How Costly are Debt Crises?[•]

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Abstract

The aim of this paper is to assess the short and medium-term impact of debt crises on GDP. Using an unbalanced panel of 154 countries from 1970 to 2008, the paper shows that debt crises produce significant and long-lasting output losses, reducing output by about 10 percent after 8 years. The results also suggest that the effects of debt crises tend to be more detrimental than the effect of banking and currency crises. The significance of the results is robust to different specifications, identification and endogeneity checks, and datasets.

Keywords: Output Losses, Debt Crises, Sovereign Defaults.

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1. Introduction

The recent general increase in public debt level and severe funding pressures facing by some European countries have brought once again discussions on the problems of sovereign debt. Unsurprisingly, the discussions have mainly focused on the impact of banking crises and economic slowdown on public debt[1], rather than the costs of debt crises. Moreover, although it is a common view that debt crises may be damaging and that large increase in public debt has frequently led to sovereign defaults, with negative effects on output, quite surprisingly, only few literature studies have tested the effect of debt crises on output, and even less works have focused on the timing of economic recovery after debt crisis episodes.[2]

The economic literature has identified three main channels trough which sovereign debt crises affect output.[3] The first channel is trough the exclusion to international capital markets. Sandleirs *et al*. (2004) show that after the occurrence of a sovereign default, countries were excluded from international capital markets for about four years on average. Similarly, Richmond and Dias (2008) find that exclusions to international capital markets after a sovereign default lasted on average 4 years (5.5 years for debt crisis episodes in the 1980s, 4.1 in the 1990s, and 2.5 in the 2000s). The second channel is trough an increase in the cost of borrowing. For example, Borensztein and Panizza (2009) find that for 31 emerging market economies in the period 1997-2004, in the year after a sovereign default episode spreads increased by about 400 basis points compared to tranquil times. The third channel is trough international trade. Rose

[1] The OECD Economic Outlook (2010) projects that the increase in the gross debt-to-GDP ratio for OECD economies during the period 2007-2014 around 35 percentage points. Similar results are provided by IMF Fiscal Monitor (2010). Furceri and Zdzienicka (2010c) analyzing a panel of 154 countries from 1980 to 2006, show that severe banking crises are associated with a significant and long-lasting increase of about 37 percentage points of the government gross debt-to-GDP ratio. Reinhart and Rogoff (2009) estimate that in the three years after the occurrence of a banking crisis the real value of government debt rose on average by 86%.

[2] Cerra and Saxena (2008) Panizza *et al.,* (2009).

[3] See Panizza *et al*. (2009) for a survey of the recent literature on sovereign debt defaults, its determinants and effects.

(2005) finds a significant reduction in bilateral trade of approximately 8 percent per year following the occurrence of a sovereign default.[4] In addition to these channels, debt crises can affect output indirectly by leading to banking and currency crises (De Paoli *et al*. 2009).

The results of the empirical literature on the relation between sovereign default and growth have in general confirmed that debt crises may lead to significant output contractions. Sturzenegger (2004), using cross-country and panel regressions finds that debt defaults are associated with a reduction in output growth of about 0.6-2.2 percentage points. De Paoli *et al.* (2009), comparing output growth five years before and after the occurrence of a debt crisis, find that debt crises are associated with output losses of at least 5 percent per year and last about ten years. In contrast, Levy-Yeyati and Panizza (2010) analyzing quarterly data for output growth find that growth recovers in the quarters immediately after the occurrence of a debt crisis.[5]

The results of these growth regressions, however, should be interpreted with some cautions since may suffer from two main biases. First, sovereign debt crises may be endogenous to output declines. Indeed, many of episodes of debt defaults have occurred in period of strong output contractions. Chiang and Coronado (2005) and Boreinsztein and Panizza (2010) attempt to address this issue by using a two–step approach, in which the probability of sovereign defaults is estimated in the first stage regression, and then used in the second stage in the growth regression. However, this approach does not fully deal with endogeneity given the impossibility to find strongly exogenous instruments for debt crises. In addition, the results of the second stage regression may be very sensitive to the particular model used to estimate debt crises probabilities.

[4] Sovereign default can also affect economic output thought domestic channels such as a reduction in consumption and investment or fall in total factor productivity.

[5] The authors argue that a more persistent impact of sovereign default found using annual data is likely to be driven by the anticipation of defaults. Panizza *et al*. (2009) comparing the impact of anticipated and non-anticipates defaults on output find no significant differences between two types of crises.

The second form of bias comes from the *indistinguishable* connection that exists between currency, banking and debt crises. This is particularly the case for emerging economies that have been frequently hit by the simultaneous occurrence of banking, currency, and debt crises. The simultaneous occurrence of these types of financial crises is often attributed to the so-called "original sin" syndrome (Eichengreen *et al*., 2003), occurring when most of the private and public debt is short-term denominated in foreign currency. Following large domestic exchange rate depreciations associated with currency crises, public debt (when mostly foreign denominated) can increase considerably and lead to defaults. Reinhart and Rogoff (2010a,b) suggest the following causality: private sector defaults precede banking sector crises that coincide or precede public debt defaults. At the same, the opposite may also occur: public debt defaults may lead to banking crises when banks are the main holders of government debt. Banking and debt crises could also lead to currency crises. For instance, *third generation* crises theory (Krugman, 1999) underlines the role of maturity mismatches and currency disequilibria in private (mostly banking sector) balance sheets as the main reason for the onset of currency crises.

This paper tries to address these issues. In particular, its contribution to the existing literature is fourfold:

- It analyzes the impact of debt crises on output both in the short and in the medium-term.
- It attempts to address endogeneity and reverse causality by using two approaches. The first, in line with the most recent empirical literature that analyzes the determinants of growth in a panel framework, consists of using a two-step GMM-system estimator. The second approach consists of estimating the impact of debt crises on growth using

the two-step GMM *only* for those debt crises episodes that occurred in periods when contemporaneous output did not fall.

- It tries to isolate the impact of debt crises from the effect of banking and currency crises using two different estimation strategies. The first approach consists of estimating the effect of debt crises on output *together* with the effect of currency and banking crises. In this way, it is possible to quantify the *marginal* contribution of each crisis to output. In the second strategy, the effect of debt crises on output is estimated *only* for those episodes for which neither a banking nor a currency crisis occurred in the 2 years before, during, or after the onset of a debt crisis for those episodes for which neither a banking nor a currency crisis occurred in the previous two years.
- To check for the robustness of our results, it uses several datasets of starting dates for debt crises episodes.

The estimates based on an unbalanced panel of 154 countries from 1970 to 2008 suggest that debt crises are very costly to output both in the short and in the medium-term. In the short-term, the results suggest that debt crises reduce contemporaneous output growth by 6 percentage points. The results are robust to different specifications, and to different robustness checks to control for endogeneity and identification of debt crises (vs. banking and currency crises). In particular, focusing on those debt crisis episodes characterized by a contemporaneous non-negative growth, the analysis suggests that debt crises reduce output growth by about 6-10 percentage points. Similarly, focusing on debt crisis episodes for which neither a banking nor a currency crisis occurred in the two 2 years before, during, or after the onset of a debt crisis, the results confirm that debt crises significantly and negatively affect contemporaneous output

growth, with a magnitude of the effect of about 8 percentage points. The results are also robust to alternative datasets with a magnitude of the effect ranging from 5 to 10 percentage points.

Debt crises are also associated with significant output losses over the medium-term: 8 years after the occurrence of a debt crisis, output contracts by about 10 percent. The statistically significance of the result is robust to the estimation procedures used (local projections and ARDL) and to different specifications.

Finally, the paper presents empirical evidence that output growth is reduced not only by the occurrence of a debt crisis, but also when public (total and foreign) debt exceeds a particular threshold.

The rest of the paper is organized as follows. Section 2 describes the data and the identification of debt crises episodes. Section 3 presents the empirical methodology used to assess the short and medium-term effects of debt crises on output, and the results. Section 4 summarizes the main results and concludes with some issues for future research.

2. Data

To identify debt crises episodes the paper relies on several datasets (Table 1):

- The first dataset is the one constructed by Laeven and Valencia (2008) who list the starting date of debt crisis episodes as a compilation of years of sovereign defaults to private lending and years of debt rescheduling. The authors rely on information from Beim and Calomiris (2001), World Bank (2002), Sturzenegger and Zettelmeyer (2006), and IMF Staff reports.[6] Overall the authors identify 63 crises episodes, which mainly occurred in the 1980s: 7

[6] The Work Bank *Global Development Finance* Report (2002) provides a list of 26 countries for which debt-restructuring agreements with their commercial creditors were completed in 2001. Beim and Calomiris (2001) provide the date of debt defaults for several emerging economies during the period 1970-2000. Sturzenegger and

episodes occurred in the period 1970-1979, 41 between 1980 and 1989, 7 in the period 1990-1999, and 8 after 1999.

- The second set of banking crises episodes is the one collected by De Paoli *et al*. (2006). The authors identify 39 episodes of sovereign default over the period 1970-2000 when the arrears on principal on external obligations towards private creditors reach at least 15 percent of total commercial debt outstanding and/or there is a rescheduling with private creditors as listed in the World Bank *Global Development Finance.*

- An alternative dataset of debt crises episodes is the one constructed by Reinhart *et al*. (2003). The authors identify 31 debt crises episodes over the period 1970-2001 using the dates reported in Beim and Calomiris (2001) on defaults and restructurings, and Standard and Poor's *Credit Week* information.

- A fourth dataset is Detragiache and Spillimbergo (2000) which covers 54 episodes of debt crises. Defaults are identified when arrears of principal on interest on external obligations towards commercial creditors exceed 5 percent of total commercial debt outstanding (excluding the episodes that occur within four years of the previous defaults) and/or there is a rescheduling with private creditors as listed in the World Bank's *Global Development Finance*.

- Finally, the last dataset considered in the analysis is Levy-Yeyati and Panizza (2010). The authors identify 20 default episodes over the period 1980-2003 (excluding the episodes that occur within three years of the previous defaults). Episodes are classified as beginning years of foreign currency bank or bond debt default, using information reported in Standard and Poor's *Credit Week,* World Bank *Global Development Finance* and the financial press.

Zettelmeyer (2006) list selected government defaults and restructurings of private held bonds and loans over the period 1920-2004.

Table 2 presents descriptive statistics for total and foreign public debt (as share of GDP), and GDP growth in relation to the debt crises episodes identified in the datasets described above. Looking at the table, it is immediately evident that starting dates of debt crises are associated with periods of negative growth and relative high domestic and foreign public debt. In particular, focusing on the first raw of the table (for which more episodes and more observations for public debt are available) debt crises generally occur when the gross public debt-to-GDP ratio is higher than 80 percentage points, the public foreign gross debt-to-GDP ratio is above 55 percentage points, and GDP growth is about - 2 percent.

Data for banking and currency crises episodes are taken from Laeven and Valencia (2008). The authors determine the starting dates of banking crises combining quantitative indicators measuring banking sector distress, such as a sharp increase in non-performing loans and bank runs, with a subjective assessment of the situation. In particular, the database extends and builds on Caprio, *et al*. (2005) banking crises database and covers the universe of systemic banking crises for the period 1970-2007. Currency crises episodes are identified when a currency have a nominal depreciation of 10 percent in one year, and 30 percent overall (Frankel and Rose, 1996). Data for real GDP are taken from the World Bank Economic Indicators. Data for public (domestic and foreign[7]) debt are taken from Panizza (2008).

3. Empirical Analysis

This section analyzes the impact of debt crises on short-term growth. The first part of the section assesses the short-term effect of debt crises also controlling for reversal causality, identification of debt crises (vs. banking and currency crises) and providing several robustness

[7] Foreign debt is defined as public debt issued in foreign countries and under the jurisdiction of a foreign court.

tests. Additionally, it investigates the impact of an important increase in public debt on output growth (*debt thresholds*). The second part of the section extends the analysis to the medium-term (i.e. up to 8 years after the occurrence of a debt crisis).

3.1 Short-term

Following previous studies in the literature on the short-term effects of banking and/or currency crises on output, the methodological approach used in the paper consists of estimating contemporaneous output growth against a dummy variable that takes value equal to 1 for the occurrence of a crisis and 0 otherwise, and a set of variables influencing short-term growth. In particular, the formal specification of the empirical model used for the short-term analysis is as follows:

$$y_{i,t} - y_{i,t-1} = \alpha_i \ + \sum_{j=1}^{2} \gamma_j \ \ \Delta y_{i,t-j} + \beta \ \ D_{i,t}^{D} + \boldsymbol{\delta}' \boldsymbol{X_{it}} + \varepsilon_{i,t} \qquad (1)$$

where $y_{i,t}$ is the log of real GDP for country *i* at time *t* and zero otherwise, $D_{i,t}^{D}$ is a dummy variable that takes the value equal to 1 if a debt crisis occurred in country *i* at time *t* and 0 otherwise, α_i are country-specific effects included to account for different growth trends among countries, $\boldsymbol{X_{it}}$ is a set of variables influencing growth in the short-term, and β represents the *marginal* effect of the occurrence of a debt crisis on growth. The empirical literature on growth has suggested numerous variables as possible determinants of growth (see, for example, Levine and Renelt, 1992; Sala-i-Martin 1997, Sala-i-Martin *et al*. 2004). However, some of these variables are likely to influence growth only over the medium–term, and are not available on a yearly basis (e.g., human capital) over a long time span and for a large set of countries. Therefore to keep the specification parsimonious, the variables included in the vector $\boldsymbol{X_{it}}$ have been restricted to: trade openness (defined as the share of total exports and imports in GDP),

population growth, (private) credit growth, real exchange rate growth and the initial (lagged) level of GDP. In addition, given that the main concern is to introduce relevant control variables into the regression so that the estimated impact of a debt crisis on output is not biased due to the omission of variables, two lags of real GDP growth have been included.

To address endogeneity due to the presence of the lagged dependent variable among regressors and to reverse causality from growth to the occurrence of debt crises, Equation 1 has been estimated using the two-step GMM-system estimator. [8]

The results obtained estimating Equation 1 (column I, Table 3) suggest that debt crises significantly reduce contemporaneous output growth by about 6 percentage points. The significance of the results is robust across the different specifications with an estimated impact that ranges from about 5 to 6 percentage points (column II-VII, Table 3).

The controls variables that have a positive and (most of the time) statistically significant effect are trade openness, population growth, credit growth and the first lag of real GDP growth. Consistency of the two-step GMM estimates has been checked by using the Hansen and the Arellano-Bond tests. The Hansen J-test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process, cannot reject the null hypothesis that full set of orthogonality conditions are valid (across the different specifications the p-value ranges from 0.3 to 1). The Arellano–Bond test for autocorrelation cannot reject the null hypothesis of no second-order serial correlation in the fist-differenced error terms (across the different specifications the p-value ranges from 0.2 to 1).

[8] The two-step GMM-system estimates (with Windmeijer standard errors) are computed using the xtabond2 Stata command developed by Roodman (2009). Openness, lagged real exchange rate growth, lagged real credit growth, lagged credit growth and lagged debt crises are as predetermined, other control variables are considered as endogenous (instrumented using up to 3 lags).

Although these tests confirm the consistency of the GMM estimates, reverse causality from growth to debt crises may be still an issue, since as shown in Table 2 debt crises tend to occur in periods of negative growth, and since the impossibility to find strongly exogenous instruments for debt crises. To address this issue and to check the robustness of the results, Equation 1 has been re-estimated excluding those debt crises episodes that occurred in periods when contemporaneous output has fallen after a period of positive growth ($growth_t < 0$, $growth_{t-1} > 0$). Two different specifications are estimated. In the first specification all observations are considered. In the second one, the observations characterized by contemporaneous negative growth and the occurrence of a debt crisis are dropped. The results obtained for both specifications confirm that debt crises have a statistically significant and negative impact on contemporaneous output growth (column VIII and IX, Table 3).[9]

To check for the robustness of the results, another approach to address reverse causality from growth to debt crises, somewhat similar to GMM estimates, has been also carried out. Following Chiang and Coronado (2005) and Boreinsztein and Panizza (2009), the approach consists of estimating the probability of default using various predictors of debt crises, and then using the predicted probability of default in the growth regression. The results obtained with this approach, not reported, confirm that debt crises have a significant and negative effect on contemporaneous output growth. The magnitude of the effect, however, is very sensible to the choice of specification used to estimate default probabilities, with point estimates that range from 1 to 25 percentage points.

[9] The probability of default is estimated using a Logit model and considering as explanatory variables: i) the debt-to-GDP ratio; ii) banking crisis dummy; iii) currency crisis dummy; iv) contemporaneous and lagged growth; v) the ratio of foreign reserve-to-GDP; vi) the ratio of short-term debt-to-GDP ; vii) openness; ix) exchange rate volatility and) inflation. The full set of results is available upon request.

Finally, as additional robustness check, Equation (1) has been re-estimated using the alternative datasets described in Section 2. The results reported in Table 4 provide robust empirical evidence that debt crises have a significant and negative effect on contemporaneous output. The magnitude of the point estimates varies across datasets, ranging from 5 to 10 percentage points. Since these datasets mainly differ for the composition of the countries for which a debt crisis is attributed, rather than the dating of the crisis itself, it is likely that the different estimates simply reflect the heterogeneous response of countries to the debt crises and the different severity of the crises. However, these differences are not statistically significant.

3.1.1. Debt vs. Currency and Banking Crises

The close connection between currency, banking and debt crises, makes it particularly difficult to isolate the impact of debt crises on the real output. For example, as pointed out by Reinhart and Rogoff (2010b) it is possible that a banking (and/or currency) crisis may trigger a debt crisis, in which case the estimated effect of debt crises on contemporaneous output growth could be just interpreted as the lagged effect of banking (or currency) crises episodes. To address this issue two different approaches have been carried out.

The first approach consists of estimating the effect of debt crises on output together with the effect of currency and banking crises. In this way, it is possible to quantify the *marginal* contribution of each crisis to output. To this purpose the following specification is estimated:

$$y_{i,t} - y_{i,t-1} = \alpha_i + b_t + \sum_{j=1}^{2} \gamma_j \Delta y_{i,t-j} + \beta_1 D_{i,t}^{D} + \beta_2 D_{i,t}^{C} + \beta_3 D_{i,t}^{B} + \theta_1 D_{i,t}^{D} D_{i,t}^{C}$$

$$+\theta_2 D_{i,t}^{D} D_{i,t}^{B} + \theta_3 D_{i,t}^{C} D_{i,t}^{B} + \vartheta D_{i,t}^{D} D_{i,t}^{C} D_{i,t}^{B} + \varepsilon_{i,t} \qquad (2)$$

where $D_{i,t}^{C}$ ($D_{i,t}^{B}$) is a dummy variable that takes the value equal to 1 if a currency (banking) crisis occurred in country *i* at time *t*. The (full) empirical specification includes three types of twin

crises: debt-currency $(D_{i,t}^{D}D_{i,t}^{C})$, debt-banking $(D_{i,t}^{D}D_{i,t}^{B})$, and currency-banking $(D_{i,t}^{C}D_{i,t}^{B})$. Similarly to Hutchinson and Noy (2005), twin crises are defined as those crises in which the onset of a given crisis occurs 2 years before, during, or after the onset of another type of crises. Finally, Equation (3) also includes *triple* debt-currency-banking crises $(D_{i,t}^{D}D_{i,t}^{C}D_{i,t}^{B})$. Analogously to the definition of twin crises, triple crises are defined as those crises in which the onset of a given crisis occurs 2 years before, during, or after the onset of the other two types of crises. The coefficients $\beta_1, \beta_2, \beta_3, \theta_{1,}\theta_2, \theta_3$ and ϑ represent the *marginal* effect of debt, currency, banking, twin and triple crises on output growth. Thus, if the $\theta_s(\vartheta)$ coefficients are found to be negative and statistically significant it implies that the occurrence of a twin (triple) crisis has an additional negative impact on output growth above and beyond the combined effect of the two (three) types of crises. The results obtained estimating Equation 3 (Table 5) confirm that debt crises significantly reduce output growth with an estimated impact that ranges across the different specifications from 5 to 8 percentage points (column I-IV). More interestingly, looking at the full specification the effect of debt crises seems to be more detrimental than the effect of currency or banking crises. Among the twin and the triple crises dummy, only the twin banking-currency crisis has a negative and statistically significant effect. The results are qualitatively robust to different year windows (1 year and 3 years).

The second approach consists of estimating the effect of debt crises on output together with the effect of currency and banking crises but *only* for those episodes for which neither a banking nor a currency crisis occurred in the 2 years before, during, or after the onset of a debt crisis. By doing this, the number of debt crises episodes is reduced to 20. The results obtained with this approach confirm that debt crises significantly reduce output growth (column V of Table 4). In particular, the occurrence of a debt crisis, not preceded nor followed by a banking

and/or a currency crisis, is found to reduce contemporaneous output growth by about 8 percentage points. In addition, this analysis also suggests that the effect of debt crises could be more detrimental than the effect of currency or banking crises.

3.1.2 Debt thresholds

The results presented in the previous section have provided strong empirical evidence that debt crises significantly reduce contemporaneous output growth. An interesting hypothesis to test is also whether output growth is reduced not only by the occurrence of a debt crisis, but also when public (total and foreign) debt exceeds a particular threshold. A first work in this direction is Reinhart and Rogoff (2010a). The authors, analyzing a multi-country historical large dataset on central government debt as well as data on external (public and private) debt, present descriptive evidence showing that when the gross public debt-to-GDP ratio exceeds 90 percent, median growth rates fall by one percentage points. Similarly, annual growth declines by about two percentage points when external debt reaches 60 percent of GDP.

To test the Reinhart and Rogoff's predictions a model specification similar to Equation (1) has been estimated, in which a dummy variable is constructed as taking a value equal to 1 if the gross debt-to-GDP (foreign debt-to-GDP) ratio exceeds a given thresholds and zero otherwise. The results obtained estimating this model specification for different thresholds for both the public debt-to-GDP ratio and the public foreign debt-to-GDP ratio are reported in Table 6. Starting with the debt-to-GDP ratio (column I-IV), the results provide no statistically evidence of a linear relationship between growth and debt, and show that output is reduced by about 1.8 percentage points when the debt-GDP ratio exceeds 70 percentage points. Lower thresholds, not reported, are found to be not statistically significant, while the 80 and 90 percent thresholds are

associated with a decline in output growth greater than 2 percentage points. This finding is consistent with the evidence provided in recent studies (Kumar and Woo, 2010; Checherita and Rother, 2010; and Carner *et al*. 2010).

The results for the foreign debt-to-GDP provide only weak statistical evidence of a linear relationship between foreign debt and output growth, and show that output growth is reduced by about 2.4 percentage points when the foreign debt-to-GDP ratio exceeds 80 percentage points. Lower thresholds, such as 60 and 70 percent, are not statistically significant at 5 percent.

Overall, the results seems to validate Reinhart and Rogoff's predictions (i.e. the existence of thresholds for the debt-to-GDP ratio and the foreign debt-to-GDPO ratio above which output growth starts to decline) although not in terms of the magnitude of these effects.

3.2 Medium-term

This paper also assesses whether the effect of debt crises on output is reverted over the medium-term. In order to estimate the medium-term dynamic impact of debt crises episodes on output, the paper follows the method proposed by Jorda (2005) and Teuling and Zubanov (2010) which consists of estimating impulse response functions (IRFs) directly from local projections. In detail, for each future period *k* the following equation has been estimated on annual data:

$$y_{i,t+k} - y_{i,t} = \alpha_i^k + Time_{it}^k + \sum_{j=1}^{l} \gamma_j^k \, \Delta y_{i,t-j} + \beta_k D_{i,t}^D + \varepsilon_{i,t}^k \qquad (3)$$

with *k*= 1,..8, α_i^k are country fixed effects, $Time_i$ are country-specific time trends and β_k measures the impact of debt crises on the change of (the log of) the real output for each future period *k*. The number of lags (*l*) has been chosen equal to two, even if the results are extremely robust to different numbers of lags included in the specification. Corrections for heteroskedasticity, when appropriate, have been applied using White robust standard errors.

Impulse response functions (IRFs) are then obtained by plotting the estimated β_k for k= 0,1,..8, with 95% confidence bands for the estimated IRFs being computed using the standard deviations associated with the estimated coefficients β_k. While the presence of a lagged dependent variable and country fixed effects may in principle bias the estimation of γ_j^kin small samples (Nickel, 1981), this does not create a bias in the estimation of the coefficients of interest β_k (Teulings and Zubanov, 2010). In addition, the length of the time dimension mitigates possible concerns of such a bias.[10]

The results from estimating the medium-term impact of debt crises on output using Equation (3) are presented in Panel A of Figure 1. The figure suggests that debt crises have long-lasting effects, reducing output even 8 years after the occurrence of the crisis. In particular, the estimates suggest that 8 years after the occurrence of a debt crisis output contracts by about 10 percent.

To check for the robustness of our results, Equation (3) has been re-estimated by alternatively including a common time trend and time fixed effects (Annex 1). The results using these different controls remain statistically significant and broadly unchanged. As an additional robustness test the medium-term impact of debt crises on output has been re-estimated using an ARDL (4, 4) equation[11]:

$$\Delta y_{it} = a_i + \sum_{j=1}^{4} \gamma_j \Delta y_{i,t-j} + \sum_{j=0}^{4} \beta_j D_{i,t-j} + \varepsilon_{it} \qquad (4)$$

[10] The finite sample bias is in the order of 1/T, where T in our sample is 39.

[11] The approach was initially proposed by Romer and Romer (1989) and then recently applied by Cerra and Saxena (2008), Furceri and Mourougane (2009) and Furceri and Zdzienicka (2011) to assess the long-term impact of banking crises on economic activity. It is worth to stress that the IRFs derived using this approach may suffer from some problem such as i) be sensible to the choice of the number of lags, making thus the IRFs less stable; ii) the significance of long-lasting effects on output can be simply driven by the use of *one-type of shock* models (Cai and Den Haan, 2009); iii) medium-term effects are more sensible to endogeneity problems, since are implicitly derived by estimating contemporaneous output growth.

The impulse response functions (IRFs) are obtained by simulating a one year crisis and by computing the response of output over time trough the estimated coefficients, and 95-percent level confidence bands are derived using Monte-Carlo simulations using one thousand of trials. The results obtained estimating Equation (4) with both OLS and GMM confirms that debt crises have long-lasting effects on output: 8 years after the occurrence of a debt crises output contracts by about 9-12 percentage points (Annex 1).

Finally, in order to address possible reverse causality[12] and identification problems discussed in the previous section, Equation (3) has been re-estimated by alternatively considering: i) those debt crises episodes with contemporaneous non-negative growth; ii) debt crises episodes for which neither a banking nor a currency crisis occurred in the nine years before, during, or after the onset of a debt crisis. The results for these two cases are shown in Panel B add C of Figure 1, and corroborate the negative impact of debt crises on output over the medium-term.

4. Conclusions and issues for future research

The paper analyzes the short and medium-run effects of debt crises on output for an unbalanced panel of 154 countries from 1970 to 2008. In the short-term, the results suggest that debt crises are very damaging, reducing contemporaneous output growth by 6 percentage points. The results are robust to different specifications, and to different robustness checks to control for endogeneity and identification of debt crises (vs. banking and currency crises). In particular, focusing on those debt crisis episodes characterized by a contemporaneous non-negative growth, the analysis suggest that debt crises reduce output growth by about 6-10 percentage points.

[12] In this approach the risk of reverse causality between changes in (the log of) output and the occurrence of a debt crisis is quite small since changes in output are estimated for subsequent periods (from t+1 to t+8). This is particularly the case for the estimates of the medium-term effect (i.e 8 years after the occurrence of a debt crisis).

Similarly, focusing on debt crises episodes for which neither a banking nor a currency crisis occurred in the two 2 years before, during, or after the onset of a debt crisis, the results confirm that debt crises significantly and negatively affect contemporaneous output growth, with a magnitude of the effect of about 8 percentage points. The results are also robust to alternative datasets with a magnitude of the effect ranging from 5 to 10 percentage points. Since these datasets mainly differ for the composition of the countries for which a debt crisis is attributed, rather than the dating of the crisis itself, it is likely that the different estimates simply reflect the heterogeneous response of countries to the debt crises and the different severity of the crises. These differences are, however, not statistically significant.

The medium term analysis confirms the negative effect of debt crises on output growth. In particular, debt crises are associated with protracted output losses: 8 years after the occurrence of a debt crisis, output contracts by about 10 percent. The statistically significance of the result is robust to the estimation procedures used (local projections and ARDL) and to different specifications. These are large estimates and should alarm policy makers about the risk of possible future debt crises.

Our study suggests that a number of interesting extensions can be pursued. First, as suggested by the results obtained for different datasets, the response of output to debt crises may vary across countries. Therefore, it would be useful to empirically examine the determinants of this heterogeneity.

An additional promising direction would be to expand the investigation on whether output is negatively affected not only by the occurrence of a debt crisis, but also when public (total and foreign) debt exceeds a particular threshold. The results presented in the paper suggest that output growth declines by about 1.8 percentage points (2.4 percentage points) when the

gross debt-to-GDP ratio (foreign debt-GDP ratio) exceeds 70 (80) percentage points. This analysis could be extended by analyzing thresholds with non-parametric approaches, and by looking at possible interactions between the share of public (total and foreign) debt and other variables such as trade openness, domestic saving, financial integration, financial development, and measures of perceived country risks.

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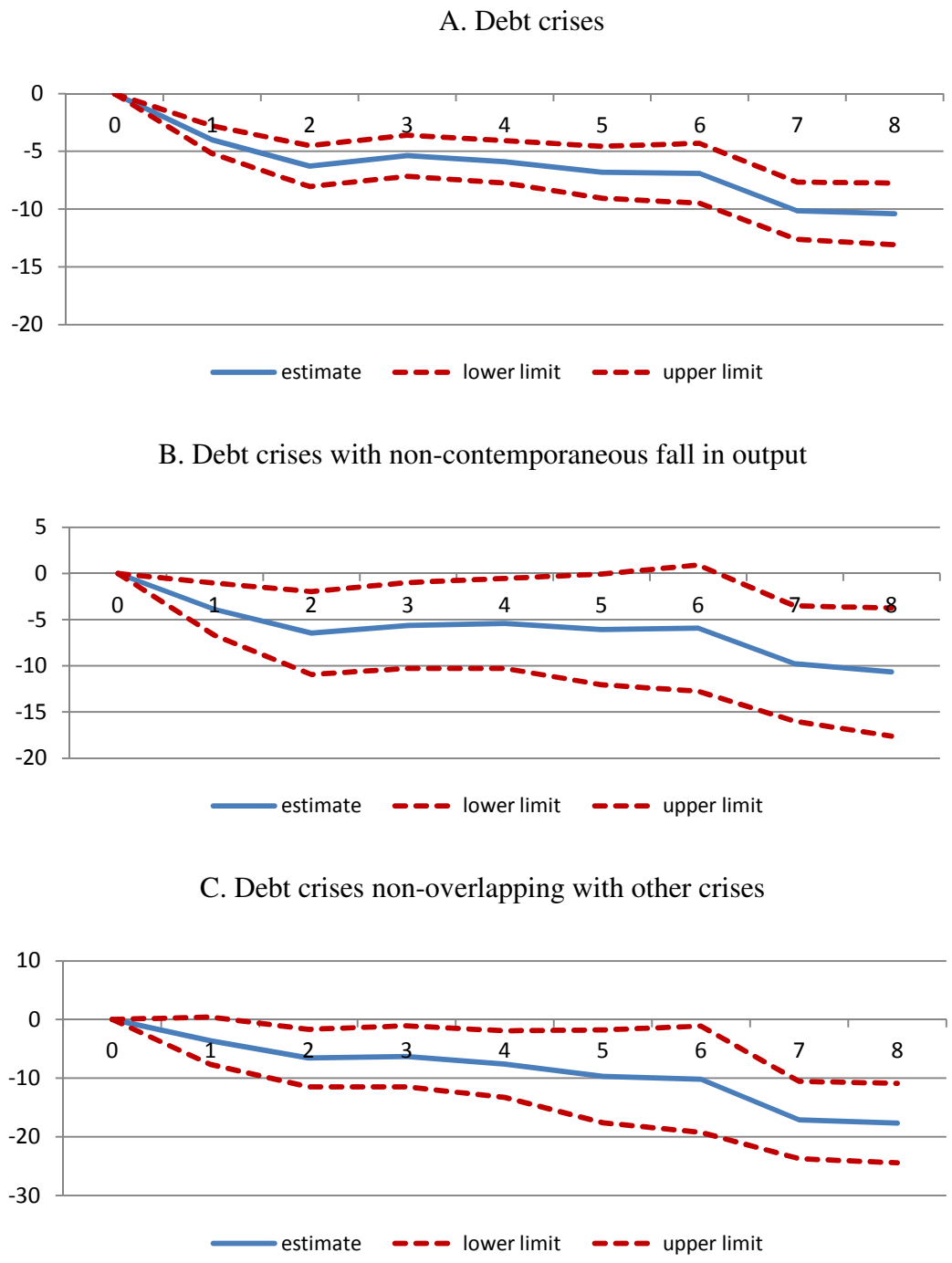
Figure 1. The effect of debt crises on output-baseline



Note: dotted lines represent 95% confidence bands.

Table 1. Debt Crises Episodes

LV					
Albania 1990	Morocco 1983	Bulgaria 1991	Argentina 1982	Dominican R. 1982,1999	Haiti 1983
Angola 1988	Mozambique 1984	Cameroon 1983	Bolivia 1980	Ecuador 1999	Honduras 1976,1983
Argentina 1982,2001	Nicaragua 1980	Chile 1983	Brazil 1983	Indonesia 1998	Indonesia 1998
Bolivia 1980	Niger 1983	Congo, D. R. 1970,1985	Bulgaria 1990	Mexico 1982	Jordan 1989
Brazil 1983	Nigeria 1983	Costa Rica 1981,1986	Chile 1972	Nigeria 1983,1986	Kenya 1990
Bulgaria 1990	Panama 1983	Cote d'Ivoire 1987	Costa Rica 1981	Pakistan 1997	Korea, Rep. 1998
Cameroon 1989	Paraguay 1982	Dominican, R.. 1984	Dominican R.1982	Peru 1980,1983	Lesotho 1990
Chile 1983	Peru 1978	Ecuador 1987	Ecuador 1982,1989	Philippines 1983	Madagascar 1990
Congo, D. R, 1976	Philippines 1983	Georgia 1994	Ecuador 1999	Russia 1991,1998	Malawi 1982,1987
Congo, Rep. of 1986	Poland 1981	Grenada 1987	Egypt 1984	South Africa 1985,1989	Mexico 1982
Costa Rica 1981	Romania 1982	Guatemala 1985	Guyana 1982	Ukraine1998	Morocco 1985
Côte d'Ivoire 1984,2001	Russia 1998	Guyana 1979	Honduras 1981	Uruguay 1990,2003	Nicaragua 1978
Dominica 2002	Senegal 1981	Haiti 1983	Iran, I.R. Of 1992	**DS**	Niger 1984
Dominican R. 1982,2003	Sierra Leone 1977	Indonesia 1998	Jamaica 1978	Algeria 1991	Nigeria 1972 ,1986
Ecuador 1982,1989	South Africa 1985	Jordan 1989	Jordan 1989	Argentina 1983	Panama 1987
Egypt 1984	Sudan 1979	Mexico 1982	Mexico 1982	Bangladesh 1978, 1991	Paraguay 1984
Gabon, 1986,2002	Tanzania 1984	Morocco 1983	Morocco 1983	Brazil 1983	Peru 1983
Gambia, The 1986	Togo 1979	Nicaragua 1978,1985	Panama 1983	Burkina 1982	Philippines 1984
Grenada 2004	Trinidad &Tobago 1989	Nigeria 1987	Peru 1978 ,1984	Burundi 1986	Senegal 1984,1989
Guinea 1985	Turkey 1978	Panama 1987	Philippines 1983	Cameroon 1979	Sierra Leone 1972
Guyana 1982	Uganda 1981	Paraguay 1983	Poland 1981	Cameroon 1985	Sri Lanka 1992
Honduras 1981	Ukraine 1998	Peru 1983	Romania 1982	Chile 1973, 1983	Sudan 1976
Indonesia 1999	Uruguay 1983,2002	Philippines 1984	Russia 1991	Colombia 1985	Thailand 1998
Iran, I.R. of 1992	Venezuela 1982	Russia 1990	Russia 1998	Congo, Dem. Rep. 1975	Trinidad & Tobago 1988
Jamaica 1978	Vietnam 1985	Sri Lanka 1990	Trinidad 1989	Costa Rica 1981	Tunisia 1991
Jordan 1989	Zambia 1983	Syrian Arab Rep. 1986	Turkey 1978	Cote d'Ivoire 1987	Venezuela 1984
Liberia 1980	**DHS**	Togo 1978, 1991	Uruguay 1983	Dominican, R. 1976,1982	Zambia 1978
Madagascar 1981	Albania 1991	Trinidad &Tobago 1989	Venezuela 1982, 1995	Ecuador 1983	
Malawi 1982	Algeria 1994	Venezuela 1984	**LP**	Egypt 1986	
Mexico 1982	Argentina 1983	Zambia 1981	Argentina 1982	El Salvador 1984,1995	
Moldova 2002	Bolivia 1982	**RHS**	Argentina 2001	Ethiopia 1987	
	Brazil 1983	Albania 1990	Chile 1983	Guatemala 1985	

LV= Laeven and Valencia (2008); DHS=De Paoli *et al*. (2006); RRS= Reinhart *et al*. (2003); DS=Detragiache and Spillimbergo (2000); LP=Levy-Yeyati and Panizza (2010).

Table 2. Descriptive statistics

Datasets	N. Crises	Debt over GDP (%)				Foreign debt over GDP (%)				GDP Growth (%)			
		Average	Max	Min	S.D.	Average	Max	Min	S.D.	Average	Max	Min	S.D.
LV	63	78.3	119.4	34.4	25.5	55.9	86.3	26.5	19.6	-2.1	7.5	-14.4	5.1
DHS	39	111.9	166.6	81.0	37.6	59.7	95.9	7.6	32.7	-2.5	10.6	-32.1	7.7
RRS	31	68.6	85.2	47.4	19.3	53.0	65.4	39.4	13.0	-2.2	5.9	-14.4	5.4
DS	54	63.8	142.0	10.8	39.7	41.0	70.6	6.0	23.3	0.7	15.4	-14.4	6.4
LY	21	64.5	96.6	21.0	26.1	46.7	78.4	21.0	20.9	-2.2	6.5	-14.1	5.3
Average		77.4				51.2				-1.7			

LV= Laeven and Valencia (2008); DHS= De Paoli *et al*. (2006); RRS= Reinhart *et al*. (2003); DS=Detragiache and Spillimbergo (2000); LP=Levy-Yeyati and Panizza (2010).

Table 3. Output Growth and Debt Crises

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII) [a]	(IX) [b]
Debt Crises $_t$	-5.566	-5.384	-5.529	-5.414	-6.065	-5.321	-6.412	-5.727	-10.043
	(-2.05)**	(-2.04)**	(-1.97)**	(-2.01)**	(-2.36)**	(-1.98)**	(-2.66)***	(-1.65)*	(-2.65)***
Real GDP growth $_{t-1}$	0.387	0.345	0.401	0.397	0.554	0.385	0.382	0.387	0.343
	(6.34)***	(6.48)***	(6.60)***	(6.89)***	(8.47)***	(6.29)***	(10.04)***	(6.33)***	(5.35)***
Real GDP growth $_{t-2}$	-0.029	-	-0.033	-0.021	-0.033	-0.029	0.01	-0.026	-0.003
	(-0.88)		(-0.99)	(-0.63)	(-0.83)	(-0.88)	(0.60)	(-0.80)	(-0.08)
Openness $_t$	0.735	0.791	-	0.769	0.532	0.377	0.526	0.738	0.771
	(2.31)**	(2.52)***		(2.42)**	(1.70)*	(1.97)**	(1.62)*	(2.38)**	(2.45)**
Population growth $_t$	0.215	0.200	0.037	-	0.067	0.082	0.235	0.200	0.241
	(1.94)**	(1.82)*	(0.39)		(0.47)	(0.93)	(2.13)**	(1.81)*	(1.99)**
Credit Growth $_t$	0.031	0.026	0.034	0.025	-	0.033	-0.006	0.028	0.020
	(1.72)*	(1.51)	(2.04)**	(1.48)		(1.95)**	(-0.22)	(1.58)*	(1.06)
Real GDP$_{t-1}$ (log)	0.197	0.199	-0.056	0.269	0.211	-	0.121	0.188	0.211
	(1.48)	(1.48)	(-0.68)	(2.04)**	(1.17)		(0.84)	(1.40)	(1.37)
Real Exchange Rate Growth $_t$	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-	-0.001	-0.001
	(-1.17)	(-1.22)	(-1.52)	(-1.15)	(-1.33)	(-1.29)		(-1.23)	(-1.04)
N	2403	2409	2403	2404	3208	2403	3398	2403	2369
Hansen test-pvalue	0.323	0.460	0.327	0.348	0.166	0.312	1.00	0.321	0.341
Arellano-Bond AR(2) test-pvalue	0.567	0.995	0.546	0.622	0.151	0.590	0.969	0.600	0.746

Note: z-statistics in parenthesis. ***,**,* denote significance at 1%, 5%, and 10%, respectively.
GMM-System Estimator: Two-step using Windmeijer standard errors, Openness , lagged real exchange rate growth, lagged real credit growth, lagged credit growth and lagged debt crises as predetermined, other control variables considered as endogenous (instrumented using up to 3 lags).
[a] Episodes of debt crises with contemporaneous non-negative output growth, and all growth observations.
[b] Episodes of debt crises with contemporaneous non-negative output growth, and observations characterized by a contemporaneous negative growth and the occurrence of a debt crisis dropped.

Table 4. Output Growth and Debt Crises

	(I) LV	(II) DHS	(III) LP	(IV) DS	(V) RRS
Debt Crises $_t$	-5.566	-5.096	-9.984	-7.143	-9.319
	(-2.05)**	(-1.72)*	(-2.27)**	(-1.94)**	(-2.63)***
Real GDP growth $_{t-1}$	0.387	0.392	0.380	0.386	0.396
	(6.34)***	(6.33)***	(6.10)***	(6.19)***	(6.10)***
Real GDP growth $_{t-2}$	-0.029	-0.023	-0.026	-0.011	-0.027
	(-0.88)	(-0.69)	(-0.79)	(-0.32)	(-0.81)
Openness $_t$	0.735	0.685	0.596	0.841	0.723
	(2.31)**	(2.35)**	(1.88)*	(2.95)***	(2.25)**
Population growth $_t$	0.215	0.182	0.176	0.259	0.207
	(1.94)**	(1.65)*	(1.56)	(2.18)**	(1.77)**
Credit Growth $_t$	0.031	0.025	0.033	0.013	0.029
	(1.72)*	(1.39)*	(1.84)*	(0.88)	(1.61)*
Real GDP$_{t-1}$ (log)	0.197	0.173	0.148	0.263	0.189
	(1.48)	(1.24)	(1.12)	(2.26)**	(1.39)
Real Exchange Rate Growth $_t$	-0.001	-0.001	-0.001	-0.001	-0.001
	(-1.17)	(-1.00)	(-1.23)	(-0.81)	(-1.17)
N	2403	2403	2403	2403	2403
Hansen test-pvalue	0.323	0.290	0.325	0.923	0.309
Arellano-Bond AR(2) test-pvalue	0.567	0.687	0.699	0.730	0.688

Note: z-statistics in parenthesis. ***,**,* denote significance at 1%, 5%, and 10%, respectively.
GMM-System Estimator: Two-step using Windmeijer standard errors, Openness , lagged real exchange rate growth, lagged real credit growth, lagged credit growth and lagged debt crises as predetermined, other control variables considered as endogenous (instrumented using up to 3 lags).
LV= Laeven and Valencia (2008); DHS= De Paoli *et al*. (2006); LP=Levy-Yeyati and Panizza (2010); DS=Detragiache and Spillimbergo (2000); RRS= Reinhart *et al*. (2003).

Table 5. Output Growth and Financial Crises: Debt vs. Banking and Currency

	(I)	(II)	(III)	(IV)	(V)[%]
Debt $_t$	-4.963 (-1.89)*	-5.435 (-1.63)*	-8.913 (-1.97)**	-8.064 (-1.90)**	-8.740 (-1.93)**
Banking $_t$	-1.667 (-0.88)	-9.312 (-2.19)**	-	-3.683 (-1.64)*	-1.800 (-0.93)
Currency $_t$	-6.02 (-3.89)***	-	-3.766 (-3.82)***	-2.173 (-1.25)	-6.076 (-3.51)***
Debt $_t$ * Banking $_t$	-	3.561 (0.63)	-	-0.220 (-0.04)	-
Debt $_t$ * Currency $_t$	-	-	5.921 (1.08)	11.812 (0.84)	-
Currency $_t$ * Banking $_t$	-	-	-	-8.616 (-2.44)**	-
Debt $_t$ * Banking $_t$ * Currency	-	-	-	-4.193 (-0.27)	-
N	4863	4863	4863	4863	4863
Hansen test-pvalue	0.869	0.888	0.865	1.00	0.890
Arellano-Bond AR(2) test-pvalue	0.311	0.308	0.310	0.325	0.308

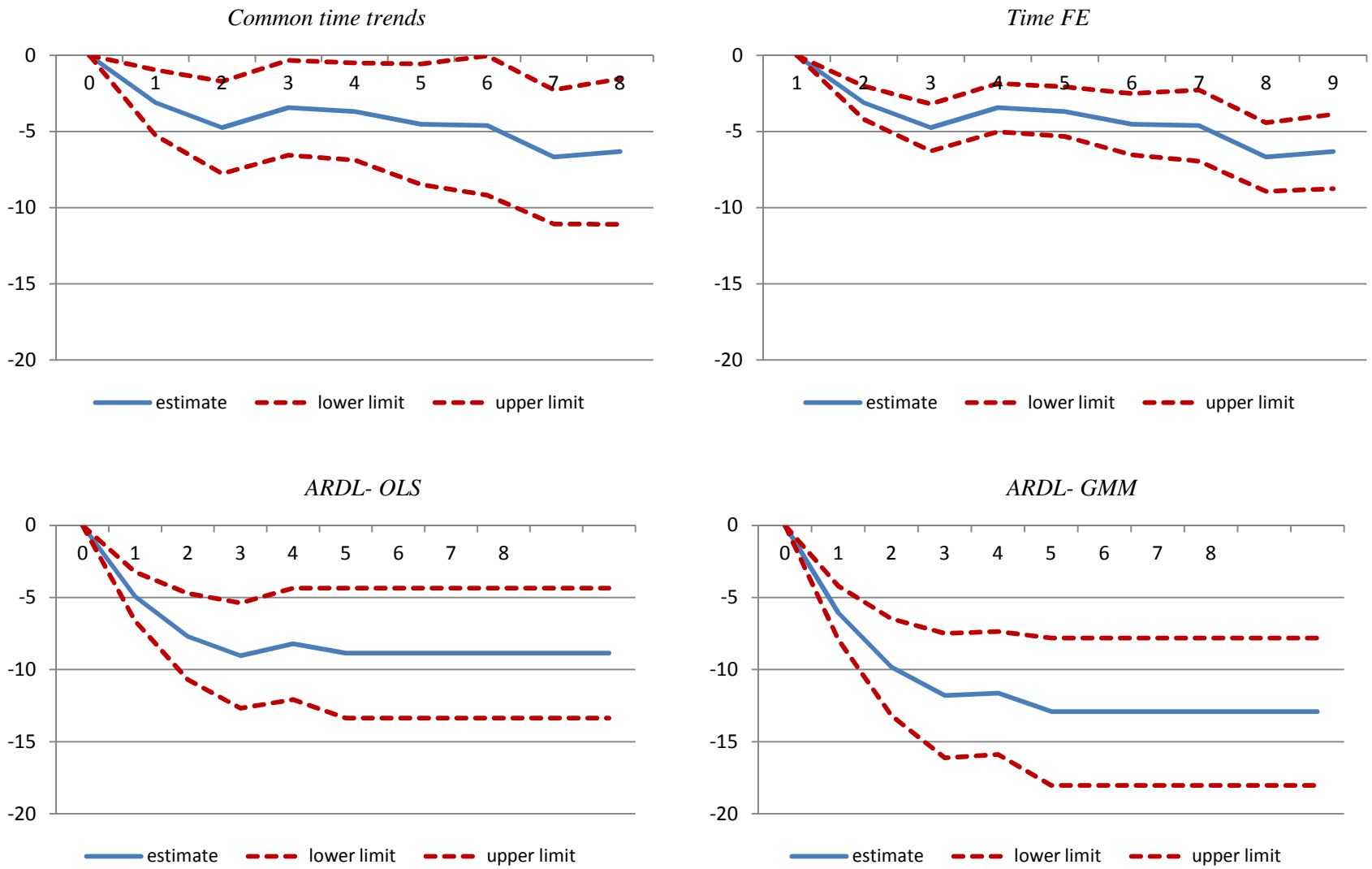
Note: z-statistics in parenthesis. ***,**,* denote significance at 1%, 5%, and 10%, respectively. Control variables included but not reported.
GMM-System Estimator: Two-step using Windmeijer standard errors, Openness , population growth, openness and lagged crises as predetermined, other control variables considered as endogenous (instrumented using up to 3 lags).
[%] Non-contemporaneous episodes of debt, banking and currency crises.

Table 6. Output Growth, Debt-GDP and Foreign Debt-GDP ratios

	Debt-to-GDP ratio				Foreign Debt-to-GDP ratio			
	(I) linear	(II) >70%	(III) >80%	(IV) >90%	(V) linear	(VI) 60%	(VII) 70%	(VIII) 80%
$Debt\_GDP_t$	-0.011	-1.776	-2.546	-2.239	-	-	-	-
	(-1.52)	(-2.62)***	(-3.14)***	(-2.79)***				
Foreign $Debt\_GDP_t$	-	-	-	-	-0.011	-1.176	-1.538	-2.418
					(-1.72)*	(-1.79)*	(-1.67)*	(-2.09)**
Real GDP growth $_{t-1}$	0.307	0.326	0.326	0.308	0.248	0.266	0.220	0.232
	(3.73)***	(4.07)***	(4.07)***	(4.29)***	(3.72)***	(3.74)***	(3.20)***	(3.26)***
Real GDP growth $_{t-2}$	0.057	0.045	0.053	0.055	0.036	0.028	0.047	0.039
	(1.44)	(1.10)	(1.14)	(1.29)	(0.73)	(0.57)	(0.97)	(0.79)
Openness $_t$	0.922	0.632	0.819	0.846	0.967	1.104	1.351	1.046
	(2.16)**	(1.54)	(1.94)**	(2.32)**	(1.77)*	(2.19)**	(2.56)***	(2.08)**
Population growth $_t$	0.267	0.231	0.332	0.287	0.154	0.241	0.262	0.228
	(2.13)**	(1.86)*	(2.59)***	(2.22)**	(1.28)	(1.65)*	(1.73)*	(1.52)
Credit Growth $_t$	-0.018	-0.022	-0.019	-0.021	-0.008	-0.001	-0.004	-0.006
	(-1.06)	(-1.01)	(-0.95)	(-1.19)	(-0.39)	(-0.05)	(-0.28)	(-0.40)
Real GDP_{t-1} (log)	0.211	0.093	0.169	0.175	0.081	0.132	0.226	0.098
	(1.25)	(0.64)	(1.11)	(1.29)	(0.33)	(0.63)	(1.16)	(0.48)
Real Exchange Rate Growth $_t$	-0.001	-0.002	-0.001	0.001	0.001	0.001	-0.001	-0.002
	(-0.19)	(-0.57)	(-0.13)	(0.07)	(0.18)	(0.13)	(-0.17)	(-0.70)
N	1505	1505	1505	1505	1403	1403	1403	1403
Hansen test-pvalue	0.676	0.648	0.663	0.706	0.649	0.537	0.754	0.683
Arellano-Bond AR(2) test-pvalue	0.214	0.307	0.208	0.217	0.146	0.211	0.126	0.161

Note: z-statistics in parenthesis. ***,**,* denote significance at 1%, 5%, and 10%, respectively.
GMM-System Estimator: Two-step using Windmeijer standard errors, Openness , lagged real exchange rate growth, lagged real credit growth and lagged credit growth as predetermined, other control variables considered as endogenous (instrumented using up to 3 lags). Debt and foreign debt crises considered as endogenous (instrumented using up to 3 lags).

Annex 1



Note: dotted lines represents 95 confidence bands.