

WORKING PAPERS



**STRUCTURAL CHANGE AND PRODUCT DIFFERENTIATION
IN THE HEAVY-TRUCK MANUFACTURING INDUSTRY, 1947-1971**

David F. Lean

WORKING PAPER NO. 4

March 1977

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**BUREAU OF ECONOMICS
FEDERAL TRADE COMMISSION
WASHINGTON, DC 20580**

Introduction

Economists generally associate producer goods' industries with negligible degrees of product differentiation. Such perceptions are derived partly from apparent physical homogeneities of goods, and partly from evidence of low advertising to sales ratios, an often used criterion of the degree of product differentiation. Because higher levels of product differentiation are generally associated with consumer goods' industries, the producer good-consumer good dichotomy has been used in some studies to help discern the influence of product differentiation on market structure and industry performance. (See for example, Mueller and Hamm [15]; Rhoades and Cleaver [18]; and Strickland and Weiss [23]).

Despite general presumptions, however, some producer goods' industries exhibit high degrees of product differentiation. 1/ Heavy-truck manufacturing is a case in point, and the substantial increase in concentration that has occurred in this industry over the post World War II period may be attributed partly to product differentiation forces. In this paper, the industry's structural change from 1947 to 1971 is analyzed. By so doing the sources and importance of product differentiation are examined along with other elements of structure.

1/ Weiss recognized that certain producer durables are differentiated. He notes, however, that classification of some industries is difficult because many producer durables are ". . . commonly produced to specifications which competing firms can meet equally well, and where strong loyalties are unlikely" [26, 73]. Accordingly, he considers only durable equipment items such as tractors, aircraft, and computing equipment to be highly differentiated producer goods.

Although generalizations from specific cases may be difficult to make, the study suggests that the concept of product differentiation in producer goods' industries may need closer scrutiny by economists. Clearly, the proxy measure, advertising to sales ratios, may be a suspect criterion. Low levels of advertising intensity in the heavy-truck manufacturing industry by no means reveal the full degree of product differentiation that exists, a feature that may well apply to other producer good industries.

Heavy Trucks and the Nature of Demand

Heavy trucks are single-unit vehicles and truck-tractor units used in on-highway haulage with gross vehicle weight (GVW) capacities over 19,500 pounds. ^{2/} For analytical purposes, the market may be further segmented into two submarkets: light-heavy vehicles, 19,501-26,000 pounds GVW, and heavy vehicles over 26,000 pounds GVW. The light-heavy

^{2/} GVW is the empty weight of the power unit, including fuel and lubricant plus the maximum gross chassis carrying capacity. Industry statistical sources recognize three separate vehicle weights within this classification: light-heavy, 19,501-26,000 pounds; medium-heavy, 26,001-33,000 pounds; and extra-heavy, over 33,000 pounds. These segments have been used for statistical reporting purposes for several years and the criteria on which they are based are not known. Efficiency-in-use considerations would clearly suggest placing a 55,000 pounds GVW capacity vehicle in a different market to that of a 23,000 pound GVW unit: the "heavy" vehicle might do the work of the "light" vehicle but at a much higher cost. Around cut-off points, the problem of economic substitutability becomes more acute, and one should be careful in treating these segments as purely defined economic markets. In this paper, data availability has constrained the analysis to these segments.

Excluded from consideration in this paper are the special-purpose vehicles (fire engines, sanitation and street cleaning equipment, snow fighters, and crane carriers, for example), and the off-highway dump trucks used in open-cut mines and quarries whose axle-load capacities exceed state highway-use limitations. In some cases, the chassis of special purpose vehicles are made in plants devoted to on-highway heavy-truck manufacture and production and sales figures may include these special purpose trucks. However, these vehicles constitute a relatively small segment of total truck output and their inclusion should not distort market shares seriously or significantly alter the conclusions of this study.

trucks are relatively more standardized in design and are used more for short-haul cartage than the heavier vehicles. The predominant power plant of light-heavy trucks is the gasoline engine, whereas the diesel engine, considered to be more economical than the gasoline engine over the long haul, predominates in trucks over 26,000 pounds. 3/

Optimal truck design varies according to vehicle use, and a considerable diversity exists among vehicles because heavy trucks move a wide variety of freight under different road and traffic conditions. 4/ Generally heavy-truck buyers are quite sophisticated in appraising the quality and performance of the different manufacturers' offerings and are highly motivated to purchase vehicles that achieve optimal operating efficiencies in use. Fleet buyers, who place orders for large blocks of vehicles at a time, even employ engineers to draw up model specifications and to consult with factory engineers about vehicle design.

Apart from diversity in design across end uses, the differentiability of products is quite high where similar vehicle use is contemplated, even where firms compete on orders drawn to individual buyer specifications. In addition, manufacturers differentiate themselves in other

3/ For depicting trends in the heavy truck market, the latter category is often used by trade statistical sources and publications, perhaps because the diesel engine--which might connote heavy truck--is the predominant power plant of vehicles in this group. In 1970, about 70 percent of these trucks were fitted with diesel engines, whereas only about 6 percent of the light-heavy trucks were equipped with diesels [1].

4/ This variation in vehicle design is observed in the number of models and options offered by the producers. In the mid-1960's, Ford advertised that it offered about 750 different heavy-truck models, whereas Mack offered 230 models, with many options and variations possible with these models. At Chevrolet, special fittings other than regular options were required for about 1 out of every 4 heavy trucks, a ratio that compares with 1:14 for medium weight trucks, and 1:150 for light-duty trucks.

ways, the more prominent of which for this industry lie in the availability of sales and service outlets, the provision of a full line of trucks and parts across the weight spectrum, the ability of firms to handle large numbers of trade-in vehicles associated with new orders, the provision of credit to help finance purchases, and media advertising, small as it is.

Structural Change, 1947-1971

From 1947 to 1971, the overall rate of growth of demand was impressive, despite the sharp declines experienced in each of the four recessions occurring in this period. Trucks are relatively expensive durable goods whose purchase is postponeable in times of recession, and sales tend to parallel movements in aggregate economic activity. Unit sales of all heavy trucks rose at an annual rate of 6.2 percent, increasing from 48,000 vehicles to 260,000 new vehicles annually. For trucks over 26,000 pounds GVW, demand grew even faster at an annual rate of 8.4 percent rising from 14,000 units to 136,000 units per year. ^{5/} Despite the rapid if erratic growth of demand, concentration increased substantially. ^{6/}

^{5/} Heavy truck volume is much smaller than trucks of lighter weights (1,400,000 vehicles in 1970) and automobiles (6,500,000 cars in 1970) [2].

^{6/} A number of economists have recognized the potential deconcentrating effects of rapid demand expansion see [3,210-211], [19, 108], [16, 248, 263]. Empirical analysis provides support for the hypothesis, but Shepherd argues that "the association is weak..." [22, 178], and notes also that "...in the face of large post-war changes and growth over two decades, oligopoly concentration has proven to be durable" [22, 118].

Over the post World War II period, the number of heavy-truck manufacturers dropped from 26 to 11. Concomitantly, four-firm concentration rose from the 60 percent to 80 percent level. 7/ Nine firms withdrew from the market entirely and seven firms were absorbed by larger rivals. White acquired Sterling, Autocar, Reo, and Diamond T, also forming an agreement to market Freightliner's trucks through White outlets. 8/ Mack acquired Brockway. Paccar (formerly Pacific Car and Foundry, Incorporated) acquired Kenworth and Peterbilt, both relatively small independents located on the west coast.

The large automotive producers were also active. Ford and Chrysler entered the market by extending their lines of automotive equipment to heavy trucks, and General Motors, already offering heavy trucks through its GMC Truck and Coach division, added a similar line through its Chevrolet division. Freightliner entered, marketing its trucks through White outlets. But Brown's effort lasted only five years from 1948 to 1953. At the end of the period then only 11 firms operated independently, 9/ and concentration had risen substantially.

As indicated in Table 1 in the case of light-heavy trucks, four-firm concentration rose from 76 percent to almost 100 percent from 1947 to 1970. The most striking feature of this change was the dramatic loss of share by the early leaders, White and Mack, with Mack actually ending

7/ This development was accentuated recently by Chrysler's decision to discontinue heavy-truck production, and by Diamond-Reo's fall into bankruptcy after being spun-off by White.

8/ Sterling was eventually dissolved by White. Reo and Diamond T were integrated together at the Reo plant in Lansing, Michigan, but were finally discarded by White in 1975.

9/ The remaining firms were International Harvester, General Motors, Ford, Chrysler, Paccar, White, Mack (controlled by Signal Companies), Marmon (controlled by Space Corporation), FWD (controlled by Wisconsin Investments), and Diamond Reo Truck, Inc.

TABLE 1.--Market Shares: Light-Heavy Trucks, 19,501-26,000 Pounds GVW

	1947 (%)	1952 (%)	1958 (%)	1964 (%)	1970 (%)
International Harvester	20.4	24.1	33.1	39.0	32.2
General Motors	6.0 ^a	13.1 ^a	19.2 ^a	24.3 ^b	24.2 ^b
Ford	c	22.0	32.3	27.9	34.5
Chrysler	5.8	2.4	6.7	6.5	8.5
Mack	17.9	6.4	3.2 ^d	0.3 ^d	c
Brockway	8.4	0.5	e	e	c
White	29.4	19.3 ^f	5.0 ^g	1.8 ^g	0.3 ^g
Sterling	0.2	h	i	i	i
Reo	3.7	5.4	h	h	h
Diamond T	1.3	3.9	h	h	h
FWD	2.4	0.9	0.1	j	k
Federal	3.4	1.0	i	i	i
Oshkosh	0.1	k	k	k	k
Studebaker	c	c	c	0.1	c
Ward La France	0.2	k	k	k	k
Miscellaneous	0.9	0.8	0.3	j	0.2
Total	100.0	100.0	100.0	100.0	100.0
Four-Firm Concentration	76.0	78.6	91.3	97.7	99.4
Eight-Firm Concentration	94.9	96.8	100.0	99.9	100.0

Notes:

- a. GMC model only.
- b. GMC and Chevrolet, which entered 1960
- c. Not in market.
- d. Includes Brockway
- e. Included in Mack.
- f. Includes Sterling
- g. Includes Reo, Diamond T.
- h. Included in White
- i. Model line discontinued
- j. Less than 0.05 percent
- k. Included in miscellaneous

Source: Calculated from "Factory Sales by GVW" Automotive News Almanac, Annual Issues.

production of this line in 1952. By contrast, Ford had attained 22 percent of this segment in 1948 only four years after entering, and by 1970 led the field with a 43.5 percent share. By contrast, four-firm concentration associated with even heavier vehicles behaved somewhat differently, rising substantially from 62.8 percent in 1947 to 86.3 percent in 1958, then declining to 74.1 percent by 1970, as shown in Table 2. Eight-firm concentration, however, climbed steadily in this segment. Major gains were made by Ford, General Motors, and Paccar (which controlled Kenworth and Peterbilt), cutting heavily into the shares held by International Harvester, White, and Mack.

Not surprisingly, the trend to higher concentration was accompanied by a considerable instability of firm shares. ^{10/} Also, as expected, market shares became more stable toward the end of the period as mergers and the entry and exit of firms abated. ^{11/} As the industry structure

^{10/} Weiss [25, 737] has argued that high market share instability is often associated with rising concentration.

^{11/} Using as a measure of instability the coefficient of variation associated with each firm's market share, higher instability values were found for the whole period, 1947-1970, than were found for the later years, 1960-1970, alone. The coefficient of variation is the standard deviation divided by the mean market share. Values may range from zero to infinity and cut-off points between high and low market share instability are arbitrary. For heavy trucks over 26,000 pounds GVW, values for each firm ranged from 21.6 to 60.1 percent from 1947-70. These figures are much higher than those calculated by Jacoby [7] for five different industries from 1930-48. Jacoby's industries were live-stock slaughter, passenger cars, cigarettes, steel, and motor fuel.

TABLE 2.--Market Shares: Heavy Trucks over 26,000 Pounds GVW

	1947 (%)	1952 (%)	1958 (%)	1964 (%)	1970 (%)
International Harvester	17.8	20.3	28.2	31.3	25.0
General Motors	9.1 ^a	21.3 ^a	8.2 ^a	10.8 ^b	15.8 ^b
Ford	c	c	6.9	12.8	15.9
Mack	13.6	20.4	23.5 ^d	15.9 ^d	15.5 ^d
Brockway	5.8	6.6	e	e	e
White	7.3	11.0	26.4 ^g	20.6 ^g	17.3 ^g
Sterling	2.7	h	i	i	i
Autocar	22.3	7.1	h	h	h
Reo	4.0	0.4	h	h	h
Diamond-T	2.7	1.9	h	h	h
Paccar	2.5 ^j	3.1 ^j	2.4 ^k	5.1 ^k	7.0 ^k
Peterbilt	1.0	1.1	l	l	l
Chrysler	m	2.7	2.2	1.9	2.3
Federal	3.1	1.4	n	n	n
FWD	1.8	0.2	0.6	0.6	0.7
Oshkosh	1.2	p	p	p	p
Ward La France	2.3	q	q	q	q
Miscellaneous	2.9	2.4	1.3	0.9	0.6
Total	100.0	100.0	100.0	100.0	100.0
Four-Firm Concentration	62.8	72.9	86.3	81.6	74.0
Eight-Firm Concentration	82.9	92.5	98.4	99.9	99.5

Notes:

- a. GMC only.
- b. GMC and Chevrolet, which entered in 1960.
- c. Not in Market, Entered 1953.
- d. Includes Brockway, which was acquired in 1956.
- e. Included in Mack.
- f. Includes Sterling.
- g. Includes Autocar, Reo, Diamond T.
- h. Included in White.
- i. Model discontinued.
- j. Kenworth model only
- k. Kenworth and Peterbilt, which was acquired in 1958.
- l. Included in Paccar
- m. Not in market. Entered 1949.
- n. Model discontinued.
- p. Included in Miscellaneous.
- q. Included in Miscellaneous. Technically not in market.

Source: Calculated from "Factory Sales by GVW" Automotive News Almanac, Annual Issues.

became more stable and evolved toward higher concentration levels, the potential for a deterioration in competition became more real. Consequently, in the mid 1960's the government deterred some mergers involving heavy-truck producers. 12/

Economies of Scale in Production

To what extent is the rise in concentration explained by economies of scale in production? Generally, scale economies tend to be manifested in the greater specialization of labor and the continuous use of specialized equipment that is less costly per unit of capacity, since it is designed for a large volume. In the case of heavy trucks, small U.S. plants were characterized in the past by station-to-station processes. Vehicles were manhandled to new fitting points by means of overhead pulleys and chains. For small volumes, these techniques are probably quite efficient, and are still utilized today in small plants where vehicle specifications are highly diverse. The growth of demand, however, provided greater opportunities for the standardization of vehicles on the line and large volume plants. Hence, the moving assembly line became a more efficient production process up to a point.

12/ In 1964, proposed mergers between White Motor Company and Cummins Engine Company, and between Chrysler Corporation and Mack Trucks, Incorporated (now a subsidiary of Signal Companies) [29, and 30] were abandoned after opposition from the U.S. Justice Department's Antitrust Division. Later, in 1970 the Justice Department prevented White Consolidated Industries from acquiring White Motor. The merger was resurrected recently, however, following a deterioration of White's financial condition, and this time the Justice Department approved the merger.

In general, the more standardized vehicle specifications are, the more standardized production procedures can be. Also, the larger the total output is, the larger the volume of similar trucks on the line can be, a feature that is accentuated if firms are more successful in capturing the big orders. But in heavy-truck manufacturing the size of the average order is small, even for a large-volume producer, and compared with automobile and light-truck (pick-up truck) production, the cost advantages of large-volume plants tend to be minimized. ^{13/} That vehicle standardization is important to efficiency where moving assembly processes are used, is seen in the fact that large-volume producers remove from the line vehicles requiring highly specialized construction that would consume large amounts of "line-time". These trucks are then fitted at special staging points rather than have them slow down the line.

The degree of uniqueness in vehicle design tends to increase with increases in the GVW capacity of a vehicle. Light-heavy trucks tend to be more standardized than heavier vehicles, making mass production techniques more applicable to them than the more customized heavy-duty trucks. Firms familiar with the problems of large-volume automobile and pick-up truck construction, such as General Motors, Ford, Chrysler, and International Harvester, may have been able to attain efficient production

^{13/} In 1966, Mack's average order was for 2.3 vehicles. Diamond T, on the other hand, catered primarily to the one truck buyer.

in the light-heavy sub-market more easily than the smaller independents. Penetration of the light-heavy market by these firms may also have been facilitated by brand allegiances less strong than those found in the market for heavy-duty vehicles. 14/

Rhys [20], with respect to the industry experience in Great Britain, attributes the successful entry of the "mass producers" to the cautious policies of the specialized producers. He argued that firms in the latter group feared overcapacity for any length of time and failed to interpret excess demand and full-order books as indicative of long term growth. Thus, the way was clear for the "mass producers" to move into the market. This argument suggests that small-firm management was not as astute as that of their larger rivals. Possibly all the above reasons help explain what happened in the U.S. market. Nevertheless, it is difficult to understand why established firms such as Mack and White retreated from the new competition in the light-heavy truck market so readily.

While the diversity of trucks on the line limits the extent to which optimal efficiencies are captured in large-volume production, other factors also mitigate against cost advantages to large scale. In

14/ In interviews, manufacturers' representatives attested to the existence of strong brand loyalties of customers to certain vehicles, citing the penchant of west-coast buyers to purchase heavy trucks made by small west-coast firms such as Peterbilt, Kenworth, and Freightliner. One reason for this behavior was that buyers felt west-coast firms could produce superior vehicles for west-coast conditions. Also, in this context, a "Cadillac" syndrome was alleged to exist. For heavy trucks, where factors such as price and quality might be presumed to dominate in the purchasing decision, status and prestige associated with the ownership of a particular vehicle seemed to be present and important among one-truck buyers.

the case of dies, a large heavy-truck producer may not have a cost advantage in spreading die costs over a bigger volume. A volume producer will use a high-quality expensive die and make a large number of stampings. With less volume, a small firm will use dies made from cheaper materials which provide a small number of stampings, and which cost less to buy. Furthermore, a small firm may get equivalent economic use out of its dies because of the absence of an annual styling race. 15/

Where cost advantages to large volume seem more apparent is in the production or purchase of components. Firms large and small produce some components and buy some, and the bigger the truck manufacturer's volume is, the more the volume of components will be sufficient for economical production by the manufacturer. Thus, it is not surprising that the larger firms (for example, General Motors and Mack) are more integrated. 16/ On the other hand, when only a few components are needed, it is cheaper to obtain them from an independent supplier, and specialized producers of engines, axles, brakes, transmissions, and clutches can achieve the volume economies by serving a number of truck producers. However, it is not clear whether a truck manufacturer should make components or buy them even when large quantities are needed.

15/ On the average, a complete redesign of an entire vehicle takes place every seven to ten years. Within this period, components or cab designs may undergo only slight modifications.

16/ Mack is probably the most integrated of all heavy-truck producers for it makes its own gasoline and diesel engines, clutches, axles, 5-, 10-, 15-, and 20-speed transmissions, axle shafts, axle housings, and substantial number of other components; See [13, 29]. International Harvester makes all its sheet-metal requirements, gasoline and liquid petroleum gas (LPG) engines, 60 percent of its axle requirements, and its own heavy-truck diesel engine.

While dependability of supply may be gained by having control over their production, cost may be less when components are purchased in large quantities from outside suppliers. Parts are often bought on a sliding-scale price basis, one price per unit being paid for a block of 10, with a decreasing scale of prices for larger and larger blocks of 50, 100, and 1,000. So the larger manufacturers may have an advantage in buying components as well as in making them. 17/

The output of U.S. heavy-truck assembly plants in 1971 ranged from about 200 to 80,000 units, as shown in Table 3. Three general size categories may be identified: small, 200 to 5,000 vehicles; medium, 10,000 to 20,000 vehicles; and large, 40,000 to 80,000 vehicles. Unfortunately production cost data are not available for U.S. plants. The size groups are remarkably similar, however, to those found by Rhys [20, 238] for the British commercial vehicle industry. Rhys, with access to some cost data, found that the short-run average cost of making light-heavy vehicles in a small-scale plant was about 25 percent higher than

17/ With respect to the British heavy-commercial vehicle industry, Rhys [20, 232-239] confirms the notion that the small-volume assemblers that purchase most components from outside suppliers, incur higher unit costs than the large-volume manufacturer-assemblers that make a high proportion of vehicle components. The ability of the small firms to survive in Britain, he concludes, has rested on their ability to build "quality" vehicles which would command a premium price sufficient to cover costs, including profits. He notes that, "... specialist producers have found by experience that custom-building, customer loyalty, and so on, allows them to charge prices some 10 percent above those charged by larger firms before orders begin falling off"; see [20, 238].

TABLE 3.--Plant Size: Heavy-Truck Output in 1971

Firm	Plant Location	Output	Size
Mack	Hayward, California	200	Small
FWD	Clintonville, Wisconsin	1,038	
Autocar	Exton, Pennsylvania	1,665	
Brockway	Cortland, New Jersey	1,962	
Freightliner	Pomona, California	2,355	
Freightliner	Portland, Oregon	3,720	
Diamond-Reo	Lansing, Michigan	5,078	
White	Cleveland, Ohio	9,661	Medium
Mack	Allentown, Pennsylvania	17,102	
International Harvester	Fort Wayne, Indiana	46,515	Large
GMC-Chevrolet	Pontiac, Michigan	53,000*	
Ford	Louisville, Kentucky	82,913	

Source: Wards Automotive Yearbook, 1972, p. 96.

* GMC-Chevrolet data estimated from heavy-truck sales data in Automotive News Almanac, 1972.

the cost incurred in a large-scale plant. ^{18/} Because even heavier trucks are more diverse in construction than light-heavy trucks, the cost penalty for producing in small rather than large-volume may not be as great as that found in light-heavy truck construction. Whether these British data represent the U.S. experience is difficult to say. The magnitude of plant production cost differences may not be the same, but large-volume plants in the U.S. do seem to have a cost edge compared with smaller counterparts.

Thus, the evidence suggests that production scale economies emerged with the expansion of the market, and have had an influence on the structure of the market. These economies appeared to be substantial between small and large-scale operations, and of lesser magnitude between medium and large-scale production.

Economies of Scale in Distribution

Significant for understanding the rise in concentration in this industry, however, are the methods necessary to sell and service these machines on a nationwide basis. The sale of what is highly technical equipment puts a premium on direct contact selling rather than impersonal

^{18/} Furthermore, he found that small British firms could not retain customer loyalty at prices more than 10 percent above the large firms' prices, a feature that helped explain the exodus of small firms from the light-heavy commercial market in that country. Some of these existing firms tried to prevent failure by moving into even heavier weight classes. But these markets were small and customers were loyal to established brands. Consequently, many of these firms failed. In one respect, the post-war American experience was similar. The so-called independents moved away from light-heavy truck production, leaving the field to General Motors, Ford, and International Harvester. These independents were, however, already strong in the heavier vehicle markets, but their position in these markets has also been eroded significantly by the entry of Ford and General Motors' Chevrolet division.

media advertising. To this end, a network of factory owned or franchised dealerships appears to be quite important. In the case of large fleet orders the factory becomes involved in the marketing process. Most sales, however, are generated by the retail outlets and, as expected then, media advertising plays a relatively minor role in enhancing sales. Data are not available for all firms, but what little exists suggests that the advertising to sales ratio is less than one percent. ^{19/} This level is akin to that normally found in producer-goods' industries, and much lower than that found in differentiated-product consumer-goods' industries [3, 414-415].

The total market for heavy trucks is such that only a few firms can have the outlets necessary for successful distribution. Conversely, a large volume is needed to sustain the profitable operation of these outlets. If a firm's market share declines over a long period, some of its dealers will most likely fail or look to another manufacturer for vehicles, and, unless replaced, the firm will be even more hard-pressed to regain output. Historically, the difficulty of finding independent dealers with sufficient capital caused the heavy-truck manufacturers either to set up their own factory-owned and operated branches or to provide loans to private individuals which would be repaid out of

^{19/} In the late 1960's, Leading National Advertisers (LNA) data [10] on media advertising taken as a proportion of truck sales imply advertising to sales ratios of about 0.30 percent for both Mack and White. While the LNA data are incomplete and include only amounts attributable to business publications and outdoor advertising, the figures are probably reasonably accurate since virtually no broadcast media advertising is carried out by heavy-truck producers. Another source indicated that White's allocation of about \$4,000,000 for advertising (about 0.50 percent of sales) in 1971 was substantially below the industry average. But even if this figure were doubled, the advertising to sales ratio would reach only one percent, or about the same as that estimated by Bain [3, 414] for the farm-equipment industry.

dealer profits. ^{20/} Nevertheless, few heavy-truck producers have used factory branches as their major means of distribution. International Harvester, with 278 factory-owned outlets, has also retailed trucks of all sizes through approximately 2,700 franchised dealerships. Automobile-oriented companies have also employed passenger-car dealers, but these firms have shown a preference toward separate outlets for truck sales because more complex sales and service requirements exist for trucks than prevail for automobiles. In this regard, heavy trucks require more specialized attention than trucks of lighter weights. Ford entered the industry by signing up about 270 of its automobile dealers, but then added a few trucks-only centers, establishing five by 1965. From the figures given for the largest producers, it would seem that between 250 to 350 retail outlets have been necessary to assure adequate penetration of the nationwide heavy-truck market.

By comparison, the small manufacturers have sold heavy trucks through a small network of distribution facilities, ranging from 60 to 80 outlets, and have tended to concentrate their activities in regional areas. Reo and Diamond T sold most of their vehicles in the midwest, east, and northeast. Autocar and Brockway have been active primarily in the northeast, and Kenworth, Peterbilt, and Freightliner have traditionally focused their efforts on the area west of the Rocky Mountains.

^{20/} As early as 1932, Fraser and Doriot [6, 69] noted that "... suitable independent dealers have been difficult to find because, with a high-priced product and expensive parts, they are seldom in a position to carry adequate stocks for proper sales effort and service to users." Hence, one finds the White Motor Company, for example, gradually establishing factory branches; there were 7 in 1906, 10 when it introduced its first truck in 1910, 17 in 1914, 22 in 1917, 34 in 1920, 43 in 1921, 50 in 1923, and 54 in 1924, when it also had 500 independently-operated dealerships throughout the United States and Canada; see [17].

In what ways does large size convey advantages in distribution? In marketing heavy trucks, an important advantage to a large firm endowed with many outlets is the relative ease with which it can handle a large volume of used vehicles traded in on a large order for new vehicles. 21/ When the percentage of "trades" on large orders is high, a dealer or factory branch has difficulty finding a market for those used vehicles in its own local area. But large manufacturers alleviate this problem by helping retail outlets shift used trucks from "surplus" to "deficit" trade-in areas. Transportation costs may limit the extent to which used trucks can be shipped from one area of the country to another. Nevertheless, a firm with a nation-wide distribution network is more strategically placed and more physically equipped to capture large orders and to accept trades from fleet buyers than are firms with a small network of retail outlets. 22/

Large size in service facilities also conveys advantages. Ubiquitous manufacturer and dealer maintenance facilities are important to long-haul truckers, since vehicles may require parts and maintenance along the road. Even though owners of large fleets often service their own vehicles, maintenance centers located around the country also provide

21/ One firm cited an 80 percent trade-in ratio, and another company described an order for 300 vehicles involving 200 trade-ins.

22/ International Harvester employs its factory-owned branches in the following way. A sale can be made with a buyer's head office in New York, the new trucks can be delivered in another area (e.g. San Francisco), and the used trade-ins can be accepted at branch locations in yet other areas (e.g. Houston or Minneapolis).

services to these vehicles. 23/ For the nation, then, a large number of service centers must complement sales outlets, and in this respect the large producers offer substantial advantages over the smaller firms that have only a small number of regionally based sales outlets. GMC sells its heavy trucks through approximately 300 of its total of about 3,000 truck outlets. Its heavy trucks can obtain some measure of service at all three thousand centers. Similarly, Ford, which has about 300 heavy-truck dealers, also has about 5,600 car and light-truck outlets at which heavy trucks may obtain varying degrees of service. International Harvester trucks can be serviced at approximately 3,000 truck and farm-equipment locations through-out the country. White Motor Company has about 950 service outlets or "authorized service stations" which do not sell trucks, but which supplement the 247 factory and private sales outlets where service can be obtained, and White, in expanding the number of these stations from 110 in 1963 to 943 in 1968, has underlined the competitive importance of the service network. 24/

A full line of heavy trucks, and even more so, a full line of trucks of all sizes, also contributes to the success of a heavy-truck producer. 25/ Buyers of heavy trucks often use light trucks for short hauls, and the purchase of a light truck from a full-line producer may also bring a buyer's heavy-truck business. Truck owners, accustomed

23/ Census material supports the notion that the larger the fleet is, the greater is the propensity for vehicles to be owner-maintained [28, 39].

24/ Data on the number of these units were obtained from company Annual Reports, 1963 to 1968.

25/ Production of a full line is similarly important in automobiles and major household appliances; see [14, 274-325], [5]. See also Scherer [21, 91].

to a full-line producer's vehicles, may become a more difficult market for the non full-line firm to penetrate. 26/ The full-line producers were International Harvester, General Motors, Ford, and Chrysler in the study period.

Heavy trucks are often purchased on credit obtained from financial institutions or the manufacturer itself. Extending credit is a sales device which led producers to set up finance subsidiaries for this purpose, and the proportion of sales financed through them is relatively high; for instance, Mack Financial Corporation provides credit for approximately 33 percent of all Mack Trucks sold [13, 31]. In supplying credit, a volume producer is able to make its dealers more aggressive in seeking sales by assuming some of the dealer's risk, and a large firm has more resources to accommodate risk factors than a small firm. Thus, size gives a large firm marketing advantages in the extension of credit. 27/

Advantages to large size in producing and marketing heavy trucks also impose substantial capital requirements upon existing firms and

26/ The management of General Motor's GMC division felt that the introduction of a light multi-stop delivery truck helped sales of heavy trucks by broadening the product line, thus keeping light-truck buyers as well as heavy-truck customers. White also extended its line by entering the lighter truck market with a vehicle called the Trend; see [27, 64].

27/ Chrysler's Dodge Division had a limited-loss Multiple-User Finance Plan under which the dealer's risk on sales of trucks over 10,000 pounds GVW to buyers of more than one truck is reduced. "A dealer sells a truck and submits the deal to Dodge and a participating financial institution. The financial institution checks the credit. In addition, Dodge checks the specifications to make sure the truck will do the job it is being sold to do If the deal is approved, the dealer's maximum loss is limited to 10 percent of the total amount of the original retail contact." See [9, 30].

potential entrants. For example, Ford's heavy truck plant in Louisville, Kentucky, which provided employment for about 4000 employees, and which produced about 40 trucks daily on a two-shift operation in 1969, cost \$90 million, exclusive of a \$23 million parts inventory [8,8]. To illustrate further, Mack, in the early 1960's, had capital needs that included \$98 million for inventories [4], \$45 million for a new plant to make engines, transmissions, axles, and other components, and \$17 million for unexpected costs incurred in start-up operations [13]. The prospect of entry is diminished by these requirements, if only because untried firms would probably pay a premium to obtain the necessary funds. 28/ It is not surprising then that entry in the post-war period has come mostly from the large automotive producers with an established reputation in the production of automotive equipment and of a size sufficient to generate or attract the needed capital.

Given what seem to be clear advantages to large-volume producers, what explains the relative success and tenure of Peterbilt, Kenworth and Freightliner trucks? The basis for this prosperity appears to lie in what Scherer describes as sequential entry sustained by product differentiation. He notes:

...a company finds an isolated geographic area or a set of demands for special qualitative product features which has not been served adequately by existing producers, carving out a snug little niche in which operation is profitable. From this base of operations it is possible, with luck, gradually to expand into other geographic areas or to a broader product line. [21, 230].

28/ On this point, a study of the mergers involving the small independent heavy-truck producers, reveals that small firms were acquired in periods of financial weakness, needing but unable to raise capital to rejuvenate old or to construct new plants. In addition to a size problem, some of these firms seemed plagued by managerial problems brought in one case by the death of the company's founder.

The above three firms appear to be a perfect example of this phenomenon. Operations have been largely restricted to limited geographical areas, and a high quality image appears to have been preserved. In some cases a snob effect appears to have been operative, and larger competitors have attested to the difficulty in breaking established customer loyalties for these products. Product differentiation forces have then permitted a few small firms to survive, although, by and large, most small firms have found life too tenuous to survive independently on this basis.

Conclusion

Heavy-truck manufacturing provides a useful example of a highly differentiated producer-good industry, in which concentration has risen sharply since World War II. While economies of scale in production help to explain this increase in concentration, the more significant explanators appear to lie in product differentiation advantages and economies inherent in large-volume distribution. In this respect, such features as the accessibility of sales and service outlets, the ability of firms to handle large numbers of trade-in vehicles, the offer of a full line of trucks across the weight spectrum, and the provision of credit, for example, are important elements of differentiation that offer concomitant economies to larger producers.

By studying this industry much has been learned about the complex and multidimensional nature and influence, of product differentiation. In examining structural change, both large and small-volume producers appear to have prospered from successful yet possibly different bases of product differentiation. This study suggests then that additional research on the nature and effect of product differentiation in producer goods' industries may well be warranted and may shed new insight into our understanding of the forces affecting the organization of these industries.

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