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CHAPTER 2

Sources and Methods

Sources of Data

PUBLISHED reports of the Bureau of the Census and the Bureau of Agricultural Economics provided most of the basic data for this study. In addition, we used as basic data the estimates of financial assets held by farmers prior to 1940 and of debts outstanding prior to 1910 that were generously made available to us by Raymond W. Goldsmith prior to their publication in *A Study of Savings in the United States, 1897-1949* (Princeton University Press, 1954). For the period before 1910 we made use of estimates of gross farm income and of prices received by farmers that were published by Frederick Strauss and Louis H. Bean in *Gross Farm Income and Indices of Farm Production and Prices in the United States, 1869-1937* (Dept. of Agriculture, Tech. Bull. 703, 1940). We also used the estimates in constant prices of farm income net of purchases of intermediate products prepared by L. Jay Atkinson and Carl Jones, in "Farm Income and Gross National Product" (*Survey of Current Business*, Dept. of Commerce, August 1954).

Except as noted below, the values in current prices of the two major classes of physical assets—land and buildings, and implements and machinery (including automobiles, motor trucks, and tractors) —were obtained, by states, from published reports of the census.[1] The values of livestock (cattle, hogs, sheep, chickens, horses, and mules) in current prices were, with a minor exception, obtained from published reports of BAE.[2] The census has regularly reported the number and value of various classes of livestock on farms, but as successive enumerations occurred at various times of the year, the data are not really comparable. BAE's published estimates for January 1 of each year are therefore much to be preferred.

[1] The first exception is the values of land and buildings for 1945, which are estimates of BAE. The substitution of these significantly higher values for 1945 seems justified by the information obtained from crop reporters and by the values reported by the census for both 1940 and 1950. The second exception applies to the values of implements and machinery for the years 1935, 1945, and 1950. In 1935 and 1950 the census did not obtain the value of implements and machinery on farms. However, BAE has estimated such values for the United States, and these were distributed to the states. The value of automobiles on farms was not obtained by the census in 1945, and for that year the BAE estimate of the United States total value of automobiles on farms was used and distributed by states.

[2] For the years before 1925 it was necessary to make our own estimate of number and value of chickens.

The values in current prices of crops stored on farms were estimated. The census has at no time enumerated the amount or the value of stored crops, while estimates by BAE are fragmentary and, in the main, available only for recent years. The census has, however, regularly reported the amount of crops produced in the year preceding the taking of the census. Estimates of the amount of crops stored on farms were therefore made in most instances by multiplying the reported production by factors relating production to the amount stored at the beginning of the following year, derived from years for which both types of data were available.

Methods of Adjusting for Price Changes

If the growth of farm capital is measured over long periods in current prices, the picture obtained is likely to be greatly distorted by price changes. To avoid such distortion we developed in one way or another, as available data permitted, a series of constant-price values for each type of capital. For each crop and class of livestock we multiplied, by states, the average price per unit on (or near) January 1 of the years 1910-14 by the number of units in the inventory at the beginning of the census years 1870 to 1950. Except for physical amounts of stored crops, which had largely to be estimated, the required data were available in publications of BAE.

For implements and machinery, constant-price values were obtained by dividing the current values by an index of prices paid by farmers for machinery. The method of preparing such an index for census years during the period 1870 to 1950 and a limitation on its usefulness are described in Appendix B.

For real estate, the calculation of constant-price values was more complex. Briefly, it consisted of multiplying for each state the estimated 1910-14 prices of improved and unimproved land by census-reported acreage of each type, and adding to this the deflated value of buildings. In thirty-seven states in which irrigation is relatively unimportant, use was made in one way or another of the acreage of "improved" and "unimproved" land in farms, the number of farms, and, after 1910, of BAE's estimates of expenditures on construction and depreciation of farm improvements for the United States.[3] In the eleven Western States in which irrigation is relatively important, account was taken of changes in the acreage of irrigated, dry farming, and grazing land. How these details and the 1910-14 average prices of farm real estate were applied in the calculations is described

[3] For a definition of improved land see footnote 1, Appendix A.

in Appendix A. This appendix also contains some discussion of the limitations and reliability of these estimates.

Cash working balances held by farmers were adjusted to meet a limited need for a measure of ready purchasing power retained for use in farming. This measure was obtained by dividing the cash balances by BAE's index of prices paid, interest, taxes, and wage rates (1910-14 = 100). In general, however, the unadjusted balances were the more useful ones.

The highly useful measure of countrywide farm production provided by Atkinson's and Jones' estimates of farm gross national product in constant prices unfortunately covers only the second half of the period of our study, and it cannot very well be used in regional analysis. Hence we use it only in a supplementary way in this study. Most of our historical and regional analysis of output is carried out with estimates of gross farm income for the United States deflated by indexes of prices received by farmers. The Strauss-Bean estimates that we used for the period 1869-1919 were divided by the Strauss-Bean "Ideal" index of farm prices for "Total farm production adjusted for changes in inventories of livestock, calendar years (1910-14 = 100)." The BAE estimates of gross farm income that we used for the period 1910-50 were divided by the BAE index of prices received for all crops and livestock (1910-14 = 100). For the period 1869-1909 the adjusted countrywide totals were distributed to states and regions on the basis of each state's proportion of the unadjusted countrywide total. Beginning with 1919 regional deflators described in Appendix H were used to adjust regional estimates of gross farm income.

Limitations of Data

COMPARABILITY OF CENSUS DATA

No attempt was made to adjust census data on number of farms, acreage, and related items to improve comparability and accuracy, as available information for this purpose is inadequate. Census reports as well as several studies made since 1930 indicate that, at least for certain areas and for certain years, the enumeration of farms varied in completeness to an extent that impairs comparability.[4] The

[4] See, for example, *Twelfth Census of the United States, 1900*, Vol. V, Part 1, pp. xvii, xviii; also I. G. Davis, "A Discussion of the Accuracy of Agricultural Census Enumeration in the Northeast," *Journal of the American Statistical Association*, September 1933, pp. 272-285; J. D. Black, "The Coming Census Enumerations," *Journal of Farm Economics*, July 1934, pp. 451-458; and J. D. Black and R. H. Allen, "The Counting of Farms in the United States," *Journal of the American Statistical Association*, September 1937, pp. 439-447.

shortcomings are most pronounced in the enumeration of the number of farms, and the comparability of this item is probably less satisfactory than that of any other data appearing in the basic tables. Despite an essentially similar definition of a farm throughout the eighty-year span, there was nevertheless enough variation in minor aspects of the definition, in instructions, and in interpretation, judgment, and zeal on the part of enumerators and their supervisors so that the count of small farms probably varied considerably more than their actual number from census to census, and from one region to another in the same year.

As most of the error was in the enumeration of the smallest farms, the effect on the comparability of acreage, value of real estate, machinery, livestock, and production was far less serious than on number of farms. Except for number of farms, the damage to comparability was perhaps not very significant, at least insofar as national and regional totals are concerned. But any conclusions involving the number of farms, if they are to be trusted must take account of the probable errors in the census figures mentioned above. In other words, care must be exercised lest small differences between two census dates, or among regions, be thought to indicate significant agricultural changes when in fact they may have resulted entirely from differences in the completeness with which farms were enumerated. We believe that the conclusions which follow in this report do not depend on differences so small that they might be the results merely of faults in the basic data.

The figures on the numbers of persons engaged in agriculture reported by states in the Census of Population lack much in accuracy and comparability, since, among other things, they suffer from recognized errors in enumeration and differences in coverage with respect to both age and types of agricultural worker. The Bureau of the Census largely overcame these deficiencies on a countrywide basis by adjustments of the number reported for the United States for census years 1870-1930 to take account of the major discrepancies. In this study these adjustments are carried to states and regions, along with additional minor adjustments made to improve the homogeneity of the class. The 1940 and 1950 data provided by the census were expanded to include workers in the ten- to thirteen-year age group. The adjustments are described in detail in Appendix F.

LIMITATIONS OF PRICE-ADJUSTED DATA

As already indicated, the limitations of some of our price-adjusted data are pointed out in appendixes that describe the methods of

adjustment. Here it will suffice to indicate and evaluate the more troublesome ones that remain.

Our purpose in adjusting for price changes, to obtain measures of physical growth, would have been served best if we could have multiplied the 1910-14 prices of each type of physical capital by the number of units employed in agriculture at each census date. Fortunately, this procedure was possible for land, livestock, and crops, since both physical quantity series and unit prices in 1910-14 were obtainable from published reports or could be estimated from published data. But it was not possible to follow this procedure for machinery and buildings, as the basic data for such calculations were lacking. To obtain a physical measure of changes in the physical inventory of machinery it seemed best to deflate reported current values with an index of farm machinery prices. For buildings beginning with 1910, BAE's estimates of the value of buildings in 1910 prices were adopted, and for earlier census dates the 1910 estimate was carried back on the basis of number of farms.[5] It goes without saying that the several methods employed give somewhat different results. It seems likely that changes in quality of the units are reflected at least to some degree in the constant-price series of machinery, buildings, and land (in view of the distinction made between improved and unimproved acreage), whereas they probably escape entirely in the series that measure changes in the volume of livestock and crops. These are faults in the data for which there is no ready remedy and which probably result in some understatement of physical growth, notably in the case of livestock. Fortunately, at least so far as the important capital-product ratio is concerned, much of this defect cancels out because of a similar bias in product at constant prices. It seems safe to assume that just as the hen and cow of 1950 were on the average better converters of feed than their progenitors of 1900, so the eggs and milk delivered by the farmer were of higher quality. In neither case is the higher quality reflected in the price-adjusted series.

A second limitation of our price-adjusted data arises from the fact that the rate of growth of the total of farm capital is somewhat influenced by the selection of the price base. After values in 1910-14 prices were calculated for each class of physical farm assets, they were added together for each census year to obtain the total constant-price value of physical farm assets. This prompts a question: If the constant prices had been those of another year or period, say of 1929 or of 1950 instead of 1910-14, would the rate at which total capital

[5] See pages 179-180.

grew have been significantly different? The percentages in Table 3 indicate that the difference would have been nominal before 1920, and even after that date the difference would have been of very moderate proportions. It seems unlikely therefore that any substantially different conclusions would be reached if an alternative price base were used.[6]

TABLE 3

Percentage That the Constant-Price Values of Physical Farm Assets Are of 1910, Calculated in 1910-1914, 1929, and 1950 Prices, United States, by Decades, 1870-1950

Year	*Based on 1910-1914 Prices (1)*	*Based on 1929 Prices (2)*	*Based on 1950 Prices (3)*
1870	43.6	43.7	44.1
1880	61.3	61.6	62.1
1890	74.3	74.7	75.4
1900	88.8	89.2	89.4
1910	100.0	100.0	100.0
1920	109.9	110.5	111.5
1930	108.4	109.6	110.6
1940	107.1	109.1	110.9
1950	118.4	122.7	126.8

Column — Source

1 — Derived from Table 9.

2 — Derived from Appendix Table G-1.

3 — Values in 1950 prices were computed in the same manner as described in Appendix G, except that the appropriate increase in land and buildings for 1950 was found to be 74.1 per cent (instead of 19.7 when converting to the 1929 price base) and the index used to convert the value of machinery to the 1950 base was as follows: 1870, 46; 1880, 38; 1890, 32; 1900, 31; 1910, 34; 1920, 60; 1930, 50; 1940, 54; 1950, 100.

Prices per head of livestock on January 1, 1950 and per unit of stored crops on December 15, 1949 were multiplied by the numbers of livestock and the volume of crops stored on farms on January 1 of census years.

The method used for the years 1869 through 1909 of distributing the adjusted gross farm income for the United States to states and regions on the basis of each region's proportion of the unadjusted countrywide amount in any census year, produces some bias in the

[6] The more rapid growth in total capital indicated when prices of 1929 and 1950 are used as constants is in line with expectations, because prices of the components that increased in relative importance were relatively higher in the later years. The largest gain in relative importance was scored by machinery—mostly at the expense of real estate. Based on 1910-14, the price indexes of farm machinery in 1929 and 1950 are 151 and 294 respectively, compared with 116 and 169 for real estate. Another case in point is the sharp decline in the number of horses and mules after 1920; this was accompanied by relative weakness in the price of these animals compared with the prices of other livestock.

regional estimates of price-adjusted income; prices received by farmers did not move with complete uniformity in the several regions. If the prices of the principal products of a region in any year rose relative to the United States index of prices received, an overestimation of the product occurred. The reverse was true, of course, if the increase in any region's prices received for principal products was less than that shown by the United States index. Unfortunately, elimination of this defect is not feasible. However, there appears to have been sufficient similarity in the movements of United States average prices received by farmers for representative products of the various regions to warrant the belief that even our regional estimates of output for 1909 and earlier years reflect with fair accuracy the underlying movements in physical output (Chart 6 in Chapter 4).