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## Debt Relief: The Day After, Financing Low-Income Countries

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# Debt Relief: The Day After, Financing Low-Income Countries

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#### **Abstract:**

In this paper, we investigate the factors of external public indebtedness for Low-Income Countries (LICs) and, as a modeling technique, we employ the iterative Bayesian shrinkage procedure to handle the differences between countries in panel data. Some LICs have benefited from two debt relief programs, the Heavily Indebted Poor Countries (HIPC) initiatives and the Multilateral Debt Relief Initiative (MDRI). We explore whether these debt reductions affect the access to external financing and credit markets of HIPCs. First, our estimation method highlights various debt dynamics across LICs from 1988 to 2018. Second, our results highlight a change in the relationships between external public indebtedness and its factors after the HIPC and MDRI. Unlike past debt reductions, most HIPCs keep borrowing, mainly from private creditors, even if the debt-to-GDP ratio increases. HIPCs' access to credit markets does not suffer from a potential risk-aversion on the part of lenders, and is facilitated by their attractiveness to private investors.

**Keywords:** Debt Relief; External financing; Low-Income Countries; Bayesian shrinkage estimator

JEL classification: F34; H63; O16; O38

## Introduction

In 2018, the IMF and the World Bank warned that The Gambia, Mozambique and Sao Tome and Principe<sup>1</sup> were at risk of external and public debt distress.<sup>2</sup> These countries benefited from the Heavily Indebted Poor Countries (HIPC) initiative, launched by the IMF and World Bank in 1996, to resolve the debt problems of low-income countries (LICs) that had been observed since the 1980s. Under these initiatives, eligible LICs were able to write off their debts. These first warnings of the external public debt vulnerabilities of LICs were heightened by the COVID crisis. This led the G20 members to introduce the Debt Service Suspension Initiative (DSSI) in April 2020. This initiative temporarily suspended the debt service payments on the 2020 and 2021 debt maturities for LICs.<sup>3</sup> Among the 23 countries that applied for the DSSI, only 4 countries had not taken part in the debt relief initiatives launched two decades earlier.

Theoretically, the HIPC initiative, complemented by the Multilateral Debt Relief Initiative (MDRI) in 2005, was intended to create a "fiscal space" through debt relief and thus allow LICs to allocate more public and social expenditure. However, some economists such as Easterly (2002) or Romero-Barrutieta, Bulir and Rodríguez-Delgado (2015) stressed the risk of moral hazard for governments that benefited from debt reduction. For Easterly (2002, p.1683): "debt relief will be met with an equivalent amount of new borrowing". The official and private creditors can sanction HIPCs, or to a lesser extent, be reluctant to lend to them. Thus, while it can be more difficult for them to borrow again after the debt relief, these countries have returned to sustainable debt levels (and therefore regained their capacity to borrow) thanks to the debt

<sup>&</sup>lt;sup>1</sup> See "The Gambia: Second Review Under the Staff-Monitored Program - Press Release and Staff Report for The Gambia, June 28, 2018"; "São Tomé and Príncipe: Debt Sustainability Analysis April 14, 2018".

 $<sup>^2</sup>$  In 2005, the IMF and the World Bank implemented the Debt Sustainability Framework, which assesses external and public debt. It compares debt levels to guideline thresholds over a 20-year projection period. These analyses integrate vulnerability to exogenous shocks, or the quality of the country's institutions. The risk of debt distress can be low, moderate, high or confirmed.

<sup>&</sup>lt;sup>3</sup> See International Monetary Fund and the World Bank. "Joint IMF-WBG Staff Note: Implementation and Extension of the Debt Service Suspension Initiative".

relief initiatives. Moreover, some emerging countries may be interested to lend to HIPCs for economic and political benefits. In the same way, private creditors can also be attracted by the profits from lending to these risky sovereigns, especially following the interest rate decreases in developed countries.

From this evidence, what are the implications of the debt relief initiatives for the subsequent re-indebtedness of HIPCs? In order to answer this question, we propose to explore the relationship between external financing factors and the external public debt of LICs before and after debt relief initiatives, country-by-country.

From the *demand-side* point of view, an economic recession can increase the need for external financing and for supplementing (or substituting) the debt with the grants generally received by the least developed countries. Since HIPCs expect new debt relief initiatives, the moral hazard tends to increase their indebtedness especially if they have to finance their economic development.

From the *supply-side* point of view, the impacts of the HIPC initiative on the external financing factors are ambiguous. Some creditors can restrict the amounts they lend to HIPC governments because of the risk of moral hazard, while other creditors can be attracted to these risky sovereigns. Official and private creditors need to be more careful about the economic outlook of LICs and hence their repayment abilities. From this point of view, the ratios of initial external public debt to GDP and external public debt service to GDP are particularly monitored by private creditors as well as by official creditors who are members of the Development Assistance Committee (DAC). When the external public debt of LICs becomes high, the creditors anticipate debt-servicing difficulties and would then be less inclined to finance these countries.

Only a few papers in the empirical literature focus on the effects of the HIPC and MDRI initiatives on the external public debt. The most recent paper (Ferry, Raffinot and Venet, 2021)

focuses on the financing conditions of HIPCs after the debt cancellations. They show that HIPCs do not access credit markets at higher costs than other LICs. Bunte (2018) looks at the lending strategies of official creditors to countries concerned by debt relief. He shows that creditor governments in small economies can lend to these risky sovereigns in order to become closer economically and politically. However, Bunte finds no empirical evidence of this strategy for large economies such as China or India.

Depending on the country, the HIPC and MDRI initiatives ended between 2005 and 2012. As the period is too short for the later ones, we will consider only the countries who reached the HIPC "completion point" in 2005. In addition, LICs are heterogenous in terms of economic development, size, commercial integration, geographical characteristics, past debt cancellations, etc. This heterogeneity increases the difficulty of implementing a robust empirical strategy.

In order to handle the differences between countries, we use the Bayesian shrinkage estimator to estimate the relationships between LIC external public debt and its factors, country-by-country. As far as we know, there is no empirical study that explores the relationships between external financing factors and the external public debt for LICs, much less country-by-country. The shrinkage estimator gives sounder results for panel data than the two other estimation methods, of either pooling the data or obtaining separate estimates for each cross-section, which are based on extreme assumptions (cross-sectional homogeneity and heterogeneity of slope coefficients). According to Maddala et al. (1997, p.91), "the truth probably lies somewhere in between. The parameters are not exactly the same, but there is some similarity between them". In this framework, we propose to investigate the debt dynamics or three types of countries: 1) countries that have benefited from debt reduction initiatives (HIPCs). 2) Low-income countries considered as highly indebted according to IMF and World Bank debt ratios (non-HIPC highly indebted countries). 3) Low-income or lower-middle-income African countries with similar

economic characteristics to HIPCs (African non-HIPCs). Our study covers the time period from 1988 to 2018 for 27 low- and lower-middle-income countries, as classified by the World Bank. The rest of this paper is organized as follows. Section 1 describes the characteristics of the external financing of LICs since 1990 and the possible impacts of debt relief initiatives on their financing. Section 2 explains the data and our empirical strategy. Section 3 presents our results. Section 4 concludes.

#### Section 1 Debt Relief and Financing Low-Income Countries

Under the enhanced HIPC initiative (1999), external debt is defined as unsustainable when the ratio of the stock of public debt (in present value terms) exceeds 150% of the value of exports and 250% of fiscal revenues.<sup>4</sup> The HIPC initiative was supplemented by the Multilateral Debt Relief Initiative<sup>5</sup> (MDRI) in 2005. Between 2000 and 2014, the initiatives allowed the cancellation of nearly USD 126 billion of debt (in nominal value) by the international financial community, including USD 99 billion for African countries (IMF, 2014). The HIPCs obtained debt relief under certain conditions: (*i*) they were eligible for International Development Association (IDA) loans; (*ii*) they had an unsustainable level of debt (as defined by the IMF); (*iiii*) they had successfully completed the programs supported by the World Bank and the IMF for at least three years; (*iv*) they had to implement Poverty Reduction Strategy Papers (PRSPs). These conditions allowed HIPCs to reach the "decision point" of the initiative and to benefit from debt reductions. When the "completion point" was reached, the HIPCs were able to obtain the reductions (determined at the "decision point") on the stock of external public debt. At the

<sup>&</sup>lt;sup>4</sup> Initially, external debt was sustainable if the stock of debt (net present value) did not exceed 250% of exports and 280% of fiscal revenues, and if debt services were below 25% of exports. In the enhanced HIPC initiative, the thresholds were set at 150% of exports and 250% of fiscal revenues, and at 15% of exports for debt services.

<sup>&</sup>lt;sup>5</sup> Countries who reached the completion point under the HIPC initiative benefited from write-offs on the claims of multilateral institutions (the IMF, the World Bank, and the African Development Fund).

end of the process, the MDRI concluded the HIPC initiative with further cancellations on the remaining debt stock, without conditions.<sup>6</sup>

Of the 42 countries considered for the initiative, 39 were eligible for debt relief (though Somalia, Sudan and Eritrea had not yet reached the "decision point"). The HIPC initiative is based on a theoretical assumption called "debt overhang". A debtor government dedicates a large share of its revenues to service its debt (Krugman, 1988). Debt overhang refers to countries' difficulties to service the debt because of an important debt burden.<sup>7</sup> The government is no longer motivated to invest, implement reforms or even repay the debt and therefore decides to default. Investors expect that the government will tax the production to service the debt with inflationary tax. In other words, if the debt exceeds debtor's capacity to repay, then the debt service is a positive function of the production. This can affect the economic activity and thus reduce the debtor's capacity to repay the public debt. Partial debt cancellations reduce the debt service repayments on the government budget (Sachs, 1989) and help to free up resources to finance investment expenditures.<sup>8</sup> Moreover, debt relief enables creditors to avoid crises, which would be costly for their investors (Copelovitch, 2010).

The impacts of debt relief on the external financing of HIPCs are difficult to predict. On the one hand, negative signals from countries that get debt cancellations may be sent to creditors. Easterly (2002) highlights the risk of moral hazard for governments that have been granted debt relief. An expectation of new debt relief in the future can cause an excessive indebtedness (Romero-Barrutieta et al., 2015). Chauvin and Kraay (2007) show that the debt reductions are not primarily motivated by countries' heavy debt burdens, but rather driven by their "persistent

<sup>&</sup>lt;sup>6</sup> Except the condition to reach the completion point under the HIPC initiative (such as a good application of PRSP). These additional cancellations on multilateral debt should help countries release resources to achieve the Sustainable Development Goals (United Nations).

<sup>&</sup>lt;sup>7</sup> A significant debt burden may dissuade domestic and foreign investors who fear an increase in taxation or even capital outflows (Claessens and Diwan, 1990). High debt can also lead to a credit rationing with detrimental effects on domestic investment (Borensztein, 1990).

<sup>&</sup>lt;sup>8</sup> Of course, to release a "fiscal space", it is required that the debtor government repaid its previous debts prior to the debt relief, and that the country moves from a situation of debt distress to a sustainable level of debt (see Cassimon et al., 2015; Ferry and Raffinot, 2019).

characteristics". If the initiatives do not change these "characteristics", these countries will continue to borrow as much as before. The repeated cycles of debt cancellation could never end. Moreover, debt relief sends similar signals to markets as those following sovereign defaults.<sup>9</sup> Consequently, the creditors may be more vigilant about the sustainability of the external debt.

On the other hand, these countries have recovered their ability to borrow thanks to debt reductions but are now considered risky sovereigns. After the HIPC and MDRI initiatives, most LICs, especially in Africa, are regaining (or accessing for the first time) global capital markets after being excluded for decades. This return to the credit markets enables LICs to issue sovereign bonds which attract international investors in search of high returns (Tyson et al., 2014), especially since the 2008 crisis, because interest rates have reached historically low levels in developed countries. Figure A.1. in the Appendix shows the increasing share of private creditors (foreign private and commercial banks and other private creditors) in the external public debt of HIPC countries since 2010. The issuance of sovereign bonds by developing countries provides them with some benefits compared to other sources of financing (loans or grants): sovereign bonds are not subject to any conditions from international financial institutions, and large amounts of funding can be obtained quickly to finance large-scale investment projects<sup>10</sup> (Te Velde, 2014; Tyson, Te Velde and Burke, 2014). Nevertheless, debt relief initiatives have raised the costs of financing for HIPCs, especially from foreign banks (Ferry et al., 2021).

<sup>&</sup>lt;sup>9</sup> Gelos et al. (2011) show that in the recent period a defaulting country takes on average 3 years to regain access to international markets. Cruces and Trebesch (2013) highlight a slower re-access to the markets for countries that have caused significant "haircuts". We can assume a complicated return to the markets for HIPCs.

<sup>&</sup>lt;sup>10</sup> Sovereign bonds are used to implement monetary policy but also for fiscal management purposes, including financing current and social or capital expenditure. For example, in 2014, sovereign bonds were used to finance electrification projects in Ethiopia, Senegal and Zambia. Cote d'Ivoire has issued bonds to finance public spending on education and health (IMF, 2014).

Since 2007, new official creditors (such as Brazil, Russia, India and China) contribute to the external debt of developing countries. The development aid policies<sup>11</sup> of these countries differ from those of bilateral creditors who are members of the DAC. While the latter are required to "peer review" their aid policies, the BRICs are not subject to DAC principles because they have not signed the Paris Declaration (Ben Artzi, 2017). These countries see potential gains in political influence by lending to more "risky" countries (Bunte, 2018; Bunte and Kinne, 2017). For all these reasons, access to credit markets is more difficult for HIPCs than for other LICs. Nevertheless, new interest-driven creditors have an increasing share of their public debt. Moreover, through debt relief, LICs have recovered their capacity to borrow and need to finance their development within the sustainable goals framework. This leads us to speculate about the impact of debt relief initiatives on the re-indebtedness of HIPC low-income countries. Have the relationships between the drivers of supply and demand of external financing and the indebtedness of LICs changed after the HIPC initiatives? In the following section, we present the data used to explore these relationships for LICs through panel analysis.

## Section 2 Empirical analysis

#### 2.1 Data

The data for outstanding external public and publicly guaranteed debt (in current USD) in total and from official and private creditors, average interest rates on new borrowing, public debt service amounts and debt reduction amounts are taken from the International Debt Statistics (World Bank, 2020). Furthermore, data for GDP in current USD, real GDP growth rate, and grants received are taken from the World Development Indicators (World Bank, 2020). In order to calculate the annual variation of the stock of external public debt relative to GDP by creditor

<sup>&</sup>lt;sup>11</sup> Traditional funders are focused on a long-term vision and consider the international financial institutions' macroeconomic forecasts or debt sustainability threshold. The BRICs, on the other hand, focus on the microeconomic benefits of debt-financed development projects. Therefore, the creditors do not share the same concept of debt sustainability.

and thus measure the indebtedness of LICs (dependent variable in our study), we selected the outstanding external public and publicly guaranteed debt (in current USD) in total and from official and private creditors, and the gross domestic product (in current USD). In order to capture the *supply and demand drivers* of external financing, we selected the real GDP growth rate, the grants received by LICs from international organizations or foreign governments, the average interest rates on new external borrowing, and the total public and publicly guaranteed debt service amounts.

The following indicators are the explanatory variables for the variation of external public debt in our study: (*i*) the ratio of external public debt to GDP, (*ii*) the difference between the interest rate on new external borrowing and the real GDP growth rate, (*iii*) the ratio of grants received from international organizations or foreign states to GDP, (*iv*) the ratio of external public debt service to GDP. All data are annual, cover the period from 1988 to 2018 and concern 27 countries:

1) The countries that have benefited from the HIPC initiatives: Benin (BEN), Burkina Faso (BFA), Ethiopia (ETH), Ghana (GHA), Guyana (GUY), Honduras (HND), Madagascar (MDG), Nicaragua (NIC), Rwanda (RWA), Senegal (SEN), Sierra Leone (SLE), Tanzania (TZA), Uganda (UGA), Zambia (ZMB). Moreover, we chose only HIPCs who reached the HIPC "completion point" early and benefited from the MDRI from 2005 (see Table A.1. in the Appendix). This allows us to have a longer time horizon and to observe a potential re-indebtedness trend.

2) The second set of countries is formed by Bangladesh (BGD), Bhutan (BTN), Laos (LAO), Indonesia (IDN), Nepal (NPL), Pakistan (PAK) and Sudan (SDN). These countries are relatively comparable to HIPCs although they did not benefit from debt relief (non-HIPC highly indebted countries). The World Bank classified these countries as LICs for at least three years before the HIPC initiative and with an external public debt stock (in nominal terms) exceeding 150% of its exports in the five years preceding the HIPC "decision point".

3) The last group includes African non-HIPCs such as Botswana (BWA), Cape Verde (CPV), Eswatini (SWA), Kenya (KEN), Lesotho (LSO), Zimbabwe (ZWE). These countries are classified by the World Bank as low- or lower middle-income (LMICs) and share economic characteristics, geographical position, size or trade integration with HIPCs.

Figure A.2. in the Appendix shows that the average external public debt of HIPCs has been approaching that of the other countries since 2006, that is, when HIPCs were granted debt relief through the MDRI. We also can observe this dynamic for external public debt from both official and private creditors (see Figure A.3. in the Appendix). This is accentuated for external public debt from private creditors since 2009, in particular following the implementation of accommodative monetary policies in developed countries. In order to give an overview of the levels of external public debt of the countries, Table A.2. in the Appendix gives some descriptive statistics. Using this data, we investigate the relationship between external public indebtedness and its different explanatory factors. In the following section, we first specify the models to be estimated. Then, we present the Bayesian iterative method used to estimate the country-specific relationships for these LICs, considering the heterogeneity in the panel.

#### 2.2 Models to be estimated

In order to investigate these relationships, we separately estimate three equations:

$$\Delta Y_{it} = c_i + \alpha_i \cdot Y_{it-1} + \beta_i \cdot DIF_{it-1} + \gamma_i \cdot G_{it-1} + \varepsilon_{it}$$
(1)

$$\Delta Y_{it} = c_i + \alpha_i \cdot Y_{it-1} + \delta_i \cdot R_{it-1} + \gamma_i \cdot G_{it-1} + \mathcal{E}_{it}$$
(2)

$$\Delta Y_{it} = c_i + \varphi_i \cdot S_{it-1} + \beta_i \cdot DIF_{it-1} + \gamma_i \cdot G_{it-1} + \varepsilon_{it}$$
(3)

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where  $\Delta Y_{it}$  is the annual change in the ratio of external public debt-to-GDP by country *i* and year *t*;  $c_i$  and  $\mathcal{E}_{it}$  are the constant and the error terms respectively. These three separately estimated equations let us to show a link between  $\Delta Y_{it}$  and the various external financing factors.

On the demand side, debtors need to finance their economic development projects or public expenditure. Consequently, we approximate the economic performance of countries by the annual growth rate of real GDP (variable R\_1). Even if the external financing potentially offsets a decrease in a country's assets (Easterly, 2002), the higher GDP growth can reassure investors and creditors about its ability to service the debt. Indeed, the LICs have large financing needs and are therefore dependent on foreign financing. Moreover, they can obtain alternative sources of external financing for public debt: the ratio of grants received from international organizations or foreign states to GDP (variable G\_1).

On the supply side, creditors (official or private) are particularly aware of the existing outstanding external public debt. To this end, we include the ratio of external public debt to GDP (variable  $Y_1$ ) in the explanatory variables. A high level of public debt can reduce a government's ability to service its debt, as mentioned earlier with the "debt overhang". The "debt Laffer curve" puts forward the idea that at a certain level of indebtedness, investors expect that the debt will not be entirely repaid (Krugman, 1988; Sachs, 1989). It suggests that at a high level of external public debt, creditors will be increasingly skeptical about lending to developing countries. Therefore, we consider the ratio of public debt service to GDP (variable  $S_1$ ) in our analysis, because creditors also monitor the country's ability to repay in the short term.

Finally, the difference between the interest rate on new borrowing and the real GDP growth rate (variable DIF\_1) makes it possible to assess the sustainability of a country's public debt. If the country is indebted at interest rates higher than its growth rate, then the debt ratio follows

an unsustainable path. The explanatory variables are all lagged to avoid reversing causality between  $\Delta Y_{it}$  and the various external financing factors.

#### 2.3 The Empirical Iterative Bayes estimator

In view of the above, we propose to apply the Empirical Iterative Bayes estimator suggested by Maddala et al. (1997) since it provides a heterogeneous (country-by-country) estimation of these relationships and makes it possible to establish a classification of countries according to their external public debt patterns. As Maddala et al. (1997) argued, in panel analysis, the problem with the two usual estimation methods of either pooling the data, or obtaining separate estimates for each cross-section is that both are based on extreme assumptions. If the data are pooled, it is assumed that the parameters are all the same. On the other hand, if separate estimates are obtained for each country, it is assumed that the parameters are all different. The truth probably lies somewhere in between. The parameters are not exactly the same, but there are some similarities between them. One way of allowing for the similarities is to assume that all the parameters come from a joint distribution with a common mean and a nonzero covariance matrix. The authors argued that the resulting parameter estimates will be a weighted average of the overall pooled estimate and the separate time series estimates based on each cross-section. Thus, each cross-section estimate is "shrunk" toward the overall pooled estimate (i.e., "shrinkage estimator"). In this way, the solution relies on the use of a random-coefficient model in which the parameters are assumed to come from a common distribution.

According to Maddala et al. (1997), the shrinkage estimator should be preferred if the model contains lagged endogenous variables (as it is the case in the dynamic models) because it gives much more reasonable parameter values than the heterogeneous estimators. Similarly, Hsiao (2003) and Hsiao et al. (1999) confirmed that, firstly, when the time-series dimension of panel sets is large, heterogeneous estimators are more appropriate from an econometric point of view,

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and secondly, in the case of panel data models with coefficient heterogeneity, the Bayesian approach performs fairly well, even when the time dimension is small. This view has been shared by several other authors (Jobert et al., 2010, 2019). For instance, Maddala and Hu (1996) have presented some Monte Carlo evidence to suggest that the iterative procedure gives better estimates for panel data models. Trapani and Urga (2009) also show, via a series of Monte Carlo simulations, that when the level of heterogeneity is high, the shrinkage/Bayesian estimators should be preferred. To conclude, in the Bayesian framework, the panel data models raise different issues from those in individual time series, such as a correct consideration of homogeneity/heterogeneity between countries. This is the reason why the Bayesian approach can be considered as an alternative estimation method, capturing cross-sectional heterogeneity in the external public debt relationships.

Let us consider the Bayesian approach to Eqs. (1)-(3), which can be rewritten in the framework of the random-coefficients model, with the following specification:

$$y_i = X_i \gamma_i + u_i \tag{4}$$

where  $y_i$  contains the annual change in the ratio of external public debt to GDP time series, X is the matrix with explanatory variables, and  $\gamma_i$  are slope coefficients. In the Bayesian framework, the *prior* distribution of  $\gamma_i$  is given by:  $\gamma_i \sim N(\mu, \Sigma)$  where the parameters  $\mu$  (mean of  $\gamma_i$ ),  $\Sigma$  (variance of  $\gamma_i$ ) and  $\sigma_i^2$  (residual variance) are unknown. That is why some assumptions have to be made on *prior* specification of these parameters. Then we can derive the *posterior* distribution for the parameters,  $\gamma_i$ . On the other hand, if  $\mu$ ,  $\Sigma$  and  $\sigma_i^2$  are all known, the *posterior* distribution of  $\gamma_i$  is normal and calculated by:

$$\gamma_{i} *= \left[\frac{1}{\sigma_{i}^{*2}} X_{i} X_{i} + \Sigma^{*-1}\right]^{-1} \left[\frac{1}{\sigma_{i}^{*2}} X_{i} X_{i} \hat{\gamma}_{i} + \Sigma^{*-1} \mu^{*}\right]$$
(5)

where  $\hat{\gamma}_i$  is the ordinary least squares (OLS) estimator of  $\gamma_i$ . The *posterior* distribution of mean  $\gamma_i$  and its variance are shown in Eqs. (5) and (6) respectively.

$$\mu^{*} = \frac{1}{N} \sum_{i=1}^{N} \gamma_{i}^{*}$$
(6)

$$V[\gamma_{i}^{*}] = \left[\frac{1}{\sigma_{i}^{*2}} X_{i}^{'} X_{i} + \Sigma^{*-1}\right]^{-1}$$
(7)

Since in general,  $\Sigma$  and  $\sigma_i^2$  are unknown parameters, one needs to specify priors for them. For this purpose, Smith (1973) suggested using the mode of the joint posterior distribution given by the following equations:

$$\sigma^{*2}_{i} = \frac{1}{T + \varsigma_{i} + 2} \left[ \varsigma_{i} \lambda_{i} + (y_{i} - X_{i} \gamma_{i}^{*})'(y_{i} - X_{i} \gamma_{i}^{*}) \right]$$

$$\tag{8}$$

and

$$\Sigma^{*} = \frac{1}{T - k - 2 + \delta} \left[ R + \sum_{i=1}^{N} (\gamma_{i} * - \mu^{*}) (\gamma_{i} * - \mu^{*})' \right]$$
(9)

where the parameters  $\zeta_i$ ,  $\lambda_i$ ,  $\delta$  and R arise from the specification of the prior distributions. Moreover, Smith (1973) proposed the approximation of these parameters by setting  $\zeta_i = 0$ ,  $\delta = 1$ and R as a diagonal matrix with small positive entries (e.g., 0.001). By doing so, the estimators take the following forms:

$$\sigma_{i}^{*2} = \frac{1}{T+2} \left[ (y_i - X_i \gamma_i^*)' (y_i - X_i \gamma_i^*) \right]$$
(10)

$$\Sigma^{*} = \frac{1}{T - k - 1} \left[ R + \sum_{i=1}^{N} (\gamma_{i}^{*} - \mu^{*}) (\gamma_{i}^{*} - \mu^{*})' \right]$$
(11)

$$\gamma_{i} *= \left[\frac{1}{\sigma_{i}^{*2}} X_{i}' X_{i} + \Sigma^{*-1}\right]^{-1} \left[\frac{1}{\sigma_{i}^{*2}} X_{i}' X_{i} \hat{\gamma}_{i} + \Sigma^{*-1} \mu^{*}\right]$$
(12)

and

$$\mu^{*} = \frac{1}{N} \sum_{i=1}^{N} \gamma_{i}^{*}$$
(13)

$$V[\gamma_{i}^{*}] = \left[\frac{1}{\sigma_{i}^{*2}} X_{i}^{'} X_{i} + \Sigma^{*-1}\right]^{-1}$$
(14)

Then Eqs. (10-14) should be solved iteratively, with the initial iteration using the OLS estimator  $\hat{\gamma}_i$  to compute  $\mu^*$ ,  $\Sigma^*$  and  $\sigma^{*}{}_i^2$ . The second iteration is based on the empirical iterative Bayes estimator  $\gamma_i^*$ . The third and following iterations are identical to the second one.

## **Section 3 Results**

#### 3.1. External Public Debt dynamics in LICs

Tables A.3 and A.4 in the Appendix present the Bayesian shrinkage estimates for the models given by Eq. 2 and Eq. 4, respectively.

The results (see Table A.3 in the Appendix) show that the estimated coefficients related to the external financing factors vary across countries, and especially across the country-groups identified previously, namely, HIPCs, non-HIPC highly indebted countries and non-HIPC African countries. In order to make the results more readable, we present the estimated parameters related to the external public debt-to-GDP ratio (Y\_1) and their standard deviations in Figure 1. We can clearly see the different dynamics in the figure between HIPCs (blue), highly indebted non-HIPCs (red), and other African non-HIPCs (green). Moreover, a fourth category of outliers appears, composed of Bhutan, Cape Verde, Nicaragua and Laos whose coefficients associated with the ratio of external public debt to GDP are positive and higher than the other countries (grey ring in Figure 1). Nicaragua accumulated large amounts of debt in the early 1990s, even though it was already heavily indebted, in order to finance social

policies and structural reforms (IMF, 2000). At the end of the 1990s, the economic growth rate in Nicaragua reached 7% in 1999 (against -12% in 1988). At the same time, Bhutan and Cape Verde experienced a steady level of external public indebtedness while their external debt was rated at low (or moderate) risk of debt distress.

Figure 1. The relationship between the change in and the level of external public debt (lagged, in % of GDP) by country



Note: The coefficients  $(\hat{\alpha}_i)$  on the x-axis and the standard deviations  $(\widehat{\sigma}_{\hat{\alpha}_i})$  on the y-axis associated with  $Y_{it-1}$ , in Eq.1, are reported in Table A.3. Parameters correspond to the estimated coefficient for the relationship between the change in and the level (lagged) of external public debt-to-GDP ratio

For most countries, the relationship between the change in and the level of the external public debt-to-GDP ratio is negative. In other words, the countries' external public indebtedness is lower as the debt-to-GDP ratio increases.

This result may suggest a decline in the government's capacity to borrow as the external public debt increases in developing countries and fits with the "debt overhang" and the "debt Laffer curve" approaches mentioned above (Sachs 1988; Krugman 1989). At high levels of external public debt, creditors are reluctant to lend to these countries because they expect that the debt will not be entirely repaid. Hence, they are particularly attentive to the external public debt levels of debtor governments. This result is supported by the estimated coefficients related to the debt service-to-GDP ratio (see Table A.4. in the Appendix). The debt service-to-GDP ratio allows creditors to better assess a country's ability to repay the debt in the short term. We find a negative and statistically significant relationship between the change in external public debt and the debt service-to-GDP ratio for all countries in the sample.

Moreover, a positive difference between the interest rate on new debt and the real GDP growth rate increases the external public debt, mainly due to interest payments (according to traditional debt sustainability analysis<sup>12</sup>).

The iterative Bayes estimators show that the external public indebtedness from 1988 to 2018 depends on the country characteristics, and especially highlights different debt paths between the country groups that we initially identified in section 2.1 (HIPCs, non-HIPC highly indebted and non-HIPC African countries). However, these estimations cover the period from 1988 to 2018 and therefore the HIPC and MDRI debt reduction initiatives between 2000 and 2006. Indeed, HIPCs recovered sustainable debt levels mainly thanks to an arrangement between some creditors to (partially) write off debts, rather than being a government achievement. Thus, in the next subsection, we estimate Eqs. 2, 3 and 4 separately from 1988 to 1999 and 2007 to

<sup>&</sup>lt;sup>12</sup> When the interest rate is higher than the GDP growth rate, generating a primary fiscal surplus can help the government to stabilize the public debt ratio.

2018 in order to exclude the debt reduction period from our estimations. Our purpose here is: to investigate a potential change in the relationship between external financing "supply and demand" drivers and external public debt before and after the debt relief initiatives, and between HIPCs and non-HIPCs, in order to analyze whether the debt relief initiatives impacted the external indebtedness of HIPCs.

#### 3.2. External financing before and after HIPC and MDRI

The output estimates of Eqs. 2 and 4 are reported in Tables A.5 and A.6, respectively, in the Appendix. Over the period from 1988 to 1999, the relationship between the change in and the level of the external public debt-to-GDP ratio is negative. Similarly, the estimated coefficients are negative for the external public debt service-to-GDP. These findings are consistent with the expectations of the "debt overhang" approach for the external public debt in low-income countries, as we explained in the previous sub-section. A positive difference between the interest rate on new debt commitments and the GDP growth rate is correlated with an external public indebtedness. In the same way, the change in external public debt-to-GDP ratio is positively correlated with the received grants.

Finally, the relationships between the change in external public debt and the external financing drivers are significantly different after the debt reduction initiatives. Tables A.5 and A.6 in the Appendix display the estimation results.

Coefficients associated with the debt-to-GDP ratio  $(Y_1)$  cease to be significant and/or become positive in most countries. However, they remain negative for two HIPCs (Ghana, Tanzania) and significant for four HIPCs (Guyana, Honduras, Nicaragua and Sierra Leone). The reasons for this *new* relationship between the change in and the level of external public debt are various: (*i*) the consequences on external debt of a lack of monitoring by creditors, despite their commitment to the DAC; (*ii*) the emergence of new official creditors, such as emerging countries, which have a different lending strategy for developing countries compared to traditional creditors;<sup>13</sup> (*iii*) the emerging countries lend to HIPCs in order to get closer economically and politically, without considering the current external debt sustainability in the country.

We find that the relationship of external financing to another factor also changed after debt relief initiatives: A higher interest rate (than the real GDP growth rate) on debt commitments no longer leads to greater external public debt. This relationship is not consistent between the countries in the sample. Thus, we prefer to focus on a potential link between external public debt and the country's economic growth. To do so, we estimate the relationship between the change in external public debt-to-GDP and the real GDP growth rate (lagged) in the model given by Eq. 3. On the one hand, a country that performs well economically would reassure investors about the debt-servicing capacity of the governments in the future. On the other hand, countries with higher GDP growth rates are less dependent on external financing. However, we reject the second assumption because LICs have large development financing needs and will necessarily rely on foreign financing. Moreover, as a country develops, its external financing shifts from a concessional and official basis to a non-concessional basis (Raffinot et al., 2020). For most countries, the coefficients associated with the real GDP growth (R\_1) are positive and significant (except for Ethiopia, Honduras, Kenya and Zambia). However, the relationship is negative for Guyana, Nicaragua and Sierra Leone (see Table A.7.). Thus, even if creditors prefer lending to developing countries with economic prospects, which can generate revenues to repay the debt, some HIPCs display non-significant positive or significant negative coefficients despite positive economic growth rates. Between 2007 and 2018, Honduras and Nicaragua had an average annual growth rate of 3.5%, Guyana 3.8%, for Sierra Leone 5% and

<sup>&</sup>lt;sup>13</sup> Indeed, some emerging countries do not focus on external public debt ratios, like the IMF or DAC members, but rather on the potential future revenues generated by these loans.

Zambia 6%. Performing well economically is probably not sufficient to get foreign financing, if creditors have some other motive for not lending to these HIPCs.

In addition, the relationships between external financing factors and external public debt change after the debt reduction initiatives. They are no longer similar either over time or between countries, probably because of creditor's fear of moral hazard on the part of the debtor government. Figure A.5. in the Appendix connects the estimated parameters related to the external public debt-to-GDP ratio (on the x-axis) and the country's average external public debt level from 1988 to 1999 (y-axis). Some HIPCs, which are either highly indebted (Guyana, Nicaragua) or have external debt-to-GDP ratios close to non-HIPCs (Ghana, Honduras, Sierra Leone, Tanzania), display estimated coefficients that are negative and lower than those of non-HIPCs. The creditors may be reluctant or cautious to lend to highly indebted LICs and those who failed to honor their past commitments. Similarly, in Figure A.6. (which connects the estimated parameters related to real GDP growth rate and the average external public debt before the HIPC initiative), we can see that high external public debt-to-GDP ratio from 1988 to 1999 is associated with negative or lower estimated coefficients, especially for HIPCs. However, this is not the case for some HIPCs in the sample, such as Benin, Burkina Faso or Rwanda. These countries have similar estimated coefficients to non-HIPCs.

International investors may fear moral hazard on the part of some countries that have benefited from debt relief. To check this assumption, we proceed in the same way as in the previous figures, but this time replacing the average external public debt-to-GDP ratio before the debt relief initiatives by the amounts (in millions of US dollars) of debt relief granted between 1988 and 2006 (see Figures A.7). It seems that debt write-offs granted to HIPCs are not considered by creditors as much as one might think. Indeed, for some HIPCs that have received large debt cancellations (such as Ethiopia, Ghana, Madagascar, Senegal, Tanzania, Uganda and Zambia), the estimated coefficients associated with the external public debt-to-GDP ratio  $(Y_1)$  are close

to those of non-HIPCs. Although these countries have benefited from debt relief initiatives, multilateral and bilateral creditors are not reluctant to provide them with financial support. The World Bank is the main creditor of Ethiopia (34% of its external public debt is held by this international institution), Madagascar (46%), Rwanda (45%), Tanzania (51%) and Uganda (39%) in 2019.

In addition, for Guyana, Honduras, Nicaragua and Sierra Leone, the estimated coefficients are much lower than for the other countries. However, they are not as sanctioned by creditors, contrary to what the figures suggest. Indeed, Nicaragua was upgraded to a lower middle-income country in 2005 and Guyana an upper middle-income country in 2015.

The relationships between external financing factors and external public indebtedness changed after the debt relief initiatives. Moreover, these relationships also changed across countries, especially for HIPCs. Indeed, some HIPCs keep borrowing – and the creditors continue lending to them – despite an increasing external debt level. Nevertheless, their recent external indebtedness is not only due to the lending strategy of emerging countries and the financial support from the international financial institutions (IFIs). Private investors are attracted by developing countries, which offer high yields, through sovereign bonds. The share of private creditors in the external debt of these countries is growing, especially following the implementation of accommodative monetary policy in developed countries. Consequently, in the next subsection, we focus on external public indebtedness from private creditors.

#### 3.3. Do the private creditors appeal to low-income countries?

It was difficult to predict the impact the debt reduction initiatives would have on the LICs' external financing from private creditors at the end of the HIPC process. On the one hand, investors may be reluctant to lend to governments that did not honor their commitments. On

the other hand, the debt relief initiatives have allowed these countries to restore debt sustainability and their ability to borrow, although they appear as risky sovereigns. Moreover, the sovereign bonds issued by LICs offer more attractive returns for private investors since an expansionary monetary policy is implemented in developed countries. The estimates of our model are given by two independent equations:

$$\Delta Y \operatorname{Priv}_{it} = c_i + \alpha_i \cdot Y \operatorname{Priv}_{it-1} + \beta_i \cdot DIF_{it-1} + \gamma_i \cdot G_{it-1} + \varepsilon_{it}$$
(15)

$$\Delta Y \operatorname{Priv}_{it} = c_i + \varphi_i \cdot S_{it-1} + \beta_i \cdot DIF_{it-1} + \gamma_i \cdot G_{it-1} + \mathcal{E}_{it}$$
(16)

The dependent variable  $\Delta Y Priv_{it}$  refers to the annual change in the external public debt-to-GDP ratio from private creditors. The explanatory variable  $Y Priv_{it-1}$  is the ratio of external public debt-to-GDP from private creditors in the previous year (Y\_1P in Tables). As in the previous subsection, we compare the relationships between external financing "supply and demand" drivers and external public debt from private creditors between countries, and before and after debt reduction initiatives.

Over the period from 1988 to 1999, the relationship between the change in and the level of external public debt from private creditors is negative for all countries in our sample. Estimated coefficients associated with debt service-to-GDP ratio are also negative and significant (see Table A.8 and A.9). After the debt crisis in developing countries in the 1980s, private creditors remain cautious and attentive to the public indebtedness and the debt-servicing capacities of debtor governments, especially when the external public rises.

However, after the debt relief initiatives, these relationships once again completely changed. Estimated coefficients associated with the external public debt ratio are negative and significant for only five HIPCs (Burkina Faso, Guyana, Madagascar, Nicaragua and Sierra Leone). The estimated coefficients related to the debt service ratio are negative and significant for only four countries in the sample (Bangladesh, Botswana, Burkina Faso and Lesotho). Figure 2 connects the estimated coefficients, for each country, associated with the external public debt-to-GDP ratio from private creditors (Y\_1P) and the amount of debt cancelled for LICs. For most countries, both HIPCs and non-HIPCs, the external indebtedness from private creditors declines as the debt-to-GDP ratio increases. Private investors are less willing to finance LICs with increasing or already large external liabilities. Thus, these creditors are risk averse to debt-servicing difficulties or even a default. However, for some HIPCs and non-HIPCs, the relationship between the change in and the level of external public debt from private creditors to the indebtedness of LICs or to the sustainability of the debt.

Worse, some HIPCs keep borrowing despite a rising debt-to-GDP ratio (even if they have been granted debt relief). This is not surprising for Ethiopia, Ghana, Senegal and Zambia. Since 2007, these HIPCs have accessed credit markets to issue sovereign bonds several times. New bonds were often issued to repay previous loans. Moreover, in 2019, private creditors were the main holders of the external public debt of Ghana (37%), Senegal (31%), Zambia (25%).

Figure 2. Parameters (Y\_1 Private) based on Bayesian shrinkage estimates by country and the debt reduction amounts (in millions USD) granted from 1988 to 2006



Note: The coefficients  $(\hat{\alpha}_i)$  on the x-axis associated with *Y*  $Priv_{it-1}$  in Eq.5 are reported in Table A.8., and the total amounts of debt forgiveness or reduction granted to the developing countries from 1988 to 2006 on the y-axis. Parameters correspond to the estimated coefficients for the relationship between the change in and the level (lagged) of external public debt-to-GDP ratio from private creditors, post-HIPC initiative.

## Section 4 Concluding remarks

Firstly, our results show that the debt dynamics (and the relationship between the change in and the level of external public debt to GDP) differ across developing countries over the time. Nevertheless, these countries tend to cluster into three categories, which are the HIPC countries, the highly indebted low-income countries that have not obtained debt relief, and the non-HIPC low-income or lower-middle-income African countries. The Bayesian iterative estimation procedure highlights the heterogeneity across countries identified in Section 2. In the second instance, we study the relationship between external financing factors and foreign public debt across countries before and after the debt reduction initiatives. We show a negative relationship between the growth and the level of the external public debt-to-GDP ratio. Indeed, the official and private creditors are cautious about the repayment capacities of debtor governments, especially after the debt crises of developing countries in the early 1980s. When the debt service relative to national income increases, the growth of external public debt decreases. This result reinforces the previous finding. Also, the relationship between external public indebtedness and grants received by LICs is positive. This result revives the "defensive grants" hypothesis, although it is difficult to prove empirically (Marchesi and Missale, 2007, 2013). Creditors may provide loans or grants to highly indebted debtors in order to spread debt problems over time. However, the relationship between the growth and the level of external public debt (or debt service) to GDP is no longer negative for all developing countries after the HIPC and MDRI initiatives. This coefficient turns positive and even significant for some countries, especially HIPCs. This result highlights two important facts. On the one hand, this result means that the creditors are less attentive to the LICs' ability to repay the debt after the debt relief initiatives. On the other hand, some HIPCs are not sanctioned by lenders, even if these countries have been granted debt relief. This paper provides evidence to support the suggestion in the literature that creditors do not particularly fear moral hazard on the part of HIPCs (Bunte, 2018; Ferry et al. 2021; Raffinot et al., 2020).

There are several reasons to explain these results. First, new bilateral creditors (i.e., emerging countries) have a different lending strategy than traditional creditors. The latter are more focused on a long-term vision and consider the macroeconomic forecasts of the World Bank and the IMF, whereas emerging countries focus on the microeconomic aspects of the

development projects financed by loans. Secondly, LICs need to finance their development in order to meet the 2030 Sustainable Development Goals. Therefore, international and regional institutions keep lending to these countries. Finally, LICs and HIPCs attract private creditors<sup>14</sup> because they are risky sovereigns and offer higher returns to investors, especially since the implementation of expansionary monetary policies in 2010. Note that these observations cannot be extended to all HIPCs. Indeed, the relationship between the growth and the level of external public debt remains negative and significant for some HIPCs.

Finally, we investigate the external public indebtedness from foreign private creditors. We see the same shift in the relationship between the growth and the level of external public debt to private creditors after the debt reduction initiatives as for the total external public debt. Indeed, some countries, especially HIPCs, keep borrowing from private creditors in spite of their rising indebtedness. On the supply side, investors benefit from the fact that HIPCs have recovered their debt capacity thanks to the debt relief initiatives. Also, yields on loans to LICs are particularly high and attract profit-seeking investors. On the demand side, Tyson (2015) highlights the opportunities that these loans provide to LIC governments. Indeed, these loans are unconditional, unlike those from international financial institutions. Bond issuance can be used to finance large-scale investment projects, to facilitate the authorities' monetary policy or to develop domestic financial markets with an important contribution in terms of liquidity.

However, these sovereign bonds are generally Eurobonds and thus denominated in strong foreign currencies such as the US dollar or the Euro. These bonds can expose sovereign debt to sustainability risks, particularly in case of foreign currency appreciation. Indeed, Uganda has refused to issue Eurobonds on the international financial markets, unlike Ethiopia, Ghana, Senegal and Zambia. In August 2014, Emmanuel Mutebile (Governor of the Bank of Uganda) warned about the risks of these issues on the sustainability of the public debt of HIPCs: "We

<sup>&</sup>lt;sup>14</sup> See Ferry, Raffinot, and Venet (2021) for a study of LICs' external financing from private creditors, especially access conditions on the capital market after debt reduction initiatives.

should not be complacent about the dangers of big projects built on sovereign debt because it would be unwise for African countries, which will never again get debt relief. From what we are seeing in Ghana, we are not yet ready to issue sovereign bonds". Figure A.8. in the Appendix shows that, since 2007, the proportion of low-income countries (classified by the World Bank and the IMF as being at high risk of debt distress) has been increasing. The World Bank and IMF created the Debt Sustainability Framework following the HIPC initiatives, to monitor the indebtedness of LICs. For example, Zambia defaulted on its debt in November 2020 due to the difficulties caused by the health crisis affecting African economies. The G20 then decided to implement a debt service moratorium in 2020 for African states whose debt was increasing in response to the health crisis, which was also constraining their ability to repay.

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## Appendix.



Figure A.1. Composition of the external public debt (in current USD million) of HIPC countries by creditors

Source: International Debt Statistics, World Bank (2020)

Figure A.2. Average external debt stock (in % of GDP) of the sample of countries from 1988 to 2018



Source: International Debt Statistics - World Bank (2020).



Figure A.3. Average external debt stock (in % of GDP) by creditor since 1988

Source: International Debt Statistics, World Bank (2020); authors' calculation

Countries	<b>Decision Point</b>	Completion Point	MDRI
	Entry	Exit	
"Lowe	st" External Public Debt	level no later than 2008	
Uganda	2000	2000	2005
Tanzania	2000	2001	2005
Burkina Faso	2000	2002	2005
Benin	2000	2003	2005
Senegal	2000	2004	2005
Rwanda	2000	2005	2005
Zambia	2000	2005	2005
Guyana	2000	2003	2005
Nicaragua	2000	2004	2005
Honduras	2000	2005	2005
Mozambique	2000	2001	2005
Mauritania	2000	2002	2005
Mali	2000	2003	2005
Niger	2000	2004	2005
Madagascar	2000	2004	2005
The Gambia	2000	2007	2007
Ethiopia	2001	2004	2005
Ghana	2002	2004	2005
Sierra Leone	2002	2006	2006
"Lowe	st" External Public Debt	level no later than 2012	
Malawi	2000	2006	2006
Cameroon	2000	2006	2006

Table A.1. Heavily	Indebted Poor	Countries
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Guinea-Bissau	2000	2010	2010
Bolivia	2000	2001	2005
Chad	2001	2015	2015
Burundi	2005	2009	2009
Congo, Rep.	2006	2010	2010
Haiti	2006	2009	2009
Central African Rep.	2007	2009	2009
Liberia	2008	2010	2010
Togo	2008	2010	2010
Cote d'Ivoire	2009	2012	2012
	"Lowest" External Public De	bt level after 2012	
Sao Tome & Principe	2000	2005	2005
Guinea	2000	2012	2012
Congo, Dem., Rep.	2003	2010	2010
Afghanistan	2007	2010	2010
Comoros	2010	2012	2012

Note: Countries in bold are the HIPCs included in the sample. Source: International Monetary Fund

Table A.2. Summary Statistics

			Mean	
Variable	Source	Full	1988-1999	2007-2018
External Debt Stocks PPG (% of GDP)	IDS (2020)			
Total		56.0121	85.8228	26.2356
Official creditors		50.6348	76.7936	22.9157
Private creditors		5.7999	9.4675	3.6710
GDP growth (%)	WDI (2020)	4.6049	3.9495	5.1234
Grants (% of GDP)	WDI (2020)	5.8070	6.6559	3.9133
Debt Service on total external debt (% of GDP)	IDS (2020)	2.3537	3.7297	1.2049

Table A.3. Bayesian Shrinkage estimates by country for the full time period with external public debt level

Country	Variable	Parameters	T-Stat	Country	Parameters	T-Stat
BGD	Const	2.0981260	11.453274	LSO	2.2475536	7.1562711
	Y_1	-0.0183705	-2.5622296		-0.0108940	-0.8519574
	DIF_1	0.1356001	14.997705		0.1402449	11.410258
	G_1	0.0847488	2.2262786		0.0545066	0.8443422
BEN	Const	1.9614901	6.2943246	MDG	2.1422576	5.9788310
	Y_1	-0.0254073	-1.9798749		-0.0184984	-1.2010043
	DIF_1	0.1306667	10.642066		0.1370510	10.087638
	G_1	0.1123249	1.7540761		0.0752824	1.0260598
BTN	Const	3.3315196	8.5443901	NPL	2.5055267	9.3304482
	Y_1	0.0378632	2.2720592		-0.0004635	-0.0433317
	DIF_1	0.1764751	12.102201		0.1490912	13.409934
	G_1	-0.1666153	-2.0863914		0.0015441	0.0278968
BWA	Const	0.9873903	3.8925525	NIC	3.0251394	8.8124376
	Y_1	-0.0665340	-5.8093657		0.0231192	1.6361730
	DIF_1	0.0969660	9.0741393		0.1667021	12.694902
	G_1	0.3117665	5.9696008		-0.1045250	-1.4851290
BFA	Const	2.1164396	5.4518815	PAK	2.1674335	13.870311
	Y_1	-0.0190196	-1.1288371		-0.0156620	-2.5531231
	DIF_1	0.1363428	9.3883498		0.1378562	16.840975

	G_1	0.0806345	1.0146526		0.0704604	2.1631393
CPV	Const	2.9562645	9.1575509	RWA	2.4547137	7.0201061
	Y_1	0.0223807	1.6195783		-0.0041516	-0.2543714
	DIF_1	0.1635650	13.038930		0.1471330	11.021566
	G_1	-0.0895576	-1.3548036		0.0115945	0.1627780
SWZ	Const	1.1389136	5.6980728	SEN	2.1094861	5.7497489
	Y_1	-0.0609164	-7.0333843		-0.0192419	-1.2210712
	DIF_1	0.1022424	11.178103		0.1357271	9.7764811
	G_1	0.2798408	6.7532913		0.0821500	1.0926833
ETH	Const	2.0103451	4.6359559	SLE	2.4423401	5.7542601
	Y_1	-0.0237434	-1.2578520		-0.0046118	-0.2515669
	DIF_1	0.1323080	8.3250305		0.1469234	9.4294999
	G_1	0.1024354	1.1546910		0.0141528	0.1629457
GHA	Const	2.6177407	8.1318822	SDN	2.1511575	10.397026
	Y_1	0.0035948	0.2655594		-0.0165088	-2.1978181
	DIF_1	0.1528803	12.194379		0.1370509	14.582090
	G_1	-0.0215213	-0.3259610		0.0737575	1.7230402
GUY	Const	2.5978676	6.3283284	TZA	2.2772266	6.7492454
	Y_1	0.0031699	0.1802353		-0.0104838	-0.7635505
	DIF_1	0.1522944	10.036859		0.1415937	10.892772
	G_1	-0.0173929	-0.2069910		0.0481843	0.6956956
HND	Const	2.3035889	7.5644877	UGA	2.3716646	5.8997594
	Y_1	-0.0112689	-0.8834459		-0.0068347	-0.3866104
	DIF_1	0.1425006	11.863898		0.1445534	9.6821353
	G_1	0.0423522	0.6774745		0.0288186	0.3505763
IDN	Const	2.1714463	10.791068	ZMB	2.2706546	6.0685621
	Y_1	-0.0158412	-1.8849806		-0.0123638	-0.7844735
	DIF_1	0.1380118	15.017036		0.1412457	10.046663
	G_1	0.0696725	1.6767427		0.0492155	0.6419338
KEN	Const	2.1118694	8.6121459	ZWE	1.7193861	7.3896643
	Y_1	-0.0175440	-1.8144783		-0.0369805	-4.0265064
	DIF_1	0.1356958	13.059692		0.1225588	12.559307
	G_1	0.0821814	1.6241411		0.1616516	3.3622049
LAO	Const	3.0366442	9.2392687			
	Y_1	0.0236335	1.7514273			
	DIF_1	0.1668722	13.073690			
	G_1	-0.1067839	-1.5836794			

Note: Const, Y\_1, DIF\_1, and G\_1 correspond to the constant, the lagged external public debt-to-GDP ratio, the difference between the interest rate and the GDP growth rate and the grants-to-GDP ratio, respectively. The number of iterations was 15. The time period covered from 1988 to 2018. The sample includes Bangladesh (BGD), Benin (BEN), Bhutan (BTN), Botswana (BWA), Burkina Faso (BFA), Cape Verde (CPV), Eswatini (SWA), Ethiopia (ETH), Ghana (GHA), Guyana (GUY), Honduras (HND), Indonesia (IDN), Kenya (KEN), Laos (LAO), Lesotho (LSO), Madagascar (MDG), Nepal (NPL), Nicaragua (NIC), Pakistan (PAK), Rwanda (RWA), Senegal (SEN), Sierra Leone (SLE), Sudan (SDN), Tanzania (TZA), Uganda (UGA), Zambia (ZMB), and Zimbabwe (ZWE).

Table A.4. Bayesian Shrinkage estimates by country for the full time period with external public debt service-to-GDP ratio

Country	Variable	Parameters	T-Stat	Country	Parameters	T-Stat
BGD	Const	1.8056293	6.8662140	LSO	1.8105816	6.0686979
	S_1	-0.2500882	-17.635847		-0.2496626	-15.864101
	DIF_1	0.1115037	6.9046594		0.1105607	6.4088965
	G_1	0.1139228	2.0924732		0.1143107	1.8753867
BEN	Const	1.9194822	6.5299702	MDG	2.0535378	7.0378039
	S_1	-0.2445536	-15.732317		-0.2379976	-15.407634
	DIF_1	0.1172196	6.8845622		0.1243475	7.3407569

	G_1	0.0901562	1.5021883		0.0630084	1.0573593
BTN	Const	1.9141875	6.2964653	NPL	1.9538482	6.4113542
	S_1	-0.2446737	-15.293492		-0.2428490	-15.149742
	DIF_1	0.1155302	6.5870974		0.1180182	6.6960558
	G_1	0.0934333	1.5034187		0.0849540	1.3613197
BWA	Const	1.2410992	4.9062449	NIC	1.9175790	6.2763576
	S_1	-0.2777645	-20.259323		-0.2446362	-15.221691
	DIF_1	0.0810608	5.2933706		0.1168040	6.6241882
	G_1	0.2293672	4.4022080		0.0916227	1.4663565
BFA	Const	2.0233988	7.4523761	PAK	2.0909574	9.3640170
	S_1	-0.2394292	-16.472687		-0.2358252	-19.142355
	DIF_1	0.1231965	7.8096861		0.1259057	8.9392832
	G_1	0.0688727	1.2497586		0.0562609	1.2162532
CPV	Const	1.8895201	7.1253054	RWA	2.1547736	9.3294173
	S_1	-0.2459055	-17.230982		-0.2330887	-18.263438
	DIF_1	0.1137797	7.3454223		0.1289740	9.2207963
	G_1	0.0989915	1.8389532		0.0425620	0.9118453
SWZ	Const	1.2273226	5.2695999	SEN	1.9654792	6.5798275
	S_1	-0.2787023	-21.784615		-0.2423623	-15.380252
	DIF_1	0.0814525	5.7158677		0.1192877	6.8940792
	G_1	0.2296640	4.7711652		0.0814772	1.3340862
ETH	Const	1.9722890	6.5348622	SLE	2.0557647	6.9051241
	S_1	-0.2419797	-15.220822		-0.2379257	-15.141729
	DIF_1	0.1195115	6.8579532		0.1240146	7.2031702
<b>.</b>	G_1	0.0802061	1.3001893		0.0629586	1.0352176
GHA	Const	2.0778132	7.1140664	SDN	1.8321707	6.1688352
	S_1	-0.2367209	-15.316035		-0.2487442	-15.856560
	DIF_1	0.1249273	7.3677588		0.1126548	6.5308198
<b>.</b>	G_1	0.0590066	0.9889451		0.1081621	1.7776554
GUY	Const	1.9790049	6.4557105	TZA	1.9378551	6.8526545
	S_1	-0.2416132	-14.991868		-0.2436072	-16.184441
	DIF_1	0.1200355	6.7879815		0.1182207	7.1921046
	G_1	0.0789396	1.2589659		0.0870146	1.5108025
HND	Const	2.1127492	7.1288029	UGA	1.9841676	7.0121699
	S_1	-0.2350411	-15.037906		-0.2413759	-16.038582
	DIF_1	0.1273826	7.4022013		0.1202070	7.3060809
	G_1 Canat	0.0511494	0.8432484	7140	0.0778347	1.3493642
IDN	Const	2.1646222	8.6922148	ZIVIB	2.0387544	6.8806565
	5_1	-0.2321465	-17.311372		-0.2387294	-15.246591
	DIF_1	0.1297397	8.6002010		0.1232500	7.1856981
	G_1 Canat	0.0413246	0.8068620		0.0004320	1.0977823
NEIN	Const	1.8703030	0.4215090 16.046772	ZVVE	1.6007004	0.0009323
		-0.2407070	-10.040772		-0.2470004	-10.731047
		0.1130900	1 7120404		0.1131000	0.3940043
	G_1 Const	1 0327696	6 2020069		0.1031022	1.0000322
LAO		-0.2420000	-15 100775			
		0.2439000	6 6053294			
		0.1109700	1 4170060			
	G_1	0.0890481	1.41/3308			

Note: Const, S\_1, DIF\_1, and G\_1 correspond to the constant, the lagged external public debt service-to-GDP ratio, the difference between the interest rate and the GDP growth rate and the grants-to-GDP ratio, respectively. The number of iterations was 10. The time period covered from 1988 to 2018.



Figure A.4 The relationship between dynamics of external public debt and explanatory variables (% of GDP) by country group

Note: Coefficients  $(\hat{\beta}_l and \hat{\gamma}_l)$  on the x-axis and Standard Errors  $(\hat{\sigma}_{\hat{\beta}_l} and \hat{\sigma}_{\hat{\gamma}_l})$  on the y-axis related to DIF\_1 and G\_1 are reported in Table A.3. DIF\_1 and G\_1 correspond to the difference between the interest rate and the GDP growth rate, and the grants-to-GDP ratio received by developing countries.

		Pre-H	HIPC	Post-	HIPC	Pre-HIPC		HIPC	Post-HIPC	
Country	Variable	Parameters	T-Stat	Parameters	T-Stat	Country	Parameters	T-Stat	Parameters	T-Stat
BGD	Const	4.0769406	14.625956	0.3402250	0.4274002	LSO	4.8497067	15.509838	2.3394193	1.5297267
	Y_1	-0.0594727	-7.0889143	0.0085251	0.2114435		-0.0361659	-3.8475097	-0.0348087	-0.9106829
	DIF_1	0.1104291	6.1860677	-0.0735049	-7.1789077		0.1561457	7.9680299	-0.0468988	-2.1409020
	G_1	0.1166420	3.8939750	0.0789858	1.0411437		0.1984543	5.9424789	-0.0596059	-0.7936082
BEN	Const	4.1135854	16.029533	0.6090745	0.4989867	MDG	4.6155026	14.300590	1.0173037	0.7979940
	Y_1	-0.0585112	-7.7369264	0.0689540	1.1630549		-0.0431322	-4.6266923	0.0007841	0.0125378
	DIF_1	0.1124940	6.7991380	-0.0384802	-2.5455146		0.1423184	7.0538955	-0.0610557	-6.0118183
	G_1	0.1205495	4.3748455	0.0272964	0.3465334		0.1735861	5.0309465	0.0275470	1.2615687
BTN	Const	4.1435524	10.188443	-0.2181905	-0.1251138	NPL	4.9233490	15.798128	0.8204845	0.5705821
	Y_1	-0.0571289	-4.5310893	0.0827482	1.9351500		-0.0338150	-3.6365338	-0.0033348	-0.0696129
	DIF_1	0.1139695	4.5594618	-0.0516535	-1.8249570		0.1605870	8.1705355	-0.0677324	-3.7960499
	G_1	0.1236409	2.8637219	0.0675558	0.5504368		0.2060894	6.1816141	0.0117617	0.1098067
BWA	Const	2.5631433	8.3195571	0.3228152	0.2274425	NIC	4.9121654	9.0477651	12.028072	12.185281

Table. A.5. Bayesian shrinkage estimates by country with external public debt-to-GDP ratio before and after debt relief initiatives

	Y_1	-0.1039152	-10.522634	0.0394138	0.6444288		-0.0333994	-2.0652783	-0.2601828	-7.9882573
	DIF_1	0.0205075	1.0515746	-0.0592668	-3.1347907		0.1600866	4.8682306	0.0788636	6.0910274
	G_1	-0.0432362	-1.3101110	0.0861417	0.8721349		0.2048478	3.5548993	-0.5758852	-13.598292
BFA	Const	4.0183753	12.735196	-0.6136074	-0.3975145	PAK	4.3147084	17.990564	0.5274520	0.2854877
	Y_1	-0.0610705	-6.2411460	0.0680337	0.9620796		-0.0523341	-7.3319951	0.0303887	0.3893185
	DIF_1	0.1069263	5.3880216	-0.0679240	-5.0055043		0.1245821	8.0185496	-0.0588471	-4.6122816
	G_1	0.1104064	3.2834389	0.0899844	1.8930217		0.1417335	5.4452546	0.0476927	0.4649202
CPV	Const	4.0677009	12.126427	0.7475260	0.4345512	RWA	3.8855341	19.728387	0.2978343	0.1829119
	Y_1	-0.0591308	-5.5722861	0.0508154	1.2446417		-0.0638798	-8.9768545	0.0793378	1.2524047
	DIF_1	0.1095386	5.2089457	-0.0436199	-1.5401081		0.0982613	7.5544616	-0.0410169	-2.1973404
	G_1	0.1154938	3.2496196	0.0303144	0.2492128		0.0960615	4.6053996	0.0524835	1.0803907
SWZ	Const	2.5615525	11.425980	-1.0038684	-1.5586688	SEN	3.7419579	10.344026	-0.9435323	-0.3757442
	Y_1	-0.1036664	-14.049421	0.0915729	2.0471996		-0.0695287	-6.3526483	0.1409618	1.6399039
	DIF_1	0.0196226	1.3386154	-0.0663487	-4.8085548		0.0903829	4.0338936	-0.0414977	-1.5908996
	G_1	-0.0434886	-1.7867232	0.1197593	1.4854267		0.0812258	2.1065038	0.0760947	0.5839452
ETH	Const	4.1035488	7.1952534	1.7532591	0.8331737	SLE	4.4757915	8.4416019	11.441136	6.1365967
	Y_1	-0.0587096	-3.4214070	0.0369737	0.5098675		-0.0472649	-2.9747696	-0.3093762	-4.9241756
	DIF_1	0.1119185	3.2449446	-0.0264397	-1.1068363		0.1341256	4.1743141	0.0414379	1.6206168
	G_1	0.1194275	1.9738690	0.0065942	0.0758817		0.1587524	2.8206747	-0.4732703	-4.7711161
GHA	Const	5.0472070	15.647860	4.2105717	3.3188085	SDN	4.2746774	14.660296	0.2185838	0.1315962
	Y_1	-0.0297431	-3.1326626	-0.0617491	-1.2162148		-0.0534390	-6.5545001	0.0029006	0.0551874
	DIF_1	0.1680818	8.3181775	-0.0139751	-1.0390327		0.1221431	6.6224227	-0.0785340	-4.3992519
	G_1	0.2191276	6.3526516	-0.0820047	-1.3802551		0.1375180	4.3911671	0.1068391	1.0730115
GUY	Const	4.5439573	7.8121600	9.1513094	3.7374138	TZA	4.7488211	18.114312	2.6364550	1.7441415
	Y_1	-0.0449908	-2.5780339	-0.2543711	-3.0924782		-0.0389908	-5.2568996	-0.0395338	-0.5987982
	DIF_1	0.1381764	3.9305927	0.0124028	0.4761774		0.1503770	8.9454874	-0.0408668	-3.0692807
	G_1	0.1659368	2.6894402	-0.3848391	-2.9911228		0.1876773	6.6806642	0.0191475	0.3878417
HND	Const	4.4914507	11.000385	7.0766140	3.1516108	UGA	4.5932523	12.153281	0.4422843	0.5099329
	Y_1	-0.0468596	-3.8580186	-0.1712103	-2.1148159		-0.0435547	-3.8561641	0.0721892	1.4651550
	DIF_1	0.1350231	5.3913699	0.0020629	0.0926683		0.1410112	6.0200989	-0.0407324	-3.2158731
	G_1	0.1604161	3.6885008	-0.3193349	-2.6873527		0.1711950	4.2557456	0.0461915	1.7742194
IDN	Const	4.4301022	10.956674	0.7330724	0.7774286	ZMB	4.4144985	10.145788	2.1166827	1.2972900
	Y_1	-0.0488344	-4.0299059	0.0359191	0.6812081		-0.0492260	-3.8188161	0.0300664	0.4937500
	DIF_1	0.1314899	5.3021624	-0.0512721	-5.4176122		0.1304440	4.9030959	-0.0203709	-1.0228918
	G_1	0.1539128	3.5689816	0.0334067	0.4594108		0.1523096	3.2922611	-0.0516860	-0.6018444
KEN	Const	4.2689028	13.003865	1.5303483	0.5496146	ZWE	3.6916718	12.285770	1.1967079	0.9831070
	Y_1	-0.0536540	-5.5001639	0.0370682	0.3626735		-0.0711664	-7.7339807	0.0125870	0.4778549
	DIF_1	0.1218187	5.9440158	-0.0314652	-1.3021488		0.0875336	4.6441177	-0.0505599	-2.2599291
	G_1	0.1369880	3.9047573	-0.0242101	-0.1578729		0.0759035	2.3563299	-0.0252268	-0.2555635
LAO	Const	5.2041289	10.244414	0.2073670	0.1459317					
	Y_1	-0.0243922	-1.6195132	0.0831317	3.4370628					
	DIF_1	0.1773523	5.7451946	-0.0413772	-1.6101351					
	G_1	0.2356951	4.3683611	0.0339758	0.3098634					

Note: Const, Y\_1, DIF\_1, and G\_1 correspond to the constant, the lagged external public debt-to-GDP ratio, the difference between the interest rate and the GDP growth rate and the grants-to-GDP ratio, respectively. The number of iterations was 10. The pre-HIPC period covered from 1988 to 1999, while the post-HIPC covered from 2007 to 2018.

		Pre-H	HIPC	Post-	HIPC		Pre-I	HIPC	Post-	HIPC
Country	Variable	Parameters	T-Stat	Parameters	T-Stat	Country	Parameters	T-Stat	Parameters	T-Stat
BGD	Const	2.1049052	12.298548	1.1255643	1.6293565	LSO	2.2280628	12.285825	1.8853483	4.2119843
	S_1	-0.2437892	-2.3604027	-0.4206794	-0.9450286		-0.1693619	-1.5478362	-0.1699987	-1.8847304
	DIF_1	0.0543467	5.7778547	-0.0291377	-1.3939921		0.0489341	4.9944744	-0.0169532	-1.5599797
	G_1	0.2019781	5.9873516	0.0049498	0.0238774		0.1786201	5.0078957	-0.0973281	-1.1914059
BEN	Const	2.1048989	11.316908	1.7102647	3.5006323	MDG	2.1489187	11.722649	1.1948336	6.2831929
	S_1	-0.2438304	-2.1724861	0.1924842	0.7737513		-0.2172388	-1.9640202	-0.2027726	-1.3191332
	DIF_1	0.0542982	5.4665604	-0.0250520	-2.1031633		0.0522938	5.3046130	-0.0306653	-4.5476815
	G_1	0.2016712	5.5200605	0.0005011	0.0051600		0.1935202	5.3731155	0.0300181	1.4154566
BTN	Const	2.1866440	11.629668	0.7734396	0.6830602	NPL	2.2405295	12.206799	2.8731173	2.8640987
	S_1	-0.1944966	-1.7142038	0.8186779	2.2831123		-0.1619286	-1.4619821	-0.6107926	-2.9748479
	DIF_1	0.0504702	5.0489798	-0.0525009	-1.9470657		0.0483474	4.9121143	0.0097014	0.4152776
	G_1	0.1861325	5.0448002	0.2911565	1.1363247		0.1760482	4.8810219	-0.3649494	-1.6818032
BWA	Const	1.7580359	13.460931	-1.3138626	-1.6307255	NIC	2.1591909	11.442507	4.7339106	10.830960
	S_1	-0.4532090	-5.7536752	1.2625423	2.6724712		-0.2110265	-1.8532385	-0.4360829	-2.3266220
	DIF_1	0.0691080	8.5603420	-0.1019305	-4.5833786		0.0519823	5.1801310	0.0460958	4.2614843
	G_1	0.2688459	10.293763	0.7713026	3.5028253		0.1915655	5.1748120	-0.6923269	-8.4140880
BFA	Const	2.1432086	11.406035	1.0903325	3.4790394	PAK	2.3103138	18.032146	0.9474524	0.9484929
	S_1	-0.2206990	-1.9464187	-0.1161495	-0.6427302		-0.1197579	-1.5505273	0.1704525	0.3214402
	DIF_1	0.0527876	5.2797486	-0.0335488	-4.2137674		0.0457433	5.5756717	-0.0406216	-1.4542120
	G_1	0.1942725	5.2666945	0.0652779	1.5749028		0.1623353	6.3488313	0.1433603	0.5103508
CPV	Const	2.2436309	12.028348	0.8473414	0.7316226	RWA	2.5264657	16.889143	1.6872763	4.5069019
	S_1	-0.1601426	-1.4226516	0.6722425	1.5530085		0.0103891	0.1150218	0.4028620	1.4459596
	DIF_1	0.0483800	4.8574606	-0.0490940	-1.7390429		0.0361879	4.1879299	-0.0283665	-3.5128423
	G_1	0.1745290	4.7750497	0.2512232	0.9228149		0.1182259	4.0671572	0.0421265	1.0063434
SWZ	Const	1.8729152	13.001366	0.7787958	0.7117556	SEN	2.0760295	11.424420	1.8080464	2.3417064
	S_1	-0.3839114	-4.4190371	-0.4556871	-0.9918129		-0.2612866	-2.3830110	0.4516502	1.2710511
	DIF_1	0.0637108	7.4986466	-0.0360599	-1.2481199		0.0553945	5.6513541	-0.0263791	-1.4000306
	G_1	0.2466397	8.6229962	0.0653774	0.2284816		0.2074136	5.8067496	0.0274086	0.1564562
ETH	Const	2.1637298	11.457553	1.7760807	3.8862200	SLE	2.1588067	11.445590	3.2503417	3.7180424
	S_1	-0.2082907	-1.8277571	0.5348131	2.0239060		-0.2112711	-1.8562115	-0.4834441	-1.1212011
	DIF_1	0.0517366	5.1536053	-0.0284868	-2.7403837		0.0519839	5.1813582	0.0157351	0.7290534
	G_1	0.1906198	5.1455015	0.0483051	0.6282537		0.1915911	5.1777619	-0.4150404	-2.0151203
GHA	Const	2.3012476	13.185441	1.9059820	5.0962768	SDN	2.1393750	11.376813	0.0110762	0.0185570
	S_1	-0.1251958	-1.1889790	0.3206719	1.6644735		-0.2229443	-1.9646308	-0.0543579	-0.2107096
	DIF_1	0.0459424	4.8046046	-0.0230100	-2.3280691		0.0528507	5.2827798	-0.0564558	-3.5654126
	G_1	0.1642744	4.7810912	-0.0142554	-0.1931927		0.1952316	5.2910346	0.2837152	1.9081922
GUY	Const	2.1710994	11.554545	4.1707905	4.9640030	TZA	2.1402445	11.423117	1.4916828	4.6764543
	S_1	-0.2038398	-1.7977677	-1.0589340	-2.9556986		-0.2225101	-1.9681267	0.2778505	1.2973742
	DIF_1	0.0514781	5.1434591	0.0422583	2.0236900		0.0528103	5.2878742	-0.0308035	-3.7979496

Table A.6. Bayesian shrinkage estimates by country with external public debt service-to-GDP ratio before and after debt relief initiatives

	G_1	0.1892166	5.1323752	-0.6936470	-3.5075114		0.1949882	5.3004036	0.0578550	1.2614928
HND	Const	2.1905232	12.958443	4.0802786	6.1540995	UGA	2.1942220	11.806572	1.5464484	5.5563270
	S_1	-0.1921018	-1.8839130	-0.7472359	-2.4591340		-0.1898643	-1.6930198	0.2235860	1.0164543
	DIF_1	0.0506495	5.3841187	0.0363599	2.1617909		0.0504345	5.0843924	-0.0286850	-3.9785934
	G_1	0.1855191	5.5717402	-0.6212675	-3.9920266		0.1847602	5.0616620	0.0375728	1.3226488
IDN	Const	2.2793501	14.812393	1.0141746	1.5810269	ZMB	2.1443899	11.529235	2.0915783	4.4586853
	S_1	-0.1384301	-1.4916798	0.1877028	0.6080518		-0.2199905	-1.9601725	0.3938846	1.3827780
	DIF_1	0.0470407	5.2614034	-0.0395065	-2.1587381		0.0525525	5.2832363	-0.0194329	-1.7417442
	G_1	0.1682944	5.5361812	0.1336369	0.7612579		0.1943386	5.3219630	-0.0372976	-0.4196082
KEN	Const	2.1326693	13.743989	1.9007091	1.4955057	ZWE	2.0757379	14.437031	2.3775061	2.8427170
	S_1	-0.2270195	-2.4262950	0.2844802	0.6632394		-0.2614619	-3.0166369	-0.3337123	-1.0269537
	DIF_1	0.0530773	5.9186074	-0.0222380	-0.7094426		0.0555449	6.4157675	-0.0035325	-0.1768642
	G_1	0.1967615	6.4051039	-0.0198571	-0.0651340		0.2076054	7.2689842	-0.2206077	-1.1969502
LAO	Const	2.1818475	11.551539	0.2046432	0.1829383					
	S_1	-0.1973505	-1.7314630	1.3747299	4.7512898					
	DIF_1	0.0509294	5.0729558	-0.0718005	-2.7108077					
	G_1	0.1872282	5.0530412	0.4987735	1.9849358					

Note: Const, S\_1, DIF\_1, and G\_1 correspond to the constant, the lagged external public debt service-to-GDP ratio, the difference between the interest rate and the GDP growth rate and the grants-to-GDP ratio, respectively. The number of iterations was 10. The pre-HIPC period covered from 1988 to 1999, while the post-HIPC covered from 2007 to 2018.

Table A.7. Bayesian shrinkage estimates by country with external public debt service-to-GDI
ratio and real GDP growth rate after debt relief initiatives

Country	Variable	Parameters	T-Stat	Country	Parameters	T-Stat
BGD	Const	0.0794497	0.1041478	LSO	1.4484689	0.8991353
	Y_1	0.0110070	0.2934977		-0.0139240	-0.3476467
	R_1	0.0952586	9.0768666		0.0739686	3.0559252
	G_1	0.0462320	0.5224467		-0.0618675	-0.9094184
BEN	Const	0.5159465	0.4220970	MDG	0.5355995	0.4552190
	Y_1	0.0635864	1.1401553		0.0189084	0.3377044
	R_1	0.0600789	3.8227696		0.0802176	7.3926266
	G_1	0.0309770	0.3669322		0.0259579	1.1918552
BTN	Const	-0.3694384	-0.2056969	NPL	0.7163897	0.4978962
	Y_1	0.0795132	1.8532509		0.0005703	0.0123908
	R_1	0.0744418	2.4457943		0.0845380	4.3556307
	G_1	0.0671278	0.5486682		-0.0393235	-0.3463634
BWA	Const	-0.0298696	-0.0210092	NIC	12.160396	11.099519
	Y_1	0.0484318	0.8473185		-0.2583489	-7.4003480
	R_1	0.0803305	4.0413136		-0.0781492	-5.1337467
	G_1	0.0902432	0.8221174		-0.5760831	-13.337722
BFA	Const	-0.9311170	-0.6314244	PAK	-0.0084144	-0.0048585
	Y_1	0.0735166	1.1636614		0.0418638	0.5907859
	R_1	0.0907686	5.8882885		0.0835206	5.6912644
	G_1	0.0893436	1.8103891		0.0449381	0.3876942
CPV	Const	0.5326817	0.2970166	RWA	0.3608672	0.2126099
	Y_1	0.0515155	1.2469915		0.0701437	1.1706965
	R_1	0.0650819	2.1204886		0.0607899	2.7446836
	G_1	0.0347538	0.2864482		0.0478604	0.9675971
SWZ	Const	-1.1788138	-1.6981053	SEN	-0.7783475	-0.3017297
	Y_1	0.0873614	2.0034881		0.1203237	1.4515461

	R_1	0.0905637	6.5222853		0.0659249	2.1409391
	G_1	0.1138511	1.1870490		0.0831019	0.6053538
ETH	Const	2.0140855	0.9464717	SLE	11.169192	5.5815420
	Y_1	0.0249598	0.3681216		-0.2861708	-4.6664805
	R_1	0.0411708	1.4905743		-0.0409300	-1.4035638
	G_1	0.0010886	0.0131495		-0.4947896	-4.8945018
GHA	Const	3.9297506	3.1011934	SDN	0.0552936	0.0322663
	Y_1	-0.0548163	-1.1398788		0.0046655	0.0887288
	R_1	0.0304109	1.9412785		0.0979893	4.7232191
	G_1	-0.0727760	-1.2123421		0.0613326	0.5844740
GUY	Const	8.5802963	3.4529254	TZA	2.1986181	1.4961161
	Y_1	-0.2280332	-2.8878437		-0.0245600	-0.4045861
	R_1	-0.0035022	-0.1167009		0.0583974	3.7788238
	G_1	-0.4126107	-3.0897421		0.0228821	0.4502218
HND	Const	7.0212579	3.2466105	UGA	0.3521585	0.4224024
	Y_1	-0.1672289	-2.2595976		0.0682676	1.5114852
	R_1	0.0070232	0.2828380		0.0617456	4.8144885
	G_1	-0.3681596	-3.0359241		0.0440568	1.6866075
IDN	Const	0.2881352	0.3179747	ZMB	1.9491068	1.1617412
	Y_1	0.0423115	0.8556073		0.0269735	0.4636862
	R_1	0.0754066	7.3462607		0.0414957	1.8176691
	G_1	0.0366136	0.4148229		-0.0436658	-0.4920566
KEN	Const	1.3871002	0.5007803	ZWE	0.8465442	0.6676848
	Y_1	0.0339412	0.3530133		0.0190418	0.7081914
	R_1	0.0523914	1.8356834		0.0719442	2.9921444
	G_1	-0.0190937	-0.1136850		-0.0500920	-0.5121356
LAO	Const	-0.1123577	-0.0763836			
	Y_1	0.0826746	3.3586293			
	R_1	0.0668936	2.4010634			
	G_1	0.0500471	0.4622037			

Note: Const, Y\_1, R\_1, and G\_1 correspond to the constant, the lagged external public debt-to-GDP ratio, the real GDP growth rate and the grants-to-GDP ratio, respectively. The number of iterations was 10. The period covered from 2007 to 2018.



Figure A.5. Parameters (Y\_1) based on shrinkage estimators and average external public debt stock

Note: The coefficients  $(\hat{\alpha}_i)$  on the x-axis, associated with  $Y_{it-1}$ , in Eq.1, are reported in Table A.5., and the average external public debt stock pre-HIPC is shown on the y-axis. Parameters correspond to the estimated coefficient for the relationship between the change in and the level (lagged) of external public debt-to-GDP ratio, following the HIPC initiative (post-HIPC).



Figure A.6. Parameters (R\_1) based on shrinkage estimators and average external public debt stock

Note: The coefficients  $(\hat{\delta}_i)$  on the x-axis, associated with  $R_{it-1}$ , in Eq.2, are reported in Table A.7., and the average external public debt stock pre-HIPC is shown on the y-axis. Parameters correspond to the estimated coefficient for the relationship between the change in and the GDP growth rate, post-HIPC.



Figure A.7. Parameters (Y\_1) based on shrinkage estimators and debt reduction amounts from 1988 to 2006

Note: The coefficients  $(\hat{\alpha}_l)$  on the x-axis, associated with  $Y_{it-1}$ , in Eq.1, are reported in Table A.5., and the total amounts of debt forgiveness or reduction granted to the developing countries from 1988 to 2006 is shown on the y-axis. Parameters correspond to the estimated coefficient for the relationship between the change in and the level (lagged) of external public debt-to-GDP ratio post-HIPC.

		Pre-HIPC		Post-	HIPC
Country	Variable	Parameters	T-Stat	Parameters	T-Stat
BGD	Const	0.0632336	8.0419385	-0.0136393	-0.4169656
	Y_1P	-0.1059779	-12.673101	-0.1455270	-12.086607
	DIF_1	0.0117945	1.7573465	-0.0026141	-0.4358924
	G_1	0.0081445	0.8219363	-0.0049461	-0.5713518
BWA	Const	0.0627443	7.9382339	-0.0118952	-0.9728494
	Y_1P	-0.1040829	-12.055394	-0.1426124	-16.373576
	DIF_1	0.0137082	2.1097050	0.0005809	0.2857911
	G_1	0.0115797	1.0283901	0.0007663	0.1615540
BFA	Const	0.0649678	8.3468589	-0.0798039	-5.7186332
	Y_1P	-0.1086498	-13.020359	-0.1575046	-17.672068
	DIF_1	0.0090955	1.2551245	-0.0035648	-1.1951096
	G_1	0.0017850	0.1958592	0.0091851	11.570661
CPV	Const	0.0639252	8.3912473	0.5600438	3.4626326
	Y_1P	-0.1059975	-13.138727	0.0265387	0.5575079
	DIF_1	0.0072507	1.0135383	0.0089020	1.1646623
	G_1	0.0082370	1.1364583	-0.0134805	-1.3143763

Table A.8. Bayesian shrinkage estimates by country with external public debt-to-GDP ratio from private creditors before and after the debt relief initiatives

SWZ	Const	0.0650164	8.2933109	0.0453023	1.0051681
	Y_1P	-0.1151102	-14.326144	-0.1267649	-9.0604906
	DIF_1	0.0037229	1.0341710	-0.0013547	-0.2115116
	G_1	-0.0085358	-0.8498835	-0.0046252	-0.4718336
ETH	Const	0.0635425	8.0347252	0.6420884	4.2635204
	Y_1P	-0.1059862	-12.294372	0.0513006	1.1638088
	DIF_1	0.0115520	1.5553032	0.0095467	1.2267708
	G_1	0.0080442	0.7066933	-0.0140787	-1.3896271
GHA	Const	0.0622682	7.8566827	0.7057746	6.3510799
	Y_1P	-0.1022696	-11.777409	0.0697940	2.1594959
	DIF_1	0.0126245	1.6818289	0.0113126	1.5444161
	G_1	0.0128183	1.1120453	-0.0164983	-1.6684716
GUY	Const	0.0640975	8.1058396	0.1248691	2.3640484
	Y 1P	-0.1072662	-12.505960	-0.1037581	-6.3399708
	DIF 1	0.0112425	1.5009667	-0.0013089	-0.1849941
	G 1	0.0062281	0.5431486	-0.0067154	-0.8344170
HND	Const	0.0635726	8.0330168	0.4661486	2.2901503
	Y 1P	-0.1056403	-12.269652	-0.0017878	-0.0295745
	DIF 1	0.0113046	1.5153446	0.0069949	0.8749167
	G 1	0.0080226	0.7004225	-0.0121850	-1.1648783
IDN	Const	0.0627704	7.9138790	0.7235975	10,198179
	Y 1P	-0 1031228	-11 863263	0.0751774	3 7266633
	DIF 1	0.0125326	1 6727080	0.0116495	1 6242026
	G 1	0.0104650	0.8996057	-0.0169983	-1 7305378
KEN	Const	0.0629453	7 9417825	0.5749829	3 4473933
KEN.	Y 1P	-0 1046444	-12 033914	0.0308870	0.6254073
	DIF 1	0.0121149	1 6148666	0.0089774	1 1560147
	G 1	0.0121146	0.8866967	-0.0139148	-1 3477012
150	Const	0.0620953	7 8446912	-0.0167867	-0.3303324
200	V 1P	-0 1024757	-11 705652	-0.1/30755	-0.5505524
		0.0130355	1 7/08300	-0.1430733	-0.5317302
		0.0134512	1.1765037	0.0027294	0.3087394
MDG	Const	0.0654704	8 3031282	0.0022294	2 4530637
MDO	V 1P	-0 1122805	-13 853658	-0.0878218	-4 0175246
		-0.1122095	1 3866612	0.0004335	0.0616860
		0.0002812	0.0292152	0.00045335	0.0010009
NDI	Const	0.0003012	7.0100614	-0.0043940	0.2522692
INFL		0.0020344	12 065524	0.1259469	16 094442
		-0.1040314	1 7516036	-0.1336468	0 2902109
		0.0130379	1.0005241	0.0001304	0.0092190
NIC	G_1 Const	0.0113190	7 8851150	0 1225778	-0.0990431
NIC		0.0025299	11 202052	0.1223778	4.1042744
		-0.1030739	-11.000932	-0.1104370	-10.143904
		0.0125365	0.0419292	0.0031408	0.0107972
DAK	G_1 Const	0.0109497	7.0926500	-0.0329014	-9.0407300
FAN	Const	0.0033769	7.9650509	0.3434042	3.0301090
		-0.1049377	-11.958966	-0.0376861	-1.1084177
		0.0119141	1.5895299	0.0043996	0.5946763
SEN	G_1	0.0093024	0.7982900	-0.0100184	-1.0058676
SEN	Const	0.0050921	0.3/33550	0.0045704	2.3913982
	Y_1P	-0.1114557	-13.321360	0.0345781	0.4/343/4
		0.0109475	1.4835039	0.0091950	1.0961327
	G_1	-0.0022172	-0.2146215	-0.0143277	-1.3308145
SLE	Const	0.0631949	7.9638746	0.3518223	7.3795674
	Y_1P	-0.1051516	-11.991130	-0.0342905	-3.0707436
	DIF_1	0.0120508	1.6049049	0.0051148	1.1961990

	G_1	0.0091346	0.7838913	-0.0103913	-1.5596627
SDN	Const	0.0624409	7.8813665	0.4318310	5.8797949
	Y_1P	-0.1024534	-11.895518	-0.0119937	-0.5794669
	DIF_1	0.0125694	1.6782207	0.0072140	1.0080944
	G_1	0.0115623	1.0000690	-0.0111278	-1.1215349
TZA	Const	0.0603983	7.8451428	0.3149881	2.1955503
	Y_1P	-0.0991331	-12.944381	-0.0467040	-1.1074386
	DIF_1	0.0141489	1.9144923	0.0042524	0.5483325
	G_1	0.0191331	2.0641294	-0.0087547	-0.8945385
ZMB	Const	0.0640009	8.1891104	0.7235743	4.2622993
	Y_1P	-0.1066295	-13.075844	0.0753168	1.5032059
	DIF_1	0.0108703	1.4731690	0.0120696	1.5700722
	G_1	0.0059065	0.5563587	-0.0167738	-1.6411226
ZWE	Const	0.0628622	7.9887990	0.2794346	3.9633751
	Y_1P	-0.1032059	-12.810561	-0.0573339	-2.9907983
	DIF_1	0.0115931	1.5759366	0.0050916	0.7910047
	G_1	0.0104282	0.9338537	-0.0090393	-0.8975167

Note: Const, Y\_1P, DIF\_1, and G\_1 correspond to the constant, the lagged external public debt-to-GDP ratio from private creditors, the difference between the interest rate and the GDP growth rate and the grants-to-GDP ratio, respectively. The number of iterations was 10. The pre-HIPC period covered from 1988 to 1999, while post-HIPC covered from 2007 to 2018. The sample includes Bangladesh (BGD), Botswana (BWA), Burkina Faso (BFA), Cape Verde (CPV), Eswatini (SWA), Ethiopia (ETH), Ghana (GHA), Guyana (GUY), Honduras (HND), Indonesia (IDN), Kenya (KEN), Lesotho (LSO), Madagascar (MDG), Nepal (NPL), Nicaragua (NIC), Pakistan (PAK), Senegal (SEN), Sierra Leone (SLE), Sudan (SDN), Tanzania (TZA), Uganda (UGA), Zambia (ZMB), and Zimbabwe (ZWE). Benin, Bhutan, Laos, and Rwanda are excluded due to lack of data availability.

Table A.9. Bayesian shrinkage estimates by country	with external public debt service-to-GDP
ratio after debt relief initiatives – Private creditors	

		Pre-HIPC		Post-HIPC		
Country	Variable	Parameters	T-Stat	Parameters	T-Stat	
BGD	Const	0.0431275	4.4100871	-0.0023890	-0.0802991	
	S_1	-0.1081866	-13.990988	-0.0196481	-1.9914832	
	DIF_1	-0.0136859	-2.2740752	-0.0025311	-0.4066730	
	G_1	0.0068390	1.0650444	-0.0068213	-0.6803740	
BWA	Const	0.0412207	3.9727202	-0.0125827	-1.0275425	
	S_1	-0.1090566	-13.457894	-0.0231222	-3.1212491	
	DIF_1	-0.0082023	-1.2582277	0.0002920	0.1367231	
	G_1	0.0049162	0.7108156	0.0024548	0.4882717	
BFA	Const	0.0388535	3.7198602	-0.0760841	-4.6152196	
	S_1	-0.1113711	-13.519210	-0.0345214	-4.2142109	
	DIF_1	-0.0115952	-1.7141009	-0.0046565	-1.2442485	
	G_1	0.0043554	0.7050916	0.0082163	7.9878841	
CPV	Const	0.0404017	3.8598063	0.2071250	1.3513209	
	S_1	-0.1103010	-13.401507	0.0341643	0.8755477	
	DIF_1	-0.0148674	-2.2924363	0.0025206	0.3267882	
	G_1	0.0076841	1.5101524	-0.0083953	-0.7412803	
SWZ	Const	0.0513159	5.4671572	-0.0163200	-0.3799374	
	S_1	-0.0967684	-14.973287	-0.0218103	-1.7570321	
	DIF_1	-0.0141683	-4.0542241	-0.0028748	-0.4433146	
	G_1	0.0086836	1.2928277	-0.0043641	-0.3992396	
ETH	Const	0.0383885	3.6344965	0.2447880	1.6307278	
	S_1	-0.1119102	-13.423636	0.0435261	1.1381610	
	DIF_1	-0.0097032	-1.3736234	0.0017454	0.2261749	
	G_1	0.0032618	0.4690895	-0.0069978	-0.6318601	
GHA	Const	0.0399413	3.7862469	0.2906748	1.9956405	

	S_1	-0.1102195	-13.266864	0.0551525	1.4855853
	DIF_1	-0.0100715	-1.4176030	0.0037440	0.4886582
	G_1	0.0049703	0.7140084	-0.0098536	-0.8806686
GUY	Const	0.0384198	3.6368530	0.0795671	1.6708467
	S_1	-0.1121711	-13.478737	0.0017999	0.1346007
	DIF_1	-0.0100246	-1.4101531	-0.0020287	-0.2843716
	G_1	0.0034404	0.4936145	-0.0063611	-0.7252258
HND	Const	0.0393868	3.7399989	0.2107876	1.4120897
	S_1	-0.1107279	-13.431393	0.0350309	0.9210756
	DIF_1	-0.0103567	-1.4592313	0.0024517	0.3189464
	G_1	0.0038742	0.5562911	-0.0089458	-0.7922670
IDN	Const	0.0394093	3.7328318	0.3918935	2.9614524
	S_1	-0.1107625	-13.324120	0.0807701	2.3909293
	DIF_1	-0.0098088	-1.3816670	0.0057882	0.7636055
	G_1	0.0040548	0.5807192	-0.0131987	-1.1801493
KEN	Const	0.0389046	3.6835499	0.2533882	1.7882446
	S_1	-0.1114685	-13.390434	0.0457496	1.2654456
	DIF_1	-0.0099990	-1.4063750	0.0029833	0.3890247
	G_1	0.0042659	0.6115935	-0.0090843	-0.8034314
LSO	Const	0.0397770	3.7670879	-0.0386186	-1.0126852
	S_1	-0.1104114	-13.263112	-0.0293527	-2.9561366
	DIF_1	-0.0097700	-1.3752836	-0.0030932	-0.5150526
	G_1	0.0052800	0.7601631	0.0020505	0.2941481
MDG	Const	0.0367279	3.5023439	0.1282572	2.1060814
	S_1	-0.1140844	-13.910459	0.0144998	0.8592753
	DIF_1	-0.0095825	-1.3559357	-0.0004431	-0.0635395
	G_1	0.0031866	0.4719073	-0.0041499	-0.8645134
NPL	Const	0.0385420	3.6719158	0.0064192	1.7071267
	S_1	-0.1118616	-13.505860	-0.0007390	-0.2099070
	DIF_1	-0.0084656	-1.2151328	-1.023E-06	-0.0033101
	G_1	0.0041704	0.6074867	-0.0020368	-1.8307539
NIC	Const	0.0387698	3.6676065	0.1256462	5.4319221
	S_1	-0.1116111	-13.374474	0.0156166	1.8964989
	DIF_1	-0.0097969	-1.3777574	0.0050803	0.9942818
DAK	G_1	0.0041653	0.5967773	-0.0407003	-11.756509
PAK	Const	0.0402379	3.8183094	0.1959645	1.0002440
		-0.1096526	-13.200916	0.0312595	1.1007403
		-0.0099960	-1.4072015	0.0017362	0.2303173
SEN	Const	0.0041990	3 6059276	0.2038085	1 3277155
OLIN	S 1	-0 1130108	-13 952788	0.0333123	0.8523371
	DIF 1	-0.0088879	-1 2610444	0.0022822	0 2957745
	G 1	0.0029496	0.4396026	-0.0087525	-0 7738703
SLE	Const	0.0387456	3.6651753	0.1446754	1.9256056
	S 1	-0.1116344	-13.374911	0.0183505	0.9071209
	DIF 1	-0.0098329	-1.3828552	0.0043319	1.1412002
	G 1	0.0039815	0.5702612	-0.0138838	-2.8658286
SDN	Const	0.0385857	3.6510032	0.2482695	2.0158034
	S_1	-0.1116771	-13.380939	0.0444668	1.4051673
	DIF_1	-0.0095129	-1.3413453	0.0039117	0.5201394
	G_1	0.0038806	0.5561815	-0.0089438	-0.7948285
TZA	Const	0.0381459	3.6307689	0.1865647	1.4018755
	S_1	-0.1122636	-13.612381	0.0288262	0.8450944
	DIF_1	-0.0091748	-1.2953367	0.0018440	0.2403733
	G_1	0.0034374	0.5325749	-0.0071122	-0.6775476
ZMB	Const	0.0376459	3.5776867	0.2224028	1.4568287
	S_1	-0.1130578	-13.753325	0.0379728	0.9767372

	DIF_1	-0.0104281	-1.4729030	0.0028804	0.3737224
	G_1	0.0022231	0.3256121	-0.0088051	-0.7833342
ZWE	Const	0.0378470	3.6060838	0.0661728	0.5841357
	S_1	-0.1129373	-13.822455	-0.0013531	-0.0462192
	DIF_1	-0.0108122	-1.5344029	0.0001413	0.0207172
	G_1	0.0035103	0.5043723	-0.0090196	-0.8112916

Note: Const, S\_1, DIF\_1, and G\_1 correspond to the constant, the lagged external public debt service-to-GDP ratio, the difference between the interest rate and the GDP growth rate and the grants-to-GDP ratio, respectively. The number of iterations was 10. The pre-HIPC period covered from 1988 to 1999, while post-HIPC covered from 2007 to 2018.



Figure A.8. Risk of debt distress for Low-Income Countries

Source: Authors' calculation; Debt Sustainability Analysis, International Monetary Fund – World Bank.