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THE GROWTH OF MANUFACTURES 1899 TO 1923

A STUDY OF INDEXES OF INCREASE IN
THE VOLUME OF MANUFACTURED PRODUCTS

BY
EDMUND E. DAY
AND
WOODLIEF THOMAS



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NOTE BY THE DIRECTOR OF THE CENSUS

This monograph was originally prepared in 1923 by Professor Day, then of Harvard University, now dean of the school of business administration, University of Michigan, to cover the period from 1899 to 1919, but owing to delays incidental to compilation of tables and preparation of text, the records of one of the newly instituted biennial censuses of manufactures (1921) were completely published and those for the census of 1923 were ready for publication before the monograph was ready for the printer. It was therefore considered advisable to revise the monograph to include later figures before final publication. In making the necessary revisions Professor Day was assisted by Woodlief Thomas, of the division of research and statistics of the Federal Reserve Board, which consented to allow him to devote a part of his time to this work.

The organization of the monograph and the main ideas presented were conceived by Professor Day and incorporated in the original draft, and in the revised draft the early chapters were rewritten by him. Mr. Thomas inserted necessary revisions in the later chapters of the monograph dealing with specific industries and geographic divisions, and assisted in compiling the index of production of manufactures for the years from 1914 to 1925 and in preparing the description of the index published in Appendix A. He also prepared Appendix C giving information for 1925.

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FOREWORD

There can be no doubt respecting the importance of the topic which Professor Day and Mr. Thomas discuss in this compact monograph. To most people census statistics have interest primarily or only because they furnish a measure of our national progress. Change and growth have been dominant characteristics of the economic life of the country. It is natural that numerical measures of growth should attract general attention. Here, very likely, is the basis of that peculiar interest in statistical facts which Europeans sometimes say they find in Americans.

The quantitative measure of population increase presents no especial difficulties. Each individual counts for one. The population census gives a direct and unequivocal measure of growth. This is not true, however, of the census of manufactures. The contrast takes on a touch of paradox when it is remembered that while the Constitution requires population to be counted periodically for the purpose of reapportioning Representatives in Congress the census of manufactures was instituted primarily in order that there might be a record of our industrial growth. In short, the present monograph is concerned with what appears to be the most important single question to which the census of manufactures might be expected to supply an answer.

The difficulty is not that the census of manufactures affords no answer or no measure of growth. On the contrary, it furnishes an embarrassing variety of measures. Which among them shall be used: Number of establishments? Capital invested? Gross value of output? Net value of output? Raw materials consumed? Physical quantity (not value) of product? Wage earners employed? Horse-power installed?

That changes in the number of manufacturing establishments have little significance for the purpose in hand is shown by the fact that in a number of rapidly growing industries the number of establishments has sometimes decreased, rather than increased, between one census and another. The amount of capital invested, even if it were known accurately, would bear an uncertain and variable relation to the general progress of manufacturing industry; and, in fact, the census statistics of capital invested are notoriously unreliable¹. In the total money value of manufacturing output there is much double counting of the products of different manufacturing industries, and there are important elements which must be attributed

¹ The Bureau of the Census has collected no data on capital invested in manufacturing industries since the census for 1919.

to agriculture, mining, and transportation rather than to manufacturing. Moreover, the gross money value of manufacturing output, like the net money value added by manufacturing, is affected and, one might say, distorted by general changes of the purchasing power of money.

Of the other possible measures suggested above, none runs in terms of money values. All of them—physical product, materials consumed, wage earners, and horsepower—are utilized by Professor Day and Mr. Thomas in one way or another. But the measure they seek, the one with which they would be contented if the figures for it were at all complete, is the volume of the output of the country's manufacturing establishments, measured not in money values but in tons, bushels, yards, etc. The measure upon which they center their attention is, in other words, the *physical product* of manufacturing industry.

Three separate considerations justify the choice of this particular measure. In the first place, it gives probably a more satisfactory and unequivocal answer than any other single measure does to the particular question that would best express the widespread general interest in the growth of our industries. Second, indexes of physical production have proved to be indispensable instruments in the scientific analysis of the processes of economic change. Third, other measures of manufacturing growth, whatever their value, are, one might say, given ready-made in the reports of the successive censuses of manufactures. Number of establishments, value added in manufacture, wage earners, and horsepower are stated in full. There are few stumbling blocks which need trip even the inexpert user of statistics. The figures for physical production, on the other hand, are incomplete, unsystematic, and, because they run in terms of heterogeneous units, are not additive. The inexpert user of statistics can do little or nothing with them. They have to be studied and manipulated with the utmost care if they are to be made to tell their story. This third consideration, alone, is sufficient to justify the authors in occupying themselves primarily with the measuring of the variations of physical production.

Any general index of physical production must of necessity lack precision. This is a consequence in part of lack of completeness and of other defects in the available data. In part, however, it is a consequence of the fact that the notion of just what an increase of physical product means is not and can not be precise. In the first place, as Professor Day and Mr. Thomas are careful to warn the reader, production, in the sense of fabrication, even within a given industry, is a matter of kind and of degree, of quality as well as quantity. Standardization of products, after all, has not gone very far, and there are substantial changes from year to year. In the

second place, even without changes in the nature of particular products, the aggregate manufacturing output changes qualitatively as well as quantitatively through changes in the *relative importance* of different products. By no system of weighting can the effects of these qualitative changes be taken fully into account. Rigidly speaking, the physical product of one year and the physical product of another year are incommensurable. In carefully constructed indexes, however, the margin of uncertainty due to changes in the proportionate importance of different products is generally very much less than the margin of error attributable to *deficiencies in the available data*. For practical purposes, and over periods of time not unduly long, the effect of these qualitative variations is taken care of by precautions such as the authors observe in the weighting of their indexes.

The difficulties which make a production index, at its best, a somewhat imperfect instrument are likewise encountered in constructing indexes of the movements of groups or aggregates of other types of variables, such, for example, as prices. Indexes do not express precise scientific concepts. They are merely useful practical tools. Essentially averages, their chief advantage is that they compress and summarize a complex mass of facts in such a way that "general" or "net" movements are brought into clear relief.

The "Harvard" index, which the authors revise and use as an important factor in their estimates, rests on census statistics of the physical product of manufactures, eked out by census statistics of materials consumed in manufactures. Census statistics of value added in the process of manufacture also figure in the index, but only as affording a basis for weighting the different series according to what is taken to be their relative importance as representative of general classes of manufactured products. Using money values in this manner, merely to determine relative or proportional weighting, does not inject a "dollar element" into the index.

In making some of their estimates the authors also draw upon the census figures for wage earners and for primary horsepower. Wage earners have, in general, increased less rapidly than product, while horsepower has increased more rapidly. That is, product per wage earner has increased, while product per unit of power has decreased. This illustrates and confirms an elementary economic principle, and is in accord with what is known about the general trend of our changing industrial organization. It is to be hoped that the authors' findings along these lines will prompt others to undertake further studies of the general relations of the use of labor and of mechanical energy to the output of different industries. The problem has fundamental economic importance, but up to the present no trustworthy studies have been made of it.

Using all the available census data, the authors construct some interesting indexes of the growth of a number of carefully classified groups of manufacturing industries. These indexes offer food for reflection. For example, over the whole period from 1899 to 1923, the percentage increase for the combined groups in physical production was 161, in number of wage earners 88, and in primary horsepower 230. Of the different groups, the following had grown by more than the average for all industries: Vehicles for land transportation, miscellaneous products, chemicals, nonferrous metals and their products, and iron and steel and their products. The rate of growth of the following groups was less than the average: Liquors and beverages, lumber and its remanufactures, leather and leather products, textiles and textile products, food products, stone, clay, and glass products, and tobacco manufactures. The general character of the change is clearly apparent. Industry as a whole is depending relatively less upon our farms and forests for its raw materials, and more upon our mines. Food products constitute an exception. The demand for food products is relatively inelastic, and manufacturing plays an increasing part in preparing them. As the authors suggest, "the factory is displacing in part the work of the housewife." In respect of the marked increase of miscellaneous manufactures, the authors note that "the lines of manufacture which have shown the most rapid rates of growth have been lines concerned with the production of goods primarily devoted to recreation and diversion of one kind and another." We depend more and more upon organized industry not only for our food but also for the devices with which we while away our leisure.

The period which this study covers happens to be one of unusual interest. By 1899 industry had pretty completely shaken off the long-continued depression which followed the crisis of 1893. Its further progress up to and through the war was persistently upward, even though halted from time to time by major or minor periods of depression. For the period as a whole, the authors find, the average annual rate of increase of the output of the manufacturing establishments of the United States was just under 4 per cent.

During the 24 years covered by this study, in the authors' opinion, the growth of manufactures was more than three times as great, relatively, as the increase of population. The increasing output of producers' goods accounted for a substantial part of this extraordinary growth. "But upon the whole," the authors find, "the evidence seems to justify the conclusion that the increase in the production of consumers' goods from 1899 to 1923 was considerably in excess of the growth of population during the same period."

The authors conclude with suggestions respecting possible developments in census methods and practice that would give more complete

and more accurate knowledge of the character of our general industrial growth. Studies such as theirs, which focus upon a definite problem such information as the census now yields, have a critical as well as a constructive value. The more precise and definite the questions to which we seek answers in the information given by the census, the more of point and purpose we shall put into the census itself. The surest way to get better statistics is to make the best possible use of what we have.

ALLYN A. YOUNG.