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Optimal Debt and the Quality of Institutions

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EXECUTIVE SUMMARY

Over the past decade, the issue of monetary and fiscal policy interactions has attracted increasing attention, stressing the need to develop efficient economic measures, particularly facing severe external shocks. The crisis triggered by the COVID pandemic revealed certain limits of the central banks and fiscal authorities' instruments. In advanced economies, the environment of low interest rates restricts monetary policy instruments that could curtail adverse shocks. Since a number of developed countries have been under the pressure of low inflation (below the target), new external shocks pushed the interest rate to zero and led to the implementation of unconventional measures by national/central banks in order to stimulate economy. Fiscal policy became the main anti-crisis tool; however, the rapidly growing debt has diminished the effectiveness of budgetary stimulus. In the long run, it reduces the fiscal space and may diminish the ability of the government to respond to external shocks.

In emerging markets and developing economies, vulnerability to economic risks has been even greater, and financial resources — essential for sustainable economic development — have remained limited. Hence, the ability of these economies to withstand global stresses, amid the weakness of their public finances, has diminished. As a result, policymakers now face the dilemma of whether to stimulate infrastructure development by debt raising, which may reduce future flexibility, or to strengthen their fiscal positions.

Empirical Analysis

This study contributes to the literature on government debt–growth nexus by examining the nonlinear influence of government debt on economic growth. We assume that there exists a debt threshold above which growth prospects might be compromised. In order to shed more light on the effect of nonlinear debt–growth relationship, we consider the development of countries' institutions and the quality of governance, applying cluster analysis to a heterogeneous sample of countries.

We used cluster analysis based on the K-means technique, in order to address the unobserved heterogeneity of countries' institutional development. We divided the sample of 174 countries into clusters, considering all six parameters of the World Governance Indicators (WGI), which characterize the institutional development of states. These indicators include government effectiveness, political stability, voice and accountability, control of corruption, rule of law, and regulatory quality. Combining these parameters, we distinguished the criteria of countries' institutional capacity, which, following Kourtellos et al. (2013), enables us to capture the driving factor explaining fiscal policy and the relationship between countries' debt and growth.

The next step consisted in developing threshold panel models to estimate the dependence of economic growth on debt indicators in the complete set of countries and in each identified cluster. Our bootstrap analysis indicates that the threshold for the debt level is significant for all models under consideration. **The general model — which does not consider institutional features of countries — indicates that the debt threshold is 37.6% of GDP.**

Investigation of the debt–GDP relationship within clusters reveals monotonic increasing of the debt threshold from less institutionally developed countries to more developed ones. While economies with weak political institutions have a 36.8% debt-to-GDP threshold, **in countries with strong institutions, the debt threshold is above 55% of GDP**. In countries with modest performance of political institutions, the threshold is close to 38% of GDP. The current distribution of debt thresholds

stresses the greater resilience of the advanced economies to growing debt burdens compared to their less institutionally sustainable peers.

The influence of debt on economic growth also differs across institutional clusters. For less institutionally sound countries, when their debt-to-GDP ratio is lower than the threshold value of 37–38%, a 1 p.p. increase in the debt-to-GDP ratio results in a 0.3 p.p. increase in economic growth. In economies with stronger institutional foundations — as long as the debt-to-GDP ratio is below the 55.8% threshold — the estimated impact of debt on GDP is 90% less. The difference is probably due to the infrastructure gap that exists in emerging and developing economies. Thus investing in infrastructure (accompanied by government debt accumulation) may have a notable effect on economic activity. Once the public debt exceeds the threshold value, the effect on growth is statistically insignificant for the countries with the weakest institutions and slightly positive for more institutionally developed economies.

We examined the model's robustness by estimating the optimal debt for specific country groups. It enabled us to investigate how our findings correspond to other empirical estimates. Our estimates of non-linear effects of debt on growth in the EU countries suggest that the optimal debt remains around 60% GDP, which differs slightly from our findings for the group of most institutionally developed countries. To complement these findings, we focused on the research of Baum et al. (2012), which analyzed 12 Eurozone countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain) and estimated that, above the debt level of 95% GDP, debt growth has negative impact on economic performance. Considering the same Eurozone countries for the period of late 1990s and early 2000s, we received similar results — the optimal debt for these euro area countries is around 100% (see Appendix B).

Policy Implications for the EFSD Member States

EFSD donor countries are in a comfortable position of low public debt (below 20% of GDP). While the EFSD recipient countries have to be cautious about their debt positions given their current debt-to-GDP ratio and limited development of institutions. Most EFSD recipient countries have remained in an uneven institutional framework, which makes them more vulnerable in periods of crisis and stagnation. Nevertheless, our findings suggest that above a threshold value of 37–38% of GDP, growing public debt still features a very small positive effect on economic growth of Armenia, while it seems insignificant for Belarus, the Kyrgyz Republic and Tajikistan. Insofar the debt-to-GDP ratio is below the threshold, external financing may benefit countries with weak institutions. The associated output growth is estimated to be around 0.3 p.p., which is higher compared to the cluster of countries with the strongest institutions. This underlines that the public debt threshold varies across the EFSD countries, which stresses the role of institutional development. While economies with stronger institutional framework tend to have notable debt obligations, less institutionally developed countries have to remain cautious about debt accumulation.

We stress that **the debt–growth nexus depends on a wide range of countries' features**, which should be considered carefully with regard to their policy implications. In developing economies, there is a number of other factors, which underline a possibility to raise debt without materially jeopardizing the country's debt position. In general, our research does not suggest to the EFSD countries reducing their actual debt level to estimated threshold. Rather, it implies that, above a certain debt level, the countries may need to access carefully whether additional financing from loan resources will stimulate their economic activity or whether it imposes unnecessary risks to their budget sustainability.

1. INTRODUCTION

Over the past decade, the issue of monetary and fiscal policy interactions has attracted increasing attention, stressing the need to develop efficient economic measures, particularly facing severe external shocks. The crisis triggered by the COVID pandemic revealed certain limits of the central banks and fiscal authorities' instruments. In advanced economies, the environment of low interest rates restricts monetary policy instruments that could curtail adverse shocks. Since a number of developed countries have been under the pressure of low inflation (below the target), new external shocks pushed the interest rate to zero and led to the implementation of unconventional measures by national/central banks in order to stimulate economy. Fiscal policy became the main anti-crisis tool; however, the rapidly growing debt has diminished the effectiveness of budgetary stimulus. In the long run, it reduces the fiscal space and may diminish the ability of the government to respond to external shocks.

In emerging markets and developing economies, vulnerability to economic risks has been even greater, and financial resources — essential for sustainable economic development — have remained limited. Hence, the ability of these economies to withstand global stresses, amid the weakness of their public finances, has diminished. As a result, policymakers now face the dilemma of whether to stimulate infrastructure development by debt raising, which may reduce future flexibility, or to strengthen their fiscal positions.

COVID-19 has forced almost all countries to reconsider the relationship between their public debt stance and economic development, since a solid understanding of the trade-off between debt and economic growth is crucial for providing proper guidance on economic policy. In order to investigate this relationship, the present study analysed the optimal debt level from a panel threshold model.

There is a wide range of approaches to calculation of the optimal public debt, which can be grouped into three types. The first type confirms that a high debt-to-GDP level has a negative effect on business activity, since it reduces national incomes and savings, and increases the fragility of the economy in a financial crisis. The second type of analyses insists on the positive role of the debt and stresses that a growing debt level (being relatively low) would boost economic growth if additional financing would facilitate the closure of the infrastructure gap and leads to productivity enhancement. The third type of studies emphasizes the underlying nonlinear impact of public debt on economic activity.

This paper is motivated by the latter view of debt–growth relationships and investigates the optimal debt level. Our study contributes to the existing literature by examining the debt threshold, above which growth prospects are dramatically compromised. In order to shed more light on nonlinear debt–growth relationships, we considered the development of countries' institutions and the quality of their governance, applying cluster analysis to a heterogeneous sample of countries. This model extension enabled us to handle the problem of unobservable heterogeneity, by allocating a relatively large number of countries to homogenous groups. Applied to a dynamic panel data with a large data set (N) and relatively long time period (T), this combination of the cluster approach and threshold modelling provides a thorough analysis of the nonlinear relationships between debt and growth.

Motivated by the necessity to ensure sustainable economic growth especially in a period of global economic crisis, this study emphasizes the importance of diligently scrutinizing countries' debt positions before implementing fiscal stimulus measures.

The rest of the paper is organized as follows. Section 2 reviews existing theoretical and empirical studies. Section 3 contains a discussion of methodology and data-related issues. Section 4 provides an assessment of the optimal debt level within the assessed countries' clusters. Section 5 summarizes the key arguments and develops a set of policy recommendations going forward.

2. LITERATURE REVIEW

Government spending can influence the economy in two ways. On the one hand, fiscal stimulus (especially for infrastructure projects) might facilitate economic growth. On the other, government investment might have a crowding-out effect, eventually resulting in a lower rate of economic growth. These are theoretical considerations that forced the authors to search for a nonlinear relationship between debt and economic growth.

The empirical literature on the nonlinear debt–growth nexus uses two major approaches. The first treats the debt threshold as exogenous, whereas the second estimates this threshold by applying various techniques. The first group originated from the seminal article of Reinhart & Rogoff (2010a), which concluded that a high debt-to-GDP ratio (90% and above) is associated with notably lower growth outcomes across both advanced countries and emerging markets. Even though the technical side of the paper was subsequently criticized — see Reinhart & Rogoff (2010b), Herndon et al. (2014), Bell et al. (2015) — it still set the tone for the further research in this field. Furthermore, this threshold value (90% of GDP), along with the Maastricht threshold (60% of GDP), were exogenously set in the forthcoming articles on the debt–growth nexus. For instance, Kumar & Woo (2015) found evidence of nonlinearity, with debt higher than 90% of GDP having a significant negative effect on growth based on the data for 38 advanced and emerging economies. Eberhardt & Presbitero (2015) used both the thresholds of 60% and 90% of GDP; they stressed systematic differences in the debt–growth relationship across countries, but found no evidence for within-country nonlinearities. Other ad hoc debt levels have also been considered. Afonso & Alves (2014) applied a 75% threshold to study the debt–growth nexus for European countries from 1970 to 2012.

The second strand of literature devoted to the debt–growth relationship considers a wide range of estimation techniques, to identify the debt threshold endogenously. One of the most obvious techniques for assessing debt–growth nonlinearities is to include higher-order debt terms in the growth equation. Checherita-Westphal & Rother (2012) applied this approach in order to estimate a turning point in debt–growth influence for 12 European countries; as a threshold, they considered a 90–100% debt-to-GDP ratio. Chang & Chiang (2012) obtained a similar threshold (98% of GDP) using the panel smooth transition model (PSTR) for OECD countries. The impact of debt-to-GDP growth was positive on both sides of the threshold. Chen et al. (2017) also used the PSTR model, which included regime-switching techniques, taking into account the debt level.

Another powerful estimation technique is panel threshold regression as outlined by Hansen (1996, 1999). This approach has been used in a number of studies, including Caner et al. (2010), Cecchetti et al. (2011), Afonso & Jalles (2013), Baum et al. (2013), Egert (2015a), and Swamy (2015a). Despite applying similar approach, their results differed substantially. Some authors have suggested that the impact of debt on economic growth exists on both sides of the threshold, whereas others indicated a significant influence only within a particular region (positive/negative). A number of studies were devoted to the robustness check of debt threshold estimates — Lof & Malinen (2014) were among them.

One way for researchers to overcome the heterogeneity of countries is to employ time series analysis for individual countries, instead of a panel data approach. This strategy was successfully implemented by Egert (2015b), Gómez-Puig & Sosvilla-Rivero (2017), and Sabina (2018). These studies indicated that debt thresholds as well as other macroeconomic relationships are largely country-specific. The drawback of this approach is that it is conducted for developed EU/OECD countries with good long

time series data. When emerging and developing countries are under consideration, there might be not enough statistical data to study each country separately.

A possible strategy to overcome data scarcity and allow for heterogeneity is to classify countries into several groups. One popular approach is to take into account the quality of institutions, as institutional quality is regarded as a plausible source of convergence segments and therefore can be used to separate countries into multiple groups, in which countries follow the same growth model within a given group. The majority of studies take into account institutional quality by including corresponding dummy variables and cross-terms — see Presbitero (2012), Kourtellos et al. (2013), Masuch et al. (2017). Pereima et al. (2015) followed another approach, employing cluster analysis, considering countries' institutional development. Then, they proceeded to the debt–growth nexus. The main advantage of cluster analysis in threshold models is its ability to address heterogeneity. In addition, the estimated debt–growth relationship varies considerably between different countries' groups. This implies that models estimated for separate countries' clusters are more precise than estimates calculated for a complete set of countries.

3. METHODOLOGY AND DATA

The purpose of this paper is to analyse the relationships between economic growth and public debt. We take a two-step approach. First, we apply machine-learning techniques and cluster the list of countries in accordance with their institutions' development. Second, we run a threshold dynamic panel regression using the methodologies of Caner & Hansen (2004). We also employ Hansen's (1996) likelihood ratio (LR) test to verify that there is evidence of a threshold effect.

Cluster Analysis

We applied cluster analysis to address the unobserved heterogeneity of countries' institutional development, since it is more effective in determining the origins of the heterogeneity than fixed or random effects techniques. We classified the sample of 174 countries into clusters considering all six parameters of the World Governance Indicators (WGI) characterizing the institutional development of states. These indicators include government effectiveness, political stability, voice and accountability, control of corruption, rule of law, and regulatory quality. Combining these parameters, we distinguished the criteria of countries' institutional capacity, which, following Kourtellos et al. (2013), enables us to capture the driving factor explaining fiscal policy and the relationship between countries' debt and growth. The estimator is considered to become more efficient within classification setting.

The segmentation model is based on K-means clustering, which is an unsupervised learning algorithm resulting in skewed estimates. This method is implemented in a dynamic manner in order to construct a model reflecting institutional development.

The K-means algorithm is an unsupervised classification technique, which classifies data into K clusters, based on object similarity. Similarity reflects the strength of the relationships between these objects, which is determined by object distance to the nearest cluster centroid (mean). Thus, the algorithm of data classification into particular number of groups is based on minimizing a sum of squared distances between points and the corresponding centroid, which is calculated as:

$$\sum_{i=0}^{n} \min_{\mu_j \in C} (\left\| x_i - \mu_j \right\|^2), \tag{1}$$

where μ_j is the nearest centroid of the data point x_i.

This algorithm requires the number of clusters, which is specified in advance. While there are about 30 procedures to determine the number of clusters following Milligan & Cooper (1985), we applied the less formal one, based on the "elbow" or "knee of a curve" method. The main principle of this method is in identifying a number of clusters, so that selecting more clusters does not significantly improve the model. This implies that the objective function, which decreases with the number of iterations, at some point (called the "the knee") starts to flatten.

Panel Threshold Model

The second step consisted in developing threshold panel models to estimate the dependence of economic growth on debt indicators in each identified cluster. The model investigated nonlinear relations between these indicators, implying that at some level, debt burden may weaken countries' fiscal positions and slow their economic growth.

The panel regression procedure consisted of several steps: (1) we estimated a reduced form regression for the endogenous variable (per capita GDP growth) to avoid an endogeneity problem; (2) we estimated

the threshold for debt-to-GDP level using predicted values of the previous step; (3) we estimated slope coefficients of the model by GMM, treating the threshold as known; and (4) we employed a test for threshold presence with the use of bootstrapped p-values, an approach developed by Hansen (1996). In general, this modelling strategy is based on Caner-Hansen's methodology (2004); however, we adapted it for dynamic panel data analysis, similar to the approach used by Baum et al. (2013).

The dynamic panel threshold model can be written as:

$$y_{it} = \mu_i + \chi y_{i,t\text{-}1} + \alpha' x_{it} + \beta_1 d_{it} I_{(d_{it} \le c^*)} + \beta_2 d_{it} I_{(d_{it} > c^*)} + \varepsilon_{it}, \quad (2)$$

where the dependent variable y_{it} represents economic growth (GDP per capita) of country *i* at time *t*; μ_i is the country-specific fixed effects; x_{it} is a set of regime-independent control variables; d_{it} is a government debt-to-GDP ratio, which could be higher or lower than the threshold value; *I* is an indicator function with c^* serving as a threshold parameter. We consider parameter c^* as unknown, so an intermediary step of threshold estimation should be done. As a result, the impact of debt on economic growth is allowed to differ in the two regimes. We anticipated that the growth of debt would boost economic activity for the debt-to-GDP ratio below the threshold c^*, whereas accumulation of debt above the threshold would result in zero or even a negative relationship between the growth of debt obligations and economic activity.

As we mentioned above, the first step of our econometric analysis consisted in running the reduced form regression of our endogenous variable (lagged per capita GDP growth) on its higher lags (the set of instruments used in Baum et al. (2013). For the further threshold estimation, we replaced lagged GDP per capita growth $y_{i,t\text{-}1}$ in equation (2) with its estimate $\hat{y}_{i,t\text{-}1}$.

After that we estimated equation (2) by least squares for all possible values of the threshold c:

$$y_{it} = \mu_i + \chi \hat{y}_{i,t\text{-}1} + \alpha' x_{it} + \beta_1 d_{it} I_{(d_{it} \le c)} + \beta_2 d_{it} I_{(d_{it} > c)} + \varepsilon_{it}, \quad (3)$$

Then we selected the threshold value c^*, which minimizes the sum of squared residuals. Next, we estimated equation (2) by GMM, treating the estimated threshold value c^* as known. The model was estimated following Blundell & Bond's (1998) dynamic panel approach, according to which the model is estimated in levels instead of differences, which are used in Arellano & Bond (1991). As a by-product of this estimation, we obtained natural test statistics for hypotheses on the threshold, which take the form:

$$LR_n(c) = n \frac{S_n(c) - S_n(c^*)}{S_n(c^*)}, \quad (4)$$

where $S_n(c)$ denotes the residual sum of squared errors from a regression with threshold c, and $S_n(c^*)$ from a regression with the optimal threshold level. This statistic is used to obtain an asymptotic confidence interval for the optimal debt estimate c^* with the test-inversion method advocated by Hansen (2000). Let C be the 85th percentile of the distribution; then the confidence interval is calculated as $\{c: LR(c) \le -2 * log(1 - \sqrt{C})\}$.

Finally, we tested whether a threshold exists. In other words, we tested the hypothesis $H_0: \beta_1 = \beta_2$ in equation (2). Since the threshold value is not identified under the null hypothesis of linearity, we followed Hansen (1996), who suggested a bootstrap procedure to simulate the asymptotic distribution of the likelihood ratio test. For each bootstrap iteration, we generated a new sequence of residuals while treating exogenous variables as fixed, and thus obtained new values for the dependent variable. Then we repeated the steps outlined above: estimating a threshold value and calculating the LR statistic from equation (4). The asymptotic bootstrap p-value was obtained by counting the percentage of bootstrap samples for which the bootstrap LR statistics exceeds the LR statistics of the final regression.

This procedure was first applied to aggregated data (without clustering the countries). Then, we proceeded with regressions for separate segments determined by cluster analysis using the countries' institutional characteristics.

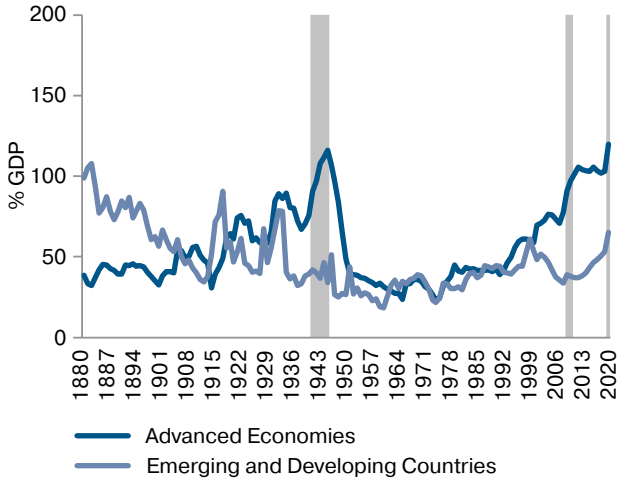
Data and Stylized Facts

The database of countries' economic and institutional characteristics covers the period from 1996 to 2018. The key variables for classifying countries into institutional clusters originate from the WGI database compiled by the World Bank. This dataset reports on six dimensions of governance for over 200 countries.

Time-series on countries' economic indicators were retrieved from the IMF World Economic Outlook (WEO) database. They include GDP per capita growth rate, general government primary net lending/borrowing (in percent of GDP), average consumer price inflation, etc. Macroeconomic variables were complemented by data on commodity prices: Commodity Fuel (energy) Index growth, Commodity Food and Beverage Price Index growth, and Commodity Metals Price growth. Independent variables were selected according to their explanatory weight and availability for the set of countries. The number of countries included in the model was also considered, based on their data quality and availability.

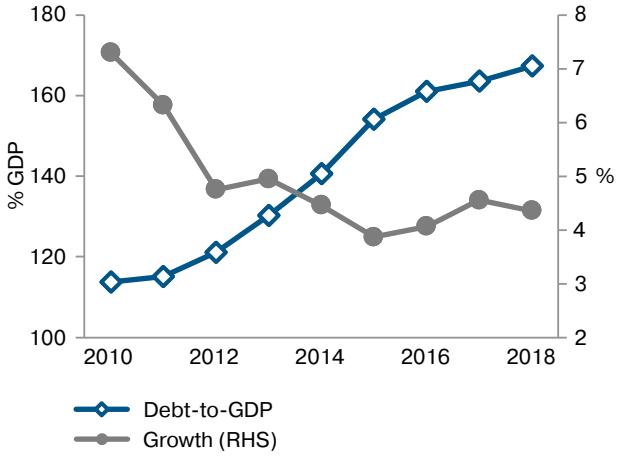
The key indicator, debt-to-GDP, is accessible for a large cross-section of countries and comes from the IMF's WEO database. According to the most recent data, global debt has risen to an unprecedentedly high level. In emerging markets and developing economies, it has reached a peak of about 170% of GDP. Although, this increase is primarily explained by debt dynamics in the private sector, public debt has also contributed to total debt growth. In advanced economies, it is above 100% of GDP, while in emerging markets and developing economies it has climbed to more than 60% of GDP (Figure 1).

Figure 1. Public Debt-to-GDP



Source: IMF

Figure 2. Total Debt and GDP Growth in Emerging and Developing Countries



Source: IMF

Global economic interdependence has grown over time, whilst debt accumulation has been a notable source of economic growth. However, a mounting stock of debt may have a detrimental effect on business activity. In developing economies, especially those shifting to less concessional debt, the debt burden is accompanied by weak economic performance (Figure 2).

Since the relationship between the public debt ratio and GDP growth may be influenced by the heterogeneity across countries, we applied our model to a large dataset of advanced and developing countries, taking into account their institutional characteristics.

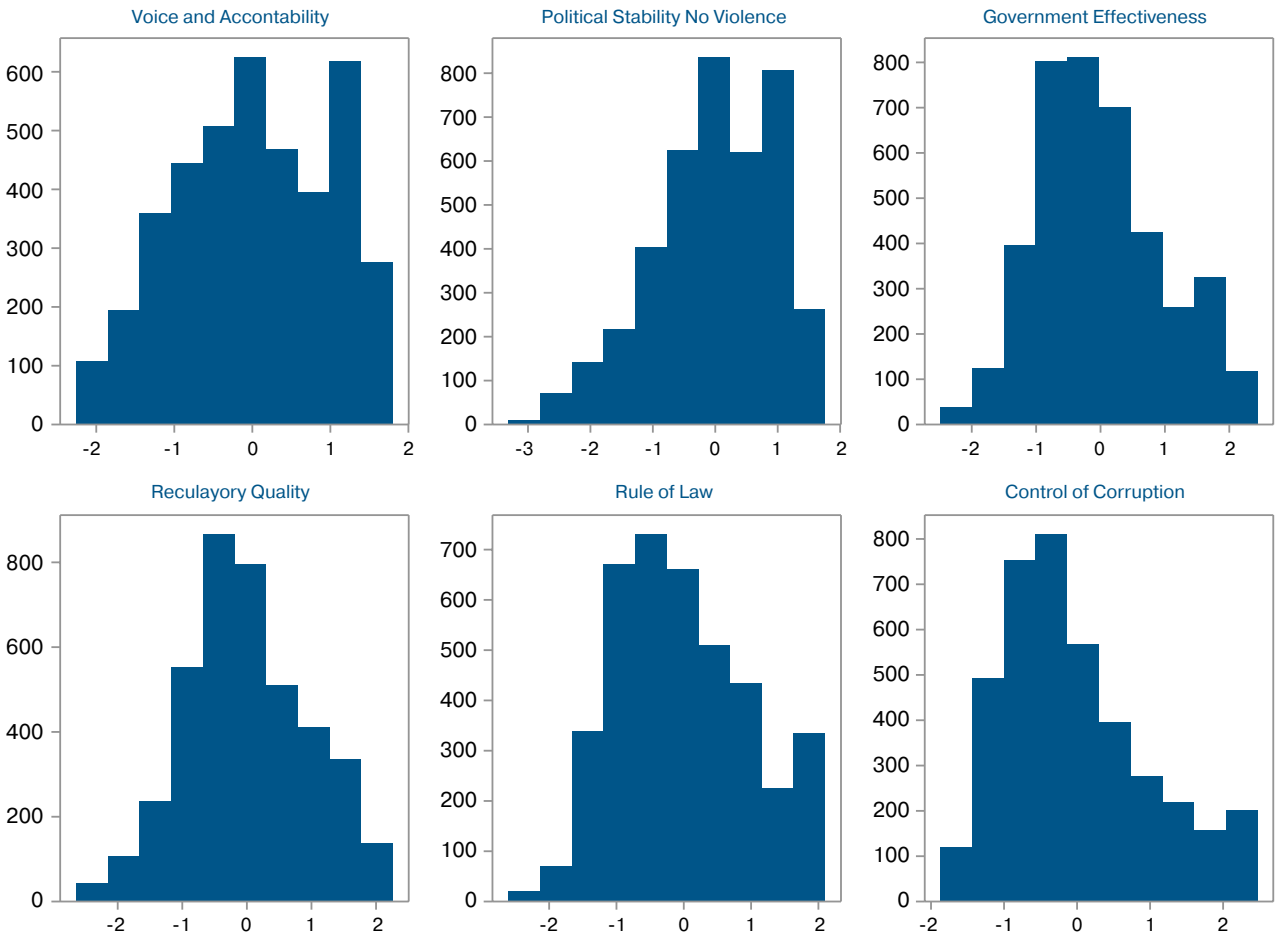
4. RESULTS

This section summarizes our findings regarding the classification of the sample of countries into clusters according to the level of their institutional development. After that, we compare debt threshold estimates in different country groups.

Institutional Clusters

Clustering is based on the K-means technique, which may result in imbalanced clusters (an unequal number of countries in each segment), especially if the data are skewed. Data visualization (Figure 3) shows that the Worldwide Governance Indicators are in general skewed, which may affect clustering outcome. In order to reduce imbalances and solve the issue of long-tailed distribution — which implies that a significant part of the observations is allocated just to one cluster — we transformed the data on institutional development by taking a natural logarithm and rescaling them.

Figure 3. Distribution of Countries with Respect to the Quality of Their Governance and Institutions



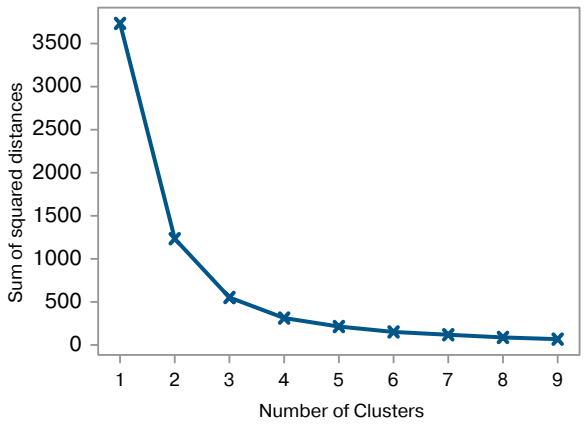
Source: WGI database, authors' calculations

The number of clusters was determined by the elbow method (Figure 4), which identifies the within-cluster sum of squares. By minimizing intra-cluster variation, we chose the optimal number of segments. According to this approach, the country pool is unbalanced, with the most institutionally developed countries having the smallest cluster (41 countries), which is natural and reflects the current state of institutional development across countries. The cluster of less institutionally developed countries is the largest and comprises 79 states. Finally, countries with the weakest institutional capacity are included in the third cluster and account for 54 states.

Since our estimates are based on the composite indicator, which aggregates individual institutional scores, we tested the quality of cluster analysis, considering classification, which is set up on separate institutional characteristics of observed countries. The results of these estimates indicate three distinct groups of data in two dimensions of institutional indicators: rule of law and regulatory quality (Figure 5). According to the scatter plot, a reasonable grouping is found.

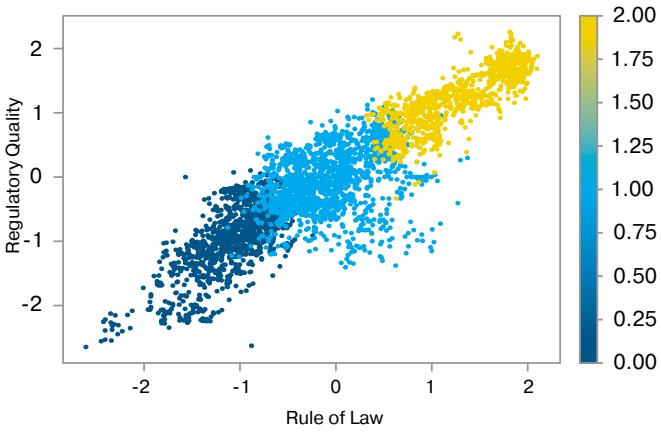
However, it is noteworthy that cluster analysis has some deficiencies: adding a new country may change the cluster, as a country originally belonging to one cluster may move to another. But this is less relevant in our case, since we used a complete dataset of all countries with available macroeconomic and institutional indicators.

Figure 4. Elbow Method for Clustering



Source: authors' calculations

Figure 5. Countries' Clustering (Points Colored by Their Assigned Cluster)



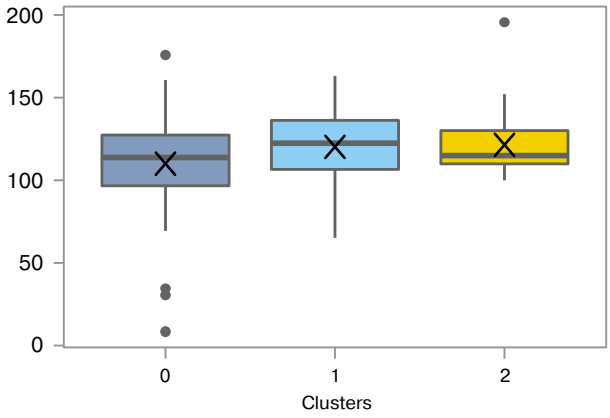
Source: authors' calculations

Our findings using the K-mean approach represent three clusters of countries. The second cluster, with the highest quality of institutions, is represented by high-income developed economies: North and Central Europe, North America, Japan, Australia, and New Zealand. The first cluster, with medium quality of institutions, comprises the majority of South American countries, Mexico, South African countries, South-Eastern Asia, China, and India. The countries with less developed institutions are the majority of African states, Middle Eastern countries, some Eastern European and Central Asian countries. EFSD countries are related to clusters with medium and less developed institutions. Since our cluster analysis is dynamic, it indicates the institutional development of some countries and their move from the one cluster to another e.g. from 2005 Georgia moved to the cluster of countries with stronger institutions, and in 2009, Kazakhstan also joined this cluster due to improvement in its institutional development.

The distribution of the key study variables — GDP per capita growth and public debt-to-GDP for countries' institutional clusters — suggests that economies with a stronger institutional framework

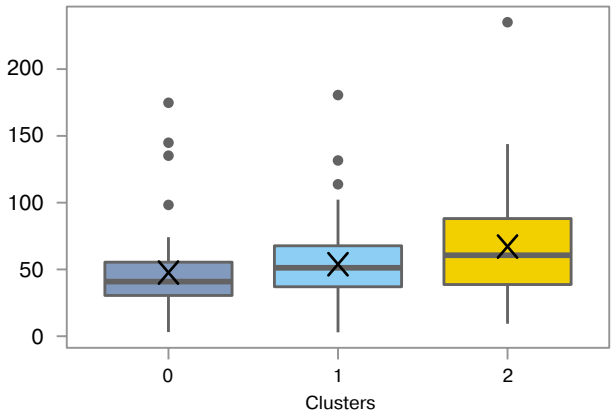
tend to have notable debt obligations, partially due to relatively sustainable growth performance (Figure 6–7). Less institutionally developed countries have remained cautious about debt accumulation amid higher growth volatility and uncertainty compared to advanced economies.

Figure 6. Distribution of GDP Per Capita Growth, %



Source: authors' calculations

Figure 7. Distribution of Public Debt-to-GDP, %



Source: authors' calculations

Considering this variety in debt–output performance among more and less institutionally developed countries, we estimated the debt threshold for each cluster. Given the specifics of dynamic clustering, which classifies countries in different groups, resulting in interrupted time-series, we applied static approach (based on a five-years average) for panel threshold estimates.

Threshold Estimation

Despite the fact that we classified 174 countries according to the quality of their governance, we had to reduce the number of countries used for panel regression estimation due to data scarcity.

The results of our regression analysis along with threshold estimates are represented in Appendix A[1]. Figure 8 depicts graphical interpretations of the threshold estimation. This figure displays a graph of the $LR_n(c)$ statistics from equation (4) as a function of the debt threshold. The point where $LR_n(c)$ hits zero corresponds to the optimal debt threshold c^*. The dashed line represents a 85% confidence level. Thus, the values of a threshold for which $LR_n(c)$ is below the dashed line constitute a confidence region. As was pointed out by Caner & Hansen (2004), the more precisely parameter c is estimated, the more "peaked" is the graph of $LR_n(c)$ statistics. In samples with strong information about the threshold, $LR_n(c)$ will tend to have a sharp V shape with a clearly delineated minimum, as in our case.

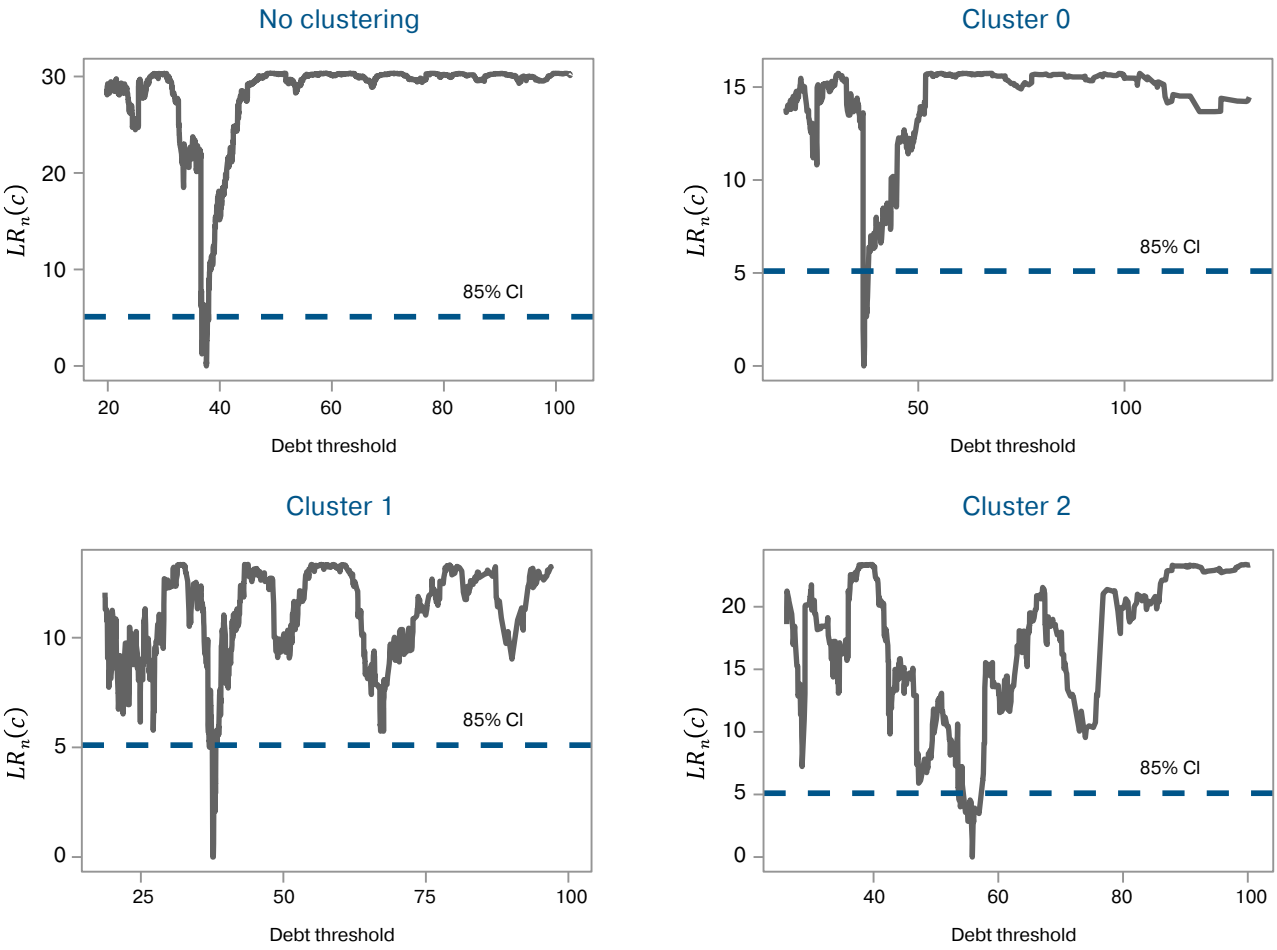
Our bootstrap analysis indicates that the threshold for the debt level is significant for all models under consideration. For the model that does not take into account institutional features of countries, the debt threshold is 37.6% of GDP, which means that debt accumulation has a positive impact on economic growth only while it fluctuates below this level. However, the Sargan test for over-identifying restrictions

[1] We tried alternative specifications covering different time spans, other sets of explanatory variables, as well as another country grouping with four clusters (available upon request). Overall, our findings remain robust to those changes, even though point estimates of the debt threshold varied slightly.

rejects the null hypothesis of the instruments' validity. This compels us to estimate separately the corresponding models for the institutional clusters derived above.

When considering the three institutional clusters of countries separately, the null hypothesis of the instruments' validity is not rejected for all three groups. The table in Appendix A shows that the estimated levels of debt threshold differ substantially between clusters. For two less institutionally developed groups of countries, the threshold is close to the one estimated for the whole sample of countries — 36.8% and 37.6% of GDP, respectively. However, non-overlapping confidence intervals indicate that the debt threshold is somewhat higher for the countries with better institutions. For the most developed countries that comprise the last group, the debt threshold is equal to 55.8% of GDP, which is substantially higher than for the rest of the countries. This points out the ability of countries with more developed institutions to bear a more substantial debt burden than their less institutionally sustainable peers.

Figure 8. Likelihood Ratio Sequence as a Value of Debt Threshold



Source: authors' calculations

The size of the debt's impact on economic growth differs across institutional clusters. For less institutionally sound countries, when their debt-to-GDP ratio is lower than the threshold value of 37–38%, a 1 p.p. increase in debt-to-GDP ratio results in a 0.3 p.p. increase in economic growth. In the

advanced economies, the estimated impact of debt-to-GDP is 90% less, while the debt-to-GDP ratio is below the 55.8% threshold. The difference is assumed to indicate the infrastructure gap that exists in emerging and developing economies. This implies that investing in infrastructure (accompanied by government debt accumulation) may have a notable effect on economic activity.

In general, the causal relationships between higher public debt and weaker economic activity runs both ways and there is no strong evidence for specific causality. One of the reasons is a high heterogeneity across countries. By considering dynamic heterogenous panel dataset, Chudik et al. (2013) estimated long-run effects, accepting reverse causality. Their results indicated that while some economies faced debt difficulties and slow growth at relatively low debt levels, others remained sustainable even experiencing high indebtedness. Although, the universal optimal debt effect was not determined, it was estimated for countries with growing debt, which implies that debt trajectory can be more important.

In this research we don't focus on the causal relations between debt and growth (assuming that it can be developed further); however, it is noteworthy that we did not see the negative effect of debt accumulation on economic growth that is mentioned in some articles. Once the public debt exceeds a threshold value, the effect on growth is negative for countries with the weakest institutions; however, it is statistically insignificant. For more institutionally developed economies, the impact of debt accumulation on per capita growth remains positive, but it is now much less.

Robustness of the Model

In this section, we discuss the robustness of our results. We checked it in several ways: (1) by trying alternative specifications covering different time spans and other sets of explanatory variables; (2) by another country grouping with four clusters; (3) by omitting countries from original sample. The first two approaches are focused on checking robustness of our original model's output — and they indicate that our findings remain robust to abovementioned changes; even though point estimates of the debt threshold varied slightly. The third approach is considered to be more important since we checked how our findings correspond to other empirical estimates, by examining particular country groups.

Our estimates of non-linear effects of debt on growth in European countries suggest that the optimal debt remains around 60% GDP, which is slightly different from our findings for the most institutionally developed countries. These results are consistent with recent studies, which treats the debt threshold as an endogenous and where the optimal debt level falls between 50–70% GDP (Fall et al., 2015). According to OECD research, the optimal debt is slightly lower for the EU, than for OECD countries, since contagion risks may compel EU economies to remain more prudent to debt accumulation.

To complement these findings, we focused on the research of Baum et al. (2012), which analyzed 12 Eurozone countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain) and estimated that, above the debt level of 95% GDP, debt growth has negative impact on economic performance. Considering the same Eurozone countries for the period of late 1990s and early 2000s, we received similar results — the optimal debt for these euro area countries is around 100% (see Appendix B). Some gap in our findings can be related to difference in our model specifications and slightly different time span.

Apart from that, we also checked the impact of debt accumulation on economic growth. Our findings indicate that the impact of debt on growth for countries with strong institutions remains positive even above the optimal debt level. According to OECD studies, while the growth-maximising debt for OECD countries accounts for 50–80% of GDP, the negative effect, is likely to emerge for debt level above 80–100% of GDP (Fall et al., 2015).

Emerging and developing economies which are more relevant to our clusters of countries with weak institutions, tend to remain more vulnerable to external shocks; as a result, they usually default at lower debt-to-growth ratio. Following this assumption, our findings indicate that the optimal debt level is around 37–38% of GDP, which is similar to a number of studies, where debt threshold is in a range of 30 to 50% of GDP (Fall et al., 2015).

All in all, we believe, that obtained findings are relatively robust and may add to the existing literature in empirical and applied way.

Empirical Application: EFSD Countries

We concluded our study with the empirical application of our theoretical approach considered above. We applied the results of cluster analysis to five EFSD member countries and identified their level of institutional development. Then our econometric analysis enabled us to identify the debt threshold for each country. Finally, we compared their actual debt levels to the estimated thresholds.

The policy implication for members of the EFSD is bidirectional: while Russia and Kazakhstan are in a comfortable position with low public debt (below 20% of GDP), the EFSD recipient countries have to be cautious about their debt positions, especially given the modest development of their institutional foundation. It is noteworthy that the EFSD recipient countries are related to different clusters according to their institutional quality. Armenia is a country with a modest development of policy institutions. This implies that until the debt-to-GDP ratio is below 38%, debt accumulation promotes stronger output growth; since public debt exceeds the threshold value, the impact of rising debt on GDP growth is negligible, although it remains positive.

Institutional development of other EFSD recipient members requires further improvement. Belarus, the Kyrgyz Republic, and Tajikistan have remained in a weak institutional framework, which makes them more vulnerable to periods of crisis and stagnation (Acemoglu, Johnson & Robinson, 2001; 2002). Furthermore, our findings suggest that above a threshold value of 37% of GDP, growing public debt does not have a significant effect on economic growth. The role of financing seems most important for countries with weak institutions: when the debt-to-GDP ratio is below the threshold, the associated additional output growth is estimated to be around 0.3 p.p., which is the highest impact compared to other clusters.

Following these estimates, we identify several channels via which the EFSD countries may eliminate the risk of indebtedness and sluggish economic activity by strengthening their policy institutions. First, efficient institutions may increase the multiplier effects of government expenditures; in general, for emerging economies with poor institutional performance, the average fiscal multiplier range is between 0.1 and 0.3, which is lower than in developed economies, where it represents 0.6 on average (Batini et al., 2014). Second, stronger institutions contribute to sustainable and inclusive economic growth, which leads to efficient tax administration and reduced costs (Masuch et al., 2017). Finally, strong institutional performance reduces eliminates countries' sensitivity to external and internal uncertainties and increase investors' confidence. This may ease countries' debt-servicing obligations and, in the long run, increase their fiscal space.

Another possible narrative consistent with our findings could be that the relationship between debt and output growth has remained heterogeneous and the cluster approach we used makes it possible to address this problem only partially. While some advanced countries can have a high debt-to-GDP ratio, remaining relatively sustainable, other economies run into debt difficulties at relatively low debt. In countries with market access it depends on whether the interest rate remains low or not -it mainly correlates with market confidence. In developing economies, there is a number of other factors, which underline a possibility to raise debt without materially jeopardizing the country's debt position. Two EFSD recipient countries, Tajikistan and the Kyrgyz Republic illustrates that access to concessional loans may mitigate default risks. Although estimated growth-maximising debt for those countries is

around 37%, which is considerably lower than the actual debt level, which is around 50–60%, Tajikistan and Kyrgyzstan have continued to accumulate debt obligations in order to meet development objectives. In general, our research does not suggest to the EFSD countries reducing their actual debt level to estimated threshold. Rather, it implies that, above a certain debt level, the countries may need to access carefully whether additional financing from loan resources will stimulate their economic activity or whether it imposes unnecessary risks to their budget sustainability. Apart from that, we stress that the debt–growth nexus depends on a wide range of countries' features, which should be considered carefully with regard to their policy implications.

5. CONCLUSION

In this study, we analysed a sample of more than 100 countries in order to contribute to the debate on the debt–growth nexus. We split our sample into three groups depending on countries' institutional development and estimated the debt threshold for each of those groups separately. Our findings are broadly in line with the existing literature. We identified the importance of heterogeneity among countries, and we addressed this problem by using clustering methodology. Moreover, we showed the significant role institutional development plays in countries' economic performance. However, our debt threshold estimates are somewhat lower than those of other studies: 35–40% of GDP for countries with weak institutions and 50–60% of GDP for those with sound institutional development. Moreover, we found that debt has a positive impact on economic growth only when it is below the threshold. When debt exceeds the threshold, its further accumulation has no further influence on GDP.

This study of the nonlinear relationship between debt and per capita growth, with its focus on optimal debt estimates, intended to provide a comprehensive analysis of the countries' debt sustainability. It has some limitations, however, and could be developed further by considering other criteria for clustering the sample of countries, such as using other indicators to perform country grouping or applying clustering techniques for subgroups. Moreover, we used only one debt threshold value in this study, and it would be of interest to consider multiple debt thresholds. Another way to enhance this study would be to focus on a smaller subsample of countries to be able to account for more individual country features. In addition, economic growth might depend not only on a government's debt level, but also on its debt-servicing costs or the composition of the debt: whether borrowed resources are channeled towards investment projects or towards social security. The investigation of these questions would also be of interest.

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APPENDIX A. ESTIMATION RESULTS

	No clustering	Cluster 0	Cluster 1	Cluster 2
GDP Growth$_{t-1}$	0.201*** (0.051)	0.249*** (0.057)	0.140* (0.076)	0.503*** (0.090)
Primary Balance	0.009 (0.049)	0.038 (0.074)	0.021 (0.049)	0.111• (0.071)
Inflation	−0.103* (0.057)	−0.052 (0.070)	−0.065 (0.056)	−0.200* (0.103)
Exchange Rate Depreciation	0.008 (0.015)	0.006 (0.018)	−0.045* (0.026)	0.033• (0.021)
Energy	0.013* (0.007)	0.029 (0.023)	0.000 (0.006)	0.006* (0.004)
Food	0.016 (0.017)	−0.022 (0.041)	0.040* (0.021)	0.015 (0.019)
Metals	0.018** (0.007)	0.017 (0.015)	0.008 (0.008)	0.040*** (0.006)
Debt*I$_{(Debt>c^*)}$	−0.006 (0.009)	−0.001 (0.010)	0.020** (0.010)	0.015• (0.010)
Debt*I$_{(Debt<c^*)}$	0.358*** (0.069)	0.314*** (0.111)	0.278*** (0.063)	0.034* (0.018)
Threshold estimate	37.6	36.8	37.6	55.8
85% Confidence Interval	36. 8–38.0	36.6–37.7	37.0–38.2	53.7–56.9
n	128	37	59	32
T	23	23	23	23
Num. obs.	2944	851	1357	736
Num. obs. used	5056	1443	2327	1286
Sargan test	102.0	34.3	55.4	30.6
p-value	0.004	1.000	0.842	1.000
Wald test	105.5	57.4	321.7	231.2
p-value	0.000	0.000	0.000	0.000

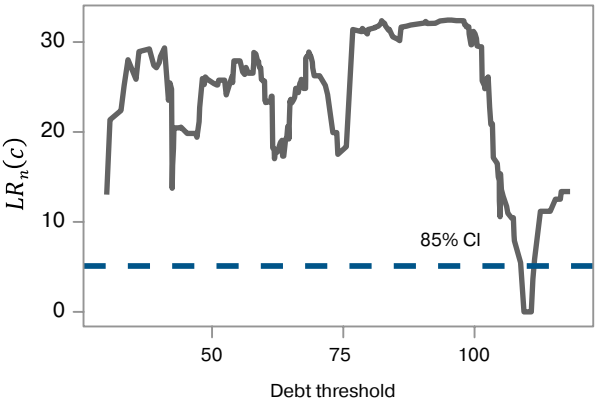
***p < 0.01; **p < 0.05; *p < 0.1; ·p < 0.15

APPENDIX B. ROBUSTNESS CHECK

Estimation results for 12 EU countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

	No clustering
GDP Growth$_{t-1}$	0.411*** (0.125)
Primary Balance	0.291** (0.113)
Inflation	−0.676* (0.373)
Exchange Rate Depreciation	0.083** (0.036)
Energy	0.003 (0.009)
Food	0.046 (0.044)
Metals	0.039** (0.016)
Debt*I$_{(Debt>c^*)}$	−0.006 (0.021)
Debt*I$_{(Debt<c^*)}$	0.031• (0.020)
Threshold estimate	109.4
85% Confidence Interval	109.4–111.1
n	12
T	23
Num. obs.	276
Num. obs. used	492
Sargan test p-value	11.1 1
Wald test p-value	307.7 0.000

***p < 0.01; **p < 0.05; *p < 0.1; ·p < 0.15



EFSD WP/19/1 (RU/EN)

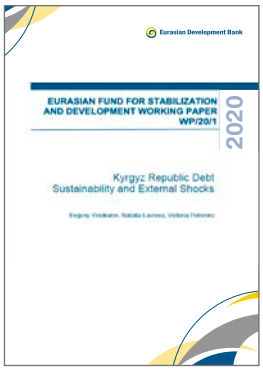
The Eurasian Fund for Stabilization and Development: A Regional Financing Arrangement and Its Place in the Global Financial Safety Net

The objective of the first working paper is to bridge the gap in understanding the dynamics of EFSD development and its place in the Global Financial Safety Net (GFSN) and the region's financial architecture.

EFSD WP/19/2 (EN)

Achieving Stabilization and Development Objectives in a Single Agenda: The Experience of the Eurasian Fund for Stabilization and Development

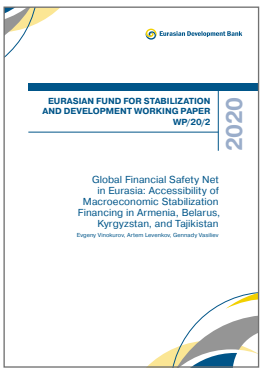
This working paper analyzes the experience of the EFSD, which suggests that in the context of low-income countries, the RFA's stabilization mandate may benefit from complementing it with developmental agenda.



EFSD WP/20/1 (RU/EN)

Kyrgyz Republic Debt Sustainability and External Shocks

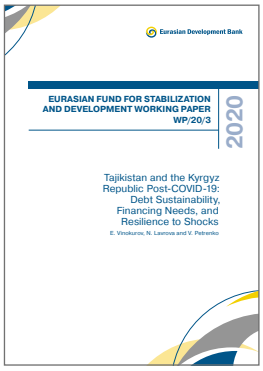
This paper contains a methodological and empirical analysis of the debt sustainability of Kyrgyzstan. The paper assesses the effect of various types of shocks on the country's debt sustainability.



EFSD WP/20/2 (RU/EN)

Global Financial Safety Net in Eurasia: Accessibility of Macroeconomic Stabilization Financing in Armenia, Belarus, Kyrgyzstan, and Tajikistan

This working paper takes into account six sources of financing — international reserves, swap arrangements, EFSD, IMF, multilateral development banks and bilateral financial support for macrostabilization.



EFSD WP/20/3 (RU/EN)

Tajikistan and the Kyrgyz Republic Post-COVID-2019: Debt Sustainability, Financing Needs, and Resilience to Shocks

The COVID-19 outbreak has revealed the sensitivity of economies and their debt positions to a wide range of disruptions. In order to shed light on how much debt Tajikistan and the Kyrgyz Republic can sustain we consider a baseline scenario as well as three alternative, more adverse scenarios: (1) a protracted global crisis, (2) a slow economic recovery in the region and (3) a natural disaster shock.

Eurasian Development Bank

E. Vinokurov, N. Lavrova, and V. Petrenko

Optimal Debt and the Quality of Institutions

The **Eurasian Fund for Stabilization and Development (EFSD)** amounting to US$8.513 billion was established on June 9th, 2009 by the governments of the Republic of Armenia, the Republic of Belarus, the Republic of Kazakhstan, the Kyrgyz Republic, the Russian Federation, and the Republic of Tajikistan. The objectives of the EFSD are to assist its member countries in overcoming the consequences of the global financial crisis, ensure their economic and financial stability, and foster integration in the region. The EFSD member countries signed the Fund Management Agreement with Eurasian Development Bank giving it the role of the EFSD Resources Manager. More information about the EFSD is available at: https://efsd.eabr.org/en/

EFSD Working Papers are the main format of the Fund's public research. They reflect the Fund's research on global, regional, and country economic trends, economic modelling, macroeconomic analysis, sectoral analysis, global financial architecture, and other issues. EFSD publications are available at https://efsd.eabr.org/en/research/

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