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ECONOMIES OF SCALE IN AGRICULTURE:

A Survey of the Evidence

by

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ABSTRACT

Economies of scale have been claimed to characterize agricultural production. If so, they affect farm consolidation and labor exit from the rural to the urban sector. The existence of scale economies was found in many empirical studies. In this paper we study the empirical evidence in American agriculture. The analysis was conducted for the US farm sector because of the availability of data, but the choice was also motivated by the desire to test the issue in the farm sector which supposedly has exhibited the strongest and the most persistent scale economies. It is shown that, if carefully examined, the data do not support the alleged scale hypothesis.

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MOTIVATION

The question of economies of scale often comes up in the discussion of agricultural development. For example, it is sometimes asserted that many of the farms in the developing countries are too small to justify investment in learning and appropriate adoption of new technologies. This means that the larger farms are comparatively more efficient and that there exist economies of scale in agricultural production and farm management. Others suggest that even if there are no economies of scale in the traditional agriculture, they will set in as the farm sector develops. This assertion was made by Hayami and Ruttan (1985), who supported it with econometric estimates of the agricultural production function.

Economies of scale, if they actually exist in a competitive industry, are a non-equilibrium phenomenon: farmers with resources--equity capital or credit--will try to acquire large plots of land, the price of land will be higher than the present value of the future stream of income of operators of small farms, they will sell-out and the land will concentrate in the larger farms. For those who sold the land this process means (a) that they enjoyed capital gains if the economies of scale are of recent origin and the acquisition or inheritance of the farm was done before these economies affected land prices; and (b) they will move to seek non-farm employment earlier or in the larger numbers than otherwise. Thus economies of scale are affecting labor's out-migration from agriculture over and above the effect of urban-rural wage differentials.

From the point of view of the economy at large, such out- migration is an efficient reallocation process, because with it agriculture enjoys increased productivity as production concentrates on larger farms. For those who move and for the urban centers that have to absorb them the process poses additional adjustment difficulties. For example, the emergence of economies of scale may in principle drive farmers to the non- agricultural sector even if they cause a reduction of non-farm wages.

It is therefore of interest and of importance to find out whether the evidence supports the assertion of the existence of economies of scale in agriculture. This examination of the evidence is not a simple and straight forward matter of counting the number of empirical studies that reported increasing returns in agricultural production, because most of these studies were and are conducted in the same methodology and may be subject to the same criticism--a criticism we shall detail below. Instead, a careful examination requires the juxtaposition of pieces of evidence accumulated with a large variety of methodological approaches. Data for such an analysis are not available for the developing countries and we turn therefore to American data. The examination of the question of increasing returns to scale in the American farm sector, beside utilizing the wealth of available information, offers another advantage: American farming was often cited as the most prominent case of economies of scale. If the evidence can be shown not to support the alleged economies of scale in the US, then the case for increasing returns to scale in other economies will also be much weaker.

PRELIMINARIES

Prevented from conducting controlled experiments, the data economists work with are far from ideal. Measurement errors abound, significant variables may be unobservable, not all simultaneity can be accounted for, and we often use state, regional, or national aggregates to estimate firm or household structural parameters. As a result, every measurement and method of estimation can be questioned. Confidence is built when the quantitative assessments of explanations and economic magnitudes can be corroborated by observations on independent sets of data and, particularly, by analyses of different aspects of the problem at hand.

In this paper we critically examine the widely held view that firms in American agriculture exhibit economies of scale. We consider three dimensions of the problem: sources of scale economies, measurement of the phenomenon, and the implied consequences. We argue that the existence of economies of scale can be questioned on both conceptual and statistical grounds, and that it is not, in general, consistent with the accumulated evidence.

Findings supporting the hypothesis of constant returns to scale in agriculture have been reported several times in the past but they seem to have been disregarded by most of the profession because farm growth was taken as a proof of increasing returns. And indeed, farm size grew substantially over the past half century. Between 1929 and 1982 gross output per farm grew 6.5 times, value added--4.8 times and land--2.8 times. (Table 1). However, unit growth can also be explained by changing factor prices without relying on economies of scale. We elaborated on this elsewhere (Kislev and Peterson 1982) and here we present new evidence that again supports the latter explanation.

Sources

It is a simple truism, that if the world is exactly multiplied, production will also exactly double. But we are not interested in the returns to multiplication of every aspect of production. Rather, changes in scale are changes in the physical dimensions of production assets and in factor flows while the environment, entrepreneurship and often also management stay the same. Then scale effects are mixed. As a pipeline is increased in diameter, the capacity of the line to transport liquids or gases increases more than in proportion to the increase in material and cost of production of the line (Cookenboo). On the other hand, increasing difficulties of coordination and direction reduce efficiency as scale expands. Scale economies in an industry reflect the sum total of these effects.

Most writers attributed economies of scale in agriculture to indivisibility of assets; a recent example is Hayami and Ruttan (p. 146): "The scale economies usually stem from the lumpiness or indivisibility of fixed capital." But it is hard to find indivisible assets on the farm. Returns to scale is a long run concept, and in the long run the size measures of land, structures, irrigation systems, herds and flocks are continuous, not lumpy. Machines are mentioned as indivisible; but tractors and their implements come in a great variety of sizes from the hand driven garden types to the 4-wheel drive behemoths that ply the prairies. Other machines also come in a large variety of sizes; and, in the few cases in which large machines are the most efficient such as combine harvesters and cotton pickers, rental markets develop. Small farmers also have the option of purchasing lower cost, used machines. Considering the wide array of machine sizes and prices along with rental markets, lumpiness and indivisibility of machines seem to be more apparent than real.

It may be argued that, although machines come in many sizes, the long run average cost curve is still U-shaped, reaching a minimum at a certain machine capacity and, consequently, a certain farm size. Economies of scale are then a disequilibrium phenomenon (Griliches 1963, p. 232), of a temporary nature. If so, scale economies will be gradually eliminated as farms adjust in size, since at the minimum--average costs are constant. In Table 1 (line 14) we present cross-section estimates of returns to scale in American agriculture. In all four estimates for the period 1949-74 the sums of the coefficients in Cobb-Douglas production functions were higher than 1.250. No indication of a reduction of the scale coefficient can be detected. One would expect at least some closing of the gap between the actual and the optimum scale over a period in which the average farm doubled in size.

An "asset" that is clearly fixed on the farm, particularly on the family unit, is entrepreneurial ability and management. This fixity raises important econometric issues which are discussed below. Here we note two considerations: (a) As with machines, adjustment should have eliminated the scale effects. (b) If the existence of a single manager were an important source of economies of scale, part-time farming would have gradually disappeared. However, between 1949 and 1969, the prevalence of part-time farming, as measured by the share of operators working 100 days or more off their farms, nearly doubled (Table 1, line 6).

Another possibility is that economies of scale are created by reduced uncertainty due to government intervention in agriculture (Madden and Partenheimer, p. 103). However, the government has been intervening since the 1930s. Adjustment should have been completed by now.

A dynamic cost hypothesis can be that technological progress results in the production of new and larger machines that are more efficient than the older and smaller ones. Then the U-shaped cost curve shifts to the right over time. Perhaps this is what Bieri, de Janvry, and Schmitz (p. 802) had in mind: "the rate of increase in farm size in the future will be determined, to a large extent, by the rate at which the machine companies manufacture larger and larger equipment." This dynamic hypothesis is indeed consistent both with the observation that farms have grown in size and that measured economies of scale have not declined. It is not consistent, however, with the continuing prevalence of part-time farming. Nor is this hypothesis consistent with the observed cessation of the growth in farm size which occurred in the mid-1970s without a corresponding halt to the progression of new technology or the ability to produce still larger machines. Indeed, below we argue that the optimum growth in farm size induced changes in size of machines, rather than the other way around.

Measurement

Three methods have been employed to test for the existence of scale economies: the survival method, synthetic firm studies, and the sum of the coefficients of Cobb-Douglas production functions.

According to the survival method (Stigler, Saving), growth of firms in an industry is an indication that large firms are more efficient than small ones; that is, economies of scale exist. Application to agriculture raises several difficulties. An implicit assumption of the method is that economic conditions have not changed. This is not true for American agriculture, where relative prices, labor's alternative income and machine cost have changed substantially over the last half century. Also, in this sector, the quality corrected labor input per farm has not grown; it remained between 1.5 and 2.0 workers for more than 50 years (Table 1, lines 4 and 5). Thus the large increase in size cannot be a regular case of increasing returns to all factors. Moreover, in agriculture, the survival method can be used to prove constant returns. By the logic of the method the existence of part-time farming, and particularly the fact that it increased during the 1950s and 1960s, suggests an absence of economies of scale.

Synthetic firm studies are reviewed by Madden and Partenheimer. The difficulty with these studies is that problems of management and coordination and differences in skills and ability of farmers cannot be appropriately accounted for. These problems are considered the major sources of diseconomies of scale. Unless they can be taken account of, the test of scale economies by synthetic cost studies is meaningless.

Summing the coefficients of Cobb-Douglas production functions is the most common method of measuring scale economies in agriculture. This measure can, however, be biased. One problem with this approach is that small farms are commonly part-time units. If the labor of the operator and the family is not adjusted correctly for off farm employment, the small units will appear to use more labor than they actually do, and the larger farms will be measured mistakenly to be more efficient. Such measurement errors will lead to overestimates of returns to scale. A more difficult problem is posed by management. Unlike labor input that can in principle be measured correctly, management is unobservable. If management is correlated with size, economies of scale will be overestimated. The same is true for other fixed factors. The following analysis of this issue is due to Mundlak; it was also applied by

Hoch (for further reference see Hoch). It is recapitulated here in some detail because of its importance.

Let the firm (farm) production function be

(1) $Y = F(X, M)$

where Y = output

X = a factor of observable inputs

M = firm specific factors, management or other fixed factors.

In general, M is unobserved and not measured. The estimated production function is then,

(2) $Y = f(X)$.

With the specification in (2), firms are on different functions--each according to its M value.

Better environmental conditions, more productive soil, superior location, as well as better management--are all reflected in higher (unobserved) firm specific factors. Consequently, complementarity prevails between the firm specific factors and most inputs. As a result, total inputs (observed plus unobserved) will be underestimated on large farms relative to small farms. In estimating the production function, the OLS regression line will be steeper than it really is, giving the appearance of scale economies. In multivariate cases, overestimates of the regression coefficients yield upward biased sums of the coefficients and overestimates of the returns to scale.

Given panel data (combination of time series and cross sections) and assuming that the farm specific effects were constant over the period of observation, the bias can be completely eliminated if, instead of OLS estimates of the pooled function, a covariance analysis is employed; in the conventional terminology--if firm dummies are included in the analysis. In a covariance analysis the regression is estimated not from the original observations, but from deviations from the firm means; and if, as assumed, M is constant, the deviations of this variable are all zeros and all firms are on the same function. The estimated coefficients are then unbiased, "within" firm estimates.

Hoch summarizes 6 previous studies that had reported both OLS and covariance analysis of farm level production functions. In all 6 cases, the sum of the coefficients in the covariance analysis was less than 85 percent of the sum calculated from the OLS estimates and in all cases the sum was smaller than 1. In his own analysis of dairy farms, reported in the same paper, Hoch found that covariance analysis reduced the sum of the coefficients to levels smaller than 1 for 10 samples of farms producing milk for the market. He found, however, increasing returns to scale (and higher sums of coefficients) for two samples of dairies producing for manufacturing. To our knowledge this is the only reported evidence of covariance analysis increasing the sum of the coefficients, and the only case in which increasing returns were found with covariance analysis.

Agricultural production functions are usually estimated for the average farm in a state, a region, or a country. Random aggregation within regions cancels out farm specific effects and eliminates the associated specification biases. However, regions are also characterized by regional specific effects, such as soil, climate or economic circumstances, and in samples of individual farms coming from different regions, the regional effects have to be accounted for. Again, one way to do it is to include regional dummies in the regressions. Failure to include such dummies, failure to account for the regional specific effects, results in specification biases. These specification biases are augmented by regional aggregation. Hence the bias in the estimated sums of the coefficients in Cobb-Douglas functions is likely to be more serious when the observations are regional or country averages than when they are farm level data (Kislev).

Since soil, climate and other growing conditions differ among the states, the sums of the coefficients calculated from Davis' estimates and presented in Table 1, line 14 are likely to be upward biased. We do not know of a parallel covariance analysis for the aggregate production function of American agriculture, but we have attempted such an analysis for the intercountry productivity estimates of Hayami and Ruttan. They found increasing returns to scale for the developed countries in their sample and constant returns for the developing countries. We recalculated their regression for the developed sub-sample (Q21 in their Table 6-2) and added country dummies. The sum of the coefficients was 1.320 without the dummies and 1.077 with the dummies. The latter sum was not significantly different from 1 (the standard error of the sum was 0.119).

Before leaving this section, a caveat should be added about covariance analysis. In general, random errors in the measurement of the observed variables cause underestimations of the regression coefficients. Griliches (forthcoming) shows that covariance analysis may exacerbate the effect of measurement errors. By giving up "between" variability we run into the danger of increasing the "noise to signal" ratio. For our discussion of economies of scale, this possibility is particularly worrying--empirical observations are never error free. The message here is, again, that one cannot rely on a single source of evidence. Continuing with the survey of evidence, we turn now to the examination of the consequences of scale economies.

Consequences

Returns to scale, if they actually exist in agriculture, affect significantly both the economics of agriculture and our understanding of the farm sector. So long as the sources of the phenomenon are not clearly defined, the term "economies of scale," just like the term "technical change," is, in a sense, a name for our ignorance. To see how ignorant, consider the following. Between 1929 and 1982 gross output per farm in the U.S. increased 6.5-fold (Table 1, line 1). If inputs were all accounted for and perfectly measured, and constant returns to scale prevailed, inputs also would have increased 6.5 times and output per unit of input would have remained constant. If in fact the agricultural production function is homogeneous of degree 1.3 (a generally accepted figure, Griliches 1963, Davis, Hayami and Ruttan), then the input growth necessary to achieve a 6.5-fold growth in output would have been 4.2 instead of 6.5 ($4.2^{1.3} = 6.5$). In other words, over half of the increase in per farm output would be left unexplained [$(6.5 - 4.2)/4.2 = .55$]. As a degree of homogeneity, 1.3 is a very large number.

Economies of scale also affect the distribution of the returns to the factors of production. If, again, the production function is homogeneous of degree 1.3, then inputs should receive \$1.30 for each dollar of output provided they are paid their VMPs (Euler's Theorem). If land is a residual claimant and has a production elasticity (factor share) of .17 (Griliches 1963) then the nonland inputs should receive .83 x \$1.30 = \$1.08 for each dollar of output. This leaves land with a negative return. Such an outcome is contrary to the evidence. In modern times at least, land rents and land prices have been positive, not negative or zero (Table 1, lines 8 and 9). In fact real land prices in the U.S. increased substantially over the 1930-1982 period.

To be accurate, one should distinguish between rent and land prices. Dynamic considerations can be used to explain positive land values even if residual returns are negative: If scale economies are a reflection of temporary disequilibrium, then as farms grow to a size in which constant returns prevail, the residual return to land will become positive. Given a sufficiently low rate of interest, the discounted present value of these positive future returns could also be positive. However, this argument does not explain the positive land rents which prevailed throughout the period for which data are reported in Table 1. Nor does it explain the apparent inability of land buyers to revise their expectations after decades of what should have been negative residual returns to land. A realization that increasing returns were not soon to be eliminated (if they existed) should have led to a decrease in real land prices. Just the opposite occurred. Land prices rose since 1949 and changes in inflationary expectations and terms of trade along with changes in real rates of interest appear to have had a large impact on real land prices during the 1970s and 1980s. It seems that land buyers and sellers did not perceive a disequilibrium to exist. There is also no evidence in the land market literature of the existence of such a disequilibrium.

Farm Growth

The major consequence attributed to economies of scale is growth of farm size. And indeed American farms grew significantly up to the mid 1970s (Table 1, lines 1, 2, and 3). However, there can be an alternative explanation to farm growth (Kislev and Peterson 1982). American farms are mostly family units with a relatively constant quality-adjusted labor input; their capital intensity and hence their size is determined by the price ratio between labor and machinery. For farming, the price of labor is the alternative earning opportunities outside agriculture (Table 1, line 12). Generally, the cost of machinery is harder to measure. Theoretically it is the rental market price. In agriculture a rental market for machinery services exists in the form of custom work for hire. Cost of machine service is, therefore, measured as the real value of custom rate in combine harvesting of wheat. Between 1929 and 1969 this cost measure declined by 30 percent (Table 1, line 11).

Up to 1974, real custom rates declined. The increase in quality of machines and the decrease in the real cost of energy were probably important factors contributing to this decline. At the same time the opportunity cost of farm labor increased; manufacturing wages, for example, grew 2.4-fold in real terms between 1929 and 1969 (Table 1, line 12) causing the wage to rental ratio to increase even more (Table 1, line 13). With these relative price changes, equilibrium machine-labor ratio in agriculture increased, enabling the family farm to cultivate a larger amount of land and in so doing maintain parity income growth with the nonfarm sector. During this time the increase in nonfarm earnings also provided an incentive for many farmers, and particularly their sons and daughters, to leave the land for alternative occupations. (The exit of hired labor from agriculture was also affected, to a large extent, by improved urban opportunities. See Peterson and Kislev 1986.) In turn this outmigration freed land for the remaining farmers to expand. Seen from this perspective, as urban wages rise, farmers are induced either to move to town, or--those that remain full-time farmers--to increase the amount of resources at their command to keep income in parity with alternative earnings.

History extended the factor price expriment during the 1970s, and in a new direction, when the trend of wage to rental ratio was reversed and the ratio declined by more than 30 percent (Table 1, line 13). Indeed, from 1974 to 1982, farm size remained essentially constant, whether measured by value of product or by land area. The developments in the same period also support the assertion that while wage-rental ratio affects farm size, the demand for land does not. In the 1970s, when farms ceased growing, the demand for land did not decline. On the contrary, it rose dramatically as the prices in line 8 show, but it rose both for those who wanted to expand their farms and as the reservation price of owners of land. On the average, farm size was not affected.

As farms are operated by a constant amount of labor, the increased machinery input has taken the form of larger machines. This explains the appearance of the large tractors and implements in agriculture. Technologically, large machines could have been supplied to agriculture much earlier than they were, and indeed large scale machines were built for other industries--earth-moving equipment for example--long before they appeared in agriculture. In fact, the first four-wheel-drive tractors were assembled by farmers, so widespread and simple was the technology. Only afterwards did the machine companies produce these large tractors. Here, as in many other cases, the companies reacted to economic changes once they were reflected in demand. The decision of the manufacturers to build larger machines is not an exogenous factor determining farm size.

It has been argued that the U.S. income tax law which taxes the earnings from capital at lower rates than earnings from labor through investment credits and accelerated depreciation promoted the growth of large capital intensive farms. This may be true. To the extent that the income tax law reduced the price of capital relative to that of labor, it would, according to our farm size model, have contributed to the increase in farm size. But unless the tax law continued to lower the price of capital, it would have resulted in a once and for all change in equilibrium farm size, not a continued increase.

Farm mechanization can be viewed a process of induced innovation. Changing factor prices for agriculture, including the price of energy, induced the machine companies to produce more efficient and larger machines. These and similar changes also induced agricultural research to produce appropriate biological and chemical technologies. Changes in factor prices induced the suppliers of factors and technology to innovate. An alternative view, that innovations occurred on the farm and in turn increased the demand for machinery even at higher real prices, cannot be supported by any evidence that we know of (Kislev and Peterson 1981).

Conclusions

We conclude that the evidence clearly supports the hypothesis that production in U.S. agriculture is characterized by constant returns to scale, and that the observed increase in farm size from 1930 to the mid 1970s is due to the increase in the wage-rental ratio. Viewed in this light, equilibrium farm size is endogenously determined within the economy by the relative prices of labor and capital, not by some unexplainable phenomena called "economies of scale" or "technical change." The discussion also highlighted an old puzzle: what are the economic, technological and institutional factors that support the family unit as the dominant form of organization and maintain it through periods of large economic and technical change? The solution to this puzzle will do much to improve our understanding of the economics of agriculture in the United States and elsewhere.

Table 1

Agricultural Data - per Farm Output, Inputs and Prices

		Unit	1929	1949	1959	1969	1974	1978	1982
1.	Gross Output	$1,000	9.5	23.1	31.6	44.3	66.8	69.1	62.1
2.	Value Added	$1,000	7.0	17.3	21.0	26.5	40.4	39.0	33.7
3.	Land	Acres	157	216	303	389	440	449	440
4.	Family Labor	Labor Years	1.2	1.2	1.3	1.1	1.0	1.0	1.0
5.	Hired Labor	Labor Years	.4	.3	.5	.4	.4	.5	*.7
6.	Part Time Farming	Percent	12	23	30	40	36	42	43
7.	Machinery	$1,000	4.3	9.8	22.2	28.2	33.9	47.8	53.9
8.	Land Prices	$ Per Acre	271	215	310	445	552	747	794
9.	Land Rent	$ Per Acre	-	-	46	69	124	106	86
10.	Diesel Fuel	$ Per Gallon	-	.60	.55	.47	.71	.68	1.11
11.	Custom Rate	$ Per Acre	14.12	11.82	11.52	9.79	15.83	13.39	13.70
12.	Manufacturing Wages	$ Per Week	140	218	292	334	346	363	330
13.	Wage-Rental	Index	41	77	105	142	91	113	100
14.	Economies of Scale	Sum of Coefficients	-	1.255	1.290	1.289	1.276	-	-

* July

Note: All dollar values in constant 1982 prices, deflated by the CPI.
See appendix for description of data and sources.

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Appendix

Data Sources and Definitions

Unless otherwise noted, all references are published by the Government Printing Office in Washington. In all cases number of farms are from Agricultural Statistics.

1. Gross Output: Cash receipts from farming plus value of home consumption from Agricultural Statistics, 1957, 1967, and 1984.
2. Value Added: Gross output less feed, seed, livestock, fertilizer, and miscellaneous expenses from Agricultural Statistics, 1957, 1967, and 1984.
3. Land: Acres per farm from the Agricultural Census, 1929, 1949, 1969, 1974, 1978, and 1982.
4. Family Labor: Number of family laborers per farm as reported in Agricultural Statistics 1957, 1967, and 1984, adjusted for quality by the following procedure: Income by years of schooling completed for rural males, ages 25-64, as reported by the 1980 Census of Population, was multiplied by the proportion of rural farm males in each schooling category and summed. The resulting weighted averages for the census years 1940-1980 were then utilized to construct a labor quality index, 1980=100. The labor quality indexes for the other four census years are as follows. 1940: 80, 1950: 82, 1960: 86, 1970: 93. The 1940 quality index is used to adjust the 1929 labor figure while the 1970 index was used to adjust the 1969 and

1974 figures. The 1980 index of 100 was applied to the 1978 and 1982 figures.

5. Hired Labor: Data source and quality adjustment procedure are the same as for family labor.

6. Part-time Farming: Proportion of farm operators working 100 days or more off the farm as reported by the Census of Agriculture, 1929, 1949, 1959, 1969, 1974, 1978, and 1982.

7. Machinery: Stock of machines on farms obtained by summing the value of shipments over the preceding 15 years each year deflated by the CPI. Data sources: Statistical Abstract, 1928 and Agricultural Statistics, 1957, 1967, and 1984.

8. Land Price: Value of land per acre, excluding buildings, as reported by USDA/ERS, "Farm Real Estate Historical Series Data", Statistical Bulletins 520, 1973 and 738, 1985.

9. Land Rent: Cash rent per acre of cropland, 1969-1982, in the following eight midwestern states: Michigan, Wisconsin, Minnesota, Ohio, Indiana Illinois, Iowa and Missouri. Data source: USDA, ERS and ESCS, "Farm Real Estate Market Developments" 1972, 1977, 1981, and 1985. Rental data for these states are not available prior to 1967. The 1959 figure was estimated by the following procedure: Oscar Burt reports a rental figure of $17 per acre for Illinois in 1959 (Burt, p. 26). His 1969 figure for Illinois is $30 per acre. The corresponding figure for 1969 for the eight midwestern states is $25 per acre, or 83 percent of the Illinois rent. We therefore estimated the 1959 rent for the eight states as .83 x $17 = $14 in current year prices, or $46 in constant 1982 prices.

10. Diesel Fuel: Data source: Agricultural Statistics, 1953, 1963, 1973, 1977, 1981, and 1984. Figure for 1949 is price of distillate.

11. Custom Rate: Charge per acre of custom harvesting of wheat in Kansas. The 1929 figure is from L.A. Reynoldson et al., "The Combined Harvester - Thresher in the Great Plains", USDA Technical Bulletin, no. 70 (February 1928), p. 35. The 1949 rate is from H. J. Friesen et al. "1952-53 Custom Rates for Farm Operators in Central Kansas", Kansas Agricultural Economic Report, no. 59 (1953) p. 14. The remaining custom rates are from an annual publication, "Kansas Custom Rates", 1970, 1975, 1980, and 1985, published by the Kansas Crop and Livestock Reporting Service.

12. Manufacturing Wages: Gross weekly earnings in manufacturing as reported in the Economics Report of the President, 1969, and 1985.

13. Line 12 divided by line 11, expressed as an index, 1982=100.

14. Economies of Scale: Sum of coefficients from a Cobb-Douglas aggregate agricultural production functions fitted to U.S. data as reported by Davis, p. 64.

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