Forecasts in Times of Crises*

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Abstract. The uncertainty surrounding models, parameters, and data is known to introduce substantial errors to economic forecasts. We analyze IMF forecasts for countries in times of crises (sharp recessions and external/fiscal shocks), which further challenge forecasts. To limit model and parameter uncertainty, we base our forecast analysis on accounting identities. Hence, the underlying true models and parameter values are known and we can focus squarely on the effects of uncertainty surrounding the data generating mechanisms of our explanatory variables. By decomposing forecast errors into *systematic bias*, *excess variance*, and *unsystematic errors*, we find that IMF crisis forecasts are, on balance, remarkably unbiased but often subject to unnecessary large variances. We highlight the key variables that contribute to errors in GDP, balance of payments, fiscal revenue and expenditure predictions to draw attention to the exact variables that deserve special attention as inputs into future forecasts.

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"A crisis is a terrible thing to waste."
↛ Paul Romer, 2004[1]

1. Introduction

Macroeconomic forecasting is challenging, and the onset of economic crises usually exacerbates forecast errors. Critics lament that "widespread failures of prediction that accompanied the recent global financial crisis" rendered economists unable to predict GDP or financial collapse.[2] This widespread thinking forced many policy makers to "fly blind" at times when decisive action was needed. Macroeconomic forecasts are generally hampered by three major sources of uncertainty: model uncertainty (the true model is unknown), parameter uncertainty (even when the model is known), and data uncertainty (systematic variations in data generating process of underlying fundamentals). The goal of this paper is to provide an assessment of IMF forecasts for "program" countries, which draw on IMF funds and technical assistance during economic crises.[3] The IMF forecasts that we examine are based on accounting identities, which rule out model and parameter uncertainty, and therefore provide an unusually precise identification of the sources of forecast errors during times of crises. To this end, we choose an approach that eliminates model and parameter uncertainty, and isolates the distinct effects of data uncertainty.

While the IMF and indeed other private, national and international institutions produce regular macroeconomic surveillance forecasts covering most countries and years, predictions during economic crises have not been systematically evaluated to date.[4] We fill this gap by drawing on the IMF's Monitoring of Fund Arrangements (MONA) dataset, which is the only large scale, time series dataset that produces a full set of forecasts for countries during times of crises. These forecasts are critical, since they determine the program that the IMF and countries jointly design. The combination of both forecasting and policy prescriptions by the IMF to program countries results in two interesting questions: First, how good is the IMF at forecasting

[1] Quotation attribution from Rosenthal (2009).
[2] See Silver (2012).
[3] Participation in an IMF program is a joint decision between a member country and the IMF. Countries that are experiencing economic difficulties first approach the IMF for a financial arrangement. The IMF then determines whether the country meets the Fund's criteria for approval.
[4] For instance, there have been only four IMF-commissioned external evaluations of the World Economic Outlook forecasts: Artis (1988, 1996), Timmermann (2007), and Faust (2013).

key indicators in times of crises? And second, how well does the IMF do in predicting the effectiveness of its own programs?

A number of recent studies examine IMF forecasts in times of crises, but their evaluations are mostly restricted to the analysis of systemic bias and program conditionality.[5] Ghosh et al. (2005) examine whether there are systematic errors in program forecasts of key macroeconomic variables such as output, inflation and the current account, and find that IMF short-run predictions are relatively accurate and do not exhibit systematic biases. However, their analysis focuses mostly on forecast biases, and they do not attempt to systematically track the sources of prediction errors. Baqir et al. (2005) collect data from IMF Staff Reports on program countries and produce forecast errors for GDP growth, inflation and the current account, and partially examine fiscal balance forecasts. The paper finds systematic deviations between forecasts and realizations for both growth and inflation, especially for 1-year ahead or longer predictions. Moreover, Baqir et al (2005) show that more ambitious fiscal targets have growth-enhancing effects in program countries.

Focusing on the period between 2002 and 2011, Luna (2014) finds that IMF forecasts of GDP growth and inflation are overly optimistic, but only for program countries with exceptional access to Fund resources. However, Luna's analysis also suggests that forecasts of the government budget and the current account balance are too pessimistic. Lastly, Atoyan et al. (2004) and Atoyan and Conway (2011) attempt to track the sources of the bias in forecasts of the fiscal balance and the external current account balance. Both papers identify the choice of the forecast model by the IMF and the poor measurement of initial conditions as important contributors to prediction bias.

In this paper, we move beyond the stylized facts analysis of forecast biases in the previous literature in the following three ways: First, we decompose prediction errors in crisis countries into systematic and unsystematic errors. This distinction helps us to more comprehensively evaluate whether IMF forecasts for program countries could be systematically improved. Second, motivated by fundamental macroeconomic identities, we analyze to what extent forecast errors for different subcomponents of such identities can be the underlying cause

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[5] There is also a few earlier studies on the performance of IMF forecasts in crisis countries, but their focus is much narrower in terms of: (i) the variables considered, (ii) the sample of program countries, and (iii) the time period under consideration. See, e.g., Goldstein (1986), Musso and Phillips (2002), and Golosov and King (2002).

of prediction errors for macroeconomic aggregates. Third, we focus our analysis not only on the evaluation of output and current account forecasts, which were the focal points of most prior studies, but also examine financial account, government revenue and government expenditure forecasts. Moreover, in contrast to the earlier studies by Ghosh et al. (2005) and Baqir et al. (2005), our paper uses data on more recent programs (2003-2016) from an updated and improved version of the IMF's MONA database. An additional advantage of our study is the greater sample size relative to previous investigations of the Fund's forecasting performance.

In the empirical analysis, we compare IMF forecasts for our variables of interest for the first program year as stated in the first program review to actually realized values as reported in the final review. Overall, we find in our full sample that IMF growth forecasts of different macroeconomic aggregates (GDP, current account, financial account, government expenditures, and government revenues) are not significantly biased. Regarding GDP growth, this result confirms earlier studies that found no bias for shorter horizon forecasts. More generally, using mean squared error (MSE) decompositions, our analysis also suggests that the majority of forecast errors for all considered macroeconomic aggregates (except current account growth) is instead due to unsystematic variance prediction errors, i.e. white noise. However, we also detect substantial bias and systematic errors in IMF forecasts in program countries for several subcomponents of these macroeconomic variables. For instance, IMF forecasts in crisis countries on average substantially overestimate public investment growth.

We also examine to what extent forecast errors in macroeconomic aggregates are driven by prediction errors in the growth rates of their respective subcomponents. Our analysis reveals some important insights. We find that forecast errors in private consumption growth are a substantial determinant of prediction errors in GDP growth. Similarly, the examination of the fiscal budget forecasts shows that prediction errors in government expenditure growth are significantly affected by errors in two subcomponents: non-interest expenditures as well as capital expenditures and net lending. On the government revenue side, it is instead mostly false predictions in tax revenue growth that lead to forecast errors in fiscal revenue growth. Finally, prediction errors of individual items in the balance of payments are not informative regarding substantial forecast errors that we observe for both the current and financial accounts.

The remainder of the paper is structured as follows. Section 2 lays out how to forecast the growth rates of macroeconomic aggregates based on their individual subcomponents. Section 3 presents our approach to evaluating IMF forecasts for countries during times of crises. Section 4 discusses the IMF's MONA dataset, and Section 5 reports our main results. Section 6 concludes and highlights the policy relevance of our findings.

2. Forecasting Based on Macroeconomic Identities

Our forecast models are motivated by macroeconomic identities. Specifically, we focus below on macroeconomic identities which are fundamental for structuring and assessing the success of IMF programs: aggregate demand, the balance of payments, and fiscal accounts. Our focus throughout this paper is on forecasting the growth rates of nominal variables, since deflators are often non-uniform across countries which would introduce confounding errors. Focusing on growth rates also allows us to circumvent potential issue related to changes in currency denominations or unit changes in between the time of the initial forecasts and the realized data in the MONA database.

We start with aggregate demand. The national income identity for an open economy decomposes nominal GDP, *Y*, into final private and public consumption (C_p, C_g), private and public investment (I_p, I_g), and imports and exports (M, X):[6]

$$Y = C_p + C_g + I_p + I_g + X - M \, . \tag{1}$$

Totally differentiating (1) yields:

$$y = \sigma_{y,c_p} c_p + \sigma_{y,c_g} c_g + \sigma_{y,i_p} i_p + \sigma_{y,i_g} i_g + \sigma_{y,x} x - \sigma_{y,m} m \tag{2}$$

where small letters indicate growth rates and $\sigma_{i,j}$ represents the elasticity between *i* and *j*. For instance, σ_{y,c_p} measures to what extent an increase in private consumption growth raises nominal GDP growth. If all subcomponents of the GDP equation are measured without errors, the elasticities are simply the share of each variable in output.

Next, we consider the balance of payments (BOP), also known as balance of international payments, which is an accounting method countries use to monitor all international monetary

[6] IMF (2007), https://www.imf.org/external/pubs/ft/pam/pam56/pam56.pdf.

transactions at a specific period of time. Most of the financial arrangements between the IMF and its 189 members take place when a member state is in BOP need, which usually means that the country is facing a decline in foreign exchange reserves and can no longer attract sufficient capital flows to finance the current account deficit. The BOP is a key indicator for the onset and recovery from economic crises. Specifically, we investigate the current and financial accounts separately to capture the potential distinct impacts of international income and capital transactions. Following the IMF decomposition of the current account, we get the following growth rate identity:[7]

$$ca = \sigma_{ca,x_g} x_g + \sigma_{ca,x_s} x_s - \sigma_{ca,m_g} m_g - \sigma_{ca,m_s} m_s + \sigma_{ca,ni} ni + \sigma_{ca,nt} nt \, , \qquad (3)$$

where ca is the current account growth rate, x_g and x_s are the growth of goods and services exports, respectively, and m_g and m_s are the corresponding measures for imports. n_i and n_t capture the growth in net income and net transfers of a country with the rest of the world. Following again the official IMF decomposition, the growth in the financial account is given by:[8]

$$fa = \sigma_{fa,fdi} fdi + \sigma_{fa,pi} pi + \sigma_{fa,res} res + \sigma_{fa,ot} ot \, , \qquad (4)$$

where the growth rate of the financial account (*fa*) is decomposed into the contributions by growth in net foreign direct investment (*fdi*), net portfolio investment (*pi*), reserve assets (*res*), and other investment (*ot*).

Finally, as government budgets are a crucial element in evaluating the sustainability of IMF programs and countries' recoveries, we consider the IMF decomposition for both government expenditures and revenues:[9]

$$gx = \sigma_{gx,\text{int}} \text{int} + \sigma_{gx,n\text{int}} n\text{int} + \sigma_{gx,cap} cap \qquad (5)$$

$$gr = \sigma_{gr,tax} tax + \sigma_{gr,ntax} ntax + \sigma_{gr,grt} grt \, , \qquad (6)$$

where government expenditure growth (*gx*) is decomposed into the growth rates of interest expenditures (*int*), non-interest expenditures (*nint*), and outlays on capital expenditure and net

[7] IMF (2015), https://www.imf.org/external/np/sta/bop/bop.htm. The BOPs are compiled by the IMF and make use of the detailed data in the Balance of Payments Yearbook. A portion of these data appears in the International Financial Statistics (IFS) dataset. For more information see: www.imf.org/external/data.htm.
[8] IMF (2009), https://www.imf.org/external/pubs/ft/bop/2007/pdf/bpm6.pdf.
[9] IMF (2014), https://www.imf.org/external/Pubs/FT/GFS/Manual/2014/gfsfinal.pdf.

lending (*cap*). Similarly, government revenue growth (*gr*) can be decomposed into the growth rates of tax revenue (*tax*), non-tax revenue (*ntax*), and grants (*grt*).

Having discussed the growth rate decompositions of aggregate demand, the balance of payments, and fiscal revenues and expenditures, the next section lays out how we can evaluate IMF forecasts of these macroeconomic identities.

3. Methodology: Evaluating IMF Forecasts

Forecasting involves a bias-variance tradeoff, since greater precision (smaller variance) may lead to increased bias. To gauge this tradeoff, we use a symmetric loss function that penalizes positive and negative errors equally, specifically, the mean squared error (MSE) and mean absolute error (MAE). The latter is useful if we want to examine the errors in the same units as the forecasted and realized quantities of interest, i.e. the MAE is unit equivalent.

To evaluate the accuracy of IMF macroeconomic forecasts in crisis countries, we follow a two-pronged approach. First, we decompose the forecast MSE for each variable into its bias, variance and covariance components. Effective forecasts should minimize the systematic portion of the forecast error as captured by the bias and variance terms. Let $\hat{x}_i$ be the forecasted growth rate of a variable of interest *x* in country *i* between years *t-1* and *t*, while x_i is the realized growth rate over the same time span. We can then decompose the forecast MSE of *x* in a sample of *N* observations as:

$$\sum_{i=1}^{N}(\hat{x}_i - x_i)^2 / N = (\bar{\hat{x}} - \bar{x})^2 + (\sigma_{\hat{x}} - \sigma_x)^2 + 2(1-r)\sigma_{\hat{x}}\sigma_x, \qquad (7)$$

where $\bar{\hat{x}}$ and $\bar{x}$ are the means of the forecasted and actual observations across all *N* countries, respectively. The contribution of the forecast bias to the MSE is given by $(\bar{\hat{x}} - \bar{x})^2$, while the second term in equation (7) constitutes the systematic difference in the variance between the forecasted and the actual values, $(\sigma_{\hat{x}} - \sigma_x)^2$. The covariance portion of the MSE, $2(1-r)\sigma_{\hat{x}}\sigma_x$, captures unsystematic forecast errors, where *r* is the correlation coefficient between the forecasts and the actual values.

Having reviewed the decomposition of MSE into bias and variance, and systematic and unsystematic errors, we can examine in a second step to what extent IMF forecast errors are driven by data uncertainty. To that end, we regress the forecast error of our variables of interest on the left-hand side of the above identities, e.g., GDP growth, on the forecast errors of our explanatory variables on the right-hand side of the respective identities. We measure forecast inaccuracy in terms of absolute errors, which, as outlined above, have the advantage of being unit equivalent regarding the interpretation of regression coefficients. In particular, for S explanatory variables, we regress:

$$\left|\hat{y}_i - y_i\right| = \alpha + \sum_{j=1}^{S} \beta_j \left|\hat{x}_{ij} - x_{ij}\right| + \varepsilon_i, \tag{8}$$

where $\hat{x}_{ij}$ and $\hat{y}_i$ are again the forecasted errors of variables x_j and y in country i between years $t\text{-}1$ and t, while x_{ij} and y_i are the realized growth rates over the same time span. The coefficients in (8) have a straightforward interpretation: A 1% increase in the mean absolute error of an explanatory variable x_j causes a β_j % change in the mean absolute error in the macroeconomic aggregate y, where the respective MAEs are defined as:

$$MAE_y = \sum_{i=1}^{N} \left|\hat{y}_i - y_i\right| / N \qquad \text{and} \qquad MAE_{x_j} = \sum_{i=1}^{N} \left|\hat{x}_{ij} - x_{ij}\right| / N \ . \tag{9}$$

4. Data

We obtain data on all forecasts and actual realizations of macroeconomic indicators in crisis countries from the IMF's Monitoring of Fund Arrangements (MONA) Database.[10] The current MONA data covers all IMF arrangements with 238 crisis countries in total since 2002.[11] However, the data availability for the identities that motivate our explanatory variables varies substantially across countries. Differences in the data coverage are mostly due to reporting, measurement and validation discrepancies that occur partly because of the exceptional circumstances under which these series are constructed. After substantial reconciliation and cleaning of the existing dataset we arrive at 170 crises observations for which at least a selection of variables are in place for our empirical analysis (see the Appendix for a list of all 170 country-

[10] Accessible at https://www.imf.org/external/np/pdr/mona/Arrangements.aspx.

[11] An older version of the MONA crisis dataset also exists, covering countries from 1993-2003. The old MONA uses, however, different variable definitions, series selections, accounting structures, and even coding that are for our purposes incompatible. A structural comparison of the series codes revealed only six commonalities without any internal harmonization mapping between the old and new accounting and series systems.

crises pairs).

In the empirical analysis below, we also eliminate countries producing forecast errors exceeding their respective means by more than four standard deviations to ensure that our dataset provides economic insights which are not driven by extreme outliers. To examine forecast accuracy, we use MONA information from the very first forecast for the first program year (undertaken at the time of the IMF program approval) and the final program review, which reports the realized data. Table A1 in the Appendix provides detailed summary statistics of the absolute forecast errors for the different macroeconomic identities discussed above.

5. IMF Forecast Errors: Decomposition and Determinants

In this section, we decompose IMF forecast errors for key macroeconomic identities in crisis countries, including GDP growth, the current and financials accounts, and fiscal revenues and expenditures. First, we disentangle the forecast errors of the macroeconomic aggregates and their respective subcomponents into bias, variance and covariance following the MSE definition in equation (7). The MSE decomposition allows us to identify prediction error magnitudes as well as systematic and random error sources in the IMF forecasts in crisis countries. Second, we estimate the MAE specifications as outlined by equation (8). These regressions allow us to deduce to what extent forecast errors of macroeconomic aggregates of interest can be traced back to subcomponents that serve as key inputs in the forecast. We also report below separate results for low-income countries (LICs) and more advanced economies (Non-LICs) to examine whether the IMF forecast errors are driven by different subsamples.

5.1 GDP Growth

As outlined in the methodology section, the predictors of the IMF GDP growth forecasts are strictly based on the national income identity. Hence, the only source of uncertainty in our forecast is data uncertainty. Descriptive statistics of the forecast errors are reported in Table 1. Columns 1a-1c provide the mean bias (in percentage points), defined as the forecasted minus the realized growth rate, for each variable motivated by the expenditure identity equation for the global, LIC and Non-LIC samples, respectively. We find that IMF forecasts of GDP growth in times of crises are, on average, 1.2 percentage points too pessimistic in the LICs subsample. That is, the realized GDP growth rate for low-income countries in IMF programs was, on average, 1.2 percentage points greater than the forecasted value. In contrast, GDP growth forecasts for Non-

LICs are 1.1 percentage points too optimistic. On balance, the opposing LIC and Non-LIC biases average out to render a remarkably unbiased forecast for the global sample, which is statistically insignificant from zero.

For the explanatory variables that are motivated by the national income accounting identity, only public investment growth exhibits a significant bias across all country samples. The 8.6-8.7% bias across the three samples shows substantial optimism on the part of the IMF forecast that is systematically not realized. Export growth also exhibits a statistically significant bias in the global and Non-LIC samples. The IMF forecasts for exports are, however, overly pessimistic with an average downward bias of 2.6% in the global sample and 3.5% in the Non-LIC sample. Finally, for Non-LICs we find that private consumption growth is forecasted too optimistically with an average upward bias of 2.5%.

Aside from the mean bias, we are also interested in a comprehensive account of the systematic and unsystematic errors in IMF forecasts in crisis countries. As outlined above in equation (7), the mean squared error (MSE) is a convenient measure in this context as it provides a decomposition of the forecast error into three components: bias, variance and covariance. The former two measures, bias and variance, form the systematic part of the prediction error, while the latter (covariance) constitutes the unsystematic or random part. Moreover, the MSE also has the advantage that it can offer insights into the tradeoff between the underfitting of the forecast (bias) and less accurate predictions (variance, covariance). Both the bias and the variance are in general two independent criteria to evaluate the quality of forecasts.

Columns 1d-1l in Table 1 show the individual contributions (as percent of the total) from the bias, variance and covariance components to the MSEs of GDP growth and its subcomponents in the three samples, respectively. Overall, the unsystematic part of the variance constitutes by far the greatest share of the GDP growth forecast MSE. This finding is good news for the IMF because it implies that even in times of crises the lion's share of forecast errors is white noise. Interestingly, however, the bias contribution is still substantial, exceeding 5% of the MSE, for several variables, especially public investment, as discussed above. Of note is that the bias only substantially contributes to the MSE when we previously identified a significant mean forecast bias in columns 1a-1c. With regard to the systematic variance, we find that it mostly contributes a significant share to the MSE in the Non-LIC sample (between 12% and 34%), in particular for the growth forecasts of private consumption, imports, exports, and private investment. In contrast, the global and LIC samples seem well calibrated regarding systematic variance prediction errors.

Finally, we explore to what degree the forecast errors in the growth rates of the GDP subcomponents contribute to erroneous predictions in GDP growth itself. Addressing this question can provide valuable insights for future IMF forecasts, in particular with regard to identifying areas where improvements in forecast accuracy would benefit the precision of GDP growth predictions the most. As outlined in equation (8), instead of using squared errors as in the case of the MSE, we use absolute errors in the regression analysis. Absolute errors have the advantage of being unit equivalent, i.e. the forecast errors are in the same units as the forecasted and realized values of the quantities of interest. Moreover, absolute errors are less sensitive to outliers than squared errors.

Table 2 presents regression results of the absolute forecast error of GDP growth as a function of all explanatory variables motivated by the national income identity. Interestingly, only forecast errors in private consumption and private investment growth (for Non-LICs) are significant predictors of the forecast errors in GDP growth. While we observed in Table 1 that the IMF estimates public investment with a substantial upward bias, the error in the public investment forecast is not a significant contributor to GDP forecast errors in countries other than Non-LICs. This result is most likely due to the fact that public investment usually represents a relatively small share in the national income identity for most countries. In contrast, forecast errors in the growth rate of the largest GDP contributor, consumption expenditures, also influences to a large extent the inaccuracy of GDP growth forecasts in all three samples.

Overall, the analysis shows IMF forecasts of GDP growth and its subcomponents in program countries are not subject to large systemic modeling errors. While we report significant mean forecast biases in some instances, in particular in Non-LICs, only forecast errors in private consumption growth (and private investment for Non-LICs) are also a significant driver of forecast errors in GDP growth.

5.2 Balance of Payments Growth

IMF forecasts for the balance of payments (BOP) in program countries are key to determining financial assistance and program design in the first place. Moreover, the forecasts are consequently used to assess progress in closing BOP gaps by increasing buffers through the reduction in current and financial account deficits as well as increases in international reserves. In this section, we therefore assess the IMF's forecasts of both the current account and the financial account in program countries. As outlined in the identities above, the growth rate of the current account can be decomposed into six subcomponents: goods import and export growth, services import and export growth, as well as the growth rates of net transfers and net income. Similarly, financial account growth can be decomposed into the growth rates of net direct investment, reserve assets, net portfolio investment, and "other investments".

Panels A and B in Table 3 provide descriptive statistics of the IMF forecast errors for current and financial account growth and their respective subcomponents in the global, LIC and Non-LIC samples, respectively. Columns 3a-3c provide the mean forecast bias (in percentage points) for each variable in the current account. While the current account growth forecast itself does not show a significant bias, the growth rates of four explanatory variables – goods exports, services imports and exports, and net transfers – are estimated with a significant downward bias in the full sample, ranging from 3 to over 10 percentage points. For LICs, the forecast errors in the growth rates of both goods and services exports exhibit substantial downward bias in the 4% range. The magnitude of the forecast error for the growth rate of net transfers is surprisingly large for Non-LICs, which exhibits an average downward bias of over 27%, and also accounts for 20% of the overall forecast MSE for this variable. Net transfers might be particularly hard to predict during times of crises because remittances and income transfers from abroad could strongly increase beyond previously observed levels to partially compensate domestic income reductions.

In contrast to the MSE decomposition of GDP growth forecasts, the clear majority of error (78 percent) in the current account growth forecast is due to systematic (bias and variance) false predictions as shown in columns 3d-3l. We also find substantial (>5%) systematic MSE contributions for all other current account subcomponents, mostly due the variance component. Of particular note is the large contribution by systematic forecast errors, mostly due to the variance component, in services exports.

Panel B in Table 3 deconstructs the IMF forecast errors for the financial account. While the mean forecast bias in columns 3m-3o is extraordinarily large, with a downward bias in the three samples between 24% and 47%, neither of the biases is significantly different from zero. We observe a similar pattern with even greater magnitudes but again insignificant mean forecast biases for the growth rates of net portfolio investment and "other investment." The fact that none of these mean forecast biases is statistically significant indicates a substantial and systematic inflation of the forecast variance, which is confirmed by our decomposition of the MSE. The IMF systematically fails to produce forecasts that accurately capture the variance of financial flow growth, which calls for an adjustment in the forecasting approach on that end.

Table 4 seeks to identify whether the forecast errors in current and financial account growth are driven by erroneous predictions of their respective subcomponents. Remarkably, of all explanatory variables only one regressor in one subsample, the forecast error in the growth rate of net transfers for Non-LICs, can be linked to aggregate balance of payments forecast errors. These results are without doubt a consequence of the immense variances from which the growth rate forecasts for the current and financial accounts as well as their subcomponents suffer. This finding reinforces the potential need to adjust the IMFs forecasting approach for balance of payments components in program countries.

5.3 Government Revenue and Expenditure Growth

Finally, we consider the IMF's forecast accuracy for the growth of government revenues and government expenditures in crisis countries. As laid out above, from the government finance identities, three subcomponents drive government expenditure growth: the respective growth rates of interest, non-interest and capital expenditures. Government revenue growth, on the other hand, can be decomposed into the growth rates of grants, tax revenue and non-tax revenues. We start again by discussing the descriptive statistics of the IMF forecast errors for both government expenditure and revenue growth, and then examine to what extent forecast errors in the respective subcomponents drive prediction errors of the aggregate expenditure and revenue variables.

Columns 5a-5c in panel A of Table 5 provide the mean forecast errors (in percentage points) for the growth rates of all variables motivated in the government expenditure identity equation in (5). Most importantly, government expenditure growth itself is on average predicted without bias in all three samples. In fact, of all four variables in the global sample, only interest expenditure growth shows a significant mean forecast bias of 16 percentage points, which implies that the IMF systematically overpredicts interest expenditure growth by a considerable amount. This discrepancy is purely driven by the LIC sample.

We observe from columns 5d-5l that both the forecast bias and the systematic variance prediction errors also contribute a substantial share (>10%) to the MSE of interest expenditure growth, which are again mostly due to the LIC sample. In terms of systematic variance contributions to the MSE, we also find substantial shares for non-interest expenditures. And while the MSE for the Non-LIC sample seems to be driven to a large part by systematic prediction errors (bias and variance), this result is most likely due to the small number of Non-LIC observations. In particular, systematic prediction errors for non-interest expenditure growth in the Non-LIC sample account for up to 73% of the MSE.

On the government revenue side (panel B), only tax revenue growth exhibits a significant mean downward bias of 2.1 percentage points, which is driven again by the LIC sample. In terms of MSE contributors in columns 5p-5x, the results are much more varied. The vast majority of the MSEs for all revenue variables are mostly driven by random forecast errors, except in the case of Non-LIC revenue growth with a contribution of only 49%. In fact, for the full sample, we only observe a substantial MSE contribution of systematic prediction errors (bias and variance) for the grants component.

In Table 6, we examine again in a more structured way the forecast error contributions of the respective government expenditure and revenue subcomponents by considering the absolute error regressions laid out in equation (8) for the different growth identities. Panel A in Table 6 presents the regressions results with the absolute forecast errors for government expenditure growth as dependent variable, while panel B shows the respective estimates for government revenue growth.

The results in panel A reveal that forecast errors in the growth rates of non-interest expenditure as well as capital expenditure and net lending are both significant drivers of prediction errors in aggregate government expenditure growth, with the results being driven mostly by LICs. Interestingly, none of the systematic forecast errors in interest expenditure growth that we identified above has significant effects on the precision of government expenditure growth predictions. Most likely, this result mirrors the fact that interest outlays usually comprise a relatively small share in government budgets relative to other expenditures, even in crisis countries.

Regarding the forecast errors regressions for government revenue growth in panel B of Table 6, we only find false predictions in tax revenue growth to be a significant determinant of errors in aggregate fiscal income growth. This result matches expectations given that we previously also found a significant bias in tax revenue growth forecasts (see Table 5). Moreover, taxes are the most important government revenue source in most countries, which gives forecast errors in this variable a substantial weight.

6. Concluding Remarks

IMF projections of macroeconomic variables in crisis countries are fundamental to the institution's program design and program assessment. These projections are also publicly reported as part of the World Economic Outlook and followed closely by the international community. In this paper, we assess IMF projections in program countries by employing a refined and improved version of IMF's Monitoring of Fund Arrangements (MONA) dataset. Our methodology makes use of the fundamental national account identities, thereby eliminating sources of model and parameter uncertainty and focusing squarely on uncertainty stemming from the data generating process.

Our findings are threefold:

- It is commonly believed that IMF GDP growth projections in program countries are destined to be poor, not the least because these forecasts are made at the time of economic crises. In contrast to this notion, we show that IMF forecasts of GDP growth and its subcomponents (consumption, investment, and net exports) are in fact not subject to large systemic modeling errors. In our global sample, we find that only forecast errors in private consumption growth are a significant driver of forecast errors in GDP growth. That said, our analysis uncovers significant heterogeneity across LICs and Non-LICs samples. While the realized GDP growth rate for LICs was, on average, 1.2 percentage points greater than the forecasted value, GDP growth forecast for Non-LICs were 1.1 percentage points too optimistic.

- Regarding IMF forecasts for the balance of payments (BOP), our results indicate that predictions of current account growth itself do not show a significant bias. However, we also uncover that the growth rates of four current account subcomponents – goods exports, services imports and exports, and net transfers – are all estimated with a significant downward bias in the global sample. Moving to the financial account projections, the IMF systematically fails to produce forecasts that accurately capture the variance of financial flow growth, which calls for an adjustment in the forecasting approach on that end.
- Finally, turning to the fiscal accounts, we consider the IMF's forecast accuracy for the growth of government revenues and government expenditures in crisis countries. We show that the IMF systematically overpredicts interest expenditure growth by a considerable amount, which is driven entirely by the LIC sample.

Overall, our analysis sheds are positive light on IMF forecasts of GDP growth in program countries, which is by far the most important proxy for the welfare of a country in crisis. While this result is indeed surprising, it gives some credibility to the IMF's firefighting mindset and disaster response procedures that were put in place over time to improve the Fund's ability to help countries during times of crises. Procedures such as official quarterly reviews, where IMF teams visit the country every three months to systematically analyze crisis countries' real, monetary, fiscal, current and financial accounts based on simple but tight macroeconomic identities, seem to do a relatively good job. Nevertheless, our analysis of the IMF's financial and fiscal account forecasts also reveals possible areas for improvements. Adjustments in the forecasting approach in these dimensions, especially in LICs, could produce much needed increases in the accuracy of IMF predictions.

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Table 1: GDP Growth Forecasts

Variables	Mean Forecast Bias (in %)			Contribution to Variable's Forecast MSE (in %)								
				Bias			Variance			Covariance		
	1a	1b	1c	1d	1e	1f	1g	1h	1i	1j	1k	1l
	All	LIC	Non-LIC	All	LIC	Non-LIC	All	LIC	Non-LIC	All	LIC	Non-LIC
GDP Growth	-0.5	-1.2**	1.1*	1	7	8	2	1	0	97	91	92
Private Consumption Growth	0.4	-0.6	2.5*	0	1	9	3	0	12	97	99	79
Public Consumption Growth	-1.3	-1.7	-0.5	2	3	1	1	2	0	97	96	99
Import Growth	-1.5	-2.1	-0.3	1	2	0	4	0	34	95	98	66
Export Growth	-2.6**	-2.1	-3.5**	4	2	13	0	2	14	96	96	73
Public Investment Growth	8.6***	8.7***	8.6**	11	10	15	1	2	0	88	88	84
Private Investment Growth	-2.4	-3.8	0.5	1	2	0	6	3	27	92	94	73
Observations	110	74	36	110	74	36	110	74	36	110	74	36

Notes: ***, ** and * indicate 1, 5 and 10 percent level of statistical significance for the mean forecast bias, respectively.

Table 2: Contributors to GDP Growth Forecast Errors

Dependent variable: GDP growth (Absolute Error, AE)	2a All	2b LICs	2c Non-LICs
Private Consumption Growth	0.202***	0.247***	0.144*
(AE)	(0.064)	(0.092)	(0.074)
Public Consumption Growth	-0.047	-0.098	0.109
(AE)	(0.054)	(0.068)	(0.078)
Import Growth	-0.029	0.018	-0.057
(AE)	(0.053)	(0.065)	(0.093)
Export Growth	0.044	0.024	0.077
(AE)	(0.047)	(0.055)	(0.057)
Public Investment Growth	-0.010	-0.006	-0.014
(AE)	(0.016)	(0.019)	(0.021)
Private Investment Growth	0.025	0.004	0.088***
(AE)	(0.021)	(0.024)	(0.026)
Constant	0.018***	0.019***	0.007
	(0.005)	(0.006)	(0.008)
Observations	110	74	36
R-squared	0.163	0.175	0.415

Notes: All variables are absolute forecast errors of growth rates. Robust standard errors in parenthesis. ***, ** and * indicate 1, 5 and 10 percent level of statistical significance, respectively.

Table 3: Balance of Payments Growth Forecasts

Panel A: Current Account Growth Forecast Errors												
	Mean Forecast Bias (in %)			Contribution to Variable's Forecast MSE (in %)								
				Bias			Variance			Covariance		
	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k	3l
Variables	All	LIC	Non-LIC	All	LIC	Non-LIC	All	LIC	Non-LIC	All	LIC	Non-LIC
Current Account Growth	33.2	41.9	16.6	0	0	3	78	80	1	22	20	96
Goods Import Growth	-1.5	-2.0	-0.6	1	1	0	5	1	17	94	97	83
Goods Export Growth	-3.7**	-4.1**	-2.9	4	4	5	7	6	9	89	89	87
Services Import Growth	-3.0**	-3.2	-2.8	3	3	3	9	8	13	89	90	84
Services Export Growth	-3.9**	-4.8*	-2.3	3	4	2	23	27	11	74	69	86
Net Transfers Growth	-10.7**	-1.6	-27.9***	4	0	20	2	1	3	94	99	76
Net Income Growth	-9.5	-18.9	8.6	1	2	3	17	20	1	82	78	97
Observations	134	88	46	134	88	46	134	88	46	134	88	46

Panel B: Financial Account Growth Forecast Errors												
	Mean Forecast Bias (in %)			Contribution to Variable's Forecast MSE (in %)								
				Bias			Variance			Covariance		
	3m	3n	3o	3p	3q	3r	3s	3t	3u	3v	3w	3x
Variables	All	LIC	Non-LIC	All	LIC	Non-LIC	All	LIC	Non-LIC	All	LIC	Non-LIC
Financial Account Growth	-47.2	-65.4	-23.6	3	5	1	28	36	7	69	59	91
Net Direct Investment Growth	9.6	15.0	2.7	1	1	0	35	55	27	64	44	72
Reserve Assets Growth	17.2	30.2	0.4	0	0	0	16	1	38	84	99	62
Other Investment Growth	-112.6	-52.4	-190.8	1	0	1	23	41	47	76	58	52
Net Portfolio Inv't Growth	-66.5	-26.9	-117.9	2	0	6	1	14	3	96	86	92
Observations	62	35	27	62	35	27	62	35	27	62	35	27

Notes: All variables are in growth rate terms. ***, ** and * indicate 1, 5 and 10 percent level of statistical significance for the mean forecast bias, respectively.

Table 4: Contributors to Balance of Payments Forecast Errors

Panel A: Current Account Balance			
Dep. variable: CA growth	4a	4b	4c
(Absolute Error, AE)	All	LICs	Non-LICs
Goods Import Growth	-5.188	-8.749	0.960
(AE)	(4.671)	(7.292)	(1.010)
Goods Export Growth	1.930	1.896	1.129
(AE)	(3.922)	(4.792)	(1.435)
Services Import Growth	-5.121	-6.478	1.253
(AE)	(4.428)	(5.666)	(0.879)
Services Export Growth	1.734	1.212	-1.836
(AE)	(1.849)	(1.703)	(1.142)
Net Transfers Growth	0.554	1.144	0.417**
(AE)	(0.636)	(1.033)	(0.202)
Net Income Growth	-0.563	-0.771	-0.188
(AE)	(0.443)	(0.577)	(0.343)
Constant	2.395*	3.643	0.288
	(1.359)	(2.192)	(0.208)
Observations	134	88	46
R-squared	0.018	0.031	0.105

Panel B: Financial Account Balance			
Dep. variable: FA growth	4d	4e	4f
(Absolute Error, AE)	All	LICs	Non-LICs
Net Direct Investment Growth	0.217	0.435	0.243
(AE)	(0.428)	(0.574)	(0.579)
Reserve Assets Growth	-0.023	0.005	-0.049
(AE)	(0.041)	(0.056)	(0.061)
Other Investment Growth	-0.014*	-0.009	-0.011
(AE)	(0.008)	(0.028)	(0.010)
Net Portfolio Investment Growth	-0.033	-0.188	0.062
(AE)	(0.059)	(0.146)	(0.109)
Constant	1.499***	1.665**	1.290**
	(0.438)	(0.669)	(0.538)
Observations	62	35	27
R-squared	0.015	0.053	0.053

Notes: All variables are absolute forecast errors of growth rates. Robust standard errors in parenthesis. ***, ** and * indicate 1, 5 and 10 percent level of statistical significance, respectively.

Table 5: Government Budget Forecast

Panel A: Government Expenditure Growth												
	Mean Forecast Bias (in %)			Contribution to Variable's Forecast MSE (in %)								
				Bias			Variance			Covariance		
	5a	5b	5c	5d	5e	5f	5g	5h	5i	5j	5k	5l
Variables	**All**	**LIC**	**Non-LIC**	**All**	**LIC**	**Non-LIC**	**All**	**LIC**	**Non-LIC**	**All**	**LIC**	**Non-LIC**
Gov. Expenditure Growth	1.0	1.6	-2.1	1	2	4	4	3	65	95	95	31
Interest Expenditure Growth	16.0*	19.6**	-5.3	10	13	11	62	62	3	28	26	86
Non-interest Expenditure Growth	-1.4	-0.5	-6.9	2	0	22	12	9	51	86	90	27
Cap. Expenditure & Lending Growth	4.2	3.0	10.7	3	2	13	1	0	8	97	98	80
Observations	34	29	5	34	29	5	34	29	5	34	29	5

Panel B: Government Revenue Growth												
	Mean Forecast Bias (in %)			Contribution to Variable's Forecast MSE (in %)								
				Bias			Variance			Covariance		
	5m	5n	5o	5p	5q	5r	5s	5t	5u	5v	5w	5x
Variables	**All**	**LIC**	**Non-LIC**	**All**	**LIC**	**Non-LIC**	**All**	**LIC**	**Non-LIC**	**All**	**LIC**	**Non-LIC**
Gov. Revenue Growth	-2.7	-1.6	-7.9	3	1	8	2	0	43	95	98	49
Grants Growth	11.3	10.0	16.9	3	2	5	20	27	0	77	71	95
Tax Revenue Growth	-2.1*	-2.6**	0.3	5	7	0	1	0	6	95	93	93
Non-tax Revenue Growth	-7.8	-6.2	-14.6	3	2	14	3	8	17	94	90	69
Observations	70	57	13	70	57	13	70	57	13	70	57	13

Notes: All variables are in growth rate terms. ***, ** and * indicate 1, 5 and 10 percent level of statistical significance for the mean forecast bias, respectively.

Table 6: Contributors to Government Budget Growth Forecast Errors

Panel A: Government Expenditure			
Dep. variable: Gov. exp. growth	**6a**	**6b**	**6c**
(Absolute Error, AE)	**All**	**LICs**	**Non-LICs**
Interest Expenditure Growth	-0.003	-0.002	0.924*
(AE)	(0.008)	(0.010)	(0.077)
Non-interest Expenditure Growth	0.548***	0.688***	0.318*
(AE)	(0.133)	(0.096)	(0.028)
Cap. Exp. & Net Lending Growth	0.242***	0.261***	-0.257*
(AE)	(0.045)	(0.035)	(0.023)
Constant	-0.002	-0.011	-0.001
	(0.010)	(0.012)	(0.011)
Observations	34	29	5
R-squared	0.717	0.792	0.991

Panel B: Government Revenue			
Dep. variable: Gov. rev. growth	**6d**	**6e**	**6f**
(Absolute Error, AE)	**All**	**LICs**	**Non-LICs**
Grants Growth	0.023	0.041	-0.131
(AE)	(0.020)	(0.026)	(0.130)
Tax Revenue Growth	0.566***	0.688***	-2.196
(AE)	(0.202)	(0.137)	(2.491)
Non-tax Revenue Growth	-0.019	0.003	0.040
(AE)	(0.038)	(0.022)	(0.138)
Constant	0.053	0.024*	0.262
	(0.038)	(0.012)	(0.241)
Observations	70	57	13
R-squared	0.096	0.434	0.131

Notes: All variables are absolute forecast errors of growth rates. Robust standard errors in parenthesis. ***, ** and * indicate 1, 5 and 10 percent level of statistical significance, respectively.

Appendix

Table A1: Summary Statistics Absolute Error (AE) Regressions (in %)

	Observations	Mean	SD	Min	Max
GDP Growth AE					
GDP Growth	110	3.0	3.1	0.0	14.7
Private Consumption Growth	110	5.8	5.8	0.0	27.4
Public Consumption Growth	110	6.9	7.1	0.0	50.3
Import Growth	110	10.0	9.4	0.2	64.6
Export Growth	110	10.2	8.9	0.2	53.2
Public Investment Growth	110	19.3	17.3	0.1	110.8
Private Investment Growth	110	14.9	15.6	0.0	65.1
Government Expenditure Growth AE					
Gov. Expenditure Growth	34	7.7	6.6	0.3	22.9
Interest Expenditure Growth	34	26.2	43.9	0.1	248.4
Non-interest Expenditure Growth	34	6.5	6.8	0.4	28.9
Capital Exp. & Net Lending Growth	34	17.9	16.4	1.1	66.7
Government Revenue Growth AE					
Gov. Revenue Growth	70	9.6	13.2	0.1	94.4
Grants Growth	70	43.1	54.5	0.8	282.1
Tax Revenue Growth	70	6.8	6.7	0.2	36.2
Non-tax Revenue Growth	70	29.8	31.5	0.3	161.6
Current Account AE					
Current Account Balance Growth	134	147.8	671.0	1.0	6928.2
Goods Imports Growth	134	11.4	11.4	0.1	61.9
Goods Exports Growth	134	12.5	12.8	0.0	72.7
Services Imports Growth	134	12.6	12.4	0.0	72.3
Services Exports Growth	134	12.9	16.6	0.1	105.4
Net Transfers Growth	134	30.1	41.7	0.5	210.6
Net Income Growth	134	55.6	96.9	0.0	820.3
Capital Account AE					
Financial Account Balance Growth	62	141.0	232.8	0.2	1322.5
Net Direct Investment Growth	62	54.0	94.7	0.2	652.6
Reserve Assets Growth	62	274.3	443.2	0.6	1903.4
Other Investment Growth	62	500.5	1143.0	3.5	6661.0
Net Portfolio Investment	62	220.7	378.6	0.1	2254.5

Countries in Broadest Global Sample

Afghanistan (x2), Albania (x2), Angola, Antigua and Barbuda, Argentina, Armenia (x4), Bangladesh (x2), Benin (x2), Bolivia, Bosnia and Herzegovina (x2), Brazil, Bulgaria, Burkina Faso (x4), Burundi (x3), Cameroon, Cape Verde (x3), Central African Republic, Chad, Colombia (x2), Comoros, Croatia, Cyprus, Democratic Republic Congo, Djibouti, Dominica, Dominican Republic (x3), El Salvador, Gabon, The Gambia (x2), Georgia (x4), Ghana (x3), Greece (x2), Grenada (x3), Guatemala, Guinea (x2), Guinea-Bissau, Haiti (x2), Honduras (x2), Hungary, Iceland, Iraq (x2), Ivory Coast (x2), Jordan (x2), Kenya (x2), Kosovo (x2), Kyrgyzstan (x3), Latvia, Lesotho, Liberia (x2), Macedonia (x2), Madagascar, Malawi (x2), Maldives, Mali (x3), Mauritania (x2), Moldova, Mongolia, Morocco, Mozambique (x4), Nepal, Nicaragua (x2), Niger (x3), Nigeria, Pakistan (x2), Paraguay (x2), Peru (x2), Portugal, Republic of Congo (x2), Romania (x4), Rwanda (x2), St. Kitts and Nevis, Sao Tome and Principe (x4), Senegal (x4), Serbia, Serbia and Montenegro, Seychelles (x3), Sierra Leone (x3), Solomon Islands (x2), Sri Lanka, Tajikistan (x2), Tanzania (x6), Togo, Tunisia, Turkey, Uganda (x4), Ukraine (x4), Uruguay (x2), Zambia. (x2)