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Forecasting Shortrun Beef and Pork Supplies Using Seasonal Analysis

by

Robert V. Price and Livia R. Cloman

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Development of forecasting models has attracted a large degree of attention from professional economists over the years. By and large, such model development has been viewed as an exercise in econometrics. Generally speaking, the exercise of model development has resulted from the desire of the professional economist to enhance his or her professional and/or academic career. Development of econometric models usually occurs over a long time span of months or years, and development and testing is largely an <u>ex ante</u> exercise based on historical data. There has been wide debate on the acceptable method of validating econometric forecasts, but validation is generally accomplished through theoretical arguments about the signs of the variables considered, review of the statistical significance of the parameters, consideration of the R^2 value of the model, or any of a host of other measures that track "goodness of fit." The results of the researcher's efforts are evaluated by his or her peer professionals on the basis of such statistical measures.

By and large, such research has contributed little to practical decision-making. Myers (1972) lists two basic reasons for this failure. First, researchers have failed to define clearly specific real world problems of importance and to identify alternative solutions before undertaking analyses. Second, the preoccupation with estimating demand and supply relationships and interpreting their practical significance in terms of flexibilities or elas-

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ticities has led only incidentally to useful forecasting. Thus, the published research is largely orientated toward exposing and explaining the statistical properties of a new technique that should make it attractive to decision makers. To a large extent, the usefulness of these techniques to decision makers involved in applied forecasting has been limited.

On the other hand, the applied commodity forecaster is, by necessity, interested in a model for its flexibility, ease in updating, availability of the necessary data in a timely manner, and with demonstratable applied results. In general, the applied forecaster has little time to devote to pure research and development as most efforts are directed toward analysis and projections of factors influencing the market. Judgements concerning the validity of the model are not made by his or her fellow professional researchers, but rather by clientele on how accurate the forecasts prove to be. It is necessary that the models be kept within manageable proportions and yet produce useful information. In the process, several statistical properties may be either violated or fall outside the bounds of conventional acceptability. In applied forecasting, however, a model can only truly be evaluated by its ability to provide adequate answers to problems and only incidentally by its internal statistical properties.

The applied forecaster often must temper a model in a nonmechanical fashion to include the "feel" of the current situation. As noted by Trapp (1981) in this conference last year, while it may be granted that the "seat of the pants" logic used by many applied commodity price forecasters contains significant amounts of economic logic, and considers information often ignored in econometric models, it is generally dismissed as nonrigorous and undocumentable by econometricians. A problem with quickly dismissing this noneconometric approach is the fact that it generally works--sometimes even better than "rigorous" econometric approaches.

The objectives of this paper are to describe the methodology developed for using seasonal indices in formulating forecasts of shortrun beef and pork supplies, and to illustrate the usefulness of a noneconometric process in adapting to the latest available information and updating forecasts rather mechanically in a simple and timely manner. Revised forecasts can be made with a calculator and a pencil in a matter of only a few minutes. However, with the relatively widespread access of lowcost computer power, such forecasts can be made in a matter of seconds. It is postulated that forecasts under the simplistic approach are quite likely to be within the error ranges of much more complex econometric models which are cumbersome and are limited only to updating by computer assistance.

The importance of accurate supply forecasts to the projection of livestock prices may be debated. Considerable discussion has been generated during the past several years to the affect of demand on livestock prices. However, it is the opinion of the authors that while demand may influence the magnitude of price changes, the direction of price movements is mostly a result of the supply of the commodity available to the marketplace. It has been the observation of the authors when evaluating several price prediction models generated by others that the largest source of deviation in price forecasts comes not from the different specifications of the model, but rather from the different assumptions used for supply forecasts. Various price prediction models tend to give quite analogous results when based on the same exogenous supply variables.

Methodology

Monthly indices of seasonality in beef and pork supplies were derived using appropriate time periods as discussed later. The indices of average seasonal variation for each data series were established by computing a thirteen month centered moving average of the original items. The original value for each month was then expressed as a percentage of the moving average for the corresponding month. The resulting percentages were then averaged for the individual months over the time period, and this is reported as the index of average seasonal variation for that month (Waite and Cox (1938)). This method of trend removal was selected as the procedure most likely to remove all elements, including cyclical affects, other than the seasonal element from the series.

Additionally, an index of irregularity was computed. This is the average deviation of the percentages of trend for particular months about the value of the index of average seasonal variation for that month. This can best be illustrated by looking at the charts of seasonal indices for cattle slaughter and beef production (Figures 1 and 2). The shaded band around the index of the average seasonal variation includes approximately two-thirds of the individual years comprising the average. As this band narrows, a greater conformity to the average seasonal pattern is noted. In more pronounced and regular seasonal movements the shaded area draws away from the baseline represented by 100 on the graph. In these cases there is reasonable expectation that a movement similar to the average seasonal will prevail in each year. In other cases the baseline may lie entirely within the shaded portion. This means that while there is an average seasonal movement present, there may be less expectation that it will be realized in a particular year. This will be discussed more fully as we look at the particular beef and pork models.

Forecasts were derived in the following manner. Monthly slaughter data for each of the latest six months from USDA was deseasonalized by dividing actual reported data by the average seasonal index for that month. A six-month weighted average of the deseasonalized data was then obtained by taking the deseasonalized slaughter for the latest month and weighting it by 6,

FIGURE 1

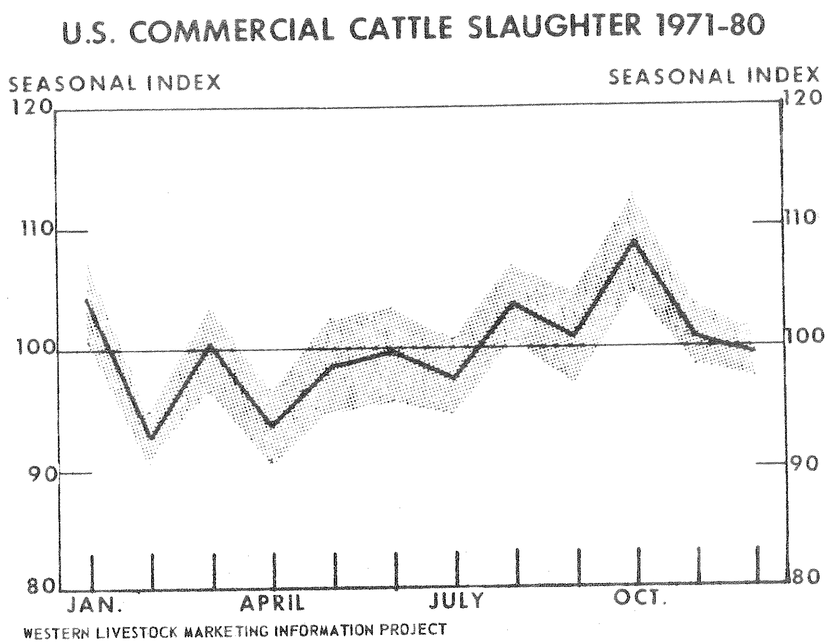
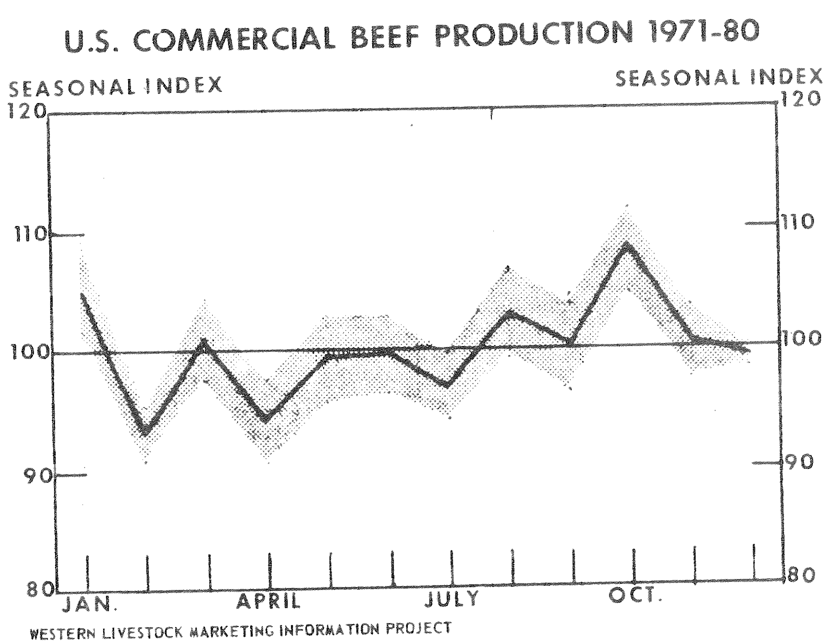


FIGURE 2



summing it to the deseasonalized slaughter for the second month back weighted by 5, etc. until a weighted sum was obtained. The weighted sum was then divided by 21 (6 + 5 + 4 + 3 + 2 + 1), giving a six-month weighted deseasonalized slaughter for the current time period. Use of the weighted deseasonalized slaughter takes into account the trend for the last six months, with greatest weight applied to the most recent data which aids in capturing turning points to trends in "real" (deseasonalized) slaughter. The same procedure was applied to production data.

The deseasonalized slaughter was then extrapolated six months into the future by taking the weighted deseasonalized average slaughter and applying the appropriate index for each of the months for the next six months. This procedure is shown by using the example shown in Table 1. Actual data (column A) was divided by the seasonal index for that month (column B), yielding a deseasonalized estimate (column C). A six-month weighted average was derived from the deseasonalized data (column D, row 6), and is marked by a single asterick. This figure was used to make the single-astericked estimates in columns E through J by multiplying the 6-month weighted average by the seasonal index (column B) for each of the lines from 7 through 12. The following month the procedure was repeated. The six-month weighted average (column D, row 7) was multiplied by the appropriate index in rows 8 through 13 to yield the forecasts marked by the double astericks in columns E through J. Thus, for each month into the future, six various estimates were obtained over time.

Results

Cattle and Beef Models

Monthly index values for seasonal variation were fitted for commercial cattle slaughter and commercial beef production for 1971-1980. The results are shown in Table 2 and graphically in Figures 1 and 2.

Table 1. Example of Methodology Used to Derive Forecasts.

Mo.	Actual data	Seasonal index	Desea-soned data	6-mo. wt'd avg.	1-mo. fore-cast	2-mo. fore-cast	3-mo. fore-cast	4-mo. fore-cast	5-mo. fore-cast	6-mo. fore-cast
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
1	1937	1.0498	1845							
2	1722	0.9315	1849							
3	1900	1.0092	1883							
4	1813	0.9413	1926							
5	1764	0.9925	1777							
6	1861	0.9968	1867	1856*						
7	1821	0.9701	1877	1862**	1801*					
8		1.0291			1916**	1910*				
9		1.0013				1864**	1859*			
10		1.0815					2014**	2008*		
11		1.0048						1871**	1865*	
12		0.9921							1847**	1842*
13		1.0498								1955**

Table 2. Seasonal Indices for Commercial Cattle Slaughter and Commercial Beef Production Using 1971-80 Data.

COMMERCIAL CATTLE SLAUGHTER				COMMERCIAL BEEF PRODUCTION			
MONTH	LOWER	INDEX	UPPER	MONTH	LOWER	INDEX	UPPER
Jan	100.60	104.32	108.04	Jan	101.25	104.98	108.70
Feb	90.76	92.83	94.90	Feb	90.86	93.15	95.43
Mar	96.56	100.17	103.77	Mar	97.53	100.92	104.30
Apr	90.64	93.59	96.53	Apr	90.73	94.13	97.52
May	94.75	98.68	102.60	May	95.53	99.25	102.96
Jun	95.82	99.49	103.15	Jun	96.39	99.68	102.97
Jul	94.35	97.45	100.54	Jul	94.06	97.01	99.96
Aug	100.61	103.79	106.96	Aug	99.07	102.91	106.74
Sep	97.04	100.97	104.89	Sep	96.43	100.13	103.82
Oct	104.79	108.60	112.40	Oct	104.53	108.15	111.76
Nov	98.34	100.80	103.25	Nov	97.58	100.48	103.37
Dec	97.44	99.31	101.18	Dec	98.06	99.21	100.35

After deriving seasonals a simple test was made with regression analysis testing forecasted slaughter based on the procedure outlined above for the period from January 1951 through December 1981. The results of the regression analysis are shown in Table 3. Similar results were obtained when regressing the estimates of beef production.

The regression analysis was performed simply to gather some statistics on goodness of fit for the forecast. Forecasts were then made for the period from January 1980 through February of 1983.[1] It should be emphasized that the forecasts for this period were not run through the regression model, but were simply derived from reindexing the six-month weighted average deseasonalized slaughter. The results for the 1980 through 1983 period are summarized in Table 4.

The results are highly encouraging. The largest absolute error for any individual month forecast during these 38 months was 219 thousand head, or slightly more than a 7 percent error in the worst possible observation. The

Table 3. Results of Regression for Commercial Cattle Slaughter.

Index values derived from 1971-80 data.

Model

Slaughter = f(six-month weighted average deseasonalized slaughter).

Regression run on data from December 1951 - December 1981.

Item	Forecast Period 1 mo.	2 mo.	3 mo.	4 mo.	5 mo.	6 mo.
Intercept	69.87	87.74	109.93	139.91	152.82	175.39
Slope	+0.977	+0.971	+0.964	+0.954	+0.950	+0.943
R^2	.952	.946	.937	.921	.917	.909
S.E. reg. coef.	.011	.012	.013	.015	.015	.015
t-value	85.61	80.29	74.17	65.64	64.16	61.05
F-value	7329.10	6446.10	5500.65	4308.62	4116.36	3727.58
S.E. of estimate	128.10	136.14	146.70	164.32	167.80	175.58
n	373	373	373	373	373	373

average absolute error for the 38 month period was slightly more than 3 percent. These results would be quite favorable when compared to much more sophisticated econometric models projecting cattle slaughter on a six-month horizon. (Hayenga and Hacklander (1974), Nelson and Spreen (1978)).

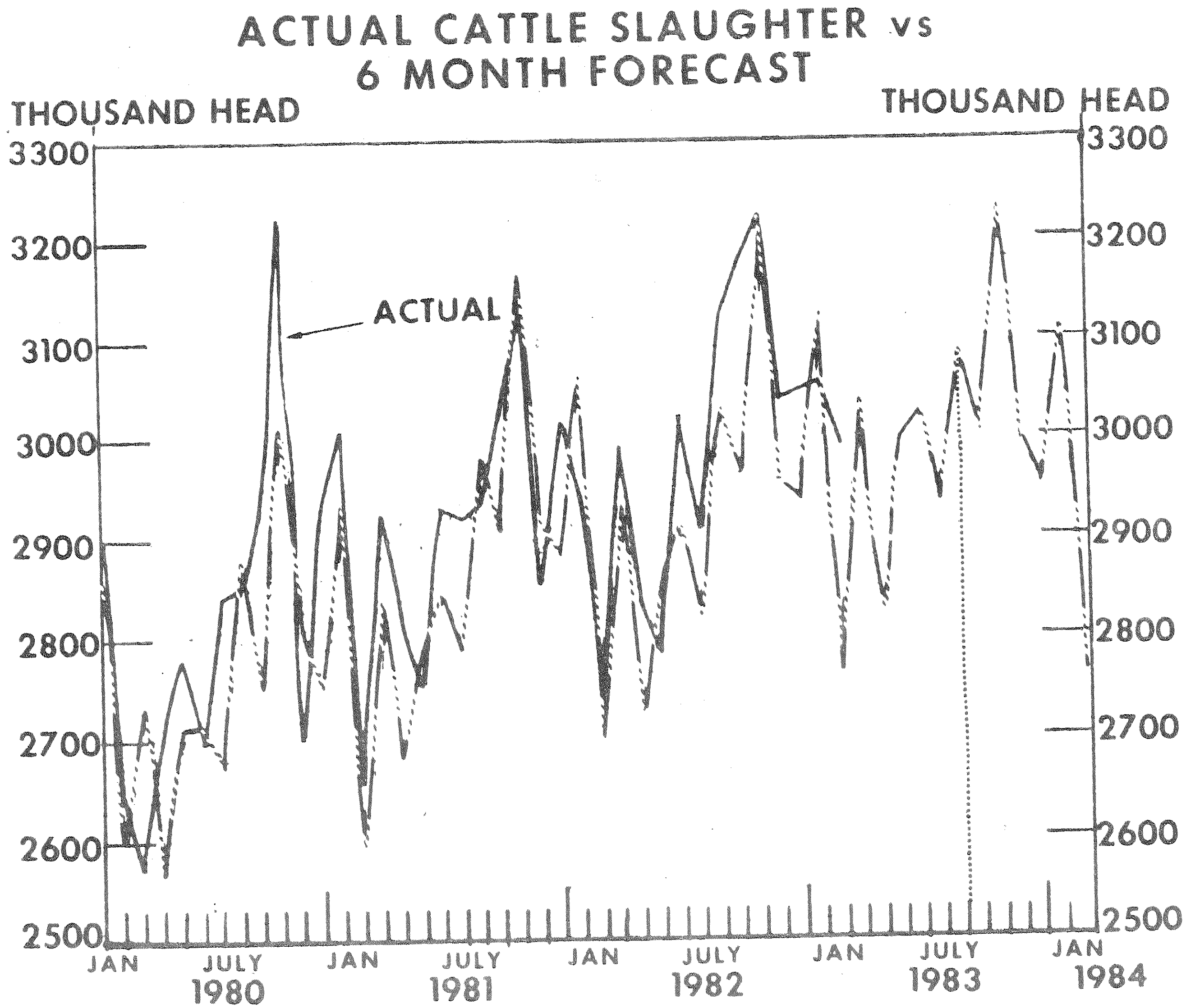
The beef production estimates were also encouraging (Table 4). The largest absolute error generated by any of the forecasts during the 38 month testing period was 163 million pounds, or slightly more than 8.5 percent. The average absolute deviation was slightly more than 3 percent.

Estimates derived from the 6-month slaughter forecast compared to actual data are shown in Figure 3. The 6-month forecast, while being the least accurate of the six estimates, still projected actual patterns quite well. The data to the right of the vertical line is **not** a tested forecast, but rather an extrapolation of trend as discussed later. The forecasts for production were within similar error ranges.

Table 4. Results of Forecasts for January 1980 - February 1983 by indexing six-month weighted moving average values.

Forecast	Average Nominal Error	Largest Absolute Error	Largest Percent Error	Smallest Absolute Error	Smallest Percent Error	Average Absolute Error	Average Percent Error
Commercial Cattle Slaughter (1,000 head)							
1 month	+15	209	8.12	2	0.07	92	3.20
2 month	+22	184	7.00	4	0.15	83	2.90
3 month	+30	192	6.22	3	0.09	83	2.89
4 month	+38	219	7.07	4	0.15	96	3.33
5 month	+44	194	6.88	3	0.10	90	3.13
6 month	+51	217	6.82	2	0.06	92	3.18
Commercial Beef Production (1,000,000 pounds)							
1 month	+7	145	8.59	2	0.10	59	3.29
2 month	+11	156	7.80	4	0.21	55	3.03
3 month	+15	163	8.15	4	0.21	55	3.04
4 month	+19	171	8.55	5	0.29	64	3.49
5 month	+22	141	7.55	2	0.11	59	3.24
6 month	+29	156	7.80	4	0.22	62	3.39
Commercial Hog Slaughter (1,000 head)							
1 month	-85	1135	16.14	2	0.02	363	4.89
2 month	-119	1118	15.90	31	0.45	372	5.03
3 month	-154	1102	15.67	15	0.22	388	5.26
4 month	-183	1259	16.34	1	0.01	425	5.75
5 month	-163	1240	16.09	22	0.32	448	6.10
6 month	-234	1255	18.61	2	0.02	465	6.37
Commercial Pork Production (1,000,000 pounds)							
1 month	-13	191	16.06	0	0.00	63	4.95
2 month	-18	191	16.06	0	0.00	64	5.05
3 month	-16	191	16.06	4	0.39	68	5.40
4 month	-29	213	15.90	5	0.48	74	5.36
5 month	-34	213	15.90	3	0.24	76	6.02
6 month	-38	213	16.48	4	0.32	77	6.19

FIGURE 3


ACTUAL CATTLE SLAUGHTER vs
6 MONTH FORECAST
THOUSAND HEAD
THOUSAND HEAD
3300
3200
3100
3000
2900
2800
2700
2600
2500
ACTUAL
JAN
JULY
1980
JAN
JULY
1981
JAN
JULY
1982
JAN
JULY
1983
JAN
1984

Hog and Pork Models

Even though hog slaughter and pork production tend to exhibit a more definitive seasonal pattern than is the case for cattle and beef, the seasonal pattern has shifted over time. Thus, the reliability of the estimates becomes to a large extent dependent upon the time period used for fitting the seasonal indices. Shifts during the 1970's are shown in Figure 4. As you can note, although the pattern for the 1971-75 and 1976-80 indices follow the general pattern of the 1971-80 indices, their were some rather large differences in individual months. This implies that the seasonal pattern of slaughter shifted during the decade. Seasonal slaughter patterns seemed to become **more pronounced** in the last half of the decade. This would appear contrary to the conventional wisdom that slaughter patterns have smoothed out more in recent years with the more widespread use of year-round confinement operations.

Upon investigation the authors decided the best fit for the current situation could be obtained from the most recent five-year period prior to the time period being forecast. Thus, seasonal indices of variation were computed for the 1976-1980 period (Table 5; Figures 5 and 6). The 1976-1980 index was regressed upon actual slaughter for the 1951 through 1981 period. The statistical measures of goodness of fit were rather dismal (Table 6); this without a doubt was due to the changing seasonal pattern of hog marketing during this 30 year time period.

The forecasts from the seasonal indices were reevaluated using the 1976 through 1981 actual data (Table 6). The statistical measures of goodness of fit increased quite dramatically as the index of seasonal variation was applied to data from the comparable time period.

The 1976-80 seasonal indices were used for forecasting the first 38 months of the 1980's. Again, forecasts during the January 1980 through

FIGURE 4

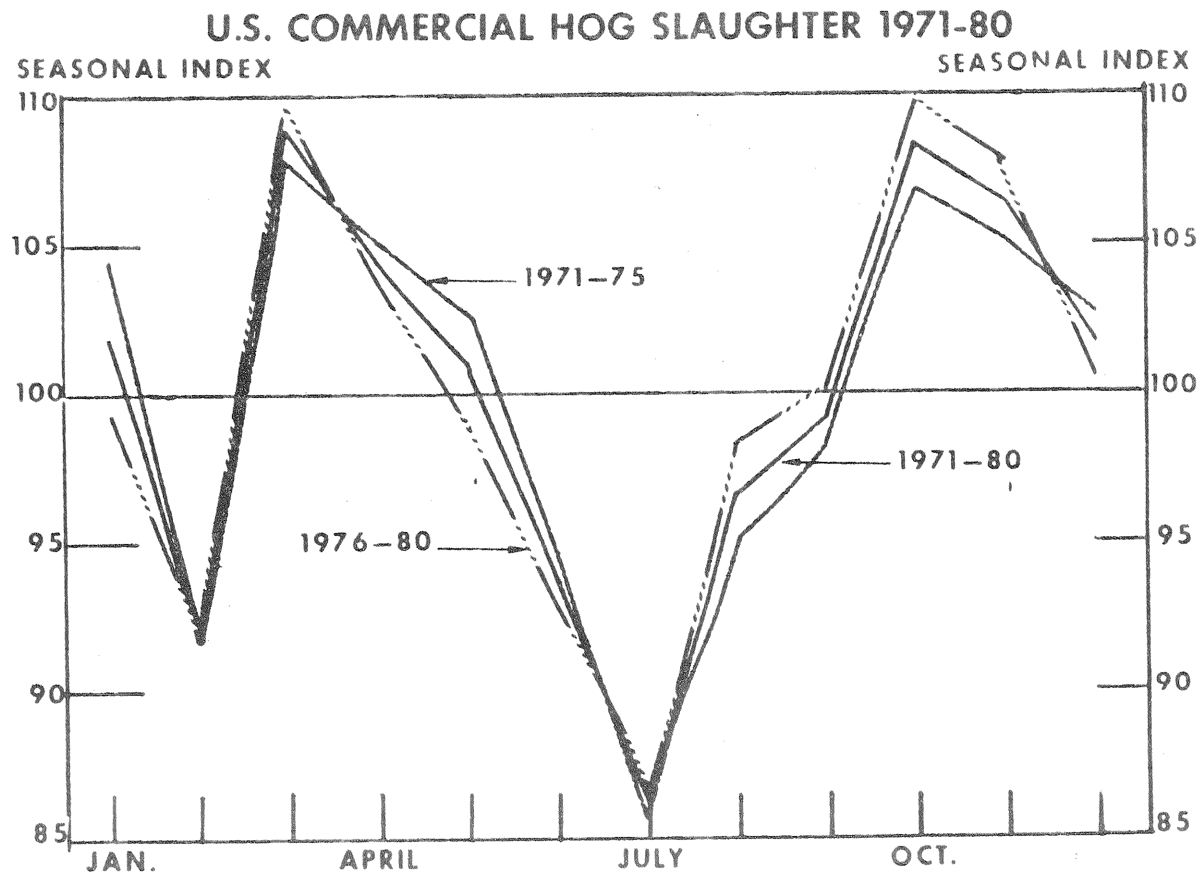


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FIGURE 5

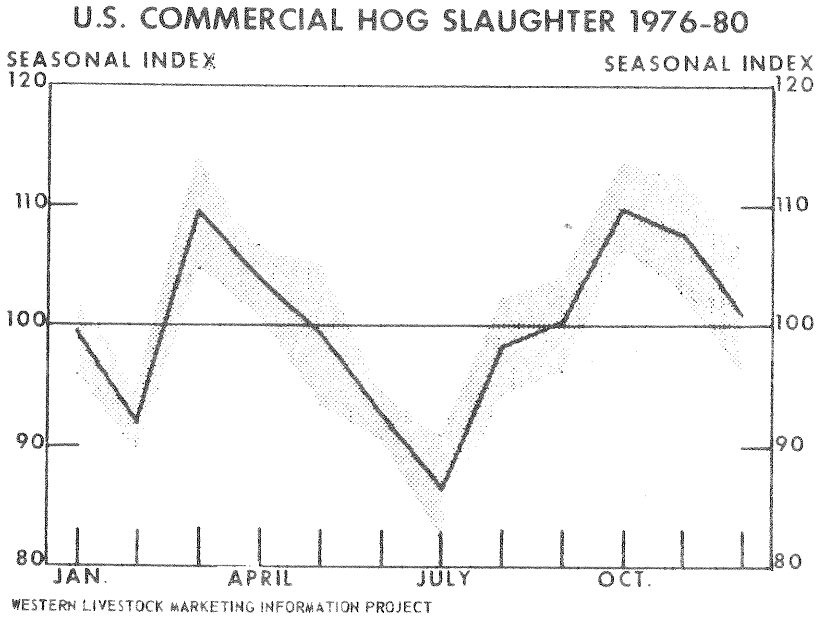

FIGURE 6

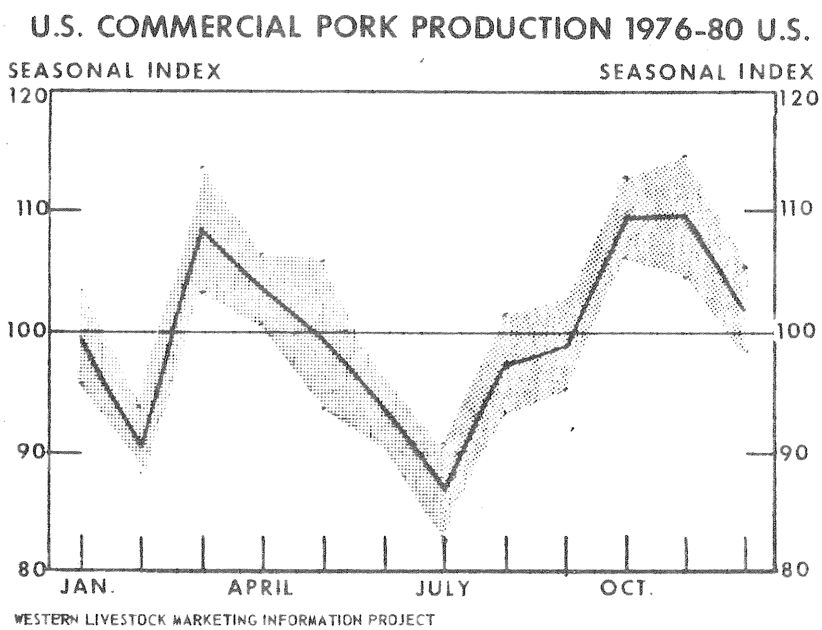

Table 5. Seasonal Indices for Commercial Hog Slaughter and Commercial Pork Production Using 1976-80 Data.

MONTH	COMMERCIAL HOG SLAUGHTER LOWER	INDEX	UPPER	MONTH	COMMERCIAL PORK PRODUCTION LOWER	INDEX	UPPER
Jan	95.90	99.30	102.69	Jan	95.54	99.42	103.29
Feb	89.36	91.92	94.47	Feb	88.18	90.86	93.54
Mar	104.93	109.70	114.46	Mar	103.21	108.48	113.74
Apr	100.71	103.70	106.68	Apr	100.47	103.36	106.24
May	93.30	99.17	105.03	May	93.66	99.79	105.91
Jun	90.73	92.67	94.60	Jun	91.77	93.88	95.98
Jul	82.29	86.62	90.94	Jul	82.43	86.94	91.44
Aug	94.17	98.27	102.36	Aug	93.20	97.36	101.51
Sep	96.16	100.13	104.09	Sep	95.01	98.92	102.82
Oct	106.07	109.87	113.66	Oct	106.19	109.57	112.94
Nov	102.92	107.86	112.79	Nov	104.48	109.55	114.61
Dec	96.64	100.79	104.93	Dec	98.19	101.87	105.54

February 1983 time period were made **not** by using the regression model but by simply extrapolating the weighted average deseasonalized slaughter and applying the appropriate seasonal index of variation. The accuracy of the forecasts were not as good as those for cattle and beef (Table 4), but errors generally were in the magnitude of 6 percent or less.

Figure 7 shows the actual slaughter data relative to the 6-month forecast. Again, the 6-month forecast was the least accurate forecast; yet the estimated values projected actual values quite closely. The data to the right of the vertical line are **not** tested forecasts, but rather an extrapolation of trend as discussed in the next section. The forecasts for pork production were similar to those for slaughter.

Although the errors are larger than desired, the forecasted slaughter and production six months out would still compare favorably with more complex econometric methods. Even if the absolute level of the forecasted data deviates from actual data, the trend and direction has tracked quite well throughout the early 1980's. The authors have found this beneficial in their

Table 6. Results of Regression for Commercial Hog Slaughter.

Index values derived from 1976-80 data.

Model

Slaugher = f(six-month weighted average deseasonalized slaughter).

A. Regression run on data from **December 1951 - December 1981.**

Item	Forecast Period 1 mo.	2 mo.	3 mo.	4 mo.	5 mo.	6 mo.
Intercept	887.88	1600.59	2152.04	2573.27	2611.08	2539.15
Slope	+0.871	+0.761	+0.678	+0.615	+0.610	+0.621
R^2	.570	.427	.329	.259	.254	.278
S.E. reg. coef.	.039	.046	.050	.054	.054	.052
t-value	22.19	16.62	13.49	11.37	11.25	11.96
F-value	492.19	276.39	182.08	129.31	126.52	142.94
S.E. of estimate	650.97	751.67	813.24	855.05	857.45	843.63
n	373	373	373	373	373	373

B. Regression run on data from **January 1976 - December 1981.**

Item	Forecast Period 1 mo.	2 mo.	3 mo.	4 mo.	5 mo.	6 mo.
Intercept	759.77	990.46	1192.79	1475.27	1578.31	1713.29
Slope	+0.902	+0.873	+0.847	+0.809	+0.797	+0.780
R^2	.814	.797	.778	.723	.711	.684
S.E. reg. coef.	.052	.053	.054	.060	.061	.063
t-value	17.48	16.60	15.68	13.50	13.13	12.31
F-value	305.48	275.61	245.93	182.33	172.36	151.52
S.E. of estimate	413.50	431.00	450.79	504.40	514.68	538.35
n	72	72	72	72	72	72

forecasting work, as often the desire to know whether slaughter and production increases or declines are expected is as important as the knowledge of the absolute levels of such slaughter and production.

A Note on Slaughter by Class and Weekly Slaughter

The authors have also investigated using the index of seasonal variation to estimate slaughter by class for cattle and hogs, as well as some applications to weekly slaughter estimates. The initial findings were quite favorable for the possibility of allocating cow and bull slaughter on a monthly basis. The fed cattle component must be estimated from data contained in Cattle on Feed reports. Nonfed steer and heifer slaughter is simply a residual number.

Weekly slaughter estimates have one very important consideration. In order to fit a true seasonal index of variation, it is necessary to adjust the weekly slaughter from one year to the next to attempt to line up holiday-shortened kill weeks. In some years this necessitates the removal of one or more data observations, and in other years it is necessary to insert and interpolate data to spread the necessary weeks between holiday kill weeks.

It should also be noted that the methodology employed in this paper can be used to produce estimates 12 months into the future on monthly slaughter and production (Table 7; Figures 3 and 7). The data to the right of the vertical line in the figures are extrapolations of trend and should **not** be viewed as absolute forecasts. Although the authors have no analysis of errors in such extrapolations to present, it has been observed that the slaughter and production pattern can be projected with an acceptable degree of accuracy for 12 months into the future.

FIGURE 7

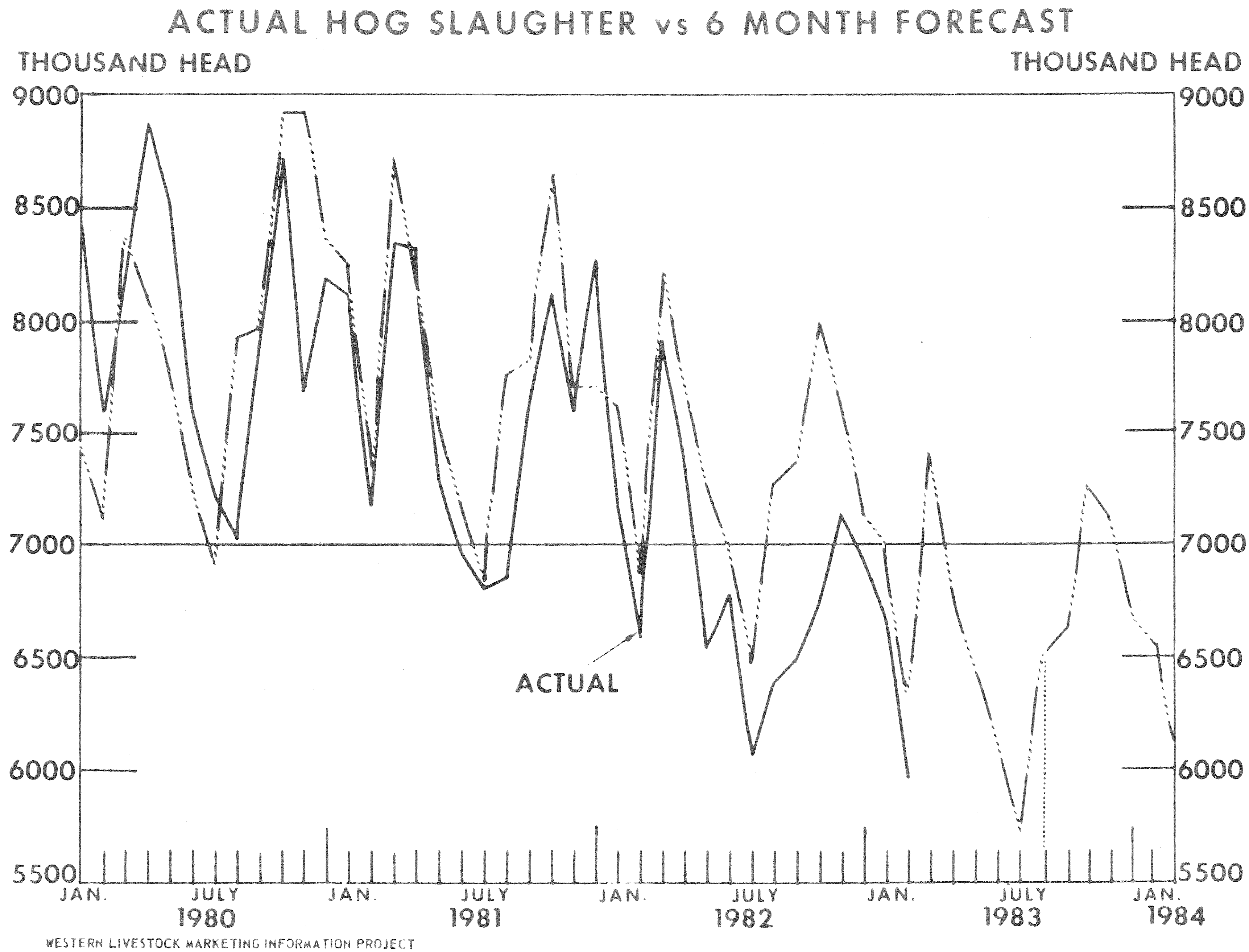
ACTUAL HOG SLAUGHTER vs 6 MONTH FORECAST
THOUSAND HEAD
THOUSAND HEAD
9000
8500
8000
7500
7000
6500
6000
5500
ACTUAL
JAN.
JULY
1980
JAN.
JULY
1981
JAN.
JULY
1982
JAN.
JULY
1983
JAN.
1984
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Table 7. Forecasted Values Using Described Methodology.

Month	Commercial Cattle Slaughter (thous. head)	Commercial Beef Production (mill. lbs.)	Commercial Hog Slaughter (thous. head)	Commercial Pork Production (mill. lbs.)
Mar 83	2980	1886	7243	1241
Apr 83	2784	1759	6847	1183
May 83	2936	1854	6548	1142
Jun 83	2960	1862	6119	1074
Jul 83	2899	1813	5719	995
Aug 83	3088	1923	6488	1114
Sep 83	3004	1871	6611	1132
Oct 83	3231	2021	7254	1254
Nov 83	2999	1877	7122	1253
Dec 83	2954	1854	6655	1166
Jan 84	3104	1961	6556	1138
Feb 84	2762	1740	6069	1040

The forecasts from September forward were derived using extrapolations of the six-month forecast. Readers are advised that the authors have **not** tested such extrapolations for their forecasting errors. The forecasts from September forward should be viewed **only** as a projection of trend and not for their absolute value.

Summary and Conclusions

This paper presents no new and exciting econometric techniques to be used in the arena of commodity forecasting. However, a rather simplistic approach that has been largely ignored by professional price researchers has been presented. In addition, forecasts from the approach have shown that the simplistic model can yield results that are within the acceptable limits for accuracy.

By attempting to keep the model within manageable proportions and yet produce useful information, undoubtedly several statistical properties either were violated or fell outside the bounds of conventional acceptability. However, in applied commodity forecasting, a model can only truly be evaluated by its ability to provide adequate answers to problems and only incidentally by its internal statistical properties.

Footnotes

[1]USDA/SRS did not report monthly data on commercial slaughter and production for the April through December 1982 period. Estimates for those nine months were derived by the authors in conjunction with Bruce Ginn of Livestock Business Advisory Services, Inc., by expanding reported Federally Inspected slaughter and production.

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