# Forecasts in Times of Crises

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- Macroeconomic forecasts suffer from three sources of uncertainty:

  1. Model uncertainty

  2. Parameter uncertainty

  3. Data uncertainty

- Plus: Forecasting issues are compounded during times of crises, which is exactly when policy makers need quality forecasts

- How do IMF crisis forecasts actually stack up?

- We address this question in the context of IMF forecasts for program countries

# Basic approach:

- We evaluate IMF forecasts based on macroeconomic identities. Why? Eliminates model and parameter uncertainty

# Contributions of our paper:

1. We decompose IMF forecast errors in crisis countries into systematic and unsystematic components

2. We identify to what extent forecast errors of key macroeconomic aggregates are driven by specific subcomponents

3. We consider a wide range of macro identities that are key in crisis countries: GDP, current account, financial account, gov. expenditure, gov. revenue

# Forecasting Based on Macroeconomic Identities

## Our focus is on:

- Macroeconomic identities at the core of IMF programs

- Growth rates of nominal variables

Example – Decomposition of GDP growth:

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

where $\sigma_{y,j}$ represents the elasticity of GDP growth with respect to the growth rate in a subcomponent $j$

- Similar approach for other identities: current account, financial account, gov. expenditures, and gov. revenues

# Evaluating IMF Forecasts

- To evaluate forecasts, we use a symmetric loss function → positive and negative forecast errors are penalized equally

- Two-pronged approach for forecast evaluation:

  1. Mean squared error (MSE) decomposition into systematic and unsystematic forecast errors

  2. Absolute error (AE) regression analysis of macroeconomic identities

# 1. Mean Squared Error (MSE) Decomposition

- Let $\hat{x}_i$ be the forecasted growth rate of variable *x*, while $x_i$ is the actually realized growth rate. Forecast MSE of variable *x* is then:

$$\sum_{i=1}^{N}\left(\hat{x}_i - x_i\right)^2 / N = \underbrace{\left(\bar{\hat{x}} - \bar{x}\right)^2}_{\text{Bias}} + \underbrace{\left(\sigma_{\hat{x}} - \sigma_x\right)^2}_{\text{Variance}} + \underbrace{2\left(1 - r\right)\sigma_{\hat{x}}\sigma_x}_{\text{Covariance}}$$

- Bias + variance = systematic forecast error

- Covariance = unsystematic forecast error, i.e. white noise

# 2. Absolute Error Regressions

- Do forecast errors for subcomponents drive forecast errors for macroeconomic aggregates?

- For macroeconomic aggregate $y$ with $S$ subcomponents, we run:

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

- Coefficient interpretation: 1% increase in mean absolute error (MAE) of $x_j$ causes a $\beta_j$% change in the MAE of $y$

- where: $$MAE_y = \sum_{i=1}^{N} \left|\hat{y}_i - y_i\right| / N$$

# Data for IMF Forecast Evaluation

- Data for forecasts and actual realization comes from IMF's Monitoring of Fund Arrangements (MONA) Database

- Program country data: 2002-2016

- Broadest sample: 170 countries

- Forecast data: Predictions for first program year from initial IMF review

- Realized data: Actual observations as noted in final IMF program review

# Results:
# Decomposition and Determinants of IMF Forecast Errors

# GDP Growth Forecast Errors
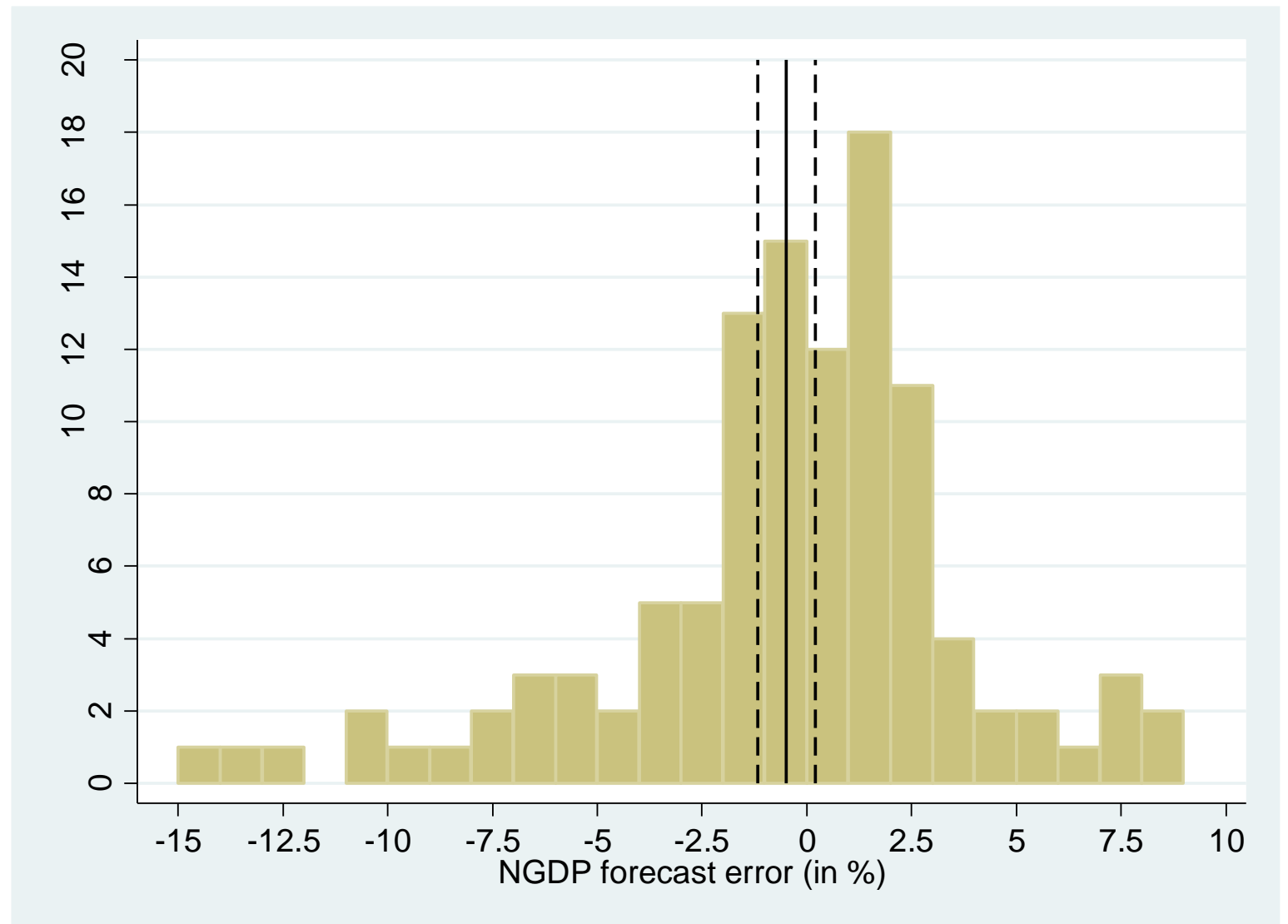


GDP growth forecasts are, on average, unbiased in the global sample

# GDP Growth Forecasts: Bias and MSE Decomposition

| 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 |

- BUT: downward bias in LIC sample and upward bias in Non-LIC sample for GDP growth

- Export and public investment growth are the only GDP subcomponents with bias

- GDP growth and subcomponent MSEs are mostly driven by unsystematic errors, i.e. white noise

# Contributors to GDP Growth Forecast Errors

- Variables with significant biases (public investment growth, export growth) do not drive forecast errors in GDP growth

- What matters instead? Prediction errors in consumption growth

- Why? Consumption = largest GDP contributor

| Dependent variable: GDP growth | 2a | 2b | 2c |
|---|---|---|---|
| (Absolute Error, AE) | All | LICs | 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 |

# Current Account Growth Forecasts: Bias and MSE Decomposition

| Variables | 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 |
| | 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 |

- Although not significant, mean forecast of CA growth shows substantial upward bias

- CA forecast errors are driven by systematic variance prediction errors

- Most CA subcomponent forecasts suffer from significant downward bias (due to LICs)

# Contributors to Current Account Growth Forecast Errors

- None of the subcomponents are significant contributors to forecast errors in CA growth itself

- Why? Most likely due to pronounced variance mismatches in CA growth forecasts

| 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 |

# Financial Account Growth Forecasts: Bias and MSE Decomposition

| | 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 | 9.6 | 15.0 | 2.7 | 1 | 1 | 0 | 35 | 55 | 27 | 64 | 44 | 72 |
| Reserve Assets | 17.2 | 30.2 | 0.4 | 0 | 0 | 0 | 16 | 1 | 38 | 84 | 99 | 62 |
| Other Investment | -112.6 | -52.4 | -190.8 | 1 | 0 | 1 | 23 | 41 | 47 | 76 | 58 | 52 |
| Net Portfolio Investment | -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 |

- Although not significant, mean forecast of FA growth shows substantial downward bias

- Growth forecasts for nearly all FA components indicate systematic failure at capturing the variance of financial flows

# Contributors to Financial Account Growth Forecast Errors

- Similar to the current account, none of the subcomponents is a significant contributor to forecast errors in FA growth

- Lack of significant results is again most likely due to systematic variance mismatches in financial flow forecasts

- Our findings indicate that the IMF's BoP forecasting approach might require a realignment

| 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 |

# Fiscal Budget Forecasts – Summary

- Growth in government revenues and expenditures are, on average, forecasted without bias

- Only two subcomponents are forecasted with bias: interest expenditures (upward bias), tax revenue (downward bias)

- Fiscal revenue and expenditure forecasts are mostly subject to unsystematic errors

- Forecast errors for non-interest and capital expenditures drive prediction errors for government spending

- Forecast errors for tax revenues drive fiscal revenue forecast errors

# Policy Implications

- IMF crisis forecasts of key macroeconomic aggregates are unbiased, in particular GDP growth

- Good news for credibility of IMF program procedures

- But analysis shows significant heterogeneity between LICs and Non-LICs

Areas in need of improvements:

- Subcomponents of BoP are forecasted with substantial bias

- Current and financial account forecasts suffer from systematic variance mismatches

- Systematic errors in IMF forecasts are more prevalent for LICs