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Marginal Product of Labor and U.S. Westward Expansion

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“Go West, young man.”

—Horace Greeley

The United States’ first 125 years as an independent nation were marked by continual, rapid westward expansion. Images of settlers in covered wagons heading into the frontier dominate history courses and films. However, beyond the basic explanation of seeking more land and resources, the full story of why American settlement in the west was so rapid is not often told.

Agriculture was the foundation of all economies until the twentieth century, with land being a key resource. The relative abundance of land available out west compared with limited land in the east is a key factor in how U.S. westward expansion was so productive.

Productivity and Standard of Living

Farming includes three types of resources, called **factors of production**: land, labor, and capital. Land is available to till, plant, and harvest. **Labor** is the human effort directed toward producing goods and services. Physical capital includes machinery, tools, and equipment that farmers use to produce crops. The way these factors of production come together determines the **productivity** of labor.

Increasing productivity enables an economy to produce the same amount of output with the same number of workers or produce more output with fewer workers. In fact, productivity is key to raising the **standard of living**. Basically, a country can consume more goods and services per person if they produce more goods and services per person. With farming a dominant part of an economy, the need for land to grow commodities is just as important as the number of workers.

As a concept, productivity is straightforward. But we’ll examine how small adjustments to the factors of production affect overall economic performance using **marginal product of labor (MPL)**. We’ll describe what MPL is and how we can apply this concept to the U.S. in the early nineteenth century—in both the original 13 eastern states and the expanding western territories. And we’ll use U.S. Census Bureau data to examine if our economic model supports a more-detailed description for why settlement occurred the way it did in the American west.

This model accounts largely for European migration—those moving of their own free will. In the context of U.S. westward expansion, it does not account for the heavy and often fatal costs imposed

on Native Americans and those enslaved. Many Native Americans were forced to migrate, and those enslaved were often relocated to work on plantations during the first decades of the nineteenth century.

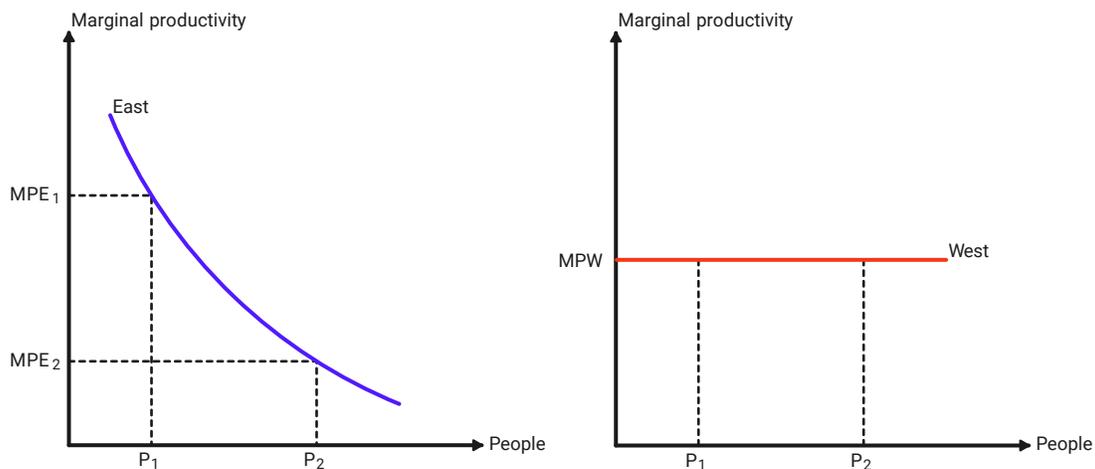
What Is Marginal Product of Labor?

Imagine an economy dominated by agriculture, where land and labor are the sole inputs into the production of goods. There are two measures of productivity: *Average* productivity is production per worker, while *marginal* productivity is the production of the “last” worker added to the labor force. When population grows and new individuals become workers, a key question for economists is, how much will productivity change with every additional worker? In other words, what is the marginal product of labor?

In a largely agricultural society, adding one more worker is only part of the story. How much land a worker uses also plays a crucial role. Remember, land must be developed before it can be used for productive purposes; and, swampland needs to be drained and prairie sod busted and tilled before agriculture can begin.

Consider the original 13 states and assume there has been no westward expansion. When new workers farm many acres, they produce a large amount and MPL is high. When new workers farm fewer acres, they are constrained and produce less and MPL is low, as shown in the left graph of Figure 1 below. The curved blue line illustrates that at population P_1 , where there are fewer workers, the MPL is greater than at population P_2 , where there are many workers. The reason for this difference, again, is that there are fewer acres available to the last worker when population is larger.

Figure 1: Marginal Product of Labor in the U.S. East (left graph) and West (right graph)



■ FEDERAL RESERVE BANK OF ST. LOUIS

SOURCE: Author’s calculations.

What if there weren’t any constraints on land? The right graph of Figure 1 represents westward expansion, where farmland was still plentiful. The horizontal red line shows the marginal productivity of workers in the west: It is the same whether the population is smaller, at P_1 , or larger, at P_2 . In this case,

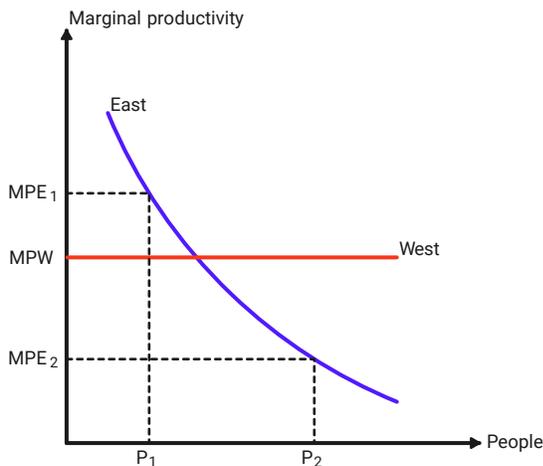
it was possible for each new worker to be given an equal amount of land; then, each new worker would be equally productive, and marginal productivity would remain the same regardless of the number of workers.

How Can We Apply Marginal Product of Labor to the U.S.?

In the late 1700s, U.S. geographic borders stretched from the Atlantic Ocean to the Mississippi River and from Canada to the Gulf of Mexico. The “east” is all land from the Atlantic Coast to the Appalachian Mountains that consists of the original 13 states and cannot be extended. As population grows in those states, from natural increases and immigration, the MPL decreases because acres-per-worker decreases.

West of the Appalachians, there is an abundance of land with smaller populations that have the potential for becoming new states. Even though this land can be costly to get to and improve, new workers in the west do not have to compete to share land as they do in eastern states.

Figure 2: Marginal Productivity in Eastern and Western States



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SOURCE: Author’s calculations.

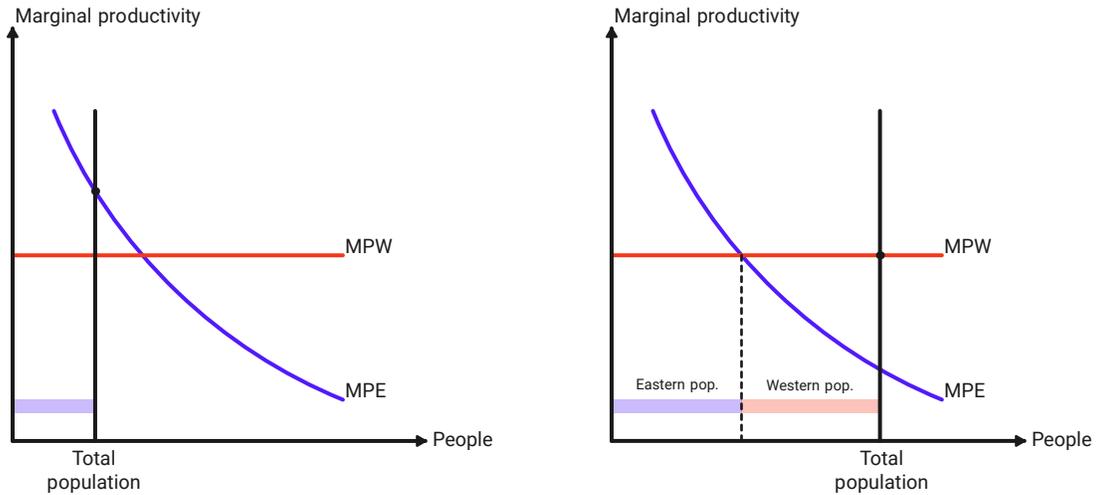
The Figure 2 graph combines eastern and western marginal productivity. Along the x-axis, P_1 shows the total population is “small” and located in the east—where there is an “ample” amount of land per worker. This implies that marginal productivity in the east, shown as MPE_1 along the y-axis, is high and greater than that in the west, shown as MPW . In this situation, the optimal allocation of population P_1 is that every additional worker stays in the east because they have no incentive to move west. If they did move, they would experience lower productivity and, hence, income.

Suppose the population in the east grows to a point, P_2 , where each additional worker is below the horizontal MPW line. Marginal productivity in the east, MPE_2 , is now significantly lower because there is less land per worker in eastern states; each additional worker there would have a lower level of productivity

than if they were to move west, which has constant returns on productivity as new land is developed. In this situation, the optimal allocation of population P_2 is that every additional worker relocates from the east to the west, where they would experience higher productivity and, hence, income.

Which is the optimal allocation of population then? The left graph of Figure 3 below shows that as population grows during westward expansion, workers would optimally remain in the east as long as marginal productivity exceeds that in the west. Beyond this point, every additional worker could go west, where marginal productivity exceeds that in the east, as shown in the right graph of Figure 3. Then, the distribution of population between east and west maximizes the output of the country and that of individual workers: Each new worker settles in the region where productivity, and hence income, is the highest.

Figure 3: The Optimal Allocation of Population During U.S. Westward Expansion

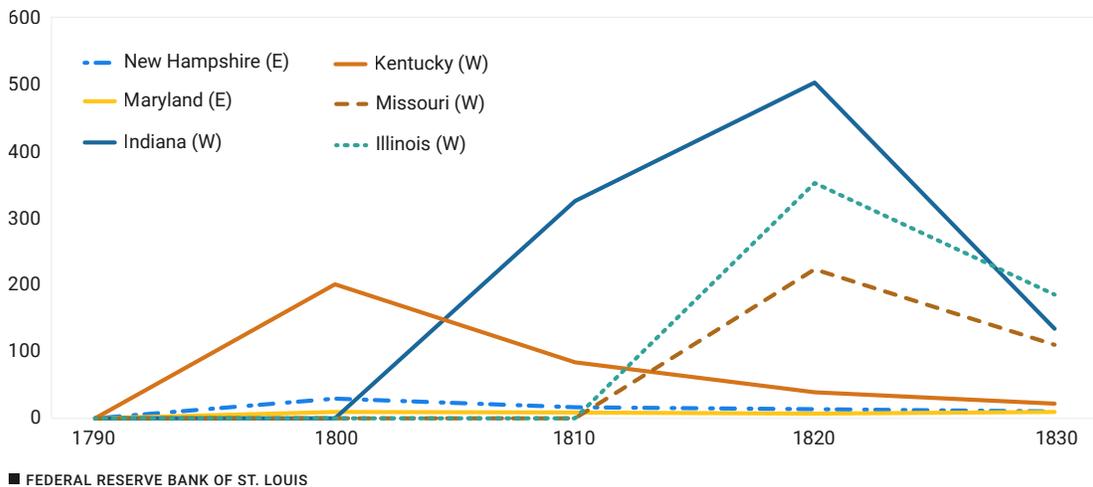


SOURCE: Author's calculations.

Does the Historical Narrative Support the Model?

If the hypothesis of using MPL to determine when westward expansion occurred in the U.S. is correct, historical population data can serve as a test. The Figure 4 graph below shows U.S. Census Bureau data measuring the percent change in population per acre in a sample of six states, starting in 1790 and continuing for the next 40 years: The percent change in population per acre is always positive. When a line decreases—for example, from 500% in 1820 to less than 200% in 1830 in Indiana—it means that population still grew, but at a slower pace.

Figure 4: Percent Change of Population per Square Mile by State



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SOURCE: U.S. Census Bureau.

The relatively flat lines of Maryland and New Hampshire indicate very little population change and are representative of the trend for the original 13 states. This suggests that, as early as 1790, marginal productivity in the east was already lesser than potential marginal productivity in the west. More importantly, the entry of each new western state into the Census data illustrates a massive increase in population per acre. Kentucky joined the Union in 1792 and over the next decade saw a 200% increase in population per acre. The state continued to see exceptional growth before stabilizing in the 1820s. This pattern of exponential growth is repeated for each successive western state, from Indiana to Illinois to Missouri.

This trend also repeats itself across time. Early pioneers explored and showed the potential for land use, which was then followed by an initial population rush to stake land claims. Millions of acres were allocated and “improved” as the cycle repeated into the next territory/state.

Individuals recognized that finding areas where they could be as productive as possible would lead to more wealth and a better standard of living. Increased productivity across the population added to the nation’s total economic output, putting the U.S. on a path to become a dominant economic power. That is, individual workers choose east or west to be as productive as possible and thus contribute to maximizing the nation’s economic output, even without that being their personal goal. Economic prosperity encouraged population growth, and further immigration led to new workers continuing to move west throughout the nineteenth century.

Conclusion

MPL offers an explanation for how and why westward expansion proceeded in the U.S. after its establishment as an independent nation. Americans’ movement west may also provide a partial answer to another economic issue—the one facing those populations remaining in eastern states. That is, if a concentration of workers is confined to a relatively small area, wages are bound to decline, as free-market forces dictate. However, as population grows, either through domestic birth rates or immigration, workers’ ability to find new areas in which to relocate acts as a “safety valve” to keep wages stable in highly populated areas. This, along with new technology developments that led to the first wave of American industrialization and increased worker productivity, helped lay the economic foundation that would eventually turn the U.S. into a dominant player on the world stage.

Glossary

Factors of production: The natural, human, and capital resources that are available to make goods and services. Also known as productive resources.

Labor: The quantity and quality of human effort directed toward producing goods and services. Also known as human resources.

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

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

Standard of living: A measure of economic well-being.

Name _____ Period _____

Reading Q&A

Marginal Product of Labor and U.S. Westward Expansion

After reading the article, complete the following:

1. What is the largest influence on the productivity of workers in an agricultural economy?
 - a. The amount of government intervention in the economy
 - b. The amount of land to produce crops
 - c. The number of exports a nation can send overseas
 - d. The amount of currency flowing in the economy

2. What was a significant incentive to settle western territories in the United States in the late 1700s and early 1800s?
 - a. Access to better education systems
 - b. Abundant availability of land
 - c. Higher wages for workers
 - d. Advanced industrial infrastructure

3. Why does the marginal product of labor (MPL) decrease in eastern states as the population grows?
 - a. The amount of land available for each worker decreases.
 - b. There is a declining demand for agricultural products.
 - c. Labor costs increase with a growing population.
 - d. State governments began to restrict farm expansions.

4. In the model, it becomes optimal for workers to move west when
 - a. wages in the east exceed those in the west.
 - b. there is a shortage of workers in the east.
 - c. marginal productivity is higher in the east than in the west.
 - d. marginal productivity in the west passes that point in the east.

5. What are the three factors of production?
 - a. Labor, capital, and productivity
 - b. Land, labor, and productivity
 - c. Land, labor, and capital
 - d. Capital, productivity, and labor

6. Marginal product of labor is the
 - a. total production by all workers.
 - b. average production per worker.
 - c. increase in output from adding one more worker.
 - d. decrease in output when a worker is removed.

7. How did westward expansion affect the overall economic output of the United States?
 - a. It decreased national economic output.
 - b. It had no significant impact.
 - c. It increased national economic output.
 - d. It benefited only the eastern states.

8. What is a consequence of westward expansion not accounted for by the marginal product of labor model?
 - a. The movement of labor into western territories and states
 - b. Overall increased agricultural output in the United States
 - c. An increase in the standard of living for many Americans
 - d. The costs of expansion put upon Native Americans and slaves

9. What pattern is observed in the population growth of western states like Kentucky, Indiana, and Missouri?
 - a. Early exponential growth followed by stabilization
 - b. A very slow increase in population in the first decade
 - c. Random fluctuations of population growth and decline
 - d. Gradual decline in population

10. What role did westward expansion play in stabilizing wages in eastern states?
 - a. It had no effect on wages in either region.
 - b. It caused wages to fluctuate wildly.
 - c. It created a safety valve for workers to earn a similar amount.
 - d. It led to an overall decrease in wages in both regions.