LIVESTOCK CYCLES AND THEIR RELATION TO WEATHER AND RANGE CONDITIONS

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Probably from earliest times man took note of periodicity in natural events around him and in his own physiology. He was also aware of the recurrent ebbing and flowing in both individual and collective well-being. It was a simple next step to speculate on a connection between the natural and the cultural. It frequently led to seeing a clockwork rhythm in human affairs. The Old Testament is full of references to repeatability in various phenomena. Apparently three, seven and 12 were the most common intervals. In the Biblical account of the Pharaoh's dream of fat and lean kine, interpreted by Joseph as foretelling good and bad crop years, it is worth noting that the number of each was that digit of divination and superstition, seven. Still today the same number is said to be held in high regard in some circles.  

Ancient perception of a link between the physical and the cultural or institutional worlds probably also brought varying behavioral reactions. Some individuals doubtless chose obeisance before the natural phenomena that seemed so governing. Others, the activists, preferred to do something about it. If the counsellor to the Pharaohs had only interpreted a dream he would never have made entry into the Book of Genesis. It was his program of action that brought him literary immortality.

Nor should we be smug about any change in the human psyche since those primeval times. According to the printed program we are to spend two days here at Ames reviewing the factual evidence of a relationship between

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\(^3\)An ingenious and interesting modern attempt to ascribe cycles in economic affairs to periodicity in the physical universe is found in the sun-spot and similar theories of business cycles. Cf., Wesley C. Mitchell, "Business Cycles," National Bureau of Economic Research, New York, 1927, pp. 12-16. Mitchell quotes the German Werner Sombart in a distinction that obliquely bears on the thesis of this paper. Sombart held that "in the organic industries . . . the condition of business is determined largely by the yield of raw materials; in the inorganic industries . . . the condition of business itself determines how much of the raw materials shall be produced." (Mitchell, pp. 15-16). This aphorism presupposes that inorganic materials are not employed in organic industries. This is not so generally true now as it once was. Capital inputs are utilized in great volume in agriculture, the output of which is no longer a mere manifestation of the bountifulness -- whether rhythmic or not -- of nature.
weather and our food supply. Then, in our own sequential pattern, we will devote a third day to the implications of those findings for national policy. It will be interesting to see how the empirical content of the first part of the seminar becomes translated into its meaning for action as sought in the second part.

The assignment for this paper falls in the first part of the schedule and the fact-finding category. The authors have been asked to sketch the relationship, if any, that exists between livestock cycles, weather and range conditions. This is the only paper at this conference that deals with livestock. The assignment takes on some complexity because livestock are no longer a primary product of agriculture. Only cattle and sheep that graze the western range are direct harvesters of "crop" (i.e., forage) production. They seldom subsist solely on range grass; most get some supplemental feeding. Furthermore, since range grass is grazed more closely in some years than others, the tonnage of beef or lamb produced is not an exact measure of the quantity of range feed that was available.

Thus any study of cycles or other variations in production of livestock by no means reflects with any precision how weather affects man's food supply. It reflects how natural events such as weather plus man's management of feed resources combine to affect our food supply.

Probably the only solid datum from which we can start is that cycles in livestock do exist. To certain time series of data relating to livestock there is enough patterned regularity to satisfy most test of cyclical configuration.

The most clearly revealed and best known cycle is in January 1 inventories of cattle on United States farms. Since 1880 that statistic has traced a pattern of cyclically successive increases and decreases. It has completed its sixth cycle and is now near the turning point in a seventh. Edward Karpoff of USDA in an unpublished study noted that the first statistics on cattle inventories published years ago did not show a cycle. Only after the series underwent massive revision did a cyclical pattern emerge. A skeptic might wonder whether the makers of estimates introduce cyclical relationships as an estimating device. To inquire into techniques of estimation is appropriate to any study that employs estimated data. Nevertheless, very few observers of cattle trends in the United States would deny that time-series data for cattle inventories have a cyclical character.

The cattle inventory cycle as an historic reality may nevertheless be in some jeopardy for the future. It has always rested fundamentally on cyclical changes in the size of the basic producing herd, especially beef
cows on the western range. Recently the producing side of the cattle industry has lost some of its prominence to that vigorous upstart, modern commercial cattle feeding. Cattle feeding may now be generating the newest of all livestock cycles. The 1963-64 price difficulty in beef cattle can be attributed only partially to the old familiar cycle in cattle production. It had more of the marks of a fed cattle cycle, or possibly of a cattle feed-lot cycle.

For sheep the empirical evidence of a cycle in numbers or production is less convincing. Almost surely, if a cyclical phenomenon exists in range cattle it must also be present in range sheep. But the sheep business has been in turmoil for so long and has undergone so many changes in make-up and location that cyclical tendencies have been overshadowed.

Is there a cycle in hogs? As long ago as 1895, Samuel Benner said there was. Countless writers have since referred to a cycle in hogs. The answer to the question may rest on one's definition -- that is, on what minimum curvilinearity in plotted data one's eye may require. Also, a distinction is to be made between the years prior to CCC storage programs for feed grains and those of their operation. This distinction will be discussed below.

Theories of Livestock Cycles

Cycles in livestock have been viewed in three different ways.

The first is pure empiricism. They are seen and charted. They are checked. Samuel Benner found hog cycles as "alternately certain as the diurnal revolutions of the earth upon its axis..." The presupposition is that cycles so clearly revealed in the past can be extrapolated into the future. The tools required are only a straight edge ruler and a French curve.

Nor need the technique be belittled. In spite of all the attempts to probe the inner workings of the cattle economy, most forecasting of cattle trends still rests heavily on graphic analogy with previous cycles.

Of more interest, nevertheless, is the question as to whether livestock cycles are self-generated or the result of outside forces. To what extent do they propel themselves in never-ending sequence, according to the principle enunciated in the Cobweb Theorem? Or to

5/ Ibid.
6/ This theorem describes the tendency toward successive waves of over-expansion and underexpansion that is seen in many sectors of the economy.
what extent are they the product of external events of which changes in feed supply are likely the most important? Each school of thought has distinguished adherents. Some years ago James H. Lorie built a cyclical model that depended basically on its internal mechanism. John Hopkins, Charles Burmeister and Frank A Pearson are among those who have emphasized outside stimuli and would lay much importance on the feed supply.

This contest can be viewed in other terms. Significantly, they match an industrial against an agrarian view of things. To whatever degree livestock cycles self-generate they are of a common mold with investment cycles and building cycles and all other members of that big but unhappy family of rhythmic instabilities. They thereby exhibit induced and autonomous investment and an accelerator and doubtless other attributes of the cycles of the industrial and business world. Cycles so viewed must be regarded as products of human institutions. They are man-created. Presumably, they can be man-corrected.

To whatever degree cycles in livestock are attributed to cyclical fluctuations in feed supply -- now primarily range feed -- they are a modern replica of an ancient phenomenon. They show that man has not yet freed himself from bondage to erratic and sometimes niggardly natural forces. Whether he cannot or merely refuses to is a separate issue; all to be said in this instance is that he has not.

The Cycle in Hogs

Hogs are almost exclusively consumers of concentrate feeds, primarily feed grains. Therefore, any analysis of hog production and feed supply relates by definition to grain and other concentrate feeds only.

If a cycle could be said to exist in hogs before CCC feed programs began, it would constitute evidence that feed grain production swings cyclically up and down. Hog production was inexorably tied to annual harvests of feed grains; and even though fluctuations in hog production were not as erratic as those in feed grains, due to the evening out effect of the life span of the hog, they were necessarily of similar cadence.

Hog production was kept closely connected with feed supply through the working of the hog-corn price ratio. The price of corn, which responded to the size of each year's corn harvest, was the prime mover in that ratio.

Whatever one's interpretation of the statistical record for hogs in pre-CCC years, there is little room for disagreement as to the experience since. CCC price support and storage programs have not produced a perfect ever-normal-granary for feed grains, but they have attained a reasonable approximation to it. Already the stabilizing effect on feed supply and price is virtually taken for granted. Only persons of middle age or older can appreciate the contrast between the present relatively stable supplies and prices of feed and the alternate feast and famine that wrought such instability up to the middle 1930's. In the years since feed prices stopped bouncing up and down, the year-to-year variations in hog production have been smoothed out fairly well.

It may nevertheless be wondered if statistical trends in livestock have an aversion to stability. No sooner had sharp and erratic annual changes in hog production disappeared than a new pattern of fluctuation appeared in their place. It has most of the tell-tale signs of a cycle. The number of hogs produced now moves up and down in fairly smooth cyclical swings much as cattle inventories do. The hog cycle is shorter than the cattle cycle. The last couple of hog cycles have been moderate in amplitude. To expect such good behavior from them in the future would, however, be overoptimistic.

Analysts now depend more on projections of cyclical patterns than on the hog-corn price ratio to explain and predict changes in hog production. As the price of corn is less unsteady than before, the hog-corn price ratio is influenced more by changes in hog prices and less by changes in corn prices than was the case in years before feed storage programs entered the picture.

Cycles in Cattle

Cattle feeding may now be cyclical, but the evidence is too recent to permit reliable analysis or lead to a firm judgment. Likewise, any cycle in construction of feedlots could be the most worrisome of all cycles relating to livestock. These cycles will not be discussed here.

Cattle production is now nationwide. Separate analyses should be made for the western range and the eastern pasture regions. To date, the

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eastern half has not been studied in depth. For this reason it is not included in the analysis that follows. 

The western producing region remains the most adapted to research analysis. From the historical record for that broad region at least a little empirical evidence can be found as to relationships between livestock cycles and range feed supplies. 

The region used in this analysis, the 17 western states, contains 45 to 50 percent of all roughage consuming animal units and about 12 percent of total animal units in the United States. 

It is well known that supplemental feeding of cattle on western range is more common now than it once was. It can be used to counterbalance changes in supply of range feed. Nevertheless, it can offset those changes only partially. Cattle production of the West remains closely linked to range conditions. 12

The customary method of analysis is to match data on livestock inventories with data on range feed condition. It has been adopted in this paper. The charts that follow compare the number of roughage consuming animal units fed each October-September year with the estimate of range condition in June, July and August as reported by the Statistical Reporting Service. The first chart summarizes data for the entire 17 western states. Separate charts relate to five smaller regions: Pacific States, Mountain States, Southwestern States, Northern Plains States and Southern Plains States. 

The data for range feed condition are simple averages of indexes for each of the three months and for each state. They have not been weighted by size of state; Nevada counts for as much as California or Nebraska. More important to analysis is the nature of the range feed index itself. It is a "condition" index as reported by farmer reporters. It is an estimate of the visible supply of range feed in the locality reported on. It is strictly a subjective figure, and its usefulness rests on the skill of farmers and ranchers in appraising the range feed supply and on their judgmental consistency from year to year.

12/Cattle feeding is almost wholly divorced from range conditions. Ideally, the data in the charts that follow would have been corrected for the cattle-on-feed component. However, it is not so very large, except for some of the areas in recent years. It accentuates the upsweep in inventories in the Pacific area, for example. It does not affect the overall relationships shown.
Moreover, being an indicator of the available feed, the range feed index is in no sense independent of the level of grazing being carried on. In a range feed-livestock inventory analysis the range feed index is not an exogenous variable. If the adjective "endogenous" can be compared, the range feed index is very endogenous indeed.

For whenever the level of stocking is high, the grass is grazed closer and the remaining supply of range feed is reduced. If stocking is light, the supply will appear greater. Thus when cattle and sheep numbers are down, the range may retain a fairly good condition even in a rather dry year. But when the stocking is heavier, a moderately dry season may appear as almost drought.

This characteristic of range feed statistics bears on the comparisons to be observed between livestock numbers and range feed condition in the West. Overall, the chart for the 17 western states (Figure 1) reveals year-to-year fluctuations in range feed conditions that sometimes are mild and other times sharp. It gives some indication of broad cyclical swings in range feed too. The inventory of roughage consuming livestock shows the familiar pattern of the cattle cycle.

It is hard to find in the summary chart for 17 states a clear tie between annual variations in range condition and in livestock numbers. But the pronounced cycles in livestock numbers and the milder cyclicality in range condition are interrelated. The timing of the relationship is important. If cyclical changes in range condition preceded changes in livestock inventories, it might be supposed that range feed does indeed go through cycles and that those cycles induce similar trends in livestock. Only during the early 1940's is there evidence that a cyclical swing in range let to a cyclical change in livestock. Usually, the relationship is one of similar timing but inverse pattern between cycles in range feed condition and in livestock numbers.

The conclusion follows that livestock cycles have more effect on range feed condition than vice versa. There is little reason to believe that range feed goes through periods of successively good years and successively poor years and that these give rise to cycles in livestock numbers. It is equally or more logical to say that livestock numbers go through cyclical fluctuations and these give rise to a cyclical pattern in the condition of range feed.

To be sure, individual years can be so dry as to force a reduction in livestock inventories. Such a year was 1934. There was a drought in several important cattle areas in 1956. Nevertheless, a year of short rainfall will be reflected in a poorer range condition, and will be regarded
Figure 1. 17 WESTERN STATES: Roughage Consuming Animal Units Fed and Index of Range Feed Conditions (June - August Average), 1923-1963.

Figure 2. PACIFIC STATES: Roughage Consuming Animal Units Fed and Index of Range Feed Conditions (June - August Average), 1923-1963.
as a more severe drougth, if it is a year of high cattle numbers than if numbers are low. The 1956 drougth appeared to be especially damaging because cattle numbers had been built up to a high level.

If the moderately cyclical pattern to range feed indexes in the West can be attributed to cycles in stocking level, it need not reflect a cyclical "beat" to western weather. Nevertheless, the analysis presented herein does not disprove the notion of a weather cycle in western country. It merely indicates that cycles in cattle do not prove it. Other data will have to be sought to confirm or refute the hypothesis of a weather cycle.

Data by Areas

Charts for the five subregions reveal differences in amplitude of fluctuations in both range feed condition and livestock numbers. They also show differences in the pattern of relationship between the two. Perhaps no one region presents as regular a pattern as does the West as a whole.

The Pacific States (Figure 2) have demonstrated relatively wide annual fluctuations in range feed conditions without any pronounced cyclical effect. In the period charted, a cycle in animal units became prominent when favorable feed conditions encouraged expansion during the war. That did not seem to change the pattern of range condition materially, although fluctuations since have not been as wide as before.

The movement in the number of animal units and in range condition in the Mountain States (Figure 3) is similar to that for the West as a whole. The two have tended to move in opposite directions, but with some exceptions. Range conditions held up particularly well during the war, for example, in spite of a high and increasing level of stocking.

The range condition in the Southwestern states (Figure 4) has not reacted noticeably to the gradual decline in the number of animal units, although the less drastic swings in the number of livestock in recent years are generally mirrored in a less changeable index of range condition.

The Northern Plains (Figure 5) have been subject to pronounced fluctuations in both livestock numbers and range feed conditions. Generally, the two have traced the same opposite path as in the West as a whole. Here, too, the range feed condition stayed high during the war years, in spite of sharply rising livestock numbers. Those must indeed have been bountiful years; they apparently favored the expansion in livestock numbers at that time.
Figure 3. MOUNTAIN STATES: Roughage Consuming Animal Units Fed and Index of Range Feed Conditions (June - August Average), 1923-1963.

Figure 4. SOUTHWESTERN STATES: Roughage Consuming Animal Units Fed and Index of Range Feed Conditions (June - August Average), 1923-1963.
The Southern Plains (Figure 6) also follow the same general pattern as the West as a whole. The poor range conditions in the early 1950's certainly appear to have taken the high peak off the livestock cycle at that time. They likely were more clearly due to dry weather than were the low range condition indexes in other parts of the West, even though the large livestock build-up had its usual aggravating effect.

Judgmentally, the above evidence by areas tends to confirm our doubt that apparent cycles in range feed in the West are due to cycles in weather. More probable is that they reflect alternate swings in understocking and overstocking of ranges. We repeat, this judgment does not entirely negate the possibility that weather cycles exist in western cattle country. It only says that livestock cycles are not to be taken as conclusive evidence thereof.

**Year-to-Year Relationships**

To study the year-to-year relationships between weather, range condition and feed supply it is necessary to turn to different sources of information. The broad regional and annual totals presented thus far are not useful for that purpose.

The short term analyses make a convincing case that yearly fluctuations in weather influence range condition and in turn affect the rate at which cattle are marketed.

Regrettably, the short term studies also have a deficiency. Whereas the cyclical analyses of Figures 1 to 6 only compare livestock numbers and range condition and omit data for weather, the short term analyses include weather data but take no account of the effect of stocking level on range feed condition. In the language of statistical procedure, most regressions made to date have been "partial."

Research conducted by Harold Abel and other members of the Western Livestock Marketing Research Technical Committee shows annual changes in summer range feed in the Northern Plains to be associated significantly with climatic conditions during the spring. "Throughout most of the northern and central Great Plains, April, May and June precipitation explains much of the variation in range-feed conditions." In a correlation study for range feed in five districts in Montana, "63 to 84 percent of the variation was explained by the log of precipitation for March through June." In other regions of the West, particularly the Southwest, fall and winter moisture also was significant in explaining changes in range conditions.

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14/ Ibid., p. 18.
Figure 5. NORTHERN PLAINS: Roughage Consuming Animal Units Fed and Index of Range Feed Conditions (June - August Average), 1923-1963.

Figure 6. SOUTHERN PLAINS: Roughage Consuming Animal Units Fed and Index of Range Conditions (June - August Average), 1923-1963.
Other climatic factors doubtless have some effect on range feed but they are much less important than rainfall. Temperature, for example, "has a statistically significant effect on ranges . . . when precipitation is below normal . . . Temperature was not significant in explaining residual variation when spring precipitation was normal or above."\footnote{14}

These findings are now being employed in livestock forecasting done by the Western Livestock Information Project at Denver.

An older study reported by Marion Clawson gave somewhat similar results. It correlated, for 1923-41, range condition in each year with precipitation in both the current and preceding years. The $R^2$s state by state ranged from 0.2 to 0.8 but for 12 of the 17 states exceed 0.5.\footnote{15} These values are high enough to indicate a significant relationship between each year's range condition and rainfall. They are not so high as to rule out a cyclical relation between stocking level and range feed condition, evidence for which has been presented in Figures 1 to 6.

Yearly variations in range feed condition have a bearing on the decisions ranchers make as to marketing their cattle. Poor conditions speed marketings; good conditions slow them. It is our hypothesis that annual marketings may be more responsible to weather and range in the northern areas of the West than in southern ones. The reason is that the northern range country has long shifted back and forth between selling calves and yearlings in keeping with the range feed supply. Southern areas are more committed to selling of calves, and their marketing program is more flexible, season to season.

**Summary and Conclusion**

The first conclusion is that there is little reason to believe that cycles in livestock production are caused primarily by cycles in weather. For the classes of livestock that consume concentrate feed, any effect of weather is ironed out to an appreciable extent by national programs of feed grain storage. Even for forage-consuming livestock, supplemental feeding has become increasingly important over the years. The clearest case for a close connection between weather and livestock is that of cattle and sheep on western range. Yet data relating thereto yield no certain proof that cycles in livestock inventories are caused by cyclicity in range feed supply. The mild cyclical pattern to be observed in indexes of summer range feed condition in the West is at least partly a reflection of swings in the stocking level.

\footnote{14}{Ibid., p. 18.}
\footnote{15}{Marion Clawson, "The Western Range Livestock Industry," McGraw-Hill, New York, 1950, p. 64.}
Livestock cycles are to be attributed much more to the errors of fallible man than to the whimsy of a just God. They primarily are of the same family as building cycles, textile cycles and even the business cycle itself.

Weighty argument in support of this conclusion is the quickness with which fluctuations in hogs were transformed into a cycle once supplies and prices of feed became relatively stable. And now a cycle in fed cattle or in cattle feedlots -- it is hard to know which -- is making its unwelcome appearance.

All we are saying is that in its modern technology livestock agriculture is taking on a more industrial character. It is using more fixed investment. In gaining much of the physical efficiency of industry it is also falling heir to characteristic industrial instability.

This is not to deny that variable climate still contributes to instability in livestock production. It does. We do not even deny that there are weather cycles; we only say that livestock cycles are not indisputable evidence of them. Year-to-year variations in weather unquestionably affect all livestock that are grazed, in spite of the considerable supplemental feeding that is carried on. Occasionally a particularly bad weather year is crucial in halting a cyclical uptrend in production of cattle. Short term weather variations would affect all livestock, including grain-consuming species, were it not for programs that maintain feed reserves and keep feed prices fairly stable.

Whatever efforts are to be undertaken in the future to bring more order and stability to the production and marketing of livestock should definitely include steps to minimize the influence of capricious weather. In the division of the populace between those who sit on their hands and those use them, the authors of this paper hope to qualify for the second category.