

ORIGINAL CHARACTERISTICS
AND CONSEQUENCES
OF THE INDUSTRIAL REVOLUTION¹

In the final analysis it is evident that two economic events have influenced the life of humanity more strongly than any other phenomena, especially if we consider their global consequences.

The first was the neolithic revolution, which marked the passage from a human society based on berry and fruit picking and hunting—implying very low population densities—to a society based on agriculture and cattle raising, which permitted higher population densities.

The second was the industrial revolution, which freed societies almost completely from agricultural contingencies.

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Although the rapid progress being made in archaeology may still uncover some surprises, it is possible to date approximately the phases of the neolithic revolution—or, if we prefer, the first agricultural revolution since this is, after all, what we are concerned with—as follows. Its initial phase took place about 7,500 B.C. to 7,000 B.C., in the Middle East. From there it spread progressively to Asia Minor, North Africa and Europe, penetrating the European continent gradually from south to north from 4,500 B.C. to 2,000 B.C.

Two other centers have been established; one in China in about the year 5,000 B.C. and the other in Central America around 4,000 B.C. The question has been raised as to whether these were autonomous centers or, on the contrary, extensions of the original (and more ancient) Near-Eastern nidus. This second hypothesis is quite conceivable for Central Asia, but very problematic for America.

The neolithic revolution for the first time permitted a durable surplus of food produced by agricultural processes and thus made possible a significant consumption of products that were not strictly alimentary. This situation in turn brought about the beginning of specialization of labor and the creation of an urban community of non-agricultural producers: an urban life that favored the intellectual and technical development out of which the civilizations of antiquity were born.

This agricultural surplus, however, remained very small, even after the progress achieved successively by ancient and Western civilizations. On the eve of the industrial revolution, that is, at the end of the 18th century, in the most developed societies between 75% and 80% of the economically active population was still engaged in agriculture; and the average consumption of food products was not only quite low in terms of calories but was almost exclusively composed of calories of vegetable origin. The consumption of transformed calories (meat, milk), was very low, being costly (about eight vegetable calories were required to produce one animal calorie).

To put it in simpler terms, this meant that the average production of a person engaged in agriculture provided a quantity of foodstuffs that was only 15% to 25% higher than the consumption of its family unit. These percentages—this surplus of 15%

to 25%—acquires full significance if we take into account a factor frequently ignored in diagrams explaining development, that is, the fluctuations in the output of agricultural production. These on the average go beyond 25%. Hence periodic crises in subsistence necessarily occur, crises that are more or less profound and that, if serious, may cause the decline of economic life and hence of the civilization that it supports. This is the reason why as long as agricultural productivity did not surpass this level, it was materially impossible to conceive of a continuous progress in the development of civilizations.

The originality—in the true sense of the term—of the industrial revolution lies precisely in this possibility. The use of the word “revolution” in the term industrial revolution has frequently been opposed; but the word “industrial” is even more debatable, since the industrial revolution was, in fact, first and foremost an agricultural revolution which gave impetus to industrial development. As a result of the agricultural revolution—in the course of two centuries—the number of the active population needed for the production of foodstuffs in a traditional economy was reduced from 80% to the present 5%, as for example in the United States, which even with this low proportion of its labor force engaged in agriculture can still export a quantity of cereals equal to the average production of an underdeveloped country of 150 million inhabitants.

In fact, the industrial revolution was ushered in by an agricultural revolution, of which it is a direct consequence. Through a series of interactions—which we will not describe in detail here—the increase of agricultural productivity made possible and gave an impetus to the development of industry, which in turn favored agriculture by supplying more productive equipment and through an increase in the demand for agricultural goods.²

The growth of agricultural productivity has led, over a span of 40 to 60 years, to an increase in the average surplus from 20% to over 50%, thus for the first time in the history of humanity passing over what could be called the threshold beyond

² For a discussion of these mechanisms and interactions we refer to our study *Révolution Industrielle et Sous-Développement*, S.E.D.E.S., Paris, 1963 (2nd edition, Paris, 1964), and in particular to Part II, “Les mécanismes économiques du développement” (pp. 71-137).

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which there is no risk of famine. In other words, an exceptionally poor harvest no longer involves, as before, severe shortages and the danger of famine.

The most arresting original aspect of the industrial revolution is this very pronounced increase in agricultural productivity, which has liberated society from highly restrictive bonds. But there are other characteristics that are original, such as the important consequences that it has entailed, not only in the countries in which it occurred, but also and primarily in territories not directly touched by it. The upheavals it has caused in these territories have had an almost exclusively negative effect on their societies.

We will consider these consequences by examining successively those brought about in the countries directly touched by the industrial revolution and those that have arisen in the countries in which it has not yet taken place.

A. CONSEQUENCES OF THE INDUSTRIAL REVOLUTION IN THE COUNTRIES WHERE IT HAS OCCURRED

Since the consequences of the industrial revolution in modern industrialized countries are known, they interest us here only indirectly. We will therefore limit ourselves to dealing briefly with certain factors that have been disregarded and to gauging exactly the extent of these consequences.

First of all is the unprecedented extent of the quantitative progress made possible by this revolution. We have already touched on the progress realized in the field of agriculture; by taking a schematic approach, we have shown that the neolithic revolution made possible the passage from an economy without a food surplus to a society in which food production occupied not more than 75% to 80% of the active population. The slow progress made in this field, from 7,000 B.C. to the beginning of the 18th century, is indicated by the very low reduction, in the order of a few percents, in the proportion of the economically active population engaged in agriculture. By contrast, the industrial revolution made possible, in less than two centuries, a reduction in the proportion of agricultural labor force in the order of 15 to 1, while it increased the consumption per inhabitant in the

order of 1 to 2. This progress continues, and it is not implausible to foresee that at the end of this century the farmers in the United States will represent no more than 2% to 3% of the active population.

In the field of industry the progress is even more important. The per capita consumption of iron was about 1-2 kilograms a year in pre-industrial societies; at present it has reached the level of 500 kilograms in developed societies, and this increase in production is accompanied by an even more marked increase in productivity in this sector. Thus, if we take the Belgian situation as the basis of our calculation, we find that one worker produced about 1-2 tons of iron a year before the industrial revolution; by 1845 this figure was 60 tons and it rose to 1,550 tons in 1964.

In the field of transport the progress has been even more considerable than is generally supposed. Thus, we have estimated the number of horse-drawn carts which would be required under the conditions prevailing in the 18th century to transport the volume of land traffic of France in 1964 to be about 60 million. And this calculation takes into account only land transport by rail or truck with a payload of over one ton, excluding vehicles of a capacity of less than one ton. It may be estimated that today these activities employ approximately 500,000 persons (in 1962 about 650,000 persons were engaged in land transport, but this comprises transporters using trucks with a capacity of one ton and less). The comparison of these two figures gives us a gross measure of the increase in productivity in this sector, which is then in the order of 1 to 120.

Examples showing an enormous expansion of material production and of productivity abound. This growth, moreover, surprised a good number of statisticians and economists, at the beginning of the industrial revolution as well as more recently. In 1835 the English economist and statistician Porter wrote that it was materially impossible for a great country to depend regularly on foreign agricultural production in order to cover its food requirements, since the means of transportation could not absorb the traffic. Thirty years later, however, such was, in fact, the case in England.

More recently, after the great depression of 1930, a number of theories were advanced on economic maturity and stagnation.

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These have continued to command fairly wide attention even after the war, when they became even more widely known in Europe. While we cannot for the future completely disregard the idea of a logistic curve of progress, it should be pointed out that we have not yet in 1966 reached the point of the curve that Hansen and Higgins or even Keynes believed was foreseeable in 1930. In fact, the rates of increase in the last twenty years since the end of World War II have been more important than those registered during any preceding period of mean duration, for one of the erroneous, fixed ideas about the 19th century is that the growth was more rapid than at present.

But aside from these material consequences, we must emphasize the progress in the sciences and medicine, which has abetted the industrial revolution by making available a great mass of research as well as by broadening the basis of education. The progress in medicine has made possible a great reduction in infant as well as general mortality rates, which have been cut down from 200‰ for the pre-industrial period (that is, more than 200 deaths under 1 year of age per 1,000 live births) to 15‰ for the developed countries, which are most advanced in this area.

In the developed countries the balance sheet of the industrial revolution is impressive and, in the final analysis, positive, despite the human cost of its first phases. By contrast, the balance sheet for the countries in the process of development is entirely different, and it is this aspect that we will now consider.

B. CONSEQUENCES OF THE INDUSTRIAL REVOLUTION IN NON-INDUSTRIALIZED COUNTRIES

As we have already noted, the originality of the industrial revolution lies mainly in the fact that it has had a profound influence—and up to now a negative one—on the majority of the countries not touched by it directly, countries that we call underdeveloped or in the process of development. It is evident that any modification in the general conditions of economic life of a society has more or less serious repercussions on neighboring societies. This has always been the case, and was so before the industrial revolution. But since the start of the industrial revolution we have been confronted with effects that are distinct from those manifest in

previous periods both in their characteristics and consequences. The effects of the industrial revolution on the countries not directly touched by it differ from those of the pre-industrial period in intensity, range, and rapidity of pace. Their intensity in fact is very great; since 1880 for example England has exported about four million tons of iron or iron products; this quantity is equivalent to 25 times that of the world's yearly production of iron before 1750. The extent of the consequences may be gauged by the huge geographical dispersion of the exports of the developed countries. Thus Belgian exports to India in 1890 represented an amount of about 10 million francs; to Uruguay, 1.3 million; to China, 8.5 million; to Chile, 8 million; to Brazil, 16 million; to Australia, 5.5 million; and to the Congo, 7.4 million, etc.

A few examples will illustrate the rapid extent of the effects. We have seen that the neolithic revolution took about 50 centuries to spread from the Middle East to Northern Europe. The technical inventions of the period separating the neolithic revolution from the industrial revolution also spread slowly and sporadically; we might recall that about 15 centuries were required for the invention of paper, originating in China, to reach Europe. It took two centuries for potatoes to be introduced from Spain into France. By comparison, with the advent of the industrial revolution, less than a century and a half was needed for its consequences to be felt in nearly the whole of the non-developed world. The first railroad was opened in England in 1825; in less than 20 years practically every European country had begun construction on a railroad network. And even more important is the fact that less than 30 years passed between the building of the first rail lines and their appearance in underdeveloped countries. Thus, by 1861 Turkey had built 109 kilometers of rail lines, Brazil, 223, Egypt, 347, and India, 1,396.

Early in this century it took only 15 years for automobiles to appear in significant number in the underdeveloped countries. And today as many underdeveloped as developed countries are among those that have ordered supersonic planes.

Having described—with the necessary schematization—the nature of the impact of the industrial revolution on the underdeveloped countries, we will go on to discuss its consequences.

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First of all there is the population explosion—the subject of much debate and rightly so. A consequence of the enormous advance in medicine in the developed countries, the population explosion is a unique phenomenon both in its duration and extent. For the first time in the history of humanity we are assisting an augmentation in the population not caused by an increase in available resources. And for the first time this growth has taken on the aspects of a genuine inflation. The rates of demographic growth in the underdeveloped countries have never been equalled for any human group over such a long period.

At present the rate of demographic growth for the whole of the underdeveloped countries may be estimated at 2.5%. In the countries touched by the industrial revolution and at a moment when their agricultural resources were increasing considerably, the demographic progression was about 0.7% yearly, and before its inception, about 0.3%. As we may see, the disparity is enormous and no longer constitutes a difference of degree but of kind.

We will not go into the fact that this demographic inflation postulates a level of investments, in order to maintain the level of income, that is not comparable to that which Western societies attained during their initial period of industrial growth. For more important still is the fact that this demographic inflation leads to a sizeable decrease in the surface of land cultivatable per worker. As a matter of fact, during the last half century the number of persons engaged in food agriculture in the underdeveloped countries has doubled. This evolution, together with a scarcity of arable land, has resulted in an accentuation of the old law of diminishing returns in agriculture in an aggravated fashion in the underdeveloped areas, especially in the Afro-Asian countries. And this is not idle speculation. We have calculated for the period 1909-1964 the indices of agricultural productivity of a great number of countries less industrialized, from which it emerges that the present agricultural productivity in the Afro-Asian countries is 20% less than that of half a century ago. We note, moreover, that the level of agricultural productivity in the Afro-Asian countries from the outset was already inferior to that of European agriculture before Europe experienced the industrial revolution. The agricultural revolution, which made

possible an increase in productivity of about 40%, permitted the transfer of a part of the agriculture labor force and buying power to the budding industry. And since the demographic progression was low, it resulted in an increase of the agricultural surface per worker—an increase in the area of holdings which is one of the essential conditions for an improvement in productivity.

But, as we have seen, far from increasing the agricultural surface per worker in the underdeveloped countries, the industrial revolution led to a considerable decrease and—what is more serious—a decrease that will continue in the next decades. This fact, together with the poor quality of the soil and climatic conditions, makes the prospect for amelioration in this essential area very limited; even if only because agriculture occupies about 75%-80% of the active population and because historically this sector has given the strongest impetus to getting the process of economic development underway.

A second series of direct consequences of the industrial revolution results more directly from the unprecedented extent of economic and technical development deriving from the industrial revolution in the developed countries.

International trade is an ancient phenomenon as the numerous fairs of the Middle Ages and the ancient Greek and Phoenician commerce illustrate. It existed even in pre-history; archaeology has uncovered the routes of commerce in tools (cut stones)—which could be called exports—over distances of several hundreds of kilometers.

But as a general rule this exchange involved only marginal products and represented only a very low proportion of economic activity with the exception of a very limited number of societies, such as the weavers of Flanders and the commercial cities of Italy. The costs of transport constituted an effective curb on commerce. The example that we have cited with regard to transport in France illustrates this aspect well.

Consequently, exchange was minimal, and this was true also for products of high specific value, since in this case the standard of living of the importing societies limited the consumption of luxury goods. Thus the United Kingdom—which now imports 260,000 tons of tea—imported only 42 tons in 1700, that is,

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7 grams per inhabitant as compared with the present 4,800 grams (these figures in both cases include temporary imports).

The considerable development in industrial productivity and the increase in the standard of living in the developed countries, along with a decrease in the costs of transport, have had the following notable consequences:

(1) The penetration of a large mass of consumers' industrial products into the developing countries;

(2) As a counterpart, this has encouraged and often compelled agricultural specialization in non-food products;

(3) An intense exploitation of mineral resources without the creation of a transformation industry in the area. Thus, the underdeveloped countries now produce 42% of the iron ore of the non-communist world but only 4% of the steel.

These phenomena have naturally had profound repercussions on the whole economic and social systems of the underdeveloped countries. We will confine ourselves to the economic aspects, which are nearly all negative. Thus, the arrival of industrial products—which are constantly being perfected at the same time that their prices decrease—has led to the disappearance of the local artisans, thereby destroying a most important link in the process of industrialization.

The exploitation of plantations has not only taken away an important fraction of the best lands from agriculture, but by the mode of exploitation, conducted for the profit of individuals or societies of industrial countries, it has led to the export of profits. At the same time the advantage offered by return freight has boosted the consumption of foreign products to the detriment of local production. Finally, as the techniques used on the plantations cannot very easily be adapted to food agriculture, the latter has not benefited from modern techniques.

The exploitation—and very frequently the milking of the mineral deposits, which is also the work of societies that are in the main not local—leads to the export of profits while rendering the local technical resources impotent.

Hence we are observing the global expansion of very restricted sectors of the economy, an expansion that benefits societies that are mainly non-local at the expense of the rest of

the economy, into which it also introduces factors inhibiting growth.³

It is moreover significant that the industrial revolution should have led to a profound modification in the forms of colonization. Certainly, the expansion of pre-industrial societies frequently led to the foundation of colonies, but it was a question then (as the etymological sense of the term indicates), of settling territories that were in general less densely populated than the motherland and that consequently were more easily developed.

This form of colonization was still followed at the beginning of the industrial revolution, notably with the European settlement of North and South America and of certain temperate climatic zones of Africa and Oceania. But, as soon as the progress in transportation was sufficiently important to permit a massive transfer of production, colonization of the pre-industrial type—based essentially on the emigration of economically active population—gradually gave way to industrial colonization—based on international trade deriving from the exploitation of the natural advantages of the colonized territories and of the industrial productivity of the developed countries.

While colonization of the pre-industrial type has generally had positive effects on the colonized territories, encouraging the spread of innovations in the broad sense of the term, the contrary was the case, as we have seen, for the underdeveloped countries; and in order to explain this difference, beside the factors discussed up to now, we must consider the rapidity of technical progress. In pre-industrial societies models of technical innovations were rare and expensive, and consequently they stimulated efforts to imitate them locally. This made possible the spread of progress. Today not only are these models numerous and inexpensive, thanks to extensive trade, but their development is extremely rapid. This has tended to reduce considerably the incentive to imitate locally. Furthermore, imitation has become increasingly difficult because of the complex nature of the products themselves—a complexity

³ For a more detailed account of these problems we refer to our study, *Révolution Industrielle et Sous-Développement*, S.E.D.E.S., Paris, 1963 (2nd edition, 1964), and particularly to Part III of this study, "Les obstacles économiques au démarrage des pays sous-développés" (pp. 138-199).

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brought about by the growing role that science has played since the beginning of this century.

In conclusion, we would like to point out that this difficulty in initiating economic and social development is all the more painful for the countries of the world, since their economic growth is no longer a matter of choice as it was for pre-industrial societies, but a necessity made imperative by the population explosion resulting from the application of advanced medicine, a by-product, in turn, of the industrial revolution.