TWO SIGMA

Street View

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EXECUTIVE SUMMARY During the past five years, forecasters have repeatedly proffered overly-optimistic predictions (by more than. 50 basis points) for inflation-adjusted, long-term growth rates but excessively pessimistic predictions (approximately 25 basis points) for the near-term. As asset allocators begin their year-end planning for 2017, they may want to account for this bias when formulating their own long-term outlooks.

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Forecast Bias for US GDP

FORECAST BIAS FOR US GDP

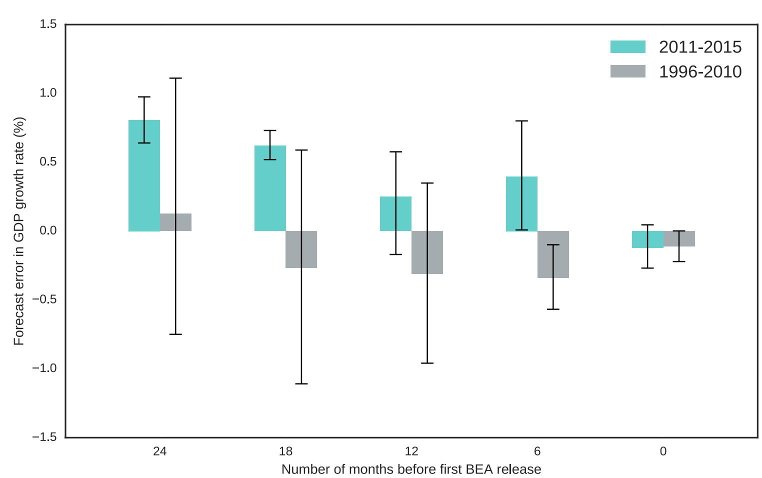
How will US GDP change during the next two years? For asset allocators evaluating the state of the global economy and pondering over its effect on asset prices, the question of the US outlook remains important. The answer, however, seems to have consistently eluded forecasters from many government, quasi-government (e.g., international authorities), and private organizations for the past five years. Point-in-time forecasts from some of these organizations since 2011 show an interesting and statistically significant trend. During the past five years, forecasters have repeatedly proffered overly-optimistic predictions (by more than .50 basis points) for inflation-adjusted, long-term growth rates but excessively pessimistic predictions (approximately 25 basis points) for the near-term. As asset allocators begin planning for 2017 and beyond, they may want to account for this bias when formulating their own long-term outlooks.

IMF FORECASTS ANNUAL US GDP GROWTH OF 2.2 PERCENT FOR 2017 AND 2.1 PERCENT FOR 2018, BUT THE RECENT TRACK RECORD OF ITS FORECASTS GIVES REASON TO DOUBT

The forecasting history of the International Monetary Fund (IMF) offers a representative case study. The IMF releases analyses of global economic developments through its World Economic Outlook report, which is published twice per year. The IMF's most recent forecast, from October 2016, predicts that the US economy will grow 2.2 percent next year and 2.1 percent during 2018. Historically, the IMF's predictions have proven consistent with the subsequent official GDP estimate from the US Bureau of Economic Analysis (BEA). Figure 1 shows the mean ex ante forecast error with 95 percent confidence bounds for the IMF's prediction relative to the BEA's ex post report. The figure shows that the IMF's forecast error did not differ significantly from zero between 1996 and 2010. This statistical result holds true for forecasts 24 months ahead and for forecasts less than six months ahead.

However, since 2011, the IMF's forecasts have exhibited a consistent bias. When making two-year horizon forecasts, the IMF has overestimated GDP by 50 to 100 basis points. The bias shrinks as the forecast horizon shortens.

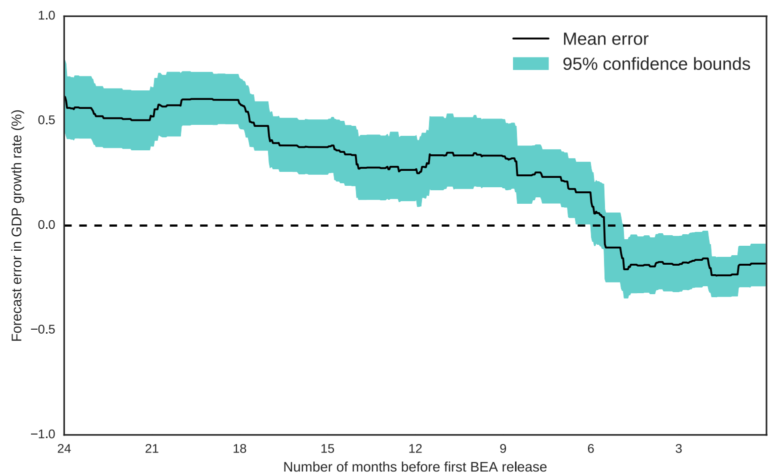
FIGURE 1 MEAN GDP GROWTH RATE FORECASTING ERROR BY IMF WITH 95% CONFIDENCE BOUNDS



Notes: Data on IMF GDP forecast from World Economic Outlook database[1] and actual GDP release from U.S. Bureau of Economic Analysis (BEA)[2].

1 https://www.imf.org/external/pubs/ft/weo/2016/01/weodata/index.aspx
2 http://www.bea.gov/newsreleases/national/gdp/gdpnewsrelease.htm

FIGURE 2 MEAN GDP GROWTH RATE FORECASTING ERROR FROM 2011-2015



Notes: Data collected from panel of GDP forecasters - European Commission (EC)[3], US Energy Information Administration (EIA)[4] , the Survey of Professional Forecasters (Philadelphia Fed)[5], the Wall Street Journal[6], the Congressional Budget Office (CBO)[7], and the IMF[1]

FEW OTHER FORECASTERS HAVE PROVEN MORE PRESCIENT DURING THE PAST FIVE YEARS

The IMF does not stand alone in offering too-rosy outlooks during the past five years. A closer look into US GDP forecasts since 2011 from a set of forecasters that also includes the European Commission (EC), US Energy Information Administration (EIA), the Survey of Profession Forecasters (Philadelphia Fed), the Wall Street Journal, and the Congressional Budget Office (CBO) reveals a similar upward bias.

Figure 2 shows the mean forecasting error in annual US GDP growth rate with 95% confidence bounds based on forecasts pooled across the full set during the most recent five-year period (2011-2015). Similar to the IMF, the average across all forecasters shows a positive bias (approximately 50 basis points) when looking two years ahead. The forecasts become more accurate as the forecast horizon shrinks, indicating that most forecasters tend to revise their estimates downward as data on actual economic conditions materialize. For near-term forecasts (i.e., less than six months), the average bias appears negative. In short, forecasters have been too optimistic about the long-term economic growth rate but too pessimistic about the near--term conditions.

IMPLICATIONS

Asset allocators planning for the next few years might still want to consider the views of experts from a range of government, quasi-government, and private institutions, but they would do well to remember that even these experts have struggled of late. In its latest annual real GDP forecast for the US (released in October), the IMF revised down its estimates for 2016 from 2.4 percent to 1.6 percent. Scientists rarely earn criticism for excessive optimism, but the data suggests that could change.

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3 http://ec.europa.eu/economy_finance/db_indicators/ameco/index_en.htm
4 https://www.eia.gov/forecasts/steo/report/us_eco.cfm
5 https://www.philadelphiafed.org/research-and-data/real-time-center/survey-of-professional-forecasters/
6 http://projects.wsj.com/econforecast/#ind=gdp&r=20
7 https://www.cbo.gov/sites/default/files/51135-2016-01-Economic%20Projections.xlsx

INTERESTING TECHNOLOGY-RELATED ARTICLES

Two Sigma views itself as a technology company that applies a rigorous, scientific method-based approach to investment management. Our technology is inspired by a diverse set of fields including artificial intelligence and distributed computing. Occasionally, we read articles in the popular press that describe applications of technology that we find interesting, thought-provoking, and relevant for people thinking about improving the investment management process. Below is a subset of the articles we read this month. Please do not view the inclusion of these articles as an endorsement by Two Sigma of their viewpoints or the companies discussed therein. Two Sigma welcomes discussions (and contributions) about these and other such technology-related articles.

"US Police to Scan Social Media for Violence Alerts" Madhumita Murgia, *Financial Times*, September 22, 2016 (https://www.ft.com/content/e2c850be-80c8-11e6-bc52-0c7211ef3198)

Cardiff University is developing a computer program to predict outbreaks of hate crime by parsing Twitter content. Funded by the US Department of Justice, the algorithm will map negative-sentiment tweets referring to politically sensitive events such as the presidential election to geographic locations in order to identify or even predict hate crime. This marks the first time US authorities have turned to social media data in an attempt to manage hate crimes. The first use case for the project will be the city of Los Angeles, whose police department has already used similar models to predict other types of crime, such as theft.

"Tech Investors Bet They'll Make More Money Mining Garbage than Burning It" Michael J. Coren, *Quartz*, September 7, 2016 (http://qz.com/774847/tech-investors-are-investing-in-recycling-funding-robotics-software-and-data-analytics-to-reuse-and-reclaim-more-of-our-garbage/)

Venture firms invested about $700 million in waste management technologies between 2011 and 2016. Over this period, investments in material recycling grew to nearly 4x their 2011 level. Meanwhile, waste-to-energy technology investments declined 50 percent from their peak in 2014. Material recycling investments have increased the effectiveness of software, data analytics, and robotics used for waste processing. This trend stems partly from new regulations from governing bodies, such as the EU and the US, which aim to reduce waste in landfills. It is also due to rising commodity prices, which are driving up the costs of metals, plastics, and glass, forcing manufacturers to find cheaper ways to obtain these materials.

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