particular shape of the cubic function, i.e., the costs associated with high and low outputs, were likely to be inadequately rectified for price and quality changes, the bias being in the direction that would create a cubic total cost function.

The four observations lying above the fitted line at the highest output levels were in December 1936, and March, April, and May, 1937 (Chart 11). Thus they occurred at a cyclical peak, when defects in rectification would be expected to overstate deflated cost. The six observations lying below the fitted line at the lowest recorded outputs were depression months—January to June 1938—a period in which the rectification devices may not have accounted adequately for price and quality fluctuations.

The negative intercept of the total cost curve, and the consequent illogical behavior of the average cost curve within the range of observations, cast some further doubt on the validity of the cubic function. Moreover, as pointed out in Section 1 and discussed in Section 2, there are indications that the technical structure of the production process does not correspond to that assumed in the cubic model.

In view of all these considerations, the curvature within the observed range does not seem to substantiate decisively the hypothesis that the total cost function is curvilinear.

8 Conclusions

The statistical evidence presented in Section 7 gives some support to the conclusion that marginal cost is constant within the range of output examined in this study. The findings of such an investigation as this that are most significant for economic theory can be presented adequately by considering solely the behavior of marginal cost; for, if the course of the marginal cost function is known, the shape of the total cost function is apparent. (Supplementary information is needed to determine the magnitude of fixed cost and the behavior of average cost.) Some caution must be observed, however, in comparing the marginal cost function of a model firm under static competitive conditions with marginal cost function derived by statistical methods from empirical data. The observations that are the basis of the statistical estimate may not have been adequately purged of the influence of extraneous variables by the sampling, rectification, and correlation analysis procedures. To the extent that dynamic factors are present in the cost and output observations the empirical curves will not be a precise counterpart of the curves described in theory. It appears likely, however, that the most important dynamic influences were eliminated in the data adjustments.

On the assumption that our statistical techniques have successfully isolated the static marginal cost curve, it is desirable to attempt to ac-

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count for the particular results observed. The explanations will be considered under the following headings: (1) possibility of excess capacity; (2) segmentized organization of plant; (3) conventional rigidities.

Possibility of excess capacity

The most obvious explanation for the constant marginal cost observed for the belt shop is that only one portion of the marginal cost curve was examined. A rising phase of marginal cost is, therefore, not disproved and, on the other hand, is almost certain to occur as physical plant capacity is approached. It is likely, however, that the major part of the possible variation of output was explored. The index of output ranged from 40 to 135, with four observations over 130. The largest output observed had not been exceeded during the preceding ten years of operation; plant managers expressed the opinion that this output represented 'practical' plant capacity. This may be interpreted to mean that somewhere beyond the range of observations marginal cost would rise markedly.

Since excess capacity of an economic sort is indicated, an exploration of its causes may lead to a better understanding of the implications of the findings. Were it possible to assume that the firm was in long-run equilibrium, so that its long-run average cost curve was tangent to a falling demand curve, the firm would be operating on the descending phase of its short-run average cost curve. In such a situation, visualized in theories of monopolistic competition, excess capacity could be ascribed to imperfections of competition. Such an assumption, however, would be highly unrealistic and unjustified by any available information concerning the firm. More valid explanations might be found in a shrinkage of demand subsequent to the time investment in fixed plant was made, or over-investment as a result of optimistic expectations. These causes, the first of which seems important, would be operative in a non-equilibrium situation. The shrinkage in demand evident in the firm's sales records is explained by the encroachment of chain drives and rubber belts on a field previously dominated by leather belting.[49] Despite the general secular decline in demand, some further reasons must be sought to explain why, in view of the large seasonal and cyclical shifts in demand, the plant was not forced to operate in the area of rising marginal cost. Two possible explanations may be mentioned. First, the possibility of anticipating peaks in sales and manufacturing for stock in times of slack demand may have made it unnecessary to force production beyond the critical level. This is especially true of leather belting manufacture

[49] Demand for leather belting has declined since about 1923 in a secular movement transcending the business cycle, the peak of 1929 being lower than that of 1923, and the peak of 1937 much lower than that of 1929.

since sales peaks can be forecast and the product can easily be stored.[50] Second, the declining trend of industry demand may have shifted the firm's individual demand function to the point where sales fell so far short of original expectations that even seasonal and cyclical peaks do not strain the plant's capacity.

Segmentized organization of plant

Constancy of short-run marginal cost is, as pointed out in Section 1, consonant with the technical organization of this plant and of similar mechanized operations. Segmentation of this plant into a number of similar operating units, each of which can be withdrawn from operation without influencing the efficiency of the others, tends to result in constant marginal cost up to the point where all units are fully utilized. Variation in the time these units are operated, attained either by changing the number of shifts or the length of the work week, will accomplish the same end.[51] Two further questions are whether all the fixed plant and equipment can be segmented and whether the essential labor force is homogeneous. Concerning the first, it is likely, in practice, that segmentation of certain parts of a fixed plant is not possible, while a high degree of segmentation is feasible for other parts. If machinery and operating equipment are segmented, even though the buildings, etc. remain indivisible, all physically fixed plant relevant for marginal cost behavior may be considered to be segmented. The second question, concerning the homogeneity of the factors of production can best be treated as a part of the question of conventional rigidities.

Conventional rigidities

If the management of this firm had been perfectly free to adapt the organization of production to variations in output by taking full advantage of the differences in efficiency in the segmented units, it is doubtful that the tendency to increasing marginal cost would be so completely offset as the statistical findings indicate. Although neither machines nor operators are of uniform efficiency, to select the units of the various factors with a view to employing them in the order of their efficiency was possible only within narrow limits. Seniority rights, repair programs, humanitarian and other considerations apparently deterred the management from taking full advantage of differences in efficiency. For these reasons, the hierarchy of efficiency that undoubtedly existed was not reflected in rising marginal cost with more intensive utilization of plant.

[50] The costs of storage, insurance, and interest on inventories of finished goods were not charged to current production since they are caused by uneven distribution of demand and are more properly attributable to cost of selling.

[51] Variation in the quality of labor inputs as a result of longer hours and night shifts lies outside the compass of static cost functions, although the effects of such influences are difficult to remove in empirical investigations.

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Restrictions of this kind therefore constitute a type of rigidity [52] that prevents the employer from selecting the minimum cost combination of factors for a given output.[53] As we know that conventional rigidities are present, we conclude that there is effective homogeneity of segments.

Thus the possibility of chronic under-utilization of plant, the existence of segmentation, conventional rigidities and therefore effective factor homogeneity further substantiate the findings of constant marginal cost. The implication of this study, an implication of interest to industrialists as well as to economists, is that constant marginal cost within the usual range of output may be more prevalent under modern operating conditions than has been implied by much economic theory.

[52] Apart from these conventional rigidities, evidence of technical rigidities was to be found in the behavior of one component of cost, overhead cost. A significant relation of overhead cost to magnitude and direction of change in output from the preceding month was observed, after the influence of output itself had been removed. It might have been expected that if output were unchanged for two successive periods, overhead cost would be less, because of the longer time allowed for adjustment, than if a given output followed either lower or higher outputs. As a matter of fact, increases in output were accompanied by lower overhead cost, while decreases in output were more costly (see Chart 7). One possible interpretation is that increases in output can be attained by temporarily overloading the staff, which results in a low cost per unit, while, when output is reduced it is difficult to adjust the personnel immediately. There are many indications that overhead cost reductions in the face of output contraction (especially when personnel changes are involved) occur less easily than cost increases when output is increased. The lack of evidence of rigidities in the behavior of combined cost can be attributed only to the relatively small importance of overhead cost in total combined cost.

[53] Although such conventional rigidities cannot be classed as dynamic forces, they may cause even greater deviations from the static model. For purposes of prediction, however, empirical cost curves possess some advantage over cost curves predicated upon the existence of a minimum cost complex of factors at every output because of their closer approximation to reality.