What if relaxing borrowing constraints work?
A theoretical and empirical application to SSA countries

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Abstract

We investigate whether relaxing recipient countries access to international credits markets complement foreign aid. The paper addresses this question theoretically and empirically. We develop a two-period, two-country, and two-good model where the recipient faces a liquidity constraint on its demand for loans. We consider three scenarios depending on whether the donor is passive/active and whether the two governments move simultaneously or sequentially. One finding is that if the donor increases unconditional aid, or decreases ex-post conditionality, the recipient increases its demand for loans. We also use data for 132 countries from 1980 to 2011 to examine this question.

Key Words: Foreign Aid, Trade, Borrowing Constraint
JEL Classifications: F35, F13, F34

1. Introduction

Developing countries have four sources of revenues: foreign aid, borrowing, and trade and fiscal revenues. However, foreign aid, trade and fiscal revenues are likely to have a positive impact on growth while the extended use of borrowing may negatively impact economic growth reversing any positive gains from the three other sources. The literature on debt and economic growth has demonstrated that debt negatively impacts growth in two ways. First, high level of debt reduces physical capital accumulation and total factor of productivity growth (Pattillo, Poirson et al. 2004). Second, high level of debt services crowds out private investment and changes the composition of public spending (Clements, Bhattacharya et al. 2003). Surprisingly, the literature on foreign aid and economic growth has also documented that foreign aid positively impacts economic growth through physical capital accumulation (Chenery and Strout 1966, Easterly 1999), the very same channel through which debts negatively impact growth.

The fiscal response literature has linked the two previous strands of literature by investigating whether foreign aid and borrowing are complementary sources of revenue. The research under this literature is based on the assumption that recipient countries have an unlimited access to both foreign aid and borrowing. This paper extends the fiscal response literature by restricting the ability of recipient countries to borrow. Accordingly, the paper investigates the interaction between foreign aid and borrowing constraints. Specifically, the goal of the paper is to examine whether relaxing recipient countries access to international credits markets complement foreign aid. The paper addresses this question theoretically and empirically.

Theoretically, the paper will have a two countries, two goods, and two periods model of international trade in which the donor's promise of disbursing aid in period 2 is conditioned on the recipient optimal tariff rate in period 1 and the recipient country is subject to liquidity constraints, which set a quantitative restriction on its demand for loans. The donor and the recipient participate in a series of games in which they alternatively play an active role. Within this framework, I consider a recipient active game and/or donor active or passive game. The games are further differentiated in simultaneous and/or sequential games.

In the empirical analysis, the paper focuses on low and middle income countries from 1980 to 2011. It uses panel data estimation techniques using a dynamic panel-data (DPD) model, which we estimate using the difference and system general method of moments (GMM). It further tests the robustness of our empirical results using alternative proxy for liquidity constraints or debt and 2 subsamples: Sub-Saharan African (SSA) and Heavily Indebted Poor Countries (HIPC).

Our empirical results support our theoretical hypothesis. Indeed, we find evidence that liquidity constraints and foreign aid are complements. That is where debt reduces growth, foreign aid enhances it. We further test this by including an interaction term of the debt proxy and foreign aid in our empirical model. The results further support the above conclusion. Our empirical results are robust.

The organization of this study is as follows. Section 2 gives a detailed description of the theoretical model. Section 3 investigates the passive donor game. Section 4 has two subsections in which we describe the two sub-games: the simultaneous game (4.1) and the sequential game (4.2). In section 5, we conclude.

2. Theoretical Model

To capture the effects of relaxing borrowing constraints, we construct a theoretical model with two-country (donor and recipient), two-period (t_1 and t_2). The donor is assumed to have an altruistic homogenous population, which derives satisfaction from giving aid. At the beginning of period 1, the donor pledges to give aid which is disbursed in period 2. The donor's promise of aid is based on the following formula:

$$(1) \qquad F = \alpha - \beta\tau$$

where, F is the total amount of foreign aid disbursed in the second period. Equation (1) has two components: a fixed component (α), a lump-sum fixed amount of aid; and a variable component ($\beta\tau$), made of two policy instruments (β and τ). β captures the donor weight or preference for τ, a tariff rate. . The donor's utility level is given by

$$(2) \qquad U^D = V\left(Y - \frac{F}{1+\gamma}\right) + \mu U^R$$

where, V is the indirect utility function with $V' > 0$ and $V'' > 0$, and the parameter γ is the donor's exogenous discount rate. Y is the donor's inter-temporal fixed income, and μ is the altruism parameter.

The recipient country produces many goods but we focus on one importable good on which the recipient imposes an ad valorem tariff rate τ in period 1. Both the donor and recipient are small open economies so that the price of the importable good, the first good, is the world price (p) and the composite price of all of the other goods is (P). Both p and P are exogenous. The production side of the recipient country involves four revenue functions for

both periods: (1) $R^1[p(1+\tau), 1, \bar{L}, \overline{K}]$ represents the first period rental income, (2) $R^2[p, 1, \bar{L}, \overline{K}+1]$ is the discounted rental income of the second period, (3) $\tau p(E_1 - R_1^1)$ is the trade revenue, and (4) the present value of foreign aid. $\bar{L}$ is the labour stock in both periods, $\overline{K}$ is the initial capital stock in period 1, and I is the investment in new capital, which is added to the capital stock in period 2. The consumption side is represented by the inter-temporal expenditure function $E\left[p(1+\tau), 1, \frac{p}{1+r}, \frac{1}{1+r}, U^R\right]$, with U^R the inter-temporal utility function. $\frac{1}{1+r}$ is the recipient discount rate where r is an endogenous interest rate.[1] The following three equations describe the equilibrium in the recipient country.[2]

$$(3) \quad E\left[p(1+\tau), 1, \frac{p}{1+r}, \frac{1}{1+r}, U^R\right] + I = R^1[p(1+\tau), 1, \bar{L}, \overline{K}] + R^2[p, 1, \bar{L}, \overline{K}+I] + \tau p(E_1 - R_1^1) + \frac{F}{1+r}$$

$$(4) \quad R_4^2[p, 1, \bar{L}, \overline{K}+1] = 1 + r$$

$$(5) \quad \bar{B} = p(1+r)E_1 + E_2 + I - \tau p(E_1 - R_1^1) = R^2 + F - pE_3 - E_4$$

Equation (3) is the inter-temporal budget constraint, with the left hand-side as the inter-temporal total expenditure (consumption and investment) and the right-hand side the inter-temporal total income. Equation (4) determines the optimal level of investment, which is obtained by setting $\frac{\partial U^R}{\partial I} = 0$. The right hand-side of equation (4) is the marginal benefit of one unit of investment in period 1, i.e., the present value of return on investment. The right hand-side represents the marginal cost of investment, or consumption foregone in period 1. Equation (5) determines the optimal level of loans or borrowing that the recipient needs in the first or second period. Borrowing can be defined in two ways: (1) excess consumption expenditure in the first period or (2) the discounted value of excess expenditure over revenue in the second period. We assume that the recipient borrows at t_1 and repays at t_2; hence, adopting our first definition. Moreover, we assume that the recipient has a quantitative restriction on its demand for loans ($\bar{B}$).

Note that U^R, I, r, and F are endogenous variables, β, α, and τ are policy instruments, and $p, \bar{L}, \overline{K}$, and $\bar{B}$ are exogenous variables.

[1] The revenues (expenditures) functions are convex (concave) in prices. The partial derivative of the revenue (expenditure) function with respect to the price of a good gives the supply (compensated demand) function of the good.

[2] For a function $f(\cdot)$, we denote by f_i the partial derivative of f with respect to the ith argument.

3. Passive Donor Game

We also consider the donor and the recipient behaviors within the framework of two games (1) a passive donor game, and (2) an active donor game. The donor active game is further differentiated into 2 sub-games: a simultaneous game and a sequential game.

Within this framework, the recipient optimally chooses its tariff rate τ by maximizing its welfare function as follows.

$$(6) \qquad \underset{\tau}{Max}\ W\ = U^R$$

Let us first totally differentiate equations (3) through (5) to obtain:[3]

$$(7)\quad (E_5 - \tau p E_{15})dU^R = -\left[\bar{B} + \frac{\tau p(pE_{13} + E_{14})}{1+r}\right]dr + \left[\tau p^2(E_{11} - R_{11}^1) - \frac{\beta}{1+r}\right]d\tau + \frac{1}{1+r}d\alpha - \frac{\tau}{1+r}d\beta$$

$$(8)\quad dI = \frac{R_4^2}{(1+r)R_{44}^2}dr$$

$$(9) \qquad dr = \frac{1}{Z}[d\alpha - \tau d\beta - (\beta - p^2E_{31} + pE_{41}]d\tau - (pE_{35} + E_{45})dU^R$$

where $Z = \bar{B} - \left(\frac{p^2E_{33}+pE_{34}+pE_{43}+E_{44}}{(1+r)^2}\right) - \frac{(R_4^2)^2}{(1+r)R_{44}^2}$

From (7), we see that the recipient's utility decreases with the interest rate (r), the tariff rate (τ), and the conditionality parameter (β), but increases with the unconditional part of aid (α). Investment decreases with the interest rate in equation (8).[4] We also observe that the interest rate decreases with the two donor's policy instruments as well as with the tariff rate and the recipient's utility. Z is the slope of the excess supply of loans over the recipient's expenditures and revenues. Z is positive due to the quantitative restriction on loans supply .

From (6) and using (7), (8), and (9), we get the first-order condition as:

[3] We consider that $E_5 - \tau p E_{15}$>0, known as the Hatta condition in the extant literature. If all goods are normal, this condition is satisfied.

[4] The second-order partial derivatives of the revenue function with respect to capital (R_{44}^2) is negative rendering the right hand-side of equation 7 negative (Dixit and Norman 1980).

$$(10) - \tau p \varepsilon_m m(1+r)Z - \beta(1+\tau)[Z - \bar{B} - \tau p \varepsilon_c E_1] + p(1+\tau)(1+r)\varepsilon_c E_1[\bar{B} + \tau p \varepsilon_c E_1] = 0$$

where $\varepsilon_m = -(E_{11} - R_{11}^1)\frac{p(1+\tau)}{m}$, $\varepsilon_c = \frac{(pE_{13}+E_{14})}{(1+r)E_1}$, $m = E_1 - R_1^1$, $c_Y^1 = \frac{p(1+\tau)E_{15}}{E_5}$, $c_Y^2 = \frac{E_{25}}{E_5}$

ε_m is the absolute value of the compensated elasticity of imports. ε_c is the compensated demand for the first good. m is the level of imports of the first good. $c_Y^1 \; and \; c_Y^2$ are the marginal propensities from consuming goods 1 and 2, respectively.[5]

The first two terms on the left-hand side of equation (10) are the marginal costs and the last term is the marginal benefit of increasing τ. Intuitively, an increase of the tariff rate leads to an increase of the price of good 1 hence decreasing the compensated demand for good 1 while lowering import, which results in a dead-weight loss (the first term in equation (10)) in the first period. The lower compensated demand for good 1 decreases the recipient's demand for loans, putting a downward pressure on the interest rate (the second term of equation (10)). At t=2, the higher tariff rate induces a reduction in aid resulting in a lower recipient's welfare due to lower income, decreasing thus its marginal benefit.[6]

The implicit functional form of equation (10) is

$$(11) \quad f_\alpha \, d\alpha + f_\beta \, d\beta + f_\tau \, d\tau = 0$$

where $f_\tau = -p\varepsilon_m Z[m(1+r)+\tau p(E_{11}-R_{11})] - \beta(Z-\bar{B}) + p(1+r)\varepsilon_c \bar{B}[E_1 + p(1+\tau)E_{11}]$
$+(1+2\tau)\, p\varepsilon_c E_1[\beta + (1+r)\, p\varepsilon_c E_1] + \tau p^2(1+\tau)\varepsilon_c[E_{11}\beta + 2(1+r)E_1]$

$f_\beta = -(1+\tau)[Z - \bar{B} - \tau p \varepsilon_c E_1] - \tau p E_{15} A[(1+r)(2p\varepsilon_c^2 E_1 - \tau\varepsilon_m Z) + (1+\tau)(\bar{B} + \tau\beta)\varepsilon_c] < 0$

$f_\alpha = pE_{15}A[(1+r)(1+\tau)\varepsilon_c(\bar{B} + 2\tau p\varepsilon_c E_1) + \tau(1+\tau)\varepsilon_c\beta - \tau p\varepsilon_m(1+r)Z] > 0$[7]

The second-order condition for the recipient's optimization problem requires that $f_\tau < 0$. f_β is negative because an increase in β leads to higher marginal cost of increasing τ. An

[5] $c_Y^1 < 0, c_Y^2 < 0, c_Y^1 + c_Y^2 = 1$

[6] $\bar{B} < \tau p \varepsilon_c E_1$

[7] Please refer to the appendix to see how A is defined.

increase in α results in higher compensated demand for loans in the first period as well as the recipient's income in the second period

From (11), we obtain:

$$\frac{d\tau}{d\beta} < 0 \text{ and } \frac{d\tau}{d\alpha} > 0$$

Hence, a rise of the donor's policy instruments has two different effects on the tariff rate. That is, a higher donor's weight on the tariff rate decreases the tariff rate but an increase of the fixed or the lump-sum component of foreign aid increases revenue. Formally,

Proposition 1: When the donor is passive and the recipient faces a quantitative restriction on its demand for borrowing, we have:

1. *a higher donor's weight on the tariff rate induces the recipient to follow a more open trade policy*
2. *whereas, an increase of foreign aid through a rise of its lump-sum component causes the recipient to follow a more restrictive trade policy.*

Intuitively, an increase in β causes the recipient to increase its demand for loans or borrowing at t=1, which results in an increase in the interest rate because of the quantitative restriction on the recipient's demand for loans. This decreases the marginal cost of increasing τ . At t=2, the higher β decreases both the volume of foreign aid disbursed and the recipient's income, which in turn causes the recipient to decrease its repayment of borrowed resources, decreasing the marginal benefit. The result of these actions is that the recipient adopts a lower tariff rate or engages in a more open trade policy.

If the donor decreases foreign aid through a decrease of its lump-sum component, the recipient increases its demand for loans in the first period which causes an increase of the interest rate. This results in a decrease of the marginal cost. In the second period, the lower volume of foreign aid disbursed decreases the recipient income and its loan repayment, and as a result, its marginal benefits.

I. Active Donor

We next move from a passive donor game to an active donor game where both the donor and recipient are active. This scenario has two sub-games: a simultaneous game and a sequential game. In the two sub-games, we endogenize one of the donor's policy instruments (β) and take the other one (α) as given.

IV.1 Simultaneous game

Here, the donor and the recipient act simultaneously taking each other policy instruments as given. The recipient's actions are the same as in the previous game; therefore, its optimality condition remains the same (equation (10)). The donor's optimization problem is:

$$(10) \qquad \underset{\beta}{Max}\ U^D = V\left[Y - \frac{(\alpha - \beta\tau)}{1+\gamma}\right] + \mu U^R$$

Where the variables and parameters are defined after (1). The first order condition is:

$$U^D = 0 \Rightarrow \frac{\tau V'}{1+\gamma} + \frac{\partial U^R}{\partial \beta}$$

Using equations (6) and (8), we obtain:

$$(11) \qquad \tau(1+r)V'E_5\left[Z\left(1+\tau-\tau c_y^1\right) + \left(1+\tau c_y^2\right)\right] = \mu\tau(1+\tau)Z$$

The left-hand side represents the marginal benefit of increasing the aid conditionality parameter and the right-hand side the marginal cost.

Intuitively, a lower β increases the volume of foreign aid decreasing the donor disposable income resulting in a decrease of the marginal cost of increasing β. An increase in β also decreases the marginal benefit of increasing β, which is detrimental to the donor, altruistic by nature. We also investigate the effect of changing α on the optimal level of the two policy instruments τ and β.

The first-order condition for the donor can be written in an implicit function form as:

$$(12) \qquad g(\alpha, \tau, \beta) = 0$$

From which, we obtain g_α, g_τ, g_β. [8] The sign of g_β is negative and this is consistent with the second order donor's optimization problem. g_α is unambiguously positive and negative if ε_c is inelastic. Under this condition, lowering τ decreases the price of the first good causing an increase of its demand and import. This results in an increase of both the marginal benefit and the marginal cost of increasing β. Differentiating (12) and (XXX), we find the total effects as:

[8] See appendix for g_α, g_β, and g_τ.

$$\frac{d\tau}{d\alpha} = \frac{g_\beta f_\alpha - f_\beta g_\alpha}{\Delta}, \qquad \frac{d\beta}{d\alpha} = \frac{g_\alpha f_\tau - f_\alpha g_\tau}{\Delta}$$

where $\Delta = f_\tau g_\beta - g_\tau f_\tau > 0$ for the stability of Nash equilibrium. From this, we find that $d\beta/\, d\alpha < 0$ whereas $d\tau/d\alpha$ is ambiguous. A decrease of α obliges the recipient to increase its demand for loans causing an increase of the recipient income. The induced increased of income causes an increase of the demand of the first good in the first period.

A lower value of α decreases the volume of foreign aid decreasing the donor's disposable income and the marginal benefit of increasing β due to its altruistic nature. A lower value of α has an indirect effect on τ via a decrease of the recipient income. Hence, the negative signs of the first total derivative. The lower α causes the recipient to increase its demand of loans resulting in an increase of the marginal cost of increasing τ. The lower disbursement of aid decreasing the recipient's welfare and the marginal benefit of increasing τ, leading up to the ambiguous relationship between τ and α

Proposition 2. *When the donor and the recipient act simultaneously and the inter-temporal elasticity of consuming good 1 is relatively inelastic, an increase in α has no impact on the tariff rate.*

IV.2 Sequential game

We also examine a sequential game where the donor and the recipient take part in a two-stage game. In the first stage, the donor chooses its policy instruments taking the recipient's optimal tariff rate as given. In the second stage, the recipient chooses its policy instrument given α and β. Using backward induction, the second stage game is simply the donor passive game. As a result, we emphasize on the donor's action in the first stage. The donor's optimization problem is:

$$(14) \qquad \underset{\beta}{Max}\ U^D = V\left[Y - \frac{(\alpha - \beta\tau)}{1+\gamma}\right] + \mu U^R\ s.t.\ f(\tau, \beta, \alpha) = 0$$

where the first order condition is given by:

$$U^D_\beta = \frac{\tau V'}{1+\gamma} + \beta\frac{V'}{1+\gamma}\frac{d\tau}{d\beta} + \mu\frac{dU^R}{d\beta} = 0 \Rightarrow \beta^*_{Seq} = h(\tau, \beta, \alpha)$$

Equation (0.18) determines the optimal value of β for the sequential game. This first order condition is similar to that obtained in the simultaneous game except for the second

term. Indeed, the second term enters equation (0.18) due to the sequential nature of this game. $d\tau/d\beta$ is obtained from the second stage where the recipient chooses its tariff rate and has negative sign. Thus, substituting (XXX) in (XXX), we find that

$$(0.1)\ \tilde{U}^{D}_{\beta^{*}_{Seq}}\Big|_{\beta^{*}_{Sim}} = \beta\frac{V'}{1+\gamma}.\frac{d\tau}{d\beta} = -\beta\frac{V'}{1+\gamma} \Rightarrow \beta^{*}_{Seq} < \beta^{*}_{Sim}$$

Equation () determines the optimal value of β in the sequential game. Taking into the sign of $d\tau/d\beta$ from the recipient first stage action, we obtain an optimal value of βlower than the optimal value of β in the simultaneous game. A lower value of β implies that the donor commits to a lower volume of foreign aid inducing the recipient to increase its demand for loans.

Proposition 3. *When the donor and the recipient are engaged in a sequential game where the donor is the leader and the recipient is the follower, the donor places a lower weight on the recipient' tariff rate, which increases the recipient demand for loans.*

4. Empirical Model

Is foreign aid a complement or substitute to liquidity constraints? Can foreign aid help developing countries to avoid debt overhang? The primary aim of this section is to address this question. These questions also have implications for the debate on the issues of high debt and aid effectiveness. We do so by initially developing a quadratic dynamic panel-data (DPD) model. We shall refer to this first model as the benchmark model. Then, we carry out a number of robustness checks on our benchmark model. We re-estimate the full model using different estimation techniques and subsamples as well as create a system of two equations for testing our theoretical hypothesis.

4.1. Empirical Model and Estimation Methodology

The benchmark model is as follow:

$$Log\ Y_{it} = \alpha_1 + \alpha_2 Log\ Aid_{it} + \alpha_3 Log\ Debt_{it} + \alpha_4 Log\ Debt_{it}^2 + \alpha_5\ Log\ Y_{i,t-1} + \alpha_6\ Int_{it} + \alpha_7\ Log\ \mathrm{X}_{it} + \alpha_8\ Z + \varepsilon_{it}$$

where subscripts i and t refer to country i and time t. To minimize the effect of business cycles, we take the logarithm of both sides of equation except for the corruption and dummy variables. Here, we follow the literature on aid effectiveness and debt for selecting the control variables in the growth equation. Y_{it} is the dependent variable. Y_{it} is defined as the average

annual growth rate of Gross Domestic Product (GDP) (World Development indicators (WDI), 2013). The two variables of interest are Aid_{it} and $Debt_{it}$. Aid_{it} is the average of net official development assistance and official aid received (WDI, 2013). $Debt_{it}$ is the total stock of the central government debt. X_{it} is the a vector of exogenous variables. Z is a vector of country-specific time invariant variables. The variable Int_{it} is an interaction term for aid and debt, which capture the interdependence of aid and debt as specified in the theoretical model.

The vector (X) includes five variables: corruption, investment, inflation, secondary school enrollment, and the initial GDP per capita. Following Mauro (1995), we introduce corruption as a control variable for capturing corruption within the political system.[9] The ICRG rates countries based on a system of points from 1 to 6, with level of corruption increasing with the score. We normalize this variable so that it takes a value between 0 and 1 (Asiedu and Lien, 2011). We expect the coefficient of this variable to be negative. The variable investment is gross capital formation is measured by the total value of the gross fixed capital formation and changes in inventories and acquisitions less disposals of valuables for a unit or sector measured as share of the GDP (World Economic Outlook, 2013). The coefficient of this variable is expected to be positive. The variable inflation (consumer price index) is a proxy for monetary policies (Fischer 1993). We include secondary school enrollment to capture the level of the human capital (Barro, 2001; Asiedu and Nandwa, 2007). We also include the initial GDP per capita in the growth regression to capture the convergence effect between countries. We compute the initial GDP per capita at the beginning of each 5-year period (Tavares, 2003). The vector Z is comprised of two dummy variables: Sub-Saharan African (SSA), South Asia (SA), and heavily indebted poor countries (HIPC). These two variables capture both region-specific fixed effect as well as the heterogeneous nature of our sample.

In estimating the growth equation, we use the difference and system of Generalized method of Moments (GMM). These two estimators mitigate the endogeneity problems between the dependent and control variables. The difference GMM estimator differences the data and then uses lagged values of the endogenous variables as instruments. However, as pointed out by Arellano and Bover (1995), lagged levels are often poor instruments for first differences. Blundell and Bond (1998) proposed the system GMM estimator, which uses additional moment conditions for mitigating the poor instruments problem. Nevertheless, Roodman (2007) comments that the system estimator utilizes too many instruments resulting in overfitting

[9] The International Country Risk Guide (ICRG) states that such corruption is a threat to foreign investment for several reasons: it distorts the economic and financial environment; it reduces the efficiency of government and business by enabling people to assume positions of power through patronage rather than ability; and, last but not least, introduces an inherent instability into the political process (2013).

instrumented variables, failing to expunge their endogenous components and biasing coefficient estimates toward those from uninstrumented estimators. Roodman recommends using the two-step robust system GMM (2007). Thus, we report the estimations for both the difference and system estimators.

4.2. Data and Descriptive Statistic

For the purpose of this data, we utilize a panel data of 139 developing countries classified as low and middle income countries over the period of 1980 to 2010. The benefit of using a large sample of countries is to reduce sample selection bias, which occurs when countries graduate from one income group to another. We use three-year averages of all the variables for minimizing the effect of the business cycle. Hence, the paper utilizes 11 periods. Our data indicate that mean of the total stock of government debt is 16.23 % of their GDP (table 1). The growth rate is on average 5.4 %. Countries face a maximum interest payment of 1.63 %.

5. Results

The results of the benchmark regressions are reported in table (2). The difference and system GMM gives two different results. Comparing the p-values of the two test of autocorrelation, we find that the p-values of the system GMM are more robust than the ones from the difference GMM. Hence, the system GMM is our preferred estimator.

In the columns 5 through 8 of table (2), the outcomes of interest have their expected signs and are significant at the 1 percent level, hence supporting our hypothesis that these two types of financing are complements. The interaction term has a negative coefficient and is significant. The squared debt variable is negative and significant. Surprisingly, in the last column, where both the squared debt and interaction term are controlled, they both keep their significance and signs.

Overall, the other control variables have their expected signs. High level of trade and investment are growth enhancing whereas corruption and inflation negatively impact growth. The lagged of the growth variable is significant at the 1% level in all eight columns, indicating the persistence of growth. There is also evidence of convergence among countries through the negative sign and significance of initial GDP per capita, particularly in the system GMM.

We also perform two post-estimation tests for GMM: the two Arrelano and Bond tests: the $m-1$ and $m-2$ tests. The $m-1$test or the first-order serial correlation determines whether there is no-first order serial correlation in the residuals; whereas the $m-2$ test determines whether there is no-second order serial correlation in the residuals. According to Arrelano and

Bond (1991), the GMM estimator requires that there is first-order serial correlation ($m-1$ test) but no second-order serial correlation ($m-2$ test) in the residuals. This means that one needs to reject the null hypothesis in the $m-1$ test but to not reject the null hypothesis of the $m-1$ test. This is the case for us. We also report the number of instruments following Roodman (2009) who states that a high number of instruments can overfit the endogenous variables, hence failing to expunge their endogenous components and biasing estimators in the direction of OLS.

6. Robustness Check

6.1. Robustness check (1): Alternative measures for liquidity constraints

As alternatives to our proxy for liquidity constraints, we opt to use two other measures: debt services and interest payments.[10] We use these variables to test the robustness of the benchmark regression (table II and III). In table 2, the proxy for liquidity constraints, debt service; support our theoretical results. Indeed, debt service is negative and significant at the 5 percent level whereas foreign aid is positive and highly significant. The results in table 2 support the nonlinear relationship between growth and debt.

A different picture is depicted in table III. Interest payment is positive and highly significant whereas foreign aid is negative and significant except in the last column (4) where we control for all exogenous variables.

All other control variables have their expected signs. The p-values of the two correlations test are robust.

6.2. Robustness check (2): two subsamples: SSA and HIPC

Using two subsamples, i.e. SSA and HIPC, and two-step system GMM, we investigate whether our hypothesis hold for both SSA and HIPC countries.

The results of the growth equation are reported in table IV. The results are consistent with the benchmark results. The coefficients of the debt and foreign aid have opposite sings and are significant. There are evidences for the non-linear relationship for both the HIPC and SSA.

Overall, the regression results discussed above are robust across differences in specification and estimations, which support the basic premise of the theoretical model.

7. Conclusion

[10] See the definitions of these variables in table (1) in the appendix.

This paper investigates the interaction between foreign aid and borrowing constraints. Specifically, the goal of the paper is to examine whether relaxing recipient countries access to international credits markets complement foreign aid. The paper addresses this question theoretically and empirically.

Theoretically, we develop a model with two countries, two goods, and two periods model of international trade in which the donor's promise of disbursing aid in period 2 is conditioned on the recipient optimal tariff rate in period 1 and the recipient country is subject to liquidity constraints, which set a quantitative restriction on its demand for loans. The donor and the recipient participate in a series of games in which they alternatively play an active role. Within this framework, I consider a recipient active game and/or donor active or passive game. The games are further differentiated in simultaneous and/or sequential games.

In the empirical analysis, the paper focuses on low and middle income countries from 1980 to 2011. It uses panel data estimation techniques using a dynamic panel-data (DPD) model, which we estimate using the difference and system general method of moments (GMM). It further tests the robustness of our empirical results using alternative proxy for liquidity constraints or debt and 2 subsamples: Sub-Saharan African (SSA) and Heavily Indebted Poor Countries (HIPC).

Our empirical results support our theoretical hypothesis. Indeed, we find evidence that liquidity constraints and foreign aid are complements. That is where debt reduces growth, foreign aid enhances it. We further test this by including an interaction term of the debt proxy and foreign aid in our empirical model. The results further support the above conclusion. Our empirical results are robust.

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Table I: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ltrade	1293	1.810444	0.267015	-0.98744	2.560028
lsecondary	1151	1.512976	0.379269	0.241271	2.093348
lgrowth	1139	0.546337	0.537938	-13.1204	1.681685
linitgdppc	1474	3.044299	0.437056	2.19607	4.023089
linflat	1124	0.936549	0.563344	-2.24528	3.998393
ldebtservice	1163	0.433443	0.445717	-2.97114	1.872581
lextdebt_tot	1164	1.623263	0.369543	-0.50541	3.258953
lintpayments	1163	-0.00296	0.426148	-2.97114	1.638031
linvest	943	1.312094	0.200205	0.332775	1.928841
loda	1016	0.54286	0.791332	-3.16162	1.906212
lcorr	1558	0.213669	0.227026	0	0.888889

Table II: Benchmark Regressions

VARIABLES	Difference GMM				System GMM			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lextdebt_tot	0.189	-0.145	-0.825	-0.368	-0.406***	-0.456***	-1.116***	-2.470***
	(0.433)	(0.657)	(0.401)	(0.724)	(0.000)	(0.000)	(0.000)	(0.000)
loda	0.316***	-0.275	0.295***	-0.327	0.133***	0.192***	0.123***	0.138***
	(0.000)	(0.510)	(0.001)	(0.522)	(0.000)	(0.000)	(0.000)	(0.000)
linvest	1.034***	1.084***	1.135***	1.070***	0.719***	0.618***	0.712***	0.582***
	(0.002)	(0.001)	(0.002)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)
ltrade	-0.051	0.067	-0.015	0.076	-0.068	-0.026	-0.131**	0.038
	(0.864)	(0.814)	(0.959)	(0.795)	(0.123)	(0.612)	(0.025)	(0.325)
linflat	-0.400***	-0.401***	-0.401***	-0.400***	0.009	0.063***	0.015	0.061***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.217)	(0.000)	(0.109)	(0.000)
lcorr	0.428***	0.465***	0.381**	0.447***	-0.015	-0.110***	-0.013	0.023
	(0.007)	(0.003)	(0.011)	(0.005)	(0.696)	(0.000)	(0.703)	(0.514)
lsecondary	-0.004	-0.049	-0.028	-0.058	0.087***	0.122***	0.095***	0.113***
	(0.971)	(0.635)	(0.776)	(0.564)	(0.000)	(0.000)	(0.000)	(0.000)
linitgdppc	-8.791***	-7.449**	-9.656***	-7.871**	-0.104***	-0.243***	-0.164***	-0.303***
	(0.000)	(0.028)	(0.000)	(0.021)	(0.002)	(0.000)	(0.000)	(0.000)
L.lgrowth	-0.650***	-0.645***	-0.672***	-0.647***	-0.304***	-0.299***	-0.246***	-0.269***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
int1		0.337		0.362		-0.505***		-0.521***
		(0.122)		(0.207)		(0.000)		(0.000)
debt2			0.297	0.055			0.124*	0.606***
			(0.281)	(0.873)			(0.062)	(0.000)
Constant	25.607***	21.898**	28.851***	23.389**	0.920***	1.063***	1.355***	2.427***
	(0.000)	(0.029)	(0.000)	(0.021)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	427	427	427	427	270	270	270	270
Number of ID	100	100	100	100	85	85	85	85
m-1 test	0.2382	0.1739	0.2435	0.1712	0.0917	0.0857	0.0772	0.0796
m-2 test	0.1873	0.1696	0.1880	0.1760	0.4877	0.2341	0.5077	0.2396

Notes: pval in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table III: Robustness Check: Debt Services

	System GMM			
VARIABLES	(1)	(2)	(3)	(4)
ldebtservice	-0.307***	-0.216***	-0.281***	-0.214***
	(0.000)	(0.000)	(0.000)	(0.000)
loda	0.112***	0.146***	0.093***	0.138***
	(0.000)	(0.000)	(0.000)	(0.000)
linvest	0.686***	0.568***	0.700***	0.507***
	(0.000)	(0.000)	(0.000)	(0.000)
ltrade	0.044	0.080	0.075	0.038
	(0.420)	(0.161)	(0.171)	(0.552)
linflat	-0.027***	-0.049***	-0.028***	-0.033***
	(0.000)	(0.000)	(0.000)	(0.000)
lcorr	-0.106*	-0.123***	-0.088***	-0.201***
	(0.055)	(0.001)	(0.003)	(0.000)
lsecondary	0.161***	0.168***	0.148***	0.179***
	(0.000)	(0.000)	(0.000)	(0.000)
linitgdppc	0.038	-0.100**	0.006	-0.096**
	(0.406)	(0.016)	(0.865)	(0.012)
L.lgrowth	-0.232***	-0.164***	-0.222***	-0.164***
	(0.000)	(0.000)	(0.000)	(0.000)
debtservice2			-0.162***	-0.075
			(0.003)	(0.214)
int2		0.079***		-0.024
		(0.007)		(0.565)
Constant	-0.477***	-0.074	-0.206**	0.213
	(0.000)	(0.459)	(0.033)	(0.188)
Observations	270	270	270	270
Number of ID	85	85	85	85
m-1 test	0.0529	0.0528	0.0560	0.0426
m-2 test	0.7334	0.6633	0.6769	0.7834

Notes: pval in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table III: Robustness Check: Interest Payments

	System GMM			
VARIABLES	(1)	(2)	(3)	(4)
lintpayments	-0.257***	-0.230***	-0.388***	-0.233***
	(0.000)	(0.000)	(0.000)	(0.000)
loda	0.134***	0.147***	0.114***	0.126***
	(0.000)	(0.000)	(0.000)	(0.000)
linvest	0.675***	0.612***	0.693***	0.502***
	(0.000)	(0.000)	(0.000)	(0.000)
ltrade	0.023	-0.013	-0.051	-0.044
	(0.608)	(0.811)	(0.287)	(0.407)
linflat	-0.032***	-0.040***	-0.019**	-0.026***
	(0.000)	(0.000)	(0.014)	(0.000)
lcorr	-0.040	-0.159***	-0.066	-0.142***
	(0.426)	(0.000)	(0.162)	(0.000)
lsecondary	0.202***	0.210***	0.209***	0.208***
	(0.000)	(0.000)	(0.000)	(0.000)
linitgdppc	-0.017	-0.027	0.019	-0.061
	(0.639)	(0.541)	(0.687)	(0.380)
L.lgrowth	-0.238***	-0.199***	-0.219***	-0.183***
	(0.000)	(0.000)	(0.000)	(0.000)
int3		-0.189***		-0.198***
		(0.000)		(0.000)
intpayments2			0.059	0.015
			(0.220)	(0.842)
Constant	-0.466***	-0.358***	-0.480***	-0.070
	(0.000)	(0.000)	(0.005)	(0.707)
Observations	270	270	270	270
Number of ID	85	85	85	85

Notes: pval in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table IV: Robustness Check: SSA and HIPC

	SSA			HIPC		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
lextdebt_tot	-0.451***	-1.280***	-2.400***	-0.520***	-1.076***	-2.610***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
loda	0.733***	-0.084***	0.641***	0.600***	-0.090***	0.733***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
linvest	0.595***	0.679***	0.498***	0.564***	0.731***	0.648***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ltrade	-0.074	-0.045	-0.015	-0.016	-0.094*	-0.005
	(0.119)	(0.427)	(0.724)	(0.718)	(0.096)	(0.888)
lsecondary	0.066***	-0.005	0.057***	0.062***	0.003	0.054***
	(0.000)	(0.543)	(0.000)	(0.000)	(0.804)	(0.000)
linflat	-0.117***	-0.022	-0.021	-0.133***	-0.042	-0.002
	(0.005)	(0.530)	(0.603)	(0.000)	(0.218)	(0.965)
lcorr	0.118***	0.072***	0.118***	0.159***	0.054**	0.127***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.025)	(0.000)
linitgdppc	-0.232***	-0.152***	-0.281***	-0.274***	-0.131***	-0.266***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.lgrowth	-0.309***	-0.263***	-0.263***	-0.460***	0.094	-0.550***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.420)	(0.000)
debt2	-0.547***		-0.497***	-0.294***	-0.251***	-0.264***
	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
int1		0.190***	0.602***		0.126**	0.675***
		(0.001)	(0.000)		(0.022)	(0.000)
Constant	1.081***	1.427***	2.449***	1.267***	1.293***	2.456***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	270	270	270	270	270	270
Number of ID	85	85	85	85	85	85

Notes: pval in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix

Table1: Definitions and data sources

Variable	Definitions and Measures	Sources
Investment		WEO
Trade		
Secondary Enrolment		
Growth		
GDP per capita		
Initial GDP per capita		
Inflation		
Debt service		
Interest payment		
Corruption (normalized)		ICRG

Appendix 1

1. $$\frac{\partial U^R}{\partial \alpha} = \frac{(1+\tau)(Z-\bar{B}-\tau p\varepsilon_c E_1)}{E(1+r)[(1+\tau-\tau c_Y^1)(Z+\bar{B}+\tau p\varepsilon_c E_1)+(1+\tau c_Y^2)(\bar{B}+\tau p\varepsilon_c E_1)]} = A > 0$$

$$\frac{\partial U^R}{\partial \beta} = \frac{-\tau(1+\tau)(Z-\bar{B}-\tau p\varepsilon_c E_1)}{E(1+r)[(1+\tau-\tau c_Y^1)(Z+\bar{B}+\tau p\varepsilon_c E_1)+(1+\tau c_Y^2)(\bar{B}+\tau p\varepsilon_c E_1)]} = -\tau A < 0$$

The two equations above are the partial derivative of the recipient utility with the two donor's policy instruments and per se are the income effect of an increase foreign aid on the recipient utility.

2. $$g_\beta = \tau(1+r)V''E_5[(1+\tau-\tau c_Y^1)(Z+\bar{B}+\tau p\varepsilon_c E_1)+(1+\tau c_Y^2)(\bar{B}+\tau p\varepsilon_c E_1)]$$

$$-\tau^2 p\varepsilon_c(1+r)B[(1+\tau-\tau c_Y^1)V'+(1+\tau c_Y^2)]-\mu\tau^3(1+\tau)(1+\gamma)p\varepsilon_c E_{15}A \Rightarrow g_\beta < 0$$

$$g_\alpha = -\tau(1+r)V''E_5[(1+\tau-\tau c_Y^1)(Z+\bar{B}+\tau p\varepsilon_c E_1)+(1+\tau c_Y^2)(\bar{B}+\tau p\varepsilon_c E_1)]$$

$$+\tau p\varepsilon_c(1+r)V'B[(1+\tau-\tau c_Y^1)+\tau(1+\tau c_Y^2)]-\mu\tau^2(1+\tau)(1+\gamma)p\varepsilon_c E_{15}A \Rightarrow g_\alpha > 0$$

where $B = A(E_{55}E_1 + E_5E_{15}) \Rightarrow B > 0$

$$g_\tau = -\tau(1+r)V'E_5(Z+\bar{B}+\tau p\varepsilon_c E_1)(1+\tau)(1-c_Y^1) - \tau(1+r)V'E_5(\bar{B}+\tau p\varepsilon_c E_1)(1+2\tau c_Y^2)$$
$$+\tau(1+r)V''E_5[(1+\tau-\tau c_Y^1)(Z+\bar{B}+\tau p\varepsilon_c E_1)+(1+\tau c_Y^2)(\bar{B}+\tau p\varepsilon_c E_1)]$$
$$+\tau^3(1+r)p^2V'\varepsilon_c E_5 E_{11}[(1+\tau-\tau c_Y^1)+(1+\tau c_Y^2)]+\mu\tau^2(1+\tau)(1+\gamma)p\varepsilon_c E_{11}$$
$$+\tau(1+r)pV'\varepsilon_c E_1[E_5+\tau pE_{51}]+\mu\tau(1+\tau)(1+\gamma)p\varepsilon_c E_1 \Rightarrow g_\tau < 0 \text{ if } -1<\varepsilon_c<0.$$