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Fruit of the Boom: The Impact of the Industrial Revolution on Economic Growth

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> "…the power of population is indefinitely greater than the power in the earth to produce subsistence for man."
> —Thomas Malthus

Introduction

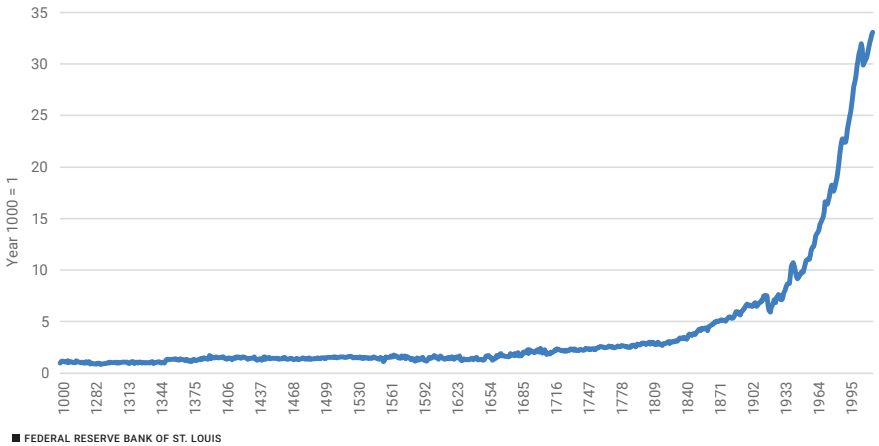
An economist, an inventor, and an entrepreneur walk into a town… While that sounds like the intro to a somewhat familiar joke, it is the beginning of one of the most important stories in history, which can teach valuable lessons about some basic economic concepts: the impact of **economic growth**, **marginal product of labor,** and **productivity** on workers and employers. Our tale begins in the United Kingdom about three centuries ago….

Economic Growth Throughout History

Historians and economists, including B. Ravikumar of the St. Louis Fed, will point out that for most of human history there has been no economic growth. One of the best and easiest ways to measure this is through **per capita gross domestic product (GDP)**: Per capita means per person, and GDP means the total market value of all final goods and services produced in an economy in a given year.

Figure 1 below shows real GDP per capita growth in the U.K. from 1000 to 1995. For close to 800 years there was no significant improvement in real GDP per capita, leading researchers to conclude that the standard of living for most citizens was stagnant for eight centuries. Starting in the eighteenth century, per capita GDP dramatically increased—doubling by 1900 and increasing another 10 times by the end of the millennium.

Figure 1: **Index of Real GDP per Capita in the U.K., 1000-1995**



SOURCE: Maddison Project Database, 2020 and authors' calculations.

Researchers commonly believe that technological advancement was responsible for this period's sudden shift in economic

growth. However, numerous technological advances, such as the plow and the printing press, had existed long before 1700 and likely did not contribute to this period of growth. So what changed?

The Economist: Thomas Malthus and Modern Economic Growth

Born in England, Thomas Malthus was a leading writer and thinker who developed a theory to describe his homeland's economy and how it changed during his lifetime. Malthus believed that before 1700 the British economy was stagnant, even with some technological advances, because of two elements—the type of production most workers did in England and the size of the national population.

Most workers in the U.K. before the eighteenth century were connected to agriculture; it was an agrarian economy. Technological advances were supposed to improve farmers' production overall, leading to economic growth and all the benefits that come with that—increased wages, better standard of living, and ultimately a larger population—but Malthus realized that wasn't the case. The problem wasn't a lack of technology or people's willingness to work hard—it was the type of work they did that kept England economically stagnant.

Malthus used the theory of marginal productivity, or the measure of how much one additional worker produces when they are added to the workforce. Think about one worker on one acre of land who produces one unit of agricultural output. If another worker were added to that same acre of land, the productivity would be *less* because each one has only one-half acre of land to produce goods. Table 1 below breaks down these figures.

Table 1: **Marginal Productivity Example in U.K. Agricultural Workers**

Number of workers	Acre / worker	Total output	Marginal productivity
1	1	1	
2	1 / 2	1.5	0.5
3	1 / 3	1.75	0.25

SOURCE: Authors' calculations.

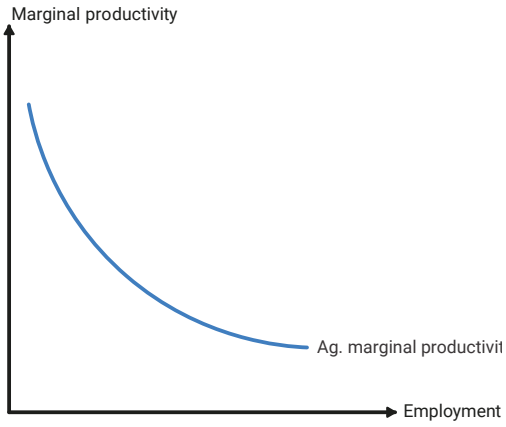
In an agrarian economy, the marginal productivity of each new worker declines. It would not be logical, then, for a landowner to increase pay for additional employees, as they would produce less; and, laborers would not want to work if they were offered lower wages than the most-established workers. Malthus concluded that this economic growth trap was where the U.K. had been for most of the previous millennium. Something big would have to change this trajectory.

The Inventor: John Kay and the Flying Shuttle

As Malthus studied his country's economy during the early 1700s, a fellow Englishman was working on a solution to a perplexing problem. John Kay wanted to reduce the time it took to weave, which until then was a handmade process of lacing sets of thread together to make fabric. In 1733 Kay applied for a **patent** from the government for his invention. He called it the flying shuttle, and it would be the U.K.'s first step to break out of the Malthus "productivity trap."

Kay's tool was transformative. It allowed workers to produce far more textiles than they could make by hand, with just a minimal amount of training. And, instead of most workers' only option for employment being toiling in the fields to produce agricultural products, a potential new type of work was available, thanks to Kay's weaving machine.

Figure 2: **Marginal Productivity for Agricultural Workers in the U.K., 1700s**



SOURCE: Authors' calculations.

Examine Figure 2 showing the allocation of workers in the U.K.'s eighteenth century economy. In the pre-Renaissance era, the number of workers was low and land was plentiful, leading to high marginal productivity (and decent wages) with each additional farm laborer. That rapidly decreased as new workers were added, indicated by the downward sloping curve.

John Kay's flying shuttle invention created opportunities for workers to produce something tied not to the amount of land, but to what they could produce using machines. The potential for a productivity revolution was in place.

The Entrepreneur: Richard Arkwright and the Industrial Revolution

No one individual is responsible for the Industrial Revolution, but Richard Arkwright's contributions have earned him the title "father of the modern industrial factory system" in many history books. Similarly to John Kay, Arkwright wanted to harness the power of water to create simple machines that reduced the time it took laborers to produce textiles. After receiving a patent from the government for his water frame, Arkwright opened a small mill in Cromford, England, in 1771. The factory, and its impact on labor, was born.

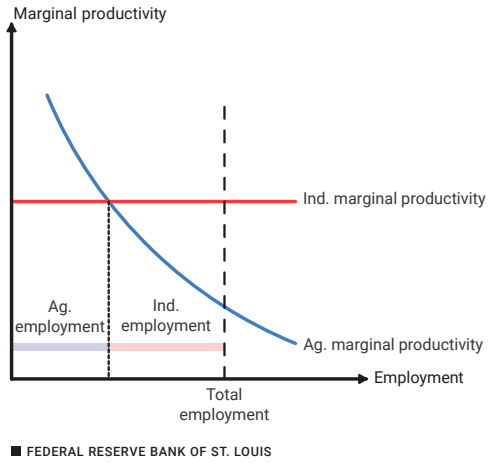
The consequences were almost immediately seen in the British economy. Arkwright had created an industrial firm. As his water frame machines were rather small, many could be placed in a relatively confined space, and, with hydropower accelerating the process, workers could be more efficient and could all produce the same amount. Marginal productivity per worker became constant, as there was a machine available for every new worker. Table 2 below shows a theorical example of marginal productivity per worker in Arkwright's mill.

Table 2: **Marginal Productivity for Industrial Workers**

Number of workers	Machine per worker	Total output	Marginal productivity
1	1	1	
2	1	2	1
3	1	3	1
4	1	4	1
5	1	5	1

SOURCE: Authors' calculations.

Figure 3: **Marginal Productivity for Agricultural and Industrial Workers in the U.K., 1700s**

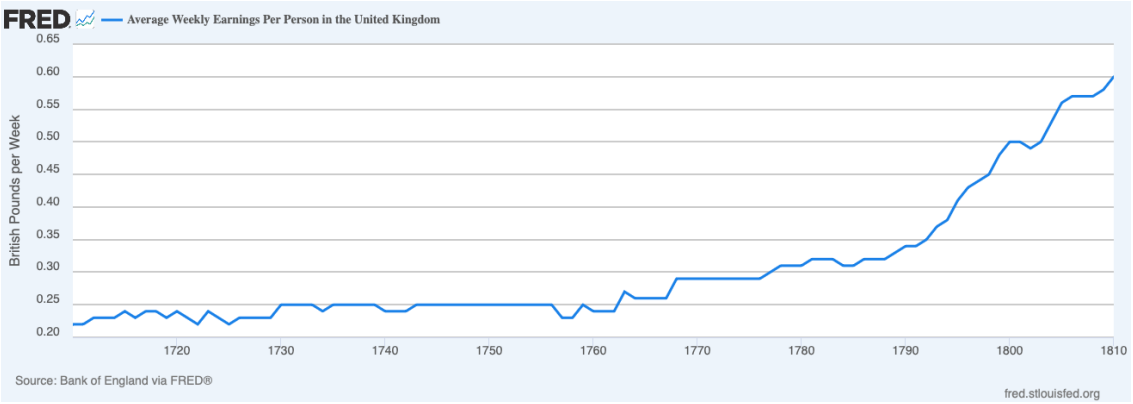


SOURCE: Authors' calculations.

With industrialization, a new opportunity arose for English workers. Refer to Figure 3. Recall that the downward sloping line shows diminishing agricultural productivity as more workers attempt to produce using the same amount of land. However, the horizontal line shows that, with industrialization, the productivity of workers in a factory is constant. Simply put, the U.K.'s eighteenth century workforce would organically divide into two segments—(1) an appropriate amount of agriculture workers producing a certain amount of products and (2) a group that migrates to work in the new factories producing more products, leading to overall sustained economic growth.

Workers had an incentive to switch to factory jobs: If every additional worker is as productive as the previous one hired, a factory owner can, and should, pay every machinist the exact same wage, as their productivity will be equal; there is no diminishing land constraints as in an agriculturally based economy. Examine Figure 4 below showing the average weekly earnings per person in the U.K. for 1710-1810. Prior to Kay's and Arkwright's inventions in the mid-1700s, weekly pay hovered around £0.20 for about 150 years. By 1800, just 40 years after these new capital equipment inventions became popular, the income of the average worker more than doubled, and it would double again in the nineteenth century.

Figure 4: **Average Weekly Earnings Per Person in the United Kingdom, 1710-1810**

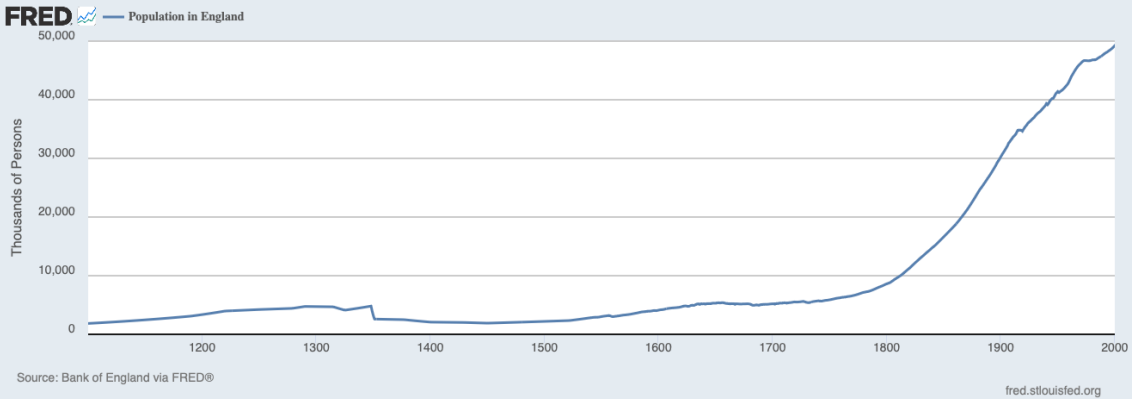


SOURCE: Average Weekly Earnings Per Person in the United Kingdom, Bank of England via FRED, Federal Reserve Bank of St. Louis; accessed December 17, 2025.

Examine the surge in population growth in the U.K. for the same period in Figure 5 below. Not only were weekly earnings increasing for workers, but the overall number of workers was also accelerating throughout the nineteenth century. When a country sees an increase in both average weekly earnings for workers and total population, it means productivity per worker must also be increasing. Increasing

productivity is a clear sign that widespread economic growth is occurring: The U.K. had become the first country to break out of the Malthusian economic growth trap.

Figure 5: **Population in England, 1100-2000**



SOURCE: Population in England, Bank of England via FRED, Federal Reserve Bank of St. Louis; accessed December 17, 2025.

Conclusion

With an economist's insight and an inventor's and entrepreneur's efforts to improve working conditions, the industrial revolution was a revolution for labor and productivity, too: It made the United Kingdom's sudden and transformative economic growth the envy of the rest of the world. Since the U.K.'s industrial revolution of the mid-1700s, many other nations worked to replicate the success, leading to dramatic consequences that would fill history books for the next 250 years.

Glossary

Economic growth: A sustained rise over time in a nation's production of goods and services.

Marginal product of labor: The increase in output from adding one additional worker.

Patent: A license that gives the inventor of a new product the exclusive right to sell it for a specific period of time.

Per capita gross domestic product: Gross domestic product (GDP) divided by the total population of a country.

Productivity: The ratio of output per worker per unit of time.

References

Maddison Project Database, version 2020. Bolt, Jutta and van Zanden, Jan Luiten. "Maddison Style Estimates of the Evolution of the World Economy. A New 2020 Update."

Ravikumar, B. and Vandenbroucke, Guillaume. "On the Transition to Sustained Growth: The Importance of Recent Agricultural Employment." Working Paper 2023-026, Federal Reserve Bank of St. Louis, April 2025.

Name_____ **Period**_____

Reading Q&A

Fruit of the Boom: The Impact of the Industrial Revolution on Economic Growth

After reading the article, complete the following:

1. What economic concept is best illustrated by the increase in U.K. GDP per capita after the eighteenth century?
   a. Inflation
   b. Economic growth
   c. Trade deficit
   d. Currency devaluation

2. According to Thomas Malthus, why did technological advances before 1700 not lead to economic growth?
   a. The government granted patents only for agricultural inventions.
   b. The population was too small to allow for growth.
   c. Most workers were in agriculture, limiting productivity gains.
   d. There was no access to capital markets.

3. What does the term "marginal product of labor" refer to?
   a. The average wage of a worker over a period of one year
   b. The total output of a factory on an annual basis
   c. The increase in output from adding one more worker
   d. The cost to a firm of hiring one additional worker

4. What invention did John Kay patent in 1733?
   a. Water frame
   b. Steam engine
   c. Flying shuttle
   d. Spinning jenny

5. How did marginal productivity change after Richard Arkwright built his factory system?
   a. It started to decline rapidly.
   b. It became unpredictable.
   c. It remained constant with each new worker.
   d. It depended on land ownership.

6. Why did wages increase after the introduction of industrial machinery?
   a. Workers went on strike.
   b. Machines reduced the need for labor.
   c. Each worker became more productive.
   d. The government mandated higher pay.

7. What is the significance of the Industrial Revolution?
   a. It led to the collapse of the British Empire.
   b. It caused widespread unemployment.
   c. It fueled economic growth in the U.K.
   d. It reduced the need for education of workers.

8. Because of the Industrial Revolution, average weekly earnings for British workers _____ while the population _____.
   a. increased; increased
   b. decreased; decreased
   c. increased; decreased
   d. decreased; increased

9. In terms of productivity, at what point would an additional worker consider taking an industrial job instead of finding employment in the agricultural sector?
   a. When the marginal productivity of the agricultural job increases above the productivity of the industrial job
   b. When the marginal productivity of the agricultural job decreases below the productivity of the industrial job
   c. When there are no more jobs available in the agricultural sector because of the mechanization of farming by machines
   d. When the government mandates that all new employment opportunities be created in urban areas