Worse Than You Think: Public Debt Forecast Errors in Advanced and Developing Economies[1]

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Abstract

We compile a unique dataset of medium-term public debt forecasts for an unbalanced panel of 174 countries, based on IMF (for the period 1995–2020) and Economist Intelligence Unit (2007–20) projections. We find that on average: (i) there is a positive forecast error (FE) in the debt-to-GDP projections—that is, realized debt ratios are larger than forecasts; (ii) the FE increases with the projection horizon and is statistically significant and large—about 10 percent of GDP at the five-year horizon; (iii) the magnitude is similar between advanced (AEs) and emerging markets and developing economies (EMDEs), and in EMDEs is present irrespective of recessions while for AEs is associated with surprise recessions in the forecast horizon; (iv) FEs are not statistically different between IMF program and non-program cases; (v) positive FEs are only partly attributable to optimism about growth; and (vi) oil-exporters and more volatile countries tend to have larger FEs. If FEs following the COVID crisis are in line with those that followed the Global Financial Crisis, average debt ratios in EMDEs would increase to close to 70 percent of GDP by 2026 instead of declining to 59 percent of GDP as currently forecast.

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I. INTRODUCTION

Public debt-to-GDP ratios have increased since the Global Financial Crisis (GFC) in both advanced economies (AEs) and emerging markets and developing economies (EMDEs). As shown in Figure 1, debt ratios peaked at about 75 percent of GDP in the mid-2010s in AEs and declined slightly to about 70 percent of GDP in 2019. In EMDEs, debt ratios have been on a relentless upward trend, exceeding 55 percent of GDP in 2019. Looking ahead, the COVID-19 pandemic, which has led to the greatest drop in global output since the Great Depression, and has been met with unprecedented fiscal stimulus globally, is likely to sharply increase debt ratios (IMF Fiscal Monitor October 2020).

However, after a sharp rise in debt ratios in 2020, projections point to debt ratios stabilizing quickly and then declining in the medium term. Alongside record-low borrowing costs, this is providing assurance of debt sustainability and servicing capacity. Indeed, if fiscal space remains ample even with the runup in debt, then policy makers should not worry about the implications of today's massive stimulus policies, and can let growth diminish the debt ratio over time, "living with high debt" in the interim (Ostry, Ghosh, and Espinoza, 2015). However, if fiscal space narrows because debt projections are optimistic, market confidence may falter. As history has shown, in these circumstances market sentiment can change swiflty, leading to abrupt changes in debt financing costs that can force costly fiscal retrenchment, especially if debt is not state-contingent and is of short maturity (Ostry et. al., 2010; Ghosh et. al., 2013; Kim and Ostry, 2021). Accurate forecasts are an essential foundation for constructing robust fiscal strategies consistent with debt sustainability (Celasun et al., 2006; Frankel 2011; Easterly 2013; Debrun et al., 2019), and robustness is even more important when debt is already very high, as today.

So, can we rely on the accuracy of public debt forecasts? To answer this question, we compile a unique, comprehensive dataset of medium-term debt forecasts made by the IMF (for the period 1995–2020) and the Economist Intelligence Unit (for the period 2007–2020) covering an unbalanced panel of 174 countries; other institutions do not offer the country coverage or medium-term horizon of our chosen data sources. We document several stylized facts about forecast errors in debt projections. Following the convention in the forecasting literature, we define forecast errors as the realized minus the forecasted debt ratio. Here, we summarize the main results which hold for both of our data sources:

- There is a significant positive forecast error in debt-to-GDP ratio projections, with the magnitude increasing with the forecast horizon. At the five-year horizon, realized debt ratios are, on average, about 10 percent of GDP higher than forecast.
- The magnitude of forecast errors is similar between countries with IMF programs and countries without, as well as across AEs and EMDEs. While positive errors in AEs are typically associated with unforeseen recessions in the forecast horizon, those in EMDEs are systematic, irrespective of the occurrence of recessions.
- The positive forecast error in the debt ratio is only partly driven by negative forecast errors in GDP growth. Controlling for forecast errors in GDP growth reduces the error in the debt ratio at the five-year horizon to about 4 percent of GDP.
- The forecast error is significantly larger when the projection is for debt ratios to decline than when increasing debt is projected. This is consistent with previous empirical evidence in the literature on the tendency of governments to run procyclical policies in good times and may suggest that announced consolidation plans were, on average, less effective than anticipated.
- Oil-exporters and more volatile countries tend to have larger forecast errors, as positive errors following adverse shocks do not get offset by negative errors after favorable shocks. Errors are also larger in countries with higher debt ratios.

Next, we use the GFC as a case study to assess debt trajectories following the COVID-19 crisis, on the assumption of similar future errors as in the past. This illustrative exercise suggests that the average debt-to-GDP ratio in EMDEs would steadily increase to about 70 percent of GDP in 2026 (instead of declining to 59 percent of GDP as forecast).

We conduct additional analysis on two topics in the Annex's to the paper. First, we explore other properties of the forecast, such as efficiency and directional accuracy. The results suggest that IMF forecasts are marginally more accurate in terms of mean squared error (MSE) than EIU forecasts or a naïve forecast which assumes no change in debt ratios. For both datasets, a weak test of efficiency of medium-term forecasts is always rejected, and the directional accuracy of forecasts tends to be higher when projections are for an increase in debt ratios rather than a decrease. The results are similar across AEs and EMDEs. Second, we do a case study on Japan, an advanced economy which has seen a spectacular increase in the debt-to-GDP ratio since the early 1990s. We find that it took more than a decade for forecasters to internalize the upward trend in Japanese debt, with projections over many years indicating a plateauing and/or decrease in debt ratios that did not materialize.

Our paper is related to two strands of the literature, one which looks at accuracy of macroeconomic (growth) forecasts and the second on accuracy of fiscal forecasts. The first strand has found widespread evidence for growth outturns underperforming forecasts, often driven by the inability of forecasters to predict recessions. The second strand has focused mainly on the accuracy of budget balance (rather than debt) forecasts, and for a relatively small group of countries, typically advanced economies (mostly European countries) and selected Latin America countries. Our paper, in contrast, focuses squarely on the debt ratio, and analyzes forecast errors for a large sample (174) of countries covering both AEs and EMDEs, including both IMF and private sector forecasts. This coverage allows us to assess how forecasts vary across countries and identify country-specific factors related to debt forecast errors; the large timespan allows us to examine how forecast errors change over time, including during periods of crises.

There is a longstanding attempt to identify and combat optimism bias in IMF debt projections (IMF, 2011, 2013, 2017a,b, 2021). In recognition of the bias, the IMF introduced mandatory realism tools (such as comparisons of projected fiscal adjustment with its historic distribution) in staff reports from 2013—see Abiad and Ostry (2005). IMF (2021) finds that forecast optimism with respect to some debt drivers declined thereafter, but debt ratio projections remained biased towards optimism, except in lending contexts. In response, IMF (2021) proposes a significant toolkit upgrade designed to address bias.

The rest of the paper is structured as follows. Section II provides a brief review of the literature on forecast accuracy of fiscal and macroeconomic (growth, inflation) variables. Section III describes our dataset and the methodology for constructing forecast errors. Section IV summarizes key stylized facts regarding the magnitude of the debt-to-GDP ratio forecast error in IMF and EIU projections, including the role of growth forecast errors. Section V explores the extent to which forecast errors are correlated with country characteristics, while Section VI focuses on the role of recessions in explaining forecast errors. Section VII draws implication for debt projections following the COVID-19 recession. Section VIII concludes.

II. Review of The Literature

The macro forecasting literature has found widespread evidence that GDP growth outturns underperform projections (Zarnowitz, 1991; Frankel, 2011; Hadzi-Vaskov and others, 2021b). Ho and Mauro (2016) compile a database of IMF WEO forecasts from 1990–2012 for 188 countries to assess the accuracy of growth projections. They find that projections are optimistic on average and that forecast errors increase with the forecast horizon, when countries enter an IMF program, and when output is below trend.

The inability of forecasters to predict recessions is one of the main factors of growth forecast errors (Loungani, 2001; Abreu, 2011; Gonzalez-Cabanillas and Terzi, 2012; IEO, 2014; Lewis and Pain, 2014; Dovern and Jannsen, 2017; An, Jalles and Loungani, 2018). Another driver emphasized in the literature is weak institutional quality (Frendreis and Tatalovich, 2000; Frankel and Schreger, 2013).

With respect to fiscal forecasts, the literature pertains mainly to European and a few Latin America countries, and usually uses forecasts of official government agencies, including in the European case under the Stability and Growth Pact (SGP). Although the samples differ across studies, the results provide consistent evidence that ex post budget balances in SGP signatories systematically fall short of official ex ante plans (Hallerberg , Strauch, and Von Hagen 2004; Bruck and Stephan 2006; Beetsma, Giuliodori, and Wierts, 2009; Marinheiro, 2010; Beetsma and others, 2013). Beetsma and others (2010) analyze Netherlands data and find that, in contrast to the EU as a whole, surplus forecasts are, on average, unbiased. Merola and Perez (2013) compare short-term projections made by the OECD and European Commission with those made by governments and find no statistical difference in their accuracy. Ademmer and Boysen-Hogrefe (2019) investigate German state-level data and find that revenue forecast errors translate into budget balance errors. In a Latin American sample covering Argentina, Brazil, Chile, Colombia, Mexico, and Peru, Hadzi-Vaskov and others (2021) find that short-term budget forecasts have been optimistic. Vasconcelos de Deus and Ferreira de Mendonça (2016) find similar results using Brazilian government forecast data. Frankel (2011) finds that, in Chile, establishing an independent government agency has improved forecast accuracy. Tovar Jalles and others (2015) and An and others (2017) cover a geographically diverse group of 29 countries, focusing on accuracy of fiscal balance forecasts. They find that fiscal forecasts are more accurate for advanced countries than for emerging economies and that there is no difference in accuracy between WEO and private sector forecasts.

The literature has generally found a connection between fiscal forecast bias and optimism of growth projections (Jonung and Larch, 2006, Beetsma and Wierts, 2009; Abbas and others, 2011; Holm-Hadulla, Hauptmeier, and Rother, 2012), terms of trade and inflation forecast errors (Hadzi-Vaskov and others, 2021a) and weaker institutional quality (Von Hagen, 2010; Masahiro 2007; Sinclair, Joutz and Stekler, 2010). Finally, IMF (2021) finds that, for the post-2013 period, the three-year change in the debt ratio is about 5 percent of GDP higher than forecast, with an interquartile range of 1–7 percent of GDP, and that higher than expected exchange rate depreciations and interest rates have been important drivers, especially in EMDEs (where the errors are larger).

III. CONSTRUCTING DEBT FORECAST ERRORS

We draw on: (i) bi-annual IMF forecasts published in the World Economic Outlook (WEO); and (ii) forecasts made by the Economist Intelligence Unit (EIU).

A. Data

IMF Forecasts

Twice a year, usually in April and October, the IMF publishes five-year ahead forecasts for 192 countries for a range of economic variables. Historical forecast data are available going back to the 1990 forecast vintages. For our analysis, we focus on four variables: gross debt, nominal and real GDP, and fiscal deficits. The availability of these indicators varies from vintage to vintage (Figure 2). For gross debt, the coverage is fairly limited before the 2002 vintages, with debt forecasts available for only 28 countries starting from the 1995 vintages. Data coverage starts improving from the 2002 vintages, increasing from 56 countries in the first vintage of 2002 to over 185 countries in some of the most recent vintages. Nominal and real GDP, and fiscal deficit data are more widely available, with country coverage increasing to around 190 countries in recent vintages.

We use the data on gross debt and nominal GDP to construct an unbalanced panel of debt-to-GDP forecasts at the country-vintage level. For each country-vintage pair, we have annual forecasts for a five-year horizon. For some countries, the data on debt-to-GDP ratios changes significantly from one vintage to the next, likely reflecting measurement error. Significant shifts in the debt series can affect our estimates of forecast errors which rely on comparing forecasts from one vintage to realized outcomes reported in future vintages. To minimize such measurement problems, we clean our dataset in two steps. First, if gross debt was reported to be exactly zero, we consider the observation to be missing. Second, we conduct a manual country specific cleaning, where we compare descriptive statistics of the debt series for each country across vintages. When the data show big shifts, we either rescale the debt series or convert some country-vintages to missing—Annex 1 provides details of all changes made in our cleaning process and can allow researchers to replicate our dataset. Table 1, column 1 provides descriptive statistics for our final unbalanced panel, as well as for AEs and EMDEs separately (IMF source).

Economist Intelligence Unit Forecasts

Our second data source is the EIU, which publishes monthly forecasts for 149 countries. To maximize comparability with IMF forecasts, we focus on vintages released in April and October, for gross debt, nominal and real GDP, and fiscal deficit variables. We restrict our analysis to forecast vintages after 2007 as gross debt forecasts from the EIU are not available for earlier vintages, and construct an unbalanced panel of debt-to-GDP ratio forecasts for 109 countries. Table 1, column 2 provides descriptive statistics. Although country coverage is more limited than for the IMF forecasts, the data are a useful private sector complement to the IMF-based results. To ensure comparability, we repeat some of our analysis for a subset of country-vintages for which both IMF and EIU forecasts are available. Columns 3 and 4 of Table 1 provides descriptive statistics for this balanced sample. For the empirical analysis, we also compile information on country characteristics and the occurrence of recessions and crises, drawing on sources described in Table 2.

B. Constructing Forecast Errors

Our baseline measure of forecast error is the realized debt-to-GDP ratio as reported in the second vintage of the year after the forecast minus the forecast ratio. We use the second vintage from the post-forecast year as a proxy for the first release estimate, recognizing that at the time of the first vintage (April), first releases are unavailable for many EMDEs. For robustness, we construct three additional measures, using realized debt ratios from the latest vintage, and comparing forecasted *changes* to realized *changes* in debt ratios. For all measures, we compute forecast errors for projections up to 2019 as realized debt ratios for 2020 are unavailable and to prevent the COVID-19 shock from impacting our results.

Baseline Measure of Forecast Error

The forecast error, $FE_{c,h}^{v}$, for country *c*, in vintage *v,* at horizon *h* can be written as:

$$FE_{c,h}^{v} = R_{c,v_y+h}^{v_y+h+1} - F_{c,v_y+h}^{v} \qquad (1)$$

where superscript "*v*" is the vintage; v_y is the year of the vintage; F_{c,v_y+h}^{v} is the forecast debt-to-GDP ratio of country *c* in vintage *v* at horizon *h;* and $R_{c,v_y+h}^{v_y+h+1}$ is the realized debt-to GDP ratio. For the April 2010 vintage, for example, the forecast for 2011 is compared to the realized ratio as reported in October 2012, and so forth.

Alternative Measures of Forecast Error

An alternative measure of realized debt-to-GDP ratio can be constructed using the historical data for debt-to-GDP ratio in the latest vintage of the IMF and EIU data (the second vintage of 2020 which we call 2020H2). In this case, the forecast error is:

$$FE_{c,h}^{v,2020} = R_{c,v_y+h}^{2020} - F_{c,v_y+h}^{v} \qquad (2)$$

where R_{c,v_y+h}^{2020} is the realized debt-to-GDP ratio as reported in the latest 2020 vintage.

The main advantage of equation (2) is that it incorporates the latest data, capturing any updates that may have been reported even years after the forecast (e.g. previously hidden debt). However, this measure can suffer from a bias due to GDP rebasing, which can result in a significant increase in the level of GDP, especially in developing economies. Such rebasing shifts the realized debt-to-GDP series downwards. Use of equation (1) is likely to attenuate, though not eliminate, the resulting downward bias as the realized GDP values are taken from vintages that are closer to the forecast vintage itself.

To further attenuate bias due to GDP rebasing, we construct two additional measures of forecast errors in which we compare *forecasted changes* in debt-to-GDP ratio to the *realized changes*. Again, for realized debt ratios, we can use the latest vintage of the IMF and EIU data, or the second vintage of the year right after the forecast:

$$FE_{change}{}_{c,h}^{v,2020} = \left(R_{c,v_y+h}^{2020} - R_{c,v_y-1}^{2020}\right) - \left(F_{c,v_y+h}^{v} - F_{c,v_y-1}^{v}\right) \quad (3)$$

$$FE_{change}{}_{c,h}^{v} = \left(R_{c,v_y+h}^{v_y+h+1} - R_{c,v_y-1}^{v_y+h+1}\right) - \left(F_{c,v_y+h}^{v} - F_{c,v_y-1}^{v}\right) \quad (4)$$

These measures are less likely to be biased due to rebasing as a shift in the level of the debt-to-GDP series biases the changes to a smaller extent. On the other hand, these measures can be more susceptible to measurement error, including in *t-1* data which only enters the change equation. The top panel of Table 3 summarizes the correlation in IMF forecast errors across the different methods at the five-year horizon. Correlation range between 0.86 and 0.96, and similarly for EIU forecast errors (Table 3, bottom panel).

IV. STYLIZED FACTS

A. Magnitude of forecast errors

Figure 3 summarizes the size of forecast errors in IMF and EIU debt projections. The top panel plots the median, interquartile range, and mean of IMF (left panel) and EIU (right panel) forecast errors at different horizons using our baseline measure of forecast errors. Mean and median forecast errors are positive at all horizons, indicating that realized debt ratios are higher than forecasted ratios, with the forecast error increasing steadily with the forecast horizon. The median error in IMF forecasts at the five-year horizon is 7.4 percent of GDP, while the mean error is 8.7 percent of GDP. Even at the one-year horizon, the mean forecast error is significantly different from zero. Standard errors are clustered two-way at the country and vintage level unless noted otherwise.

EIU forecast errors are larger on average, with a mean error at the five-year horizon of over 10 percent of GDP. However, the difference in magnitude relative to the IMF forecast errors is driven entirely by differences in sample coverage. The bottom panel of Figure 3 shows the average forecast errors for the balanced sample of country-vintages for which data are available for both sources and finds mean forecast errors at the five-year horizon of about 11.7 percent of GDP. The correlation in forecast errors at the five-year horizon across the two datasets is about to 0.8 (see Annex Table 2.1).

Forecast errors using different measures: The magnitude of the forecast error is quantitatively similar across the four different methods of computing forecast errors discussed in the previous section. The mean IMF forecast error at the five-year horizon ranges from 7.7 to 10.1 percent of GDP (Figure 4). As expected, the forecast error is slightly larger for the baseline measure and those based on the change in the debt-to-GDP ratio, as these measures attenuate the downward bias introduced by GDP rebasing.

Cross-country distribution of forecast errors: Figure 5 shows the distribution of forecast errors across countries. For both IMF and EIU data, in addition to the median being above zero, the distribution also has a longer right tail. For example, the average IMF forecast errors is close to 40 percent of GDP in Venezuela and the Republic of Congo, reflecting the significant unanticipated increase in debt ratios in recent years.

Forecast error by income level: The average forecast error is about the same in AEs and EMDEs, both for IMF (Figure 6, Panel A) and EIU forecasts (Panel B).[2] However, Figure 7 shows that, for AEs (Panel B), the vintages leading up to the global financial crisis (GFC) had large forecast errors, as the recession and ensuing fiscal stimulus were unanticipated, leading to a large unanticipated increase in debt. After the GFC the average forecast error in AEs has been close to zero. On the other hand, for EMDEs (Panel A), the forecast errors have been consistently positive after the GFC, indicating a more systematic pattern. We explore the relation between forecast errors and recessions in Section VI.

[2] Within the group of EMDEs, there is no significant difference in the average forecast errors for low-income and developing countries (LIDCs) compared to emerging markets (EMs)—see Annex Figure 2.1.

Forecast errors by region: The forecast errors are positive for all regions. The magnitude is larger for sub-Saharan Africa and the Middle East and North Africa (Figure 8), where the average forecast error is over 10 percent of GDP; the Asia-Pacific region has the smallest average forecast error at about 7 percent of GDP. However, mean forecast errors across regions are not statistically different from each other.

IMF programs: As shown in Figure 9 (left panel), the average forecast error is similar in country-vintages with IMF programs versus no programs; mean forecast errors in General Resources Account (GRA) and Poverty Reduction and Growth Trust (PRGT) programs are also of similar magnitude. There is a difference in precautionary versus non-precautionary programs (Figure 9, right panel), with smaller errors in the former.

Dependence on forecasted debt trajectory: The magnitude of the forecast error depends on the forecasted path of the debt ratios in the IMF forecasts. When the forecast is for debt ratios to decrease over the next five years, the average forecast error is over 10 percent of GDP. On the other hand, the average forecast error is only 3.3 percent of GDP when the forecast is for debt ratios to remain stable or to increase (Figure 10, left panel). For EIU data as well, debt forecast errors are larger when the projection is for a decline in debt ratio (Figure 10, right panel). This is consistent with the previous empirical literature on the tendency of governments to run procyclical policies in good times, and may suggest that announced consolidation plans were, on average, less effective than anticipated.

Persistence of forecast errors: Figure 11 shows the extent of autocorrelation in forecast errors across vintages. One-year ahead forecasts display positive autocorrelation with three vintages (a year and a half), indicating some persistence in forecast errors. In comparison, five-year ahead forecasts display greater persistence as more vintages have the same shock falling in the forecast horizon (Figure 11, right panel).

B. What Drives Debt-To-GDP Ratio Forecast Errors?

Several factors could account for the large positive forecast errors, including disappointing growth outturns, unfulfilled fiscal consolidation plans, unexpected shocks to exchange rates and real interest rates, realizations of contingent liabilities, and measurement errors.[3] Identifying the contribution of each factor is not feasible, however, in part because of limited data availability of projections for several of these components such as the real interest rate and contingent liabilities. Here we conduct a less ambitious exercise, focusing on the role of growth and deficit forecast errors for which data are more widely available.

We use two approaches. First, we examine the contribution of growth and deficit forecast misses on debt forecast errors using an accounting decomposition based on the standard debt dynamics equation.[4] The results of this decomposition are illustrated in Figure 12 and suggest that both fiscal deficit and growth forecast errors have played a role in the positive forecast error in debt projections, with the contribution of fiscal deficits being larger. [5] However, these results should be interpreted with caution. The accounting decomposition equation is only an approximation, as a perfectly separable decomposition of the role played by each factor in explaining debt dynamics is not possible (see Escolano, 2010 for details). Furthermore, growth and fiscal deficit forecast errors are correlated, and the accounting exercise cannot identify, for example, the extent to which forecast errors in fiscal deficits may themselves be caused due to growth misses.

Second, to better account for correlation between growth and deficit forecast errors, we examine what is the average debt ratio forecast error conditional on the growth forecast error or the deficit forecast errors, or both. Starting with GDP growth, we run simple reduced form regressions of the five-year debt forecast error on growth forecast errors at each horizon from time zero to five. As expected, the coefficients on growth forecast errors are negative and significant, indicating that debt forecast errors are larger when realized growth is lower than

[3] World Economic Outlook (WEO) forecasts are normally based on officially announced budgets, adjusted for differences between the national authorities and IMF staff regarding macroeconomic assumptions and projected fiscal outturns. When no official budget has been announced, projections incorporate policy measures judged likely to be implemented. As such, forecast errors in fiscal projections could arise due to (i) macroeconomic outturns being different to assumptions made by staff; (ii) assumed policy measures that were not implemented; or (iii) other factors such as the realization of contingent liabilities.

[4] The debt dynamics equation takes the form $d_t - d_{t-1} = fd_t - \frac{g_t}{1+g_t} d_{t-1} + o_t$ where d_t is the debt-to-GDP ratio, fd_t is the fiscal deficit as a percent of GDP, g_t is the real growth rate, and o_t is other debt-creating flows (including the contribution of inflation and exchange rate, contingent liabilities, measurement errors etc.). The contribution of growth and fiscal deficit forecast errors in explaining debt forecast errors is calculated as the difference between the realized and forecasted values of the two terms in the equations.

[5] Annex Figure 2.2 extends the analysis to the contribution of inflation forecast errors. The median contribution is very close to zero, although the mean is negative, partly reflecting very large negative contribution for some countries which experienced episodes of hyperinflation (for example, Venezuela). Given the small median effects and the disproportionate impact of outliers, we restrict our analysis to growth and fiscal deficit forecast errors only.

what was forecasted (Table 4, column 2). Furthermore, the constant in the regression which includes growth forecast errors (column 2) is about half as large as the constant when growth errors are excluded (column 1). This result is consistent with previous evidence for European countries (e.g., Jonung and Larch, 2006). At the same time, even when growth forecast errors are zero, the average debt forecast error is about 4 percent of GDP, suggesting that other factors play a significant role in generating positive debt forecast errors.

Next, we consider the role of forecast errors in the deficit-to-GDP ratio. The coefficients on the deficit forecast errors are positive as expected—that is, underestimating deficits leads to larger debt forecast errors (Table 4, column 3). Clearly, forecast errors in the deficit-to-GDP ratio are in turn influenced by forecast errors in growth projections. To control for this, we include in the same regression both growth and fiscal deficit forecast errors (Table 4, column 4). Interestingly, while the constant in column 4 is smaller than in column 2, the difference is quite small. This suggests that fiscal deficit projections play only a limited role in explaining the positive average forecast error in debt ratio once we control for growth forecast errors. Other factors such as exchange rate effects, realization of contingent liabilities, and measurement errors that are not perfectly correlated with growth forecast errors are therefore playing a significant role in the positive forecast error observed in the debt projections. Columns 5 through 12 repeat the regressions for EMDEs and AEs only. The results are broadly similar across both country groups.

V. WHICH COUNTRIES HAVE LARGER FORECAST ERRORS?

To answer this question, we use a simple cross-country regression of the form:

$$\overline{FE_c} = \alpha + \beta X_c + \epsilon_c \tag{6}$$

where $\overline{FE_c}$ is the average five-year ahead forecast error for country c and X_c is the country characteristic of interest. When computing $\overline{FE_c}$, we consider two samples. First, for each country we take the average over all vintages for which forecast errors are available. As a robustness check, we consider a second sample in which we average over vintages after the GFC. This second sample prevents the large GFC shock from unduly impacting forecast errors and ensures a more balanced sample across countries as data coverage for debt forecasts improves significantly in the post-GFC vintages.

Table 5 presents results for the first sample.[6] As shown in the first column, the average forecast error in oil-exporting countries is almost 15 percent of GDP higher than non-oil-exporters. This could reflect the large shocks faced by these countries, combined with the asymmetric response to shocks and procyclicality of fiscal policy during periods of higher growth (Frankel 2013)—that is, large positive shocks do not lead to under-accumulation of debt relative to forecast, whereas large negative shocks do lead to over-accumulation of debt relative to forecast. Furthermore, growth forecast errors also tend to be larger on average for oil exporters, potentially contributing to larger debt forecast errors. In column 2 of Table 5, we add the standard deviation of GDP growth as a measure of a country's economic volatility. More volatile countries have larger forecast errors on average, again indicating an asymmetric response to shocks. The results are consistent with Lane (2003), who suggests that more volatile countries are more prone to procyclical fiscal policy during expansions. Furthermore, countries with larger average debt ratios have larger forecast errors (column 3), likely reflecting the fact that growth or exchange rate shocks have larger effects when debt ratios are higher. Adding other variables to the model such as control over corruption (Column 4), volatility of interest and exchange rates (columns 5 and 6), and presence of a fiscal rule (column 7) do not yield significant results.

Table 6 reports results for the sample of post-GFC vintages. The coefficient on log per-capita GDP (PPP) is now negative and significant, i.e., poorer countries have larger average forecast errors post-GFC. This echoes our finding that post-GFC vintages have had positive forecast errors for EMDEs, and close to zero in AEs (Figure 6). Results with the smaller EIU sample should be interpreted with caution (Annex Tables 2.2 and 2.3).

[6] Although debt forecasts are available for more than 185 countries in the latest WEO vintages, our sample consists of only 174 countries because the debt forecasts were available for fewer countries in the 2014 vintages which are the last vintages for which five-year ahead forecast errors can be computed.

VI. ROLE OF RECESSIONS

To what extent is the positive average forecast error simply due to the fact that recessions are not anticipated and lead to a large, unexpected increase in debt ratios? To answer this question, we run simple pooled regressions of the form:

$$FE_{c,5}^{v} = \alpha + \beta R_{c,v} + \epsilon_{c,v} \quad (7)$$

where $FE_{c,5}^{v}$ is the five-year forecast error in country c in vintage v, and $R_{c,v}$ is a dummy variable which takes value 1 for any country-vintage where a recession or crisis starts at any time in the forecast horizon i.e. if a recession starts in one of the five years following the vintage. The constant α is an estimate for the average forecast error in vintages where no recession falls in the forecast horizon, while β is the estimate for the extent to which the forecast error is larger in vintages where a recession does fall in the forecast horizon. Standard errors are clustered two-way at the country and vintage level.

For our baseline, we use the simplest defintion of recession: years in which a country has negative real GDP growth. To check the robustness of our results, we also consider several other definitions, including: (i) recession years based on the Harding-Pagan algorithm applied to annual real GDP data; (ii) recession years based on the Harding-Pagan alogirithm applied to annual per-capita GDP data; (iii) defining any year with an output gap of less than -2 percent to be a recession, where output gap is estimated using a simple Hodrik-Prescott filter on annual GDP data; and (iv) any year defined as a financial, debt, or currency crisis by Laeven and Valencia (2018). Table 7 summarizes the results from these regressions. For our baseline in column 1, the forecast error in non-recession vintages is 4.5 percent of GDP and is significantly different from zero. When a recession does fall in the forecast horizon, the forecast error is significantly larger at about 15.5 percent of GDP. Columns 2 through 5 repeat the regression with different recession dummies. For all variables, the constant is positive and significant, implying a systematic positive forecast error even when no recession falls in the forecast horizon. Interestingly, the above result is driven entirely by EMDEs. Table 8 and 9 repeat the regressions for just the sample of EMDEs and AEs respectiverly. For EMDEs, the constant is always positive and significant, indicating a systematic forecast error in non-recession years. By contrast, for AEs, the constant is usually insignificant, while the magnitide of the coefficient on the recession variable is larger.[7] This indicates that for AEs, there is a much larger forecast error when a recession falls in the forecast horizon, potentially reflecting the larger fiscal stimulus that AEs can implement in response to a recession. On the other hand, in non-recession vintages, IMF forecasts for AEs are not significantly different from zero. Results using EIU forecast errors are broadly similar—Annex Tables 2.4-2.6.

Finally, Figure 13 shows the average forecast errors in vintages around a recession. For EMDEs, the forecast error is positive in vintages leading up to a recession as well as in vintages after a recession, consistent with the results reported in Table 8. By contrast, for AEs the forecast errors in vintages just before a recession is significantly larger, while the forecast error essentially declines to zero two vintages after the start of a recession.

VII. Possible Implications For Post-COVID Debt Paths

In the 2009H1 vintage, the first vintage after the GFC shock, the IMF was projecting average debt ratios to increase in 2009, before plateauing and then declining towards the end of the forecast horizon. Realized debt ratios (as reported in the second vintage of 2015), however, increased throughout this period (Figure 14), contributing to an average forecast error of about 10 percent of GDP. Positive forecast errors were recorded for AEs as well as EMDEs. By the 2010H1 vintage, the forecast errors for AEs had declined significantly, but large errors remained for EMDEs (Figure 15). For the current crisis, the latest projections for debt-to-GDP ratio (as reported in the 2021H2 vintage) are pointing to a steady decline in debt ratios (Figure 16, left panel) for AEs as well as EMDEs (Figure 16, right panel).

What can past forecast errors tell us about the possible future path for debt ratios? To answer this question, we use the GFC as a proxy for a large shock and construct counterfactual debt paths, assuming the post-GFC forecast errors materialize again. Of course, there remains considerable uncertainty regarding the medium-term effects of the pandemic; and the GFC, where financial stresses resulted in a persistent decline in economic activity, may not be an ideal comparator for the current crisis. However, we view this exercise as a useful illustrative

[7] For AEs, the constant is only significant for the Laeven and Valencia (2018) crisis variable, as several recessions in AEs are not accompanied by crises but are still associated with large positive forecast errors.

benchmark to get a sense of possible debt trajectories in the future. We use country level forecast errors from the 2010H1 vintage and apply them to the latest WEO projections from the 2021H2 vintage. This gives us a "corrected" forecast for each country which we then aggregate up, doing both simple and weighted averages. Our sample here includes countries for which forecast errors (to five years) were available in the 2010H1 vintage.[8]

Using simple averages, debt ratios in 2026 may be almost 8.5 percent of GDP higher. Using weighted averages, the difference is smaller as forecast errors after the GFC were smaller for the bigger countries (Figure 17). The implications of underestimating debt at the current juncture may be especially severe for EMDEs. Our calculation suggests that the average debt-to-GDP ratio in EMDEs may increase to about 70 percent of GDP in 2025, as opposed to declining to 59 percent of GDP as currently projected by the IMF (Figure 18).

VIII. Conclusion

Do forecasters project public debt accurately? Our answer, based on a unique and comprehensive dataset of debt forecasts made by the IMF and the EIU, is: No. Projections tend to under-estimate actual debt ratios, with the forecast error increasing over the forecast horizon. The error in five-year ahead projections is close to 10 percent of GDP, on average. The magnitude of forecast errors is similar in AEs and EMs. While in AEs, forecast errors are typically short-lived and reflect unexpected recessions, in EMDEs the forecast error is more systematic, both during bad and good times.

The IMF and other commentators have rightly called attention to debt vulnerabilities in EMDEs in the aftermath of the COVID-19 crisis (IMF, 2020). Our results underscore the salience of calls by the international community to accelerate efforts to tackle debt vulnerabilities in many low-income economies that have been hit particularly hard by the COVID-19 crisis, have little policy space to respond, and will require financial assistance for the foreseeable future. Where sustainability is in question, global cooperation via the G-20 Common Framework will be key to ensure orderly restructuring of debt so that countries can rebound and grow. Our results also highlight the importance of continuous efforts to improve the realism of debt

[8] An earlier version of the paper used the forecast errors for the 2009H1 vintage to correct forecasts made in the 2020H2 vintage.

projections (IMF 2021) Taking a conservative approach to fiscal projections by potentially building in a "safety margin" when assessing debt vulnerabilities would also help. Finally, an important factor affecting debt projections is growth. This puts a premium on policies to ensure fiscal sustainability over the medium term, through policies that deliver strong, resilient growth and mitigate the economic scarring effects of the pandemic.

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TABLE 1: SUMMARY STATISTICS DEBT-TO-GDP FORECASTS, IMF AND EIU

		(1) IMF	(2) EIU	(3) IMF Balanced	(4) EIU Balanced
All Countries	**No. Observations**	**26077**	**16285**	**10480**	**10480**
	Mean	51.58	52.96	51.87	51.90
	Standard Deviation	34.57	37.65	36.99	36.16
	Max.	261.02	884.20	254.95	339.20
	Min.	-11.60	-4.80	-0.57	-0.30
Advanced Economies	**No. Observations (%total)**	**32%**	**31%**	**35%**	**35%**
	Mean	61.63	67.52	68.19	67.36
	Standard Deviation	40.60	45.39	45.93	44.32
	Max.	256.60	340.20	254.95	339.20
	Min.	-2.32	-0.30	-0.57	-0.30
Emerging Economies	**No. Observations (% total)**	**68%**	**69%**	**65%**	**65%**
	Mean	46.85	46.49	43.15	43.65
	Standard Deviation	30.21	31.55	27.48	27.60
	Max.	261.02	884.20	214.45	241.60
	Min.	-11.60	-4.80	0.18	0.40

Note: Table shows descriptive statistics for IMF and EIU debt-to-GDP forecasts. Column 1 is for the full IMF sample, column 2 covers the full EIU sample, column 3 provides statistics for IMF forecasts for the balanced sample where debt projections are available for IMF and EIU, while column 4 does the same for EIU data.

TABLE 2: DATA ON COUNTRY CHARACTERISTICS AND RECESSIONS

Variables	Source	No Countries	Time
Per-capita GDP PPP	IMF WEO	195	1950-2025
Oil Exporter	IMF WEO	195	1950-2025
Volatility of GDP Growth	IMF WEO	195	1950-2025
Control over Corruption	Worldwide Governance Indicators	214	1996-2019
Volatility of Exchange Rate	IMF WEO	195	1950-2025
Volatility of Inflation	IMF WEO	195	1950-2025
Fiscal Rules	IMF Fiscal Affairs Department	96	1985-2015
Crisis	Laeven and Valencia 2018	185	1970-2016

TABLE 3: CORRELATION OF FORECAST ERRORS ACROSS DIFFERENT METHODS; FIVE-YEAR HORIZON

Panel A: IMF

	$FE_{c,h}^{v,2020}$	$FE_{change\,c,h}^{v,2020}$	Baseline	$FE_{change\,c,h}^{v}$
$FE_{c,h}^{v,2020}$	1.00			
$FE_{change\,c,h}^{v,2020}$	0.88	1.00		
Baseline $FE_{c,h}^{v}$	0.96	0.86	1.00	
$FE_{change\,c,h}^{v}$	0.86	0.96	0.88	1.00

Panel B: EIU

	$FE_{c,h}^{v,2020}$	$FE_{change\,c,h}^{v,2020}$	Baseline	$FE_{change\,c,h}^{v}$
$FE_{c,h}^{v,2020}$	1.00			
$FE_{change\,c,h}^{v,2020}$	0.94	1.00		
Baseline $FE_{c,h}^{v}$	0.98	0.94	1.00	
$FE_{change\,c,h}^{v}$	0.93	0.99	0.95	1.00

Notes: The table shows the correlation coefficient for the four measures of forecast error discussed in Section III. The first row uses the realized level of debt-to-GDP ratio from the latest available vintage to compute forecast errors., the second row uses realized debt-to-GDP from the second vintage of the year right after the forecast, the third row compares the forecasted change in debt ratios to the realized changes as measured from the second vintage of the year right after the forecast, while the fourth row compares the forecasted change in debt ratios to the realized changes as measured from the latest data vintage (2020H2). Panel A shows the correlation for five-year ahead forecast errors computed using IMF forecasts while Panel B reports the same for EIU forecasts.

TABLE 4: DRIVERS OF DEBT FORECAST ERRORS, IMF FULL SAMPLE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	All Countries				EMDEs				Aes			
Growth FE, t=0		-0.161		-0.166		-0.164		-0.210		-0.189		0.188
		(0.274)		(0.331)		(0.308)		(0.369)		(0.558)		(0.646)
Growth FE, t=1		-0.766***		-0.531***		-0.580***		-0.431***		-1.463***		-0.754***
		(0.134)		(0.134)		(0.154)		(0.152)		(0.218)		(0.191)
Growth FE, t=2		-0.695***		-0.616***		-0.451***		-0.453***		-1.519***		-0.880***
		(0.0983)		(0.116)		(0.108)		(0.129)		(0.196)		(0.241)
Growth FE, t=3		-0.838***		-0.557***		-0.732***		-0.494***		-1.340***		-1.002***
		(0.0926)		(0.120)		(0.0965)		(0.143)		(0.196)		(0.284)
Growth FE, t=4		-1.001***		-0.666***		-0.891***		-0.542***		-1.426***		-1.158***
		(0.146)		(0.170)		(0.179)		(0.188)		(0.202)		(0.271)
Growth FE, t=5		-1.240***		-1.067***		-1.235***		-1.054***		-1.613***		-1.276***
		(0.201)		(0.206)		(0.270)		(0.268)		(0.260)		(0.370)
Fiscal deficit FE, t=0			0.100	0.223			0.134	0.202			0.355	0.778
			(0.207)	(0.203)			(0.191)	(0.204)			(0.786)	(0.621)
Fiscal deficit FE, t=1			0.133*	0.0792			0.139*	0.0886			0.182	0.116
			(0.0738)	(0.0901)			(0.0741)	(0.0787)			(0.587)	(0.388)
Fiscal deficit FE, t=2			0.582***	0.427**			0.421*	0.327			1.419***	1.117***
			(0.199)	(0.181)			(0.227)	(0.199)			(0.210)	(0.228)
Fiscal deficit FE, t=3			0.420	0.163			0.329	0.0955			0.911***	0.604**
			(0.259)	(0.258)			(0.314)	(0.299)			(0.224)	(0.249)
Fiscal deficit FE, t=4			1.015***	0.933***			1.064***	1.004***			0.632**	0.209
			(0.278)	(0.298)			(0.263)	(0.292)			(0.298)	(0.330)
Fiscal deficit FE, t=5			0.131	-0.0125			-0.0312	-0.115			1.214**	0.663
			(0.214)	(0.203)			(0.183)	(0.192)			(0.484)	(0.479)
Constant	8.707***	4.065***	6.527***	3.771***	8.398***	3.707**	6.257***	3.408**	9.278***	4.027***	6.533***	3.848***
	(1.255)	(1.124)	(1.064)	(0.996)	(1.762)	(1.671)	(1.598)	(1.485)	(2.310)	(1.433)	(1.661)	(1.195)
Observations	3,383	3,378	3,360	3,356	2,193	2,188	2,170	2,166	1,190	1,190	1,190	1,190
R-squared	0.000	0.218	0.226	0.335	0.000	0.178	0.203	0.297	0.000	0.416	0.398	0.539

Note: Observations are at the country-vintage level. Dependent variable in each regression is five-year ahead forecast error in debt ratios of country *c* in vintage *v*. Column 1 simply regressions the independent variable on a constant. Columns 2 regresses the independent variable on growth forecast errors for all horizons going from 0 to 5. Columns 3 regresses the independent variable on fiscal deficit forecast errors for all horizons going from 0 to 5. Column 4 includes both growth and fiscal deficit forecast errors. Columns 5 through 8 repeat the regressions for the sample of EMDEs only, while columns 9 through 12 does the same for AEs. Standard errors are clustered two-way at the country and vintage level. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

TABLE 5: CORRELATION BETWEEN FORECAST ERRORS AND COUNTRY CHARACTERISTICS, IMF FULL SAMPLE

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Per-capita GDP PPP (ln)	-0.880	-0.556	-0.824	-1.371	-0.809	-0.808	-1.565
	(0.955)	(0.984)	(0.911)	(1.927)	(0.956)	(0.961)	(1.214)
Oil Exporter = 1	14.83***	10.43**	14.83***	15.60***	14.41***	14.17***	16.12***
	(4.296)	(4.530)	(3.835)	(4.514)	(4.370)	(4.436)	(4.590)
Volatility of GDP Growth		0.997**					
		(0.478)					
Average Debt Level			0.120***				
			(0.0387)				
Control over Corruption				0.750			
				(2.118)			
Volatility of Exchange Rate					0.000949		
					(0.00169)		
Volatility of Inflation						0.00152	
						(0.00179)	
Fiscal Rule (imputed and averaged)							4.881
							(4.176)
Constant	15.14*	7.733	7.986	19.54	14.34	14.36	19.76*
	(8.948)	(10.07)	(8.811)	(17.36)	(8.943)	(8.998)	(10.31)
Observations	174	174	172	174	174	174	174
R-squared	0.102	0.137	0.146	0.102	0.105	0.106	0.109

Note: Dependent variable in each regression is average forecast error of each country across all vintages. Independent variables are also averaged across all years in the sample. Sample consists of 174 countries. For fiscal rule, if the dataset did not have any information on a country, we assume that there is no fiscal rule. Robust standard errors reported in parenthesis. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

TABLE 6: CORRELATION BETWEEN FORECAST ERRORS AND COUNTRY CHARACTERISTICS, IMF POST-GFC

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Per-capita GDP PPP (ln)	-3.673***	-3.300***	-3.538***	-2.439	-3.617***	-3.618***	-3.662***
	(1.094)	(1.107)	(1.060)	(2.084)	(1.087)	(1.094)	(1.294)
Oil Exporter = 1	19.31***	14.25***	19.74***	17.37***	18.99***	18.81***	19.29***
	(4.220)	(4.447)	(3.720)	(4.596)	(4.324)	(4.376)	(4.522)
Volatility of GDP Growth		1.146**					
		(0.456)					
Average Debt Level			0.123***				
			(0.0452)				
Control over Corruption				-1.889			
				(2.413)			
Volatility of Exchange Rate					0.000743		
					(0.00188)		
Volatility of Inflation						0.00115	
						(0.00192)	
Fiscal Rule (imputed and averaged)							-0.0796
							(4.492)
Constant	40.68***	32.14***	32.25***	29.62	40.05***	40.08***	40.60***
	(10.03)	(10.84)	(10.09)	(18.74)	(9.915)	(10.01)	(11.10)
Observations	173	173	172	173	173	173	173
R-squared	0.170	0.209	0.208	0.174	0.172	0.173	0.170

Note: Dependent variable in each regression is average forecast error of each country across all vintages after 2008. Independent variables are also averaged across all years in the sample. Sample consists of 174 countries. For fiscal rule, if the dataset did not have any information on a country, we assume that there is no fiscal rule. Robust standard errors reported in parenthesis. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

TABLE 7: FORECAST ERRORS WHEN RECESSION FALLS IN HORIZON, ALL COUNTRIES

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Negative Real Growth	Harding-Pagan on Real GDP	Harding-Pagan on per-capita GDP	Output gap less than -2 percent	Crisis
Recession Start in Forecast Horizon	10.93***	10.57***	10.47***	6.094***	14.70***
	(2.260)	(2.183)	(1.962)	(2.217)	(3.444)
Constant	4.512***	4.676***	2.954*	6.738***	6.277***
	(1.379)	(1.378)	(1.566)	(1.311)	(1.265)
Observations	3,350	3,360	3,383	3,383	3,350
R-squared	0.051	0.047	0.049	0.015	0.055

Note: Observations at country-vintage level. Dependent variable in each regression is forecast error of country *'c'* in vintage *'v'*. Independent variable is a dummy which takes value 1 if the start of a recession occurs in country *'c'* in the forecast horizon. Columns correspond to different recession definitions as described in Section VI. Standard errors are clustered two-way at country and vintage level. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

TABLE 8: FORECAST ERRORS WHEN RECESSION FALLS IN HORIZON, EMDES

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Negative Real Growth	Harding-Pagan on Real GDP	Harding-Pagan on per-capita GDP	Output gap less than -2 percent	Crisis
Recession Start in Forecast Horizon	6.965**	6.416**	8.047***	1.342	8.659*
	(2.807)	(2.692)	(2.413)	(2.975)	(4.468)
Constant	5.933***	6.126***	3.950*	7.977***	7.212***
	(1.907)	(1.925)	(2.187)	(1.872)	(1.730)
Observations	2,174	2,182	2,193	2,193	2,174
R-squared	0.018	0.015	0.026	0.001	0.015

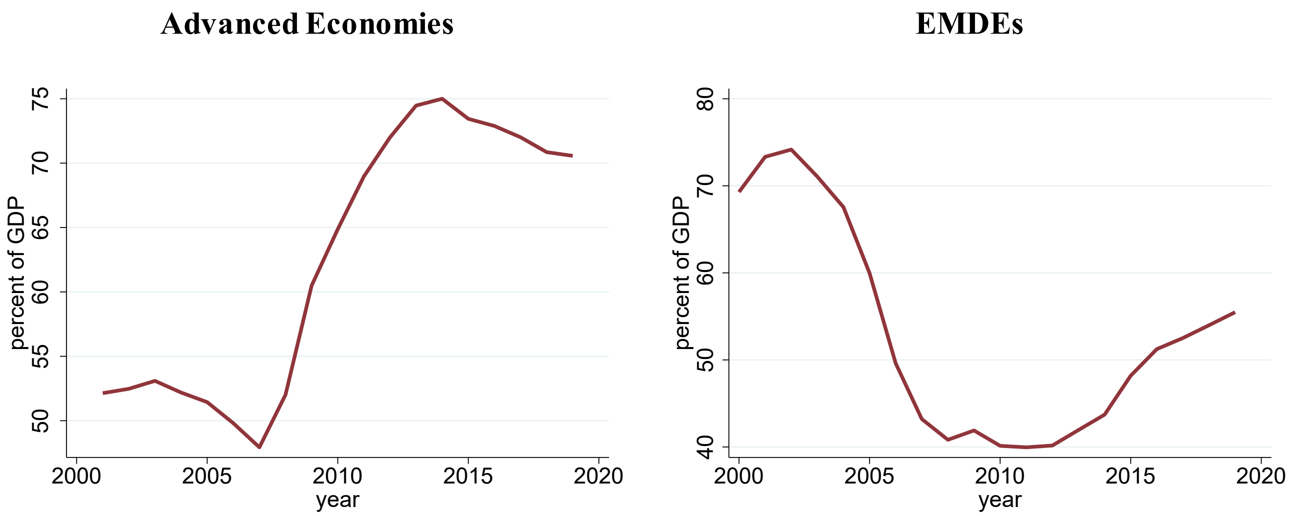
Note: Observations at country-vintage level. Sample only includes EMDEs. Dependent variable in each regression is forecast error of country *'c'* in vintage *'v'*. Independent variable is a dummy which takes value 1 if the start of a recession occurs in country *'c'* in the forecast horizon. Columns correspond to different recession definitions as described in Section VI. Standard errors are clustered two-way at country and vintage level. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

TABLE 9: FORECAST ERRORS WHEN RECESSION FALLS IN HORIZON, AES

VARIABLES	(1) Negative Real Growth	(2) Harding-Pagan on Real GDP	(3) Harding-Pagan on per-capita GDP	(4) Output gap less than -2 percent	(5) Crisis
Recession Start in Forecast Horizon	17.87***	17.81***	14.94***	14.44***	23.33***
	(3.449)	(3.446)	(3.541)	(2.846)	(5.074)
Constant	1.616	1.683	1.155	4.365**	4.420**
	(1.800)	(1.803)	(2.147)	(1.698)	(2.004)
Observations	1,176	1,178	1,190	1,190	1,176
R-squared	0.180	0.179	0.128	0.108	0.206

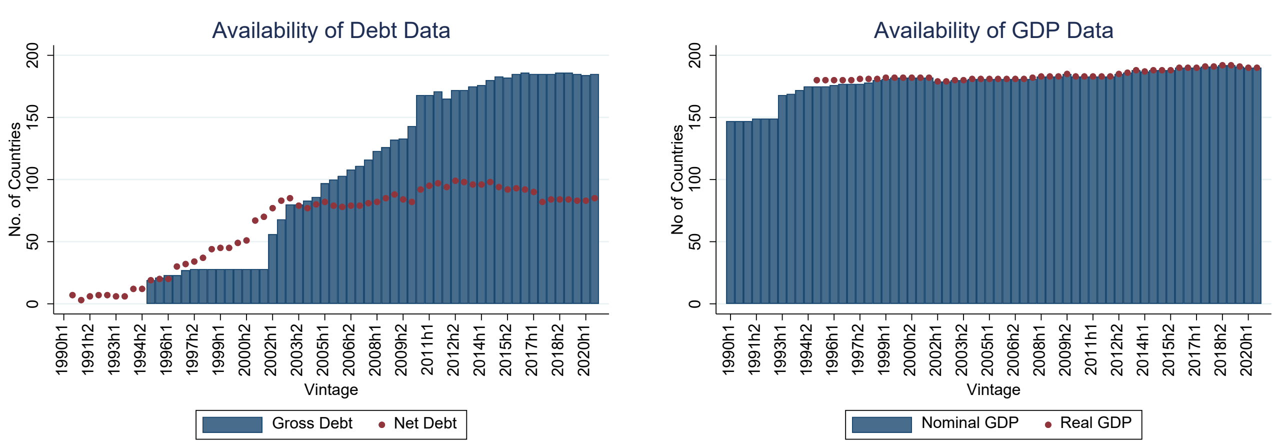
Note: Observations at country-vintage level. Sample only includes AEs. Dependent variable in each regression is forecast error of country *'c'* in vintage *'v'*. Independent variable is a dummy which takes value 1 if the start of a recession occurs in country *'c'* in the forecast horizon. Columns correspond to different recession definitions as described in Section VI. Standard errors are clustered two-way at country and vintage level. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

FIGURE 1: DEBT-TO-GDP RATIO



Notes: Chart shows the historical debt-to-GDP ratio for AEs and EMDEs as reported in the latest IMF WEO vinatge (second vintage of 2020).

FIGURE 2: DATA AVAILABILITY

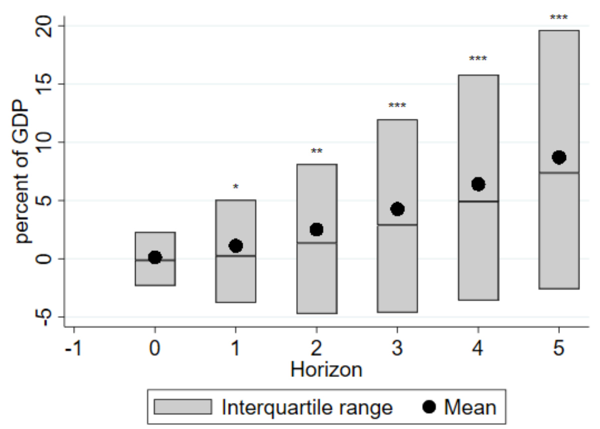


Notes: Chart shows the number of countries for which debt and GDP data is available for each WEO vintage. Two WEO vintages are available for each year, with "H1" referring to the first vintage of the year (usually released in April) while "H2" referes to the second vintage of the year (usually released in October).

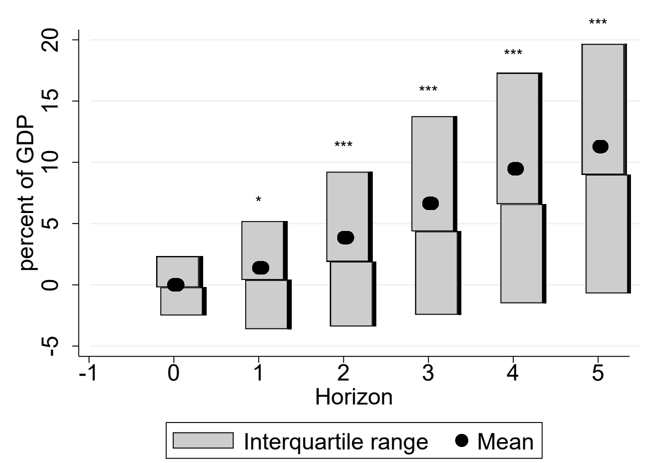
FIGURE 3: DEBT-TO-GDP RATIO FORECAST ERRORS ACROSS HORIZONS, IMF AND EIU

Panel A: Full Sample

IMF

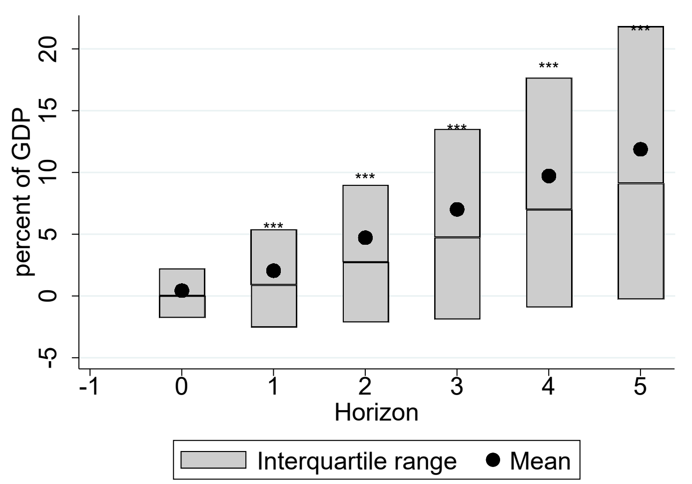


EIU

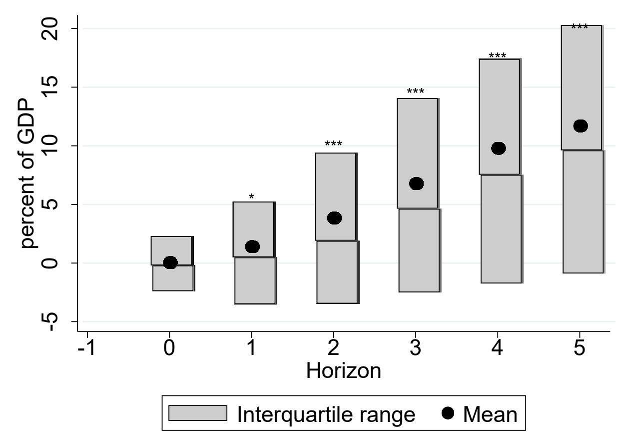


Panel B: Balanced Sample

IMF

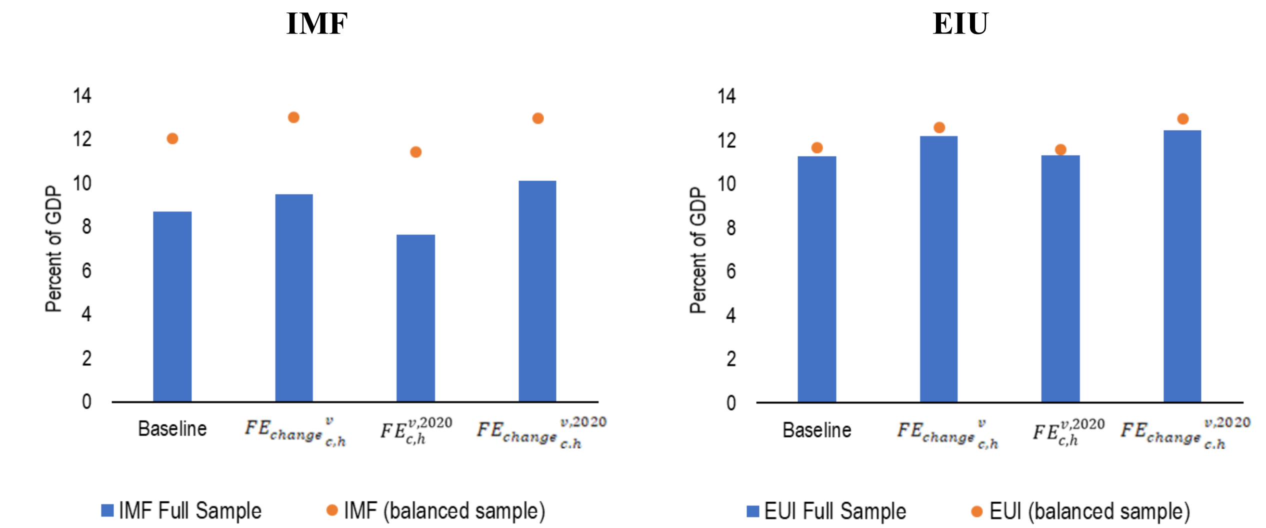


EIU



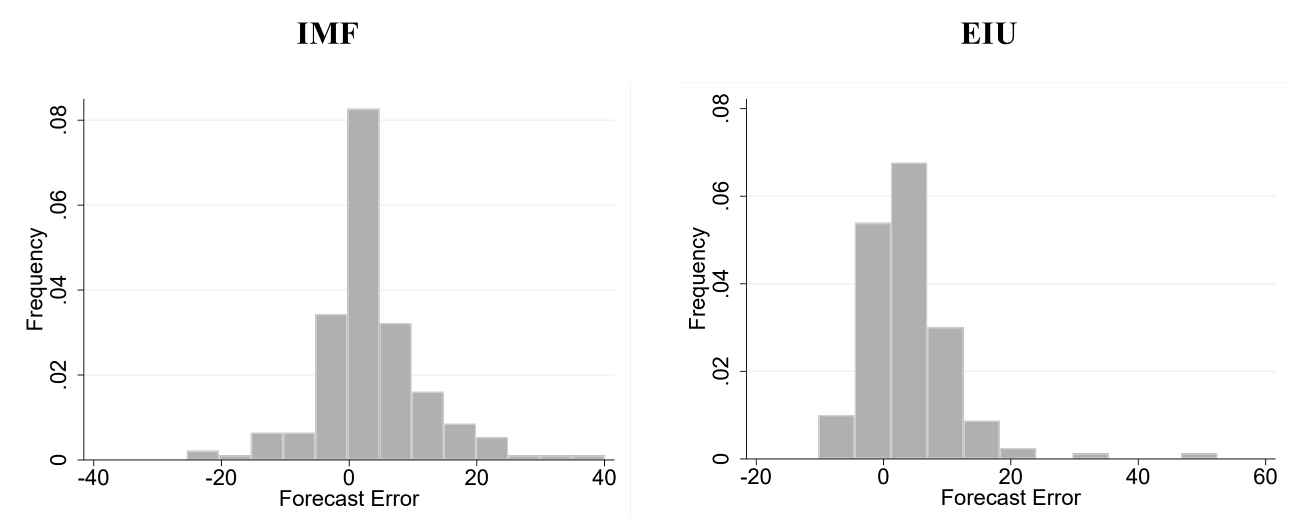
Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for debt-to-GDP forecast errors for different time horizons. Panel A uses the full IMF sample (left chart) and EIU sample (right chart). Panel B uses a balanced sample where forecast errors for IMF and EIU were available. The baseline measure of forecast errors is used. Stars on top of the shaded regions indicates whether the mean in significantly different from zero based on standard errors that are clustered two-way at the country and vintage level. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

FIGURE 4: MEAN FORECAST ERRORS ACROSS DIFFERENT METHODS, FIVE-YEAR HORIZON



Notes: The charts show the mean for the the four measures of forecast error discussed in Section III for the five-year horizon. The left panel is IMF forecast errors while the right panel is EIU forecast errors. Dots show the means for the balanced sample of country-vintages for which data is available for IMF and EIU forecast errors.

FIGURE 5: DISTRIBUTION OF FORECAST ERRORS ACROSS COUNTRIES, IMF AND EIU

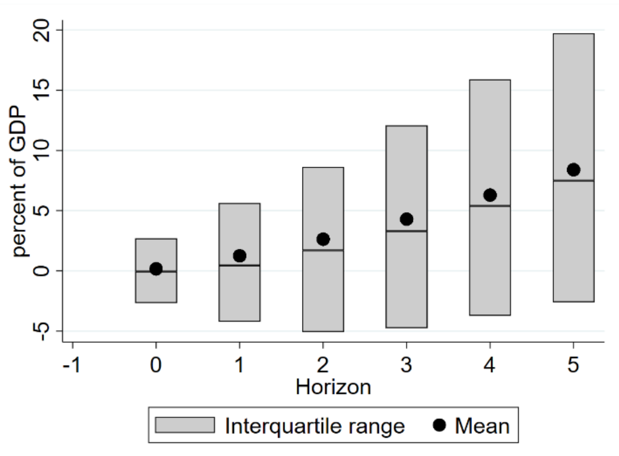


Notes: For each country, average forecast error is computed by taking the mean across all vintages and forecast horizons. The charts plots the historgram for the country average, The left panel is for IMF forecast errors and covers 174 countries. The right panel is for EIU forecast errors and covers 109 countries.

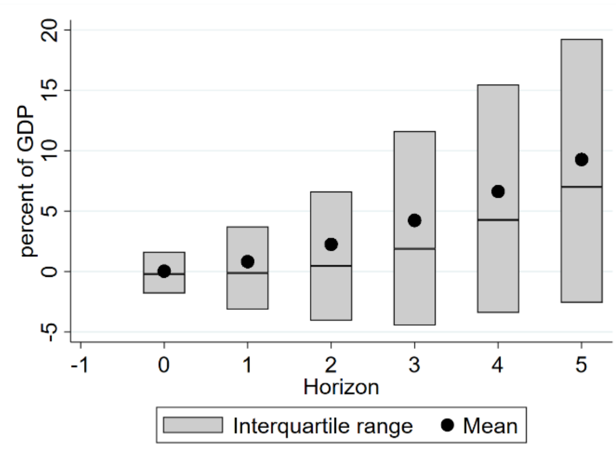
FIGURE 6: FORECAST ERRORS FOR AES VERSUS EMDES

Panel A: IMF Forecast Errors

EMDEs

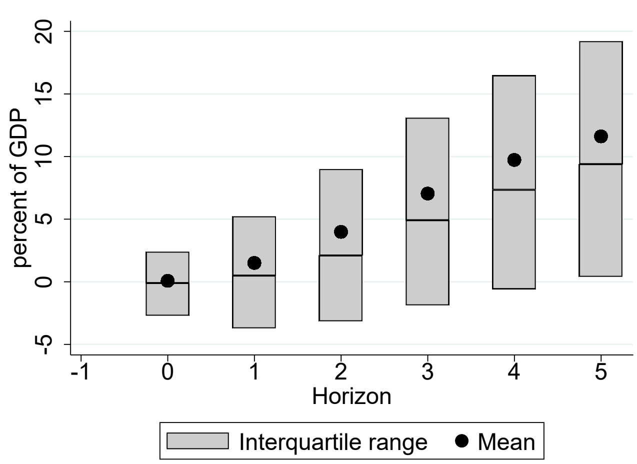


AEs

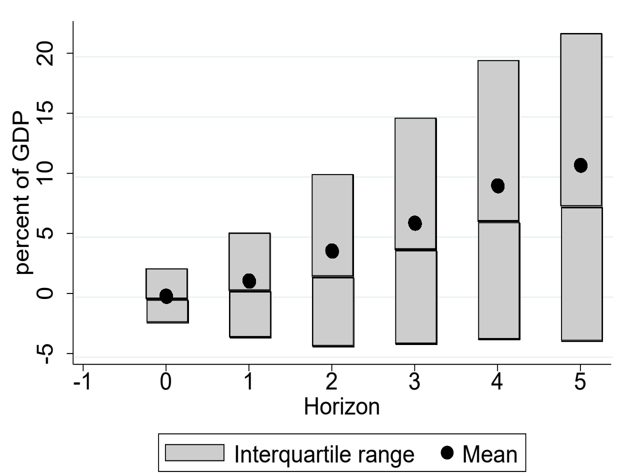


Panel B: EIU Forecast Errors

EMDEs



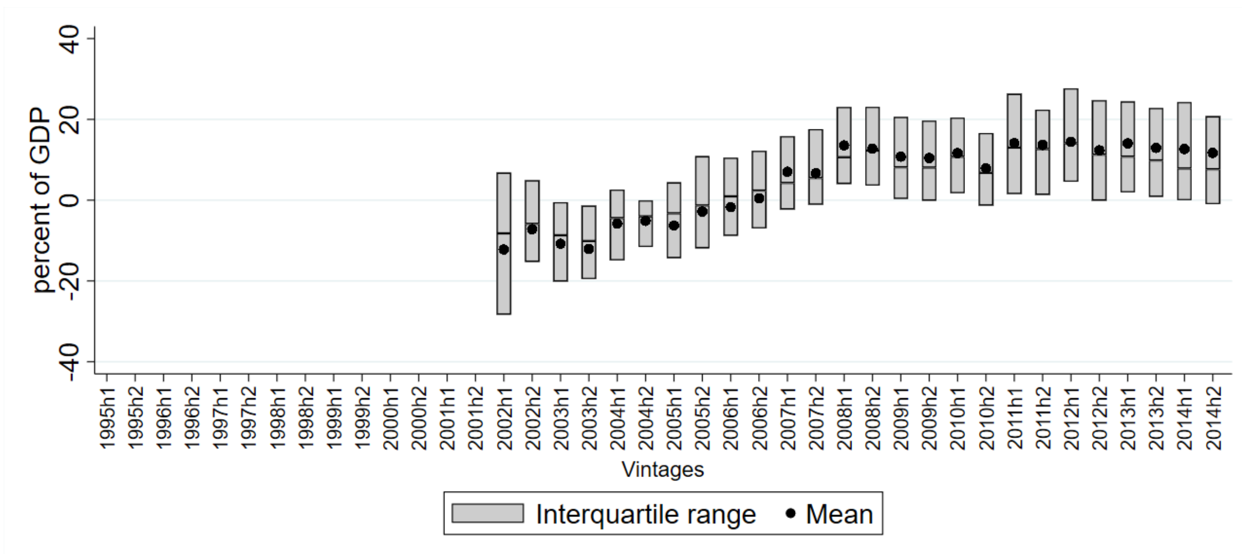
AEs



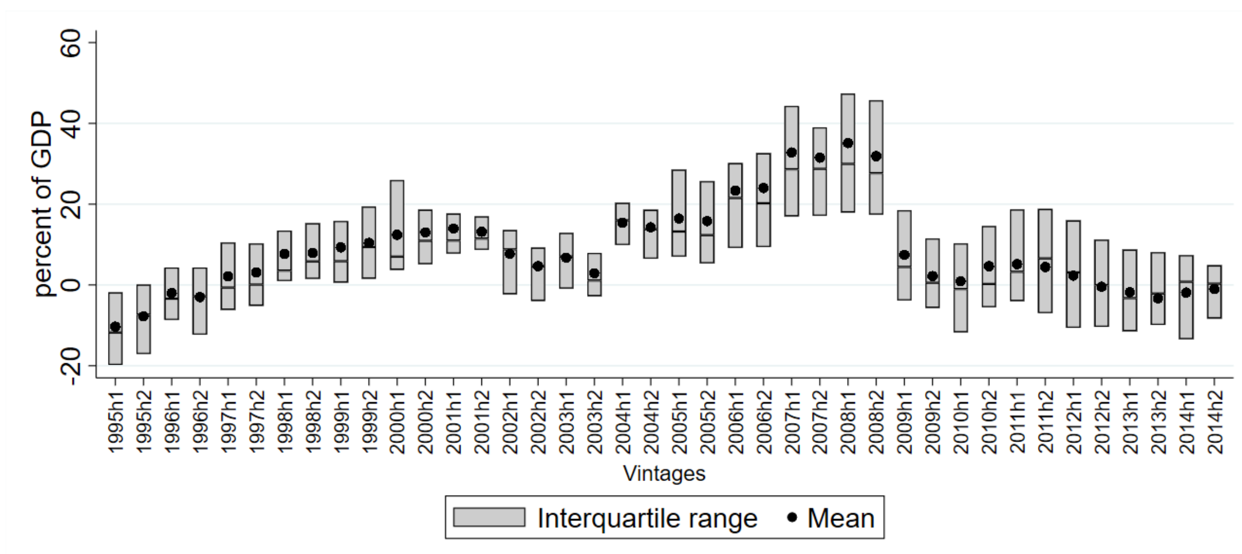
Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for debt-to-GDP forecast errors for different time horizons for EMDEs (left charts) and AEs (right charts). Panel A uses the full IMF sample while Panel B uses the full EIU sample. The baseline measure of forecast errors is used.

FIGURE 7: IMF FORECAST ERRORS ACROSS VINTAGES, 5-YEAR HORIZON

Panel A: EMDEs

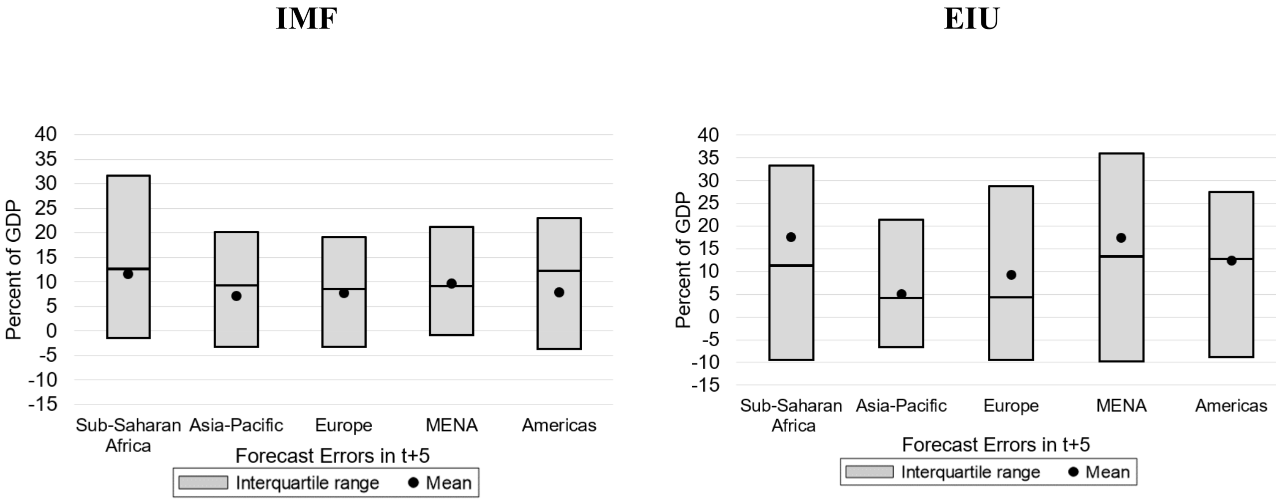


Panel B: AEs



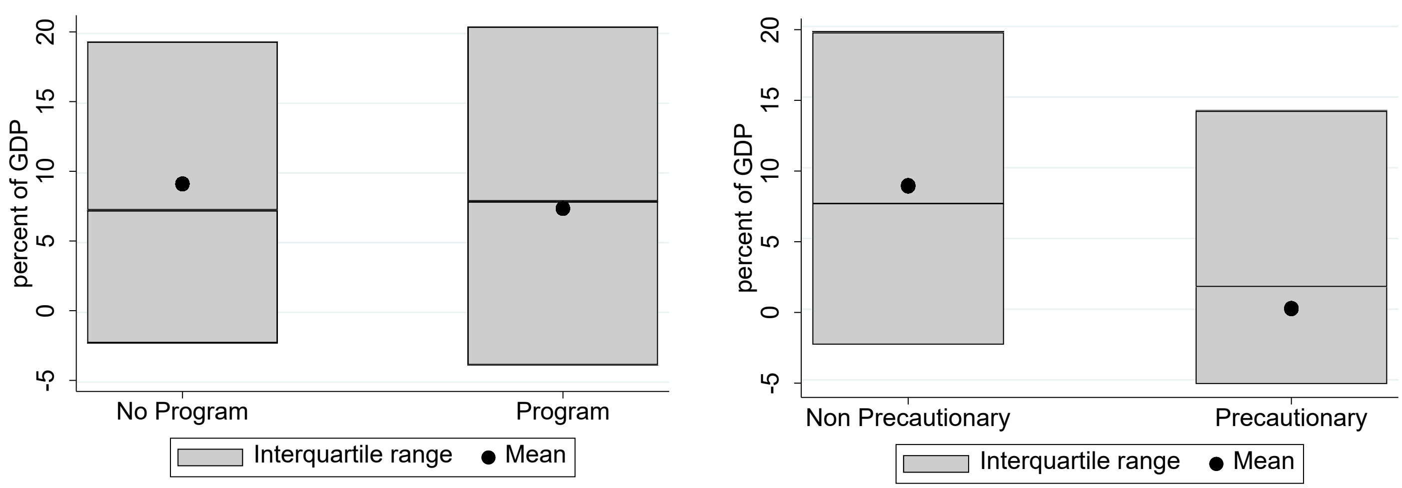
Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for IMF debt-to-GDP forecast errors for each vintage for the five-year horizon for EMDEs (Panel A) and AEs (Panel B). The baseline measure of forecast errors is used. For each year, we have data for two vintages, usually corresponding to April (called H1 for first half of the year) and October (called H2 for the second half of the year) data releases.

FIGURE 8: FORECAST ERRORS ACROSS REGIONS, 5-YEAR HORIZON



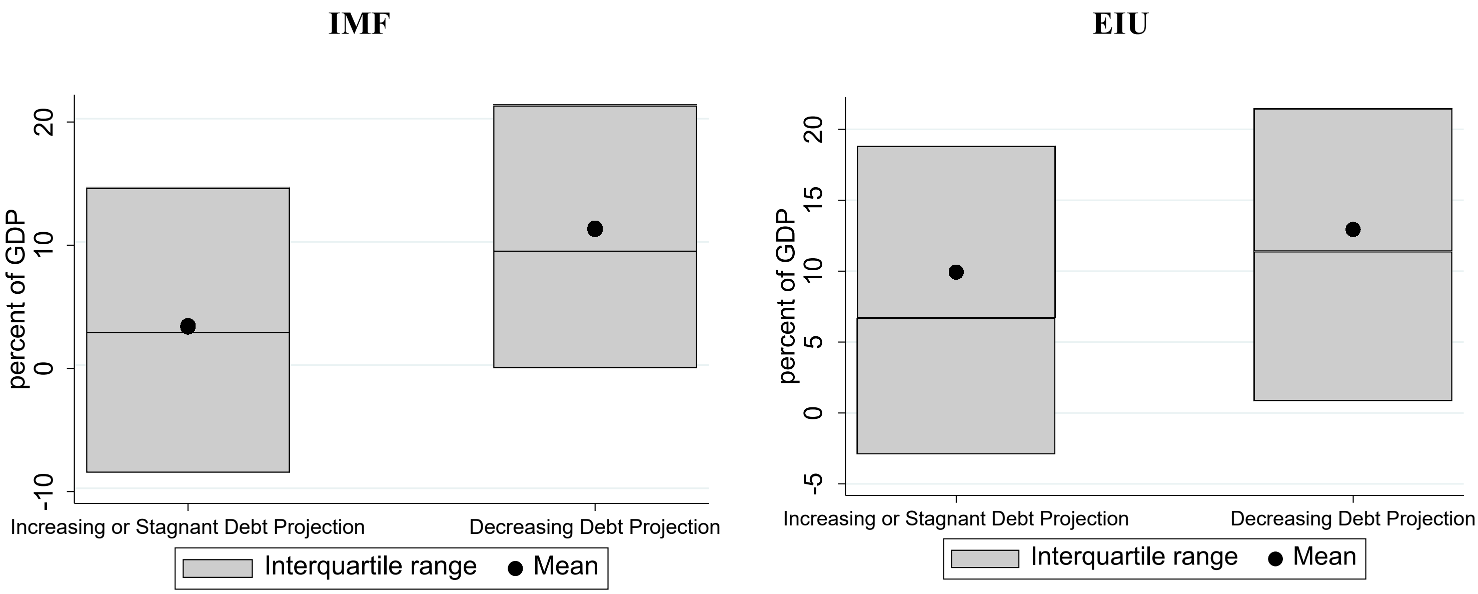
Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for debt-to-GDP forecast errors for the five-year time horizons for different regions of the world. Left chart uses the full IMF sample while the right chart uses the full EIU sample. The baseline measure of forecast errors is used.

FIGURE 9: IMF FORECAST ERRORS IN PROGRAMS



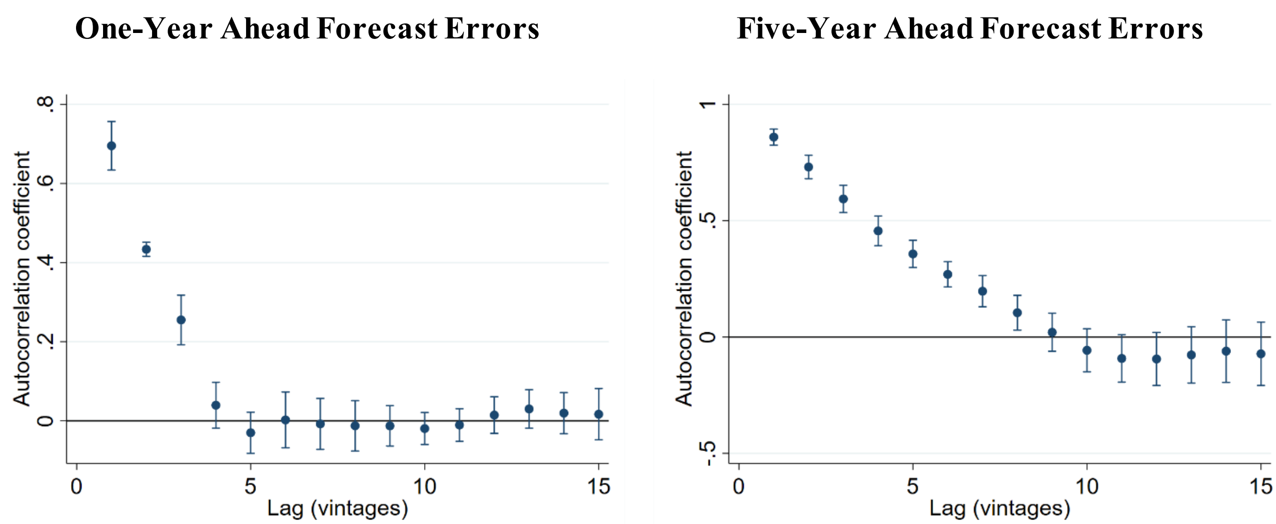
Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for IMF debt-to-GDP forecast errors for the five-year time horizons. Left chart distinguishes between forecast errors during programs and non-programs, where a country-vintages is classified as a program if the country had an IMF program ongoing in the year of the vintage. The right chart shows forecast erros in precautionary versus non-precautionary programs. The baseline measure of forecast errors is used.

FIGURE 10: FORECASTS ERRORS CONDITIONAL ON FORECASTED DEBT TRAJECTORY, FIVE-YEAR HORIZON



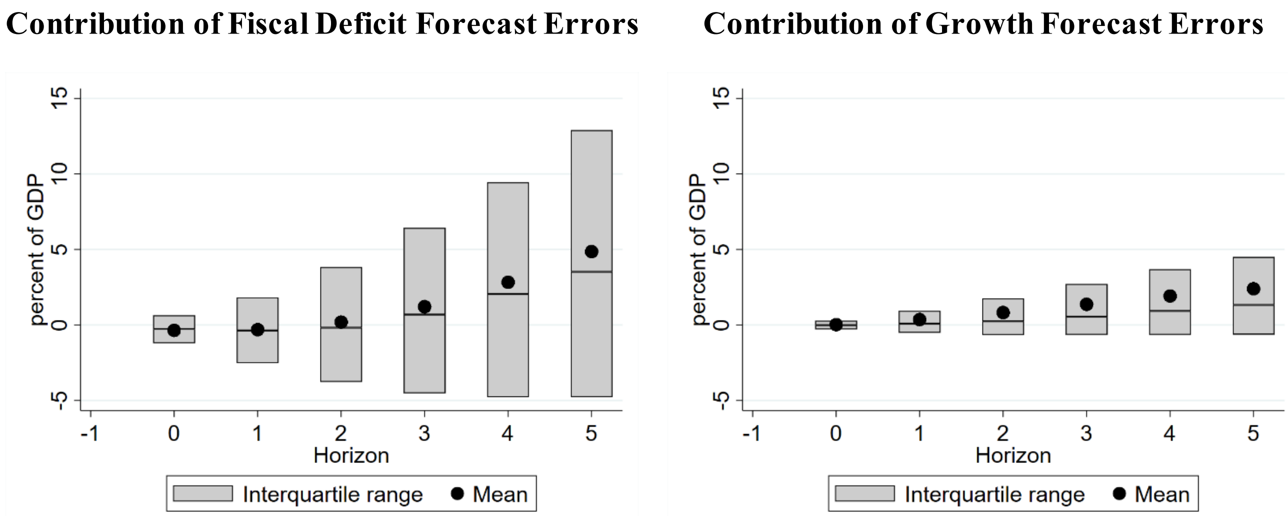
Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for IMF (left chart) and EIU (right chart) debt-to-GDP forecast errors for the five-year time horizon. The charts show average forecast errors conditional on whether the forecast was for debt ratios to increase of decrease over the forecast horizon. The baseline measure of forecast errors is used.

FIGURE 11: AUTOCORRELATION ACROSS VINTAGES IN FORECAST ERRORS



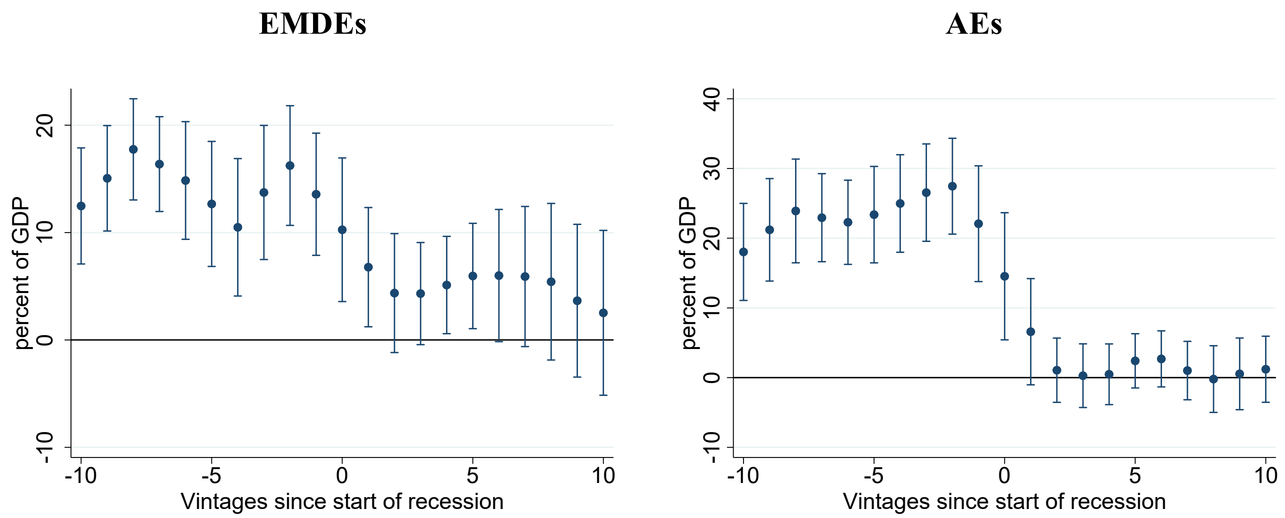
Notes: Charts show the extent of autocorrelation in one-year (left chart) and five-year (right chart) ahead IMF debt-to-GDP forecast errors. The x-axis shows different lags in terms of vintages (we have two vintages each year). Each dot is the coefficient from a regression of forecast errors on a different lags (as plotted on the x-axis) of the forecast error. 90 percent confidence intervals based on two-way clustered standard errors (country and vintage) are shown.

FIGURE 12: IMF FORECAST ERRORS: CONTRIBUTION OF FISCAL DEFICITS AND GROWTH



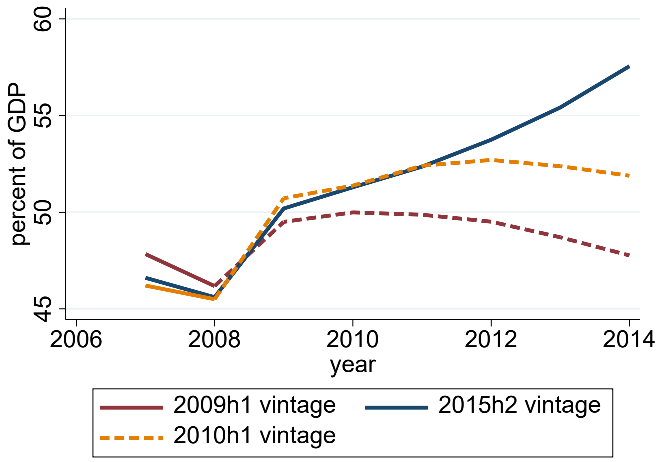
Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for the contribtuion of fiscal deficit (left chart) and growth (right chart) forecast errors in explaining the forecast error in debt projections. The contribution of fiscal deficit is simply calculated as the sum of realized fiscal deficits (as a percent of GDP) over the forecast horizon minus the sum of fiscal deficits that were forecasted. As we use fiscal deficits instead of primary deficits in this calculation (due to data constraints), real interest rate shocks, which interact with the level of debt itself, are included in the contribution of fiscal deficits. For the contribution of growth, we use the standard debt decomposition equation which identifies the contribution of growth to changes in debt ratios as $\frac{g_t}{1+g_t} * d_{t-1}$ where 'g' is the growth rate of real GDP and 'd' is the debt-to-GDP ratio. As with fiscal deficit, the contribution to forecast error is computed as the contribution of growth to the accumulation of debt in realized data minus the contribution in the forecast data.

FIGURE 13: FORECAST ERRORS IN VINTAGES AROUND A RECESSION



Note: Charts plot the average five-year ahead IMF forecast errors in vintages around the start of a recession. Start of a recession defined as the first year in which real GDP growth is negative. Left chart restricts the sample to EMDEs while the right chart restricts the sample to AEs. The x-axis plots vintages since the start of a recession, where negative values indicate that a recession occurs in the forecast horizon, while positive values indicate that a recession occurred in the past. Each dot is simply the mean forecast erroros at different lags across all recessions. 90 percent confidence intervals based on two-way clustered standard errors (country and vintage) are shown.

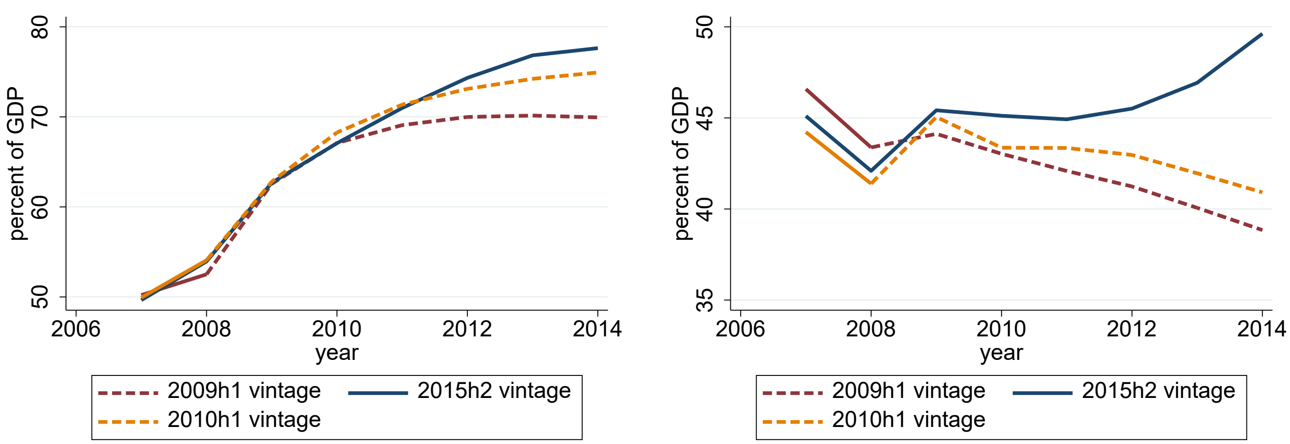
FIGURE 14: DEBT PROJECTIONS AND OUTCOMES AFTER GFC



Notes: Chart compares the simple average across countries of the forecasted debt-to-GDP ratio in the 2009H1 and 2010H1 vintages (first and third vintage after the GFC shock) to the outturn as reported in the 2015H2 vintage. Dashed line is for the forecast period. IMF data is used.

FIGURE 15: DEBT PROJECTIONS AND OUTCOMES AFTER GFC, BY INCOME LEVEL

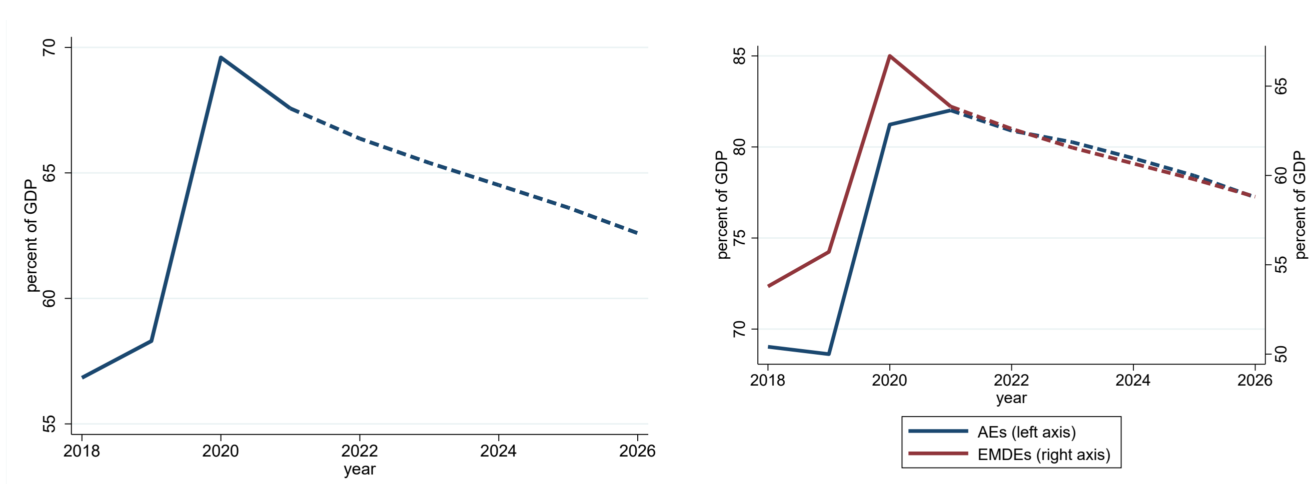
AEs **EMDEs**



Notes: Charts compare the simple average across countries of the forecasted debt-to-GDP ratio in the 2009H1 and 2010H1 vintages (first and third vintage after the GFC shock) to the outturn as reported in the 2015H2 vintage. Left panel is for advanced economies only, while the right panel is for EMDEs only. Dashed line is for the forecast period. IMF data is used.

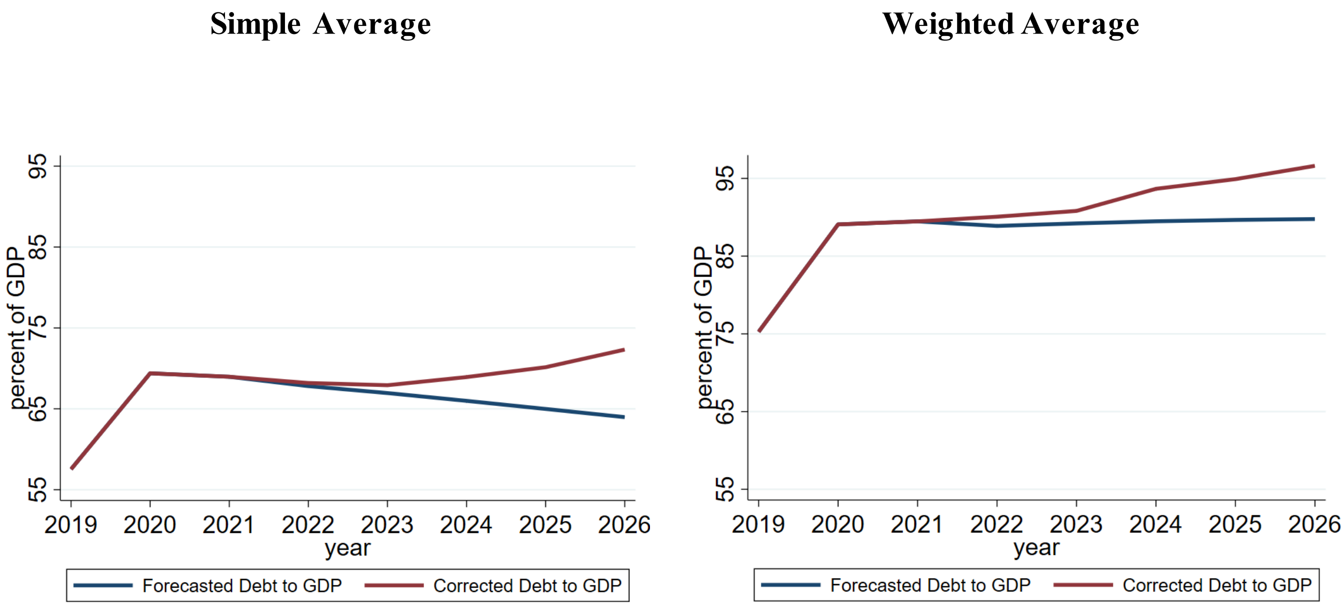
FIGURE 16: PROJECTED DEBT OUTCOMES AFTER COVID-19, 2021H2 VINTAGE

All Countries **By Income Level**



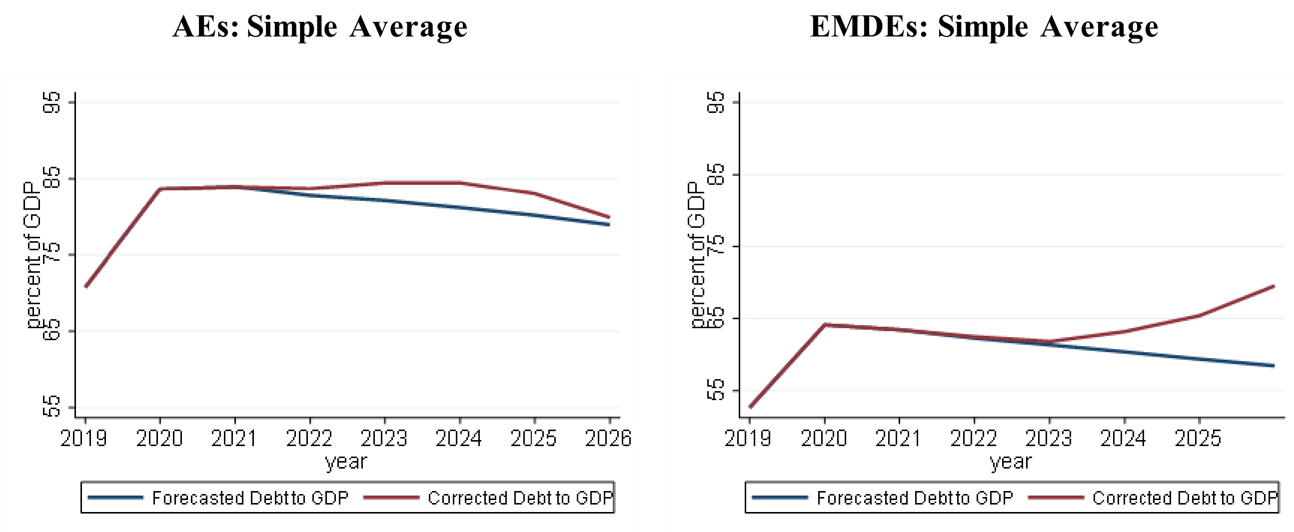
Notes: Charts show the projected path for debt-to-GDP as reported in the 2021H2 vinatge. Left panel plots the simple average across all countries, while the right panel shows the breakdown for AEs and EMDEs separately. Dashed line is for the forecast period. IMF data is used.

FIGURE 17: CORRECTING WEO PROJECTIONS FOR GFC LEVEL FORECAST ERRORS



Notes: Charts compare the forecast for debt-to-GDP as reported in the 2021H2 vinatge (i.e. the third vintage after the COVID-19 shock) to a counterfactual path if forecast errors for countries were as large as they were during the 2010H1 vinatge (i.e. the third vintage after the GFC shock). Left panel is based on a simple average across countries, while the right panel is based on a weighted average where GDP (PPP) weights are used. IMF data is used.

FIGURE 18: CORRECTING WEO PROJECTIONS FOR GFC LEVEL FORECAST ERRORS: EMDES VS AES



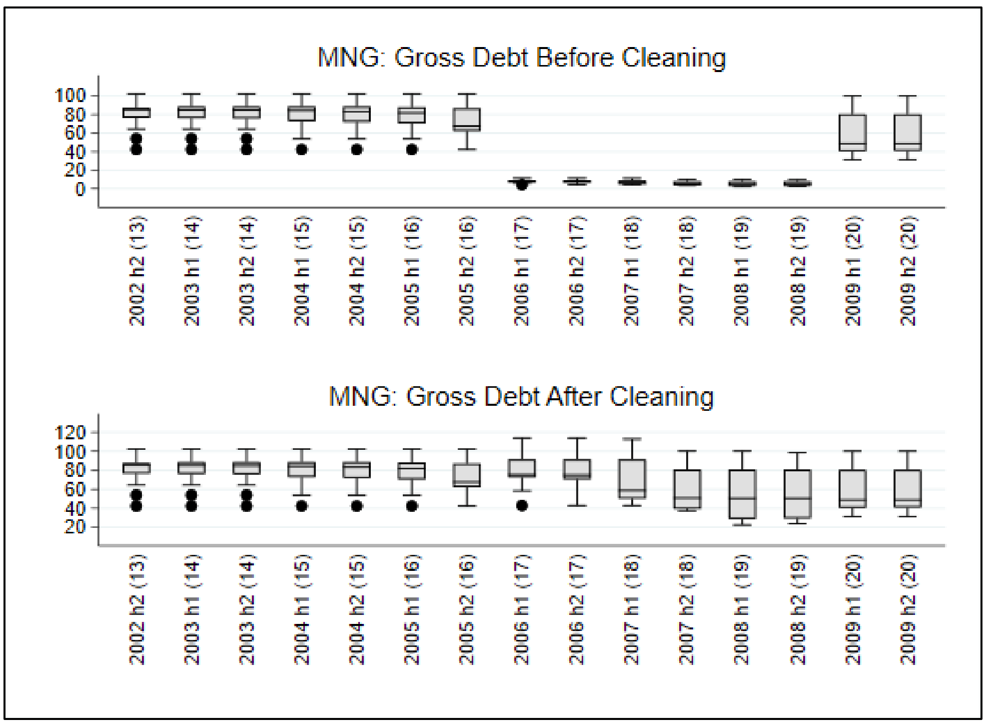
Notes: Charts compare the forecast for debt-to-GDP as reported in the 2021H2 vinatge (i.e. the first vintage after the COVID-19 shock) to a counterfactual path if forecast errors for countries were as large as they were during the 2010H1 vintage (i.e. the third vintage after the GFC shock). Left panel is for the sample of AEs only, while the right panel is for EMDEs only. IMF data is used.

ANNEX 1: DATA CLEANING

In this annex, we provide details on how we clean the IMF data. As described in Section II of the paper, we conduct a manual country specific cleaning, where we compare descriptive statistics of the debt series for each country across vintages. When the data shows big shifts, we either rescale the debt series or convert some country-vintages to missing. For a few countries, we drop all vintages as the debt series shifted several times across vintages.
To implement country specific cleaning, we first generated box charts by county and vintages.[9] If the median, interquartile range or extreme values shifted significantly from one vintage to the next, we explored the reason for the shift and either rescaled, converted some vintages to missing, or completely dropped the country from the sample. Below we summarize all the changes we made to the raw data.

1.1. Rescaling

Mongolia:

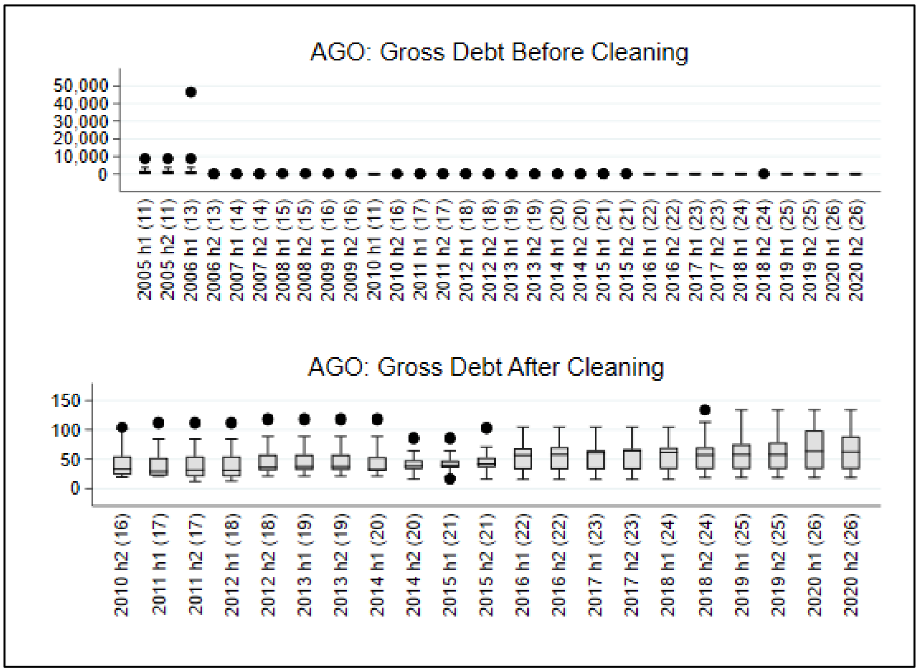


Gross debt series multiplied by 10 for vintages between the second vintage of 2005 and the first vintage of 2009 (both excluded)

[9] In the box-plots below, the number in the brackets after the vintage on the x-axis shows the number of observations available for debt-to-GDP ratio for each country-vintage.

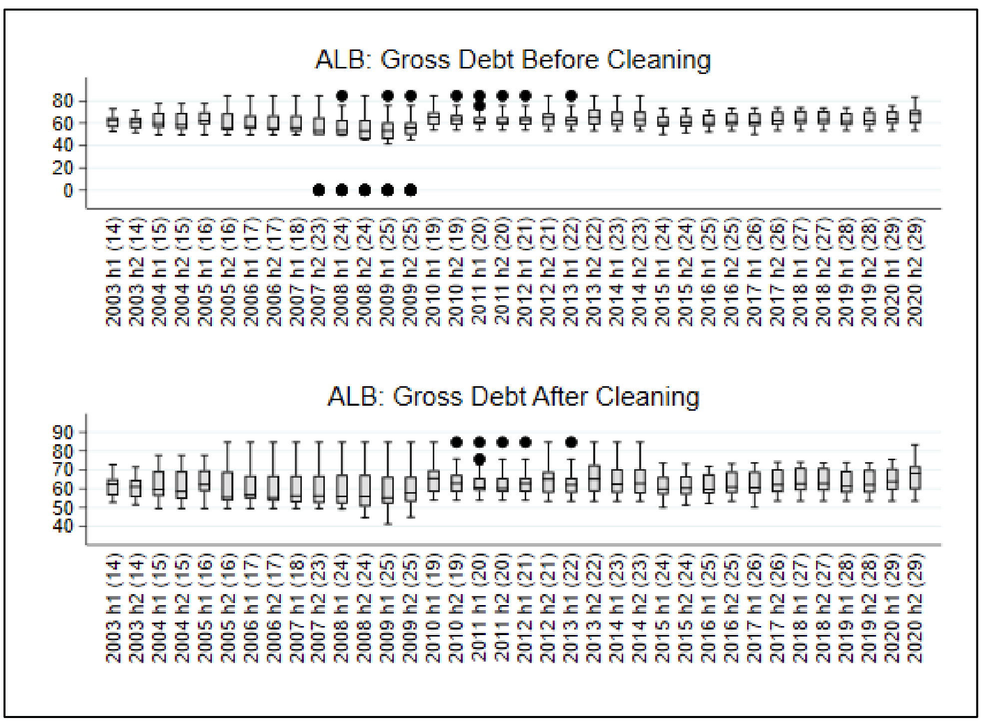
1.2. Converting some Vintages to Missing

Angola



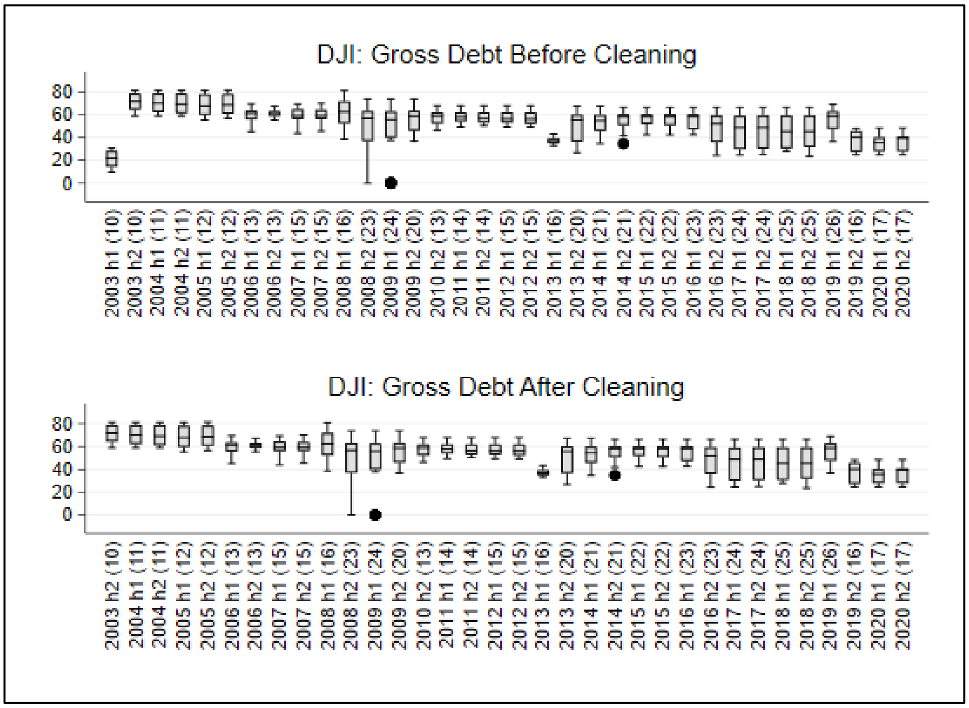
All gross debt series converted to missing before the second vintage of 2010

Albania



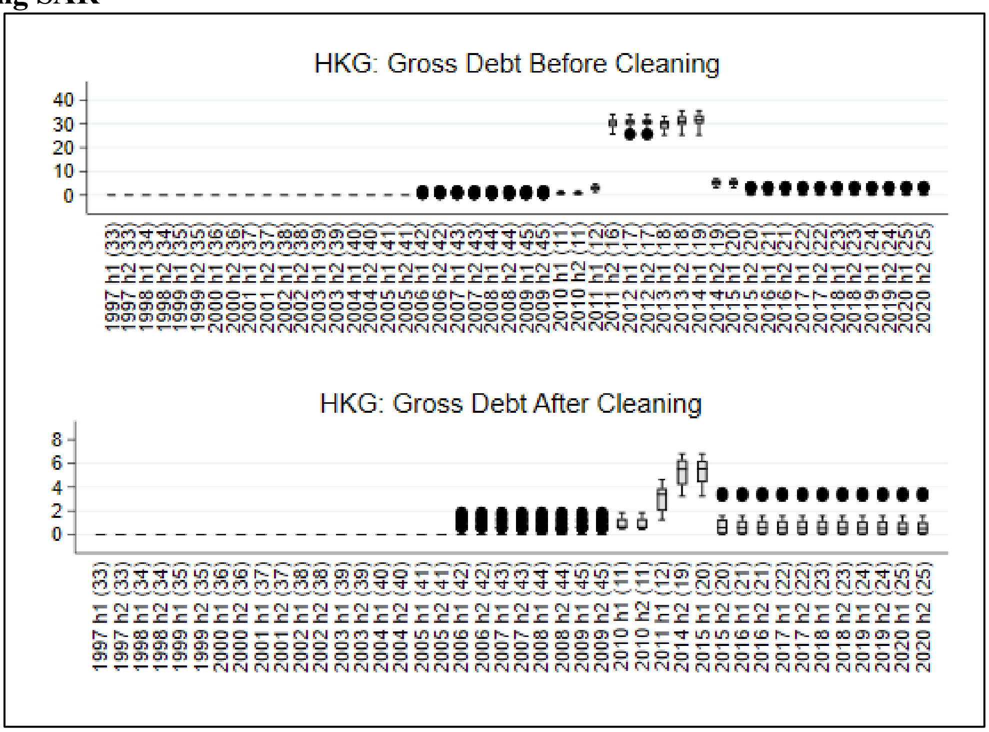
All gross debt series converted to missing when its equal to 1.000e-13

Djibouti



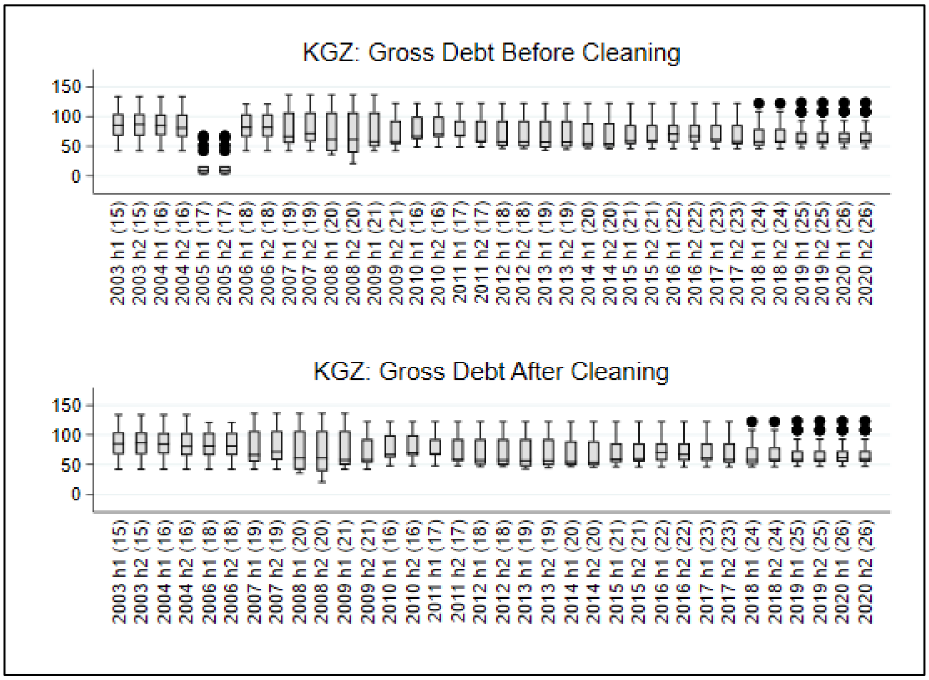
All gross debt series converted to missing for the first vintage of 2003

Hong Kong SAR



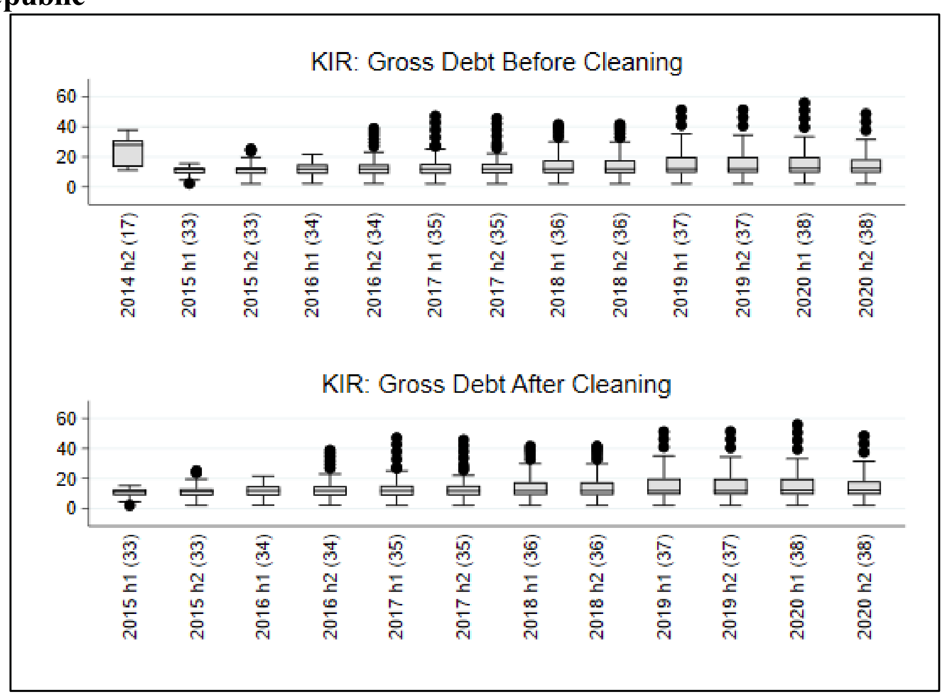
All gross debt series converted to missing between the second vintage of 2011 and the first vintage of 2015

Kazakstan



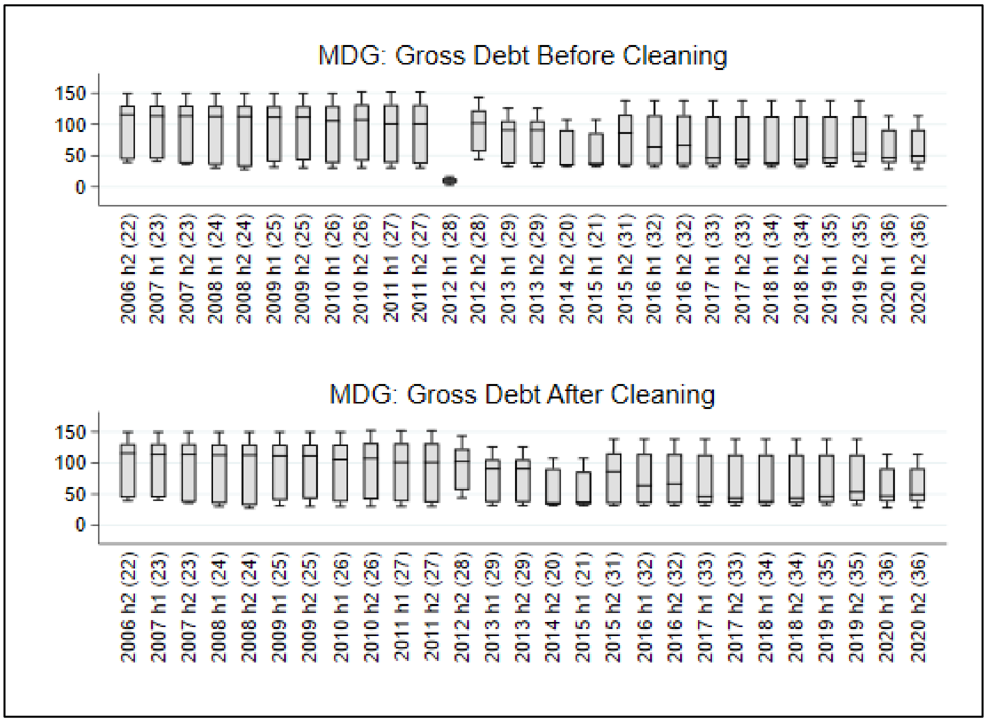
All gross debt series converted to missing for the first and second vintage of 2005

Kyrgyz Republic



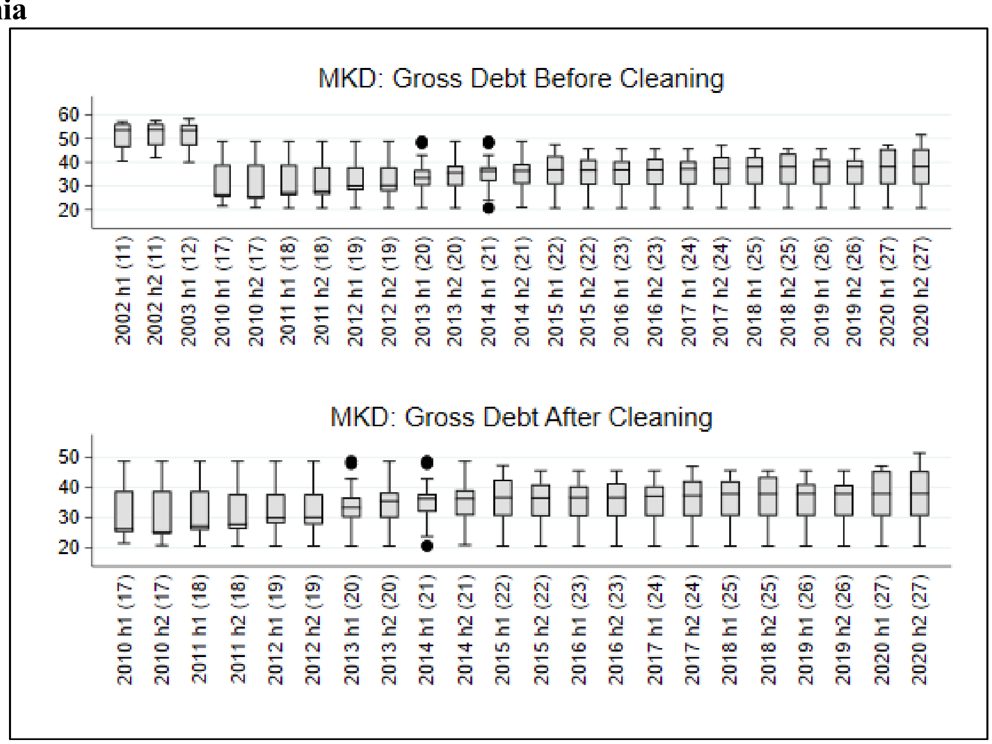
All gross debt series converted to missing for the second vintage of 2014

Madagascar



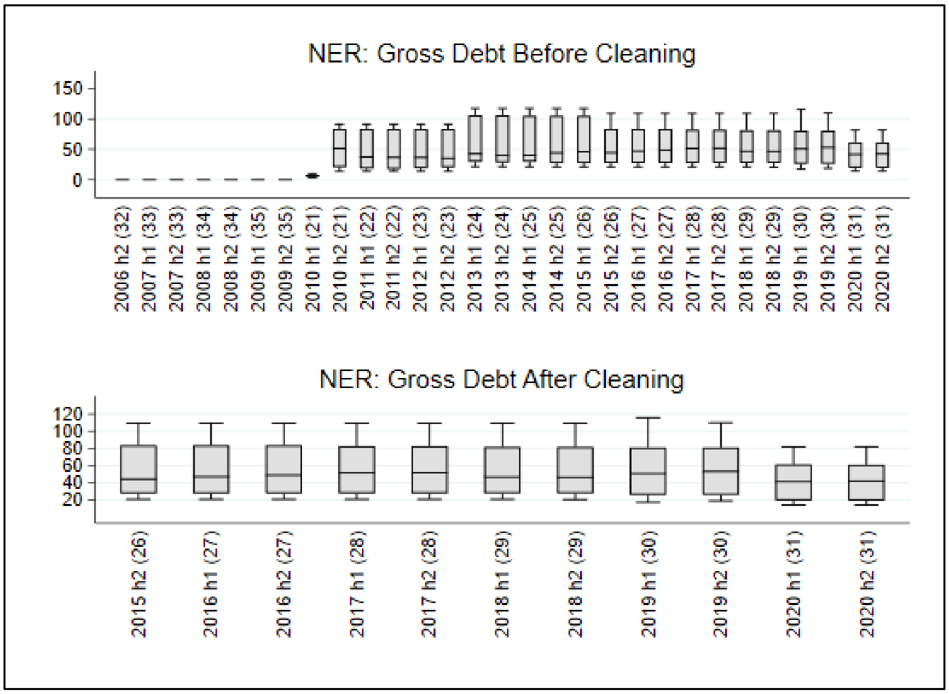
All gross debt series converted to missing for the first vintage of 2012

Macedonia



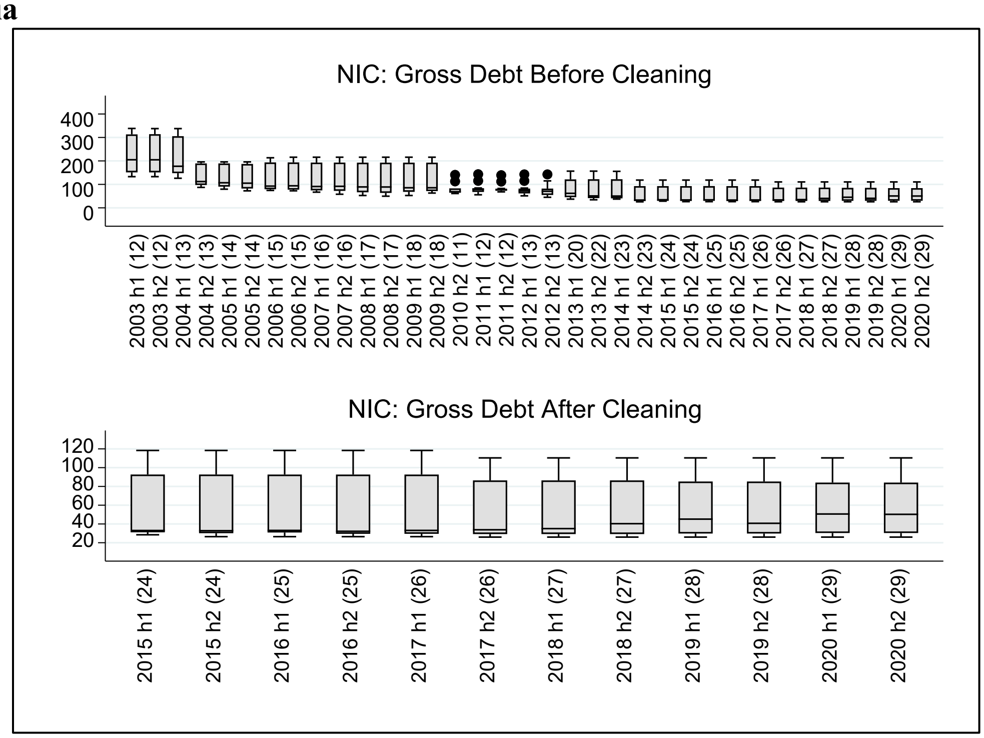
All gross debt series converted to missing for all vintages before the first vintage of 2010 (not included)

Niger



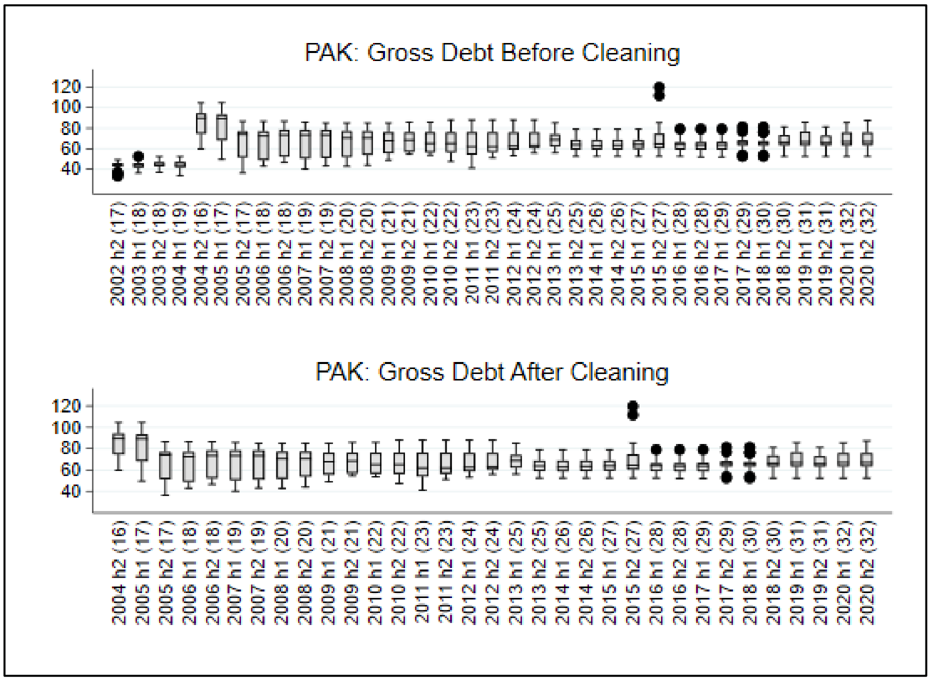
All gross debt series converted to missing for all vintages before the second vintage of 2015 (not included)

Nicaragua



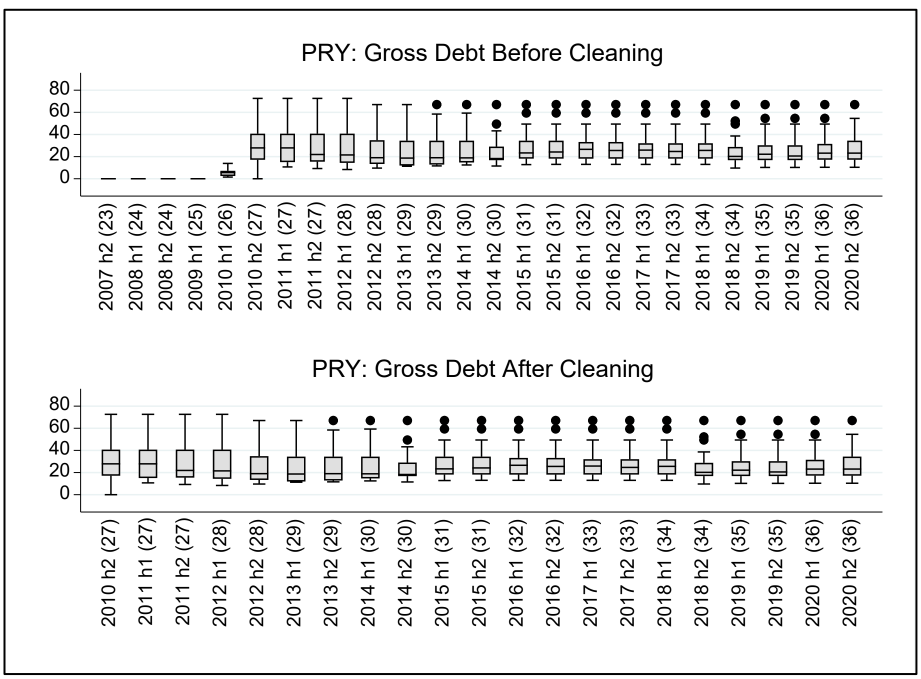
All gross debt series converted to missing for all vintages before the second vintage of 2014 (not included)

Pakistan



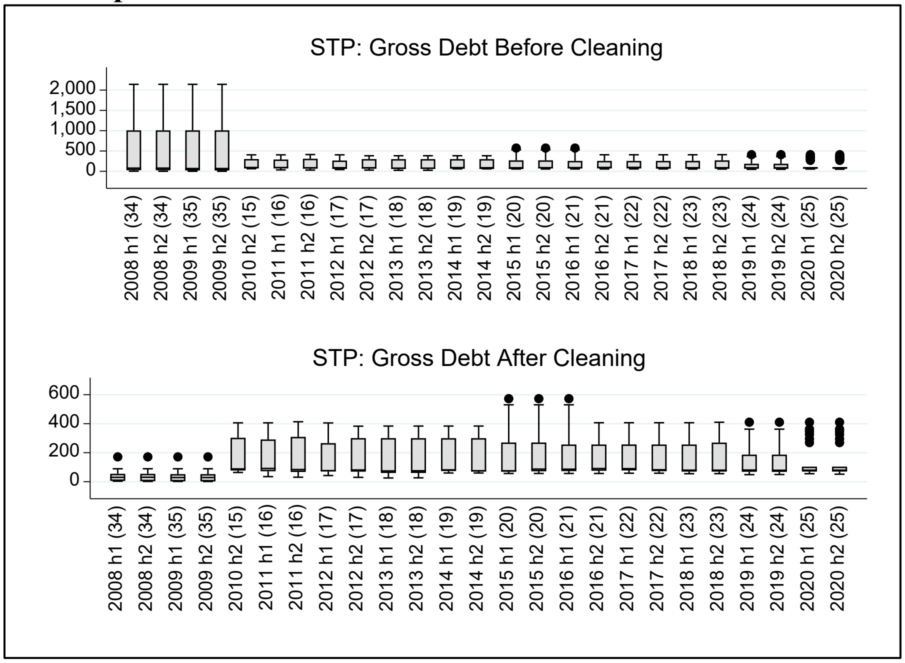
All gross debt series converted to missing for all vintages before the second vintage of 2004 (not included)

Puerto Rico:



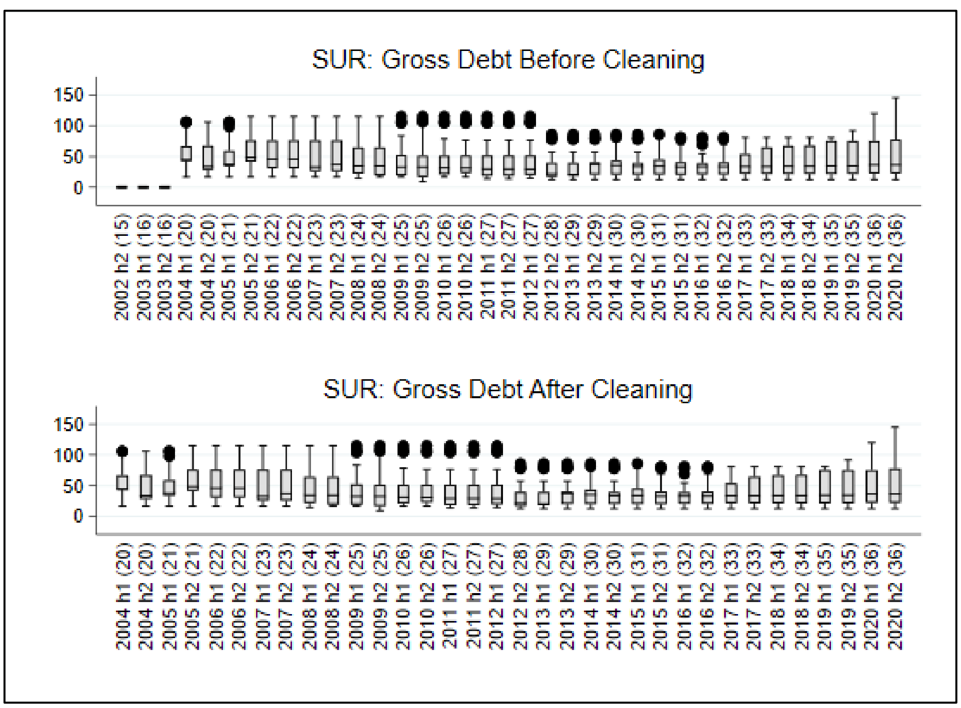
All gross debt series converted to missing for all vintages before the second vintage of 2010 (not included)

Sao Tome and Principe



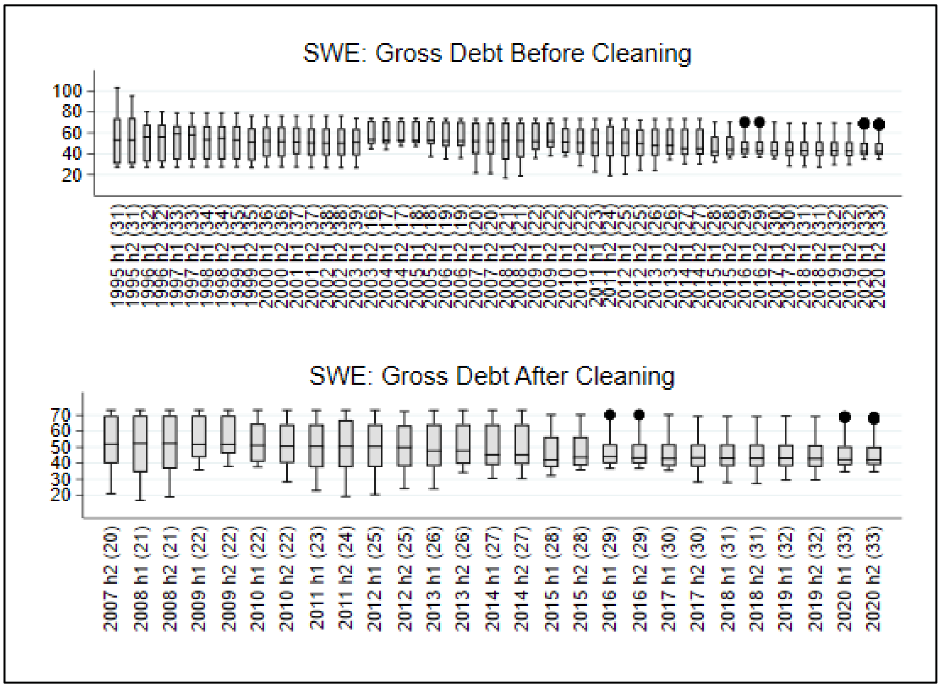
All gross debt series converted to missing for all vintages before the first vintage of 2008 and before the second vintage of 2010 for all years before 1995 (none included)

Suriname



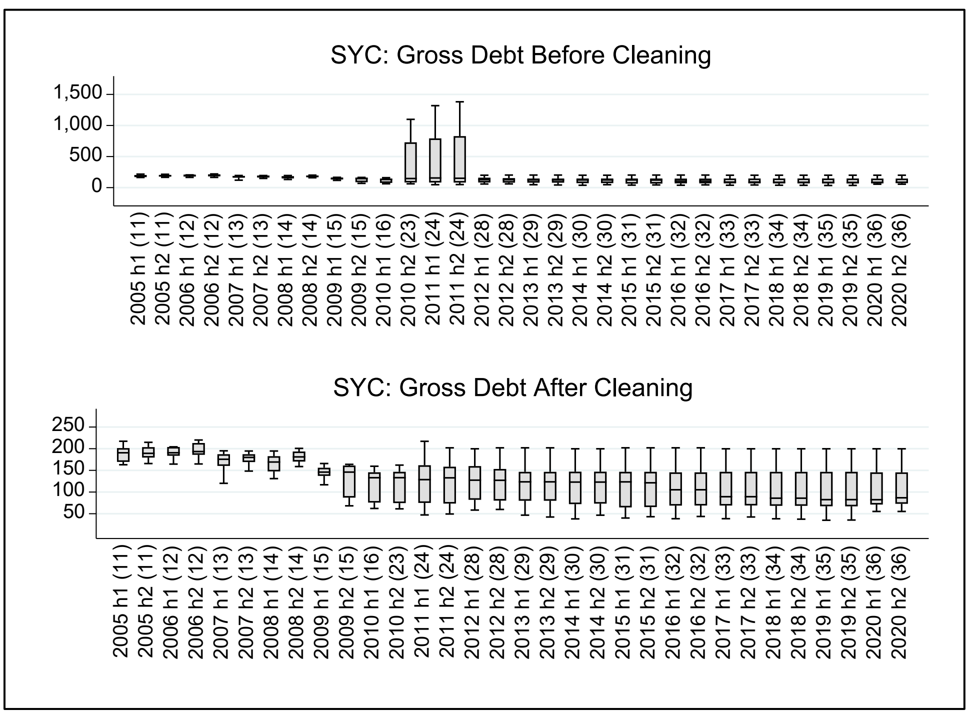
All gross debt series converted to missing for all vintages before the first vintage of 2004 (not included)

Sweden



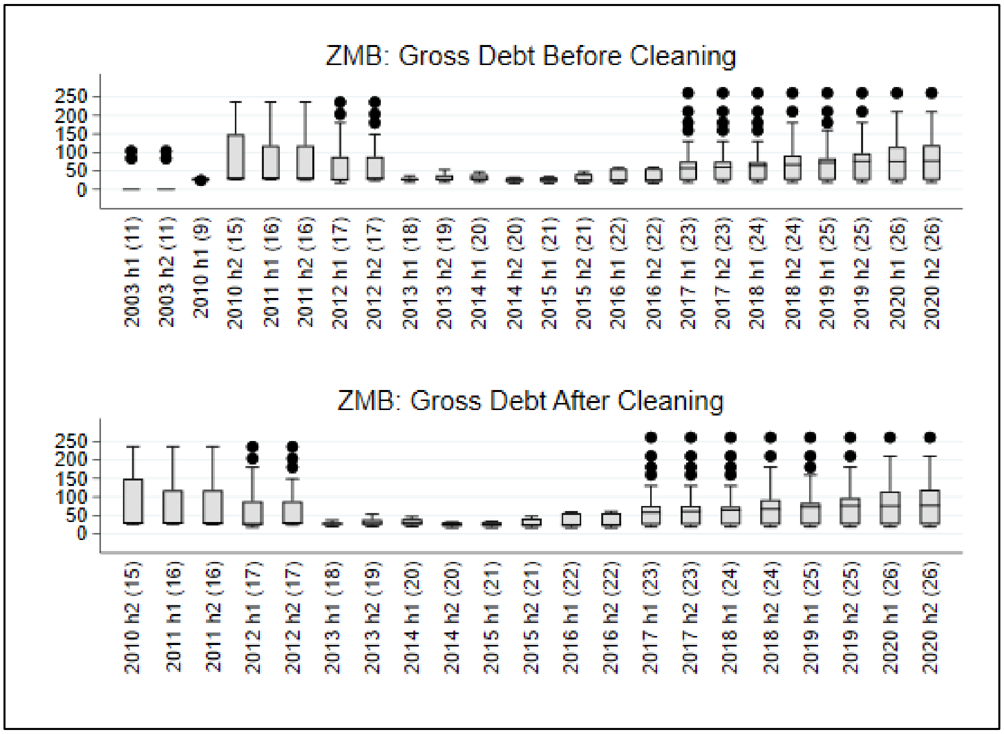
All gross debt series converted to missing for all vintages before the second vintage of 2007 (not included)

Seychelles



All gross debt series converted to missing for all vintages between the second vintage of 2010 and the second vintage of 2009 for all years are before 2000 (2000 not included). Plus, all vintages before the first vintage of 2005 also converted to missing.

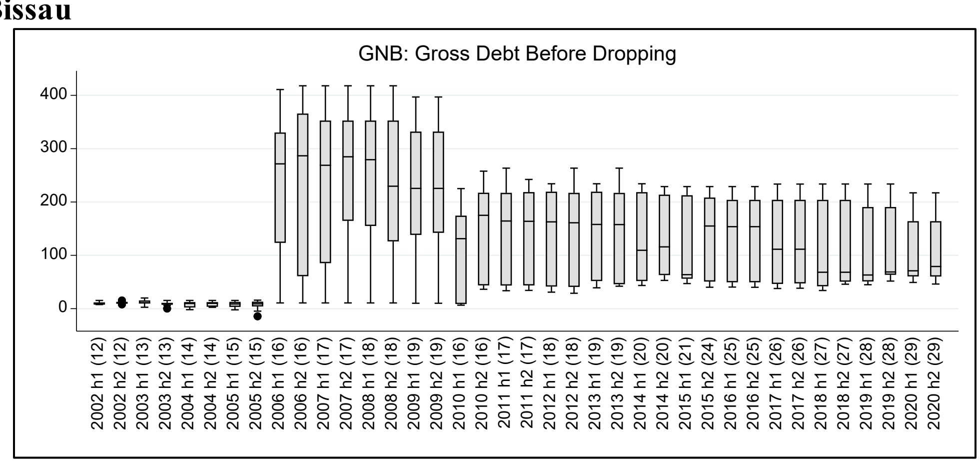
Zimbabwe



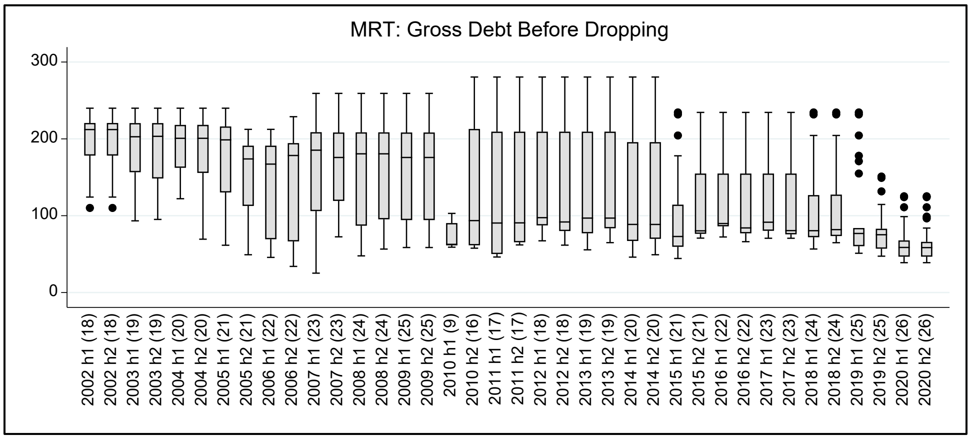
All gross debt series converted to missing for all vintages before the second vintage of 2010 (not included)

1.3 Dropped All Vintages

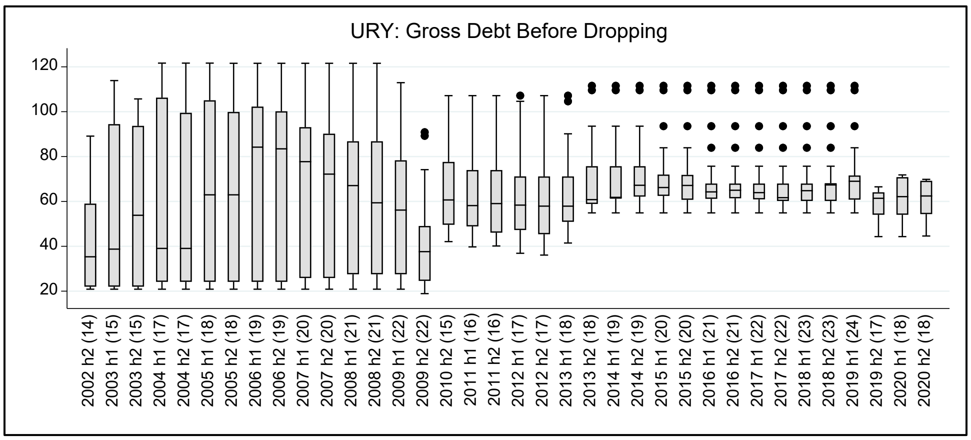
Guinea-Bissau



Mauritania



Uruguay



ANNEX 2: ADDITIONAL TABLES AND FIGURES ON FORECAST BIAS

Annex Table 2.1: Correlation between IMF and EIU Forecast Errors across Different Horizons

Horizon	Correlation between IMF and EIU Forecast errors
1	0.33
2	0.5
3	0.65
4	0.71
5	0.77

Note: Table shows correlations for our baseline measure of "Ex-post Level" forecast errors between EIU and IMF data.

Annex Table 2.2: Correlation between Forecast Errors and Country Characteristics, EIU Full Sample

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Per-capita GDP PPP (ln)	-0.558	-0.280	-0.711	3.470	-0.398	-0.464	0.226
	(1.558)	(1.491)	(1.486)	(3.319)	(1.580)	(1.574)	(1.812)
Oil Exporter = 1	9.023**	3.356	12.65***	4.370	8.055*	8.088*	7.497
	(4.140)	(4.594)	(4.057)	(5.297)	(4.255)	(4.357)	(4.621)
Volatility of GDP Growth		1.495***					
		(0.475)					
Average Debt Level			0.165**				
			(0.0738)				
Control over Corruption				-4.815			
				(2.964)			
Volatility of Exchange Rate					0.00153**		
					(0.000614)		
Volatility of Inflation						0.00150**	
						(0.000682)	
Fiscal Rule (imputed and averaged)							-4.205
							(5.176)
Constant	15.88	7.098	8.184	-21.09	14.10	14.87	10.15
	(15.24)	(14.79)	(14.00)	(30.95)	(15.48)	(15.41)	(16.60)
Observations	108	108	108	108	108	108	108
R-squared	0.050	0.133	0.146	0.080	0.063	0.057	0.056

Note: Dependent variable in each regression is average forecast error of each country across all vintages. Independent variables are also averaged across all years in the sample. Sample consists of 108 countries. For fiscal rule, if the dataset did not have any information on a country, we assume that there is no fiscal rule. Robust standard errors reported in parenthesis. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

Table 2.3: Correlation between Forecast Errors and Country Characteristics, Post-GFC EIU Full Sample

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Per-capita GDP PPP (ln)	-3.441*	-3.156*	-3.576**	1.976	-3.289*	-3.361*	-2.222
	(1.742)	(1.679)	(1.692)	(3.454)	(1.763)	(1.758)	(2.146)
Oil Exporter = 1	14.64***	8.827*	17.82***	8.381	13.72***	13.84***	12.26**
	(4.745)	(5.318)	(4.777)	(5.789)	(4.896)	(5.006)	(5.382)
Volatility of GDP Growth		1.533***					
		(0.543)					
Average Debt Level			0.145*				
			(0.0779)				
Control over Corruption				-6.476**			
				(3.206)			
Volatility of Exchange Rate					0.00146*		
					(0.000757)		
Volatility of Inflation						0.00128*	
						(0.000762)	
Fiscal Rule (imputed and averaged)							-6.543
							(5.866)
Constant	40.61**	31.61*	33.88**	-9.105	38.91**	39.76**	31.71*
	(16.76)	(16.44)	(15.79)	(32.32)	(16.99)	(16.93)	(19.08)
Observations	108	108	108	108	108	108	108
R-squared	0.132	0.200	0.189	0.175	0.141	0.136	0.143

Note: Dependent variable in each regression is average forecast error of each country across all vintages after 2008. Independent variables are also averaged across all years in the sample. Sample consists of 108 countries. For fiscal rule, if the dataset did not have any information on a country, we assume that there is no fiscal rule. Robust standard errors reported in parenthesis. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

Annex Table 2.4: EIU: Forecast Errors when Recession Falls in Horizon, All Countries

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Negative Real Growth	Harding-Pagan on Real GDP	Harding-Pagan on per-capita GDP	Output gap less than -2 percent	Crisis
Recession Start in Forecast Horizon	13.44**	12.64**	9.668**	6.133	19.48***
	(4.357)	(3.912)	(3.620)	(4.290)	(4.497)
Constant	5.912**	6.374**	6.246**	9.769***	7.801***
	(2.103)	(1.945)	(2.484)	(1.759)	(1.649)
Observations	525	525	525	525	525
R-squared	0.086	0.076	0.045	0.016	0.118

Note: Observations at country-vintage level. Dependent variable in each regression is forecast error of country *'c'* in vintage *'v'*. Independent variable is a dummy which takes value 1 if the start of a recession occurs in country *'c'* in the forecast horizon. Columns correspond to different recession definitions as described in Section V. Standard errors are clustered two-way at country and vintage level. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

Annex Table 2.5: EIU: Forecast Errors when Recession Falls in Horizon, EMDEs

VARIABLES	(1) Negative Real Growth	(2) Harding-Pagan on Real GDP	(3) Harding-Pagan on per-capita GDP	(4) Output gap less than -2 percent	(5) Crisis
Recession Start in Forecast Horizon	7.295	5.629	5.323*	-4.039	7.779
	(4.190)	(3.202)	(2.549)	(3.136)	(4.861)
Constant	8.880***	9.417***	8.463***	12.78***	10.09***
	(1.976)	(1.874)	(2.153)	(1.748)	(1.722)
Observations	362	368	368	368	362
R-squared	0.031	0.019	0.017	0.009	0.025

Note: Observations at country-vintage level. Sample only includes EMDEs. Dependent variable in each regression is forecast error of country 'c' in vintage 'v'. Independent variable is a dummy which takes value 1 if the start of a recession occurs in country 'c' in the forecast horizon. Columns correspond to different recession definitions as described in Section V. Standard errors are clustered two-way at country and vintage level. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

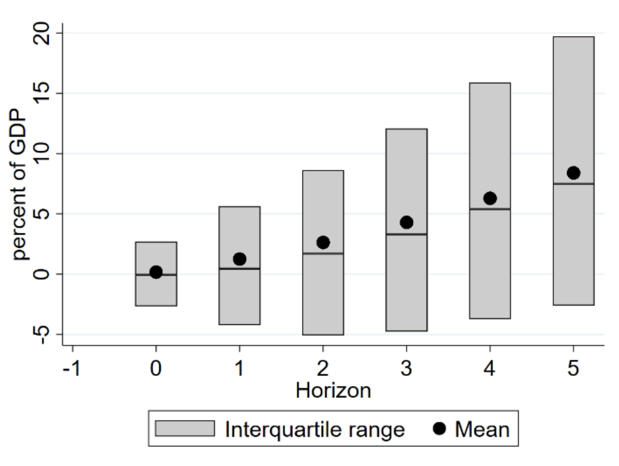
Annex Table 2.6: EIU: Forecast Errors when Recession Falls in Horizon, AEs

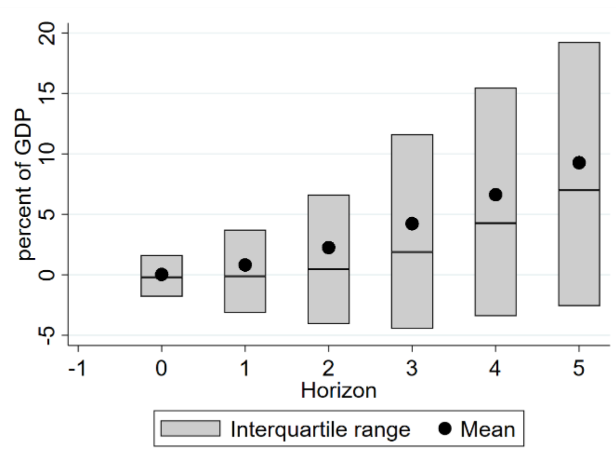
VARIABLES	(1) Negative Real Growth	(2) Harding-Pagan on Real GDP	(3) Harding-Pagan on per-capita GDP	(4) Output gap less than -2 percent	(5) Crisis
Recession Start in Forecast Horizon	21.51**	21.51**	15.66*	18.69**	34.33***
	(6.638)	(6.638)	(7.896)	(6.783)	(6.093)
Constant	0.618	0.618	2.285	3.496	4.243
	(3.173)	(3.173)	(4.668)	(3.233)	(3.113)
Observations	217	217	217	217	217
R-squared	0.179	0.179	0.095	0.129	0.281

Note: Observations at country-vintage level. Sample only includes AEs. Dependent variable in each regression is forecast error of country *'c'* in vintage *'v'*. Independent variable is a dummy which takes value 1 if the start of a recession occurs in country *'c'* in the forecast horizon. Columns correspond to different recession definitions as described in Section V. Standard errors are clustered two-way at country and vintage level. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

Annex Figure 2.1: Forecast Errors for LIDCS versus EMs

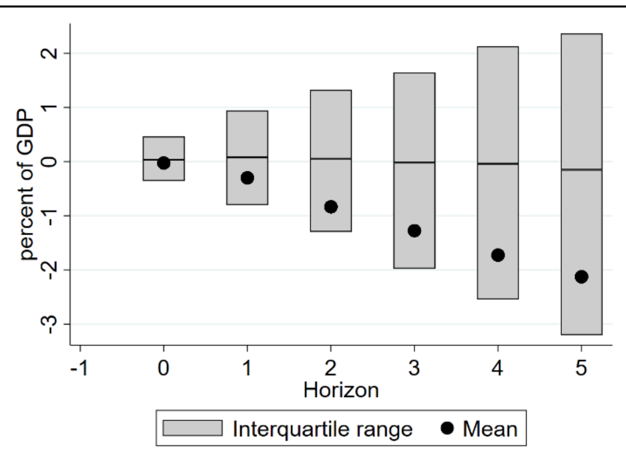
LIDCs | **EMs**





Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for debt-to-GDP forecast errors for different time horizons for low-income and developing economies (LIDCs) and emerging markets (EMs). LIDCs include all countries covered by the IMF report "Macroeconomic Developments and Prospects in Low-Income Developing Countries—2019" while the EMs consist of all other non-advanced economies. IMF data and the baseline measure of forecast errors is used.

Annex Figure 2.2: IMF Forecast Errors: Contribution of Deflator Growth



Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for the contribtuion of inflation forecast errors in explaining the forecast error in debt projections. The contribution of inflation is simply calculated as using the standard debt decomposition equation which identifies the contribution of inflation to changes in debt ratios as $\frac{-\pi_t}{(1+g_t)(1+\pi_t)} * d_{t-1}$ where *'π'* is GDP deflator growth, *'g'* is the growth rate of real GDP and *'d'* is the debt-to-GDP ratio. The contribution to forecast error is computed as the contribution of inflation to the accumulation of debt in realized data minus the contribution in the forecast data.

ANNEX 3: ADDITIONAL FORECAST PROPERTIES

While the main paper focused on the extent of average bias in the debt forecasts, this annex provides additional details on other properties of forecast errors, including accuracy of forecasts in terms of absolute and mean squared errors, comparison of forecasts to some naïve estimates, tests for efficiency of forecasts, and statistics on directional accuracy.

3.1. Size of Forecast Errors

Two metrics, average absolute errors and root mean squared errors, are generally used to assess the size of forecast errors. For each horizon *h,* these are defined as follows:

$$\boldsymbol{AAE(h)} = \frac{1}{N}\sum\nolimits_{c,v}\left|FE_{c,h}^{v}\right| \qquad (A1)$$

$$\boldsymbol{RMSE(h)} = \sqrt{\frac{1}{N}\sum\nolimits_{c,v}\left(FE_{c,h}^{v}\right)^{2}} \qquad (A2)$$

where AAE is the average absolute error, RMSE is the root mean squared error, N is the number of observations, and $FE_{c,h}^{v}$ is the forecast error as defined in the main paper which can be from IMF or EIU.

Annex Table 3.1 summarizes AAE and RMSE for IMF and EIU forecasts for all horizons for the full samples as well as the balanced samples. Size of errors are larger for longer horizons indicating a decline in accuracy, consistent with our findings of larger average bias's at longer horizons. For the balanced samples, IMF AAE and RMSE are somewhat smaller than EIU measures, indicating slightly smaller size of errors for the IMF.

Diebold and Mariano (1995) propose a test for comparing accuracy of two forecasts by regressing the difference in the squares of the forecast errors on a constant and testing if the constant is different from zero. In our case, this test is equivalent to running the following regressions

$$\left(FE_{c,h}^{v,IMF}\right)^{2} - \left(FE_{c,h}^{v,EIU}\right)^{2} = \alpha + \epsilon_{c,h}^{v} \qquad (A3)$$

and testing if α different form zero.

Annex Table 3.2 shows the results for this test. The constant is negative and marginally significant at the 10 percent level for short horizons, indicating that IMF forecasts are slightly more accurate. However, the constant becomes insignificant at longer horizons.

Next, we compare the accuracy of IMF and EIU forecasts relative to a naïve forecast where no change in debt is expected throughout the forecast period i.e. the estimated debt level at t-1 of the vintage is assumed to be the forecast for all horizons. Annex Table 3.3 shows the RMSE for this naïve forecast compared to the actual IMF and EIU forecasts. Except at the very short horizon for EIU, the RMSE for the naïve forecast is always larger than that of the actual forecast, indicating additional information content in the IMF and EIU forecasts. However, when testing for whether the actual forecasts are statistically different from the naïve forecast, only the IMF forecasts are statistically different from the naïve ones (Annex Table 3.4).

3.2. Efficiency of Forecasts

Different tests for efficiency of forecasts are used in the literature. Here, we use a test for "weak efficiency". We run the regression

$$AD_{c,h}^{v} = \alpha + \beta FD_{c,h}^{v} + \epsilon_{c,h}^{v} \qquad (A4)$$

where $AD_{c,h}^{v}$ is the actual realized debt-to-GDP ratio that is realized, while $FD_{c,h}^{v}$ is the forecasted level of debt-to-GDP ratio. "Weak efficiency" requires that $\alpha = 0$ and $\beta = 1$ jointly [and uncorrelated errors].

Annex Table 3.5 shows results for the Equation A4 along with the p-value for the joint test of $\alpha = 0$ and $\beta = 1$. Weak efficiency is rejected at all horizons for both IMF and EIU forecasts.

3.3. Directional Accuracy

Finally, in Annex Table 3.6 we look at some simple statistics on directional accuracy of forecasts. The table shows that of the total number of times that debt ratios were forecasted to decline in the medium-term, the projections turned out to be directionally accurate a little less than half the times. On the other hand, projected increases in debt ratios were directionally accurate much more often, with 80 percent of forecasts which were projecting an increase in debt actually seeing debt ratios rise. This points to the asymmetric nature of forecasts errors which we also saw in Figure 10 where errors were significantly larger when debt ratios were projected to decline.[10]

[10] All the results in this annex are robust to conducting the analysis for AEs and EMDEs separately, except for the test on weak efficiency where we fail to reject the null hypothesis at short horizons in some samples, usually in AEs. These results are available on request.

Annex Table 3.1: Size of Forecast Errors. IMF and EIU

Average Absolute Error

	Full Sample		Balanced Sample	
Horizon	IMF	EIU	IMF	EIU
0	4.7	4.9	3.9	4.6
1	7.7	7.4	6.6	7.2
2	10.3	10.1	9.3	10.1
3	12.7	12.5	12.0	12.8
4	14.9	14.9	14.8	15.3
5	17.3	16.8	17.0	17.4

Root Mean Squared Error

	Full Sample		Balanced Sample	
Horizon	IMF	EIU	IMF	EIU
0	8.7	11.9	7.0	10.0
1	13.3	14.2	10.8	13.3
2	16.8	18.2	15.9	17.9
3	19.7	20.1	18.8	20.6
4	22.5	22.4	22.1	23.0
5	25.2	24.7	24.6	25.5

Notes: Table shows average absolute error (left panel) and root mean squared error (right panel) for different horizons based on equations A1 and A2 for IMF and EIU forecast errors.

Annex Table 3.2: Comparing Accuracy of IMF and EIU Forecasts

	(1)	(2)	(3)	(4)	(5)	(6)
	t=0	t=1	t=2	t=3	t=4	t=5
Dependent variable: IMF forecast error square - EIU forecast error squared						
Constant	-51.894*	-61.221*	-69.677	-70.749	-39.733	-47.594
	(26.582)	(32.924)	(50.562)	(64.237)	(56.775)	(51.269)
Observations	2,616	2,337	1,964	1,628	1,410	525
R-squared	-0.000	0.000	0.000	-0.000	0.000	-0.000

Notes: Estimates for equation A3. Dependent variable is the difference in the square if IMF and EIU forecast errors. Columns are for different forecast horizons. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

Annex Table 3.3: Root Mean Squared Error Compared to a Naïve Forecast

	Full Sample				Balanced Sample			
Horizon	IMF	IMF Naïve	EIU	EIU Naïve	IMF	IMF Naïve	EIU	EIU Naïve
0	8.7	11.1	11.9	11.4	7.0	8.3	10.0	9.7
1	13.3	15.5	14.2	15.1	10.8	13.0	13.3	13.9
2	16.8	18.9	18.2	19.0	15.9	17.3	17.9	18.5
3	19.7	21.9	20.1	20.4	18.8	20.3	20.6	20.9
4	22.5	24.7	22.4	23.7	22.1	23.3	23.0	24.3
5	25.2	27.0	24.7	25.9	24.6	25.1	25.5	26.3

Notes: Table shows root mean squared error based on equation A2 for IMF and EIU forecast errors compared to a "naïve" forecast which assumes that *t-1* debt ratios persist throughout the forecast horizon.

Annex Table 3.4: Comparing IMF and EIU Forecasts to Naïve Forecast

IMF Compared to Naive

	(1) t=0	(2) t=1	(3) t=2	(4) t=3	(5) t=4	(6) t=5
Dependent variable: IMF forecast error square -Naïve forecast error squared						
Constant	-47.599***	-64.494***	-73.639**	-95.019**	-106.758**	-97.959
	(16.874)	(20.729)	(29.304)	(39.651)	(48.534)	(58.329)
Observations	5,237	4,855	4,481	4,107	3,741	3,380
R-squared	-0.000	-0.000	-0.000	-0.000	0.000	-0.000

EIU Compared to Naive

	(1) t=0	(2) t=1	(3) t=2	(4) t=3	(5) t=4	(6) t=5
Dependent variable: EIU forecast error square -Naïve forecast error squared						
Constant	10.425	-24.261	-9.917	-5.230	-13.958	35.111
	(20.920)	(29.348)	(33.326)	(39.993)	(40.878)	(69.461)
Observations	2,931	2,646	2,203	1,811	1,580	593
R-squared	0.000	0.000	0.000	-0.000	-0.000	0.000

Notes: Estimates for equation A3. In the top panel, dependent variable is the difference in the square if IMF forecast errors compared to a naïve forecast which assumes that *t-1* debt ratios persist throughout the forecast horizon. In the bottom panel, dependent variable is the difference in the square if EIU forecast errors compared to a naïve forecast which assumes that *t-1* debt ratios persist throughout the forecast horizon. Columns are for different forecast horizons. Columns are for different forecast horizons. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

Annex Table 3.5: Weak Efficiency of Forecasts

IMF Forecasts

	(1) t=0	(2) t=1	(3) t=2	(4) t=3	(5) t=4	(6) t=5
Forecasted debt	0.973***	0.941***	0.905***	0.872***	0.838***	0.802***
	(0.009)	(0.018)	(0.028)	(0.040)	(0.056)	(0.070)
Constant	1.592***	4.253***	7.463***	10.802***	14.463***	18.254***
	(0.479)	(1.041)	(1.538)	(2.030)	(2.553)	(2.959)
Observations	5,239	4,857	4,483	4,109	3,743	3,383
R-squared	0.939	0.861	0.785	0.719	0.655	0.599
P-value of joint test for efficiency	0.00643	0.000780	4.26e-05	1.24e-06	1.31e-08	8.05e-11

EIU Forecasts

	(1) t=0	(2) t=1	(3) t=2	(4) t=3	(5) t=4	(6) t=5
Forecasted debt	0.938***	0.930***	0.901***	0.883***	0.894***	0.869***
	(0.028)	(0.028)	(0.040)	(0.050)	(0.052)	(0.059)
Constant	3.226**	5.001***	8.851***	12.395***	14.480***	17.354***
	(1.264)	(1.418)	(2.008)	(2.410)	(2.520)	(2.674)
Observations	2,931	2,646	2,203	1,811	1,580	593
R-squared	0.896	0.858	0.775	0.745	0.709	0.671
P-value of joint test for efficiency	0.0321	0.00258	4.81e-05	3.13e-06	1.69e-06	0.000301

IMF Forecasts Balanced Sample

	(1) t=0	(2) t=1	(3) t=2	(4) t=3	(5) t=4	(6) t=5
Forecasted debt	0.983***	0.969***	0.943***	0.923***	0.912***	0.902***
	(0.009)	(0.014)	(0.022)	(0.032)	(0.041)	(0.050)
Constant	1.326***	3.691***	7.698***	10.926***	14.107***	16.649***
	(0.476)	(1.000)	(1.387)	(1.780)	(2.182)	(2.209)
Observations	2,616	2,337	1,964	1,628	1,410	525
R-squared	0.964	0.919	0.844	0.799	0.751	0.721
P-value of joint test for efficiency	0.0219	0.00186	1.23e-05	2.81e-06	2.35e-06	0.000283

EIU Forecasts Balanced Sample

	(1) t=0	(2) t=1	(3) t=2	(4) t=3	(5) t=4	(6) t=5
Forecasted debt	0.952***	0.930***	0.899***	0.881***	0.895***	0.868***
	(0.025)	(0.029)	(0.043)	(0.052)	(0.053)	(0.057)
Constant	2.612**	5.113***	9.108***	12.809***	14.956***	18.094***
	(1.155)	(1.513)	(2.177)	(2.586)	(2.627)	(2.768)
Observations	2,616	2,337	1,964	1,628	1,410	525
R-squared	0.924	0.871	0.783	0.738	0.706	0.665
P-value of joint test for efficiency	0.0553	0.00238	5.83e-05	6.94e-06	3.11e-06	0.000455

Notes: Test for "weak efficiency" for different horizons for equation A4 for IMF and EIU forecasts. Dependent variable is realized debt level. The row "P-value of joint test for efficiency" shows results for the joint test of the constant being 0 and the coefficient on forecasted debt being 1. Columns are for different forecast horizons. Columns are for different forecast horizons. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively.

Annex Table 3.6: Directional Accuracy of IMF Forecasts

	t=0	t=1	t=2	t=3	t=4	t=5
Decline realized as a share of decline projected	0.75	0.66	0.60	0.55	0.52	0.48
Increase realized as a share of increase projected	0.78	0.78	0.77	0.78	0.81	0.82

Notes: Table shows the share of forecasts where the projections turned out to be directionally accurate.

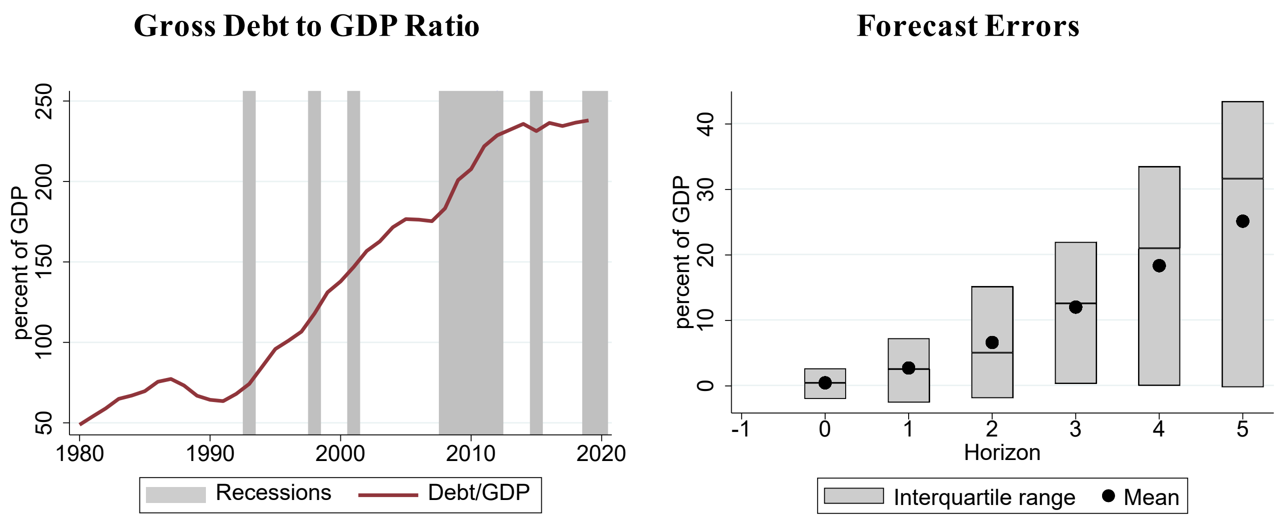
ANNEX 4: JAPAN

Debt has been increasing almost continually in Japan since the early 1990s (Annex Figure 4.1, left panel), rising from about 65 percent of GDP in 1990 to almost 240 percent of GDP in 2019. The rising debt ratios have been accompanied by very large forecast errors, with the median five-year ahead error across all vintages being a little over 30 percent of GDP (Annex Figure 4.2, right panel). Annex Figure 4.3 shows the forecast error for each vintage separately. Throughout the 1990s and up to the GFC, forecast errors ranged between 20 to 60 percent of GDP. Throughout, IMF forecasts were projecting a plateauing and/or a decrease in debt ratios that did not materialize (see Annex Figure 4.3 for an example), indicating that it took forecasters more than a decade to internalize Japan's rising debt trend. Forecast errors have been significantly lower post-GFC, a period when realized debt ratios stabilized.[11]

Annex Figure 4.4 shows the contribution of fiscal deficits and growth in accounting for the forecast error in debt to GDP ratio in Japan. Realized deficits were significantly higher than forecasted, and growth outturns were also lower than projected, each contributing about 10 percent of GDP to the debt forecast errors. Inflation outturns were also lower than projected, contributing to Japan's large debt forecast errors.

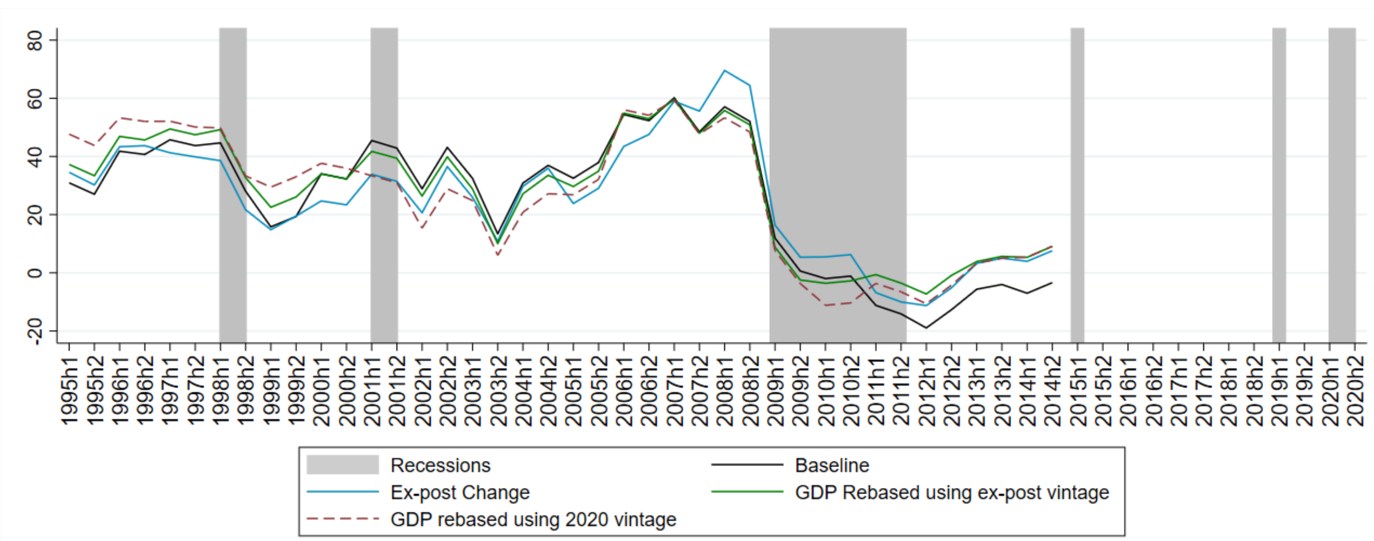
[11] Our baseline measure shows a significant negative forecast error post-GFC. However, this reflects an upward revision in GDP in later vintages. The error is close to zero for the measure based on changes in realized and forecasted debt ratios, which better controls for changes in the level of GDP over vintages, as well as two additional measures using a proxy rebased GDP series for each vintage.

Annex Figure 4.1: Japan: Debt Levels and Forecast Errors



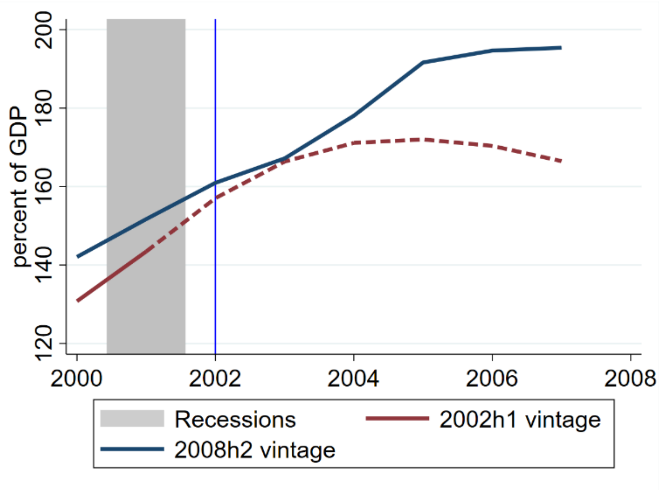
Notes: The left chart shows the evolution of Japan's debt-to-GDP ratio between 1980 and 2019. The right chart shows the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) across different vinatges for debt-to-GDP forecast errors for Japan for different time horizons. The baseline measure of forecast errors is used. IMF data is used.

Annex Figure 4.2: Japan: Vintage by Vintage Forecast Errors



Notes: In addition to the baseline, we also plot the vintage-by-vintage forecast errors using two different methods as the "rebasing" bias is significant in the post-GFC period. The line "Forecast Error—compare Change" is based on our "ex-post change" methodology. In addition we implement two new ways of computing forecast erros where we essentially rebase the realized GDP to the t-1 level for each vintage and recompute forecast errors. IMF data is used.

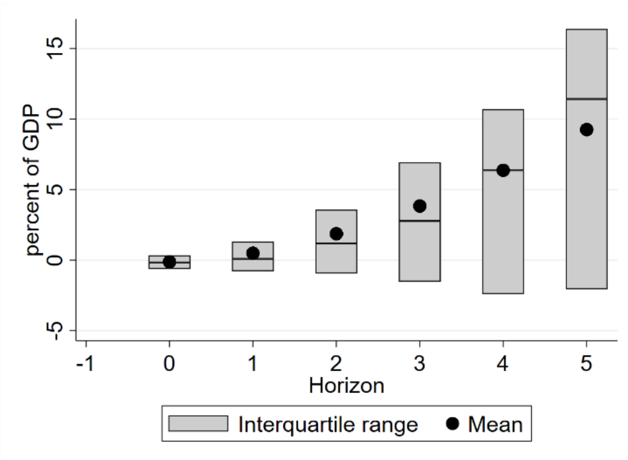
Annex Figure 4.3: Japan Debt-to-GDP Ratio: Comparing 2002H1 Vintage Forecast to Realized Outcome



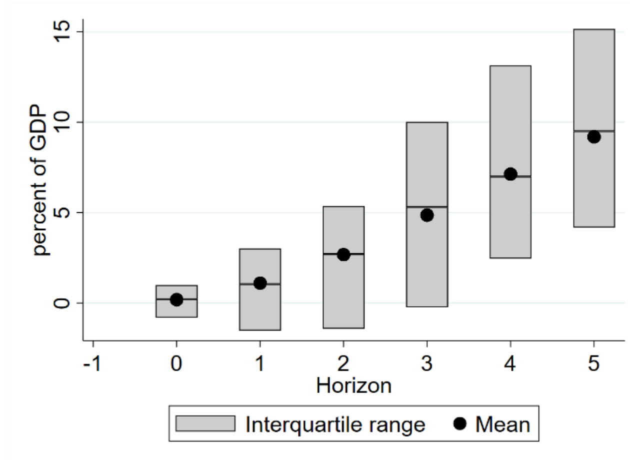
Notes: Chart compares the forecasted debt-to-GDP ratio in the 2002H1 vintage to the outturn as reported in the 2008H2 vintage for Japan. Dashed line is for the forecast period. Gray shaded area corresponds to recession years. IMF data is used.

Annex Figure 4.4: Japan: Contribution of Fiscal Deficit and Growth

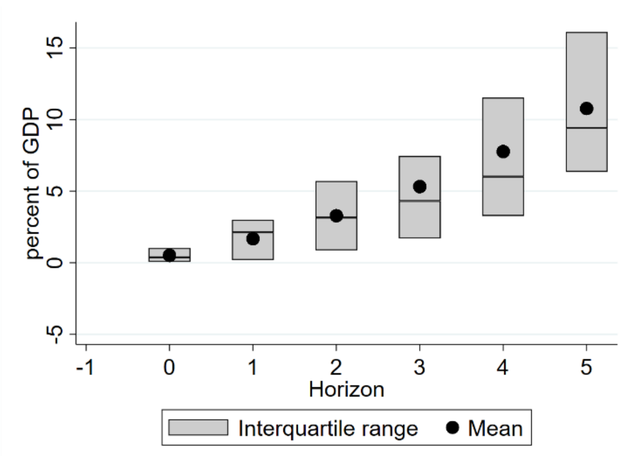
Contribution of Fiscal Deficit



Contribution of Growth



Contribution of Inflation



Notes: Charts show the interquartile range (shaded gray region), mean (black dot), and median (black line in the shaded box) for the contribtuion of fiscal deficit, growth, and inflation forecast errors in explaining the forecast error in debt projections for Japan. IMF data is used. The contribution of fiscal deficit is simply calculated as the sum of realized fiscal deficits (as a percent of GDP) over the forecast horizon minus the sum of fiscal deficits that were forecasted. As we use fiscal deficits instead of primary deficits in this calculation (to ensure comparability with the broader sample in the main text), real interest rate shocks, which interact with the level of debt itself, are included in the contribution of fiscal deficits. For the contribution of growth, we use the standard debt decomposition euqation which identifies the contribution of growth to changes in debt ratios as $\frac{-g_t}{1+g_t} * d_{t-1}$ where 'g' is the growth rate of real GDP and 'd' is the debt-to-GDP ratio. The contribution of inflation is calculated is computed as $\frac{-\pi_t}{(1+g_t)(1+\pi_t)} * d_{t-1}$ where 'π' is GDP deflator growth. As with fiscal deficit, the contribution to forecast error is computed as the contribution of growth and inflation to the accumulation of debt in realized data minus the contribution in the forecast data.