financial stability.

Since the early warning indicators literature does not allow for causal conclusions, the dependence on ST debt might be a symptom rather than the cause of a crisis (see Benmelech and Dvir, 2013; Detragiache and Spilimbergo, 2004; Diamond and Rajan, 2001): Vulnerability itself may force countries to borrow at short maturities. The direction of causality, however, does not question our conclusions: Even if ST debt rises in anticipation of a crisis, reserves help to rely more on LT debt, which, in turn, reduces the rollover risk and the amount of capital flight.

Finally, reserves also affect the access to external credit. Credit ratings improve in the level of reserves and sovereign risk premia fall (see Levy-Yeyati, 2008). Sovereign risk, in turn, is a crucial determinant of private sector access to external capital. Lower sovereign bond spreads are found to increase the volume of corporate debt and equity issued (Das et al., 2009). External credit to the private sector is significantly lower during periods of sovereign debt restructuring (Arteta and Hale, 2008). The same holds true after large depreciations where external credit to the private sectors drops substantially, mainly due to a decline in supply (Hale and Arteta, 2009). Hence, through their positive influence on external financial resources, reserves contribute in an additional way to financial stability.

5. Concluding remarks

This paper examines the effect of central banks' international reserves on the maturity structure of countries' external debt. Our theoretical model shows that higher reserves may reduce the costs of both ST and LT external debt by lowering the riskiness of the debt contract: Reserves are a form of insurance that lowers the incidence of default and reduces the risk for creditors. Our theory suggests that these effects reduce the cost of LT debt more than that of ST debt, which results in a flattened yield curve. This makes LT loans relatively more attractive and may induce a re-structuring of foreign debt to longer maturities.

Our empirical analysis for a sample of 66 emerging and developing countries confirms the hypothesis that international reserves positively affect the share of LT external debt. This effect holds for both private and public external debt. When investigating the maturity of new public loan contracts only, the positive effect of reserves persists. Finally, after controlling for endogeneity in a dynamic panel data VAR framework, we confirm the positive effect of reserves on the share of LT debt, both public and private one.

These findings reveal a collateral benefit of reserves: While reserves are accumulated as insurance and/or buffer stocks against financial crises, they also attract those types of foreign debt that reduce the vulnerability to sudden stops and capital outflows. To some extent, the endogenous response of capital flows makes the country more resilient to capital account crises. Given that the ratio of ST external debt to reserves is considered a major indicator for financial crises (Frankel and

Saravelos, 2012), reserves reduce the crisis probability and enhance financial stability via two complementing channels: First, reserves directly improve this indicator. Second, by reducing the share of ST debt, reserves affect the maturity structure of external debt in a way favourable for financial stability. Reserves seem to provide a reinforcement effect promoting financial stability that rarely has been discussed in the international finance literature.

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Appendix A. Country samples

A.1. Emerging markets (MSCI classification)

Brazil, Chile, China, Colombia, India, Indonesia, Malaysia, Mexico, Morocco, Peru, Philippines, Romania, South Africa, Thailand, Turkey.

A.2. Other developing countries

Albania, Algeria, Angola, Argentina, Bangladesh, Bolivia, Botswana, Bulgaria, Burkina Faso, Cameroon, Costa Rica, Ecuador, El Salvador, Ethiopia, Gabon, Ghana, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Jordan, Kenya, Lebanon, Liberia, Madagascar, Malawi, Mali, Mongolia, Mozambique, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Senegal, Sierra Leone, Sri Lanka, Sudan, Tanzania, Togo, Tunisia, Uganda, Uruguay, Vietnam, Zambia, Zimbabwe.

Appendix B. Variable definitions

Debt	External debt stocks, total (disbursed outstanding debt, current US$). Data source: World Bank International Debt Statistics
ST debt	External debt stocks, short-term (disbursed outstanding debt with an original maturity of one year or less, current US$). Data source: World Bank International Debt Statistics
LT debt	External debt stocks, long-term (disbursed outstanding debt, current US$). Data source: World Bank International Debt Statistics
LT public	External debt stocks, long-term (public and publicly guaranteed). Data source: World Bank International Debt Statistics
LT private	External debt stocks, long-term (private). Data source: World Bank International Debt Statistics
Maturity	The weighted average maturity (years) on new public and public guaranteed external debt commitments. Data source: World Bank World Development Indicators (WDI)
Int. reserves	Total reserves minus gold over GDP in current US dollar coverage of ST debt. Data source: World Bank World Development Indicators (WDI)
GDP per capita	GDP per capita (constant 2000 US$). Data source: World Bank World Development Indicators (WDI)
M2/int. reserves	Money and quasi money (M2) as % of international reserves measures the risk of domestic capital flight or internal drain (Obstfeld et al., 2010). M2 is also a measure of financial development. Data source: World Bank World Development Indicators (WDI)
Imports coverage	Imports of goods and services % of international reserves to measure the coverage of current account imbalance risk. Data source: World Bank World Development Indicators (WDI).
Inflation	Inflation rate measured by annual percentage changes in consumer price index. Data source: IMF IFS
Political uncertainty	Dummy for government or regime change in a country. Variable is defined according to Jong-A-Pin and *de* Haan (2011) and takes on the value one in the five years following a regime change. A regime change is defined as a three-unit change in the Polity score of the Polity IV dataset
Bureaucracy	Bureaucracy quality as measured by the International Country Risk Guide (ICRG). High points are given to countries where the bureaucracy has the strength and expertise to govern without drastic changes in policy or interruptions in government services in the face of shocks
Law and order	Law and order as measured by ICRG. High ratings indicate strong law and order

Capital controls	Chinn-Ito index for de jure capital controls. A higher value indicates a more open capital account, in other words, less capital controls
US treasury yield spread	Global factor of the debt composition, measured by the log yield differential of ten-year and one-year US Treasury security
Macroprudential policy	A qualitative variable that takes on the value one if a country applied any of the macroprudential policies described in Lim et al. (2013). Policies include capital-related, credit-related and liquidity-related instruments
Mexican crisis	Mexican crisis of 1994, dummy variable, I($t \geq 1994$ and $t < 1997$) = 1
Asian crisis	Asian financial crisis of 1997, dummy variable, I($t \geq 1997$ and $t < 2008$) = 1
Global fin. crisis	Global financial crisis beginning in 2008, dummy variable, I($t > 2008$) = 1
Trend	Time trend

Appendix C. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jimonfin.2017.02.015.

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