Comparison of Agricultural Baseline Projections for the United States, the European Union, and China

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Comparison of Agricultural Baseline Projections for the United States, the European Union, and China

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Introduction

- Long-term agricultural projections play an important role in agricultural decision-making and in the global economy by assisting in the formulation of policies that encourage transparency.
- U.S. Department of Agriculture (USDA), Organization for Economic Cooperation and Development (OECD) have been frequently used to establish a country's annual budget expenditures, as well as to assess the impact of various policies on agricultural commodity procurement.
- The projections are based on specific assumptions concerning macroeconomic conditions, agricultural and trade policy settings, weather conditions, long-term productivity trends and international market development.
- These long-term projections for the agricultural sector describe several important aspects affecting the agricultural market in the next decade, including forecasts of commodity yields, production, global agricultural trade, and farm income.
- However, these crucial projections have not been rigorously evaluated in the literature.

Objectives

- To examine the accuracy of both USDA and OECD projections using standard measures of accuracy.
- To investigate the degree to which each projection exhibits systematic bias, following holden(1990) and Bora and Katchova(2022).
- To test whether USDA or OECD provide more accurate baseline projections.(quaedvlieg, 2019) and (Bora and Katchova, 2022)

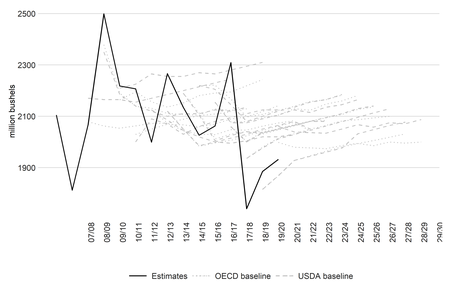

Fig. 1: Realized Value of U.S. Wheat Yield and baseline Projections between 2007-2020

- Figure 1 plots the baseline projections of US wheat production for the USDA and OECD reports between 2007 and 2021. As can be seen in the figure, the baseline projections are usually smoothed, particularly over longer horizons, and often fail to capture market shocks.

Data and Methods

- Data
  - We compile our dataset from the Albert R. Mann Library at Cornell University for an electronic archive of USDA baseline projections and OECD website.
    We evaluate two major projection series contained in baseline reports in three different regions.
    First, we analyze the yield, harvested acreage, and production projections of two cereal commodities: rice and wheat.
    Second, we examine trade projections, including exports and imports to different regions.
    It is important to note that our dataset spans the baseline projections between 2007 and 2020, yet the evaluation period T differs for each projection horizon.
- Methods
  - Errors: for each variable at horizon h, the percent prediction error can be expressed as: $e^i_{t+h|t} = 100 \times (Y_{t+h} - \hat{Y}^i_{t+h|t})/Y_{t+h}$, at reference year t and $i = \{USDA, OECD\}$. Standard measures of accuracy have been used: mean absolute percent error (MAPE) and root mean squared percent error (RMSPE),

$$\text{MAPE}^i_h = \frac{1}{T}\sum_t |e^i_{t+h|t}| \tag{1}$$

and

$$\text{RMSPE}^i_h = \sqrt{\frac{1}{T}\sum_t (e^i_{t+h|t})^2}. \tag{1'}$$

  - Bias: Followed Isengildina-Massa et al. (2020) and Bora, Katchova (2021), we use modified Holden and Peel's (1990) regression-based test to test whether the USDA and OECD projections are biased. For each series of projections, we test for bias at each horizon $h = \{0, 1, \dots 9\}$:

$$e^i_{t+h|t} = \alpha^i_h + \varepsilon^i_{t+h}. \tag{2}$$

where α^i_h is an unknown constant to be estimated and ε^i_{t+h} is white noise regression residual. We evaluate the null hypothesis that the projections are unbiased by testing the regression constraint $H_0 : \alpha^i_h = 0$.

  - Multi-horizon comparsion tests:

(1) Modified Diebold-Mariano (MDM) tests: We calculate the loss differential for year t between the USDA and OECD projections as a 10-dimensional vector:

$$d_t = L^{USDA}_t - L^{FAPRI}_t. \tag{3}$$

The comparison of baseline projections is based on the mean loss differentials, $\mu = \lim_{T\to\infty} \frac{1}{T}\sum_t E(d_t)$. The MDM tests for single horizons compare the USDA and OECD projections by calculating a standard t-test:

$$t^h_{DM} = \frac{\sqrt{T}\bar{d}_h}{\hat{\omega}_h} \tag{4}$$

where $\bar{d}_h = \frac{1}{T}\sum d_{t,h}$, and $\hat{\omega^2_h}$ is a HAC estimate of the variance of $d_{t,h}$. We first test the null hypothesis that the mean loss differential at horizon h is less than or equal to zero ($H_0 : \mu_h \leq 0$).

(2) Multi-horizon superior predictive ability test: following Bora, Katchova(2022), and Quaedvlieg (2019), we use this test to jointly consider all horizons along the entire projection path. The uniform SPA test is based on the minimum loss differential:

$$\mu^{uSPA} = \min_h \mu_h. \tag{5}$$

The uniform SPA test is given by the null hypothesis $H_0 : \mu^{uSPA} \leq 0$ against the alternative hypothesis $H_a : \mu^{uSPA} > 0$.
The average SPA test is based on the minimum loss differential:

$$\mu^{aSPA} = w'\mu = \sum_h w_h \mu_h. \tag{6}$$

The average SPA allows losses at different horizons to compensate for one another.
To make sure our findings are robust to this choice, we examine alternative weighting procedures. Equal weights and weighing the loss differentials by the variance have been considered. The test statistic for the multi-horizon comparison tests are given by:

$$t_{uSPA} = \min_h \frac{\sqrt{T}\bar{d}_h}{\hat{\omega}_h} \tag{7}$$

and,

$$t_{aSPA} = \frac{\sqrt{T}\bar{d}_h}{\hat{\zeta}_h}, \tag{7'}$$

Results

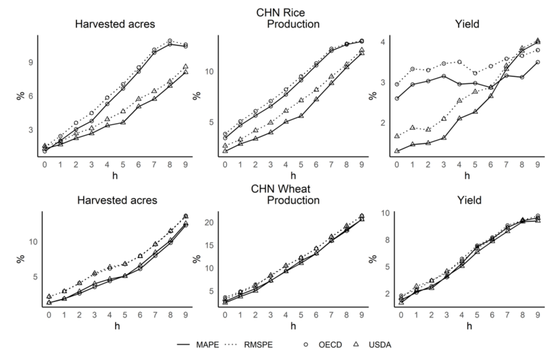

Fig. 2: MAPE and RMSPE for projections of wheat and rice by projection horizon, China

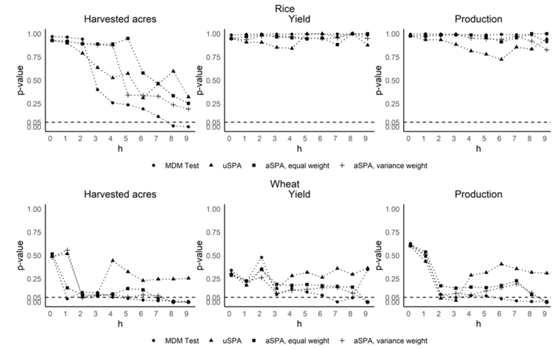

Fig. 3: Multi-horizon comparison tests of baseline projections by horizon, EU

Conclusions

- Our measures of prediction error show that the projections become less accurate as the projection horizon increases.
- Our test of Bias suggest that both baselines mostly biased in China, less biased in EU and US, and the magnitude of the bias increases as the projection horizon increase. For US, USDA is always overestimating wheat exports at 5% significance level; and both OECD and USDA imports have considerable bias at the 10% significance level.
- Our multi-horizon comparison tests suggest that the OECD baselines do not outperform USDA projections for most variables in three regions, as OECD tends to fail to reject the null hypothesis for both crops and different variables, except for wheat projections of EU in the longer horizons and rice and wheat harvested acres for some horizons in the US.