Liquidity and Growth: the Role of Government Debt

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Abstract

This paper provides evidence that government debt has a large causal effect on long-run growth by enhancing the supply of liquidity. I build an endogenous growth model where the liquidity provision of government debt is more growth-enhancing in sectors hit by large liquidity shocks. The presence of credit market imperfections amplifies this growth effect. Using a cross-industry cross-country approach, I test the model's predictions based on a sample of manufacturing industries across 39 developing and developed countries over the period 1990-2000. Domestic government debt is used as a proxy for government-supplied liquidity within a country, while external government debt fulfils the role of placebo liquidity. I find that industries with greater liquidity needs grow relatively faster in countries with higher domestic debt-to-GDP ratio, while external debt has no growth differential effect across sectors. These results are robust using various specifications, including controlling for the impact of financial development and competing explanations. I also show that the liquidity-enhancing effect of domestic government debt on growth becomes larger when industries face severe financial frictions.

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1 Introduction

Policymakers and most economists view government debt as detrimental to long-run economic growth by reducing national saving and capital accumulation. Various theoretical channels has been proposed to rationalize this conventional view of government debt, but empirical evidence remains scarce partly because providing a direct test of causality is difficult.[1] Non-Ricardian models reach opposite conclusions when government debt is held by the private sector as a store of value for precautionary purposes. Under financial imperfections and the presence of risk, government debt by enhancing the supply of liquidity triggers some positive macroeconomic effects on welfare (Aiyagari and McGrattan, 1998), consumption (Challe and Ragot, 2011), investment (Woodford, 1990; Holmström and Tirole, 1998; Taddei, 2007) and excessive volatility due to bubble crashes (Caballero and Krishnamurthy, 2006; Farhi and Tirole, 2011). This paper attempts to empirically uncover the liquidity effect of government debt on growth.

First I build an endogenous growth model where the liquidity provision of government debt is more growth-enhancing in sectors hit by large liquidity shocks. The presence of credit market imperfections amplifies this growth effect. Using a cross-industry cross-country approach, I test the model's predictions based on a sample of manufacturing industries across 39 developing and developed countries over the period 1990-2000. Using a cross-industry cross-country approach, I test the model's predictions based on a sample of manufacturing industries across 39 developing and developed countries over the period 1990-2000. The empirical strategy I use utilizes on the one hand the heterogenous nature of government debt in terms of liquidity supply, on the other hand the panel structure of the data. First, I decompose government debt into a liquidity and placebo component according to the place of issuance and jurisdiction. Domestic government debt is used as a proxy for government-supplied liquidity within a country, while external government debt fulfils the role of placebo liquidity. Second, in the spirit of Rajan and Zingales (1998), I exploit the heterogeneity in liquidity needs across industries to construct a control group. The industries with low liquidity represent a control group for sectors with high liquidity needs. Depending on which component triggers a change in government debt, sectoral growth is expected to show two types of response. Specifically the growth response to a change in domestic debt should be heterogenous across sectors, while industries should not respond differently to a change in external debt. Such a growth pattern sharpens the causal interpretation of our results.

I find that industries with greater liquidity needs grow relatively faster in countries with higher

[1] See Elmendorf and Mankiw (1999) who survey the theoretical mechanisms supporting the conventional view. Exceptions regarding empirical evidence are cross-country regressions by Reinhart and Rogoff (2010) and Kumar and Woo (2010). Reinhart and Rogoff (2010) show that public debt impedes growth only when government debt-to-GDP ratio is above 90 percent. Kumar and Woo (2010) carefully control for potential omitted variables and find a negative and significant effect government debt on per capita GDP growth. They also provide some evidence of nonlinear effects as in Reinhart and Rogoff (2010). However none of these papers test a specific channel by which government debt affect the real economy, which makes difficult to interpret these negative correlations in a causal sense. On the other hand, a much deeper literature has been devoted to study the real effects of external (private and public) debt. See for instance Imbs and Ranciere (2005) who find an overhang level of debt above which investment falls precipitously but only in countries with poor property rights and underdeveloped financial markets.

domestic debt-to-GDP ratio, while external debt has no growth differential effect across sectors. My estimates indicate that the differential effect is sizeable. These results are independent of the impact of financial development. I also show that the liquidity-enhancing effect of domestic government debt on growth becomes larger when industries face severe financial frictions.

This paper contributes to the literature analyzing the macroeconomic effects of government debt used as private liquidity. (Barro, 1974) mentions the liquidity services rendered government debt. He shows that an increase in public debt has a positive effect on private wealth if the government is more efficient to produce liquidity than the private sector. The relative efficiency of the goverment to provide liquidity is empirically confirmed by Krishnamurthy and Vissing-Jorgensen (2007) for the U.S. economy. They provide evidence that U.S. Treasury debt renders additional liquidity services with respect to similar private assets. Besides liquidity services, they also show U.S. Treasuries carry a safety attribute. As anecdotal evidence, practioneers worried about the economic consequences that the reduction in goverment debt in Europe and in the U.S. that occured in the the late 1990's could have by restraining the ability of the private sector to hoard liquidity (see Fleming, 2000; Reinhart and Sack, 2000). On the same line of reasoning, sovereign default is expected to have large real effects. In a model where entrepreneurs hold government bonds to meet future liquidity needs, Brutti (2011) show that a sovereign default triggers a liquidity crisis. Gennaioli et al. (2011) show that lending activities of banks requires government bonds in their balance sheet. Therefore financial development increases the exposure to government debt and in turn boosts the costs of default by trigger a credit crunch (see also Basu, 2009, for a similar mechanism). Their mechanism is supported by the data. Bolton and Jeanne (2011) analyze the contagion effects of sovereign default when countries are financially integrated.

The liquidity role of government debt is also related to the literature on macroeconomics of asset shortage. Caballero (2006) claims that financial underdevelopment is the major cause of liquidity shortage plaguing emerging countries. Kiyotaki and Moore (2005) stress the role of outside money such as government bond by improving the allocation of resources when output pledgebility is limited making entrepreneurs credit-constrained. Asset shortage played also a key role in the context of global imbalances. Caballero et al. (2008) provides a theoretical explanation based the differential abilities to generate wealth and stores of value. The U.S. is natural producer of assets but is poor producer of wealth, the opposite for China. Closer to my paper, Bacchetta and Benhima (2010) focues on the demand of liquid assets, which is stronger in China due to underdeveloped financial markets.

The paper is organized as follows. In the next section I provide a theoretical framework that rationalizes the empirical results. Section 3 explains the empirical strategy used to identify the growth effect of government debt and describe the data used in the empirical analyisis. Section 4 presents the main empirical results. I conclude in Section 5. In the Appendix I briefly present some robustness checks.

2 The Model

In this section, we propose a stylized endogenous growth model *à la* Aghion et al. (2010) to rationalize the following empirical findings. First, the liquidity provision of government debt is more growth-enhancing in sectors with high liquidity needs. Second, the liquidity-enhancing effect of domestic government debt on growth becomes larger when industries face severe financial frictions.

2.1 The Environment

Consider a closed economy with an infinite number of periods $t = 0, 1, 2, ...$ and two representative productive sectors.[2] Each sector is populated by overlapping generations of entrepreneurs who live for two periods, are risk-neutral and uniformly distributed over the unit interval. For notational simplicity I do not denote sectors and supress superscript whenever entrepreneurs are homogenous. The preferences of an entrepreneur in a given sector are given by:

$$U_t = C_{y,t} + \beta E_t C_{o,t+1} \tag{1}$$

where $C_{y,t}$ and $C_{o,t+1}$ denote her consumption when young and old, respectively, and $\beta \in (0, 1)$ is the time discount factor. At the beginning of period t, each new-born entrepreneur in given sector has access to wealth $W_t \equiv wA_t$ ($w > 0$) and a sectoral stock of know-how A_t which I call productivity. Current producitivity in each sector depends on investment choices of old entrepreneurs and hence evolves endogenously. Lower case letters $x_{t+1} \equiv X_{t+1}/A_t$ denote productivity-adjusted values.

Central features. The model contains three central features. *First*, each sector is characterized by a sector-specific production technology that only differs in terms of liquidity needs captured by the parameter $\phi \in \{\underline{\phi}, \overline{\phi}\}$ ($\overline{\phi} > \underline{\phi}$). Specifically, entrepreneurs are possibly hit by a liquidity shock before the sector-specific project matures. A liquidity shock requires a reinvestment of ϕ per unit of initial investment to complete the project, else the return vanishes. *Second*, credit market imperfections prevent entrepreneurs to borrow in an unlimited way. Depending on their liquidity needs and the financial frictions they face, they might need instruments to transfer wealth across period and overcome the liquidity shock. *Third*, entrepreneurs have access to a financial and a real store of value. The financial store of value is a liquid one-period government bond. One unit of this asset bought at (endogenous) price q_t at the end of a period yields one unit of output at the end of next period. Government debt gives rise to a supply of government bonds $\widetilde{B}_{t+1} \equiv \widetilde{b} A_t$ where $\widetilde{b} \geq 0$ is an exogenous parameter.[3] This asset is assumed to be liquid in the sense that it can sold without any transaction cost before maturity. The real store of value is an investment in a short-term, standard project less efficient than the sector-specific project.

Investment technologies. Consider now the investment technologies associated to the sector-specific and standard projects undertaken at the end of period t. Investment K_{t+1} in the short-term

[2] I consider a two-sector model to obtain a stationary equilibrium. Indeed if the analysis is extended to a multi-sector framework, sectors would grow at different rates such that the competitive price for government bonds would be not stationary.

[3] The political and economic determinants of government debt are outside the scope of the model.

project that returns at the beginning of period $t+1$:

$$\Pi_{k,t+1} = A_t \pi_k(k_{t+1})$$

while investment Z_{t+1} in the sector-specific project that generates output at the end of period $t+1$:

$$\Pi_{z,t+1} = e_{t+1}[\gamma A_t \pi_z(z_{t+1}) + \Phi_{t+1}]$$

where A_t is the current sectoral productivity and e_{t+1} is an indicator variable that takes the value one if the liquidity shock Φ_{t+1} is met at the beginning of period $t+1$ (0 otherwise). The liquidity shock is 0 with probability p but ϕZ_{t+1} with probability $1-p$. With this specification the liquidity shock is transitory in the sense entrepreneurs who reinvest Φ_{t+1} recover the cost at the end of the period.[4] Note that once production is completed capital K_{t+1} and Z_{t+1} fully depreciate. Production functions π_k and π_k are strictly increasing and convave. We then make the following assumption:

Assumption 1. $p\gamma = 1$

This assumption states that the expected productivity for an entrepreneur that does not secure the sector-specific investment by hoarding enough liquidity is equivalent to that of the short-term project.

Endogenous productivity. We need to specify the law of motion for sectoral productivity. Entrepreneur $i \in [0,1]$ denoted by the superscript i undertakes two projects heterogenous in terms of producitivity. To get entrepreneur i's aggregate productivity, the productivity associated to each project is adjusted by the relative investment in it. The law of motion for sectoral productivity becomes:

$$A_{t+1} \equiv \int_0^1 A_{t+1}^i di = \gamma A_t \int_0^1 \frac{e_{t+1}^i Z_{t+1}^i}{Z_{t+1}^i + K_{t+1}^i} di + A_t \int_0^1 \frac{K_{t+1}^i}{Z_{t+1}^i + K_{t+1}^i} di \tag{2}$$

Note that only successful sector-specific investment is considered as a contribution to productivity improvement.

Timing of events and credit maket imperfections. Consider now the timing of events for entrepreneurs born in period t in one of the two sectors. At the *beginning of period* t, they transfer their wealth endowment W_t to the end of period t by making a deposit to lenders. The return on deposits is R_t. At the *end of period* t, they allocate $R_t W_t$ between consumption goods $C_{y,t}$, one-period government bonds B_t, investment in the sector-specific project Z_{t+1} and in the short-term project K_{t+1}. Their budget constraint is the following:

$$R_t W_t = C_{y,t} + q_t B_{t+1} + Z_{t+1} + K_{t+1} \tag{3}$$

At the *beginning of period* $t+1$, credit markets open.[5] Lenders receive deposits W_{t+1} from new-born

[4] Therefore the liquidity risk only affects investment by its impact on the completion of sector-specific project.

[5] The assumption that the government bonds and credit markets open only once per period is made without loss

entrepreneurs. We assume that lenders have access to a storage technology where storage *within periods* takes place at one-to-one rate. The key assumption leading to endogenous credit frictions is that upon default lenders go to courts and seize a fraction $\theta \in [0,1]$ of the capital stock pledged as collateral.[6] The parameter θ reflects the domestic strength of creditor rights or more generally the level of financial development. Competitive lenders and entrepreneurs sign a financial contract defined by the triplet (r_t, L_{t+1}, Z_{t+1}), where r_t is the gross lending rate and L_{t+1} is the size of the loan associated to capital Z_{t+1} used as collateral. Moreover entrepreneurs hit by the liquidity shock sell their government bonds at price p_t to new-born entrepreneurs on competitive secondary markets. Alternatively, one can think of government bonds used by entrepreneurs to secure ex-ante a credit line from lenders. From Assumption 1, we have $B_{t+1} + Z_{t+1} < W_t \leq W_{t+1}$ which ensures no *aggregate* liquidity shortage at the beginning of each period. Therefore competition in credit and secondary markets satisfies equilibrium prices $r_t = R_t = p_t = 1$. The entrepreneur can only credibly commit to repay θ per unit of collateral at the end of period $t+1$, which gives rise to the following credit constraint:

$$L_{t+1} \geq \theta Z_{t+1} \tag{4}$$

At the *end of period* $t+1$, they consume the return on their investment

$$C_{o,t+1} = B_{t+1} + A_t \pi_k(k_{t+1}) + e_{t+1} \gamma A_t \pi_z(z_{t+1}) \tag{5}$$

2.2 Entrepreneurs' Investment Choices

Entrepreneurs are forward-looking in the sense that they make ex-ante an investment choice that enables ex-post to meet or not the liquidity shock. A *safe investment choice* means that entrepreneurs accumulate enough liquidity to meet the liquidity shock at the beginning of period $t+1$ such that investment in the sector-specific technology is secured ($e_{t+1} = 1$ with certainty). They face a liquidity constraint as an a additional constraint. They know that they will borrow from competitive lenders at the beginning of period $t+1$, but that borrowing may be limited due to credit market imperfections. Therefore, the liquidity constraint is:

$$B_{t+1} + A_t \pi_k(k_{t+1}) \geq (\phi - \theta) Z_{t+1} \tag{6}$$

using credit constraint (4). A *risky investment choice* means that entrepreneurs are liquidity-unconstrained but investment in the sector-specific technology is risky ($e_{t+1} = 1$ with probability

of generality. Assuming that both markets are always opened would not change our results. Indeed at the end of a period entrepreneurs would not borrow from competitive lenders because of the liquidity demand, while at the beginning of a period, government bonds would be sold at unit price.

[6]Kiyotaki and Moore (1997) consider the perfect enforcement case (i.e. $\theta = 1$), while in Eisfeldt and Rampini (2007) θ lies in the unit inerval.

p). Entrepreneurs solve:

$$V_t = \max\{V_{s,t}, V_{r,t}\}$$

where $V_{s,t}$ and $V_{r,t}$ are the period-t value functions associated to the safe and risky investment choices, respectively. We next derive $V_{s,t}$ and $V_{r,t}$.

Safe investment choice. Given life-time utility (1), budget constraint (3) with $R_t = 1$ and end-of-life consumption (5), the value function of an entrepreneur making a safe investment choice is:

$$V_{s,t} = \max\left\{A_t\left[w + \beta\pi_k(k_{s,t+1}) - k_{s,t+1} + \beta\gamma\pi_z(z_{s,t+1}) - z_{s,t+1} - (q_t - \beta)b_{s,t+1}\right]\right\}$$

subject to liquidity constraint (6). Suppose first that the liquidity constraint is not binding. Entrepreneurs invest in both projects until marginal returns are equalized: $\pi_k'(k_s^*) = \gamma\pi_z'(z_s^*) = \frac{1}{\beta}$. We denote the first-best investment choice as (k_s^*, z_s^*). The optimal holding of safe and liquid assets satisfies the following pattern:[7]

$$b_{s,t+1}^* \begin{cases} = 0 & \text{if } q_t > \beta \\ \in [0, \infty) & \text{if } q_t = \beta \\ \to \infty & \text{if } q_t < \beta \end{cases} \tag{7}$$

Suppose now that the liquidity constraint is binding. The optimal decisions are given by:

$$q_t - \beta = \lambda_{t+1} \tag{8}$$

$$\pi_k'(k_{t+1}) = \frac{1}{q_t} \tag{9}$$

$$\beta\gamma\pi_z'(z_{t+1}) = 1 + (\phi - \theta)(q_t - \beta) \tag{10}$$

where λ_{t+1} is the Lagranger multiplier attached to the liquidity contraint (6). As credit markets are not enough developed to satisfy ex-post the liquidity needs that supports the first-best investment choice, government bonds carry a liquidity premium $q_t - \beta > 0$ which distorts the allocation of wealth relative to the first-best. Entrepreneurs overinvest in the short-term project ($k_s(q_t) > k_s^*$) and government bonds ($b_s(q_t) > b_{s,t+1}^*$ as $q_t > \beta$) to satisfy the liquidity constraint, but underinvest in the sector-specific technology ($z_s(q_t) < z_s^*$). Underinvestment results from the additional cost that they have to pay to secure the return of the project. Specifically, in addition to the unit marginal cost to buy capital, they have to bear the marginal cost $(\phi - \theta)(q_t - \beta)$ to hoard liquidity.

Risky investment choice. Let us now consider the problem solved by an entrepreneur making a

[7] We do not allow short selling (i.e. $b_{s,t+1}^* < 0$) when $q_t > \beta$. However it should be noted that it would not be an equilibrium as $\widetilde{B}_{t+1} \geq 0$.

risky investment choice:

$$V_{r,t} = \max \{A_t [w + \beta\pi_k(k_{r,t+1}) - k_{r,t+1} + \beta p\gamma\pi_z(z_{r,t+1}) - z_{r,t+1} - (q_t - \beta)b_{r,t+1}]\}$$

Entrepreneurs equalize the marginal return to investment in the short-term project to the *expected* marginal return to sector-specfic investment: $\pi'_k(k^*_r) = p\gamma\pi'_z(z^*_r) = \frac{1}{\beta}$. As $k^*_r = k^*_s$, we denote the optimal risky investment choice as (k^*_s, z^*_r). As sector-specfic investment is risky, entrepreneurs invest less relative to the first-best $(z^*_r < z^*_s)$. However risk neutrality leads to the same demand for liquid assets $(b^*_{r,t+1} = b^*_{s,t+1})$.

2.3 Financial Development, Government Debt and Liquidity Premium

We make the following assumption on the upper limit of government debt

Assumption 2. $\widetilde{b} \in [0, \overline{b}]$ *with* $\overline{b} \equiv \frac{w-k^*_s-z^*_s}{\beta}$

This assumption ensures positive consumption when young even if the economy supports the first-best investment choice.[8] To ensure stationarity, we assume that:

Assumption 3. $\underline{\phi} \leq \frac{\pi_k(k^*_s)}{z^*_s}$

This assumption means that entrepreneurs in the sector with low liquidity needs $\underline{\phi}$ are never liquidity constrained. Let $V^*_{s,t}$ and $V_s(q_t)$ denote the period-t value functions associated to the first-best and constrained safe investment choice, respectively.

Proposition 1. *Suppose that Assumptions 1 to 3 hold. Let the cutoffs be denoted as:*

$$\boldsymbol{\theta}_1 \equiv \overline{\phi} - \frac{\overline{b} + \pi_k(k^*_s)}{z^*_s} \tag{11}$$

$$\boldsymbol{\theta}_2 \equiv \overline{\phi} - \frac{\pi_k(k^*_s)}{z^*_s} \tag{12}$$

(i) *If $\theta < \boldsymbol{\theta}_1$, then in equilibrium government bonds carry a liquidity premium $q_t - \beta > 0$. The liquidity premium is maximal at $q_t = \overline{q} = V_s^{-1}(V_{r,t})$ but monotonically decreases with government debt. If $q_t = \overline{q}$, then only a fraction $\mu(\widetilde{b}) \equiv \frac{\widetilde{b}}{\underline{b}}$ of entrepreneurs makes the safe investment choice where $\underline{b}$ is the level of debt that supports this equilibrium with $\mu = 1$.*
(ii) *If $\boldsymbol{\theta}_1 < \theta < \boldsymbol{\theta}_2$, the same as in case (i) applies, except that the liquidity premium can be zero if $\widetilde{b}$ is large enough.*
(iii) *If $\theta > \boldsymbol{\theta}_2$, then $q_t = \beta$.*

Proof. See Appendix A.

[8] As $k^*_r = k^*_s$ and $z^*_r < z^*_s$, $c^*_r > c^*_s \geq 0$ under Assumption 2. As π'_k is a convex function, one can show that $c'_s(q_t) > 0$. Hence $c_s(q_t) > c^*_s \geq 0$ if $q_t \in (\beta, \overline{q}]$.

The intution behind Proposition 1 is quite simple. If credit frictions are large (cases (i) and (ii)), credit markets do not provide enough liquidity ex-post to overcome the liquidity shock. It results that entrepreneurs with a sector-specific that requires high liquidity needs overinvest in governement bonds, which increases the price of government bonds $q_t - \beta > 0$. The supply of government bonds can be so small that $q_t = \overline{q}$. In this situation only a fraction of entrepreneurs makes the safe investment choice and have a positive demand of government bonds. But if $q_t \in (\beta, \overline{q})$, an increase in the supply of government bond decreases the price of public liquidity. Indeed an increase in the supply of governement bonds requires that in equilibrium entrepreneur hold more liquid assets, which makes the liquidity constraint unbinding. But given expression (8), this is not an equilibrium. To restore the equilibrium, the price has to decrease to change the composition of investment in favor of sector-specific investment such that the liquidity constraint binds. On the other hand if credit markets are developed enough (cases (iii)), there is no overinvestment in public liquidity since private liquidity is an ex-post insurance. Hence $q_t = \beta$.

2.4 The Growth Effect of Government-Supplied Liquidity

Let $\Delta g_{t+1} \equiv g_{t+1}(\overline{\phi}) - g_{t+1}(\underline{\phi})$ be defined as the difference in growth rates between a sector with high liquidity needs and a sector with low liquidity needs. From the expression for endogenous productivity (2) and Proposition 1, the difference in sectoral growth can be written as:

$$\Delta g_{t+1} = \begin{cases} 0 & \text{if } q_t = \beta \\ (\gamma - 1)\left(\frac{z(q_t)}{z(q_t)+k(q_t)} - \frac{z_s^*}{k_s^*+z_s^*}\right) < 0 & \text{if } q_t \in (\beta, \overline{q}) \\ (\gamma - 1)\left(\mu(\widetilde{b})\frac{z(\overline{q})}{z(\overline{q})+k(\overline{q})} - \frac{z_s^*}{k_s^*+z_s^*}\right) < 0 & \text{if } q_t = \overline{q} \end{cases} \quad (13)$$

From Assumption 3, the sector with low liquidity needs always makes the first-best investment choice. Therefore if $q_t = \beta$, the sector with low liquidity needs necessarily makes the same choice since financial development provides ex-post enough liquidity. Hence $\Delta g_{t+1} = 0$. Conversely if private liquidity is not large enough to overcome the liquidity shock, entrepreneurs overinvest in the short-term project and government bonds and underinvent in the sector-specific project. Their investment choice is less efficient than the first-best so that $\Delta g_{t+1} < 0$.

The differential growth effect of government debt can be simply obtained by differenting expression (13) with respect to $\widetilde{b}$:

$$\frac{\partial \Delta g_{t+1}}{\partial \widetilde{b}} = \begin{cases} 0 & \text{if } q_t = \beta \\ (\gamma - 1)\frac{z'(q_t)k(q_t) - k'(q_t)z(q_t)}{[z(q_t)+k(q_t)]^2}\frac{\partial q_t}{\partial \widetilde{b}} > 0 & \text{if } q_t \in (\beta, \overline{q}) \\ \frac{(\gamma-1)}{\underline{b}}\left(\frac{z(\overline{q})}{z(\overline{q})+k(\overline{q})}\right) > 0 & \text{if } q_t = \overline{q} \end{cases}$$

In case a liquidity premium, sectors that rely relatively more on liquidity develop disproportionately faster in countries with more government debt since more governemnt debt improves the efficiency of investment choices at the sectoral level either by decreasing the price of public liquidity or by increasing the fraction of entrepreneurs making a safe investment choice. It results two corollaries:

Corollary 1. *Consider an representative economy characterized by a moderate financial development (case (i) or case (ii) of Proposition 1). Then government debt is relatively more growth-enhancing in sectors with high liquidity needs.*

Corollary 2. *Consider two types of economy. One is characterized by a low financial development (case (i) of Proposition 1). The other is characterized by a high financial development (case (iii) of Proposition 1). Then the growth effect of government debt is stronger in countries characterized by a low level of financial development.*

2.5 Discussion

To be added.

3 Data and Econometric Framework

3.1 Government Debt in a Cross Section of Countries

3.1.1 The Liquidity and Placebo Components of Government Debt

Government bonds are one of the most liquid assets, especially in emerging countries where private bond and equity markets are underdeveloped.[9] However the nature of government debt in terms of liquidity supply is heterogenous. We guess that the place of issuance and jurisdiction that regulates the sovereign debt contract is the criterion to know in which market, government debt provides liquidity. Under this criterion, government debt issued domestically under domestic law captures the domestic supply of liquid assets feeded by government debt and thus represents the liquidity component of government debt. Conversely government debt issued under foreign law provides liquidity in foreign markets and fulfills the role of liquidity placebo. I use Panizza (2008)'s data on government debt-to-GDP ratio decomposed according to the criterion based on the place of issuance and jurisdiction. This dataset relies on several publicly available sources and covers central government debt of up to 130 countries for the period 1990-2007. Due to differences in country coverage between datasets of government debt and sectoral growth, the baseline regression sample dataset includes 39 countries.[10]

I now test the conjecture that the criterion based on the place of issuance and jurisdiction is empirically plausible to decompose government debt into a liquidity and placebo component. I use an

[9] An asset is liquid if it allows to obtain cash quickly with low transaction costs, either via a sale or access to external finance.

[10] When data on central government debt were not available, Panizza (2008) uses data for the general government and the non-financial public sector. Only three countries are concerned in the baseline regression sample: Panama (general government), Tunisia and Uruguay (non-financial public sector).

indicator of the size of the domestic government bond market relative to the size of the economy. The size of domestic government bond market captures how liquid are government securities, as the size is an important determinant of liquidity (BIS, 2000). This indicator computed by Beck et al. (2010) is measured as the ratio of domestic marketable securities issued by the government to GPD. The original data are collected by Bank for International Settlements (BIS, 2009) from market and instutional sources. According to the BIS classification, domestic government bonds are securities (1) launched in the domestic market (2) targeted at domestic investors and (3) denominated in domestic currency. In Table 1 we report the row correlation between the size of domestic government bond market and government debt. Despite the conservative classification

Table 1. Correlation Between the Size of Domestic Government Bond Market and Government Debt

	Domestic government debt-to-GDP ratio	External government debt-to-GDP ratio
Full sample	0.74	−0.07
	(0.00)	(0.62)
Countries	44	44
Regression sample	0.55	−0.00
	(0.00)	(0.98)
Countries	24	24

Notes: This table reports the Pearson's coefficient correlation between (domestic / external) government debt-to-GDP ratio from Panizza (2008) and public bond market capitalization to GDP from Beck et al. (2010). Each ratio is averaged over the period 1991-2000. The full sample corresponds to the sample of countries present in both datasets, while countries in the regression sample are the ones we use for the regression analysis. In paranthesis we show the *p*-value associated to a test of no correlation.

of government-supplied liquidity from BIS, the data support that the criterion based on the place of issuance and jurisdiction to select the liquidity and placebo components of government debt is empirically correct.[11] Indeed domestic government debt is highly and significantly correlated with the size of domestic government bond market, while external debt is orthogonal.

The demand side also confirms the conjecture. Even with the process of financial globalization, domestic residents hold most of government domestically issued debt while a large part of governement external debt is held by foreigners (see Reinhart et al., 2003; Reinhart and Rogoff, 2011a,b).[12] This pattern shows that domestic and external government debt are not perfect subsitutes. Hence only domestic government debt supports a liquid bond market and hence provides liquid assets within a country. Since most often domestic debt is denominated in local currency (see Mehl and Reynaud, 2010) and external debt in foreign currency, the home bias due to exchange rate fluc-

[11] The classification is conservative in the sense that government bonds issued domestically but denominated in foreign currency or targeted at non-residents are classified as international even if most holders are domestic (see Kumhof and Tanner, 2005).

[12] Reinhart and Rogoff (2011a) note that the U.S. case is an exception where all U.S. government debt is domestic but about 40% is held by non-residents (mostly central banks and other official institutions).

tuations is a potential candidate to explain the imperfect substituability.[13] Fidora et al. (2007) document the exchange rate volatility as an important determinant of the bond home bias in developed and emerging countries. Moreover foreigners appear to be reluctant to hold debt regulated by a domestic jurisdiction.[14] Chamon et al. (2005) reports responses of a survey study of market participants attitudes conducted by the IMF toward innovation in emerging markets debt instruments. They were askey to mention obstacles to invest in government bonds denominated in domestic currency. They indicate exchange rate manipulation, expected rise in inflation and the domestic legal jurisdiction as major obstacles.

3.1.2 Risky Government Debt

In this section we make any observations regarding the risky government debt composition across countries included in the baseline regression. Government debt becomes risky due to either its level or its structure. A risky level refers to a threshold of (domestic/external) government debt-to-GDP ratio above which debt might be unsustainable. A risky structure refers to financial vulnerabilities arising from currency composition, maturity structure and indexation of domestic debt. The risky composition of government debt will be exploited in the empirical analysis.

Regarding the risk arising from the level of government debt-to-GDP ratio, the composition of government debt between domestic and external debt matters. The two components of government debt cannot be summed up to gauge the sustainability of debt level for several reasons.[15] First and importantly, the law that regulates the sovereign debt contract is central in case of default (Panizza et al., 2009). A default on external debt does not necessarily involves a default on domestic debt since legally they are separate contracts. Second, macroeconomic distress in the run-up to domestic default is more severe than for an external default (both in terms of output declines and increase in inflation) (Reinhart and Rogoff, 2011a). Third the financial vulnerabilities appear to be different, mostly in emerging countries. Domestic debt is plagued by the inability of government to issue long-term securities (maturity mismatch), while the inability to borrow abroad in local currency is the central problem for external debt (currency mismatch) (Hausmann and Panizza, 2011). Lastly the costs of default are different.[16] The risk of being shut off from international credit markets is larger under external default (Reinhart et al., 2003). Conversely a liquidity crunch caused by domestic default should have much more adverse real impacts on the domestic economy as domestic government debt represents the liquidity component and hence the overwhelming majority of domestic debt is held by domestic residents. For my empirical invetigation, the last point is particularly valuable. Figure 1 shows the composition of government debt across 39 developed and developing countries include in the baseline regression sample. The scatter diagram highlights

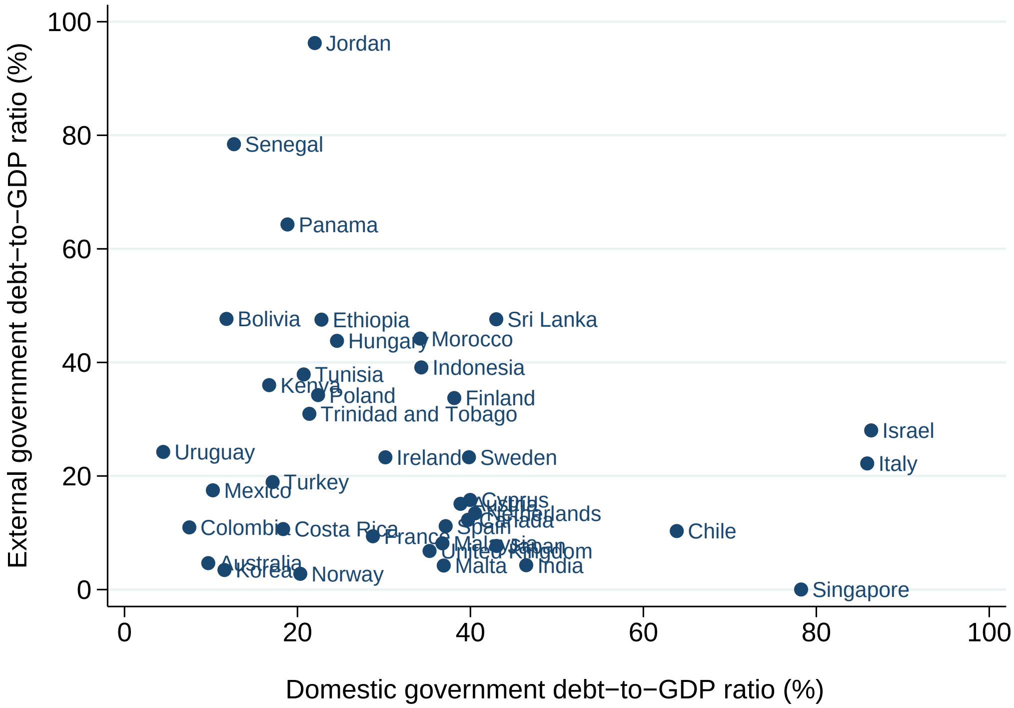
[13] The foreign-currency-denominated government debt refers to one of the component of the original sin (see Hausmann and Panizza, 2003, 2011).

[14] The home bias due to informational frictions seems less true for sovereign bonds because they are homogenous Portes et al. (2001).

[15] According to Reinhart and Rogoff (2011a), domestic default appears to be a rarer event but far too common to be ignored.

[16] See Borensztein and Panizza (2009) who survey the costs of sovereign external default.

Figure 1. The Cross-Sectional Composition of Government Debt



Notes: This figure plots the external government debt-to-GDP ratio over the period 1990-2000 for a cross-section of 39 countries included in the baseline regression against the external government debt-to-GDP ratio over the same period. Countries in the baseline regression sample are listed in Table A.1. in the Appendix.
Source: Panizza (2008).

three distinct groups of countries. Most of the countries belong to the first group of countries with a moderate level of government external and domestic debt (below 50 percent of GDP). The second group is made up of countries with external debt obove than 60 percent of GDP (Panama, Senegal and Jordan), while in the last group countries are above 60 percent in terms of domestic debt (Chile, Singapore, Italy and Israel). I will exploit the ”natural” break points from the cross-sectional distribution of government debt to split the observations and hence identify how risk in terms of level affects my channel. The advantage of this strategy is that I will not select arbritarily a threshold above which the debt level is considered as risky.

The structure of domestic goverment debt shows substantial variability. The sources of finanical vulnerability arising from the struture of domestic debt are the currency composition (currency mismatch), maturity structure (roll-over risk and maturity mismatch) and indexation (contingent interest payments). I use data compiled by Mehl and Reynaud (2010) for emerging countries and by Falcetti and Missale (2002) for OECD countries. Government in emerging countries seem to issue riskier domestic sovereign debt than OECD countries. Two-thirds of their domestically issued debt is short-term, denominated in foreign currency and indexed, while this number reduces to one-third in the OECD group countries.[17]

3.2 Measuring Growth and Demand for Liquidity

Sectoral growth is measured using data on value added at the industry level collected annually by the United Nations Industrial Developlment Organization (UNIDO). Specifically, we use the database compiled by Nicita and Olarreaga (2007) which covers 100 countries over the period 1976-2004. The data are disaggregated into 28 industries of the manufacturing sector according to the ISIC Rev. 2 classification. The dependent variable is defined the average annual real growth rate of value added by ISIC sector in each country over the period 1990-2000, and is measured as the log of real value added in 2000 less the log of real value added in 1990 (divided by 10). I construct a cross-sectional panel by averaging the domestic and external government-to-GDP ratio over the period 1990-2000. Hence I do not exploit the time dimension of the data for several reasons. First, I am interested in assessing the effect of governement-supplied liquidity on long-run growth. The period 1990-2000 is the longest period that allows the maximum coverage of countries. Second the time series variation of government domestic and external debt within countries is almost one-third the cross-sectional variation between countries.[18] Therefore I choose an identification coming purely from the cross-sectional variation in government debt.

Due to differences in country coverage between datasets of government debt and sectoral growth, the baseline regression sample dataset includes 39 countries. For some of 100 potential countries data on value added for the years 1990, 2000 and in-between are missing. Moreover, we drop sectors located in United States to take care of the potential endogeneity as the sectoral demand for liquidity is calculated from U.S. industry data. The resulting dataset is an unbalanced panel of 39 countries associated to 899 observations (instead of 1092=39$\times$28 possible observations). The countries included in the baseline regression with the number of industries available for each country are listed in Table A.3. in the Appendix.

In order to provide evidence for the microeconomic channel whereby government-supplied liquidity affects growth, a technological characteristic that measures the sectoral dependence to outside liquidity needs to be indentified. I use the measure of *liquidity needs* developed in Raddatz (2006). The index is defined as the fraction of inventory investment that can be financed from sales. Inventory investment is one of the component of investment in working capital and seems to be particularly suitable to capture the technological aspects associated to the length of the production process (Raddatz, 2006). Sectors with a greater ability to finance inventories from cash flows are likely to undertake investment projects with longer gestation periods and to be plagueg by a more frequent asynchronicity between their access to and need for liquidity. Hence these industries are relatively more dependent on liquidity. Opler et al. (1999) stress that firms with a low inventories to sales should have a short gestation period and hoard less liquid assets. Bigelli and Sánchez-Vidal (2011)

[17] p-value associated to the null hypothesis of no difference in means of 0.2%.

[18] The data indicate for the regression sample that the standard deviation of domestic (external) debt-to-GDP ratio within a country over the period 1990-2000 is on average 22% (34%) of its mean, while the standard deviation of domestic (external) debt-to-GDP ratio across countries over the period 1990-2000 is 62% (85%) of its mean

provide evidence for such a conjecture for a large sample of Italian unlisted firms. Given that the original measure in Raddatz (2006) is reported at the four-digit ISIC level, I use the measure of liquidity needs from Aghion et al. (2009) who recompute it for the three-digit ISIC level using U.S. firm-level data.

The industry measure of liquidity needs is computed solely from U.S. data and extrapolated to industries located in other countries. The validity of this approach relies on two basic assumptions.[19] First, there is a technological reason why some industries undertake projects with shorter gestatation periods and hence are able to self-finance a largeer fraction of their inventories. If the U.S. economy can be considered as relatively frictionless and thus represents a good benchmark, the computation of the liquidity needs from U.S. data should reflect exogenous characteristics of the sectoral production technology. Second, we assume that the technological differences underlying the ranking of liquidity needs across industries persist across countries.

3.3 Empirical Strategy

This paper aims at identifying the causal effect of government-supplied liquidity on growth. The empirical strategy I use for such an identification utilizes on the one hand the heterogenous nature of government debt in terms of liquidity supply, on the other hand the panel structure of the data. First, I decompose government debt into a liquidity and placebo component according to the place of issuance and jurisdiction. The rationale for such a decomposition has been deeply discussed in subsection 3.1.1. Second, in the spirit of Rajan and Zingales (1998), we exploit the heterogeneity in liquidity needs across industries to construct a control group. My model predicts that industries with low liquidity needs are less sensitive to the liquidity component of government debt and hence represent a control group for sectors with high liquidity needs. Depending on which component triggers a change in government debt, sectoral growth is expected to show two types of response. Specifically the growth response to a change in domestic debt should be heterogenous across sectors, while industries should not respond differently to a change in external debt. Such a growth pattern would sharpen the causal interpretation of our results.

The baseline empirical specification is as follows:

$$g_{ic} = \alpha_i + \alpha_c + \beta_d(L_i \times DD_c) + \beta_e(L_i \times ED_c) + \phi X_{ic} + \varepsilon_{ic} \tag{14}$$

where g_{ic} measures real growth in value added in industry i and country c, α_i is an industry fixed effect, α_c a country fixed effect and ε_{ic} a random error. The variables of interest are the interaction terms $L_i \times DD_c$ and $L_i \times ED_c$, where L_i is a measure of sectoral liquidity needs, DD_c and ED_c are government domestic and external debt-to-GDP ratios, respectively. X_{ic} is a set of additional determinants of sectoral growth. We control for the catching-up effect by including in each regression the initial industry size as an explanatory variable. The coefficient β_d quantifies the within-country

[19] This approach is based on Rajan and Zingales (1998) and frequently used in the finance and growth literature (see, e.g., Braun and Larrain, 2005; Ilyina and Samaniego, 2011; Beutler and Grobéty, 2011).

causal effect of government-supplied liquidity on industry growth, while the coefficient β_e captures the growth effect of placebo liquidity. We expect β_d to be significantly positive and β_e to be insignificant. Point estimates of β_d and β_e in line with this prediction would indicate that industries with high liquidity needs grow relatively faster *only* when government debt provides liquidity within a country.

A potential bias in the estimation of coefficients β_d and β_e might come from the endogeneity of the liquidity and placebo components to the growth process. I believe that reverse causality is unlikely to be a serious problem for several reasons. First, the dependant variable is measured at the sectoral level while government debt is a country-specific variable. As the size of each industry is small relative to the size of the economy, the feedback effect from industry growth to government debt is unlikely to arise.[20] A feedback of this kind looks much more likely in cross-country regressions. Moreover as only highly liquidity dependent sectors should be sensitive to a change in domestic goverment debt, the probability of a feedback mechanism is reduced. Second, government debt is a stock variable and hence should be less affected to change in growth. However even if the growth-generated process of government debt decumulation would be important, our results would be biased downwards. Third, we consider the face value of government debt. Our model predicts that only high liquidity dependent sectors affect the market value through a change in the price of liquidity. Fourth, as external debt is a placebo, the reverse causality problem would be a serious concern only if growth of industries with high liquidity needs would reduce significantly more domestic debt than external debt. We are not aware of any empirical or theoretical evidence that confirms this mechanism. For the aforementioned reasons empirical specification (14) is estimated using OLS.

Empirical specification (14) allows to include industry and country fixed effects that control for any unobservable determinants of sectoral growth that vary at the industry or country level (e.g. sectoral shocks and financial frictions, econonomic and financial development, institutional efficiency, macroeconomic volatility, ...). The inclusion of fixed effects reduces the concern of omitted variable bias to a large extent. In cross-country regressions as in Reinhart and Rogoff (2010) and Kumar and Woo (2010), governement debt correlated with *any* country-specific variables not included in the regression is endogenous. In the cross-industry cross-country approach (14), the estimates of β_d and β_e are biased *only if* an omitted variable is correlated with *both* sectoral liquidity needs and government debt. In Section 4.2, we control for the potential differential growth effect of domestic liquidity provided by financial markets. In Section 5.2 we deal with competitive channels that vary over both dimensions and might be correlated with the interaction terms.

The panel structure of specification (14) raises the problem of clustering standard errors. If not properly adressed the problem results in a downward bias in the estimate of standard errors and gives rise to overrejection (Moulton, 1986, 1990; Bertrand et al., 2004). I expect on the one hand unobservable characteristics of the same industry to be correlated across countries, on the other hand unobservables of different industries to be correlated within countries. Hence robust standard

[20] In our sample, the largest sector corresponds to 6.3% of the total size of the economy.

errors are adjusted for two-way clustering at the industry and country level using the correction of Cameron et al. (2011).

4 Empirical Results

4.1 Government-Supplied Liquidity, Risky Government Debt and Growth

The results of our benchmark estimation are presented in Table 2. The dependent variable is the real annual growth of value added over the period 1990-2000, while country-specific variables are averaged over the same period. All specifications are estimated using OLS. Robust standard errors reported in parentheses are adjusted for two-way clustering at the industry and country level using the correction of Cameron et al. (2011). I first discuss the baseline regression specifications related to empirical equation (14) which include country and industry fixed effects (columns 1 to 3). The initial industry share, defined as the (log) share of sectoral value added to total value added in 1990, has the expected negative sign in all regressions (significant at conventional levels in most of them) indicating a catching-up effect at the sectoral level. In terms of the main predictions, I find that the coefficient estimates on the variables of interest are in line with the expected pattern. The estimate on *Liquidity needs* × *Domestic debt* has the positive sign and is significant at the 5% level, while the estimate on *Liquidity needs* × *External debt* is insignificant (p-values of 0.489 in column 2 and of 0.393 in column 3). These results suggest that sectors that rely relatively more on liquidity develop disproportionately faster in countries with more government debt but only if this debt triggers a larger provision of liquidity. The fact that the liquidity placebo measured by the government external debt-to-GDP ratio is shown to have any insignificant differential growth effect sharpens the causal interpretation of our results. Specifically sectoral growth heterogenously reacts to the goverment-supply liquidity but does not show any signficant differential response to the placebo.

Empirical specification (14) does not allow to identify the *general* growth effect of government debt, the main object of analysis in cross-country regression, since this effect is subsumed in the country fixed effect. The presence of country fixed effects is the most efficient way to control for any unobserved heterogeneity at the country level that might bias the estimate of the specific channel stressed in my model. However, it might be interesting to investigate whether domestic government debt affects industry growth mostly through more efficient investment choices, as opposed through a general effect, for example, of larger subsidies or more favorable taxation to the manufacturing sector. This is done by excluding the country fixed effects and instead including domestic and external government debt-to-GPD ratio in specification (14). I do not find any significant general effect of both domestic and external debt on industry growth. Most importantly, including domestic and external government debt does not change the magnitude or the significance of the coefficient on the interaction term associated to the liquidity component. Furthermore the interaction associated to the liquidity placebo remains statistically insignificant. This result suggests that the major effect of more domestic government debt operates through more efficient investment choices and that the

Table 2. The Growth Effect of (Risky) Liquidity-Enhancing Government Debt

	Domestic and external debt				Domestic and external risky debt			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liquidity needs × Domestic debt	**0.651****		**0.610****	**0.581****	**1.221****		**0.872*****	**0.415****
	(0.277)		**(0.246)**	**(0.231)**	**(0.517)**		**(0.162)**	**(0.166)**
Domestic debt				−0.057				
				(0.047)				
Liquidity needs × Domestic debt × D_c^d					−0.590**			
					(0.301)			
Liquidity needs × External debt		−0.196	−0.175	−0.135		−0.545		
		(0.283)	(0.204)	(0.176)		(0.576)		
External debt				0.029				
				(0.032)				
Liquidity needs × External debt × D_c^e						0.486		
						(0.423)		
Liquidity needs × Risky domestic debt							−0.707***	
							(0.149)	
Liquidity needs × Risky composition								−0.269***
								(0.071)
Initial industry share	−0.008*	−0.010**	−0.008*	−0.010**	−0.008*	−0.010**	−0.007	−0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
Causal effect (% points)	**1.06**	–	**0.99**	**0.94**	**1.98**	–	**1.15**	**0.57**
	–	–	–	–	**1.00**	–	–	**−0.79**
R^2	0.399	0.486	0.399	0.175	0.402	0.487	0.531	0.531
Observations	899	927	899	899	899	927	586	586
Countries	39	40	39	39	39	40	24	24

Notes: All regressions include a constant, initial industry share and fixed effects at the country and industry levels (coefficient estimates not reported) except in column 4 (only industry fixed effects). Each specification is estimated using OLS. Robust standard errors reported in parentheses are adjusted for two-way clustering at the industry and country level . ***: signficant at 1% level. **: signficant at 5% level. *: signficant at 10% level.

be almost zero (0.165=0.872−0.707).

4.2 The Growth Effect of Public and Private Liquidity Provisions

In a recent paper, Gennaioli et al. (2011) document that financial development is an important determinant of the size of (domestic plus external) government debt. Without controlling for financial development, I might simply capture that setors with high liquidity needs perform relatively better in countries with higher government debt because government is supported by financial development and financial development disprotionaly favors those industries. Additionally, financial development helps the economy to generate fiancial assets (private provision of liquidity). Another channel that might bias my results is related to financial openess of the economy. It might be that industries that rely more on liquidity do not need the public provision of liquidity in financially opened countries since they have access to international liquidity. However even in financially opened countries, industries can be liquidity constrained if they do not generate current account surplus and hence accumulate international liquidity.

I carefully control for the differential growth effect that might have financial development and openess by providing liquidity. First, I include in empirical specification (14) an interaction term *Liquidity needs* $\times L_c$, where L_c stands for the type of liquidity provided by financial markets (loan (credit), bonds, stocks, international liquidity). The country-specific variables are averaged over the period 1990-2000. Second, I control for the effect of private liquidity on industry growth in an unrestricted way by adding an interaction term $D_i \times L_c$, where D_i is an industry dummy. This variable absorbs the *whole* growth effect of private liquidity L_c.

Table 3 reports the estimation of regression (14) once the differential growth effect of private liquidity is accounted for. Controlling for this effect does not change the magnitude or the significance of the coefficient on the interaction term associated to the liquidity component, even if the interaction term $D_i \times L_c$ is included. Furthermore the interaction associated to the liquidity placebo remains statistically insignificant. An interesting part of the excercise is to analyze the growth effect of private liquidity itself. First, private liquidity provided the loan market does not appear to have any significant growth effect (column 1). This result is in line with the prediction of my model, which predicts no direct growth-enhancing role for the development of the loan market. The effect is indirect in the sense that it provides an ex-post insurance such that the sector with high liquidity needs invest more in real assets and less in liquid assets which in turn improves the investment choice. Raddatz (2006) finds evidence that financial development affects volatility by providing liquidity but has no effect on growth. Second, the size of the stock market matters more for growth in the provision of private liquidity than the size of bond markets (columns 3 and 5). However this result has to be taken with caution as regression (3) is estimated with a significantly lower number of countries. Third, international liqudity appears to matter more for firms with high liqudity needs insofar as openess is concerned (columns 7 and 9).

4.3 Liquidity Shortage, Government-Supplied Liquidity and Growth

My model predicts that the growth effect of government-supplied liquidity is stronger in presence of liquidity shortage, i.e. in case credit markets are not developed enough to provide the liquidity required to overcome the liquidity shock (see Corollary 2). However a liquidity shortage can also come from the inability of financial markets to generate liquid assets, a mechnanism which is absent from my model. Caballero (2006) claims that a lack of institutional development supporting financial markets and contracts is the major cause of asset shortage plaguing emerging countries. Imam and Chen (2011) document that underdeveloped legal institutions is one of the factors explaining asset shortage. In Caballero and Krishnamurthy (2006) government-supplied liquidity plays a key role in the context of crisis due to bubble crashes. If the government is able to provide enough public liquidity used as a store, the emergence of bubbles is limited and financial crisis due to bubble crashes is prevented. Instead of focusing on volatility, I investigate the effect of public liquidity on growth in the presence of liquidity shortage.

I proceed as follows. I first identify different channels that can explain the liquidity shortage (see Imam and Chen, 2011). Liquidity shortage can comes from the inability of domestic banking system to provide liquidity, the inability of the financial markets in general to generate assets (bonds or stocks) or the inability to access foreign assets (either through closed capital account or through current account deficits). The second step consists of identifying the legal determinants of each financial frictions. According to (Djankov et al., 2008), the quality of debt enforement predicts the development of credit markets. The index of creditor rights from Djankov et al. (2007) appears to be a good predictor of the size of bank loans (La Porta et al., 1997; Djankov et al., 2007) and of private bond markets (Burger and Warnock, 2006; Djankov et al., 2007). The index of shareholder rights is a significant determinant of the development of equity markets (La Porta et al., 1997). Finally I split the countries included in my regression into two subsamples according the median of each financial friction indicator. Countries below the median of an indicator of financial frictions are expected to face more severe liquidity shortage than countries above the median. The calculated causal effect is reported for each regression in Table 4 directly below the coefficient estimates as well as the difference in causal effect between the two subsamples. A significant difference suggests that liquidity shortage due the considered financial frictions plays a role in explaining the difference in growth effects of government-supplied liquidity.

The results of the estimation for each subsample is presented in Table 4. Due to a significant reduction in the sample size for each regression, the results appear to be sensitive to the presence of the countries with a high level of domestic government debt. Therefore I include an interaction term interacted with a dummy for Chile, Singapore, Italy and Israel. Estimates in columns 1 and 2 confirm the prediction of my model. The growth effect of government-supplied is only significant in countries with large credit market imperfections. The difference in causal effect is signficant at the 5% level. The legal determinants of credit frictions are line with these results (columns 3 and 4 for debt enforcement and columns 7 and 6 for creditor rights). A shortage in fixed-income assets also appears to significantly affect the growth effect of public liquidity provision (columns 5 and

Table 3. The Growth Effect of Public and Private Liquidity Provisions

	Domestic liquidity						International liquidity			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Liquidity needs × Domestic debt	**0.548***** **(0.207)**	**0.549**** **(0.232)**	**0.364**** **(0.150)**	**0.391**** **(0.166)**	**0.475**** **(0.216)**	**0.547**** **(0.237)**	**0.541**** **(0.229)**	**0.553**** **(0.250)**	**0.597**** **(0.273)**	**0.580**** **(0.285)**
Liquidity needs × External debt	−0.094 (0.138)	−0.087 (0.144)	0.017 (0.369)	−0.072 (0.357)	−0.037 (0.174)	−0.040 (0.151)	−0.122 (0.198)	−0.105 (0.203)	−0.160 (0.192)	−0.195 (0.205)
Liquidity needs × Private credit	0.126 (0.118)									
Liquidity needs × Bond market capitalization			0.423 (0.282)							
Liquidity needs × Stock market capitalization					0.161*** (0.060)					
Liquidity needs × Financial openness							0.078** (0.031)			
Liquidity needs × Current account									0.002 (0.013)	
Initial industry share	−0.008* (0.005)	−0.011** (0.005)	−0.008 (0.006)	−0.009 (0.007)	−0.008* (0.005)	−0.010** (0.005)	−0.008* (0.005)	−0.009* (0.005)	−0.008* (0.005)	−0.010** (0.005)
$D_i \times L_c$	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
R^2	0.400	0.433	0.497	0.527	0.426	0.458	0.408	0.430	0.404	0.424
Observations	0.400	0.433	0.497	0.527	0.426	0.458	0.404	0.424	0.399	0.424
Countries	39	39	23	23	37	37	39	39	39	39

Notes: All regressions include a constant, initial industry share and fixed effects at the country and industry levels (coefficient estimates not reported). Each specification is estimated using OLS. Robust standard errors reported in parentheses are adjusted for two-way clustering at the industry and country level . ***: signficant at 1% level. **: signficant at 5% level. *: signficant at 10% level.

Table 4. Liquidity Shortage, Liquidity-Enhancing Government Debt and Growth

	Domestic liquidity (debt channel)							
	Private credit		Debt enforcement		Bond market		Creditor rights	
	w/Low	w/High	w/Low	w/High	w/Low	w/High	w/Low	w/High
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liquidity needs × Domestic debt	**1.636****	**0.189**	**1.189****	**−0.234**	**1.315*****	**0.407*****	**1.839****	**0.401**
	(0.691)	**(0.277)**	**(0.586)**	**(0.250)**	**(0.484)**	**(0.128)**	**(0.720)**	**(0.416)**
Liquidity needs × Domestic debt × D_c^d	−0.950**	0.306	−0.786*	0.257	−0.687**	0.091	–	−0.149
	(0.459)	(0.346)	(0.445)	(0.199)	(0.339)	(0.201)	–	(0.342)
Liquidity needs × External debt	−0.143	−0.059	−0.226	0.240	−0.007	−0.158	−0.050	−0.190
	(0.478)	(0.074)	(0.288)	(0.371)	(0.578)	(0.694)	(0.262)	(0.457)
Initial industry share	−0.012**	−0.010	−0.000	0.007	−0.005	−0.018**	−0.005	−0.008
	(0.006)	(0.008)	(0.003)	(0.005)	(0.009)	(0.008)	(0.007)	(0.007)
Causal effect (% points)	**3.33**	**0.25**	**2.05**	**−0.34**	**2.54**	**0.62**	**3.13**	**0.93**
Difference in causal effect	3.08**		2.39***		1.93**		2.21**	
b/w Low and High (p-value)	(0.014)		(0.008)		(0.019)		(0.036)	
R^2	0.393	0.489	0.094	0.035	0.492	0.548	0.417	0.460
Observations	434	465	362	367	310	279	404	435
Countries	20	19	16	15	12	11	18	18

Table 4. *(continued)*

	Domestic liquidity (equity channel)				Financing frictions		International liquidity			
	Stock market		Shareholders rights		Collateral value		Financial openess		Current account	
	w/Low	w/High	w/Low	w/High	w/Low	w/High	w/Low	w/High	w/Low	w/High
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Liquidity needs × Domestic debt	**1.672***	**0.653***	**1.290*****	**0.528****	**2.277*****	**0.648**	**1.411***	**0.700**	**1.675****	**0.854***
	(0.942)	**(0.371)**	**(0.496)**	**(0.266)**	**(0.770)**	**(0.482)**	**(0.770)**	**(0.503)**	**(0.805)**	**(0.506)**
Liquidity needs × Domestic debt × D_c^d	−0.811	−0.352	−0.732*	−0.418	−1.033**	−0.415	−0.955***	−0.223	−1.164***	−0.285
	(0.750)	(0.285)	(0.406)	(0.387)	(0.470)	(0.379)	(0.335)	(0.396)	(0.339)	(0.424)
Liquidity needs × External debt	−0.333	−0.041	0.248	−0.661	−0.665	0.043	−0.043	−0.192	0.083	−0.878*
	(0.569)	(0.064)	(0.238)	(0.722)	(0.526)	(0.145)	(0.256)	(0.202)	(0.116)	(0.494)
Initial industry share	−0.016**	−0.007	−0.005	−0.003	−0.007	−0.009*	−0.016**	0.002	−0.016**	−0.001
	(0.007)	(0.007)	(0.006)	(0.009)	(0.008)	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
Causal effect (% points)	**2.48**	**0.83**	**2.86**	**0.56**	**3.67**	**1.04**	**2.70**	**0.97**	**3.11**	**1.23**
Difference in causal effect	1.66		2.30**		2.63**		1.73		1.88	
b/w Low and High (*p*-value)	(0.118)		(0.018)		(0.017)		(0.119)		(0.103)	
R^2	0.427	0.502	0.566	0.570	0.477	0.427	0.311	0.551	0.348	0.489
Observations	410	458	302	360	466	433	442	457	438	461
Countries	19	18	12	14	39	39	20	19	20	19

Notes: All regressions include a constant, initial industry share and fixed effects at the country and industry levels (coefficient estimates not reported). Each specification is estimated using OLS. Robust standard errors reported in parentheses are adjusted for two-way clustering at the industry and country level . ***: signficant at 1% level. **: signficant at 5% level. *: signficant at 10% level.

6). Conversely the results for a shortage in stocks are less clear-cut (columns 1 to 4 in the second part of Table 4). I then split the sample according an industry characteristic capturing financial frictions at the sectoral level. I use the measure of collateral value of real assets developed by (Beutler and Grobéty, 2011), a proxy for assets' pledgeability at the sectoral level. As expected, domestic government debt has significant larger growth effect for industries facing severe financial frictions. The result of this test confirms that financial frictions is an central feature in the real effect of government-supplied liquidity. In regressions (7) to (10), I investigate whether a shortage of foreign assets stresses a difference in the growth effect of public liquidity. Although the difference is significant in quantitative terms, it is not significant is statistical terms at convential levels.

5 Conclusion

To be added.

Appendix

A Proof of Proposition 1

Under Assumption 3, only behavior of entrepreneurs in sector $\overline{\phi}$ affects the competitive price for government bonds, since entrepreneurs in sector $\underline{\phi}$ have so low liquidity needs that they are able to achieve the first-best without holding any liquid assests.

(i) Under Assumption 2, entrepreneurs in sector $\overline{\phi}$ cannot achieve the first-best investment choice even if $\widetilde{b} = \bar{b}$. Therefore this economy supports a competitive price for liquid assets $q_t > \beta$. Using the Envelop Theorem, one gets $V_s'(q_t) = -B_{t+1} < 0$ which shows that the value function associated to the constrained safe investment choice is monotonically decreasing in q_t. Therefore it might be that q_t reaches a price level $\overline{q}$ that makes entrepreneurs in the high liquidity needs sector indifferent between the risky and constrained safe investment choice. Therefore the equilibrium in this economy satisfies $q_t \in (\beta, \overline{q}]$ where $\overline{q}$ solves $V_s(\overline{q}) = V_{r,t}$.

If every entrepreneur chooses the safe allocation at price $\overline{q}$, the asset market is in equilibrium. We denote $\underline{B}_t \equiv \underline{b}A_t$ the supply of safe and liquid assets that sustains this equilibrium. Now suppose that in the same economy outside liquidity decreases, which creates an excess demand at price $q_t = \overline{q}$ if the safe allocation is chosen. The liquidity premium has to increase. But at price $q_t > \overline{q}$, every entrepreneur is better off to switch to the risky allocation since $V_{s,t} < V_{r,t}$. Given optimal demand (**??**) there is an excess supply of liquidity. Therefore no equilibrium exists. Since at price $q_t = \overline{q}$, entrepreneurs are indifferent between the safe and risky allocation, we assume that in case $\widetilde{B}_{t+1} < \underline{B}_{t+1}$, only a fraction $1 - \mu(\widetilde{b}) = 1 - \frac{\widetilde{b}}{\underline{b}}$ switches to the risky allocation, while the remaining fraction of entrepreneurs continues to choose the safe allocation. The equilibrium is stable since demand for liquidity is constant. This shows that the maximum price that sustains an equilibrium is $\overline{q}$.

Entrepreneurs take the price of outside liquidity as given in the sense that they do not internalize that a lower consumption level when young raises q_t. Moreover they are indifferent about the intertemporal consumption choice given the linearity of preferences. As a result, we have that consumption when young simply exhausts resources, i.e. $c_s(q_t) = w - [k_s(q_t) + z_s(q_t) + q_t b_s(q_t)]$ where $k_s(q_t)$ and $z_s(q_t)$ solve equations (9) and (10), respectively. Therefore if $V_{r,t} < V_s(q_t) < V_{s,t}^*$, the equation that determines the equilibrium price q_t is the liquidity constraint (6). Using the market clearing condition $\widetilde{b} = b_s(q_t)$, the liquidity constraint can be written as:

$$\widetilde{b} + \pi_k[k_s(q_t)] = (\phi - \theta) z_s(q_t)$$

Differentiating the liquidity constraint with respect to $\widetilde{b}$ and rearranging yields:

$$\frac{\partial q_t}{\partial \widetilde{b}} = \frac{1}{(\phi - \theta) z_s'(q_t) - \frac{1}{q_t} k_s'(q_t)}$$

using the investment condition (9). The result immadiately follows since $z_s'(q_t) < 0$ and $k_s'(q_t) > 0$.

(ii) The liquidity premium is zero if and only if $\widetilde{b} \geq (\overline{\phi} - \theta)z_s^* - \pi_k(k_s^*)$.
(iii) The liquidity premium is zero for all $\widetilde{b} \in [0, \bar{b}]$, since credit markets are developed enough to support alone the first-best. $\square$

B Sample

Table A2. Country Sample

Country	Number of sectors	Country	Number of sectors
Australia^{b}	20	Republic of Korea^{b}	28
Austria^{b}	22	Malaysia^{b}	26
Bolivia^{a}	26	Malta	17
Canada^{b}	27	Mexico^{a,b}	26
Chile^{a,b}	28	Morocco^{a}	12
Colombia^{a,b}	25	Netherlands^{b}	26
Costa Rica^{a}	22	Norway^{b}	26
Cyprus	25	Panama	16
Ethiopia^{a}	21	Poland^{a,b}	10
Finland^{b}	26	Senegal^{a}	10
France^{b}	23	Singapore^{b}	21
Hungary^{a,b}	26	Spain^{b}	27
India^{a}	28	Sri Lanka^{a}	26
Indonesia^{a,b}	24	Sweden^{b}	28
Ireland^{b}	26	Trinidad & Tobago^{a}	18
Israel^{a}	17	Tunisia^{a}	17
Italy^{a,b}	26	Turkey^{a,b}	26
Japan^{b}	28	United Kingdom^{b}	26
Jordan	27	Uruguay^{a}	21
Kenya^{a}	25	Portugal^{b}	26

Notes: This table displays each country present in growth regressions when the ratio of domestic over GDP from Panizza (2008) is used (except Portugal). The exponent a denotes countries characterized by a low level financial devlopment (i.e. countries that are below the median of mean private credit to GDP over the period 1991-2000). The exponent b indicates countries present in the dataset from BIS (2009).

C Robustness

TABLE 6. STANDARD ROBUSTNESS AND SENSITIVITY ANALYSIS

	Standard Robustness				Sentsitivity Analysis					
	Public Bond	Debt 1990	Output growth	Product-ivity growth	Dropping 1% outliers	Dropping 5% outliers	Dropping countries sectors<20	Excluding African countries	DFBETA	Robust regress-ion
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Liquidity needs × Domestic debt	0.517**	0.437*	0.433**	0.451**	0.458**	0.245**	0.626***	0.613**	0.710***	0.401**
	(0.240)	(0.225)	(0.181)	(0.197)	(0.193)	(0.106)	(0.228)	(0.258)	(0.236)	(0.168)
Liquidity needs × External debt	–	−0.185	−0.081	−0.077	0.013	0.029	−0.102	−0.096	−0.157	0.048
	–	(0.158)	(0.210)	(0.142)	(0.167)	(0.056)	(0.274)	(0.193)	(0.184)	(0.155)
Initial industry share	−0.010*	−0.011**	−0.007	−0.036***	−0.006	−0.002	−0.008	−0.009*	−0.008*	−0.006***
	(0.006)	(0.005)	(0.004)	(0.005)	(0.004)	(0.003)	(0.005)	(0.005)	(0.005)	(0.002)
R^2	0.518	0.381	0.373	0.364	0.435	0.440	0.411	0.442	0.453	0.505
Observations	646	741	892	878	881	809	782	814	854	899
Countries	26	32	39	39	39	39	31	34	39	39

Notes: Notes: All regressions include a constant, initial industry share and fixed effects at the country and industry levels (coefficient estimates not reported). Each specification is estimated using OLS. Robust standard errors reported in parentheses are adjusted for two-way clustering at the industry and country level . ***: signficant at 1% level. **: signficant at 5% level. *: signficant at 10% level.

Table 7. Testing for Competing Explanations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Liquidity needs × Domestic debt	0.560**	0.572**	0.641**	0.605***	0.553**	0.511***	0.601**	0.533**	0.587**	0.641***	0.634**	0.698***
	(0.227)	(0.258)	(0.325)	(0.229)	(0.230)	(0.177)	(0.238)	(0.209)	(0.272)	(0.243)	(0.265)	(0.267)
Liquidity needs × External debt	−0.086	−0.085	−0.103	−0.170	−0.106	0.061	−0.260	−0.112	−0.167	−0.135	−0.103	−0.197
	(0.114)	(0.144)	(0.159)	(0.181)	(0.137)	(0.267)	(0.254)	(0.137)	(0.198)	(0.229)	(0.180)	(0.246)
Liquidity needs × Economic development	0.052											
	(0.080)											
Industry dummy × Economic development		–										
		–										
Skill intensity × Human capital			0.031**									
			(0.015)									
Contract intensity × Rule of law				0.003								
				(0.020)								
Industry dummy × Sovereign default					–							
					–							
Industry dummy × Sovereign restructuring						–						
						–						
Liquidity needs × Reserve money							0.535					
							(0.651)					
Liquidity needs × Cash								0.181				
								(0.193)				
Liquidity needs × Banks bondholdings									0.119			
									(0.632)			
Liquidity needs × Exchange rate flexibility										0.031		
										(0.046)		
Industry dummy × Subsidies											–	
											–	
Growth opportunities × Domestic debt												0.740**
												(0.347)
Initial industry share	−0.008	−0.012*	−0.011**	−0.008*	−0.012**	−0.010*	−0.008*	−0.008*	−0.008*	−0.008*	−0.012**	−0.008*
	(0.005)	(0.006)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
R^2	0.400	0.461	0.442	0.399	0.428	0.433	0.394	0.400	0.399	0.399	0.459	0.406
Observations	899	899	817	899	899	899	883	899	899	899	878	853
Countries	39	39	35	39	39	39	38	39	39	39	38	39

Notes: All regressions include a constant, initial industry share and fixed effects at the country and industry levels (coefficient estimates not reported). Each specification is estimated using OLS. Robust standard errors reported in parentheses are adjusted for two-way clustering at the industry and country level . ***: signficant at 1% level. **: signficant at 5% level. *: signficant at 10% level.

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