Technological Change & the Inequality Cycle in an Aging Society

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The United States, Europe, and Japan and other Asian countries are at the forefront of the global challenge of rising income inequality in aging societies. Let us take a look at the direction of technological progress and the self-corrective powers of the market economy from this perspective. Key to the discussions will be "directed technical change" (DTC), a concept put forward in the late 1990s by Prof. Daron Acemoglu, an economist at the Massachusetts Institute of Technology.

Bipolarization of Labor Market Proceeding Worldwide

Income inequality has grown in the United States and developed economies in Europe since the 1970s. This phenomenon also appears to have emerged in Japan in the 1980s, but it did not become much of an issue there, coinciding as it did with the boom years of the bubble economy. The bubble burst in the 1990s, though, pushing the Japanese economy into a long-term slide. As irregular employment began increasing near the end of the decade, attention was drawn to the growing income inequality, which became a major social issue in Japan in the first decade of the new millennium.

The US labor market is increasingly polarized, according to "The Polarization of the U.S. Labor Market" (National Bureau of Economic Research, Working Paper No. 11986, 2006) by David H. Autor, Lawrence F. Katz, and Melissa S. Kearney, and other studies. Polarization of the labor market is the phenomenon where the middle-income group divides into high- and low-income groups. The gist of the cause of such polarization, according to Autor and his colleagues, is that high-skill workers such as business managers and creators saw their incomes rise as the introduction of computers and the Internet enhanced their productivity, while low-skill workers yielded their functions to the computer and suffered a drop in their incomes as a consequence. Thus, income inequality continues to widen in the developed countries. However, this trend will not necessarily continue forever.

Technological Change Oriented by Market Economy

In economics, a conventional assumption is that the direction of technological progress is determined by the natural sciences and engineering independent of economic and social conditions. But Acemoglu put forth his DTC theory, which states that "The conditions of the market economy determine the direction of technical change" and uses it to explain the growth in income inequality. According to this theory, the current technological trend should eventually change direction in response to the market conditions where income inequality is growing. The technological trend should change over the long run in a direction that narrows income inequality.

The essence of Acemoglu's theory is simple. Since firms conduct research and development to maximize profits, they strive to develop technology that utilizes abundant factors of production while minimizing the use of scarce ones. As a result, technological change also moves in a direction that emphasizes the use of abundant resources and cuts back on the use of scarce ones. This is the essence of DTC as a consequence of the relative abundance and scarcity of resources in the marketplace.

For example, DTC can be used to explain that the increase in recent years of the "college premium" — the wage gap between workers with college degrees and those with high school qualifications or less — has been caused by the increased supply of college graduates in the workforce. The expansion of higher education in the United States produced a rapid surge in the number of college graduate workers, making them cheaper in relative terms than before. Businesses changed the direction of technological development toward one that used more of this cheaper college graduate workforce. This in turn pushed up the college premium. This is the essence of the DTC theory.

Sidebar

Acemoglu's DTC theory is based on Prof. Yujiro Hayami's theory of "induced innovation". While the core of Acemoglu's argument is that the profit motive drives technology development by businesses, Hayami places more emphasis on the institutional environment determined by government policies than the role of private firms. His theory emphasizes the importance of the realities of the marketplace, such as the volume of available resources, which in his view induces not only innovation by businesses but also changes in the economic institutions themselves. His theory covers a broader range of phenomena than Acemoglu's, but it fails to clarify who the decision-makers are where technological and institutional innovations are concerned. In this respect, DTC presents a definitive decision-making structure that makes the theory amenable to rigorous policy analysis. That is why it is being used in this report to explore where technological change is headed.

History of Income Differential Inequality

DTC can also be used to explain long-term fluctuations spanning decades in income inequality.

Triggered by the 18th century invention of the steam engine, the Industrial Revolution generated a huge number of unskilled workers when handicraft artisans and workers could not keep up with the changes in the technological paradigm. This led to a significant rise in income inequality in the United Kingdom in the first half of the 19th century. However, the gap narrowed through the second half of the 19th century and the first half of the 20th, a phenomenon that DTC explains thus: in the second half of the 19th century, the market featured a surfeit of low-skill workers and a dearth of high-skill workers. In other words, the labor market was structurally constituted to supply a large amount of low-skill labor and a small amount of high-skill labor.

Consequently, businesses developed the mass production system and other technologies in order to utilize the abundant and low-cost unskilled workers and cut back on expensive artisans, which led to the widespread use of production technology relying mainly on unskilled labor. In other words, by standardizing production processes and operations, it became possible to manufacture complex products using unskilled labor and forgoing the use of the advanced technical skills of artisans. The Ford Production System, which went into use in the early 20th century, is representative of this phenomenon. As a result of this technological change, unskilled labor saw business demand increase, which in turn raised their wages, swelling the ranks of the middle class and shrinking income inequality. The increase in unskilled labor had evoked a change in the direction of technological change.

Inequality Cycle

What, then, does the future hold for the continuing phenomenon, in Japan and the rest of the world, of rising income inequality? Studies in recent years taken together indicate that the ongoing rise of income inequality is being caused by the abundant supply of cheap, low-skill labor under the new technological paradigm founded on informatization. White-collar workers executing standardized clerical tasks had belonged to the middle class before informatization, but computers took their jobs and turned them into low-skill labor. On the other hand, the high-skill labor of the information age — creative knowledge workers — are becoming ever more expensive and scarce because information technology enables high-skill workers to deliver their abilities to more clients and also complements their creativity.

This situation, where low-skill workers are cheap and abundant while high-skill workers are expensive and scarce, is analogous to the situation in the 19th century, where income inequality also rose. The DTC theory predicts that technology will shift in a direction that conserves expensive and scarce production factors and increases the use of cheap and abundant production factors. These historical and theoretical perspectives taken together indicate that technology will change over the coming decades in a direction that conserves high-skill labor and increases the use of low-skill labor. In other words, technological change will move in the direction of production technology systems that enable ordinary people who lack exceptional creativity to produce goods and services using information technology. This will increase demand for low-skill labor and exert upside pressure on their wages, resulting in a long-term decline in income inequality.

Every hundred years or so, scientific progress produces one or two paradigm shifts in technological systems such as informatization. During the shift, income inequality rises between a small number of winners — high-skill labor under the new technological paradigm — and the large number of people who cannot keep up with the change — low-skill labor under the new technological paradigm. However, widening inequality impacts the direction of technological change and shifts the vector of technological progress in a direction that diminishes inequality. The result is the emergence of an inequality cycle, in which expansion and contraction of income inequality repeats itself once or twice each century. Inequality never grows forever; instead, it reverses itself and contracts over time. The market has certain self-corrective powers.

The Kuznets Curve has long existed as an explanation for the expansion and contraction of inequality. As proposed by the economist Simon Kuznets, it is a curve that shows that when an economy develops and per capita production increases, income inequality expands in the beginning but later contracts. According to Kuznets, income inequality grows as modernization turns an agrarian society into an industrialized society but diminishes as people adapt to industrialization and social security programs are expanded.

The Inequality Cycle is similar to the Kuznets Curve, but there is an important difference. The Kuznets Curve represents a one-off historical event in which 18th-20th century modernization produced an expansion and contraction of inequality. The Inequality Curve, which regards the expansion and contraction of inequality as a recurring phenomenon, can be considered a vernalized version of the Kuznets Curve. It expects the cycle to repeat itself again and again as a consequence of systemic shifts in the technological paradigm. It sees the expansion and contraction of inequality as an enduring and fundamental characteristic of the market economy.

Expansion of General Purpose Technology

The idea in the Inequality Cycle that inequality grows when a new technological paradigm emerges but shrinks when the new technology is fully adopted is reflected in another theoretical work, "General Purpose Technology and Wage Inequality" (*Journal of Economic Growth*, Vol. 7 (4), 2002) by Philippe Aghion, Peter Howitt, and Giovanni L. Violante. Following in the footsteps of Joseph Schumpeter's theory of economic growth, Aghion et al analyze how businesses and workers adapt during the transition period when an existing "general purpose technology" (GPT — more or less synonymous with the technological paradigm) is being replaced by a new one. When a new GPT first emerges, high-skill workers — human resources with high learning capabilities that enable them to acquire the new technology — become necessary, so their incomes rise, increasing the gap with low-skill labor. However, once the new GPT is fully adopted by society at large, high learning capabilities are no longer needed, and the income inequality between high-skill and low-skill labor shrinks. In the model put forth by

Aghion et al, the proposition that the wage gap shrinks when GPT is fully adopted is a theoretical premise and technical condition. There, a decrease in income inequality is treated as a technical by-product that accompanies the general adoption of new technology.

Meanwhile, the Inequality Cycle based on DTC emphasizes the point that changes in the market behavior of business and other actors cause changes in the direction of technological progress, which in turn diminishes inequality. It is different because it introduces the self-corrective powers of the market.

Aging & Declining Birth Rates in Japan

DTC also provides important insights regarding innovation for an aging society with a low birth rate. The Diet passed legislation last year to raise the consumption tax rate from 5% to 10% — the first such hike in 15 years. However, as important a step as the tax hike may be for maintaining the fiscal health of the social security system, the trajectory generated by demographic dynamics cannot be altered. Whereas the ratio of the population aged 65 and older to the working age population is now roughly one to three, the Japanese population is aging and the ratio will be one to one by the middle of this century. The physical supply of younger workers available to provide care for seniors will shrink, all things being equal, to one-third of current levels. If the technology for medical and nursing care for seniors remains as labor-intensive as it is now, there will be a shortage of supply for such services relative to the senior population. This fact cannot be changed at all even if taxes are raised and the social security system is reformed. Costs will soar for medical and nursing care services, so the standard of living for seniors should deteriorate significantly even if pension benefits are maintained at current levels or even raised. If the Ministry of Health, Labour and Welfare maintains price levels for senior care services through regulation, it will only mean ever longer waiting lines for services since the physical supply will shrink. Either way, the standard of living will decline significantly for the elderly by the middle of the century.

Technological Change Oriented by Aging Society with Lower Birth Rate

In which direction, then, will technological innovation in caring for the elderly turn? The long-term outlook for production factors in industries related to caring for the elderly is a chronic labor deficit and capital surplus. DTC tells us that businesses will alter the technological structure of industries related to caring for the elderly in the direction of conserving scarce labor and increasing reliance on abundant capital. Specifically, Japanese businesses should be working to develop technology that shifts medical and nursing care and other services for the elderly in a capital intensive direction. Robot suits for care providers and mechanized nursing beds are such examples. One name for engineering technology related to care for the elderly is "gerontechnology". This is a new concept proposed by Dutch scientists in 1989 as the science of aging, and is a portmanteau created from "gerontology" and "technology". Gerontechnology at a fundamental level consists mainly of engineering technology to support the self-reliance of the elderly, but also includes support for young workers engaged in nursing care for the elderly and the establishment of an ergonomically sound environment.

Robot suits and other equipment providing ambulatory support and equipment compensating for deterioration in visual and aural functions are two examples of advances in gerontechnology that we can look forward to. Progress in a wide range of technologies should make it easier for the elderly to live independently and enable a small number of care providers to tend to a large number of elderly people in an efficient manner. It is important to jumpstart the industrial development of caregiving for the elderly in a way that compensates for the labor deficit in an aging society with a low birth rate through capital stock in the form of machinery and equipment.

Hope in Resilience of Market Economy

If technological change occurs that changes the industries related to the elderly from labor-intensive to capital-intensive, wages for caregiving workers will rise and many difficulties around aging will be mitigated. Given that aging demographics is a global trend, demand for goods and services related to aging is certain to grow worldwide over the coming decades. The aging process is particularly rapid in China, South Korea, Thailand and other Asian countries, so equipment related to the elderly should become a large part of Asian trade in the second half of this century. Japanese and other developed countries are struggling in household appliances and other conventional export industries, where emerging economies are increasingly competitive. Is it possible that by mid-century equipment and services related to caring for the elderly will take the place of automobiles and the like as the new core of Japanese export industries? At the forefront of the global phenomenon of aging demographics, Japan may be able to secure a new driver for economic development if it could develop new export goods in industries related to the aging process. This future is not some piece of science fiction, as aging is sure to continue in Japan as well as the rest of the world for several decades.

However, major manufacturers are being held captive to existing product lines and are reluctant to fully engage in research and development in areas related to aging. Technological development related to the elderly is mainly being conducted by small venture businesses and at the individual university laboratory level. The challenge lies in providing effective financing for these technological development undertakings.

Technological development by businesses driven by the profit motive alters the direction of technological systems and ultimately mitigates the challenges of income inequality and an aging society. The market economy does not merely achieve impersonal equilibriums through the price mechanism; it can also enhance the welfare of the people by altering the direction of technological change. The self-correcting powers of the market will improve social welfare even if this cannot be achieved within a single generation; there rest the hopes of the public in these most difficult of times. JS

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