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Trends in the accuracy of USDA forecasts of beef and pork production and supply are evaluated. The USDA forecasts underestimated production and supply in the 1980s, but this bias has now disappeared. The variance of forecasts has also declined. Thus, the accuracy of the forecasts has improved. The most recent forecasts meet the criteria of optimal forecasts while the forecasts in the 1980s were not optimal.

Introduction

The value of USDA outlook reports and forecasts has been discussed and analyzed frequently in recent years. This is likely related to external pressure on the U. S. government to find areas of real or perceived cost inefficiencies within government. Also, since many private market information sources exist, some question the need for public information such as that provided by USDA. Economists have been especially interested in the costs and benefits associated with USDA forecast information and inventory reports. The literature has reflected this interest especially relating to how accurate this information is and how it influences changes in commodity futures contract prices (e.g., Sumner and Mueller; Carter and Galopin, 1993, 1995; Colling and Irwin, 1990, 1995; Meyer and Lawrence).

While arguments about the relative value and accuracy of USDA market information have continued, little attention has been paid to whether this information has improved over time or whether USDA's forecasts meet Diebold and Lopez's optimal forecasts criteria. If USDA forecasts have increased in accuracy over time the value of the information has potentially increased. Also, if USDA forecasts are optimal it implies that researchers cannot use the forecasts to make better forecasts. For example, if the forecasts were biased (i.e., non-optimal) one could adjust the forecasts for the bias and obtain better forecasts.[1] This paper determines if 1) USDA beef and pork production and supply forecasts became more accurate during1982-96, 2) the rate of improvement for USDA forecasts during the year being forecasted, and 3) if USDA forecasts for beef and pork production and supply are optimal.

USDA information is used in most fundamental commodity market analyses. The accuracy of USDA forecasts is important since accurate forecasts will contribute to efficient

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decision making. If USDA's forecasts exhibit steady improvement, it offers some support for continued funding since their value would be greater now than in the past, ignoring possible improvements in other information sources.

Theory suggests that the availability of public forecasts such as USDA forecasts reduces market price variation (Smyth). Consequently, one possible impact of improved USDA forecasts may be reductions in commodity price variability. For example, cattle price variability has declined during the 1990s[2] but the variance of live hog futures prices has remained basically unchanged since 1982. Improved USDA forecasts could be one source of the reduced cattle price variability. Of course, inventory management by meat packers and feedlots through contracts or integration might explain the reduced price variability by making beef supplies less variable. However, Ward et al. (p. 21) indicate that cash price variability is positively related to the level of captive supplies held by meat packers. Also, although hog contracting has increased dramatically during the last ten years hog price variability has not changed.[3]

The second possible reason cattle price variability is declining (besides improved USDA forecasts) may be as Purcell has suggested that beef demand is more elastic now than it was 15 years ago. We do not directly test the influence of these factors (forecasts, inventory management, or demand) on price variability other than to regress price and supply variability on a linear trend (see endnote 3). However, we believe it is important to point out the possible reasons why cattle price variability is decreasing and point out that improved price forecasts might be one of the reasons.

USDA production and supply forecasts are analyzed rather than inventory data because they represent a consistent and continuous time series of forecasts. Inventory reports such as ***Cattle on Feed*** or ***Hogs and Pigs*** report data such as placements, marketings, and intended farrowings and are not true forecasts.

Past Analyses of USDA Forecast Information

USDA makes monthly estimates for total annual beef and pork production beginning approximately 17 months prior to December of the year for which the estimate is being made. Production and supply forecasts for the coming year normally begin in August of the preceding year. The potential value of this information depends on how accurate and relevant it is (Lawrence). The relevance and timeliness of USDA production forecasts and inventory estimates has been tested in the past primarily by the effect the release of this information has had on commodity futures contract prices (e.g, Colling, Irwin, and Zulauf; Grunewald, McNulty, and Biere; Sumner and Mueller; Colling and Irwin 1990, 1995).

These past studies have investigated whether USDA inventory estimates and production forecasts provided in scheduled reports such as ***Cattle on Feed***, ***Hogs and Pigs***, and ***Crop Production*** represent new and significant market information that was not available prior to the release of the reports. Most of these studies conclude that USDA reports do influence the movement and direction of futures prices and, consequently, do provide valuable new information in commodity markets. However, USDA forecasts have also been criticized as being biased in some cases (Meyer and Lawrence).

Sumner and Mueller indicate that USDA annual crop supply estimates improve during the forecasted period, but we are unaware of any published research examining whether USDA forecasts for meats have improved over a period of years or within their specific forecast period. We do not directly measure the value of information generated by the USDA production forecasts, but rather examine if there has been a systematic decline in USDA forecast errors during the study period.

Methods

Trends are estimated for both the mean and variance of percentage forecast errors. Trends are included across years and across forecast horizons. The model used to describe the trends in USDA forecast errors is:

(1)

$$\frac{y_{kt} - y_{0t})}{y_{0t}} = \beta_0 + \beta_1 k + \beta_2 t + \beta_3 kt + \varepsilon_{kt}$$

$$\varepsilon_{kt} \sim N(\,0,\ \exp(\alpha_0 + \alpha_1 k + \alpha_2 t + \alpha_3 kt))$$

$$k = 1,\ .\ .\ ,K_t\ ;\ t = 1,\ .\ .\ ,15$$

where y_{kt} is USDA's production estimate for year t given k months before the end of the year and y_{0t} represents actual production. K_t is the number of months forecasted for year t. In most cases, K_t is 17 meaning that the first estimate is 17 months before the end of year t. Some values of k are not integers since the reports were sometimes spaced irregularly. The dependent variable is the percentage forecast error (PFE). All the parameters in the mean equation (the β vector) should be zero if there is no bias in the estimates.

Equation (1) defines a model with multiplicative heteroskedasticity. The model was first estimated with maximum likelihood using the HET command in SHAZAM.[4] The rescaled residuals had considerable autocorrelation.[5] Plots indicated that autocorrelation was slow to decline since forecast errors in a given year tended to be all negative or all positive. An error components model was used to obtain estimates and standard errors of β adjusted for the autocorrelation. PROC MIXED of SAS was used using the inverse of the estimated variance as weights.

If $\alpha_1 < 0$, then the PFEs become systematically smaller within USDA's 17-month forecast period. It would be a surprise if α_1 were not negative since for $k < 12$ the USDA has some information about production in the first few months of the year. If $\alpha_2 < 0$, then USDA's forecasts have become more accurate in general since 1982. If $\alpha_3 > 0$, it indicates the variance of the PFEs during the early months of a forecast are smaller in the final years of the study period than during the initial years.[6] If so, then USDA is providing better forecasts during the early months of the forecast period suggesting decision makers now receive better information earlier than in past years. The hypotheses regarding the signs of α_1, α_2, and α_3 are tested using the sign of the parameter estimates for the variance equation and their corresponding t-statistics.

We also determine if USDA forecasts for beef and pork production and supply are optimal. Diebold and Lopez define optimal forecasts as having the following criteria:

1. Optimal forecast errors have a zero mean.
2. 1-step-ahead optimal forecast errors are white noise, i.e., have a zero mean and a constant variance.
3. p-step-ahead optimal forecast errors are at most a moving average of order p-1.
4. The p-step-ahead optimal forecast error variance is non-decreasing in p.

The test of criterion 1 can be undertaken using the parameter estimates of the mean equation (β). If these parameters are all zero no bias exists in the forecast because the forecast errors have a zero mean. Criterion 2 is unlikely to be violated here, but we test it by regressing the annual FPE (January forecast) against the previous year's annual forecast. If criterion 2 is met, the current year's forecast should have no significant correlation with the previous year's forecast. Criterion 3 does not apply in this case since the forecasts are monthly, but the series being forecasted is annual. Criterion 4 implies that the derivative of the variance equation with respect to *k* should be negative. We also plot the forecast variance over the forecast period. The variance of optimal forecasts should decline continuously throughout the forecast period if criterion 4 is met.

Data

Data are taken from USDA's World Outlook Board World Agricultural Supply and Demand Estimates (WASDE). These forecasts are published on basically a monthly basis and estimate year-end production and supply for meats and crops.

Since 1982, WASDE estimates of annual beef and pork production and supply have been available beginning approximately 17 months prior to the end of the year being forecasted. The data cover the period of May 11, 1982 through August 12, 1996 (260 observations). The difference between the production and supply series is the amount of imports. Hence, differences in accuracy between production and supply are basically measures of USDA's ability to forecast imports relative to domestic production.[7]

Figure 1 presents the standard deviations for the beef and pork production and supply PFEs within their forecast periods.[8] The variability of forecast errors declines dramatically during the forecast period. In the case of beef, the variability of the forecast errors declines in basically a linear fashion, thus fulfilling criterion 4 for optimal forecasts. Pork forecast variability sometimes rises which violates criterion 4.[9] The inconsistency with criterion 4 could be due to random variation and the variance does trend downward for all four series.

Higher variability in forecast errors for pork than beef probably results from pork's shorter production cycle. Slaughter hogs finish at an age of about six months, but cattle are usually well over a year old at slaughter. As a result, resources to produce beef are committed before the forecast period. However, hog numbers depend on decisions made during the forecast period which makes forecasting during the first part of the 17-month forecast period more difficult for pork than for beef.

Results

Table 1 reports the parameter estimates of equation (1) for forecasts of domestic production and total supply of beef and pork. The parameter estimates for all four models are similar. The production and supply estimates had to be close since supply equals production plus imports.

The forecast errors are not optimal since all of the parameters in the mean equation are significant (criterion 1) and therefore the forecasts are biased. In the early years of the study period, USDA's forecasts during the first few months of the forecast period underestimated production and supply by 5-7%. But, the bias disappeared by the end of the year being forecasted. For years at the end of the study period, the net effect of the four coefficients in the mean equation is approximately zero. This means that more recent USDA forecasts are unbiased and that whatever problem USDA had with their forecasts appears to have been corrected. This is confirmed in Figure 2 and 3 where the estimated mean FPEs for beef and pork production in 1983 and 1996, respectively, are plotted against the number of months within the forecast period. The confidence interval for 1996 includes zero for both beef and pork but 1983 exhibits a statistically significant negative bias for both meats (fig. 3 and 4).

The variance of USDA forecast errors, as expected, declines during the forecast period for all four series. This is evidenced by the negative parameter estimates for the within period trend. Forecasts have also improved with the passage of time for beef production and beef supply since the parameter estimates for these models have a significant negative overall trend. Although pork production and supply forecasts also improved between 1982 and 1996, the improvement is only statistically significant with pork supply.

The coefficients in the variance equation are the percentage change in variance with respect to a change in time. The time change over the entire period is 15 years. So the percentage changes in variance are quite large. The predicted standard deviations in 1996 were less than half of what they were in 1982. This reduction in the variability of forecast errors occurs primarily early in the forecast period when forecast errors are the largest (interaction term). This may help farmers, buyers, and processors allocate resources better since forecasts before calves and piglets are born are more accurate now than before. There is little reduction in variability in forecast errors for the end of the year being forecasted.

Criterion 2 for optimal forecasts is met for all but the beef supply series (Table 2). Since all four models fail to meet criterion 1 and the pork models violate criterion 4, USDAs forecasts were not optimal over the entire study period. However, USDA forecasts for beef and pork production and supply appear to meet the optimality criteria during the last few years of the study period.

Conclusions

This paper determined whether or not USDA forecasts of domestic production and total supplies of beef and pork have become more accurate and if they are optimal forecasts. The most recent USDA forecasts are optimal forecasts. A significant downward bias was found for both beef and pork forecasts of production and supply in the early years of the study period (1982-96), but the bias is no longer present. The forecast error variability of USDA forecasts has declined during the study period. This reduction in variability could be due to improvements in USDA's forecast procedures or to changes in the markets which made quantities or demand easier to forecast.

The variability of beef forecasts has dropped more than the variability of pork forecasts. This reduced forecast error variability is a possible explanation for the reduced beef price variability which has also occurred. The efficient gathering and dissemination of relevant market information helps to reduce long-run price swings and thus reduces risk for both buyers and sellers in livestock markets. Most studies have found that USDA forecasts offer new and valuable information in the marketplace. This study shows that this information has improved with the passage of time.

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Endnotes

1. In other words, we are not testing to determine if USDA could make better forecasts with the data they use to produce their forecasts, but rather if the forecasts themselves could be used to produce better forecasts.

2. The monthly variance of percentage price changes in daily live cattle and live hog futures were regressed against linear trends. Price variance for live cattle exhibited a significant downward trend during the 1982-1996 period while the variance of live hog futures showed no significant trend during the study period.

3. Further evidence that changes in supply variability have not been a major influence in decreasing price variability is our analysis of trends in the variability of weekly beef and pork production between 1980-1997. No significant trend in beef production variability since 1980 was found while pork production variability declined significantly during the same time period. This suggests beef inventory management has not significantly reduced supply variability although beef price variability has declined during the last decade. At the same time, pork producers have succeeded in reducing supply variability but not price variability.

4. We also estimated a linear regression of absolute value of the percentage forecast errors against k and t. The conclusions were unchanged. We report the maximum likelihood estimates because they are slightly more asymptotically efficient.

5. Because the exogenous variables are the same in all four models using equation (1) in this paper (beef and pork production and supply) and the variance is rescaled to one, the parameters in the variance equation of all four models will have the same standard errors.

6. One can think of the interaction term (α_3) as a time varying parameter. Mathematically, $\alpha_1 k + \alpha_3 kt$ may be written as $k(\alpha_1 + \alpha_3 t)$. Thus, the parameter on k (α_1) changes over time and α_3 says how much it changes. Since α_1 is negative and α_3 is positive, α_1 becomes less negative over time and the slope of the estimated variance function flattens as a result.

7. Exports are not considered in the total supply figures.

8. Average PFEs follow almost the same pattern as the standard deviations during the forecast period.

9. An examination of the standard deviations of the FPEs for the first seven years of the study period (1982-88) and the second eight years (1989-1996) reveals basically the same graph for beef and pork production and supply. However, during the last eight years the variance is much lower during the first few months of the forecast compared to the variance during the first seven years of the study period. This is confirmed by figure 4.

Table 1. Estimated Trends in the Mean and Variance of USDA Percentage Forecast Errors of Domestic Production and Total Supply of Beef and Pork, 1982-96.

Independent Variable	Beef Production	Beef Supply	Pork Production	Pork Supply
Mean Equation:				
Intercept	-0.07617**	-0.07898**	-0.05957**	-0.06532**
	(0.00947)	(0.00816)	(0.01361)	(0.01358)
Within (*k*)	0.00438**	0.00428**	0.00328**	0.00353**
	(0.00052)	(0.00045)	(0.00075)	(0.00074)
Overall (*t*)	0.00539**	0.00626**	0.00632**	0.00679**
	(0.00107)	(0.00083)	(0.00162)	(0.00152)
Interaction(*k***t*)	-0.00031**	-0.00033**	-0.00035**	-0.00036**
	(0.000051)	(0.00004)	(0.00008)	(0.00008)
Variance Equation:				
Intercept	-4.781**	-4.741**	-4.556**	-4.790**
	(0.384)	(0.384)	(0.384)	(0.384)
Within (*k*)	-0.377**	-0.386**	-0.381**	-0.361**
	(0.038)	(0.038)	(0.038)	(0.038)
Overall (*t*)	-0.132**	-0.189**	-0.083**	-0.115**
	(0.043)	(0.043)	(0.043)	(0.043)
Interaction (*k***t*)	0.013**	0.013**	0.014**	0.018**
	(0.004)	(0.004)	(0.004)	(0.004)

Note: Numbers in parentheses are standard errors. A double asterisk (**) indicates significantly different than zero at the 1% level while a single asterisk (*) indicates significantly different than zero at the 5% level.

Table 2. Test for One-Step-Ahead Forecast Errors as White Noise (Criterion 2).

Independent Variable	Beef Production	Beef Supply	Pork Production	Pork Supply
Intercept	-0.00858	-0.00570	-0.00472	-0.00044
	(0.00990)	(0.00890)	(0.01531)	(0.01038)
Lagged Annual FPE	0.44994	0.60346*	-0.24715	-0.02228
	(0.2861)	(0.2585)	(0.2602)	(0.26100)

Note: Numbers in parentheses are standard errors. A single asterisk (*) indicates significantly different than zero at the 5% level.

Figure 1. Standard Deviations of USDA Beef and Pork Production and Supply Forecast Errors, 1982-96.

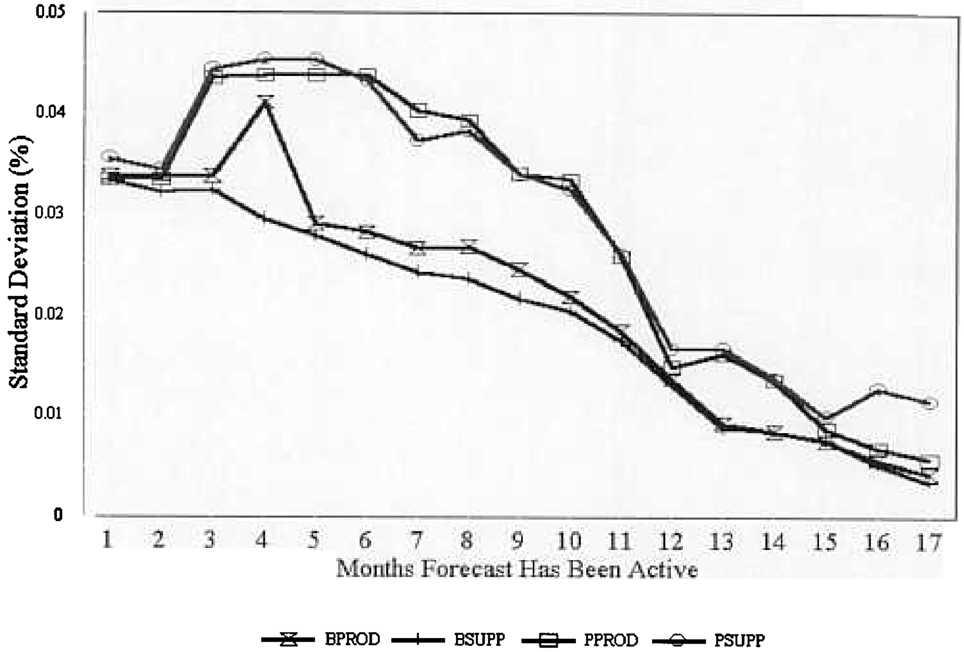

Figure 2. Predicted FPEs for Beef Production with 95% Confidence Intervals for 1983 and 1996.

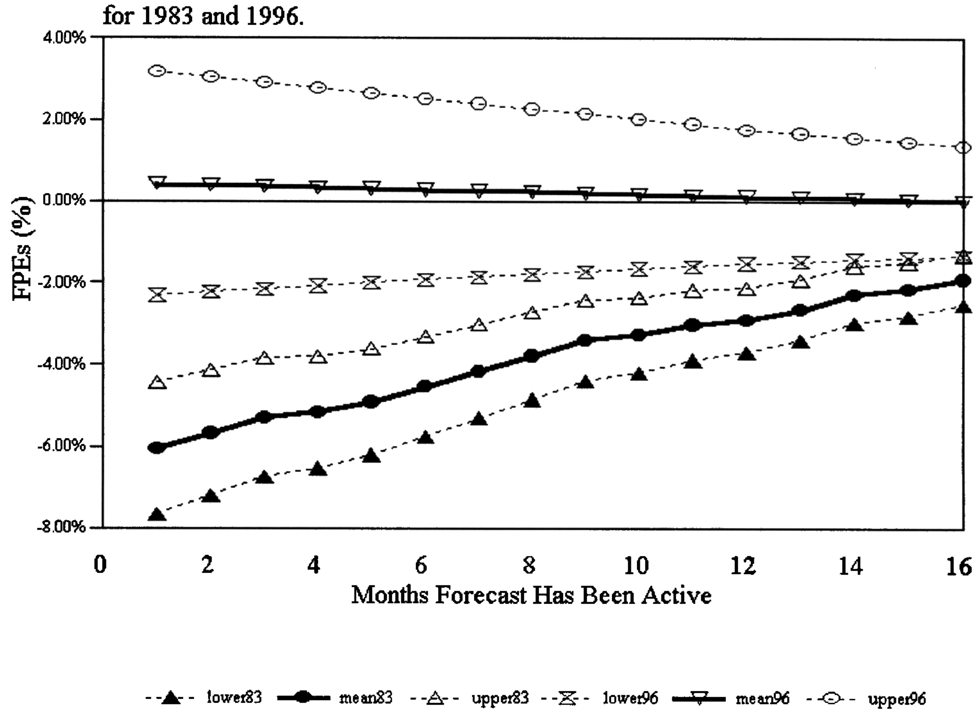

Figure 3. Predicted FPEs for Pork Production with 95% Confidence Intervals for 1983 and 1996.

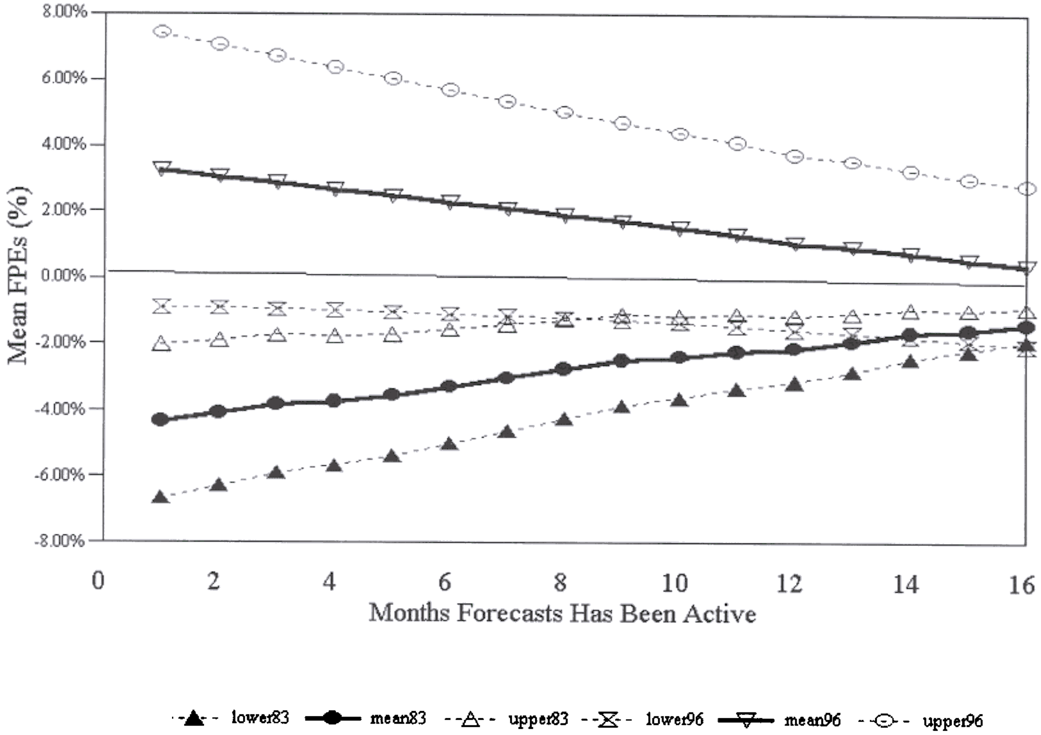

Figure 4. Predicted Variances for the FPEs for 1983 and 1996.