Chapter Title: The Relation of Capital to Product

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CHAPTER 7

The Relation of Capital to Product

THE salient questions that we now raise concern the amounts of agricultural capital of various types that have been used over the years to supply a unit of agricultural product, and the reasons for the trends that we observe in capital-product ratios. Since we desire to elicit from these historical relationships information that will help to estimate future requirements of capital, there is reason to establish ratios of farm capital to some measure of product which reflects as clearly and simply as possible the demand for farm products made directly or indirectly by consumers, domestic and foreign. For this purpose it would seem suitable to use estimates which combine the gross value of products sold to the nonfarm sectors and the value of products added to inventory or consumed by persons living on the farms where they were produced. These are, of course, the chief components of gross farm income.[1]

However, gross farm income has some fairly serious shortcomings as a measure of what is actually produced by farm operations. Particularly in a period like 1920-50, when the use of intermediate products from other economic sectors expanded rapidly, gross farm income overstates substantially the actual product or "value added." It follows that capital-product ratios in which gross farm income is used to reflect product fall faster for such a period than they would if growing efficiency of capital or shifts in the proportion of capital to labor used in farming were the only forces inducing the decline. Such bias might be avoided by use of estimates of farm income net of intermediate products, like those provided by the Department of Commerce in current and constant dollars for the United States for 1910 and later. Unfortunately, these estimates are available for only half of the period covered by this study. Moreover, the estimates of farm income net of intermediate products cannot be distributed satisfactorily by regions. Hence we use gross farm income estimates while recognizing their shortcomings as reflectors of the product units which ideally we should like to relate to farm capital, because the admittedly rough results show relationships that are highly instructive if we keep in mind the likelihood and possible extent of bias. Fortunately, some idea of the extent of this bias, on a countrywide basis, can be gained by comparing the trend of ratios obtained by

[1] Appendix H contains descriptions and comparisons of various measures of farm production together with a description of methods used to estimate gross farm income by regions.

using gross farm income as divisors with that obtained by using the net data, for years in which both are available.

For reasons given elsewhere (page 208) we have excluded the rental value of the farm residence from income although we have included the residence as an item of capital. This exclusion should be borne in mind, particularly if comparisons are made between the capital-product[2] ratios of this study and those calculated for other sectors where the residences of workers are not considered to be a part of the industries' capital.

Trend of Capital-Product Ratios

The trend in the ratio of physical capital to product has been unmistakably downward during the eighty-year span under study (Table 20). The decline was not without interruptions, but these appear to have been caused by special short-term factors which temporarily overcame the more persistent forces working to lower the ratio.[3]

From 1870 to 1920 the decline in the ratio of capital to product was very moderate—13 per cent in fifty years.[4] Thereafter the decline

[2] In this chapter gross farm income in constant prices will usually be referred to as "product."

[3] The deviations from trend in the ratios for 1910 and 1920 were probably the result of the marked upswing in the income of farmers that occurred after 1900. The average gross income per person engaged in farming for the 1870's, 1880's, and 1890's was $325, $337, and $298. By contrast, the averages for the following two decades were $432 and $795 respectively. This remarkable increase in the gross income of persons engaged in farming undoubtedly contributed to a volume of investment in buildings and machinery that altered the trend of the ratio.

The deviation from trend in the ratio for 1935 can be accounted for in part by the widespread droughts of 1934 and 1936 that severely damaged crops and restricted livestock production, and in part by the restrictions on crop and livestock production which were part of the government's farm program. The slight deviation in the ratio of capital to gross farm income for 1950 might be explained as having occurred because of the extent to which the ratio for 1945 was depressed by factors that were particularly associated with the war years—limitation on the supply of building materials and machinery, and five years of consistently favorable weather which coincided with war-inspired attempts by farmers and the government to push production to the limit of facilities. But the ratios of capital to *net* farm income suggest that the higher ratio for 1950, like those for 1910 and 1920, reflects mainly a further impressive expansion of capital inspired by a prolonged period of high income. But this further expansion of capital was not matched by a corresponding increase in output. For reasons given above, production in the period centering on 1945 was so large that the level of output was not quite maintained in the following period.

[4] Throughout this chapter the comparisons of growth in product (gross farm income in 1910-14 prices) or of capital-product ratios before and after 1920, are based on the estimates of Strauss and Bean for the period before 1920, and

TABLE 20

Relation of Physical Farm Capital to Farm Income in 1910-1914 Prices, United States, Census Years, 1870-1950

(dollars in millions)

YEAR	PHYSICAL FARM CAPITAL (1)	FIVE-YEAR AVERAGE GROSS FARM INCOME (2) Strauss-Bean	BAE	RATIO OF PHYSICAL FARM CAPITAL TO AVERAGE GROSS FARM INCOME (3) Strauss-Bean	BAE	FIVE-YEAR AVERAGE NET FARM INCOME (4)	RATIO OF PHYSICAL FARM CAPITAL TO AVERAGE NET FARM INCOME (5)
1870	$19,758	$2,392		8.26			
1880	27,819	3,542		7.85			
1890	33,707	4,400		7.66			
1900	40,307	5,748		7.01			
1910	45,367	6,313	$ 6,708	7.19	6.76	$5,330	8.51
1920	49,842	6,973	7,471	7.15	6.67	6,020	8.28
1925	48,013		8,021		5.99	6,310	7.61
1930	49,160		8,660		5.68	6,735	7.30
1935	47,178		8,015		5.89	6,036	7.48
1940	48,572		9,623		5.05	7,267	6.68
1945	51,376		11,348		4.53	7,733	6.64
1950	53,693		11,778		4.56	7,606	7.06

Source

Column

1   Table 9.

2   Average for 1870 is three-year average of 1869-71; 1880-1950 are five-year averages centered on year preceding census year; 1870-1920 averages in Strauss-Bean column are calculated from annual estimates in Frederick Strauss and Louis H. Bean, *Gross Farm Income and Indices of Farm Production and Prices in the United States, 1867-1937*, Dept. of Agriculture, Tech. Bull. 703, 1940, Table 8, deflated by "ideal" index of farm prices, Table 79, same work; BAE averages for 1910-1950 are calculated from annual income estimates found in *Farm Income Situation*, September-October 1953, Tables 11 and 14, deflated by index (1910-14=100) of prices received by farmers, *Agricultural Statistics*, 1953, Table 640, p. 540.

4   Dept. of Commerce estimates in 1947-49 prices of total farm output (total farm output less gross rental value of farm homes multiplied by 0.370 (the 1910-14 average implicit deflator for total farm output), minus the value in 1947-49 dollars of intermediate products consumed other than rents paid to landlords multiplied by 0.439 (the 1910-14 average implicit deflator for this item); values in 1947-49 dollars and implicit deflators from L. Jay Atkinson and Carl Jones "Farm Income and Gross National Product," *Survey of Current Business*, August 1954, pp. 22, 23.

In order to obtain five-year averages centered in 1909 for BAE's gross farm income and for the estimates of "net" income, we assumed that the five-year (1907-11) estimates in these series would bear the same relation to the respective incomes of 1910 and 1911 as the Strauss-Bean estimates of gross farm income for the five-year period bore to the estimates for 1910-11.

was much more rapid. In the thirty years that ended with 1949 the ratio fell 32 per cent, or about 4 times the rate in the earlier period.

The acceleration after 1920 in the decline of the ratio of farm capital to product was the consequence mainly of two developments: (1) a growing importance in farm operation of intermediate products furnished by nonfarm sectors, and (2) many and far-reaching technological advances, which included improvement in seeds, feeds, breeding animals, and the care of crops and livestock.

A substantial increase in farm products was made possible by the rise in importance of intermediate products supplied to farmers by other sectors, quite aside from the increase made possible by the greater technical efficiency that often accompanied the use of intermediate products. For example, the progressive substitution during these three decades of automotive power for horses and mules on farms permitted more effective cultivation of crops at the same time that it released millions of acres of cropland and much other farm capital and labor which previously had been employed in the production of work animals and their feed.

The influence on the denominator of the capital-product ratio of this release of cropland from feed production that accompanied the shift to mechanical power is revealed by a comparison of BAE's index of gross farm production and gross farm income, as the former includes, and the latter excludes, the value of crops and pasture consumed by horses and mules and the product added by converting this feed into animal power. Between 1890 and 1920, before the rapid decline in farm-produced power began, the increase in the index of gross farm production and deflated gross farm income was about the same—63 and 60 per cent respectively (Table 21). However, between 1920 and 1950, the increases were 24 and 71 per cent respectively.

Although the substitution of mechanical for animal power was the chief development that caused farmers after 1920 to purchase intermediate products in relatively much larger volume than before, it was by no means the only one. The growing reliance on commercial sources for seed, feed, and fertilizers likewise opened the way to greater concentration on the production of items that entered directly into gross farm income. A rough indication of the extent to which the more general use of intermediate products, supplied mainly by nonfarm sectors, was responsible for the rise in gross farm income (and the decline of our capital-product ratio) can be obtained by

on estimates of BAE for the period following that pivotal date (see Appendix H for descriptions of the series).

TABLE 21

Value of Physical Farm Capital, Gross Farm Income, and Gross and Net Farm Production in 1910-1914 Prices, United States, 1890, 1920, 1950

(dollars in millions)

YEAR	FARM CAPITAL Value (1910-14 dollars) (1)	Percentage Change	GROSS FARM INCOME Value (1910-14 dollars) (2)	Percentage Change	GROSS FARM PRODUCTION Index 1870=100 (3)	Percentage Change	NET FARM PRODUCTION Value (1947-49 dollars) (4)	Percentage Change
1890	$33,707		$ 4,465		188		$16,590	
1920	49,842	48	7,148	60	306	63	23,325	41
1950	53,693	8	12,210	71	379	24		

Source

Column

1   Table 9.

2   For 1890, From Frederick Strauss and Louis H. Bean, *Gross Farm Income and Indices of Farm Production and Prices in the United States, 1869-1937*, Dept. of Agriculture, Tech. Bull. 703, 1940, Table 8, adjusted to 1910-14 price level by "ideal" index, Table 79, same work; for 1920, an average of amount calculated for 1920 from sources used for 1890, and amount calculated by adjusting BAE's estimate of gross farm income less rental value of farm homes by BAE's index of prices received by farmers; for 1950, BAE's estimate of gross farm income excluding government payments and less rental value of farm homes adjusted by index of prices received by farmers.

3   Supplied by BAE, Division of Farm Management and Costs; for 1920 and 1950 these indexes have been converted from those published by BAE on the 1935-39 base; the index for 1889 was computed for this study by the Division of Farm Management and Costs.

4   Total value of farm output less gross rental value of farm homes and intermediate products other than rents paid to nonfarm landlords, from L. Jay Atkinson and Carl Jones, "Farm Income and Gross National Product," *Survey of Current Business*, August 1954, Table 3, pp. 22, 23.

comparing the growth of gross farm income in constant prices with the growth of farm output less intermediate products as calculated in constant prices by the Department of Commerce.[5] The value of gross farm income adjusted to 1910-14 prices is 71 per cent higher for 1950 than for 1920. This compares to a 41 per cent rise in the value of farm output less intermediate products in 1947-49 prices, and to a 24 per cent increase when calculated in 1939 prices. Since the percentage increases in these constant price estimates are so sensitive to the prices used as weights, no more precise comparison is possible. But this comparison suggests that something like one-half of the increase in gross farm income during the three decades preceding 1950 had its source in the expanding use of purchased intermediate products associated with the substitution of mechanical power for work animals, and with greater specialization on farms in other respects.

The second factor that contributed to the acceleration in the decline of the capital-product ratio after 1920 was the widespread adoption of technological improvements in farming. The extensive use of improved varieties of crops like hybrid corn and disease-resistant small grains; the closer planting of row crops; the great increase in the use of lime, commercial fertilizers, and insecticides; the improvement of techniques of cultivation and of harvesting of crops made possible by improved machinery and mechanical power are familiar developments of the 1930's and 1940's that account in large measure for the increase of one-third in crop production per acre in the two decades preceding 1950.[6] This is in contrast to the almost imperceptible rise in yield per acre between 1870 and 1930. Moreover, better livestock management led to a level of production per animal unit half again as high in 1950 as in 1920.[7]

The difference in the impact of technological improvements on the

[5] John W. Kendrick and Carl E. Jones, "Gross National Farm Product in Constant Dollars, 1910-1950," *Survey of Current Business*, September 1951, and L. Jay Atkinson and Carl Jones, "Farm Income and Gross National Product," *Survey of Current Business*, August 1954. Total value of farm output in the Department of Commerce estimates is made up of the same components as gross farm income in the present study, except that it includes gross rental of farm homes, which we have excluded. As Kendrick and Jones point out, this item is practically offset by gross rent paid to landlords, an item listed by them under intermediate products, but not so considered in this study.

[6] *Agricultural Outlook Charts 1951*, Bureau of Agricultural Economics, p. 4. Three-year averages of indexes of production per acre, centered on 1930 and 1950, were compared. The three-year average for 1920 is identical with that for 1930.

[7] *Ibid.* Three-year averages of production per animal unit, centered on 1920 and 1950, were compared.

volume of farm production before and after 1920 may be further emphasized by comparing the rates of growth of capital with BAE's index of gross farm production in the thirty years preceding and following 1920 (Table 21). As indicated above, this index includes the value of farm-produced power and hence reflects more clearly than the estimates of gross farm income the effects of technological improvements on over-all physical production in a period that witnessed the substitution of mechanical for animal power. From 1890 to 1920 the value of farm capital in constant prices increased 48 per cent, and the index of gross farm production increased 63 per cent. From 1920 to 1950 the increases were respectively 8 and 24 per cent. Accordingly, in the period 1920-50 the rate of increase of gross farm production was 3.0 times the rate of increase of capital, whereas in the thirty years preceding 1920 the rate of increase of gross farm production was only 1.3 times that of capital.[8] Although the Department of Commerce estimates of intermediate products and net farm production do not begin early enough to permit a similar comparison of relative growths of capital and "value added" by farmers—which is reflected in the estimates of net farm production—it is significant that in the thirty years following 1920 "value added" by farmers increased 41 per cent—five times the percentage increase in farm capital. It seems certain that the rate of growth of value added by farm operation in the thirty years preceding 1920 did not exceed that of farm capital by anything like this amount. Indeed, for a decade preceding 1920, for which the Department of Commerce estimates permit comparison, far from exceeding fivefold the rate at which farm capital grew, value added by farmers increased at a substantially lower rate than farm capital—less than 3 per cent for the former in contrast to 10 per cent for the latter.

That product increased so much faster than physical capital in the period following 1920 cannot in any wise be ascribed to greater participation of labor. The farm labor force shrank notably in each decade following 1920, whereas it expanded during at least two decades of the earlier period.

[8] The thesis that improvements in farm capital and in methods of farming contributed much to the rapid decline in the capital-product ratio between 1920 and 1950 is supported by another line of reasoning. In the absence of improvements of the kind mentioned in the preceding paragraph a decline in total production would have accompanied the very substantial decrease in the number of farm workers for which the relatively small increase in farm capital was hardly an adequate substitute. This decline in production would have led to a rise in the capital-product ratio instead of the sharp decline which in fact occurred.

Regional Differences in Capital-Product Ratios

At the outset it is necessary to warn the reader that our regional capital-product ratios may be considerably less reliable than those computed for the country as a whole. This is largely because it was necessary to use a countrywide deflator for 1869 through 1909; to some extent it is due to difficulties encountered in distributing gross farm income to regions prior to 1924, and to shortcomings in the regional deflators used on income for 1919 and later. How we modified, deflated, and distributed gross farm income so as to obtain regional measures of output in constant dollars is described in Appendix H. There, also, warnings are sounded that small differences among regions in capital-product ratios are hardly significant.

The differences in the regional ratios of physical farm capital to product are striking (Table 22). The lowest ratios are found in the Delta States and the Southeast throughout the entire eighty-year span. The extraordinary reliance on hand labor in the production of crops in these regions accounts for the persistence of low ratios of capital to product as well as low value of capital per farm worker. In contrast, the Corn Belt, Mountain, and Great Plains states have consistently had relatively high ratios of capital to product. As was shown in the preceding chapter, these are the regions in which the amount of capital per person engaged in farming was highest throughout the period. Thus a positive correlation exists between the level of capital per worker and the ratio of capital to product.

However, over time, capital per worker and the ratio of capital to product have moved in opposite directions. Whereas capital per worker rose impressively throughout the eighty-year period in all regions except the Pacific, the capital-product ratio everywhere declined. Technological changes that affected every major class of physical farm capital, and the methods of farming, caused production on farms to rise faster than capital even though the latter increased steadily in relation to labor. The innovations therefore were capital-saving as well as labor-saving, raising the efficiency of both factors of production.

INFLUENCE OF INTERREGIONAL SHIFTS IN AGRICULTURE

It is a matter of special interest to observe the extent to which the trend of the countrywide capital-product ratio may have been influenced by the substantial changes since 1870 in the relative importance of the various regions as sources of agricultural products, as against changes of an intraregional character, such as technological

improvements. The influence of interregional shifts in agricultural production in any period can be shown by calculations in which the capital-product ratios for each region are held constant but in which the regional shares in the countrywide total of output that serve as weights in the countrywide ratio are allowed to vary. Similarly, by holding the relative share of each region in farm output constant in any period while permitting the ratios to vary, it is possible to isolate the contributions to change in the countrywide ratio made by intra-regional factors during that period.

The results of such calculations, which appear in Table 23, support the following conclusions: (1) Developments within regions which affected existing types of farming influenced the countrywide capital-product ratio far more than did shifts in importance of regions as producers of farm products. This was so even in the earliest decades when such interregional changes were most pronounced. The greater influence of internal developments emphasizes the dominant role of improved breeding stock, crops, and methods of farming that were raising product relative to capital even in the early decades, when such improvements had by no means reached the importance they were to display after 1930. (2) Until 1920 the effect of interregional shifts (in this case the growing importance of the western regions) was to retard the decline in the countrywide ratio, but from 1920 to 1940 interregional shifts contributed somewhat to the decline. In this connection it is of particular interest to note that insofar as investment in farm buildings is concerned the rise in importance of the westerly regions contributed from the beginning to the decline in the capital-product ratio (instead of retarding it). This is not surprising, since the types of agriculture which dominated the developing regions—range livestock, small grains, and, in some of the far western areas, fruit and vegetables—did not call for the relatively elaborate shelter or storage facilities that were provided for livestock, machinery, and crops in the dairy and livestock feeding areas of the North and East.

PERSISTING REGIONAL DIFFERENCES IN CAPITAL-PRODUCT RATIOS

Among the impressions that the regional ratios shown in Table 22 convey is that their range has narrowed over time, but when their average deviations are expressed as percentages of the countrywide ratios, as is done in the final line of the table, it becomes apparent that, at most, convergence has been small and frequently interrupted. It follows that although the capital-product ratios were declining with great consistency in all regions, the regional differences largely persisted.

TABLE 22

Ratio of Physical Farm Capital to Gross Farm Income in 1910-1914 Prices, by Regions, Census Years, 1870-1950[a]

Region	1870	1880	1890	1900	1910	1920	1925	1930	1935	1940	1945	1950
United States:												
Strauss-Bean	8.77	7.83	7.43	6.97	7.33	7.01	6.10	5.67	6.98	5.07	4.56	4.57
BAE					6.88	6.61						
Northeast:												
Strauss-Bean	6.60	6.12	5.38	5.40	6.45	4.91	4.38	4.17	3.86	3.32	3.38	2.85
BAE					6.05	4.64						
Appalachian:												
Strauss-Bean	7.25	6.35	6.16	5.09	5.29	5.61	4.65	4.00	4.06	3.64	3.28	3.41
BAE					4.97	5.29						
Southeast:												
Strauss-Bean	4.90	4.10	3.23	3.69	3.34	4.92	3.59	2.64	2.82	2.45	2.54	2.83
BAE					3.13	4.64						
Lake States:												
Strauss-Bean	8.45	7.17	7.23	6.97	8.05	6.80	6.12	6.38	7.35	5.42	5.15	4.68
BAE					7.56	6.42						
Corn Belt:												
Strauss-Bean	12.70	10.30	10.38	8.83	9.20	9.85	8.33	7.64	10.67	6.33	5.88	5.52
BAE					8.63	9.29						
Delta States:												
Strauss-Bean	3.45	3.07	2.82	3.33	3.84	4.62	3.62	2.56	3.16	2.34	2.41	2.70
BAE					3.60	4.35						
Great Plains:												
Strauss-Bean	11.23	11.87	9.99	8.51	8.70	8.21	7.37	7.80	36.97	9.81	6.73	7.70
BAE					8.17	7.75						

(continued on next page)

TABLE 22 (continued)

Region	1870	1880	1890	1900	1910	1920	1925	1930	1935	1940	1945	1950
Texas-Oklahoma:												
Strauss-Bean	10.80	9.91	7.72	7.27	6.96	5.39	5.01	5.43	7.21	5.31	4.49	4.02
BAE					6.53	5.08						
Mountain:												
Strauss-Bean	8.50	11.12	11.09	7.76	7.68	7.38	6.87	6.36	7.59	5.69	5.24	5.53
BAE					7.20	6.95						
Pacific:												
Strauss-Bean	16.87	12.53	9.76	9.71	9.63	6.69	5.92	4.98	4.20	4.13	3.32	4.11
BAE					9.04	6.31						
Weighted av. dev.:												
Strauss-Bean	2.96	2.41	2.42	1.72	1.72	1.94	1.40	1.59	3.44	1.55	1.26	1.17
BAE					1.62	1.51						
Weighted av. dev. as percentage of mean:												
Strauss-Bean	33.8	30.8	32.6	24.7	23.5	27.7	23.0	28.0	49.3	30.6	27.6	25.6
BAE					23.5	22.8						

a Physical farm capital is for specified census years. Annual income data are for years preceding census years.
Source: Based on Tables 9 and H-3.

TABLE 23

Changes in Capital-Product Ratios Attributable to Intraregional Developments
and to Interregional Shifts of Agricultural Output,
United States, by Decades, 1870-1950

Decade and Type of Change	Total Physical Farm Capital	Farm Land	Farm Buildings	Machinery plus Horses and Mules	Livestock minus Horses and Mules	Crop Inventories
1870-80:						
Total	−0.94	−0.67	−0.14	−0.05	−0.09	+0.02
Intra	−1.30	−1.00	−0.11	−0.07	−0.15	+0.02
Inter	+0.37	+0.33	−0.04	+0.02	+0.06	0.00
1880-90:						
Total	−0.40	−0.32	−0.16	+0.05	0.00	+0.03
Intra	−0.53	−0.44	−0.12	+0.04	−0.05	+0.04
Inter	+0.14	+0.12	−0.04	+0.01	+0.05	0.00
1890-1900:						
Total	−0.46	−0.21	−0.08	−0.02	−0.10	−0.04
Intra	−0.74	−0.44	−0.05	−0.04	−0.16	−0.05
Inter	+0.28	+0.23	−0.03	+0.02	+0.06	0.00
1900-10:						
Total	+0.36	+0.03	+0.26	+0.09	−0.03	0.00
Intra	+0.34	−0.02	+0.31	+0.09	−0.04	+0.01
Inter	+0.02	+0.06	−0.05	0.00	+0.01	0.00
1910-20:						
Total	−0.27	−0.34	+0.02	+0.05	+0.01	−0.01
Intra	−0.31	−0.41	+0.04	+0.05	−0.01	+0.01
Inter	+0.05	+0.06	−0.02	0.00	+0.01	−0.01
1920-30:						
Total	−0.94	−0.50	−0.16	−0.15	−0.08	−0.06
Intra	−0.86	−0.44	−0.14	−0.14	−0.06	−0.06
Inter	−0.09	−0.05	−0.02	−0.01	−0.01	0.00
1930-40:						
Total	−0.60	−0.27	−0.17	−0.13	0.00	−0.01
Intra	−0.46	−0.15	−0.18	−0.12	0.00	−0.01
Inter	−0.13	−0.13	+0.01	−0.01	0.00	0.00
1940-50:						
Total	−0.50	−0.53	−0.02	+0.08	−0.04	+0.01
Intra	−0.60	−0.62	−0.01	+0.08	−0.05	+0.01
Inter	+0.10	+0.09	0.00	0.00	+0.01	0.00

Source: Based on Tables 22, 26, 30, 31, 32, 33, and H-3.

In the period 1870 to 1920, when regional ratios converged mildly
but with fair consistency, the narrowing of the range came about
because the ratios of the newer regions (which generally were ex-
ceptionally high in the early years) fell more nearly into line (Table
24). For this development two reasons may be given. First, the

TABLE 24

Weighted Average Deviation as a Percentage of Countrywide Mean Capital-Product Ratio for Selected "Old"[a] and "New"[b] Regions, Decennial Census Years, 1870-1950

Asset Group	1870	1880	1890	1900	1910	1920	1930	1940	1950
Total physical farm capital:									
Old	25.77	25.93	31.36	29.41	29.80	26.17	34.74	36.69	33.04
New	49.03	47.00	27.59	19.08	15.41	14.37	18.69	32.35	27.79
Land									
Old	34.71	36.25	41.70	42.47	43.89	42.92	51.07	51.87	51.70
New	60.66	57.25	33.99	28.45	23.14	21.70	23.53	40.63	35.03
Buildings									
Old	56.52	57.43	56.47	58.44	50.52	23.23	38.55	37.88	25.00
New	37.39	36.63	30.59	40.26	34.02	36.36	33.73	31.82	28.12
Machinery plus horses and mules									
Old	14.04	13.46	21.05	10.91	16.67	7.69	14.00	5.41	6.67
New	45.61	42.31	28.07	12.73	10.00	16.92	24.00	27.03	22.22
Livestock other than horses and mules									
Old	25.00	25.45	36.36	33.33	33.33	27.50	34.38	34.38	28.57
New	225.00	145.45	87.27	53.33	30.77	27.50	34.38	40.62	35.71
Crops									
Old	8.57	10.81	15.00	13.89	8.82	15.15	7.41	19.23	18.52
New	34.29	51.35	50.00	27.78	32.35	27.27	37.04	46.15	48.15

[a] Includes Northeast, Appalachian, and Southeast regions.
[b] Includes Great Plains, Texas-Oklahoma, Mountain, and Pacific regions.
Source: Based on Tables 22, 26, 30, 31, 32, 33, and H-3.

growing importance of the western regions naturally increased their influence on the countrywide mean itself. Second, with thicker settlement came fuller use of farm capital. The characteristic frontier practice of applying meager amounts of labor to resources gradually gave way to more intensive applications, thereby encouraging product to rise faster than the capital used in its production.

Table 24 shows also that during most of the seventy-year span from 1870 to 1940, the capital-product ratios of old regions tended to diverge from the countrywide mean, and that the ratios even of those regions that were late in settlement tended to diverge after 1920. In view of this there is considerable reason to doubt that the narrowing of the range of the regional capital-product ratios which occurred between 1940 and 1950, presumably in connection with countrywide developments like intensive mechanization, will persist. The recent tendency to converge is hardly sufficient either in duration or in

strength to justify the conclusion that the tendency of the regional capital-product ratios to diverge, so persistent in the older regions before 1940, and even in the newer regions after 1920, is now permanently reversed.

Trends in the Ratio of
Selected Classes of Capital to Product

The developments whose general impact on the capital-product ratio were described above affected somewhat differently the amount of each major class of capital that was used to produce a unit of product. The origins of a given change in the all-embracing ratio are therefore more easily discerned if changes are noted in the amounts of specific classes of capital per unit of product. Accordingly, in what follows, the values of land, buildings, machinery, horses and mules, other livestock, and stored crops are each related to product, and the significant changes that occurred in these ratios, together with the more important regional differences, are considered. Finally, the growing importance of operating cash balances is noted.

LAND-PRODUCT RATIO

The ratio of the value of land to gross farm income, both in 1910-14 prices, declined throughout the eighty-year period with even greater consistency than the ratio which involves all capital (Table 25). The declining ratio reflected rising output per unit of land which resulted from developments whose individual importance varied with time and place. The relatively mild decline of the land-product ratio prior to 1920 was associated with the rapid extension of farming into new areas, which resulted in a somewhat higher average quality of land, and, despite a large increase in the farm labor force, in a substantial increase (two-fifths) in the amount of land per person engaged in farming.[9] As reproducible capital per person engaged did not rise at a comparable rate, the intensity of utilization of land did not increase much, if at all, before 1920. Hence, despite the influence of higher average quality of soil and of some technological advances in farming, the decline in the amount of land per unit of product was limited to 20 per cent in fifty years.

In the thirty years following 1920 the decline in the ratio of land to product was 31 per cent, or two and one-half times the annual rate in the period of marked expansion that preceded 1920. This expansion in output per unit of land in the face of a radical decline in

[9] Amount of land measured in value at constant prices.

TABLE 25

Ratio of Specified Types of Farm Capital to Gross Farm Income (Five-Year Averages) in 1910-1914 Prices, United States, Census Years, 1870-1950[a]

| | TOTAL CAPITAL | | PHYSICAL CAPITAL | | | | REPRODUCIBLE CAPITAL | | | | | | | | CROPS | | CURRENCY AND DEMAND DEPOSITS | |
| | | | TOTAL | | LAND | | TOTAL | | BUILDINGS | | MACHINERY AND HORSES AND MULES | | LIVESTOCK OTHER THAN HORSES AND MULES | | | | | |
YEAR	Strauss-Bean	BAE	Strauss-Bean	BAE	Strauss-Bean	BAE	Strauss-Bean	BAE	Strauss-Bean	BAE	Strauss-Bean	BAE	Strauss-Bean	BAE	Strauss-Bean	BAE	Strauss-Bean	BAE
1870	n.a.		8.26		5.70		2.56		1.09		0.54		0.61		0.33		n.a.	
1880	n.a.		7.85		5.40		2.46		1.01		0.52		0.56		0.37		n.a.	
1890	n.a.		7.66		5.21		2.45		0.88		0.58		0.57		0.42		n.a.	
1900	7.13		7.01		4.87		2.14		0.78		0.55		0.45		0.36		0.12	
1910	7.34	6.91	7.19	6.76	4.79	4.50	2.40	2.26	1.01	0.95	0.63	.59	0.41	0.39	0.35	0.33	0.16	0.15
1920	7.31	6.83	7.15	6.67	4.58	4.27	2.57	2.40	1.07	1.00	0.70	.65	0.43	0.40	0.36	0.34	0.17	0.15
1925		6.15		5.99		3.88		2.10		0.92		.54		0.35		0.29		0.16
1930		5.82		5.68		3.75		1.93		0.83		.50		0.32		0.27		0.14
1935		6.07		5.89		4.13		1.76		0.81		.41		0.35		0.18		0.18
1940		5.26		5.05		3.45		1.60		0.65		.37		0.32		0.26		0.21
1945		4.79		4.53		2.97		1.56		0.59		.40		0.31		0.26		0.26
1950		4.82		4.56		2.93		1.63		0.64		.45		0.28		0.27		0.26

[a] Farm capital is for specified census years. Five-year income data are five-year averages centered on year preceding census year, except average for 1870, which is three-year average for 1869-71.

n.a. = not available.

Source: Ratios were calculated from: (1) average gross farm income data in Table 20, (2) value of physical farm capital in Table 9, and (3) amount of currency and demand deposits in Table 13, deflated by index of prices paid by farmers.

the farm labor force was made possible by a greater use of reproducible capital and by the development and adoption of many technological improvements, mentioned elsewhere, which individually or together saved labor, increased crop yields, and improved the performance of productive livestock to a degree not matched prior to 1920. As a result of these developments, the amount of land, the basic agricultural resource, required to produce a unit of farm product in 1950 was hardly more than half the amount required in 1870.

From 1870 to 1910 the two highest regional ratios of land to product prevailed in the Pacific states and in the Corn Belt. After 1910, apparently influenced by the development of labor-intensive enterprises like fruit and vegetable growing and the production of poultry and dairy products, the land-product ratio of the Pacific region declined sharply, so that the ratios in the Great Plains and the Corn Belt were at, or near, the top of the list. At the other end of the scale were the land-product ratios of the Southeast and Delta regions, with that of the Northeast frequently only a little higher. Indeed, in 1920 and again in 1950 the ratio for the Northeast was lowest of all.

Regional variations in the land-product ratio apparently were caused by several factors. Differences in average quality of land, in the availability of other productive factors, in the use of intermediate products, and in the size, proximity, or availability of markets were important influences.

In the South the abundant supply of unskilled farm labor encouraged the growth of labor-intensive crops like tobacco and cotton, which produced relatively high yields per unit of land and thereby contributed to the low land-product ratios of the Southeast and Delta regions. The emergence of great consumer markets in the Northeast encouraged farmers of that region to restrict the production of grain and sheep and to expand the production of dairy and poultry products and of fruits and vegetables. Compared with the types they replaced, dairy and poultry enterprises are both labor-intensive and reproducible capital-intensive, and fruit and vegetable production are at least labor-intensive forms of agriculture. Moreover, intermediate products —feeds, insecticides, and the like—became increasingly important in these types of agriculture. Hence, it is not surprising that the land-product ratio for the Northeast, with its below-average quality of land, declined so sharply after 1910 and ever since has been at, or near, the bottom of the list. Similarly, the sharp decline of the land-product ratio in the Pacific region was associated with the growing prominence of fruit and vegetable farming and of dairy and poultry enterprises encouraged by growing consumers' markets, more plentiful

labor supply, and other developments that attended and encouraged thicker settlement of the region.

Why did not labor-intensive and reproducible capital-intensive forms of agriculture develop in the Great Plains and Corn Belt just as they did in the Pacific region and the Northeast? For the Great Plains the answer seems to be that a combination of abundant land of good quality (though in parts subject to very limited rainfall), sparse population, and lack of nearby consumer markets of large size led to the development of types of farming that emphasized extensive rather than intensive land use. As a result, the product per unit of land was relatively low and, conversely, the ratio of land to product was relatively high.

The high land-product ratios of the Corn Belt may stem from somewhat similar causes, although sparseness of population and remoteness of consumers' markets were less general than in the Great Plains. On the other hand, the relatively high average quality of land in the Corn Belt and abundant rainfall probably encouraged the production of crops and the use of methods that are land-intensive, and in which labor and reproducible capital play a relatively less important role than in other regions.[10]

An examination of Table 26 will show that a decline of the land-product ratio was common to all regions throughout most of the eighty-year span. Moreover, everywhere but in the Great Plains and Texas-Oklahoma regions the ratio fell more rapidly after 1920 than before (Table 27). The regions in which the land-product ratio declined most rapidly after 1920, with hardly an exception, are those in which the amount of reproducible capital per unit of land was rising most, and the regions in which the land-product ratio declined

[10] In the Corn Belt and the Great Plains regions land values in the base period 1910-14 reflected a higher than average rate of capitalization of rent. This may give some upward bias to the land-product ratios in these regions. A rough indication that regional differences in rate of capitalization may have contributed to these results is found in a comparison of the rate of growth, between 1900 and 1910, of the value of land and buildings and of gross farm income. For the United States in the decade which immediately preceded the base period, the increase in the value of land and buildings was 135 per cent of the increase in the value of production. But in the Great Plains and the Corn Belt the increases in the value of land and buildings were respectively 190 and 141 per cent of the increase in the value of production. In the Southeast and Delta regions, where the land-product ratios were lowest, these percentages were 123 and 168 respectively. The below-average percentage in the Southeast further supports the view that regional differences in rate of capitalization of rent into land values may be partly responsible for the differences in the land-product ratios. But the relation of growth of real estate values to growth of income in the Delta States makes it appear that other influences described in the text were decidedly stronger.

least rapidly (or rose) are without exception those in which the volume of reproducible capital per unit of land declined (Table 28). Thus the more intensive utilization of land that is reflected in the notable decline in the land-product ratio during this period was closely associated with the increase in the amount of reproducible capital that was applied per unit of land. Only in limited areas was the more intensive utilization brought about by shifts to crops that required greater amounts of hand labor. Except in the Pacific region, the labor force itself declined notably in this period, a factor that would have increased the amount of land per unit of product had other influences not offset it. Before 1920 the connection between the expansion of reproducible capital and the decline in the land-product ratio is less obvious—perhaps because in this period in many regions a larger proportion of the additions to reproducible capital was in the form of buildings. The annual increase in product that is attributable to additional buildings is normally a lower percentage of their cost than in the case of less durable forms of capital.

Over time the regional land-product ratios converge in much the same pattern as the ratios involving all capital—an expected similarity, since land is the largest and hence the dominating component. The tendency to converge up to 1910, shown in Table 26, results mainly from changes in the ratios of the "new" western regions, where a more intensive utilization of land naturally accompanied thicker settlement (Table 24).

After settlement was complete, the range of the land-product ratios widened again. This means that the most economical proportions of land, labor, and reproducible capital utilized in production varied increasingly among regions. In some instances this may have been due to growing regional specialization. Probably more often it was due to inherent differences in the quality of land which determined the amount of labor and reproducible capital that could profitably be used on it.

BUILDING-PRODUCT AND MACHINERY-POWER-PRODUCT RATIOS

Farm buildings and farm machinery (including horses and mules) are similar in that they represent the more durable types of reproducible capital. This similarity accounts for the fact that their respective capital-product ratios moved through time in much the same way. Since, generally speaking, the two sets of ratios are likely to be influenced by the same or similar developments, they are treated together in this section.

The ratios presented in Table 25 indicate that although the

TABLE 26

Ratio of Value of Farm Land to Gross Farm Income in 1910-1914 Prices
by Regions, Decennial Census Years, 1870-1950[a]

Region	1870	1880	1890	1900	1910	1920	1930	1940	1950
				Computed from Annual Income Data					
United States:									
Strauss-Bean	6.05	5.38	5.06	4.85	4.88	4.49			
BAE					4.58	4.24	3.74	3.47	2.94
Northeast:									
Strauss-Bean	3.40	3.11	2.63	2.59	2.94	2.17			
BAE					2.76	2.05	1.74	1.47	1.18
Appalachian:									
Strauss-Bean	5.09	4.26	4.04	3.25	3.12	3.04			
BAE					2.93	2.87	2.15	2.00	1.59
Southeast:									
Strauss-Bean	3.68	2.91	2.22	2.43	1.97	2.53			
BAE					1.85	2.38	1.49	1.47	1.53
Lake States:									
Strauss-Bean	5.48	4.72	4.69	4.66	4.88	3.84			
BAE					4.58	3.63	3.55	3.11	2.57
Corn Belt:									
Strauss-Bean	9.69	7.72	7.65	6.56	6.60	6.72			
BAE					6.19	6.34	5.35	4.41	3.65
Delta States:									
Strauss-Bean	2.29	1.95	1.77	1.95	2.18	2.44			
BAE					2.05	2.30	1.39	1.36	1.34
Great Plains:									
Strauss-Bean	7.87	8.57	7.15	6.36	6.30	5.87			
BAE					5.92	5.54	5.75	7.89	5.87
Texas-Oklahoma:									
Strauss-Bean	5.82	6.37	5.00	5.28	4.91	3.57			
BAE					4.61	3.36	3.92	4.01	2.81
Mountain:									
Strauss-Bean	2.73	4.60	5.45	4.98	4.82	4.83			
BAE					4.52	4.55	4.49	4.22	3.90
Pacific:									
Strauss-Bean	13.84	10.61	8.12	8.12	7.76	5.29			
BAE					7.28	4.99	3.89	3.30	3.14
Weighted av. dev.:									
Strauss-Bean	2.67	2.18	2.10	1.66	1.56	1.68			
BAE					1.47	1.42	1.33	1.34	1.04
Weighted av. dev. as percentage of mean:									
Strauss-Bean	44.1	40.5	41.5	34.2	32.0	37.4			
BAE					32.1	33.5	35.6	38.6	35.4
				Computed from Five-Year Average Income Data					
United States:									
Strauss-Bean	5.70	5.40	5.21	4.87	4.79	4.58			
BAE					4.50	4.27	3.75	3.45	2.93

[a] Land value is for specified census years. Annual income data are for years preceding census years. Five-year average incomes (for 1870, three-year average) are centered on years preceding census years.

Source: Ratios calculated from data in Tables 9, 20, and H-3.

TABLE 27

Percentage Change in the Ratio of the Value of Land to Gross Farm Income in 1910-1914 Prices, by Regions, 1890-1920 and 1920-1950[a]

Region	1890-1920	1920-1950
United States	−11	−31
Northeast	−17	−42
Appalachian	−25	−45
Southeast	+14	−36
Lake States	−18	−29
Corn Belt	−12	−42
Delta States	+38	−42
Great Plains	−18	+6
Texas-Oklahoma	−29	−16
Mountain	−11	−14
Pacific	−35	−37

[a] Land value is for specified census years. Annual income data are for years preceding census years.

Source: Calculated from ratios in Table 26.

TABLE 28

Percentage Change in the Ratio of the Value of Reproducible Farm Capital to the Value of Land in 1910-1914 Prices, by Regions, 1890-1920 and 1920-1950

Region	1890-1920	1920-1950
United States	+24	0
Northeast	+20	+13
Appalachian	+62	+33
Southeast	+84	−10
Lake States	+43	+6
Corn Belt	+28	+11
Delta States	+48	+15
Great Plains	0	−23
Texas-Oklahoma	−6	−16
Mountain	−75	−21
Pacific	+30	+19

Source: Based on Table 9. Reproducible farm capital consists of all physical farm assets except land.

amount of land that was used to produce a dollar's worth of farm product at 1910-14 prices declined consistently prior to 1920, capital in the form of machinery, horses, and mules increased faster than product during most of this period, and in at least two decades preceding 1920, capital in the form of farm buildings increased faster than product. So decisive was the upswing in the ratios of these two types of capital to product that the ratio involving all capital

moved up sharply and stood in both 1910 and 1920, well above the level of 1900. After 1920 the amount of every class of physical capital used to produce a unit of farm product declined. The decline in relation to production was most pronounced in farm buildings and in machinery, horses, and mules—precisely the two classes in which the opposite tendency prevailed so strongly before 1920. How are the differences in the direction and rate of growth of the ratios of these classes of capital to product to be explained?

For the two decades before 1920 the most plausible explanation of the rising ratio of buildings to product is that the high level of prosperity which characterized the period led to expenditures on farm buildings that raised the standards of comfort and adequacy, but did not proportionately increase farm product. Expenditures on buildings during these prosperous years, in which prospects for future years also appeared bright, probably were made without the careful calculation of relative advantage that less prosperous times and a less rosy outlook would have evoked. As a result, it is likely that the amount invested in farm buildings contributed less to production than if it had been invested, at least in part, in more or better livestock, and land.

Although it is difficult to distinguish a trend in the ratio of machinery, horses, and mules to product before 1900, for the two decades following that date the ratio rose impressively. The reversal in the middle 1890's of the downward price trend doubtless contributed to this rise in much the same way as it did to the rise in the ratio of farm buildings to product. As prospects for agriculture improved, farmers were increasingly inclined to purchase new machinery (Table 29).

Many of the implements and machines purchased in this period

TABLE 29

Percentage Increase in Value of Farm Machinery per Person
Engaged in Farming, in 1910-1914 Prices, United States,
by Decades ending January 1, 1880-1950

1880	17
1890	26
1900	43
1910	43
1920	62
1930	20
1940	−1
1950	204

Source: Based on Tables 4 and 9.

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differed not so much in the quality or quantity of work performed as in convenience to the farmers. For example, the "sulky" plows and cultivators that replaced "walking" models were not greatly superior in the quantity or quality of the work done, but they required less effort on the part of the operator and, being somewhat more elaborate, they cost more. Other new machines differed from the models they replaced not so much in the effort required on the part of the operators as in their labor-saving aspects. For example, the substitution of hay-loaders for pitch-forks as a means of getting hay on racks did not notably reduce the strenuousness of farm labor in the haying season or increase the quantity of hay loaded, but it reduced very materially the labor force necessary to make a crop of hay. By and large, the new machines of this period were labor saving rather than capital saving. Their increase and the increase in the power necessary to propel them was not matched by an equivalent increase in product, hence the tendency for the ratio of this form of capital to product to rise.

The most plausible explanation of the reversal of trend in the building-product and machinery-product ratios after 1920 is that in the 1920's and 1930's relatively hard times induced farmers to curtail sharply their expenditures for these more durable types of capital. As a result the stock of capital was reduced by the amount that depreciation exceeded outlays for new buildings and machinery. Between 1920 and 1940, the value in 1910-14 prices of farm buildings was reduced by $1.2 billion or about one-sixth, while the value of machinery, horses, and mules was reduced by $1.3 billion, or more than one-fourth. These reductions in inventory were due to a decline in the condition and remaining life of farm buildings, machinery, and work animals, if not in the numbers of units themselves. However, no comparable reduction in product resulted from reductions in the inventories of these classes of capital. A barn that is twenty years old provides as much shelter for hay and livestock as when it was new, but the structure's depreciated value, which is a part of the inventory of farm buildings, is not much more than half its original value. The same principle applies with somewhat less force to machinery, and to a considerable extent even to work animals. This trend toward lower inventories of buildings and machinery was finally reversed in the 1940's by the return of a high level of farm prosperity.

In the 1940's farmers regained a level of prosperity they had not known since 1920. However, war regulations greatly restricted investment in new buildings, so that depreciation exceeded new con-

struction until after 1945. After 1940 purchases of new machinery outran depreciation, and after 1945 expenditures on new construction exceeded depreciation of buildings. The ratios for the years 1945 and 1950 clearly reflect these developments.

The foregoing analysis probably accounts for most, but not all, of the movement of the building-product and machinery-power-product ratios. Since 1920, the building-product ratio has probably been influenced to some extent by capital-saving developments. The shift to mechanical power has reduced the volume of buildings necessary to house the power units required to propel farm implements. The physical dimensions and the quality of a machine shed that will adequately house a tractor and gasoline barrel are far less than those of a barn adequate to care for work animals and their feed. Modern methods of making hay, which involve baling in the field, require far less capacity for storage in barns than did the older methods. Moreover, new types of construction have been developed, and adopted on a limited scale, which greatly reduce the capital necessary to provide adequate shelter for dairy cows. For example, a recent study made cooperatively by the Bureau of Agricultural Economics; the Bureau of Plant Industry, Soils and Agricultural Engineering; and the Illinois Experiment Station indicates that dairy barns of the loose-housing type, which provide a loafing area without special flooring and a milking parlor with modern equipment, could be built at 1947 prices for a cost per cow little more than three-fifths the cost of a conventional two-story stall barn.[11] Even a stall barn, if limited to one story, could be built at a cost per cow considerably less than the conventional two-story type. Moreover, the one-story barn has a distinct advantage in the saving of labor.

Whether the investment in farm machinery and power has been similarly affected by technological improvements since 1920 may be a moot question. The problem of measurement is complex, for it involves not merely a comparison of the original cost of, say, a tractor and tractor-mounted or drawn implements with that of work animals and the implements that customarily were used with them, but it also involves comparisons of depreciation, investment in feed or fuel, shelter, intensity of use in rush periods, and adaptability to a variety of uses.

All things considered, it seems doubtful that the new machinery that found its way to farms before the mid-1920's was capital-saving.

[11] R. N. Van Arsdall, D. B. Ibach, and Thayer Cleaver, *Economic and Functional Characteristics of Farm Dairy Buildings*, University of Illinois, Agricultural Experiment Station, Bull. 570, 1953, p. 61.

Before 1925 farm tractors generally lacked the adaptability to various uses that was later developed and often displaced only a few of the work animals. But that there have been capital-saving developments in farm machinery and power since then will hardly be doubted. Not only has the capacity of tractors to save labor been enhanced, as when speed was markedly increased, but improvements, such as the development of models adaptable to a variety of jobs, have reduced costs per unit of work done.

An outstanding example of this kind of improvement was the alteration of the position and width of wheels and of the tractor's clearance, so that it could be used in the cultivation of row crops as well as for plowing and other jobs where the older type of wheels and lower clearance were no obstacle. The substitution of rubber for steel tires, which greatly enhanced the tractor's usefulness for hauling, is another innovation that widened the use to which the tractor could be put and thereby effected a capital saving.

The regional building-product ratios move through time in much the same pattern as that described for the countrywide totals (Table 30). This similarity of movement for regions differing greatly in location, types of farming, and time of settlement emphasizes the overriding importance of general economic conditions as a factor that determines the course of these ratios over periods of a decade or two or even longer. Thus the reversal in the late 1890's of the downward drift of general prices, followed by a persistent rise in prices that culminated in the sharp advance of the World War I period, resulted in an upsurge of construction of farm buildings that is clearly revealed in the building-product ratio of most regions. Even more striking was the stifling effect on construction that the unfavorable price and income situation during the 1920's and 1930's had in all regions.

The highest ratios of buildings to product were consistently present in the Northeast and the Lake States. This was to be expected, since dairying is the most prevalent type of farming in both regions, and both lie in latitudes where shelter for dairy animals necessarily is relatively elaborate. The lowest ratios were consistently in the South, where livestock enterprises, except for range livestock in Texas-Oklahoma, were relatively unimportant, and where the mild winter climate makes possible a minimum of shelter even for work animals. Low ratios of buildings to product have prevailed in the Mountain region also, where emphasis has been on range livestock, for which little shelter is provided.

The range of the regional building-product ratios has narrowed over time somewhat more consistently than the ratios involving other

TABLE 30

Ratio of Value of Farm Buildings to Gross Farm Income in 1910-1914 Prices,
by Regions, Decennial Census Years, 1870-1950[a]

Region	1870	1880	1890	1900	1910	1920	1930	1940	1950
			Computed from Annual Income Data						
United States:									
Strauss-Bean	1.15	1.01	0.85	0.77	1.03	1.05			
BAE					0.97	0.99	0.83	0.66	0.64
Northeast:									
Strauss-Bean	1.85	1.78	1.54	1.61	2.08	1.48			
BAE					1.95	1.40	1.37	1.01	0.81
Appalachian:									
Strauss-Bean	0.73	0.79	0.77	0.73	0.99	1.17			
BAE					0.93	1.10	0.91	0.80	0.83
Southeast:									
Strauss-Bean	0.25	0.32	0.28	0.38	0.53	0.95			
BAE					0.50	0.90	0.46	0.40	0.54
Lake States:									
Strauss-Bean	1.45	1.14	1.07	0.98	1.49	1.40			
BAE					1.40	1.32	1.36	0.99	0.87
Corn Belt:									
Strauss-Bean	1.21	0.98	0.90	0.79	1.13	1.36			
BAE					1.06	1.28	1.03	0.76	0.72
Delta States:									
Strauss-Bean	0.23	0.24	0.25	0.37	0.59	0.83			
BAE					0.55	0.78	0.43	0.34	0.49
Great Plains:									
Strauss-Bean	1.30	1.22	0.79	0.54	0.76	0.81			
BAE					0.71	0.76	0.65	0.61	0.47
Texas-Oklahoma:									
Strauss-Bean	0.48	0.60	0.41	0.37	0.60	0.58			
BAE					0.56	0.55	0.51	0.42	0.44
Mountain:									
Strauss-Bean	0.93	0.60	0.53	0.30	0.61	0.61			
BAE					0.57	0.57	0.46	0.36	0.49
Pacific:									
Strauss-Bean	0.72	0.51	0.45	0.51	0.71	0.57			
BAE					0.67	0.54	0.52	0.39	0.46
Weighted av. dev.:									
Strauss-Bean	0.45	0.35	0.30	0.27	0.35	0.35			
BAE					0.33	0.30	0.30	0.21	0.15
Weighted av. dev. as percentage of mean:									
Strauss-Bean	39.1	34.7	35.3	35.1	34.0	33.3			
BAE					34.0	30.3	36.1	31.8	23.4
			Computed from Five-Year Average Income Data						
United States:									
Strauss-Bean	1.09	1.01	0.88	0.78	1.01	1.07			
BAE					0.95	1.00	0.83	0.65	0.64

a Value of farm buildings is for specified census years. Annual income data are for years pre-
ceding census years. Five-year average incomes (for 1870 a three-year average) are centered on
years preceding census years.

Source: Ratios calculated from data in Tables 9, 20, and H-3.

major types of farm capital. This fairly consistent convergence may reflect some standardization of buildings. For example, it seems likely that regional differences in farm residences may have become less pronounced as the rough houses of the pioneers gave way to better accommodations. The converging ratios may also reflect changes in methods and facilities used in the production of certain crops and of animal products which reduce the differences in the need for service buildings. For example, the substitution of mechanical power for work animals in recent decades must have reduced the difference between northern and southern regions in investment in buildings necessary to protect the power units and related supplies.

The regional ratios of machinery, horses, and mules to product show considerable diversity of movement before 1900, but thereafter the ratios of most regions follow much the same course, in general rising to 1920, falling to 1940, and rising again to 1950 (Table 31). This is, of course, the pattern that was described earlier for the countrywide totals, which corresponds to the trends in the building-product ratio and, as has already been indicated, was determined essentially by the same factors.

The increase in the machinery-product ratio in the Southeast and especially in the Delta region is striking. These are the only regions in which this ratio was higher in 1950 than in any other year except 1920. In 1950 the ratio for the Delta States was actually exceeded only by the ratio for the Great Plains region. The rise in importance of machinery and power as factors of production in the southern regions reflects not only a decline in the relative importance of the hitherto labor-intensive cotton crop, but also the recent impressive spread of machine methods of cultivating and picking this crop.

The regional machinery-product ratios had a narrower range than did the ratios involving other types of capital, and they displayed no marked tendency either to converge or to diverge.

Up to 1910 the ratios of the western regions drew steadily closer to the countrywide average. But between 1910 and 1940 the machinery-product ratios even of the western regions steadily diverged. It is difficult to determine the reason for this. Conceivably unequal rates of mechanization contributed to it.

LIVESTOCK-PRODUCT RATIO

The ratio of livestock other than horses and mules to product declined during the eighty-year period with considerable consistency, and it declined further, proportionately, than any other ratio, including that involving land (Table 25). A question naturally arises

TABLE 31

Ratio of Value of Implements, Machinery, Horses, and Mules to Gross Farm Income in 1910-1914 Prices, by Regions, Decennial Census Years, 1870-1950[a]

Region	1870	1880	1890	1900	1910	1920	1930	1940	1950
			Computed from Annual Income Data						
United States:									
Strauss-Bean	0.57	0.52	0.57	0.55	0.64	0.69			
BAE					0.60	0.65	0.50	0.37	0.45
Northeast:									
Strauss-Bean	0.47	0.44	0.47	0.52	0.69	0.58			
BAE					0.64	0.55	0.53	0.36	0.42
Appalachian:									
Strauss-Bean	0.57	0.52	0.55	0.51	0.56	0.68			
BAE					0.53	0.64	0.45	0.37	0.50
Southeast:									
Strauss-Bean	0.39	0.34	0.29	0.40	0.41	0.69			
BAE					0.38	0.65	0.36	0.31	0.45
Lake States:									
Strauss-Bean	0.57	0.52	0.61	0.59	0.73	0.73			
BAE					0.68	0.69	0.66	0.51	0.55
Corn Belt:									
Strauss-Bean	0.71	0.57	0.67	0.55	0.66	0.79			
BAE					0.62	0.75	0.52	0.37	0.43
Delta States:									
Strauss-Bean	0.37	0.34	0.31	0.49	0.54	0.71			
BAE					0.51	0.67	0.39	0.34	0.55
Great Plains:									
Strauss-Bean	0.67	0.73	0.72	0.61	0.72	0.76			
BAE					0.67	0.72	0.64	0.51	0.56
Texas-Oklahoma:									
Strauss-Bean	1.14	0.96	0.73	0.61	0.69	0.60			
BAE					0.65	0.56	0.54	0.40	0.37
Mountain:									
Strauss-Bean	0.49	0.79	1.25	0.76	0.73	0.76			
BAE					0.68	0.72	0.55	0.36	0.46
Pacific:									
Strauss-Bean	0.70	0.50	0.53	0.53	0.57	0.43			
BAE					0.54	0.41	0.28	0.20	0.29
Weighted av. dev.:									
Strauss-Bean	0.11	0.08	0.13	0.04	0.07	0.12			
BAE					0.07	0.08	0.09	0.05	0.06
Weighted av. dev. as percentage of mean:									
Strauss-Bean	19.3	15.4	22.8	7.3	10.9	17.4			
BAE					11.7	12.3	18.0	13.5	13.3
			Computed from Five-Year Average Income Data						
United States:									
Strauss-Bean	0.54	0.52	0.58	0.55	0.63	0.70			
BAE					0.59	0.65	0.50	0.37	0.45

[a] Value of implements and machinery, horses, and mules is for specified census years. Annual income data are for year preceding census years. Five-year average incomes (for 1870, a three-year average) are centered on years preceding census years.

Source: Ratios calculated from data in Tables 9, 20, and H-3.

whether this may have gone hand in hand with a decline in the relative importance of animal products in the total. The evidence points rather to an opposite trend in farm production. Between 1890 and 1920 the value at 1910-14 prices of dairy products, chickens and eggs, and meat animals (other than poultry) that entered into gross farm income increased 66 per cent.[12] This compares with an increase of 46 per cent for twelve major crops and of 59 per cent for all farm products including animal products. Between 1920 and 1950 the relative importance of animal products continued to increase. In 1950 their constant-price value was 70 per cent above 1920, whereas the constant-price value of twelve major crops had increased only 34 per cent, and that of all products had increased only 54 per cent.

The conclusion therefore seems warranted that improvements in the breeds of livestock and in livestock feed and management have been sufficient to permit animal products to become increasingly important in the farm-product mix, while the investment in productive livestock per dollar of total farm product declined greatly. Thus it appears that the most significant technological advances in agriculture, at least in the six decades preceding 1950, have quite consistently been connected with the production of livestock and of livestock products. So far as it pertains to the period since 1920, this conclusion is supported by the indexes of production per acre of cropland and per animal unit computed for 1919 and subsequent years by BAE. As was shown in another connection a three-year average of the indexes of crop production per acre centered on 1950 is 33 per cent higher than a similar average centered in 1920.[13] A similar comparison of the indexes reflecting production per animal unit indicates a 50 per cent rise for this period. This is surprising, in view of the important innovations in the production of crops which occurred after 1930 mentioned earlier in this chapter.

The regional variation in the behavior of the livestock-product ratio was far greater in the period of rapid expansion that preceded 1920 than it was thereafter (Table 32). By far the greatest declines in this ratio in the fifty years before 1920 occurred in the Texas-Oklahoma, Mountain, and Pacific regions. As a result, the range of the regional ratios declined quite consistently through 1910.

[12] These percentages and those that follow in this paragraph were calculated from five-year averages of annual gross farm income data, adjusted to 1910-14 prices, from Strauss and Bean farm income estimates for comparisons involving 1920 and earlier years and from BAE farm income estimates for comparisons involving 1920 and later years. Data for 1950 are four-year averages provided by BAE.

[13] See text and footnotes, p. 104.

TABLE 32

Ratio of Value of Livestock, Other than Horses and Mules, to Gross Farm Income in 1910-1914 Prices, by Regions, Decennial Census Years, 1870-1950[a]

Region	1870	1880	1890	1900	1910	1920	1930	1940	1950
					Computed from Annual Income Data				
United States:									
Strauss-Bean	0.64	0.55	0.55	0.45	0.42	0.42			
BAE					0.39	0.40	0.32	0.32	0.28
Northeast:									
Strauss-Bean	0.51	0.46	0.39	0.36	0.39	0.33			
BAE					0.36	0.31	0.28	0.27	0.24
Appalachian:									
Strauss-Bean	0.50	0.40	0.40	0.28	0.27	0.30			
BAE					0.25	0.29	0.20	0.21	0.20
Southeast:									
Strauss-Bean	0.35	0.28	0.20	0.20	0.17	0.26			
BAE					0.16	0.25	0.12	0.14	0.14
Lake States:									
Strauss-Bean	0.55	0.45	0.48	0.40	0.47	0.45			
BAE					0.44	0.42	0.43	0.41	0.32
Corn Belt:									
Strauss-Bean	0.71	0.55	0.61	0.48	0.44	0.52			
BAE					0.42	0.49	0.40	0.39	0.33
Delta States:									
Strauss-Bean	0.29	0.25	0.22	0.20	0.22	0.29			
BAE					0.21	0.27	0.13	0.16	0.16
Great Plains:									
Strauss-Bean	1.07	0.82	0.72	0.58	0.44	0.44			
BAE					0.41	0.41	0.42	0.47	0.40
Texas-Oklahoma:									
Strauss-Bean	3.01	1.73	1.29	0.69	0.49	0.39			
BAE					0.46	0.36	0.31	0.36	0.26
Mountain:									
Strauss-Bean	4.34	5.05	3.60	1.48	1.16	0.92			
BAE					1.09	0.86	0.59	0.51	0.42
Pacific:									
Strauss-Bean	1.51	0.81	0.55	0.42	0.43	0.28			
BAE					0.40	0.27	0.20	0.18	0.16
Weighted av. dev.:									
Strauss-Bean	0.22	0.18	0.21	0.14	0.10	0.13			
BAE					0.10	0.10	0.11	0.11	0.08
Weighted av. dev. as percentage of mean:									
Strauss-Bean	34.4	32.7	38.2	31.1	23.8	31.0			
BAE					25.6	25.0	34.4	34.4	28.6
					Computed from Five-Year Average Income Data				
United States:									
Strauss-Bean	0.61	0.56	0.57	0.45	0.41	0.43			
BAE					0.39	0.40	0.32	0.32	0.28

[a] Value of livestock other than horses and mules is for specified census years. Annual income data are for years preceding census years. Five-year average incomes (for 1870, a three-year average) are centered on years preceding census years.

Source: Ratios calculated from data in Tables 9, 20, and H-3.

The especially large declines of the livestock-product ratios of the western regions reflect the marked increase in farm products other than those derived from livestock that accompanied thicker settlement of regions which, in the early years, were so overwhelmingly devoted to range livestock production. After 1920 this de-emphasis on range livestock, associated with the rapid expansion of field crops, appears to have continued at least in the Mountain and Pacific regions. Elsewhere the decline after 1920 was remarkably similar to that in the western regions. As was pointed out earlier, there was no countrywide de-emphasis on livestock enterprises during this period that might have accounted for the falling ratio. Hence in regions other than the Mountain and Pacific the decline after 1920 must be ascribed mainly to technological changes. The similarity in the extent of the decline in the livestock-product ratios of the remaining regions indicates the countrywide impact of the improvements in livestock strains and in livestock management that characterized this period.

STORED-CROPS-PRODUCT RATIO

As our estimates of stored crops for years before 1930 are based so largely on crop production, the trends in stored crops-product ratios from 1870 to 1930 can hardly be meaningful even though our measure of product reflects much more than crop production. For this reason we include in Table 33 only averages of the regional ratios for 1870-1920, which are interesting as a reflection of regional differences in the importance of stored crops that have persisted throughout the eighty-year span.

The highest ratios of stored crops to product have consistently been in regions in which production and feeding of livestock were a prominent, if not the dominant, enterprise. Thus the Corn Belt, which is the center of cattle, hog, and sheep feeding enterprises, and the contiguous Lake and Great Plains states, in which these feeding operations are also very prominent, have usually had the highest ratios of stored crops to product. By contrast, regions of the far West and of the South have had relatively low ratios—in the South because livestock enterprises have never been prominent, and in the West because producers of range livestock do not emphasize feeding of harvested crops.

Except for the Northeast, it is hard to discern any firm trends after 1930. In most instances the ratio for 1950 is lower than for 1930, but more often than not the ratio is higher for 1950 than for

TABLE 33

Ratio of Value of Crop Inventories to Gross Farm Income in 1910-1914
Prices, by Regions, Decennial Census Years, 1870-1950[a]

Region	1870-1920[b]	1930[c]	1940[c]	1950[c]
	Computed from Annual Income Data			
United States	0.37	0.27	0.26	0.27
Northeast	0.34	0.26	0.22	0.21
Appalachian	0.37	0.28	0.26	0.29
Southeast	0.30	0.21	0.14	0.17
Lake States	0.39	0.38	0.39	0.37
Corn Belt	0.45	0.35	0.40	0.38
Delta States	0.31	0.22	0.14	0.17
Great Plains	0.44	0.34	0.34	0.40
Texas-Oklahoma	0.28	0.15	0.11	0.14
Mountain	0.28	0.27	0.24	0.25
Pacific	0.12	0.08	0.06	0.06
Weighted av. dev.	0.08	0.07	0.11	0.10
Weighted av. dev. as percentage of mean	21.6	25.9	42.3	37.0
	Computed from Five-Year Average Income Data			
United States	0.37	0.27	0.26	0.27

[a] Value of crop inventories is for specified census years. Annual income data are for years preceding census years. Five-year average income (for 1870, a three-year average) are centered on years preceding census years.
[b] Average income from Strauss-Bean.
[c] BAE income data.
Source: Ratios calculated from data in Tables 9, 20, and H-3.

1940. However, most of the ratios for 1930 and later are substantially below the averages for the preceding half-century.

Although the data in Table 33 hardly suggest it, there is considerable reason to believe that developments in recent decades may have lowered the stored-crops-product ratios somewhat. First, and perhaps most important, the progressive substitution of mechanical power units for crop-consuming horses and mules, which reduced these animals on farms from 24.9 million in 1920—the all-time high—to 7.3 million in 1950, made possible a comparably large reduction in the amount of hay and grain stored for their use, without reducing production in any way. Second, the improvement of livestock as converters of crops into animal products has progressively increased the downward pressure on this ratio. Farmers have made greater headway in improving the average quality of their productive livestock since 1920 than they made in earlier decades.[14] Finally,

[14] For example, a single dairy-herd improvement association is reported for 1906. In 1920 these associations numbered 468, and in 1950 they had in-

changes in feeding practices may have lowered the stored crops to product ratio. It seems likely that the increasing emphasis on scientifically balanced rations for livestock of all kinds has reduced the ratio by increasing the denominator through beneficial effects on output, while at the same time it decreased the numerator by substituting commercial feeds for home-grown, home-stored crops. This development has been perhaps most striking in the poultry industry, but it is by no means so narrowly confined.

CURRENCY AND BANK DEPOSITS PRODUCT RATIO

For the five decades for which we have estimates there has been an almost unbroken rise in this ratio (Table 25). From a very minor role in 1900, when "cash on hand" per dollar of product amounted in purchasing power to 12 cents in 1910-14 prices, the importance of currency and demand deposits grew until in 1950 farmers' working balances contained an amount of cash per dollar of product whose purchasing power was more than two times that held in 1900. The major reasons for this development are the same as those that have already been given in Chapter 5 for the increasing prominence of cash working balances among the assets used in farming. They center on the growing industrial specialization of agriculture, which is reflected in the increasing use of intermediate products and of durable capital items purchased by the farmer for use in production.

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creased to 1,973. As late as 1939 there were only 7 artificial breeding associations (units) found in five states, whereas by 1950 these had increased to 1,460 scattered throughout the forty-eight states.