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Forecast Errors and Uncertainty Shocks

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Abstract

Macroeconomic forecasts are persistently too optimistic. This paper finds that common factors related to general uncertainty about U.S. macrofinancial prospects and global demand drive this overoptimism. These common factors matter most for advanced economies and G-20 countries. The results suggest that an increase in uncertainty-driven overoptimism has dampening effects on next-year real GDP growth rates. This implies that incorporating the common structure governing forecast errors across countries can help improve subsequent forecasts.

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I. INTRODUCTION

High-quality macroeconomic forecasts are crucial inputs for economic decisions and policy making. At the IMF, macroeconomic projections guide country-specific policy advice, form the basis of the global economic outlook presented in the World Economic Outlook (WEO), and shape the institutional strategy. Consequently, both the accuracy of forecasts and the efficiency with which information is incorporated into forecasts are of critical importance to the institution and its membership.

Yet the IMF's macroeconomic projections are persistently, overwhelmingly too optimistic.[2] Genberg and Martinez (2014) reference dozens of studies—dating back to 1983—pointing to too rosy growth and inflation forecasts across different forecast horizons, country groups, and spans of time. More recently, Timmermann (2006) and IEO (2014) independently evaluate the accuracy of IMF forecasts to find systematic overprediction of real GDP growth during global, regional, and country-specific recessions. Loungani (2001), IEO (2014), and The Economist (2016) also highlight the WEO's inability to forecast forthcoming recessions, with Loungani (2001) wryly observing that "the record of failure to predict recessions is virtually unblemished."

Does the optimistic bias observed in times of regional and global recessions reflect the asymmetric impact of economic uncertainty? The recent uncertainty literature, building on the seminal work of Bloom (2009), underscores the countercyclical nature of aggregate macroeconomic uncertainty, with uncertainty shocks having larger effects on macroeconomic variables during recessions. We build on this premise and explore common drivers of forecast overoptimism under different states of the world. Ultimately, if economic uncertainty matters for forecasts accuracy, then incorporating economic uncertainty in forecasting models should result in better forecasts.

The main results of this paper are threefold. First, most of the variability in the optimistic next-year forecast errors can be explained by just four common factors. These factors explain between 50 and 80 percent of the variability in the real GDP growth forecast errors, and between 50 and 70 percent for inflation and current account balance forecast errors. In other words, there seems to exist a common structure that governs forecast errors across countries, and the optimism or pessimism with respect to GDP targets exhibit a certain degree of consistency across countries. However, regional differences and country-specific idiosyncrasies matter. For example, the first four components explain more than 80 percent of forecast errors in European growth rates; but these components explain less than a half of

[2] Of course, forecast overoptimism is not unique to either the IMF only or to macroeconomic forecasts only. For example, financial analyst forecasts also tend to be optimistically biased and inefficient in incorporating publically available information embedded in prior stock prices or accruals (Easterwood and Nutt, 1999).

forecast errors in the case of low income countries where country-specific heterogeneity plays a bigger role.

Second, uncertainty about U.S. macrofinancial developments and global demand are the key drivers of forecast overoptimism. The first two principle components are most closely correlated with measures of uncertainty about U.S. business conditions and the VIX; the next two factors are most closely related to changes in global economic activity, inflation expectations, and measures of macrofinancial uncertainty outside the United States. Uncertainty about U.S. business conditions and financial market volatility account for about two-thirds of the variability in optimistic forecast errors for advanced economies and G-20 countries but only one-third of the variability in errors for other income groups. Changes in global demand explain about 20 percent of forecast overoptimism across all country groups.

Third, the explicit link between uncertainty about U.S. macroeconomic developments and next-year forecast errors has implications for the future trajectory of macroeconomic variables. Results of a vector autoregression (VAR) analysis show that upward surges in uncertainty about U.S. business conditions lead to a decline in the next-year GDP growth rate in advanced economies and emerging countries. This result supports the link between uncertainty and overoptimism in next-year forecast errors.

The rest of the paper is organized as follows. Section 2 describes the data and results of the principal component analysis. Section 3 examines the relationship between forecast overoptimism, uncertainty shocks, and business cycles. Section 4 concludes.

II. Exploring The Structure of Forecast Errors Using Principal Components Analysis

IMF produces macroeconomic forecasts for publication in the WEO twice each year. The spring forecasts are usually published in April and the fall forecasts are published in October. Forecasts of GDP growth rates, inflation, current account balances, and other macroeconomic variables are produced for all member countries and the main regions of the world. Forecast horizons range from current year to five years ahead. Short-term forecasts are produced at quarterly and annual frequencies; medium-term forecasts—from two to five years ahead—are annual only.

This analysis focuses on next-year forecast errors for real GDP growth, inflation, and current account balances for 122 countries with continuous data from 1995 and 2015. The sample consists of 26 advanced economies (AEs), 58 emerging markets (EMs), and 38 low income countries (LICs). Fragile countries have been excluded from the analysis to eliminate country-specific noise. Next-year forecast errors are calculated as the difference between

forecasts published in the spring vintage of WEO in year *t* and the outturn in year *t+1*, as measured in Spring 2016 vintage of WEO. For real GDP growth and current account balances, optimistic errors indicate forecasts greater than the outturn while pessimistic errors imply forecasts smaller than the outturn. For inflation, optimistic errors indicate forecasts smaller than the outturn.

Table 1. Next-Year Forecast Errors—Summary Statistics, 1995-2015

	All countries	AEs	EMs	LICs	G-20	Non-G-20
			Real GDP Growth (in percent)			
Average size of forecast error						
1995-2015	0.1	0.3	-0.1	0.2	0.4	0.0
2011-2015	0.6	0.9	0.5	0.6	0.7	0.6
Share of optimistic errors (in percent)						
1995-2015	52.2	53.3	51.3	52.8	57.4	51.3
2011-2015	61.8	70.8	61.0	56.8	81.1	58.5
Average size of optimistic error						
1995-2015	2.5	1.9	2.8	2.5	2.1	2.6
2011-2015	1.8	1.5	1.8	2.1	1.2	2.0
Average size of pessimistic error						
1995-2015	-2.6	-1.6	-3.1	-2.4	-2.0	-2.7
2011-2015	-1.4	-0.7	-1.7	-1.4	-1.6	-1.4
			Inflation (in percent)			
Average size of forecast error						
1995-2015	-1.6	0.1	-2.0	-2.3	-0.7	-1.8
2011-2015	0.0	0.2	-0.1	0.0	0.0	0.0
Share of optimistic errors (in percent)						
1995-2015	52.6	46.9	51.6	58.0	49.7	53.1
2011-2015	40.8	37.7	40.7	43.2	46.7	39.8
Average size of optimistic error						
1995-2015	-5.1	-0.9	-6.5	-5.5	-3.2	-5.4
2011-2015	-2.6	-1.1	-3.1	-2.7	-1.3	-2.8
Average size of pessimistic error						
1995-2015	2.3	1.0	2.9	2.2	1.8	2.3
2011-2015	1.8	1.1	1.9	2.0	1.1	1.9
			Current Account Balance (in percent of GDP)			
Average size of forecast error						
1995-2015	-0.1	-0.3	-0.1	-0.1	-0.7	0.0
2011-2015	-0.1	-0.5	0.1	-0.2	-0.2	-0.1
Share of optimistic errors (in percent)						
1995-2015	49.6	48.7	47.5	53.4	46.3	50.1
2011-2015	46.1	46.2	44.8	47.9	45.6	46.2
Average size of optimistic error						
1995-2015	4.6	1.9	5.2	5.4	1.5	5.1
2011-2015	4.3	1.5	4.6	5.6	2.0	4.6
Average size of pessimistic error						
1995-2015	-4.7	-2.4	-4.9	-6.3	-2.6	-5.1
2011-2015	-3.9	-2.1	-3.6	-5.5	-2.1	-4.2
Sample size	122	26	58	38	18	104

Source: IMF's World Economic Outlook; and IMF's staff calculations.
Note: Forecast error is defined as difference between projection and actual data, as measured in Spring 2016 vintage of WEO.

The Fund's forecasts of next-year global real GDP growth are, on average, too optimistic—about 0.1 percentage points higher than outturns in 1995-2015 and 0.6 percentage points higher in 2011-2015. Optimistic forecast errors prevail, especially in the recent years, with 62 percent of forecasts over-predicting next-year growth across all countries in 2011-2015. For G-20 countries, 80 percent of recent forecasts are too rosy. The size of optimistic errors varies between 1.9 percent for AEs and 2.8 percent for EMs in 1995-2015 and 1.5 percent for AEs and 2.1 percent for LICs in 2011-2015. Similarly, inflation forecasts are more likely to be optimistic—though not recently—but this bias is not observed for current account balance forecasts. Detailed summary statistics are provided in Table 1.

We use the principal component analysis (PCA) to explore the underlying factor structure of forecast errors. PCA starts from the premise that a few common factors may explain much of the variation in the forecast errors. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible. We carry out the PCA on demeaned and standardized forecast errors across the entire sample as well as the subsamples of optimistic errors and pessimistic errors. Given the pervasiveness of overoptimism in the Fund's forecasts, the rest of this paper is focused on optimistic errors, with the results for all errors and pessimistic errors presented in the appendix. A different set of factor analyses is used to identify isolate factors for each country group and each macroeconomic variable.

Table 2. Drivers of Optimistic Next-Year Forecast Errors
(in percent of cumulative variance explained by the top four principal components)

	All countries	AEs	EMs	LICs	G-20	Non-G-20
			Real GDP Growth			
Component 1	24.6	54.2	22.5	16.4	35.6	23.0
Component 2	35.5	66.2	35.5	27.7	52.2	33.9
Component 3	44.4	76.3	45.2	37.9	65.0	43.0
Component 4	51.2	82.4	53.0	47.4	73.2	49.8
			Inflation			
Component 1	18.6	36.7	15.5	17.6	29.0	18.2
Component 2	27.9	49.9	27.9	29.0	47.9	27.7
Component 3	36.2	59.5	36.3	39.2	58.6	36.0
Component 4	43.1	67.1	43.9	47.2	68.1	43.4
			Current Account Balance			
Component 1	14.0	18.9	16.2	18.9	20.6	14.9
Component 2	25.1	35.3	29.4	31.6	37.3	26.4
Component 3	34.5	46.4	40.9	41.8	50.0	36.2
Component 4	42.7	57.0	49.2	50.4	60.0	44.8

Source: IMF's World Economic Outlook; and IMF's staff calculations.
Note: Forecast error is defined as difference between projection and actual data, as measured in Spring 2016 vintage of WEO.

Results of PCA analysis suggest that the first four principal components explain about 50 to 80 percent of the variation in the optimistic growth forecast errors across various country

groups (Table 2). Common factors play a larger role in AEs and systemic countries, while country-specific factors play a larger role in LICs. Most of this heterogeneity is due to the first common factor, which explains three times more of the variation in AEs than in LICs. Across different country groups, the next three common factors each explain around 10 percent of the variability. Incorporating the common structure in the forecasting process may be particularly insightful for G-20 countries, given that 80 percent of recent forecasts are positively biased and the first four principal components explain about 70 percent of the variation 80 percent of forecast errors.

Similarly, common factors matter more for other macroeconomic variable forecast errors in AEs and G-20 countries, with the first four principal components explaining up to 75 percent of the variation in the optimistic inflation forecast errors in AEs and 60 percent of the variation in the optimistic current account forecast errors in G-20 countries.

III. Optimistic Forecast Errors, Uncertainty, and Recessions

What are the global factors behind the common structure of forecast errors and—more broadly—behind forecast overoptimism? The uncertainty literature suggests there is a link between macroeconomic uncertainty, real activity, and forecast errors in real variables. Bloom (2009) shows that uncertainty shocks can lead to sharp, significant output drops as firms postpone investment decisions in response to higher uncertainty. As uncertainty recedes, there is a recovery characterized by a medium-term volatility overshooting. This impact of economic uncertainty on macroeconomic activity is countercyclical, with uncertainty raising more strongly during recessions (Bloom, 2014). Jurado and others' (2015) results support this hypothesis. Their measure of uncertainty, constructed from the unforeseeable component of a large number of economic indicators—in essence forecast errors—displays strong countercyclical tendencies, explaining a much larger component of total uncertainty during recessions and exhibiting stronger linkages with macroeconomic variables during recessionary episodes in business cycles. Rossi and Sekhposyan (2015) report comparable results for measures of macroeconomic uncertainty based on nowcast and forecast error distributions.

The countercyclical impact of uncertainty and the relationship between macroeconomic uncertainty and forecast errors tie in with the systematic overoptimism observed in the IMF's forecasts during recessions, as documented by Timmermann (2006) and IEO (2014). We use these linkages as a starting point to evaluate the economic interpretation of the principal components governing WEO forecast errors. Specifically, we calculate correlations between the top four principal components and about two dozen measures of macroeconomic and macrofinancial uncertainty as well as measures of real activity and monetary policy. Appendix II lists all the variables under consideration. Table 3 reports variables that have the maximum correlation with each principal component.

Uncertainty about U.S. macrofinancial developments and global demand appear to be the key drivers of forecast overoptimism. Uncertainty about U.S. business conditions, measured using standard deviation of the Philadelphia Fed's Aruoba-Diebold-Scotti Business Conditions Index (ADS index), is most strongly correlated with the first principal component across all country groups, with the correlation coefficient ranging from 0.66 for EMs to 0.78 for AEs. The positive correlation coefficient implies that as macroeconomic conditions in the United States become more uncertain, forecasts become even more optimistic. These results are aligned with the findings of Timmermann (2006), who notes that spillover effects from U.S. real GDP growth are not fully accounted for in the Fund's forecasting process, especially for AEs. Indicators of financial market volatility, U.S. monetary stance, and changes in global demand are most closely correlated with the other three principal components. In particular, overoptimism in LIC growth forecast errors seems to be related to changes in global commodity prices and demand in the industrial commodity markets.[3]

Table 3. Correlations Between the Principal Components and Measures of Uncertainty and Real Activity—Optimistic Next-Year Real GDP Forecast Errors

	All countries	AEs	EMs	LICs	G-20	Non-G-20
Component 1	ADS_Index_Std	ADS_Index_Std	ADS_Index_Std	ADS_Index_Std	ADS_Index_Std	ADS_Index_Std
	0.79	0.78	0.66	0.75	0.79	0.79
Component 2	VIX	VIX	VIX	VIX	Kilian_Index	VIX
	0.46	0.46	-0.32	0.50	-0.46	0.50
Component 3	FFR	FFR	Kilian_Index	Comm_PI	COPPER	FFR
	0.46	0.27	-0.45	-0.46	-0.32	0.57
Component 4	WTI	Comm_PI	MSCI_EM_Std	Kilian_Index	MSCI_World	MSCI_EM_Std
	-0.53	0.78	-0.39	-0.66	-0.43	-0.41

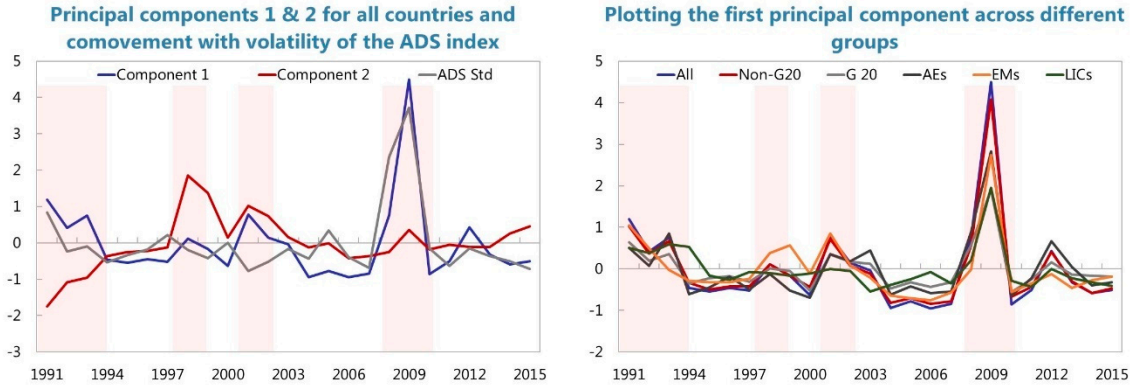
Sources: Bloomberg; Economic Policy Uncertainty; IMF's *World Economic Outlook*; Philadelphia Fed; and IMF's staff calculations.

Note: The table records the variable that has the maximum correlation with the relevant component. Variable definitions are provided in Appendix II.

Decomposing the forecast errors into optimistic and pessimistic errors helps isolate the common components that characterize recessionary regimes across countries and identify the extent of comovement in real GDP growth rates across regions as well for all the countries included in the sample. The interaction between overoptimism and recessions is highlighted

[3] We find similar results when we use AR(1) residuals from the regressions of the next-year real GDP growth forecast errors on their first lag. This robustness check controls for possible inefficiencies in the IMF forecasting process due to underreacting to incoming data about the future development of the GDP growth rate. The top four common factors explain between 47 percent of the cumulative variance in the AR(1) residuals for LICs and 83 percent for AEs. Volatility of the ADS index is most strongly correlated with the first principal component for all countries and in most country groups. These results are available from the authors upon request.

in the text figure below, which examines the extracted first two principal components along with the volatility of the ADS index across time. The figure documents the existing close link between forecast overoptimism, measures of uncertainty, and recessions. The results of the correlation analysis and the dynamics of the components over time provide an observable link between overoptimism in next-year forecast errors and aggregate macroeconomic uncertainty.

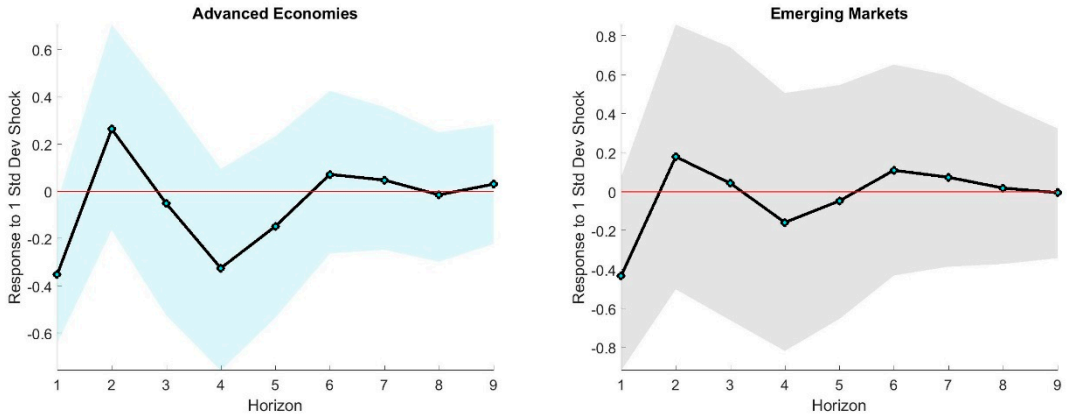


The PCA results, in conjunction with the findings from the correlation exercise, map a direct link between forecast overoptimism and measures of macrofinancial uncertainty. The revealed strong correlation between the volatility of the ADS index and the first principal component of optimistic growth forecast errors across all country groups provides us with a measurable proxy that governs the latent uncertainty underlying forecast overoptimism. So as the next step we employ the VAR framework to understand whether an increase in aggregate macro uncertainty translates into a persistent decline in real variables. We used the following specification:

$$Y_t = B(L)Y_t + \varepsilon_t,$$
$$Y_t = \left[ADS_{\{t-1\}}^{\{std\}}, GDP_t^g, \pi_t, \frac{NX_t}{NGDP_t}\right]' \text{ and } L = 2$$

where $ADS_{\{t-1\}}^{\{std\}}$ stands for volatility of ADS index at time *t-1*, GDP_t^g is the real GDP growth rate at time *t*, and π_t is the CIP inflation at time *t*. We also include net exports in percent of GDP at time *t* $\left(\frac{NX_t}{NGDP_t}\right)$ as the response of real variables to uncertainty shocks varies by degree of openness (Chatterjee, 2016). All variables are demeaned. One standard deviation shock to lagged volatility of the ADS index in this specification helps examine the impact on real GDP growth in the next period and in turn examine the persistence for overoptimism. The timing of the variables enables the use of Cholesky for identification. We estimate the VAR model for each advanced and emerging economy in our sample and calculate an impulse response to one standard deviation shock to the lagged volatility of the ADS index using bootstrapping over 9 periods. Results are averaged for each country group.

Impulse Response of Real GDP Growth Rate to One Standard Deviation Shock to the Lagged Volatility of the ADS Index



In line with Bloom (2009), we find that fluctuations in macroeconomic uncertainty shock have a large impact on next-year real GDP growth. A one standard deviation shock to the lagged volatility of the ADS index results in about a 0.40 percentage point decline in real GDP growth on impact, with incomplete recovery in the following year. The decline on impact is slightly greater and the subsequent recovery is weaker for EMs compared to AEs. These results are comparable to the findings of Carrière-Swallow and Céspedes (2013), where the authors demonstrate the asymmetric effect of uncertainty shocks between advanced and emerging countries highlighting that uncertainty shocks produce larger decline in real activity followed by weaker recovery in EMs.

IV. Conclusions

Macroeconomic forecast errors move together and tend to be positively biased in times of regional and global recessions. This paper isolates common factors underlying forecast errors for the key macroeconomic variables and highlights the asymmetric impact of aggregate macrofinancial uncertainty on forecast accuracy. Uncertainty about U.S. macrofinancial developments and global demand are the key drivers of overoptimism in economic growth forecasts, with an increase in uncertainty-driven overoptimism having a dampening effect on next-year real GDP growth rates. This implies that incorporating economic uncertainty in forecasting models can help improve subsequent forecasts through regime-specific forecasting techniques.

This work enables a range of future research. Investigating the impact of financial frictions could be used to develop narratives about the bearing of the large forecast errors recorded during the global financial crisis. Another possible extension could focus on interactions of financial access and dynamics of forecast errors and business cycle comovement for advanced countries.

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APPENDIX I. PRINCIPAL COMPONENT ANALYSIS RESULTS FOR THE ALL ERRORS AND PESSIMISTIC ERRORS ONLY

Table A.I.1. Drivers of Next-Year Forecast Errors

(in percent of cumulative variance explained by the top four principal components)

	All countries	AEs	EMs	LICs	G-20	Non-G-20
			Real GDP Growth			
Component 1	22.5	56.1	20.8	17.2	38.3	20.4
Component 2	34.2	66.9	35.4	29.6	54.4	32.1
Component 3	41.9	75.1	44.1	38.7	66.5	40.2
Component 4	49.1	81.1	52.1	47.1	75.0	47.6
			Inflation			
Component 1	20.8	41.7	24.1	23.7	29.0	21.6
Component 2	37.1	55.0	39.6	39.1	45.8	37.4
Component 3	48.0	63.2	49.8	52.1	57.5	49.1
Component 4	55.2	70.2	57.8	61.5	68.1	55.9
			Current Account Balance			
Component 1	17.0	21.4	19.7	18.8	23.0	17.7
Component 2	28.5	36.0	33.1	32.0	37.8	29.8
Component 3	37.4	49.2	43.3	44.0	49.0	38.6
Component 4	45.5	58.8	51.2	52.9	58.9	46.8

Source: IMF's World Economic Outlook; and IMF's staff calculations.

Note: Forecast error is defined as difference between projection and actual data, as measured in Spring 2016 vintage of WEO.

Table A.I.2. Drivers of Pessimistic Next-Year Forecast Errors

(in percent of cumulative variance explained by the top four principal components)

	All countries	AEs	EMs	LICs	G-20	Non-G-20
			Real GDP Growth			
Component 1	19.8	51.3	17.7	16.9	43.3	16.9
Component 2	29.4	63.1	29.5	29.5	58.8	26.8
Component 3	38.5	70.3	38.8	40.0	68.4	35.4
Component 4	46.2	76.8	47.0	48.8	75.7	43.5
			Inflation			
Component 1	22.5	42.3	26.0	24.3	27.0	23.6
Component 2	39.6	56.9	44.5	40.8	43.3	40.9
Component 3	50.0	66.7	54.4	54.0	55.3	51.9
Component 4	56.8	74.3	61.4	63.8	66.1	58.1
			Current Account Balance			
Component 1	16.1	19.4	19.9	16.6	21.2	16.6
Component 2	26.2	35.3	31.2	30.9	35.4	27.0
Component 3	34.6	46.2	41.4	41.2	46.5	35.7
Component 4	42.4	55.1	49.1	49.8	56.6	43.5

Source: IMF's World Economic Outlook; and IMF's staff calculations.

Note: Forecast error is defined as difference between projection and actual data, as measured in Spring 2016 vintage of WEO.

APPENDIX II. MEASURES OF MACROFINANCIAL UNCERTAINTY AND REAL ACTIVITY

Variable name	Variable definition	Interpretation
ADS_Index; ADS_Index_Std	The Philadelphia Fed's Aruoba-Diebold-Scotti Business Conditions Index tracks real business conditions in the United States; positive values indicative of optimistic outlook and negative values indicative of pessimistic outlook	Indicator of U.S. macroeconomic sentiment; second moment measures macroeconomic uncertainty in the United States
Kilian_Index	Kilian Economic Index tracks global demand in the industrial commodity markets; deviation from its long-term trend measures change in global real economic activity	Sentiment indicator for the world economy
VIX	Volatility of prices for options on the S&P 500	Macrofinancial uncertainty in the United States
EURECUN	European Economic Policy Uncertainty Index	Economic policy uncertainty in Europe
USECUN	U.S. Economic Policy Uncertainty Index	Economic policy uncertainty in United States
MSCI_World; MSCI_World_Std	The MSCI World Index captures large and mid-cap representation across 23 advanced economies (excluding the United States); the index covers approximately 85 percent of the free float-adjusted market capitalization in each country	Average return measures profitability of firms in AEs and, more broadly, macroeconomic conditions in AEs; second moment measures macrofinancial uncertainty in AEs excluding the United States
MSCI_EM; MSCI_EM_Std	The MSCI Emerging Markets Index captures large and mid-cap representation across 23 emerging markets countries; the index covers approximately 85 percent of the free float-adjusted market capitalization in each country	Average return measures profitability of firms in EMs and, more broadly, macroeconomic conditions in EMs; second moment measures macrofinancial uncertainty in EMs
FFR	Federal Funds Rate	Stance of U.S. monetary policy; expectations of future growth and inflation
TENMINUSFFR	Difference between 10-year yield and the FFR	Expectations of future growth and inflation

Forward_Rate_US	One-year forward rate on zero coupon bonds	Indicator of future economic activity captured through inflation expectations
WEQUN	Uncertainty in world equity markets	Macroeconomic/stock market uncertainty
WTI	Benchmark West Texas Intermediate crude oil prices, U.S. dollars, monthly, not seasonally adjusted	Commodity prices; global commodity demand
COPPER	Global copper prices, U.S. dollars, monthly, not seasonally adjusted	Commodity prices; global commodity demand
Comm_PI	IMF's Commodity Price Index	Commodity prices; global commodity demand

Sources: Bloomberg; Economic Policy Uncertainty; IMF's *World Economic Outlook*; and Philadelphia Fed.