Modeling the Impact of Food Irradiation Technology on U.S. Meat and Feedgrain Exports

by

Dermot J. Hayes, Greg Hertzler, and Evert Vander Sluis

Comparing USDA Hogs and Pigs Reports to Subsequent Slaughter: Does Systematic Error Exist?

by

Steve R. Meyer
and
John D. Lawrence

Problem Situation

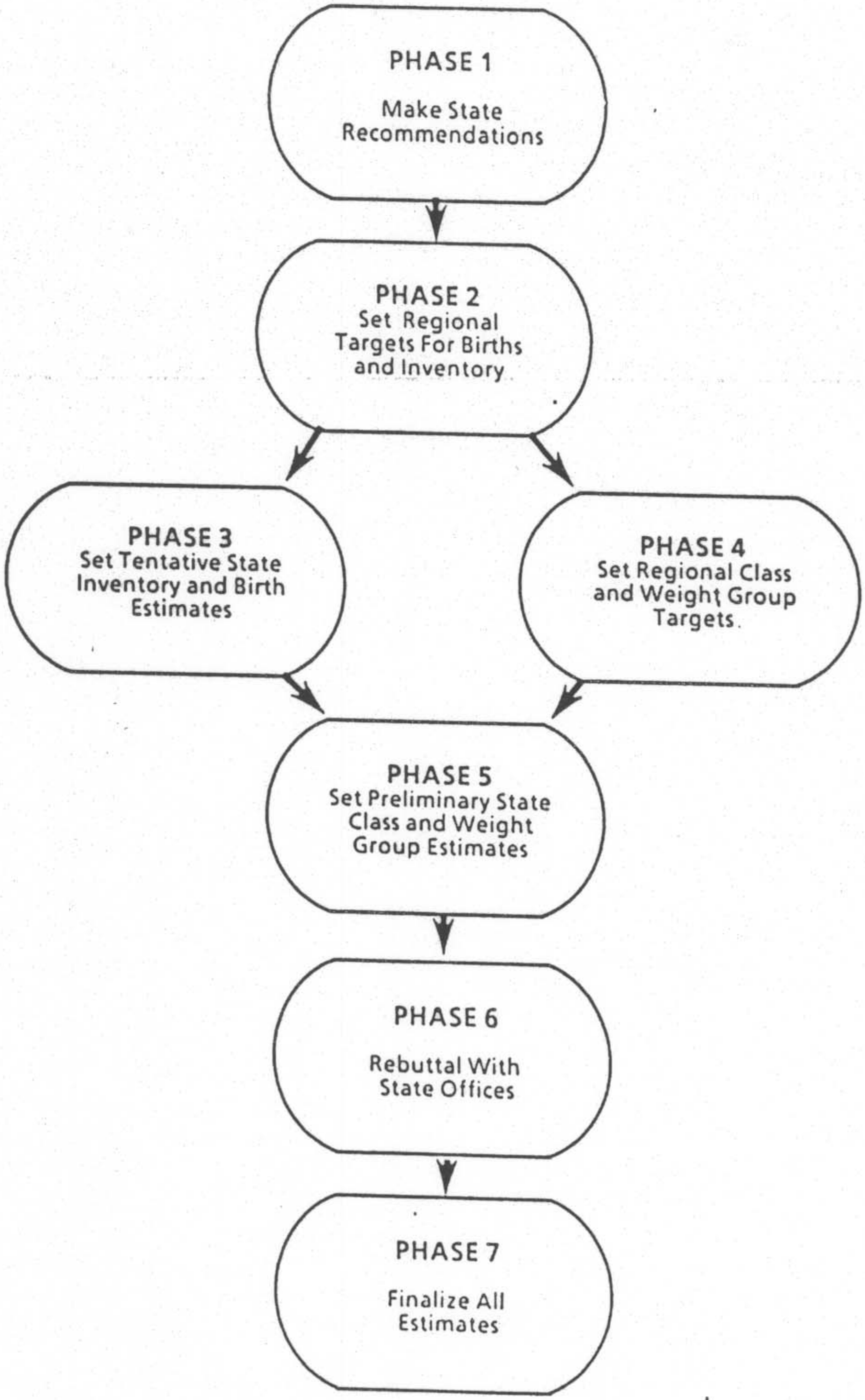
The quarterly Hogs and Pigs Report of the USDA is a major source of information concerning the number of hogs in the United States and the productive capacity of the pork industry. The information contained in the report often influences cash markets, futures markets and producer decisions regarding expansion or contraction of the breeding herd. However, the reports are subject to several types of error and thus may convey erroneous information.

Two events prompted this research. First, in April 1987, a knowledgeable hog producer commented privately that "the March report is always wrong." His reasons for the statement are unknown, but the presence of this belief on the part of a knowledgeable swine producer, especially with regard to the report for a specific quarter, raises questions about report accuracy and the possibility of systematic errors. Second, the accuracy of the March 1987 and June 1987 reports is highly questionable since slaughter numbers subsequent to their releases did not verify the relatively high inventories reported.

Relatively few studies have investigated the accuracy of the Hogs and Pigs Reports. Blanton, et al. (1985) developed a quarterly econometric model using biological restrictions. This model included equations for additions to the breeding herd, sow slaughter and barrow and gilt slaughter and results suggested that the Report may be made more accurate by incorporating an econometric model into the process of data evaluation. Moe, Futrell and Brown investigated the relationship between USDA pig crop and sow farrowing estimates and barrow and gilt slaughter lagged six months. They concluded that pig crop estimates were more closely related to lagged slaughter values than were sow farrowings and that the differences between the USDA estimates and lagged slaughter are influenced by the profitability of hog feeding. Blanton, et al. provide a comprehensive review of the history of the Hogs and Pigs Report.

Producer responses to the hogs and pigs inventory survey go through a seven phase process before being published as a Hogs and Pigs Report (U.S. Dept. of Agriculture, 1988). Figure 1 depicts this process. As with any data analysis, some degree of subjectivety exists in, say, delineating outliers and nonsample errors. Note that input from various state agricultural statistics offices occurs mainly in phases 1 and 6. All other phases involve a group of only 8-12 USDA analysts in Washington, D.C. The involvement of this many people underscores the possibility that individual judgment may affect inventory estimates.

Figure 1: Hogs and Pigs Report estimation process (U.S. Department of Agriculture, 1988)



Objectives

The objectives of this research are to test three hypotheses regarding observed errors in the Hogs and Pigs Report. These hypotheses are:

1. Current prices of hogs and corn and/or prices of these items during the quarter immediately preceding the release of a report influence either producer responses to survey instruments or the data reviews and manipulations of USDA personnel, thus resulting in report errors.
2. Hog and corn prices during the breeding period corresponding to a given weight class of the report explain apparent errors in report values due to their influence on either producer responses or USDA data manipulation and review.
3. The errors in the Hogs and Pigs Reports are seasonal.

Procedures

The major procedure undertaken to test the above hypotheses was to develop a tracking model which is used to estimate the number of pigs in specific weight classes of the Hogs and Pigs Report. The difference between model estimates and USDA estimates are then analyzed. This model begins with barrow and gilt slaughter and slaughter weights and works backward in time using estimates of gilt retention (Grimes, 1988), average daily gain for various weights and ages of pigs (Ewan, et al., 1982), death losses for various ages (University of Missouri, 1975 and 1987) and seasonal indexes of average daily gain. The seasonal indexes for average daily gain were derived from data collected in Northern Missouri in 1986.

Table 1 shows the average daily gain and death loss values used in the model. Table 2 shows the seasonal adjustment coefficients for average daily gain.

Farrowings were assumed to be uniformly distributed in all months therefore yielding a uniform distribution of pig weights within a month. The ratio of males to females born was assumed to be 1:1 (i.e. 50 percent males and 50 percent females).

Data were collected for 1975 through 1987. Barrow and gilt slaughter came from Livestock Slaughter (USDA, various issues). Slaughter weights and hog prices were those reported by five major hog markets while corn prices were U.S. average cash prices. Initial (not revised) Hogs and Pigs Report inventories were collected for the same time periods.

The model begins by assuming an even distribution of monthly slaughter thereby yielding an average slaughter date at mid-month. Gilt retention is added to barrow and gilt slaughter to arrive at the total inventory of market-weight hogs for each mid-month day. One-half month's growth is then deducted from the average slaughter weight to arrive at the average weight of the month's market-weight hogs on the first day of the month. Total market-weight hogs is then multiplied by one plus the death loss from Table 1 which corresponds to the age of the pigs on the month's first day. This yields an adjusted inventory figure for the first day of the month. This procedure of deducting one month's growth and adding death losses to

Table 1: Average daily gain and death losses by time period, t = slaughter month.

Time period (months) Begin	End	ADG (lbs.)	Death Loss (%)
t-5.5	t-5.0	.5	17.7
t-5.0	t-4.5	.5	
t-4.5	t-4.0	.6	7.8
t-4.0	t-3.5	1.0	
t-3.5	t-3.0	1.25	2.0
t-3.0	t-2.5	1.50	
t-2.5	t-2.0	1.55	1.0
t-2.0	t-1.5	1.65	
t-1.5	t-1.0	1.70	0.5
t-1.0	t- .5	1.75	
t- .5	t	1.75	0.5

Table 2: Monthly indexes of average daily gain.

Slaughter Month	Index
January	1.029
February	1.029
March	1.007
April	.986
May	1.014
June	.971
July	.957
August	.899
September	.964
October	1.036
November	1.094
December	1.144

subsequent month's inventories is repeated until a given group has been worked back to less than five pounds in average weight thereby yielding the group's computed birth month and the number of pigs farrowed in the birth month.

At the beginning of each reporting quarter, inventories for each USDA weight class are computed. Due to the assumption of an uniform farrowing distribution and the use of constant average daily gains across all animals, each slaughter group for a month was uniformly distributed in weight at any point in time. Therefore, the group could be divided between inventory weight classes by computing the ratio

$$P = \frac{W_{t + .5} - LW}{W_{t + .5} - W_{t - .5}}$$

where $W_{t + .5}$ = average weight of the group one-half month after the report date,

$W_{t - .5}$ = average weight of the group one-half month before the report date

LW = lower weight of the inventory weight class.

P represents the percentage of the group whose weight exceeds the lower weight of the class and one minus P gives the percentage weighing less than the lower weight and therefore falling into the next lighter weight classification. This procedure prevented entire slaughter-month groups from being moved from one weight class to another and therefore prevented lumpiness in the predicted inventory values.

Finally, differences between inventory levels reported by the USDA and the levels predicted by the model were computed for all quarters from the first quarter of 1975 to the second quarter of 1987. These differences were analyzed for systematic components using ordinary least squares with various combinations of seasonal dummy variables, hog prices, corn prices, hog-corn price ratios and lagged values of the price variables as regressors.

Results

Figures 2 through 7 show plots of differences between USDA values and predicted values for six different report classifications. All differences are computed by subtracting predicted values from the USDA estimates. Total differences (Figure 7) refers to the total number of market hogs. The reader should note that the scale of the vertical axes in the figures differ.

Errors in USDA estimates for the pig crop, under 60 pounds and for 60-119 pounds are greater in magnitude than are the errors for the heavier weight classes. This is due, at least in part, to the fact that the lighter weights represent a new group of pigs while the heavier weight classes of each report represent pigs that were included in lighter weight classes of the previous report. Pigs that appear in two successive reports afford the USDA an opportunity for cross-checking survey results and revising estimates.

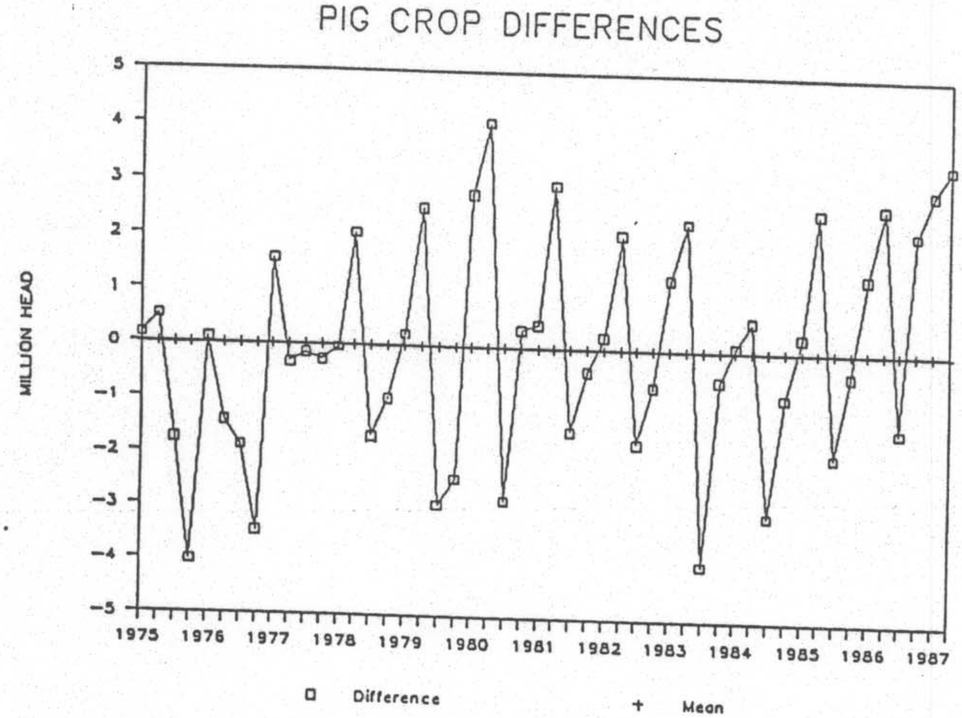


Figure 2

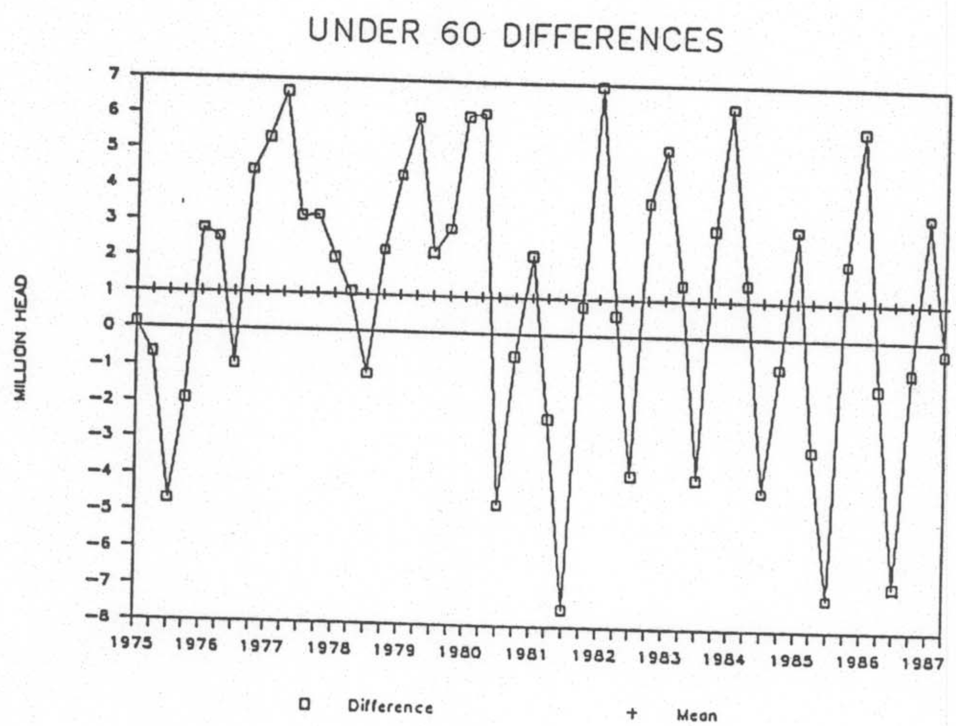


Figure 3

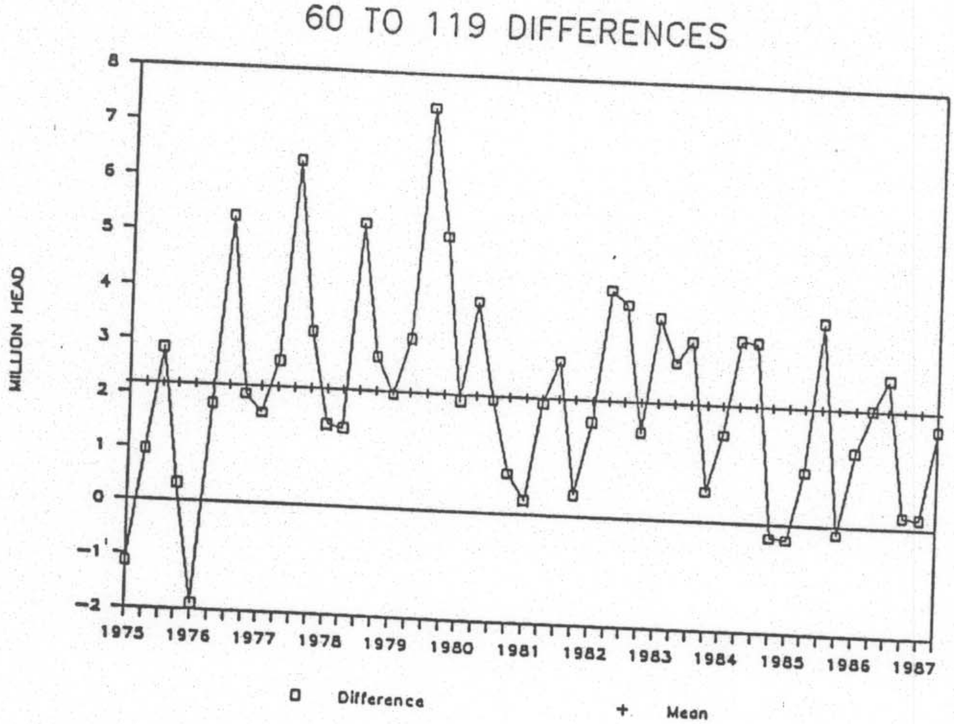


Figure 4

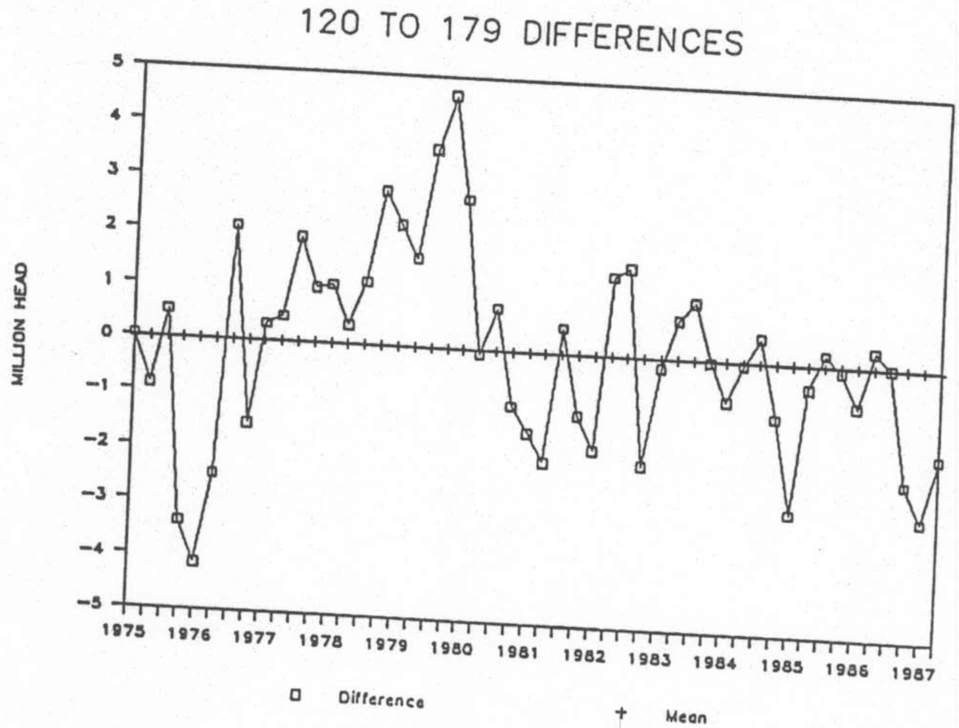


Figure 5

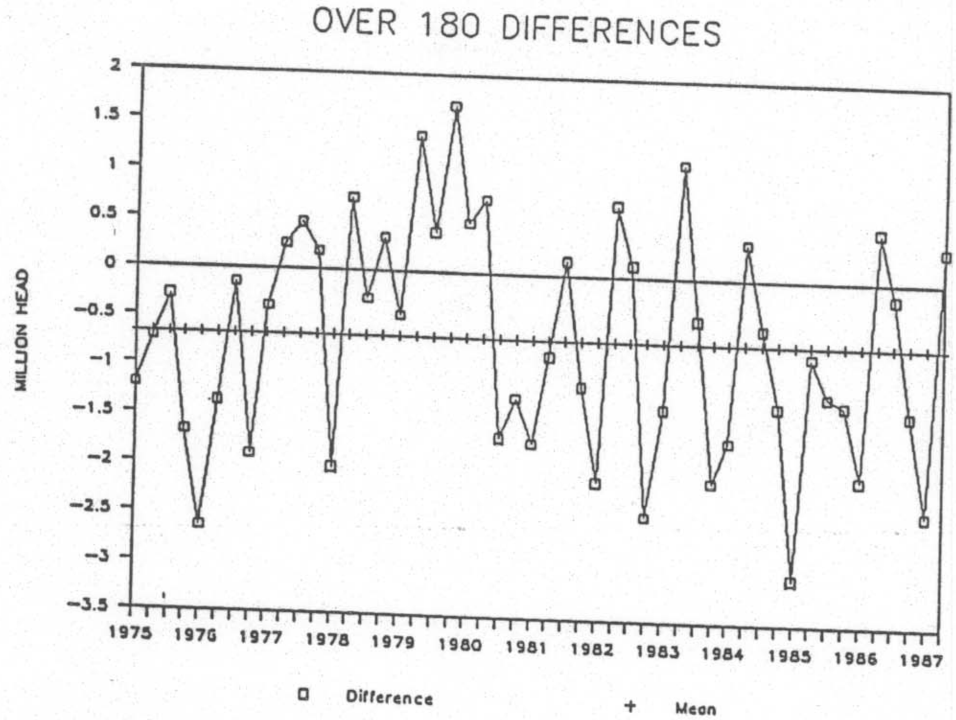


Figure 6

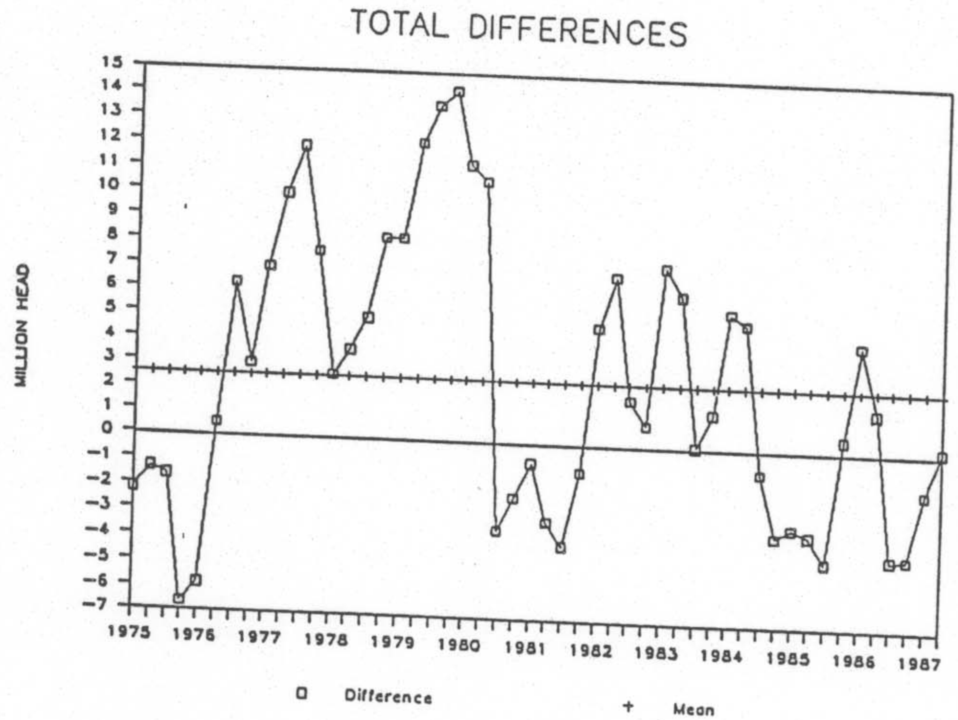


Figure 7

Since 1978, the largest pig crop differences occur in the second quarter (i.e. June report), suggesting that the USDA consistently overestimates March, April and May farrowings and/or litter size. Similarly, every peak in differences for the under 60 pounds class since 1980 has occurred in the first quarter (i.e. March report), while the third quarter (September report) has represented the peak differences for the 120 to 179 pound category. Third quarter peaks in the 120-179 pounds differences are consistent with overestimating March through May farrowings. First quarter peaks in the under 60 pounds differences are inconsistent with differences found for heavier classes in later reports. Patterns of differences were not nearly as consistent in the 60 to 119 pounds and over 180 pounds classes.

A marked downward shift in differences for all classes representing pigs over 60 pounds as well as the total market hogs class (Figures 4 through 7) occurred in 1980. Because of this shift, mean values for the differences after 1980 were computed for all weight classifications and tests were made to discover if these means were significantly different from zero. Table 3 contains the results of these tests. Only the means of the differences for the under 60 to 119 pounds and 180 pounds and over classes were significantly different from zero for the recent time period. Also, the mean of the differences for the total market hogs class declined markedly and is not significantly different from zero. The mean of differences for the pig crop increased somewhat during the recent time period, but is still not significantly different from zero.

Table 3: Number of observations, means and t values for H_0:M = 0 1975-1987 and 1980-1987.

	1975-1987			1980-1987		
Class	N	Mean	t[1]	N	Mean	t[2]
Pig Crop	50	-30.14	-.11	30	431.30	1.13
Under 60 pounds	50	1002.17	1.87	30	356.39	.46
60-119 pounds	50	2204.52	8.43	30	1914.92	7.45
120-179 pounds	50	-25.74	-0.10	30	-420.67	-1.74
180 pounds and over	50	-678.97	-4.22	30	-876.00	-4.32
Total mkt. hogs	50	2501.99	3.19	30	974.64	1.18

[1]Critical value of t for 49 d.f. and .05 significance level is 2.01
[2]Critical value of t for 29 d.f. and .05 significance level is 2.04

No obvious explanation exists for the apparent improvement of the USDA inventory estimates for years since 1980. Blanton, et al. list no major changes in collecting and reporting procedures that were initiated in 1980. The authors' best hypothesis is that a talented person (an agricultural economist no doubt) was placed in charge of the Hogs and Pigs Reports at this time.

The previously discussed graphs suggested the need for quarterly dummy variables in regression equations, and estimation of these equations confirmed this need. All equations for all classes have at least two significant quarterly dummy variables. The reader is referred to the Appendix for tables showing the results of all regressions.

The current hog-corn price ratio (HC) and average hog-corn price ratio for the previous quarter were significant predictors for DIFFPC (pig crop differences) only. No price variables were significant predictors of DIFF60 (under 60 pounds differences) and only quarterly average corn prices and hog-corn price ratios for lags of two quarters (QCPT2), three quarters (QCPT3) and four quarters (QCPT4) were significant price variables in prediction equations for differences in the 60 to 119 pounds (DIFF119), 120-179 pounds (DIFF179) and 180 pounds and over (DIFF180) classes, respectively. These lags relate report categories to the corresponding time period when breeding decisions were made. The parameter estimates for the corn price variable are negative while those for the hog-corn price ratios are positive; results that were expected.

There are two possible explanations for these results. First, producers may alter the way in which they answer survey questions in a manner which reflects what economic logic dictates "should" be happening. This action would be taken because producers wish to protect their positions. Favorable current or past price ratios suggest that inventory differences increase. Large inventory reports would tend to discourage entry into the hog business thereby leaving current producers in a better situation with regard to future profitability. Therefore, producers increase the numbers of hogs and pigs in their responses to surveys.

The second explanation is similar, but involves USDA personnel rather than producers. Favorable prices, whether current or past, would encourage data analysts to adjust survey data upward simply because they know that such prices should have encouraged expansion. Thus, many people have an input in this seven-phase process previously discussed and adjustments are made to the data. The authors are not, in any way, accusing USDA personnel of carelessness or manipulation for personal gain, but are only pointing out that market conditions may influence the adjustments made to data. While such biases are unintentional, the information that results from them may easily mislead producers and other decision-makers.

Summary and Conclusions

This report has described a tracking model that was developed to predict the number of pigs in the various weight classes of the USDA Hogs and Pigs Report for the years 1975 through 1987. Slaughter numbers are the base values for the model because they represent enumeration data, not estimates. Differences between USDA estimates and the predicted inventories were regressed on current and lagged prices of hogs and corn and seasonal dummy variables to investigate the existence of predictors for these errors.

Several conclusions may be drawn from the results of this study. They are:

1. Means of the differences between predicted and reported data for pig crop, inventory under 60 pounds and total market hog inventory for the time period 1980-1987 are not significantly different from zero. This suggests that the USDA, on average, does a good job of estimating the number of lightweight hogs in the U.S. However, these three classes also possess the most variation of all inventory classes.
2. The mean value of differences in the 180 pounds and over classification is significantly different from zero. The negative value of this mean implies that USDA reports are, on average, below the inventories predicted by our model. Since this class represents hogs that will be slaughtered in the short term, USDA inventory estimates may, again on average, positively influence cash markets. It should be noted, however, that the predicted inventories of hogs 180 pounds and over is directly related to the gilt retention data used. While the authors view this data as sound, they do come from a small sample of pork packers.
3. USDA estimates of second quarter pig crop and third quarter (September 1) inventories of pigs between 120 and 179 pounds are consistently high. These results are consistent with one another.
4. Prices at the time of report release or immediately preceding report release are significant predictors of differences between USDA estimates and predicted values for the pig crop. This result suggests that high hog-corn price ratios (or low corn prices) may cause upward bias in the USDA estimates. The exact source of such bias could not be determined within the scope of this study.
5. Prices for time periods which correspond to the breeding period for pigs weighing all the way from 60 pounds to market weight were significant predictors of differences for the three classes in which such pigs would be included. The positive relationship between hog-corn price ratios and differences and the negative relationship between corn prices and differences reinforces the postulation of bias discussed in result number 4.

The USDA and its personnel face a difficult task each quarter in their attempt to estimate the number of hogs and pigs on farms in the United States. Dedicated people use sophisticated techniques to gather and process a great deal of data. But they face this difficult task with limited resources.

Results of this study suggest, first, that the effect of current market conditions on producer responses to survey instruments should be evaluated. Second, care should be taken by USDA personnel who compile inventory data to not be influenced by the same market conditions. Finally, the seasonal nature of hog production in the United States should be closely scrutinized. Hogs and Pigs Reports appear to overemphasize this seasonality, an occurrence which may be the result of inadequate consideration of structural changes within the industry which have resulted in a lower proportion of the pasture farrowing which was long a major contributor to seasonal highs in farrowings in the spring and early fall months.

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Appendix 1: Parameter estimates for pig crop difference (DIFFPC) prediction equations.*

Int	HCT2	QHPT2	QCPT2	QHCL1	HC	HPT2	CPT2	QHCT2	D1	D2	D3	D4	R^2	F
-8.93	44.58									1028.01	-2822.65	-1786.59	.61	16.53
(-.01)	(1.11)									(1.86)	(-4.90)	(-3.81)		
									864.48 (2.31)	1837.19 (4.92)	-2078.08 (-5.34)	-974.34 (-2.51)	**	16.09
-938.3 (4.26)				89.78 (2.75)						1120.52 (2.25)	-2910.66 (-5.77)	-1940.67 (-3.54)	.64	20.28
-472.84 (-.75)					73.35 (2.58)					819.75 (1.63)	-3141.09 (-6.11)	-2031.71 (-2.94)	.64	19.71
3740.04 (1.97)						-24.18 (-.78)	168.10 (-1.51)			977.89 (1.78)	-3015.69 (-5.28)	-1725.61 (3.95)	.62	13.73
469.74 (.51)								23.06 (.54)		989.23 (1.76)	-2984.37 (-5.33)	-1839.38 (-3.23)	.60	15.96
4675.64 (2.17)		-40.92 (-1.27)	-651.98 (-1.38)							723.66 (1.27)	-3181.07 (-5.70)	-2135.95 (-3.70)	.62	13.91

*Numbers in parentheses represent t values for $H_0:b_1=0$.

**R^2 not applicable because model was restricted.

Appendix 2: Parameter estimates for less than 60 pounds differences (DIFF60) prediction equations.*

Int	HCT2	QHPT2	QCPT2	QHCL1	HC	HPT2	CPT2	QHCT2	D1	D2	D3	D4	R^2	F
1662.37 (.88)	-4.98 (-.06)								2885.88 (2.56)		-4857.80 (-4.13)	69.10 (-.06)	.53	12.05
									4110.92 (5.37)	1384.85 (1.81)	-3279.68 (-4.11)	1501.68 (-1.88)	**	13.13
2099.93 (1.37)				-38.79 (2.75)					2789.93 (2.54)		-4614.44 (-4.22)	224.70 (.20)	.50	11.38
2686.84 (1.83)					-64.08 (1.04)				2592.43 (2.38)		-4624.70 (-4.18)	151.72 (.14)	.51	11.77
7525.23 (1.98)						-65.30 (-1.05)	-1213.30 (-1.32)		2970.52 (2.68)		-4882.65 (-4.22)	347.57 (.31)	.56	10.60
509.38 (.26)								49.45 (.58)	2959.16 (2.62)		-4725.25 (-4.14)	144.57 (.12)	.53	12.23
5668.78 (1.39)		-19.02 (-.24)	-1372.50 (-1.42)						3311.88 (2.84)		-4573.05 (-4.04)	261.35 (.23)	.55	7.54

*Numbers in parentheses represent t values for H_0:b_1=0.

**R^2 not applicable because model was restricted.

Appendix 3: Parameter estimates for less than 60 to 119 pounds differences (DIFF119) prediction equations.*

Int	HCT2	QHPT2	QCPT2	QHCL1	HC	HPT3	CPT3	QHCT2	D1	D2	D3	D4	R^2	F
777.20 (.78)	19.47 (.45)									1360.36 (2.30)	2980.96 (4.84)	249.34 (.42)	.42	7.70
									1006.40 (2.49)	2421.74 (5.99)	4087.30 (9.71)	1384.38 (3.29)	**	36.82
1064.43 (1.23)				-2.89 (-.08)						1410.58 (2.43)	3079.87 (5.22)	381.25 (.65)	.92	8.05
1526.28 (2.12)					-28.51 (-.87)					1474.80 (2.55)	3158.08 (5.34)	452.96 (.77)	.43	8.37
4064.54 (1.94)						-9.82 (-.30)	-905.26 (-1.80)			1142.80 (1.84)	2812.08 (4.68)	70.47 (.12)	.47	7.22
205.12 (.21)								49.68 (1.15)		1284.86 (2.19)	2941.67 (5.03)	327.62 (.55)	.43	8.14
4460.88 (1.99)		-10.16 (-.30)	-1059.62 (-2.15)							1043.51 (1.76)	2792.20 (4.81)	142.11 (.24)	.47	7.54

*Numbers in parentheses represent t values for $H_0: b_1=0$.

**R^2 not applicable because model was restricted.

Appendix 4: Parameter estimates for less than 120 to 179 pounds differences (DIFF179) prediction equations.*

Int	HCT3	QHPT3	QCPT3	QHCL1	HC	HPT3	CPT3	QHCT3	D1	D2	D3	D4	R^2	F
-1573.05 (-1.33)	47.58 (.82)									416.35 (.57)	1856.46 (2.52)	436.42 (.60)	.17	2.09
									-643.18 (-1.36)	-216.45 (-.46)	1156.45 (2.36)	232.43 (-.68)	**	2.02
398.59 (.40)				-51.88 (-.08)						341.31 (2.43)	1781.19 (5.22)	369.60 (.65)	.17	2.38
487.21 (.60)					-62.00 (-1.66)					556.01 (.84)	1967.43 (2.91)	473.98 (.70)	.20	2.78
5028.43 (2.05)						-41.06 (-1.07)	-1410.21 (-2.39)			187.09 (.27)	1564.72 (2.22)	29.02 (.04)	.28	3.12
-3602.78								169.40 (2.84)		101.18 (.15)	1476.39 (2.12)	63.26 (.09)	.29	4.27
1935.24		42.36 (1.08)	-1725.10 (-2.87)							289.12 (.42)	1500.76 (2.18)	125.85 (.19)	.31	3.76

*Numbers in parentheses represent t values for $H_0: b_1 = 0$.

**R^2 not applicable because model was restricted.

Appendix 5: Parameter estimates for over 180 pounds difference (DIFF180) prediction equations.*

Int	HCT4	QHPT4	QCPT4	QHCL1	HC	HPT4	CPT4	QHCT4	D1	D2	D3	D4	R^2	F
-3109.60 (-4.70)	88.90 (2.47)									1738.89 (4.66)	1078.22 (2.78)	402.60 (1.03)	.46	8.69
									-1576.75 (-6.09)	186.57 (.72)	-300.20 (-1.12)	-1023.33 (-3.80)	**	13.33
-1553.43 (-2.80)				-1.14 (-.05)						1760.95 (4.73)	1275.65 (3.38)	554.21 (1.64)	.37	6.56
-1447.69 (-3.12)					-7.05 (-.33)					1777.53 (4.78)	1295.14 (3.40)	571.46 (1.50)	.37	6.61
-139.35 (.11)						18.86 (.89)	-884.59 (-2.55)			1845.19 (4.77)	1175.40 (3.02)	451.03 (1.15)	.47	7.11
-3756.53 (-5.39)								113.54 (3.30)		2072.98 (5.81)	1320.53 (3.67)	551.81 (1.53)	.51	10.60
-68.37 (-.05)		23.97 (1.10)	-1048.77 (-3.16)							2011.39 (5.58)	1384.72 (3.76)	536.12 (1.47)	.51	8.40

*Numbers in parentheses represent t values for $H_0:b_1=0$.

**R^2 not applicable because model was restricted.