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Intra-Industry Heterogeneity and the Great Depression: The American Motor Vehicles Industry, 1929–1935

TIMOTHY F. BRESNAHAN AND DANIEL M. G. RAFF

Reliance on a "representative firm" approach in studying industrial behavior during the Great Depression obscures economically interesting patterns. A newly discovered data source lets us form and study an establishment-level panel dataset on the motor vehicles industry, one of the largest in 1929. Substantial intra-industry heterogeneity led to large composition effects in employment, output, and productivity: the large number of plants that shut down were unlike the continuing ones. Oddly, output does not seem to have shifted among continuing producers to the relatively low-cost ones. Reconciling these should illuminate links between industrial organization and macroeconomics.

INTRODUCTION: THE SUPPLY RESPONSE TO THE GREAT DEPRESSION

Most studies of industries' response to business cycles have relied heavily on the "representative firm" paradigm. The most prominent recent work on employment, hours, and wages in the Great Depression, that of Ben Bernanke, used it to provide an explicitly microeconomic interpretation of industry-level data.[1] But whether the convenient abstraction of a representative firm clarifies or disguises important economic behavior and history is an empirical issue. Price-taking firms with convex technologies will all operate to have the same marginal cost and the same marginal value product of labor: the error in treating them as a single decision-making unit might therefore be small. Between 1929 and 1933, however, one-third of U.S. manufacturing

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[1] See Ben S. Bernanke, "Employment, Hours, and Earnings in the Depression: An Analysis of Eight Manufacturing Industries," *American Economic Review*, 76 (Mar. 1986), pp. 82–109. The representative firm paradigm is also widely used in the literature on short-run increasing returns to labor that started with Thor Hultgren, *Changes in Labor Cost During Cycles in Production and Business* (New York, 1960), and that has again become a focus of interest. See, for example, Lawrence H. Summers, "Some Skeptical Observations on Real Business Cycle Theory," *Federal Reserve Bank of Minneapolis Quarterly*, 10 (Fall 1986), pp. 23–27; and Ben S. Bernanke and Martin L. Parkinson, "Procyclical Labor Productivity and Competing Theories of the Business Cycle: Some Evidence from Interwar U.S. Manufacturing Industries" (National Bureau of Economic Research Working Paper No. 3503, Oct. 1990).

establishments closed. In the motor vehicles industry, which had grown in the twenties to be manufacturing's largest, the fraction was one-half. To the extent that closing establishments differed significantly from those continuing in operation—for example, with respect to their costs—aggregate statistics may disguise significant composition effects.

This article investigates the motor vehicles industry contraction using newly discovered establishment-level data. There is good reason to expect such microdata to reveal substantially more than industry aggregates. We believe that within-industry heterogeneity in technology led to very substantial cost heterogeneity. Contemporary observers seem to have been cognizant of this, but they did little to track its economic effects.

At the beginning of the Depression, mass-production techniques had only partially diffused through the manufacturing economy.[2] In motor vehicle manufactures, some firms had followed the lead of Ransom Olds in the spirit of Henry Ford. Others had not.[3] This may not be surprising. The literature on technology diffusion has always emphasized the long lag before universal adoption of best-practice technology.[4]

The heterogeneity in choice of technique was accompanied by heterogeneity in organizational structure and in scale. A mass-production plant is necessarily large, as is any firm that contains one. Efficient use of mass-production techniques also implied a change in the role of management and in relationships with labor, suppliers of materials, and the retail sector.[5]

Economists writing in the 1930s noted the emergence of these new organizational forms. In their statistical tabulations, they expected to find differences between the behavior of large, centrally managed firms and the older, more traditional organizational forms.[6] They also noted that mass production led to a newly important industry structure, the

[2] See the foreword by Willard L. Thorp and "Trends in the Scale of Manufacturing Operations" by Willard L. Thorp, Don D. Humphrey, and Martha H. Porter in Thorp et al., *Temporary National Economic Committee Monograph No. 27: The Structure of Industry* (Washington, DC, 1941).

[3] David A. Hounshell, in *From the American System to Mass Production: The Development of Manufacturing Technology in the United States* (Baltimore, 1984), gives a careful treatment of the development of the methods at Ford. He also provides an authoritative discussion of the general slowness of the diffusion of American System methods.

[4] See Zvi Griliches, "Hybrid Corn: An Exploration in the Economics of Technical Change," *Econometrica*, 25 (Oct. 1957), pp. 501–22.

[5] On central office management, see Walter F. Crowder, "The Integration of Manufacturing Operations," in Thorp et al., *The Structure of Industry*. On the technical advantages of mass production, see Frank Fetter, "The Fundamental Principle of Efficiency in Mass Production," Appendix D, in *Temporary National Economic Committee Monograph No. 13: Relative Efficiency of Large, Medium-Sized, and Small Businesses* (Washington, DC, 1941). The key modern study is Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA, 1977).

[6] See Walter F. Crowder, "The Concentration of Production in Manufacturing," in Thorp et al., *The Structure of Industry*.

concentrated oligopoly.[7] These changes in firm organization and industry structure were widely thought to explain the changed cyclical response of the economy.[8] Our attention will be focused on the first of these structural changes, as we concentrate on intra-industry differences between newer and older technology, plants, and firms.

We expected this heterogeneity to affect the industrywide contraction in motor vehicles production by two distinct routes. The first is the changing composition of the stock of plants in operation caused by widespread closures. If it were plants embodying the older technology that closed, we would expect systematic differences between the average plant and the average continuing plant. In particular, continuing plants would, on average, be larger, have lower unit costs, use less skilled labor, and produce cheaper products. We would then expect the aggregate change in employment-per-unit output, for example, to reflect a mixture of proportional decline at closing facilities and of the dynamic labor demand behavior at continuing ones.

The second route by which heterogeneity plays itself out is "reweighting" within the stock of continuing plants. Suppose that competition or other forces tended to divide output among firms in an approximately cost-minimizing way, and that short-run marginal cost were concave (perhaps because of capacity constraints). Then less efficient plants would contract more in the trough, even if they did not close. As a result, a large fraction of aggregate output, employment, and wages would be accounted for by new-technology plants. At the time of the Great Depression, there was a marked secular trend toward the increased importance of large establishments.[9]

We present here an investigation of the size, sign, and origins of these composition effects, exploiting a new data source that we are systematically developing.[10] We have constructed a panel dataset of plants in the motor vehicles industry.[11] By exploiting the panel data feature we are able to explore differences between closing, continuing, and newly

[7] But see Fetter, "The Fundamental Principle," for the view that efficiencies are insufficient to explain the increase in concentration.

[8] See Gardner C. Means, "Industrial Prices and Their Relative Inflexibility," *Document No. 13: Letter from the Secretary of Agriculture* (Washington, DC, 1935). For some statistical calculations, see Crowder, "The Concentration," chap. 5.

[9] See Thorp et al., *The Structure of Industry*.

[10] The U.S. Bureau of the Census conducted a Census of Manufactures covering each of the years 1929, 1931, 1933, and 1935. See Frederick Bohme, "U.S. Economic Censuses, 1810 to the Present," *Government Information Quarterly* (1987), pp. 221–43. The overwhelming majority of the manuscript returns have survived. We are engaged in a long-term project of coding, editing, and analyzing data from them. Then, as now, the sampling frame for these censuses is establishments. Questions varied from year to year, and budgetary restrictions prevented tabulation of all the data. Nonetheless, the enumerators collected a huge and fascinating body of data on the costs of variable inputs, output, revenue, output composition, and some aspects of capital investment and organization.

[11] More precisely from Census Industry 1408, "Motor Vehicles." The upstream industry, "Motor Vehicle Bodies and Parts," is classified separately as Census Industry 1407.

TABLE 1
CENSUS STATISTICS FOR ALL MANUFACTURING

	1929	1931	1933	1935
Establishments[a]	206.7	171.5	139.3	167.9
Wage-earner months[b]	100.4	73.9	69.5	86.4
Wages (nominal)[c]	10,884	6,688	4,490	7,311
Wages (1929 $)[c,d]	10,884	7,703	6,020	8,947
Value of products (nominal)[c]	67,994	39,830	30,557	44,993
Value of products (1929 $)[c,d]	67,994	45,872	40,972	55,063
Production index[e]	364	262	228	301
Salaried officers[a]	1,290	n.a.	n.a.	1,058

[a] In thousands.
[b] Sum over 12 months of the number (in millions) of wage-earners employed.
[c] In millions.
[d] The deflator is the predecessor to the CPI calculated in Robert A. Sayre, *Consumer Prices 1914–1948* (New York, 1948).
[e] Solomon Fabricant, *The Output of Manufacturing Industries, 1899–1937* (New York, 1940).
Note: n.a. = not available.

opening plants—differences that turn out to be large and systematic. The panel data feature also allows us to examine "reweighting." There is little evidence that it was quantitatively important.

THE EXTENT OF THE CRASH

Table 1 reproduces some census-based statistics for all manufacturing during the Depression years.[12] With some few exceptions, the data definitions used then were essentially the same as the ones used now.[13] In particular, the establishments' value of products, wage bill, and materials expenditures reported in the table correspond to current definitions.

From the 1929 peak to the 1933 trough, the manufacturing economy shrank dramatically.[14] Fabricant's production index fell by 37 percent (see Table 1). The real value of all manufactured products fell by 40 percent. The deflated manufacturing wage bill fell by 45 percent, while wage-earner months (WEM) fell by 41 percent.[15] There were one-third fewer establishments operating at the trough than at the peak. Although 1933 figures for salaried officers were not tabulated by the census, the

[12] All these data were taken from the 1939 Census of Manufactures summary volume.

[13] The greatest departures from modern practice are in the treatment of capital. There were no questions about the value of the capital stock or about investment. For 1929 and 1935, however, there were questions about the physical capital stock. These asked about the horsepower of installed machines. The 1935 figures were neither tabulated nor reported by the Census Bureau.

[14] The actual trough probably occurred somewhat earlier: 1933 was in fact a year of very slight growth. We will refer to 1933 as the trough throughout this article, however. The usage is conventional, and more accurate descriptions are cumbersome.

[15] The census schedule asked for "[the] number [of wage earners] on [the] payroll for [the] week which included [the] 15th day of [the] month, if this was a normal week" for each month in the year. (If that week was not normal, respondents were to give the number for one that was.) We summed these over the 12 months to calculate WEM.

recovery year of 1935 showed an 18 percent decline from 1929. This is roughly comparable to the 1929-to-1935 decline in wage-earner months of 14 percent. On any basis—establishment, labor, or output—the decline in the measured size of the manufacturing sector was dramatic.

On all measures, the peak-to-trough decline in the motor vehicles industry was even more dramatic. As can be seen in Table 2(A), the real wage bill, vehicles produced, and deflated value of products all declined over 60 percent. WEM were down 59 percent, and the number of both establishments and salaried employees declined 42 percent.[16] The larger size of the decline in the motor vehicles industry presumably reflects the durability of its products and, possibly, less flexible prices than the manufacturing average. The pattern of percentage declines mimicked all manufacturing. All the variables declined in roughly the same percentage except for establishments and salaried officers, which declined less. As in all manufacturing, the year 1935 showed a partial recovery.

This broad similarity between motor vehicles and the overall manufacturing economy masks substantial intra-industry variety in behavior. The second part of Table 2 shows statistics on the operating motor vehicles plants in census years. We report establishment means, which could be inferred from census publications. We also report standard deviations across establishments, which could not: they can only be observed directly from the microdata. Note that for almost any size measure in almost any year, the standard deviation was roughly twice the mean. The size of the establishments was remarkably varied.

It is clear at this juncture that both of the a priori promising composition stories might conceivably have occurred. When we examine cross-sectional evidence, we see tremendous size variation in all time periods. This lends credence to the possibility that large plants are even more dominant in the 1933 statistics than in the 1929 ones. When we examine time-series evidence, we see very considerable plant closure. Clearly, panel data are needed to resolve the question of which kind of composition effects were quantitatively important, and how.

A NEW PANEL DATASET: ACCOUNTING FOR PLANT CLOSURE

To investigate changes in economic activity at the plant level, we needed to link the records of individual establishments over time. This was a somewhat more difficult undertaking than it would have been for postwar data, because the census did not assign a plant-unique identifier in the earlier period.[17]

[16] We are able to report the 1933 Salaried Employees figure because the Census Bureau collected the information, even though it did not publish any statistics.

[17] Unique identifiers were a key element in the Census Bureau's construction of the longitudinal establishment database from the postwar Census of Manufactures and Annual Survey of Manufactures. See Robert H. McGuckin, "Longitudinal Economic Data at the Census Bureau: A New Database Yields Fresh Insights on Some Old Issues" (U.S. Bureau of the Census Center for Economic Studies Discussion Paper CES 90-1, 1990).

TABLE 2
STATISTICS FOR CENSUS YEARS

(A) Motor Vehicle Industry Totals

	1929[e]	1931	1933	1935
Establishments[a]	211	178	122	121
Value of products (nominal)[b]	3,710	1,568	1,097	2,391
Value of products (1929 $)[b,c]	3,710	1,806	1,470	2,926
Vehicles produced[d]	5,259	2,295	1,848	3,923
Wage-earner months[d]	2,696	1,618	1,117	1,764
Wage bill (nominal)[b]	364	157	104	217
Wage bill (1929 $)[b,c]	364	181	139	266
Salaried employees[d]	27	n.a.	16[f]	17
Nominal salaries[b]	78.9	n.a.	25.6[f]	32.5
Salaries (1929 $)[b,c]	78.9	n.a.	34.4	39.8
Horsepower[d]	899	n.a.	n.a.	787[f]

(B) Establishment Means: Motor Vehicles
(standard deviation across establishments in parentheses)

	1929	1931[g]	1933	1935
Value of products	17.66	9.65	8.99	197.6
(in nominal $)[b]	(31.97)	(16.57)	(17.54)	(35.17)
Value of products	17.66	11.11	12.05	24.18
(in 1929 $)[b,c]	(31.97)	(19.09)	(23.52)	(43.04)
Vehicles produced[d]	25.0	14.5	15.1	32.4
	(48.4)	(25.9)	(32.7)	(58.0)
Wage-earner months[d]	12.84	10.40	9.15	14.58
	(31.3)	(21.8)	(21.4)	(29.9)
Wage bill (nominal)[b]	1.74	1.00	0.85	1.81
	(4.40)	(2.08)	(2.07)	(4.01)
Wage bill (1929 $)[b,c]	1.74	1.16	1.14	2.21
	(4.40)	(2.39)	(2.78)	(4.91)
Salaried employees	130	n.a.	126	140
	(262)		(247)	(238)
Nominal salaries[b]	0.38	n.a.	0.20	0.27
	(0.84)		(0.36)	(0.94)
Salaries (1929 $)[b,c]	0.38	n.a.	0.27	0.33
	(0.84)		(0.49)	(1.15)
Horsepower[d]	4.28	n.a.	n.a.	6.50
	(13.29)			(16.21)

[a] Number count.
[b] In millions of dollars.
[c] For the deflator, see Table 1 notes.
[d] In thousands.
[e] Excluding trailer plants (so as to be comparable to the other columns).
[f] Computed by authors—not published by the Census Bureau.
[g] Computed on available 1931 subsample.

Our primary goal was to ensure that plants that were linked together were the same physical plant (rather than, for example, simply belonging to the same firm). We used plant name, firm name, and reported street address as the primary criteria for matching plants, but we also took advantage of the form fields devoted to reporting changes of

ownership and location. We attempted to find true matches for every establishment in the motor vehicles industry (Census Industry No. 1408) for which we had a form in any of the four census years.

Precision in this effort was important, because the match implemented two of our key concepts: whether a plant was "open" and whether "open" plants were "continuing." We called a plant "open" in a year if it returned a Census of Manufactures schedule.[18] We called a plant "continuing" if it was open in both of two years. A plant was "new" or "closing" if it was open in only one of two years. In making our match, we tried to avoid false nonmatches over time, to avoid recording false closures and newly opening plants.[19]

We were initially concerned by the number of new establishments that appear to have opened in 1931, 1933, and 1935. We wondered whether these "new" establishments might be upstream plants (that is, from the motor vehicles bodies and parts industry) that had been reconfigured or possibly merely relabeled as motor vehicles plants. A search of the bodies and parts industry forms, however, revealed that transition of this sort was not an important phenomenon.[20] The openings seem to have been genuine entry.

There is one problem with this data set. Some of the 1931 schedules have not survived. Where possible, we have determined whether those plants were open or closed in 1931 by using extracensal sources.[21]

PATTERNS OF PLANT CLOSURE

The overall pattern of plant closure and reopening is shown in Figure 1. As one might have expected, there was ongoing and substantial exit

[18] Note that the census was actually conducted in the first quarter of the following year. A plant might therefore have been open during the census year but closed and unresponsive by the time of the survey. We do not believe this problem seriously affects our data.

[19] These considerations apply principally to small, single-plant firms. If the firm had only one plant in a city, we called it a match even if the address changed. This reflects the reality of the way the address fields were filled in. It also reflects our analytical concerns. The ongoing assets of the establishments and firms under study here are not so much buildings as firm-specific human capital, both managerial and blue-collar. These assets would most likely be preserved in a short move of the physical plant.

[20] We searched through the 1929 body-and-parts industry forms to see whether these apparently new establishments were simply relabelings of establishments previously classified in the other industry. We found that only two (out of well over a thousand) might conceivably qualify. One was an Auburn plant in Connersville, Indiana, the other a McCann (truck) Corporation plant in Cumberland County, Maine. The match was not compelling in either case.

[21] We searched the pages of *Automotive Industries* and *Cram's Automotive Reports* (the ancestor of *Ward's*) for references to plant openings and closures. This resolved the status of a number of the missing establishments. Unfortunately, it left 30 unresolved. As the problem was overwhelmingly worst at single-plant firms, we had hopes of using *Thomas' Register of Manufactures* to resolve many more. This source has been used to document shakeouts before—for example, in the influential article by M. Gort and S. Klepper, "Time Paths in the Diffusion of Product Innovations," *Economic Journal*, 92 (1982), pp. 630–53. Unfortunately, a comparison of plant closure news stories in the industry trade sources with *Thomas's* showed that deletion of a *Thomas* listing could lag actual closure by four or more years.

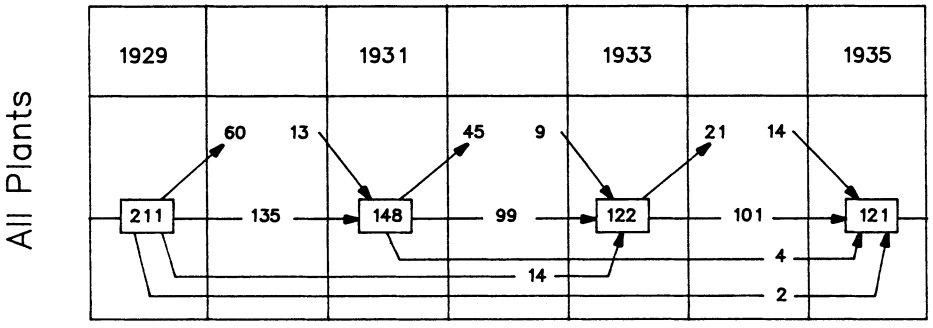

FIGURE 1

FLOW CHARTS FOR INDUSTRY 1408

for each year shown. But there are two other very striking features. First, simultaneous with the exit, there was substantial and ongoing entry. Second, the evidence indicates mothballing—that is, plants being taken out of production for some period but later reintroduced with no change in ownership. This was not a huge or dominant phenomenon, but it appears to have been a pronounced one. Part of this appearance—in 1931—may be artifactual: there are nine plants for which there are 1929 and 1933 forms but none for 1931 whose status we have not been able to confirm by other means. So those nine establishments might in fact have been open and the amount of mothballing thus proportionately lower. But even ignoring those nine, it is clear that there was mothballing. And we know, in fact, that these figures understate the phenomenon's true extent: sources in the Ford Archives indicate that local assembly plants closed during this period were being reopened throughout the decade.[22]

We now turn to less aggregated details. Figure 2 shows the pattern broken down by type of ownership. Among the Big Three's stock of plants, mothballing was definitely going on, even without counting subsequent openings. Further, these operators appear to have been markedly slower than single-plant firms to shut down facilities between 1929 and 1931 and between 1933 and 1935.

The establishments operated by multiplant firms that were not among the Big Three showed no mothballing at all. The number of these establishments shrank proportionately more than that of the Big Three—by 1935, the population was only 55 percent of what it had been (compared to 71 percent for the Big Three).

The single-plant firms were nominally the hardest hit: the population shrank to 52 percent of its 1929 level. Note that this shrinkage was little greater than in the multiplant firms beyond the Big Three. The net flows for single-plant firms were consistently heavier.

All this suggests the possibility of heterogeneous opportunities and

[22] See M. L. Wiesmyer, *Reminiscences* (typescript in the Ford Archives, Dearborn, MI), for example, p. 58.

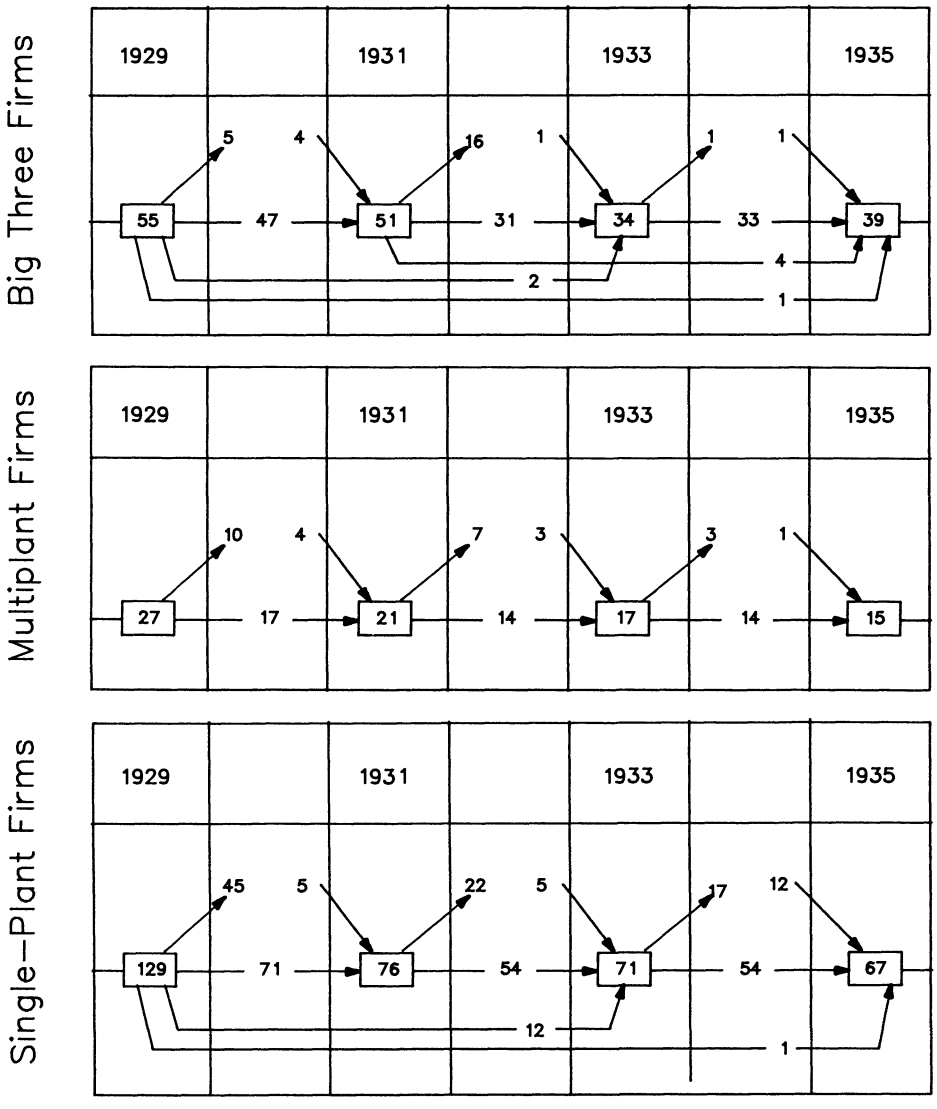

FIGURE 2

FLOW CHARTS FOR SOME SUBSETS OF INDUSTRY 1408

the winnowing effects of competitive forces. It suggests, in particular, that we take a closer and more systematic look at the cohorts of exiting, entering, and ongoing establishments.

COMPOSITION EFFECTS FROM PLANT CLOSURE

Table 3 compares the average levels of several 1929 and 1933 quantities for three classes of plants: those open in 1929 and 1933, those

TABLE 3
CHANGING COMPOSITION OF THE MOTOR VEHICLES ESTABLISHMENT LIST: REVENUE, VEHICLES, AND EMPLOYMENT PER PLANT, 1929–1933

Schematic: Averages	
1929	1933
Continuing Plants	Continuing Plants
Closing Plants	Newly Opening Plants

Number		Salaried Employees	
106	106	208	147
105	16	49	44
Wage-earner Months[a]		**Nominal Salaries**	
20,599	10,538	$629,626	$231,839
$4,931	3,586	$140,154	$66,284
Nominal Revenues		**Salaries (1929 $)[b]**	
$27.24m	$9.86m	$629,626	$310,870
$7.83m	$3.22m	$140,154	$88,876
Revenues (1929 $)[b]		**Total Horsepower[d]**	
$27.24m	$13.22m	7,101	8,874
$7.83m	$4.32m	1,410	558
Vehicles[c]		**Vehicles/WEM**	
36,564	16,465	2.09	1.50
13,173	6,128	1.36	1.14
Nominal Wage Bill		**Revenues (1929 $)/WEM[b]**	
$2.83m	$0.94m	$1,806	$1,424
$0.62m	$0.28m	$1,244	$1,055
Wage Bill (1929 $)[b]		**Wage (Wage Bill/WEM) (1929 $)[b]**	
$2.83m	$1.27m	$132	$116
$0.62m	$0.37m	$127	$93

[a] This is the sum over 12 months of the number of wage earners employed.
[b] For the deflator, see Table 1 notes.
[c] The number of vehicles produced includes chassis.
[d] Horsepower figures compare 1929 and 1935, because the census did not collect the information in 1933. The sample here is divided into plants present in 1929 and 1935, and those present in only one year.

open in 1929 but not 1933, and those open in 1933 but not 1929. The first block of figures in the table shows that these groups numbered 106, 105, and 16 establishments, respectively. The rest of the blocks of figures are reported in the schematic format shown in the box. For example, plants open in both years employed 20,599 wage-earner months of labor in 1929, on average, and 10,538 in 1933. Plants open only in 1929 were smaller, employing an average of 4,931 WEM. Plants open only in 1933 were smaller still, employing 3,586 WEM in that trough year.

Looking down the left side of the table, we note that several plausible measures of size tell a similar story. Continuing plants are substantially larger than plants that will close, whether measured by 1929 employ-

ment (WEM), revenues, vehicles produced, or installed horsepower.[23] This is consistent with our cost-heterogeneity story, of course.

The second way to use Table 3 is to read horizontally. There are almost exactly as many continuing plants as closing plants. Looking at the wage-earner months block, we see that employment at the average continuing plant declined by just over 10,000 WEM. At closing plants, WEM declined by 4,931. As a result, plant closures accounted for 32.7 percent of the decline in the industry's employment.[24] This figure is striking; it alone should encourage researchers to closely examine plant closures.[25]

Table 3 holds further clues to the importance of plant closures in the decline of employment in the industry. The main reason is that closing plants were very numerous and, though small compared with the *level* of employment at continuing plants, were not so small compared with the *decline* in employment at continuing plants. There are other clues as well. Look at the two blocks showing output per WEM. Whether we measure output by vehicles or by deflated revenues, labor productivity appears to have fallen at continuing plants. Something like labor hoarding appears to be going on there. Thus, the overall number of jobs lost to plant closure was somewhat larger than one might have expected, whereas the decline in employment at continuing facilities was somewhat less than their decline in output would suggest. These two opposing tendencies produce the important composition effect—that is, the large share of plant closures in employment declines.

While blue-collar labor hoarding is important in the data, it is hard to argue that wage earners were the factor of production most hoarded. Salaried employees at continuing facilities declined only about 25 percent compared with a decline of about 50 percent for WEM. As a result, closing plants accounted for 44 percent of the declines in salaried employment. Similarly, from 1929 to the early-expansion year of 1935, installed horsepower actually rose at continuing plants. Some of the investment this implies may well have occurred after the 1933 trough. Nonetheless, Table 3 suggests that managerial and physical capital were more fixed than worker capital at the continuing plants.

COMPOSITION EFFECTS IN THE EARLY EXPANSION

Table 4 resembles Table 3, but compares the trough year 1933 to the early-expansion year 1935. Although Table 4 is the conceptual inverse

[23] These data, like most microdata, are very noisy. The noise levels documented in Table 2(B) notwithstanding, the mean levels of these variables are, statistically as well as economically, significantly different. Simple F-tests reject equality of the 1929 means of continuing and closing plants for all the variables mentioned in the text. The F-tests assume normality, perhaps falsely; but the test statistics are very far from the margin of rejection.

[24] This statement uses a "jobs" definition rather than the more familiar "employed persons" definition. This is because we can follow plants, but not people, over time.

[25] Treating openings as negative closures only reduces the figure to 30.2 percent.

TABLE 4
CHANGING COMPOSITION OF THE MOTOR VEHICLES ESTABLISHMENT LIST: REVENUE, VEHICLES, AND EMPLOYMENT PER PLANT, 1933–1935

Schematic: Averages	
1933	1935
Continuing Plants	Continuing Plants
Closing Plants	Newly Opening Plants

Number		**Salaried Employees**	
101	101	157	159
21	19	20	33
Wage-earner Months[a]		**Nominal Salaries**	
12,077	17,963	$247,681	$329,453
768	3,298	$29,557	$44,226
Nominal Revenues		**Salaries (1929 $)**[b]	
$10.75m	$22.04m	$332,099	$480,291
$0.49m	$8.14m	$39,631	$54,125
Revenues (1929 $)[b]		**Vehicles/WEM**	
$14.43m	$26.97m	1.55	1.86
$0.65m	$9.97m	0.55	1.60
Vehicles[c]		**Revenues (1929 $)/WEM**[b]	
18,075	35,797	$1,245	$1,511
843	16,047	$832	$1,402
Nominal Wage Bill		**Wage (Wage Bill/WEM) (1929 $)**[b]	
$1.09m	$2.07m	$113	$132
$0.06m	$0.40m	$111	$116
Wage Bill (1929 $)[b]			
$1.37m	$2.54m		
$0.07m	$0.49m		

[a] This is the sum over 12 months of the number of wage earners employed.
[b] For the deflator, see Table 1 notes.
[c] The number of vehicles produced includes chassis.

of Table 3, the expansion results do not mirror those of the contraction. Few plants opened—only 19.[26] Some of these were existing facilities reopening, some new plants (see Figure 1). The statistics are dominated by the continuing facilities. As a result, the composition effects due to plant opening (or reopening) are much less important than those due to plant closure (compare with Table 3).

The nature of the supply response to the expansion is in itself interesting. Output, measured by vehicles, almost doubled at the continuing plants. Yet WEM rose by only about one-half. Productivity (measured in vehicles per WEM) was almost back to the 1929 level. The number of salaried employees hardly increased at all. Thus, it seems clear that the hoarding of labor and managers seen in the downturn was

[26] The total number of establishments operating in 1937 and 1939 rose slightly again. We do not know whether this small net entry masks a larger gross flow.

being undone. Real wages and salaries at continuing facilities rebounded.

Table 4 provides additional support for the shakeout story. The departures in the early 1930s downturn were largely permanent. Already by 1935, the auto industry resembled its postwar self: a standing body of mass-production plants with quasi–permanently affiliated management and labor.

COMPOSITION EFFECTS AMONG CONTINUING PLANTS

Were there also important composition effects among continuing plants? We can imagine arguments for either side of the question. The continuing plants varied tremendously in size—see Table 2(B). Thus, the hypothesis that they embodied a mix of choices of technique is a priori plausible. To the extent that less efficient plants contracted more than the more efficient ones did, there could be substantial composition effects.

The a priori argument that the effects were small is also plausible. Within the firm, managers would close the most inefficient plants. Within the remnant kept open, managers would contract the least efficient plants the most. Across firms, competitive forces rather than managerial decisions might induce the same reallocation. Yet it appears unlikely that the automobile oligopoly had a pricing rule near perfect competition in this period. Instead, efficient producers may have provided a price "umbrella" for the inefficient ones. Thus one might easily imagine that there were no interfirm composition effects, either. Which way it actually was appears to be an empirical issue.

The obvious question is whether the mass-production plants contracted less. We pursue this question in an empirical framework familiar from the analysis of firm (or plant) size and growth.[27] For each year—1931, 1933, and 1935—we regress the log of size, measured by either employment (WEM) or output (vehicles or revenue), on the log of 1929 size, measured the same way. We correct the regression for the sample selection induced by plant closure and include dummy variables for market segments.[28]

If the coefficient on the 1929 size variable were near unity, Gibrat's law would be approximately true: the rate of growth (or contraction) in percentage terms would be unrelated to size.[29] We already know that Gibrat's law is false because small plants are much more likely to shut

[27] See, for example, Bronwyn H. Hall, "The Relation between Firm Size and Firm Growth in the U.S. Manufacturing Sector," *Journal of Industrial Economics*, 35 (June 1987), pp. 213–36.

[28] See Timothy F. Bresnahan and Daniel M. G. Raff, "Intra-Industry Heterogeneity and Composition Effects in the Supply Response to the Great Depression: The American Motor Vehicle Industry 1929–1935" (Hoover Institution Domestic Studies Program Working Paper, Oct. 1990), p. 15.

[29] For Gibrat's law, see Hall, "The Relation."

TABLE 5
COEFFICIENT OF $LN(SIZE_{1929})$ IN REGRESSION FOR $LN(SIZE_{193X})$

Size Definition	1931	1933	1935
WEM	0.945	0.969	0.979
	(0.046)	(0.043)	(0.043)
Revenue	0.920	0.980	1.010
	(0.038)	(0.058)	(0.044)
Vehicles	0.947	1.030	1.080
	(0.037)	(0.046)	(0.037)

down. The sample-selection regression asks whether there is a further failure of Gibrat's law among continuing plants.

Table 5 reports the coefficient of primary interest for each regression. It is clear that Gibrat's law is approximately true for continuing facilities whether we look at employment or output. The composition effects among continuing firms either do not exist or are very subtle.

CONCLUSION

The partial diffusion of mass-production technology and related organizational changes formed the initial conditions for motor vehicles competition in the Great Depression. Those firms whose plants and organizations embodied mass production had a competitive advantage. There were two separate routes by which this advantage could play out. Low-average-cost firms can survive bad times when less efficient ones fail. Second, low-marginal-cost firms can have high market shares among survivors, as competition assigns more output to the lower-cost firms. Only the first of these two routes was important for the motor vehicles industry in the Great Depression. But it was very important, as the downturn caused a major shakeout of the inefficient.

Evidence for the shakeout view is very solid. Half the plants, and more than half the firms, closed between the 1929 peak and the 1933 trough. The closures accounted for almost one-third of the decline in industry employment. Output per worker in the industry did not decline nearly so much as output per worker at a typical continuing plant from 1929 to 1933. Because the exiting plants were low in labor productivity and because their numbers were large in the aggregate, they account for this large composition effect. This was truly a shakeout; the following upturn was largely accomplished by expansions of existing plants and firms, not by replacement of former exiters.

In this investigation, 1929 size was the only indicator of mass production. This is clearly very crude. Elsewhere we discuss evidence for the technical heterogeneity view of the shakeout.[30] A group of

[30] Bresnahan and Raff, "Intra-Industry Heterogeneity," pp. 10–18.

census and extracensal variables, plausibly very closely linked to mass-production techniques and organization, is in fact quite effective in predicting plant closure.

But shutdown is the only clear size-related source of composition effects in these data. Table 5 showed that, conditional on survival, all plants tend to contract proportionately. Both large and small surviving facilities tended to employ about half as many wage earners at the trough as at the peak.

This article has proceeded with data-intensive rather than model-intensive techniques. It has nonetheless exposed thought-provoking patterns. The simple view of an aggregate demand shock striking a representative firm economy is too simple. The aggregate statistics disguise large composition effects. The Depression thus was, at the level of industries, an evolutionary event. Furthermore, markets seem to have adjusted by shutting down plants and firms but not by reallocating output across plants staying open. The balance between output adjustment at these extensive and intensive margins bears on the relevance of neo-Keynesian macroeconomic theories. Thus for several reasons the root causes of this behavior and the extent to which they characterize other industries deserve further investigation.