Detecting the Sources of Information Rigidity: Analyzing Forecast Bias and Smoothing in USDA's Soybean Forecasts

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Abstract

USDA's U.S. soybean ending stock forecasts are upwardly biased. To determine the source of this bias, we examine the revision characteristics of the ending stocks forecasts, and examine USDA's forecasts of other U.S. soybean balance sheet variables and foreign soybean balance sheet variables. Bias in USDA's soybean export forecasts is the most likely source of ending stock forecast bias. In turn, bias in the U.S. export forecasts has diverse sources, including bias in foreign trade estimates and late in the forecast cycle slow updating of the forecasts to reflect new information.

Keywords: USDA, forecasting, forecast evaluation, revision efficiency.

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Introduction

Recent studies on the market impact of USDA's monthly forecasts have highlighted two characteristics of world commodity markets relevant to this study. One is that the monthly publication of USDA's *World Agricultural Supply and Demand Estimates* (WASDE) has significant impact on futures markets, although not in every month. The other is the difference in this impact between soybeans and other commodities. For most annual crops, the WASDE's impact is concentrated almost exclusively in the months when the National Agricultural Statistics Service (NASS) or USDA's Interagency Commodity Estimates Committees (ICECs) are revising their U.S. production estimates (August-January for NASS and May, June, and July for ICEC). But soybean markets also respond to WASDE releases in March through May (see Adjemian (2012) and Isengildina, Irwin, and Gomez (2008)). This difference in the timing of USDA's forecasts market impact is in large part due to the unusual concentration of world soybean production in the Southern Hemisphere—more than half of world production is from the Southern Hemisphere versus 7-16 percent for grains and cotton—so for soybeans, market impact is evident for USDA's forecasts of developments in the Southern Hemisphere as well in the United States.

Another difference between soybeans and grains is the growing concentration in the source and destination of world trade. OECD-FAO (2016) notes that by 2025 soybeans are predicted to be the commodity with the highest concentration on its top 5 import markets of any agricultural commodity in the world. China alone is expected to account for a greater share of world imports than even all 5 of the top importers of all but a handful of agricultural commodities. On the export side, soybeans are expected to have the highest concentration of exports among its top three exporters, the United States, Brazil, and Argentina. In 2015, China accounted for 38 percent of all imports and the United States, Brazil, and Argentina together accounted for 88 percent of all exports (USDA, 2016).

The focus of this study is a less benign difference between soybeans and other commodities: USDA's forecasts of U.S. ending stocks have been biased upwards over a significant portion of the seasonal forecasting cycle between the first release of a USDA forecast in the May before the beginning of the marketing year (soybeans have a September-August marketing year in the United States) and the estimate's finalization in the November of the following year. This bias is not a function of a broader phenomenon in USDA's crop forecasting since bias has not been observed in other major commodity ending stock forecasts by USDA (fig 1). Concern among industry and policy-makers has varied over time (Botto, et al. 2006), but with world soybean production on a faster upward trend than grains or cotton the need to resolve persistent errors in USDA's soybean forecasts is more likely to grow than diminish.

Methodology

The impact of the Southern Hemisphere on the seasonality of the market impact of USDA's soybean forecasts is shown by comparing figures 2 and 3. Figure 2 shows the 1993-2013 average absolute percent monthly revision in USDA's forecasts for U.S. soybean production and exports. U.S. soybean production, like that of most northern hemisphere crops, is complete by December, which is the month of USDA's 8th WASDE forecast for the most recent marketing year. The revisions to USDA's estimates begin diminishing in magnitude earlier as uncertainty about the year's acreage and yield diminishes. Revisions to forecast and estimated U.S. exports persists until the month after the U.S. Bureau of the Census releases its first estimate of the level of soybeans exported during the final month of the marketing year. With lags due the transfer of data from the U.S. Customs and Border Protection to Census, time to tabulate the data, and then to await the next WASDE publication date, the first month with official trade data for the complete year in the WASDE is November.

The seasonality of production in the Southern Hemisphere is largely the inverse of the northern hemisphere's, but USDA begins its WASDE forecasts for these crops well before they are planted. Figure

3 compares the seasonal pattern of revisions for USDA's forecasts of soybean production in the United States and Brazil. Brazil's soybeans are planted from September to December and harvested from January to May, and Argentina's follow a slightly later schedule. Forecast revisions peak in February, but remain high through April. USDA's final estimate of production is delayed several months after the Southern Hemisphere harvests as USDA awaits the marketing year estimates of net trade, and the crop estimate is calibrated to account for use. The estimates for Southern Hemisphere and other foreign countries are finalized around the 24th month.

The result is that errors in the forecasts of US balance sheet variables are calculated as their difference from the estimate in the 19th forecast for that marketing year and errors for non-US variables are calculated based on the 24th forecast, keeping with the pattern of regular USDA revisions through that period.

The dynamic nature of world soybean markets means forecast errors and revisions are best examined in log difference form. As China's economy has been transformed, its income driven sharply higher, and the protein consumption of its population risen to nearly the OECD average, its soybean imports have risen from negligible levels to become one of the world's largest agricultural trade flows. Similarly, Brazil's expansion of soybean production into the cerradho in states like Mato Grosso has enabled its soybean production to keep pace with China's growing imports and come to rival the United States as the world's largest producer. The log transformation of the data ensures that later observations will not be given greater weight in the analysis simply because they occur later in the course of a rising trend in the variable's data generating process.

Forecast error in a given month is defined as the difference between the actual marketing year level for a given variable (estimate 19 or 24) and the forecast for that month (*t*):

$e_t = a - f_t$ (lower case letters indicate logged values of the actual realization, A, and the forecast, F)

Bias is tested for the 1993-2014 and 2003-2014 forecasts published in a given month by regressing the forecast errors on a constant. If the estimated constant is statistically different from zero, that month's forecast was biased for the years in the sample. This approach utilizes the "rolling-event" attribute of a set of forecasts—the forecasts are examined at the same frequency as the events they are forecasting, in this case annually:

$$e_t = \alpha - \varepsilon_t$$

Forecasts can also be evaluated without relying on the determination of an end point from which to measure error by examining the characteristics of the month-to-month revisions. Nordhaus (1987) pioneered this approach, examining sets of high-frequency forecasts all directed at one "fixed" event at a lower frequency. Efficient forecasts that fully utilize available information from one period to the next, also must demonstrate efficiency in higher-frequency, interim revisions. We can exploit the combined fixed- and rolling-event aspects of the WASDE forecasts by testing for the efficiency of revisions during a given month across sets of years.

Revisions are defined as the difference in the logged values of the forecast in month t from month $t\text{-}1$:

$$r_t = f_t - f_{t-1}$$

Revision inefficiency is tested for the 1993-2014 and 2004-2014 forecasts by regressing the set of revisions in a given month (t) across the years in the sample on the lagged revision (that year's revision in the previous month, $t\text{-}1$):

$$r_t = \alpha + \beta r_{t-1} + \varepsilon_t$$

If the parameter on the lagged revision (β) is statistically different from zero, the process of revising in inefficient. If the parameter is positive, the forecasts are smoothed as the impact of new information is spread out over multiple periods. If the parameter is negative, adjustments involve over-corrections, a characteristic of forecasts that is less frequently observed than smoothing. The constant (α) can be excluded in this test if the forecast is unbiased. If the forecast is biased, and it meets the minimal efficiency standard of diminishing average errors as the forecast horizon approaches, then a downward trend is expected in the revisions, necessitating inclusion of α.

Each test is applied to the sets of forecasts published each month in the course of the each crop cycle. If we designate each month the crop cycle as i, then May before the start of the marketing year is i=1, and the actual realization of the variable is determined in i=19 for the United States. Restating the test equations we have:

$$e_{i,t} = \alpha_i - \varepsilon_{i,t}$$

$$r_{i,t} = \alpha_i + \beta r_{i,t-1} + \varepsilon_{i,t}$$

Tests on the significance of the difference from zero of the estimated α_i's and β_i's for i = 1-19 are reported in Tables 1-10.

The variables examined are U.S. soybean ending stocks, production, consumption, exports, and a version of net exports. Net exports here also include soybean meal exports and imports, multiplied by 1/0.78 to estimate the volume of soybeans implied by a given volume of meal. We also examine: Brazil soybean production, exports, and net exports; Argentina soybean production, exports, and net exports; China net imports.

Results

The 20 year data set shows strong US ending stock upward bias (Table 1), ranging from as high as 23 percent to 16 percent during the early months of the forecast cycle (forecasts $i = 4\text{-}11$). The second half of the sample (2003-2014, Table 2) shows only 2 months with bias significant at the 5 percent level (the first November forecast and the January forecast, $i = 7$ and 9), but bias persists at the 10 percent significance level. The November and January bias is 25 percent.

Both consumption and exports show some downward bias in the full sample estimates. The export and net export estimates in particular show significant bias in most months $i = 4$ to 16, with significance levels as high as 0.1 percent. In the second half of the sample consumption shows virtually no bias with 5 percent significance, but highly significant net export bias persists as late as forecast 18.

Tables 3-5 show that revision inefficiency or smoothing is found for the forecasts of every U.S. balance sheet variable. Ending stocks shows smoothing in a limited number of months as does consumption. But, U.S. soybean export forecast revisions are smoothed in a larger number of months. Tables 3 and 4 show statistically significant constants in the test equations: inclusion of the constant is appropriate for exports since Tables 1 and 2 show these forecasts are biased. In Table 4, the final revision to the export estimate in forecast 19 shows complex behavior, with negative revision inefficiency—indicating overcorrection in the previous month—and a significant downward adjustment. In each case however, the inefficiencies are small.[1]

[1] The apparent forecast inefficiency may be a function of differences between the trade data recorded by two official sources: Federal Grain Inspection Service (FGIS) inspections and Census Foreign Trade data. FGIS data is

Foreign forecast bias in the full sample (Table 6) is largely confined to Brazilian production (forecasts 13-19). Only the 18th forecasts of China's net imports also show bias in the full sample. In each case, the direction of the bias is consistent with a causal relationship with the bias in the US export forecasts and ending stock forecasts. Note that the confinement of the realization of statistically significant bias to just the late season forecasts has two sources: the size of the bias and the magnitude of the variance. Late season forecasts are not necessarily more biased, but if intra-seasonally efficient have significantly smaller variances. The parameter values for the forecasts earlier in the season are comparable and even larger than the significant late season forecasts, and the cumulative effect of importer and exporter errors could be source of the bias the U.S. export forecasts in those earlier months.

In the more recent half of the sample period (Table 7), virtually every month shows a foreign trade forecast bias consistent with a causal relationship with the observed bias in US export and ending stock forecasts. Forecasts for Argentina's net exports are biased upward, but not the forecasts of Argentina's soybean forecasts alone: Argentina's trade policy drives a large share of its forecasts to occur in the form of meal rather than beans, making the examination of the beans and meal total crucial for this analysis. The bias persists at the 5 percent significance level over forecasts numbers 6-9. Downward bias is observed in the China net import forecasts in forecasts 13 and 15-18. Note that in the more recent half of the sample (2003-2014) the forecasts of Brazil's exports show virtually no signs of bias consistent with a causal relationship with the U.S. export bias.

Revision inefficiency is evident in the forecasts for at least one month for all the foreign variable forecasts examined (Tables 8-10). But, smoothing is largely confined to a relatively small subset of months in each case. For the second half of the sample, Table 9 provides the appropriate results for the biased late season

reported earlier and are use an important component of the information set for late season export U.S. grain and oilseed forecasts.

Chinese import and early-season Argentine net export forecasts. China imports in month 14 show both smoothing and a persistent tendency to revise downward. Argentina's net export forecasts show some months of smoothing, largely focused in the same period that smoothing is evident in the forecasts for production in Argentina. Brazil's production and export forecasts are also smoothed around this same time, a period beginning in February and extending through June for some variables (forecasts 10-14).

Discussion

The results show that the bias in the forecasts of U.S. soybean exports is in the direction consistent with a causal relationship with the bias in ending stocks, and other characteristics of the forecasts and the market for soybeans suggest such a causal relationship. Correlations across years of the errors and revisions in U.S. export and ending stock forecasts in the later months of the forecasting cycle are negatively correlated (Table 11). While actual causality between exports and stocks can theoretically be bidirectional (William's and Wright, 1991), but it is also plausible that USDA's forecasting methodology treats ending stocks as a residual from expected supplies and expected levels of other sources of demand.

Note that demand for soybean stocks at the end of the marketing year is much smaller relative to use than is the case for grains and cotton, reflecting the outsized role of the Southern Hemisphere in meeting global demand. As a result, U.S. soybean exports over 2007-13 were 8-22 times as large as ending stocks in a given year. Given the low level of actual stocks demanded in a given year relative to demands for use and export, it would be very difficult for errors in estimating demand for physical stocks could approach the magnitude of errors in forecasting the level of exports. This suggests it is appropriate to interpret the correlation as indicative of a causal relationship between ending stocks and exports.

The relationship between the U.S. export forecast errors and foreign trade forecast errors is more complex, with errors in Argentina's trade forecasts consistent with the U.S. export errors only in the first months of the forecast cycle. Errors and revisions in the China import forecasts are consistent with the U.S. export error bias, but the bias in the China forecasts only has statistical significance in the later months of the forecast cycle. An unpublished USDA study (cited in USDA, 2004) cited China's rapid import growth as a likely source of USDA's underestimation of U.S. soybean exports. Previous studies have observed a pattern where USDA commodity forecasts underestimate the rate of annual change in either direction for exports (MacDonald, 1992; Isengildina-Massa, MacDonald, and Xie, 2012). Thus, errors in USDA's forecasts for China could be a causal factor in USDA's soybean export forecast errors.

However, the upward bias in USDA's forecasted net exports of Argentine soybeans (and meal) must be independent of any persistent failure to account for expansion of China's imports, since the Argentine bias is in favor of larger rather than smaller exports. Most of Argentina's soybean production is exported in one form or another (70-90 percent), so the direction of causality in USDA's early season forecasts could be in either direction given the limited information available here. In the short run, actual causality might be expected to flow from production to exports, given that the impact of unpredictable weather shocks on planted area and yields. But it would not be expected that USDA's errors in anticipating weather events would be unidirectional, so the correlations between early-season forecast errors in Argentine production, Argentine exports, and U.S. exports may not be the ultimate result of errors in understanding soybean production in Argentina.

Table 12 shows the result of forecast bias tests on USDA's forecasts of soybean's exported share of production in the United States, Argentina, and Brazil over 2003-2014. During months 6-13, USDA's forecasts were biased downwards. The forecasts for Argentina's forecast had average errors consistent with upward bias, but the averages were not significantly different from zero.

Note also the lack of bias in Argentine forecasts for soy exports in the form of whole beans, but the significant bias once both meal and beans are aggregated. This could indirectly be a function of underestimating China's demand. Argentina's differential export taxes virtually necessitate that a disproportionate share of its soybeans are exported in processed form. However, the world’s largest market--China--long ago shifting to importing whole beans, in part to internalize the value-added from processing. Thus Argentine exports are increasingly directed to smaller, dispersed markets in Europe, the Middle East, and Southeast Asia that import soybean meal for their livestock industries. Ultimately, these countries compete with China for access to soybeans produced in the United States and South America, but the competition is by definition indirect and more difficult to both observe and predict. Errors in USDA’s forecasts of Chinese imports could be dispersed among these markets, but show up when these markets’ import forecasts then are balanced with a forecast for exports from Argentina.

Conclusions

USDA’s forecasts of U.S. soybean exports were biased downward during 2003-14, leading to upward bias in USDA’s forecasts of soybean ending stocks. More research is necessary to establish statistical relationships among USDA’s soybean forecast errors and revisions that help indicate the sources of the bias, but the evidence found in this study indicates that a combination of underestimating import demand by China and the competitiveness of U.S. soybean exports relative to soybean meal from Argentina are causal factors. This does not rule out additional causes, or the possibility that these two factors have a joint, underlying third factor that is the ultimate source of the bias, but the analysis advances our understanding of the patterns in USDA’s soybean forecasts. The role of processed Argentine soybean exports in the biased net trade forecasts highlights another market the forecasts for which might be usefully examined: the European Union, which accounts for about one-third of global soybean meal imports.

Forecast smoothing is observed for many soybean balance sheet variables in the USDA forecasts, but is found in the greatest number of months of the forecasting cycle for U.S. exports. The delays in updating information that this forecast smoothing implies could contribute to the continuation of forecast bias to nearly the end of the forecast cycle. However, further research will be necessary to determine if the delayed adjustment in the biased export forecasts is a cause or a consequence of complementary biases on U.S. export and Chinese import forecasts late in the forecasting cycle.

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Table 1—

Bias in 1993-2014 USDA forecasts for U.S. soybeans

Month	Forecast	Ending Stocks	Production	Consumption	Exports	Net trade
Aug	4	-0.206*	0.012	0.013	0.060*	0.057*
Sep	5	-0.167*	0.014	0.015	0.063*	0.060*
Oct	6	-0.211**	0.009	0.014	0.050*	0.047*
Nov	7	-0.226**	0.004	0.013	0.042*	0.039
Dec	8	-0.198**	0.004	0.013	0.036	0.033
Jan	9	-0.199**	0.004	0.014	0.037*	0.034*
Feb	10	-0.175**	0.004	0.013	0.036**	0.034*
Mar	11	-0.158*	0.004	0.015*	0.032**	0.030*
Apr	12	-0.110	0.004	0.012*	0.022*	0.021*
May	13	-0.081	0.004	0.010*	0.019**	0.019**
Jun	14	-0.046	0.004	0.006	0.016**	0.017**
Jul	15	-0.011	0.004	0.004	0.011**	0.011**
Aug	16	0.010	0.004	0.002	0.009***	0.009***
Sep	17	0.054	0.004	-0.000	0.001	0.002
Oct	18	0.005	0.000	-0.000	0.000	0.001
Nov	19	0.000	0.000	0.000	0.000	0.000
		N=22	N=22	N=22	N=22	N=22

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).

* p<0.05 ** p<0.01 *** p<0.001

Table 2—

Bias in 2003-2014 USDA forecasts for U.S. soybeans

Month	Forecast	Ending Stocks	Production	Consumption	Exports	Net trade
Aug	4	-0.076	0.044**	0.018	0.087*	0.102**
Sep	5	-0.081	0.039*	0.017	0.088*	0.102*
Oct	6	-0.202	0.019*	0.014	0.062	0.076*
Nov	7	-0.253*	0.009	0.010	0.057	0.066*
Dec	8	-0.227	0.009	0.011	0.053	0.063*
Jan	9	-0.249*	0.005	0.008	0.055*	0.061**
Feb	10	-0.220	0.005	0.009	0.052*	0.058**
Mar	11	-0.180	0.005	0.010	0.043*	0.049**
Apr	12	-0.156	0.005	0.013	0.030*	0.040**
May	13	-0.113	0.005	0.012	0.023*	0.031**
Jun	14	-0.053	0.005	0.007	0.020*	0.024**
Jul	15	-0.028	0.005	0.006	0.013*	0.015*
Aug	16	-0.013	0.005	0.004	0.011***	0.011**
Sep	17	0.029	0.005	0.003	0.003***	0.004*
Oct	18	0.011	0.001	-0.001*	0.002*	0.002*
Nov	19	0.000	0.000	0.000	0.000	0.000
		N=11	N=11	N=11	N=11	N=11

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).

* p<0.05 ** p<0.01 *** p<0.001

Table 3—

Revision inefficiency in 1993-2014 USDA forecasts for U.S. soybeans

		Ending stocks		Production		Consumption		Exports		Net Exports	
		Lagged		Lagged		Lagged		Lagged		Lagged	
Month	Forecast	revision	Constant	revision	Constant	revision	Constant	revision	Constant	revision	Constant
Aug	4	0.003	-0.093*	0.714	-0.017	1.319**	-0.009*	1.249*	-0.010	1.249*	-0.010
Sep	5	0.149	-0.026	0.086	0.000	0.228	-0.000	0.074	-0.001	0.079	-0.001
Oct	6	0.118	0.043	0.255	0.004	0.529*	0.002	-0.113	0.011	-0.117	0.011
Nov	7	0.226	0.010	0.256**	0.005	0.377**	0.001	0.220	0.006	0.218	0.006
Dec	8	0.234	-0.031	0.000	0.000	0.115	-0.001	0.238	0.004	0.219	0.004
Jan	9	0.799***	0.020	0.000	-0.000	1.179**	-0.000	0.959***	-0.007*	0.941***	-0.007*
Feb	10	0.115	-0.023	0.000	0.000	0.251	0.001	0.648***	0.002	0.648***	0.001
Mar	11	0.431*	-0.005	0.000	-0.000	0.183	-0.002	0.542**	0.004	0.536**	0.004
Apr	12	-0.250	-0.052**	0.000	0.000	-0.576	0.002	0.808***	0.006	0.761***	0.005
May	13	0.221	-0.018	0.000	-0.000	0.137*	0.002	0.386**	-0.000	0.386**	-0.001
Jun	14	0.653***	-0.017	-1.000	-0.000	0.634*	0.002	0.584**	0.000	0.647***	0.000
Jul	15	0.273	-0.024	0.000	0.000	0.750	0.000	0.450*	0.004*	0.390	0.007*
Aug	16	0.253	-0.013	0.000	0.000	0.282**	0.001	0.553**	-0.001	0.124	0.004
Sep	17	0.320*	-0.035***	0.000	0.000	0.247	0.001	0.351*	0.007***	0.414*	0.005**
Oct	18	0.355	0.062	0.000	0.003	-0.226	0.000	0.022	0.001	0.122	0.002
Nov	19	-0.010	0.005	-0.006	0.000	-0.030	-0.000	-0.250	0.000	-0.270	0.001
		N=22		N=22		N=22		N=22		N=22	

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).

* p<0.05 ** p<0.01 *** p<0.001

Table 4—

Revision inefficiency in 2003-2014 USDA forecasts for U.S. soybeans

		Ending stocks		Production		Consumption		Exports		Net Exports	
		Lagged		Lagged		Lagged		Lagged		Lagged	
Month	Forecast	revision	Constant	revision	Constant	revision	Constant	revision	Constant	revision	Constant
Aug	4	-0.008	-0.099*	0.686	-0.020	1.330**	-0.010*	1.192*	-0.015	1.194*	-0.015
Sep	5	0.339	0.034	0.219	0.011	0.273	0.004	0.259*	0.007	0.253*	0.006
Oct	6	0.176	0.106	-0.341	0.020	-0.073	0.004	-0.975	0.020	-0.976	0.020
Nov	7	0.203	0.032	0.193	0.008	0.338	0.003	0.269	0.001	0.265	0.001
Dec	8	0.347*	-0.042	0.000	0.000	0.592**	-0.003*	0.273	0.002	0.244	0.001
Jan	9	0.862**	0.036	0.000	0.003	1.378**	0.003	1.166***	-0.007	1.160***	-0.007
Feb	10	0.206	-0.027	0.000	0.000	0.400	-0.002	0.693***	0.005*	0.687***	0.004*
Mar	11	0.547*	-0.022	0.000	-0.000	0.290**	-0.001	0.449*	0.007*	0.447*	0.007
Apr	12	-0.150	-0.029	0.000	0.000	-0.523	-0.004	1.017**	0.004	0.946**	0.002
May	13	0.572	-0.030	0.000	-0.000	0.142	0.002	0.416*	0.002	0.437*	0.001
Jun	14	0.651***	-0.032*	-1.000	-0.000	0.198	0.004	0.540*	-0.001	0.565*	-0.001
Jul	15	0.264	-0.010	0.000	0.000	0.667	-0.002	0.672	0.004	1.299*	0.000
Aug	16	0.379	-0.005	0.000	0.000	0.349*	0.002	0.466	-0.001	0.038	0.004
Sep	17	0.433*	-0.035*	0.000	0.000	0.289	0.000	0.383**	0.007***	0.353*	0.005**
Oct	18	1.408	0.077	0.000	0.004	-0.103	0.004	0.068	0.001	0.274	0.000
Nov	19	-0.005	0.011	-0.015	0.001	0.010	-0.001*	-0.773*	0.003**	-0.001	0.002
		N=11		N=11		N=11		N=11		N=11	

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).

* p<0.05 ** p<0.01 *** p<0.001

Table 5—

Revision inefficiency in 2003-2014 USDA forecasts for U.S. soybeans (no constant in test equation)

Month	Forecast	Ending stocks Lagged revision	Production Lagged revision	Consumption Lagged revision	Exports Lagged revision	Net Exports Lagged revision
Aug	4	0.193	0.877	1.256*	1.361*	1.365*
Sep	5	0.177	0.088	0.188	0.215	0.214
Oct	6	0.182	-0.160	-0.029	-1.011	-1.024
Nov	7	0.245	0.280	0.424*	0.277	0.274
Dec	8	0.266	0.000	0.360	0.284	0.252
Jan	9	0.771**	0.000	1.288**	1.112***	1.116***
Feb	10	0.167	0.000	0.358	0.675***	0.669***
Mar	11	0.661**	0.000	0.318**	0.498*	0.481*
Apr	12	0.109	0.000	-0.006	1.141**	1.028**
May	13	0.705	0.000	0.094	0.467**	0.475**
Jun	14	0.757***	-1.000	0.664	0.507**	0.545**
Jul	15	0.326	0.000	0.513	0.814*	0.703*
Aug	16	0.378	0.000	0.320*	0.440	0.478
Sep	17	0.504*	0.000	0.317	0.540*	0.467*
Oct	18	0.672	0.000	0.135	0.178*	0.189
Nov	19	0.000	0.000	-0.006	0.112	0.114
		N=11	N=11	N=11	N=11	N=11

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various

* p<0.05 ** p<0.01 *** p<0.001

Table 6—

Bias in 1993-2014 USDA forecasts for non-U.S. soybeans								
		China		Argentina			Brazil	
Month	Forecast	Net imports	Exports	Net exports	Production	Exports	Net exports	Production
Aug	4	0.145	-0.118	-0.011	0.026	0.063	0.030	0.033
Sep	5	0.134	-0.130	-0.020	0.019	0.057	0.025	0.031
Oct	6	0.113	-0.134	-0.021	0.005	0.051	0.021	0.022
Nov	7	0.089	-0.122	-0.021	-0.001	0.054	0.019	0.018
Dec	8	0.073	-0.130	-0.025	-0.004	0.047	0.017	0.017
Jan	9	0.065	-0.129	-0.025	-0.006	0.042	0.011	0.015
Feb	10	0.064	-0.104	-0.020	-0.006	0.021	0.003	0.008
Mar	11	0.068	-0.091	-0.021	-0.011	0.018	0.001	0.010
Apr	12	0.124	-0.081	-0.020	-0.007	0.033	0.011	0.016
May	13	0.116	-0.022	-0.009	0.005	0.012	0.006	0.016**
Jun	14	0.094	0.024	-0.002	0.008	0.017	0.003	0.013**
Jul	15	0.086	0.018	-0.000	0.009	0.015	0.003	0.015**
Aug	16	0.086	-0.015	0.004	0.009	0.014	0.008	0.014**
Sep	17	0.056	-0.001	0.005	0.008	0.006	0.003	0.014**
Oct	18	0.030*	-0.011	0.009	0.005	0.006	0.007	0.011**
Nov	19	0.000	-0.011	0.011	0.005	0.004	0.006	0.010**
		n=20	n=21	n=21	n=21	n=21	n=21	n=21

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).
* p<0.05 ** p<0.01 *** p<0.001

Table 7—

Bias in 2003-2014 USDA forecasts for non-U.S. soybeans								
		China		Argentina			Brazil	
Month	Forecast	Net imports	Exports	Net exports	Production	Exports	Net exports	Production
Aug	4	0.065	-0.196	-0.103	-0.058	0.025	0.009	-0.008
Sep	5	0.058	-0.197	-0.108*	-0.060	0.011	-0.001	-0.014
Oct	6	0.051	-0.180	-0.099*	-0.067	0.018	0.006	-0.017
Nov	7	0.045	-0.159	-0.096*	-0.070	0.010	0.001	-0.014
Dec	8	0.042	-0.161	-0.095*	-0.073	0.008	0.000	-0.013
Jan	9	0.041	-0.145	-0.091*	-0.065	0.005	-0.004	-0.015
Feb	10	0.044	-0.073	-0.066	-0.046	-0.004	-0.003	-0.012
Mar	11	0.044	-0.049	-0.058	-0.038	0.009	0.001	-0.005
Apr	12	0.046	-0.034	-0.047	-0.030	0.021	0.012	0.005
May	13	0.047*	0.013	-0.036	-0.010	0.014	0.010	0.007
Jun	14	0.039	0.075	-0.018	-0.004	0.012	0.007	0.006
Jul	15	0.036*	0.031	-0.018	-0.003	0.019	0.010	0.011
Aug	16	0.026**	0.024	-0.008	0.000	0.011	0.006	0.009
Sep	17	0.018**	0.048	-0.001	0.000	-0.000	0.002	0.009
Oct	18	0.012**	0.023	0.004	0.000	0.000	-0.000	0.009
Nov	19	0.000	0.004	0.001	0.001	-0.002	-0.000	0.009
		N=11	N=10	N=10	N=10	N=10	N=10	N=10

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).
* p<0.05 ** p<0.01 *** p<0.001

Table 8--

Revision inefficency in 1993-2014 USDA forecasts for non-U.S. soybeans

		China				Argentina						Brazil			
		Net imports		Exports		Net exports		Production		Exports		Net exports		Production	
Month	Forecast	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant
Aug	4	0.548	0.005	0.511	0.019	0.075	0.015*	0.138	0.003	1.693	0.009	1.375	0.010	0.000	-0.000
Sep	5	0.306*	0.009	0.166	0.006	-0.073	0.009*	0.244	0.006*	-0.165	0.011	-0.057	0.007	-0.003	0.003
Oct	6	0.422	0.016	0.367	-0.001	0.542*	-0.004	0.274	0.012	0.160	0.006	0.085	0.004	-0.187	0.010
Nov	7	0.703***	0.009	0.065	-0.008	0.268	-0.000	0.010	0.006	0.302	-0.004	0.035	0.002	0.003	0.004
Dec	8	0.794***	-0.004	0.019	0.009	-0.034	0.004	-0.148	0.004	0.265	0.006	0.235*	0.001	0.142*	-0.000
Jan	9	0.114	0.006	0.336	-0.002	0.275	0.000	0.202	0.001	0.036	0.004	0.242	0.005	0.408	0.003
Feb	10	-0.314	0.003	0.835	-0.023	0.589	-0.003	1.139*	0.001	0.093	0.019*	0.047	0.007	0.125	0.006
Mar	11	0.373*	-0.003	0.115	-0.009	0.232	0.002	0.223	0.004	0.578	-0.008	0.486*	-0.001	0.450*	-0.005
Apr	12	0.798**	0.008	0.291	-0.006	0.062	-0.001	0.417	-0.005	0.143	-0.015*	0.026	-0.009	1.092***	-0.003
May	13	0.578	-0.008	1.683*	-0.040	-0.065	-0.010	0.941***	-0.008	0.114	0.022	0.099	0.005	0.337**	0.001
Jun	14	0.274	0.020	0.896***	0.006	0.411*	-0.003	0.443***	0.003	0.630***	-0.017	0.602*	0.000	0.448**	0.004
Jul	15	0.138	0.005	0.240*	0.017	0.148	-0.002	0.529***	0.001	0.293*	0.004	0.057	0.001	0.186	-0.002
Aug	16	0.590	-0.004	-0.229	0.041	0.081	-0.001	0.338**	-0.000	0.490*	0.003	0.573	-0.003	0.026	0.001
Sep	17	0.181	0.030	0.394**	-0.025	0.064	-0.000	0.015	0.000	0.057	0.007	-0.013	0.004	-0.024	0.000
Oct	18	0.583***	0.009	0.206	0.006	0.234	-0.005	-0.006	0.003	0.124	-0.003	0.105	-0.004	-0.063	0.003
Nov	19	0.718***	0.011*	0.336	-0.002	0.222	-0.000	-0.003	0.000	0.028	0.003	0.130	0.002	0.123	0.000
		N=20		N=22		N=22		N=22		N=22		N=22		N=22	

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).

* p<0.05 ** p<0.01 *** p<0.001

Table 9--

Revision inefficency in 2003-2014 USDA forecasts for non-U.S. soybeans

		China				Argentina						Brazil			
		Net imports		Exports		Net exports		Production		Exports		Net exports		Production	
Month	Forecast	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant	Lagged revision	Constant
Aug	4	0.647	-0.004	0.506	0.026	-0.148	0.016*	0.151	0.003	1.834	0.006	1.585	0.009	0.000	-0.000
Sep	5	0.682**	0.008	0.169	-0.012	0.043	0.001	0.596**	0.002	0.007	0.017*	0.069	0.011	0.013	0.008
Oct	6	-0.081	0.007*	-0.353	-0.017	-0.521	-0.007	-0.347	0.007	-0.178	-0.000	-0.151	-0.002	-0.180	0.006
Nov	7	0.692	0.002	-0.404	-0.018	-0.226	-0.005	0.058	0.002	0.322	0.009	0.219	0.006	0.136	-0.002
Dec	8	0.054	0.002	0.028	0.004	0.002	0.000	-0.046	0.003	0.448**	-0.003	0.285	-0.002	0.219**	-0.001
Jan	9	0.196	0.000	1.087	-0.013	0.605	-0.002	0.862	-0.010*	0.296	0.003	0.129	0.004	0.210	0.004
Feb	10	0.387	-0.003	0.593	-0.055*	1.289	-0.015	2.145*	0.003	0.146	0.007	0.329	-0.002	0.496	-0.005
Mar	11	-0.132	0.001	0.344*	0.001	0.222	-0.001	0.184*	-0.004	0.433	-0.012	0.523*	-0.001	0.953*	-0.002
Apr	12	-0.727	-0.002	0.450	-0.004	1.009*	-0.003	1.498	0.005	0.525*	-0.005	1.254*	-0.006	1.105***	-0.002
May	13	1.119	0.001	1.660**	-0.021	0.772	-0.001	1.223***	-0.009	0.633	0.013	0.255	0.003	0.246***	0.000
Jun	14	0.388**	0.008**	0.676**	-0.027	0.407*	-0.015*	0.469***	0.003	0.680	-0.003	0.424	0.003	0.491	0.002
Jul	15	0.503	-0.001	-0.008	0.040	-0.118	-0.005	0.161	0.001	-0.167	-0.004	-0.038	-0.000	0.201	-0.005
Aug	16	1.108	0.008	0.531	0.001	-0.042	-0.004	0.442	-0.002	0.752*	0.016*	0.489	0.008	0.044	0.001
Sep	17	0.043	0.007*	0.556	-0.034	0.146	-0.005	0.045	-0.000	0.122	0.009	-0.029	0.004	-0.045	0.001
Oct	18	0.262	0.004	0.096	0.025	0.211	-0.004	0.000	0.000	-0.064	0.002	-0.001	0.003	-0.031	0.002
Nov	19	-0.196	0.013*	-0.154	0.029	0.100	0.007	0.000	-0.001	-0.005	0.002	-0.075	0.000	0.000	0.000
		N=11		N=11		N=11		N=11		N=11		N=11		N=11	

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).

* p<0.05 ** p<0.01 *** p<0.001

Table 10—

Revision inefficency in 2003-2014 USDA forecasts for non-U.S. soybeans (no constant in test equation)

		China	Argentina			Brazil		
		Net imports	Exports	Net exports	Production	Exports	Net exports	Production
		Lagged	Lagged	Lagged	Lagged	Lagged	Lagged	Lagged
Month	Forecast	revision	revision	revision	revision	revision	revision	revision
Aug	4	0.605	0.600	-0.308	0.000	2.150	1.737	0.000
Sep	5	0.639**	0.163	0.070	0.650**	0.114	0.176	0.000
Oct	6	0.019	-0.196	-0.688	0.000	-0.235	-0.218	0.000
Nov	7	0.793*	-0.294	-0.056	0.121	0.269	0.154	0.085
Dec	8	0.105	0.023	0.002	0.000	0.415**	0.250	0.227**
Jan	9	0.234	0.978	0.605	0.318	0.303	0.109	0.000
Feb	10	0.339	0.813	1.444	2.035**	0.243	0.269	0.415
Mar	11	-0.142	0.337**	0.232*	0.214*	0.262	0.527**	0.984*
Apr	12	-0.723	0.488	1.117**	1.308	0.600*	1.367*	1.120***
May	13	1.103	1.765**	0.799	1.269***	0.399	0.208	0.244***
Jun	14	0.377*	0.759**	0.518*	0.443***	0.661	0.430	0.439
Jul	15	0.460	-0.187	-0.008	0.151	-0.171	-0.039	0.147
Aug	16	1.194	0.450	-0.009	0.429	0.657	0.479	0.000
Sep	17	0.102	0.510	0.163	0.048*	0.350	0.051	0.000
Oct	18	0.484	0.090	0.252	0.000	-0.001	0.023	0.000
Nov	19	0.211	0.076	-0.005	0.000	0.006	-0.073	0.000
		N=11	N=11	N=11	N=11	N=11	N=11	

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).
* p<0.05 ** p<0.01 *** p<0.001

Table 11—

U.S. soybean net trade forecast errors and revisions correlations with other forecasts (2003-2014)

Forecast	U.S. ending stocks Errors	U.S. ending stocks Revisions	Brazil net trade Errors	Brazil net trade Revisons	Argentina net trade Errors	Argentina net trade Revisions	China net trade Errors	China net trade Revisions
	Percent							
4	-1	19	35	-43	-26	-67	40	39
5	-10	68	16	-34	-32	-14	40	27
6	-59	29	26	-73	-24	-79	51	-26
7	-59	-19	19	26	-6	-25	63	17
8	-52	-87	23	-22	-3	2	69	21
9	-46	-45	16	-19	10	-36	73	1
10	-41	-80	11	1	34	-56	72	26
11	-31	-76	14	-26	33	-27	69	28
12	-49	8	27	-57	37	-48	67	13
13	-32	-77	11	55	25	-30	48	71
14	-31	-85	15	-1	25	-15	31	42
15	-42	-12	33	28	3	-11	-9	44
16	-24	-65	13	25	-4	36	-23	-9
17	-44	-33	-46	33	19	-23	-32	-9
18	28	-37	-20	-59	-18	-8	-43	-37
19	--	28	--	-15	--	-14	--	-43

Source: ERS calculations based on data from WASDE (various issues).

Table 12—

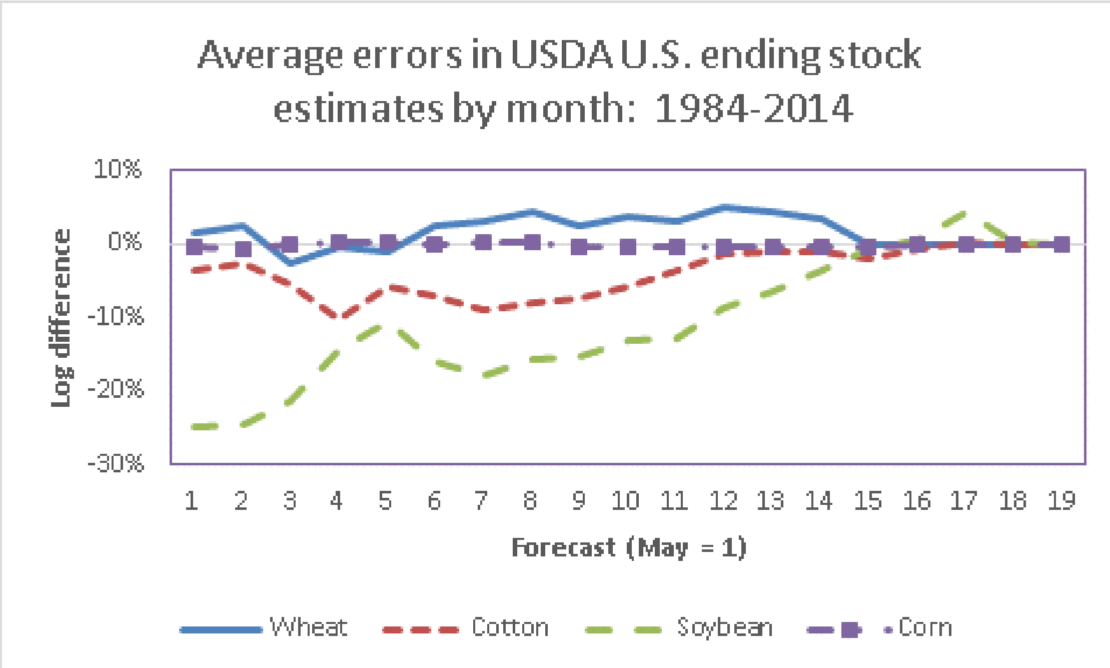
Bias in 2003-2014 USDA forecasts for export shares of soybean (and soybean meal) production

Month	Forecast	United States	Argentina	Brazil
Aug	4	0.032	-0.035	0.014
Sep	5	0.034	-0.039	0.011
Oct	6	0.031*	-0.025	0.018
Nov	7	0.030*	-0.019	0.012
Dec	8	0.029*	-0.015	0.011
Jan	9	0.030**	-0.019	0.009
Feb	10	0.028**	-0.015	0.007
Mar	11	0.023**	-0.015	0.005
Apr	12	0.017*	-0.013	0.006
May	13	0.012*	-0.024	0.003
Jun	14	0.008	-0.013	0.001
Jul	15	0.003	-0.014	-0.000
Aug	16	0.001	-0.007	-0.001
Sep	17	-0.002	-0.002	-0.005
Oct	18	0.001	0.003	-0.007
Nov	19	0.000	-0.001	-0.007
		N=10	N=10	N=10

Source: ERS calculations based on data from World Agricultural Supply and Demand Estimates (various issues).

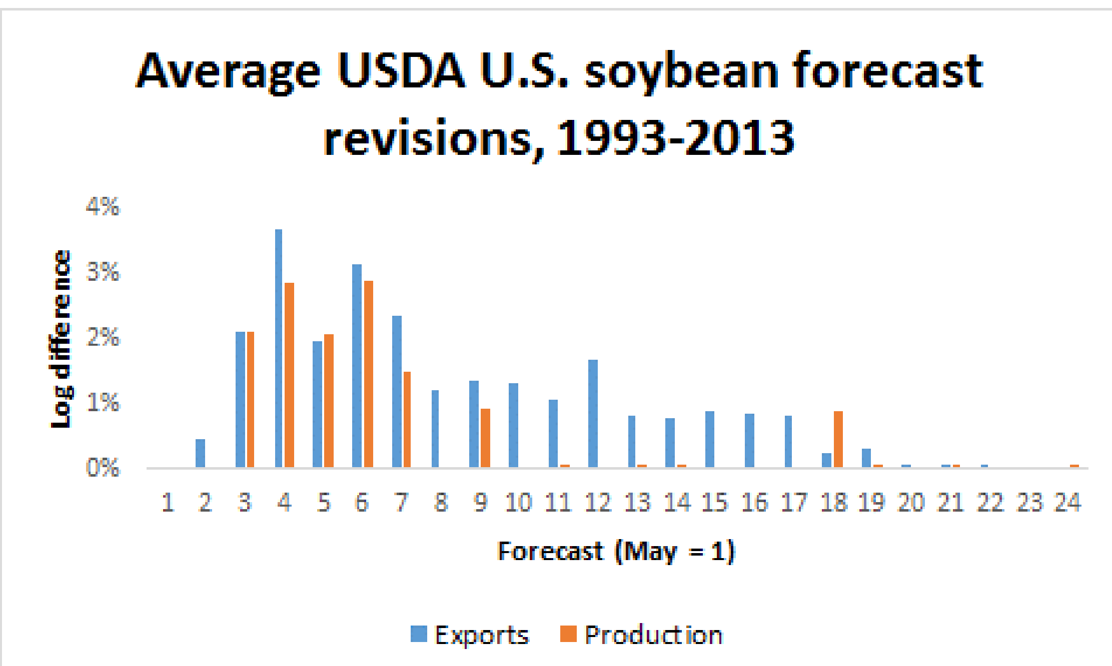
* p<0.05 ** p<0.01 *** p<0.001

Figure 1—



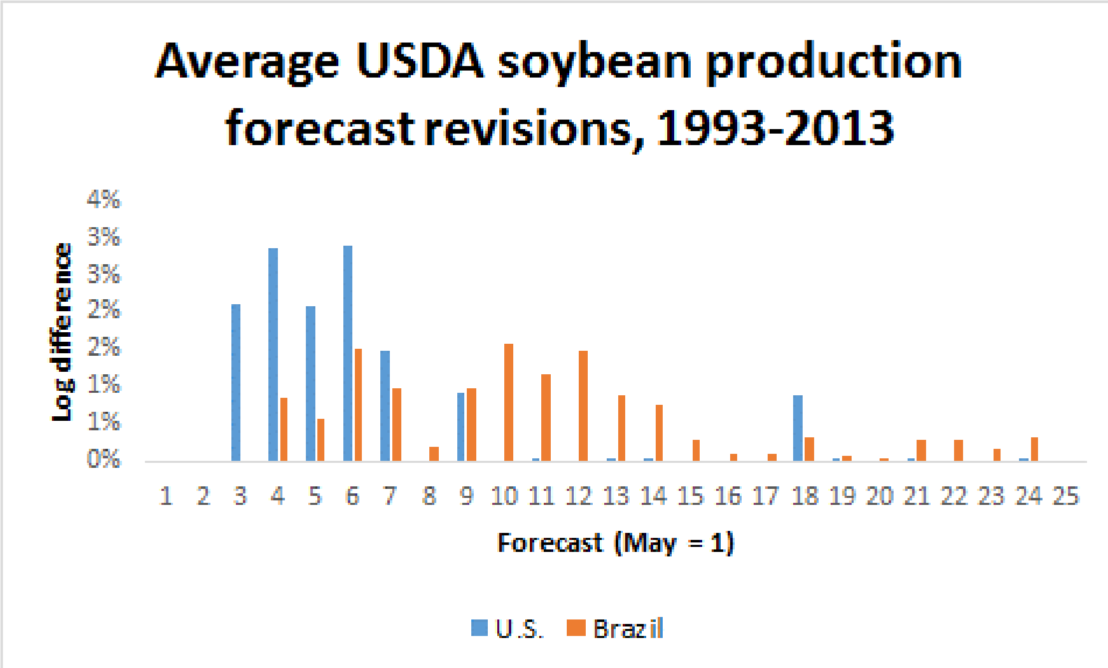
Source: ERS calculations based on data from *World Agricultural Supply and Demand Estimates* (various issues).

Figure 2—



Source: ERS calculations based on data from *World Agricultural Supply and Demand Estimates* (various issues).

Figure 3—



Source: ERS calculations based on data from *World Agricultural Supply and Demand Estimates* (various issues).