Automation and the Minimum Wage

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The minimum wage was created by President Franklin Delano Roosevelt in 1938 as part of the Fair Labor Standards Act, which set the wage at 25 cents. The wage applied to a relatively small group of workers and was established “to end starvation wages and intolerable hours,” especially for child laborers.\(^2\) The current federal minimum wage is $7.25 and was last changed in 2009.\(^3\) Although the nominal minimum wage (green line, Figure 1) has been raised several times, the purchasing power of the minimum wage (blue line, Figure 1) has varied over time. For example, although the nominal minimum wage is at a historical high, the real (inflation adjusted) minimum wage is low relative to historical values and has the same purchasing value (red line, Figure 1) today as it did in 2007, 2005, 1990, 1989, and 1950 (see where the blue line crosses the red line).

The Textbook Approach

Although a simple supply and demand model fails to capture the nuances of a minimum wage policy, it is a useful place to start the discussion. The labor market has both a supply side (workers) and a demand side (employers seeking workers). The supply curves tell us how many workers are willing to work at any given wage. The demand curve tells us how many workers employers are willing to hire at any given wage (Figure 2). These curves intersect at the equilibrium wage (labeled \(W_e\) on Figure 2). At equilibrium, the number of people wanting to work equals the number of workers employers want to employ.

If the government thinks that the equilibrium wage is too low, then it might establish a minimum wage that is higher than the equilibrium wage, such as \(W_m\). In this case, the minimum wage acts as a price floor. The increase in the wage would cause the quantity of labor supplied (by workers) to increase, as people seeking the higher wage would enter the low-skilled labor market (indicated by the move from \(Q_n\) to \(Q_s\)). The quantity of labor demanded (by employers) would decrease as firms adjust to higher labor.

"Hard-working Americans deserve sufficient wages to put food on the table and keep a roof over their heads, without having to keep multiple jobs.”
—President Joseph Biden\(^1\)
costs (indicated by the move from $Q_e$ to $Q_d$). The demand curve determines the number of workers hired by employers, and $Q_d$ notes the number of workers employed at the higher minimum wage. These workers earn a higher wage than before—they are the beneficiaries of the higher minimum wage. However, the graph also shows the surplus of labor created by the higher minimum wage as the distance between $Q_d$ (employed workers) and $Q_s$ (workers seeking employment). In other words, the mandated minimum wage results in more workers seeking employment than there are jobs available—these workers are unemployed.

Models can miss nuances, however, because they are simplified versions of reality. For example, Nobel Prize laureate David Card and Alan Krueger used an innovative research method to examine the effects of an increase in the minimum wage in New Jersey and found no reduction in employment. Their research casts doubt on whether raising the minimum wage causes businesses to lay off workers. Although this study was specific to a time and place, it reminds us that even though models are useful tools, they have limitations. So, let’s dig a little deeper.

**Who Earns the Minimum Wage?**

Although the minimum wage receives a lot of attention, the 1.1 million workers who earn the minimum wage (or below) make up only 1.5 percent of all hourly workers. Minimum wage workers tend to be young. Of the workers paid at or below the federal minimum wage, nearly half (48 percent) are under 25 years of age and 20 percent are teenagers. Even though teenagers are generally not the primary providers of household income, working helps them develop skills and experience.
Tradeoffs: The Pros and Cons of Raising the Federal Minimum Wage

As with the general public, economists fall on both sides of the minimum wage issue. Proponents of a $15 minimum wage argue that increasing the wage would improve the lives of low-income workers, making it easier for them to afford food, rent, and other necessities, thereby raising their standard of living. Specifically, the Congressional Budget Office (CBO) estimates that raising the minimum wage to $15 per hour by 2025 would increase wages for at least 17 million people and reduce the number of people in poverty by 900,000. Proponents also suggest that raising the minimum wage will increase employee morale, reducing an employer’s turnover and hiring/training costs.

Opponents of a $15 minimum wage argue that the policy might hurt the very group of people it intends to help, by reducing the number of low-skilled jobs. Specifically, the CBO estimates that raising the minimum wage to $15 by 2025 would reduce employment by 1.4 million workers, or 0.9 percent. Economically, the number of workers hired at a particular business is based on how each worker’s labor contributes to that business’s total revenue. Economic theory suggests that if a worker’s labor results in at least enough additional revenue to offset the worker’s wage, the job will exist, and a worker will be employed. If the government mandates a higher wage, the revenue generated might fall short of labor costs for some workers. In short, for some firms it will no longer be feasible to keep the same number of workers at the higher wage. In this case, a policy intended to support low-income workers might result in job loss for low-skilled workers.

Some economists prefer the earned income tax credit (EITC) as a more targeted way to increase workers’ take-home pay and alleviate poverty. The EITC is an income subsidy (as a refundable tax credit) to low-income families. The benefits phase out slowly, so workers are not penalized as they earn more income. Proponents of the EITC see it as a better option because it directly supplements the incomes of the working poor while minimizing some of the unintended employment consequences associated with raising the minimum wage.

Automation and the Minimum Wage

Automation is the automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that takes the place of human labor. Automation is not new—it began with the industrial revolution and continued thereafter—but more and more tasks are becoming automated. Robots and artificial intelligence are modern variations of automation. Although science fiction droids may come to mind when robots are mentioned, a robot is simply a device or algorithm that replaces human tasks. For example, a thermostat is a device that turns your furnace on or off as the temperature in your house changes. Unlike other physical capital or forms of technology, robots can be programmed to perform many repetitive tasks and do not need a human operator.

Often, we think of jobs being automated, but jobs are actually composed of a series of tasks. Each of these tasks can either be completed by human labor or by physical capital. Tasks (and jobs) that are routine and repetitive are more susceptible to automation. And, because some tasks are more easily automated, as technology advances, it continues to change the mix of tasks completed by human labor and those completed by automation. Think of an assembly line used to manufacture automobiles. When the automotive industry began in the early 1900s, humans with tools completed nearly all steps of the process; but over time, robots took over many of the key steps—such as welding and painting. Parts of the process that require more dexterity, however, are still completed by humans.

Complements and Substitutes

The move toward automation is driven by economics. A firm will consider substituting capital for labor for a given task when the marginal cost of producing goods with capital is less expensive than the marginal cost of producing goods with labor. This substitution is known as the displacement effect. There are two forces at work here:

(i) The cost of capital: As technology advances and becomes more widely adopted, the cost of performing tasks with capital often falls (in inflation-adjusted terms).
(ii) The cost of labor: As wages for low-skilled labor rise due to labor market conditions, regulations, or minimum wage laws, they can make the tasks workers do more susceptible to displacement.

Increasing the minimum wage provides economic incentives for firms to adopt new technologies that replace workers: That is, a higher minimum wage raises the cost of labor and increases the range of tasks that are susceptible to displacement by automation—especially the tasks of minimum wage jobs, which tend to be labor intensive and composed of low-skill tasks. For example, consider the self-checkout lanes at grocery stores and digital kiosks at a fast-food restaurant that substitute for employees or the robot arms in an assembly line that complete simple tasks that human hands once did. As research bears out, increases in the minimum wage decrease the share of automatable employment held by low-skilled workers; it also suggests that the largest effects are felt in manufacturing and by older workers, females, and Black workers.

Preparing for the Future

Although some fear a “robot apocalypse” that substitutes human labor with machines, it is important to remember that automation also complements human labor. Even though automation replaces low-skilled workers, it also creates job opportunities for higher-skilled workers. Using a historical example, the spreadsheet eliminated many “bookkeeper” jobs but created high-skilled jobs for people who could analyze the numbers, such as accountants and management consultants. In manufacturing, companies that eliminate some low-skill assembly line jobs will likely need higher-skilled employees to operate, troubleshoot, and maintain new equipment and reward those employees with higher wages.

Students can prepare for a changing world by building skills that complement technological change rather than those that can be easily substituted. And, since routine and repetitive tasks are the most susceptible to displacement by automation, students and workers should also strive to develop their human capital by learning skills in areas that require a higher level of skill and training. Andrew McAfee recommends that students prepare for the future by pursuing a double major, one in the liberal arts (to develop critical thinking skills) and another in the sciences (to develop quantitative and technological skills). Economics is well positioned between these categories: It is a social science that explains human and institutional behavior, and it leans on quantitative (mathematical) models and data to explain and test theories.

Conclusion

Increasing the minimum wage is a controversial issue. Although a higher minimum wage can provide higher income for low-wage workers, it can also reduce the number of job opportunities for those workers. Some of the reduction in jobs occurs because a higher minimum wage increases production costs, causing firms to shift away from, or stop, production of some goods. A higher minimum wage can also result in employers using automation to replace more expensive human labor; however, automation can also create job opportunities for higher-skilled workers. Students concerned about automation can prepare for the future by acquiring job skills that complement technology.
Notes
3 Although the federal minimum wage sets a standard for what individuals must be paid, certain people can be paid below the minimum wage, including vocational education students; full-time students employed by retail or service establishments, agriculture, or institutions of higher education; and individuals whose productive capacity is impaired by a physical or mental disability. These workers are allowed to be paid less than the minimum wage to prevent the loss of employment opportunities for them. Employers must obtain special certificates from the Department of Labor for these types of employment.
After reading the article, answer the following questions:

1. When was the minimum wage established?
   a. 1912
   b. 1938
   c. 1965
   d. 2009

2. The minimum wage acts as a price floor
   a. when the minimum wage is set higher than the equilibrium wage.
   b. when the minimum wage is set equal to the equilibrium wage.
   c. when the minimum wage is set below the equilibrium wage.
   d. when the equilibrium wage is rising.

3. An effective minimum wage (price floor) results in a market
   a. shortage, because the quantity of labor supplied is greater than the quantity of labor demanded.
   b. shortage, because the quantity of labor demanded is greater than the quantity of labor supplied.
   c. surplus, because the quantity of labor demanded is greater than the quantity of labor supplied.
   d. surplus, because the quantity of labor supplied is greater than the quantity of labor demanded.

4. Nearly half of minimum wage workers are
   a. retired.
   b. middle aged.
   c. under 25 years of age.
   d. teenagers.

5. Which of the following is a reason people support raising the minimum wage?
   a. It will increase employment.
   b. It will raise low-income workers’ standard of living.
   c. It will boost the quantity of labor demanded and employment.
   d. Business owners will be happier.
6. Which of the following is a reason people oppose raising the minimum wage?
   a. It will cause a decrease in labor supplied.
   b. It will encourage businesses to hire only low-skilled workers.
   c. It will increase business costs and reduce job opportunities.
   d. It will increase the turnover rate for businesses.

7. When will a firm substitute production using capital for production using labor?
   a. When the marginal cost of producing goods using labor exceeds the marginal cost of producing goods with capital
   b. When the marginal cost of producing goods with capital exceeds the marginal cost of producing goods with labor
   c. When the total cost of labor exceeds the total cost of capital
   d. When the total cost of capital exceeds the total cost of labor

8. How does increasing the minimum wage affect whether companies choose to automate?
   a. It increases the range of tasks that are susceptible to displacement by automation.
   b. It increases the cost of using technology, so companies will reduce production using automation.
   c. It decreases companies’ budgets, making it more expensive to increase automation over time.
   d. It decreases the levels of production using labor and automation.

9. How does automation create jobs?
   a. Automation is a substitute for labor.
   b. Automation decreases production, so more jobs are needed.
   c. Automation creates demand for other types of jobs and skills.
   d. Automation decreases the marginal product of capital, so more labor is needed to maintain production.

10. What types of jobs should students prepare for in the future?
    a. Low-skill jobs that require little education or training
    b. Jobs composed of routine and repetitive tasks
    c. Jobs that combine critical thinking and quantitative skills
    d. Jobs composed of repetitive tasks that are easy to automate