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Why Did Productivity Fall So Much During the Great Depression?*

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The Great Depression brought a striking short-run productivity change to the U.S. economy. Between 1929 and 1933 in the United States, real output per adult fell more than 30 percent, and total factor productivity (TFP)—changes in output not accounted for by changes in measured inputs—fell about 18 percent. This TFP decrease is much larger than expected from just extrapolating the TFP decrease that typically has occurred during postwar U.S. recessions. During the average postwar downturn (between 1947 and 1992), output has fallen about 2 percent and TFP, 0.3 percent. This relationship suggests that TFP should have fallen only about 4–5 percent during the Depression, rather than 18 percent. It is unlikely that this decrease is due to technological regress, which is the simplest interpretation of this productivity change. If that is not the cause, however, then what is? The Depression remains one of the most important and enduring mysteries in macroeconomics, and identifying the causes of this productivity decrease may shed new light on this mystery.

Here I present productivity data from the Depression and assess how much of the TFP decrease can be explained by five commonly suggested factors: two types of errors in the measurement of inputs—changes in capacity utilization and in the quality of factor inputs—plus three other factors—changes in the composition of production, the hoarding of labor, and increasing returns to scale. I find that all of these factors combined explain less than one-third of the 18 percent decrease. I conclude by suggesting that decreases

in *organization capital* (the knowledge firms use to organize production) may be a promising candidate for explaining the productivity decrease. But as yet that decrease remains a tantalizing puzzle.

Factor Mismeasurement?

My analysis uses John Kendrick's (1961) TFP measure, which is the ratio of real gross national product (GNP) to an index of total factor input. This input measure is a factor share–weighted average of aggregate capital input and labor input. Table 1 shows Kendrick's 1930–33 values for the TFP measure, output, capital, and labor relative to their values in 1929. According to this measure, TFP fell throughout the Depression and was about 18 percent below its 1929 level in 1933.

I begin my analysis by estimating how much of the productivity decrease is due to factor mismeasurement. Micro-

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This study was undertaken to honor Stanley Engerman's distinguished career, which has included contributions to many areas of economics, among them, analyses of long-run productivity change. See, for example, the 2000 work of Engerman with Kenneth Sokoloff.

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Table 1

A Measure of U.S. Aggregate Productivity
and Its Components
During the Great Depression

Year	Value in Each Year as % of 1929 Value			
	Output	Capital	Labor*	TFP**
1930	89.6%	102.5%	92.7%	94.2%
1931	80.7	103.2	83.7	91.2
1932	66.9	101.4	73.3	83.4
1933	65.3	98.4	73.5	81.9

*Labor here is employment.

**Total factor productivity is the ratio of real gross national product to an index of total factor input. That index is a factor share-weighted average of aggregate capital and labor input.

Source: Kendrick 1961, p. 329

economic studies indicate there were changes in capital utilization and in the average quality of capital and labor input during the Depression. Capital utilization fell, and the average quality of employed capital and labor rose as the least productive inputs were idled. These changes are not all captured in Kendrick's TFP measure, so I adjust his input measures to take account of them.

Adjusting capital input requires estimating how much of the capital stock (measured in efficiency units) was idle during the period. Since there is no standard aggregate measure of idled capital, I estimate it using manufacturing data from the work of Timothy Bresnahan and Daniel Raff (1991). They report that the number of active manufacturing plants fell one-third between 1929 and 1933. There are at least three reasons, however, that one-third is too large an estimate of the fraction of the aggregate capital stock idled. First, the manufacturing sector contracted more than average in the period 1929–33, which suggests that a greater fraction of its capital was idled than the capital in other sectors. Second, the idled plants tended to be much smaller than the plants that remained active (Bresnahan and Raff 1991). Third, the idled plants tended to be the least productive plants (Bresnahan and Raff 1991). This indicates that the idled plants (measured in efficiency units) were much smaller than the operating plants. While a detailed analysis of idled capital is beyond my scope here, these three facts

suggest that the fraction of the aggregate capital stock idled is much less than one-third. For this study, I assume that the fraction idled is 20 percent.

I next examine changes in the average quality of labor input during the Depression. I focus on two types of quality changes: *intersectoral* changes and *intrasectoral* changes.

Intersectoral quality changes arise from shifts in the composition of production across sectors. These shifts change average labor quality because labor quality varies by sector. For example, agricultural workers at the time of the Great Depression were less skilled, on average, than manufacturing workers. Kendrick's labor measure adjusts for this source of quality change by multiplying sectoral hours by the sectoral wage.

Intrasectoral quality changes arise from changes in the average quality of workers within sectors. Kendrick's labor measure does not adjust for this type of quality change. But we can get a rough idea of its size from other studies. Stanley Lebergott (1993) reports that employee quality rose during the Depression; employment loss was concentrated among low-wage workers, and the most productive workers worked the longest shifts. This suggests that the average quality of individuals who continued to work during the Depression was higher than the average quality of individuals working before the Depression. Harold Cole and I (2001) use macroeconomic data to estimate how much measured wages were biased upward by layoffs of low-wage workers during the Depression. That estimate suggests that the quality of workers may have increased as much as 15–18 percent during this period (Cole and Ohanian 2001, p. 204). Lebergott (1993) also reports microeconomic data suggesting that the average quality of workers at the two largest firms in the electrical equipment industry (General Electric and Westinghouse) rose about 10 percent during just the first two years of the Depression. Given these estimates, I assume that average worker quality rose 7 percent during the Depression. This is a more conservative adjustment than either of the two preceding estimates and thus will produce a relatively small revision to Kendrick's TFP measure.

I recompute aggregate TFP with these capital and labor adjustments. I find that these adjustments explain only about two percentage points of the 18 percent TFP decrease. This is because the change in labor input, multiplied by labor's share, offsets much of the change in capital input, multiplied by capital's relatively small share.

Production Shifts?

Since these factor mismeasurements do not explain much of the decrease in aggregate TFP, I now examine sectoral data to see if less-aggregated productivity measures also fell during the Depression.

The first column of numbers in Table 2 shows TFP values in 1933 relative to TFP values in 1929, for the five sectors Kendrick reports. These five sectors account for about half of 1929 GNP. The data show that these sectoral productivities fell during the Depression much less than aggregate productivity did. Manufacturing and railroads are the only sectors that show substantial TFP declines, and these declines are only about half as large as the decline in aggregate TFP.

The fact that aggregate productivity fell more than these sectoral productivities raises the possibility that shifts in the composition of production from sectors with a high value of marginal product to sectors with a low value of marginal product contributed to the aggregate TFP decrease. Labor and relative wage data are also consistent with this view. The second column of numbers in Table 2 shows the level of sectoral hours worked in 1933 relative to its level in 1929, while the third column shows the 1929 average wage in the sector relative to the 1929 average wage in all sectors. These labor and wage data show that the agricultural sector, which pays relatively low wages, had only small declines during the Depression, while the manufacturing and mining sectors, which pay relatively high wages, both had substantial declines.

How much did these shifts in the composition of output decrease aggregate TFP? Kendrick tries to correct his aggregate TFP measure for the effect of compositional shifts by multiplying sectoral inputs by sectoral factor prices. He estimates that compositional shifts reduced aggregate TFP by about 2.5 percent. Without the compositional correction, Kendrick's aggregate TFP measure would have decreased 20.5 percent rather than 18 percent.

Kendrick's 2.5 percent adjustment seems small, however, relative to the large expansion of the low-value agricultural sector. As a robustness check, I independently estimate the size of the compositional effect. I begin by constructing a model to understand the connection between sectoral productivities and aggregate TFP. The model specifies that sectoral outputs Y_i are produced from constant returns to scale production functions using capital K_i and labor L_i that differ only by their TFP level. The TFP is denoted by A_{it} :

Table 2

A Sectoral View of Productivity and Production During the Great Depression

Sector	1933 Value as % of 1929 Value		1929 Sectoral Wage as % of 1929 Aggregate Wage†
	TFP*	Labor**	
Manufacturing	91.5%	59.4%	127.2%
Farming	104.5	97.4	38.2
Mining	99.5	54.4	162.5
Railroads	90.2	51.3	119.7
Communications and Public Utilities	100.9	67.6	114.3
<i>Aggregate</i>	81.9%	73.5%	—

*Manufacturing and mining TFP values are estimated from Kendrick 1961, assuming that each sector's capital stock did not change between 1929 and 1933.

**Labor is "manhours" (employment x average hours worked per employee) for the sectors and employment for the aggregate.

†Relative wages for each sector as a percentage of the aggregate wage are estimated as the ratio of Kendrick's measure of labor input (the product of "manhours" and the relative value of the sector's output) to "manhours."

Source: Kendrick 1961, pp. 319, 329, 363, 398, 466, 545, 581

$$(1) \quad Y_{it} = A_{it}F(K_{it}, L_{it}).$$

Aggregate output is the sum of sectoral outputs multiplied by base-year sectoral prices, which are denoted as p_i :

$$(2) \quad Y_t = \sum_i p_i Y_{it}.$$

With these assumptions, aggregate TFP is a weighted average of sectoral productivities multiplied by relative prices, with weights equal to each sector's share of total labor:

$$(3) \quad A_t = \sum_i [p_i A_{it} (L_{it} / \sum_i L_{it})].$$

This equation can be used with price, productivity, and labor data to estimate the compositional effect. To make that estimate, however, I need a proxy for the relative price term. I substitute for this term using wage data. I use this proxy since profit maximization implies that a sector's relative price is equal to the sector's relative wage divided

by the sector's marginal product of labor. Unfortunately, the data required to construct the marginal products are not all available, so I use the relative wage as a proxy for the relative price. This proxy will overstate the compositional effect because the marginal product of labor is probably above average in high-wage sectors.

I now estimate the effect of compositional shifts by calculating aggregate TFP holding sectoral productivity levels fixed at their 1929 levels and changing labor inputs as in the data. (I use employment and wage data for all sectors from U.S. Bureau of the Census 1975.) I estimate that between 1929 and 1933, changes in the composition of production reduced aggregate TFP about 4.5 percent. Since this estimate is probably biased upward, it seems unlikely that the compositional effect is bigger than Kendrick's 2.5 percent correction.

This analysis suggests that Kendrick's measure of aggregate TFP adequately corrects for the effect of compositional shifts and that the sectors for which Kendrick does not report productivity (construction, finance/insurance/real estate, services, wholesale and retail trade, and government) account for most of the 18 percent decrease in aggregate TFP. That is, the residual productivity decrease is likely due to lower productivity in these omitted, or *residual*, sectors. The other possible cause, a compositional shift from the highest to the lowest valued-added sectors within the residual group, is unlikely because wage differences are small in these sectors. This suggests that accounting for the 18 percent aggregate productivity decrease requires that productivity fell more than 25 percent, on average, in Kendrick's residual sectors.

Labor Hoarding? Increasing Returns?

Why did productivity fall so much during the Great Depression in some sectors (manufacturing, railroads, and the residual sectors) but not in others? I now briefly consider two other possible explanations, which have been cited by Ben Bernanke and Martin Parkinson (1991) and others: labor hoarding and increasing returns to scale.

Economists have often advanced labor hoarding as an explanation for low productivity during run-of-the-mill recessions. (See, for example, the 1986 work of Lawrence Summers.) The standard labor hoarding thesis is that the firing and hiring costs associated with temporary layoffs exceed the cost of hoarding workers, that is, not laying off workers but instead reducing their utilization relative to paid hours. This utilization decrease reduces measured productivity.

The duration of the Depression, however, raises questions about the plausibility of the labor hoarding explanation. It is difficult to reconcile this thesis, which is based on the temporary nature of recessions, with a major depression that lasted well over a decade. It seems unlikely that firms hoarded workers because they mistakenly expected the Depression to end quickly; consumption data suggest that it was expected to last a long time. Purchases of nondurable goods and services fell sharply during the first year of the Depression. Viewed through the lens of Milton Friedman's (1957) permanent income hypothesis, this large decrease indicates that households thought their permanent income had fallen significantly at the start of the Depression. This is consistent with a large and very persistent negative shock, rather than a transitory shock. A challenge for those who hold the labor hoarding view is to explain why firms hoarded labor during such a long and deep depression and why labor hoarding did not affect all sectors.

Increasing returns to scale is another commonly offered explanation for low productivity during recessions. This idea is that with increasing returns, a reduction in factor inputs will show up as lower productivity under a standard Solow residual accounting exercise based on constant returns. Recent econometric studies, however, estimate constant returns to scale at both aggregated and disaggregated levels with small standard errors. (See, for example, the 1997 work of Susanto Basu and John Fernald.) These findings are strong evidence against big increasing returns and suggest that only about three percentage points of the 18 percent productivity decrease could be plausibly explained by this factor.

A Promising Explanation

In summary, I find that all five of the traditionally suggested factors combined account for only about five percentage points of the 18 percent productivity decrease during the Great Depression (two points from capital and labor input changes and three points from increasing returns). This leads me to consider an alternative view, that lower production efficiency contributed to the productivity decrease. Efficiency may have been reduced by a decrease in *organization capital*, the knowledge firms use to organize production (as discussed in 1980 by Edward Prescott and Michael Visscher). Changes in organization capital might be a promising explanation because this factor is quantitatively important, and it plausibly may have fallen during the Depression.

Regarding its quantitative importance, Andrew Atkeson and Patrick Kehoe (2001) use a version of the neoclassical growth model to measure organization capital in the United States, and they estimate that in 1959–99 it was roughly two-thirds of the value of the total physical capital stock. There are several reasons this large stock of capital could have shrunk during the Depression, including breakdowns in supplier relationships that led to changes in production plans and breakdowns in customer relationships that led to changes in marketing, distribution, and inventory plans.

These breakdowns could have reduced efficiency by leading managers to shift time away from production and into search activities. For example, the failures of intermediate-good suppliers could have reduced efficiency by requiring managers to search for new suppliers. This search activity would have lowered efficiency by reducing the amount of managerial labor input dedicated to organizing and planning production. Similar reasoning suggests that the failures of either wholesalers or retail customers could have reduced efficiency by leading managers to substitute out of production and into search activities.

Breakdowns in these relationships could have also reduced efficiency by leading firms to adopt different technologies that initially were operated inefficiently. Atkeson and Kehoe (2001) present manufacturing plant-level data that support this hypothesis. They find that the productivity of plants adopting leading-edge technologies is initially lower than the productivity of much older plants. This suggests that organization capital is technology-specific and that firms must accumulate new organization capital to operate new technologies efficiently.

Conclusion

The usual suspects for explaining procyclical productivity (changes in capital utilization, changes in the quality of factor inputs, shifts in production from high-productivity to low-productivity sectors, labor hoarding, and increasing returns to scale) explain only about five percentage points of the 18 percent decrease in aggregate productivity during 1929–33. I conclude that the Great Depression productivity puzzle remains largely unsolved.

This analysis suggests two alternative interpretations of the productivity puzzle. One interpretation is that some forms of measurement error are responsible for the productivity decreases. Measurement error hypotheses tend to raise two possibilities: either output fell significantly less than measured, which would imply that the Depression was less severe than previously thought, or inputs fell more

than measured, which would deepen the puzzle of why employment fell so much during the Depression.

The other interpretation of the productivity puzzle is that lower production efficiency contributed to the productivity decreases. A version of this lower efficiency view is that the Depression reduced firm-specific organization capital by disrupting normal production, distribution, marketing, and inventory plans.

These different interpretations of the productivity puzzle suggest very different views about the nature of the Great Depression. Thus, solving this puzzle may considerably advance our understanding of this fascinating period. More research is needed, however, to determine how much of the Depression's productivity decrease is due to changes in efficiency, through either lower organization capital or other shocks to efficiency, and how much is due to measurement error or other factors. A major challenge is to explain not only why measured productivity fell, but also why productivity change varied so much across sectors.

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