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HIGHLIGHTS

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Side Effects of Progress

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An increase in the pace of technological change can have two profound side effects in the labor market. It can increase the rate and the average duration of unemployment. Because firms may not consider it cost-effective to retrain some types of workers to keep up with change, notably the less-educated and older employees, these workers may be jobless for long periods of time, with some of them perhaps never working again. If technological change causes workers to become unemployed more often and for longer periods of time, not only will the level of unemployment increase, but the "natural rate of unemployment," the hypothesized minimum sustainable rate of unemployment, will increase as well.

In saying that the level and duration of unemployment may be increased by accelerating technological change, we are emphatically not asserting that this is the only factor in such developments. However, the evidence supports the conclusion that an increase in the pace of innovation, all else equal, will have these effects.

The Natural Rate of Unemployment and the Pace of Technological Change

Consider, first, the effect of an increase in the pace of technological change on the level of unemployment in the economy. "Frictional unemployment" is the period of joblessness before workers can find new positions after leaving or being laid off from a job. "Structural unemployment" is joblessness caused by the obsolescence of workers' skills. Both of these types of unemployment will be affected by the frequency with which plants close down either permanently or for a period of reconstruction or retooling. An increase in the rate of technological change will increase the frequency with which plants close and thus will increase the portion of the labor force that is unemployed in any period. The continuous character of technological innovation is central to the increase in the rate of unemployment that prevails through all stages of the business cycle.

An example can help describe the logic of the effects on level of unemployment. Assume that, initially, the rate of technological innovation is such that an average plant can be expected to need to close for redesign and retooling once every 50 years and that it will need to be closed for 1 year. If an employee of the plant is laid off during this period and is then rehired or, on average, takes 1 year to find a new job, technological change will have contributed 2 percent to the unemployment rate; that is, the employee will have been unemployed for 1 year in 50 (or 2 years in 100) because of the change. Now, consider a speed up in the rate of change so that the plant must be modernized every 25 years instead of every 50. If everything else remains as before, the contribution of technological change to unemployment will double to 4 percent. These numbers may not correspond even approximately to reality, but the conclusion is valid in general. The constant creation and loss of jobs resulting from technological change do not simply balance out, even if the two occur at identical rates. The process stirs up job change and that takes time, contributing a net increase in the natural rate of

unemployment and one that is not transitory as long as the pace of change continues.

Duration of Joblessness and the Pace of Technological Change

We turn now to a discussion of the duration of joblessness. The distinction between the level of unemployment and its duration is of considerable importance for the social consequences of unemployment. Even if the unemployment rate does not change, the duration of joblessness can vary substantially. The unemployment rate will be the same when 4 million workers are unemployed for three months on average during a year and when 1 million workers are unemployed for a full year. Yet the consequences of the extended period of joblessness for the mental state and behavior of the people without jobs and for the functioning of society can be significant.

Firms believe it is not cost-effective to retrain older or less-skilled workers, either because the retraining costs are higher or because the workers will not be on the job long enough or will not be productive enough for firms to recoup the costs of retraining. Firms, therefore, prefer to replace these workers with younger, more-educated workers, who may receive a higher wage but whose retraining cost is not as high. This preference (combined with the reduction in overall level of employment) not only leads to an increase in the share of the unemployed labor force made up of workers with high retraining costs, but it also threatens them with permanent unemployment or at least a long period of job search before they are able to find a new job. Of those who suffer long-term unemployment, two groups are most affected. A disproportionate share is made up of older workers whose place of employment moved or closed down or simply underwent substantial job trimming and younger people in depressed urban and rural areas, particularly members of minority groups with characteristically low incomes, many of whom have had inferior education and have never held anything but dead-end jobs or jobs in the underground economy.

The most important relationships in this analysis can be explained with a simplified example. (The same basic story applies to unskilled and older workers.) Suppose the wage of an unskilled worker is $9,000 per year and the cost of retraining is $4,000, while a skilled worker costs $30,000 in wages and $6,000 in retraining. If retraining is required every two years, the average yearly cost to the employer of an unskilled worker is $11,000, that is, $9,000 in wages plus $2,000 in retraining (half of the $4,000 required every two years). The cost of a skilled worker is $33,000 ($30,000 in wages plus $3,000 in retraining costs). This means that a skilled worker costs the employer three times as much as the unskilled employee, which implies the employer believes a skilled worker is three times as productive as an unskilled worker. Now suppose there is an acceleration of innovation so that retraining is required once a year. Assuming no change in wages, the annual cost of the unskilled worker rises to $13,000 ($9,000 + $4,000) and the annual cost of the skilled worker rises to $36,000 ($30,000 + $6,000). Now the cost of a skilled worker is less than three times the cost of an unskilled worker, meaning that unskilled employees are relatively more expensive than they used to be. If this is so, firms will try to hire more skilled and fewer unskilled workers. If many employers are facing a similar situation, unskilled workers will be more likely to lose their job and will find it more difficult to find another job.

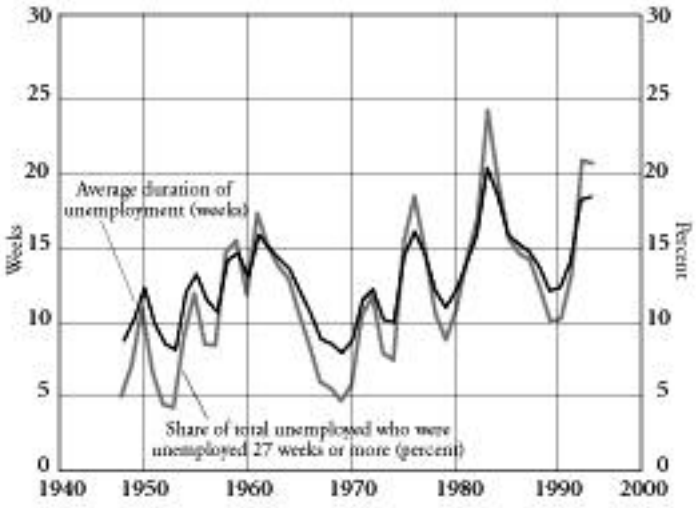
In other words, as the frequency with which workers need retraining increases, a higher percentage of those who are fired will be unskilled, and it will take those workers longer than before to find reemployment. This is clearly a way in which increased rapidity of technical change can add to the average duration of unemployment, even without taking into account the frequency with which such change increases the need for superior worker skill and education, thereby reducing still further the relative value of an unskilled worker.

Trends in the Duration of Unemployment

The duration of unemployment has risen rather dramatically over the last half century (see chart). The mean duration of unemployment approximately doubled in the United States between the early 1950s and the mid 1990s, with most of the increase occurring since the early 1970s. Between the 1970s and the early 1990s the

rise in unemployment duration was almost universal among demographic groups, with the average weeks of unemployment increasing generally about 3 to 4 weeks. Average weeks of unemployment rose more among older workers, so that the spread in unemployment duration between older (ages 55?64) and younger (teenage) male workers widened sharply, with the difference increasing from 10.8 to 17.1 weeks. Over this period the share of the unemployed composed of persons unemployed 27 weeks or more (the longest period covered in the available data) about quadrupled.

Trends in Duration of Unemployment, United States, 1948–1993



Source: U.S. Bureau of Labor Statistics, *Employment and Earnings* (Washington, D.C.: Government Printing Office, 1977–1994); *Handbook of Labor Statistics* (Washington, D.C.: Government Printing Office, 1985), Bulletin 2217, Table 15.

Protracted joblessness is an international phenomenon. For example, between the 1970s and 1990s growth in the share of long-term unemployed rose by 320 percent in Germany, 257 percent in Canada, 245 percent in France, and 144 percent in Sweden.

Effects of Technological Variables on Unemployment Duration

We carried out a statistical analysis to sort out the effects of technological, institutional, and demographic variables on changes in unemployment duration (see Baumol and Wolff 1998 for details). The analysis is based on aggregate time-series data for the United States, covering the period 1950 to 1995. Since the pace of technological change is itself almost impossible to observe directly, we used five alternative indexes to measure technological activity: the standard rate of total factor productivity (TFP) growth, the ratio of research and development (R&D) expenditures to gross domestic product (GDP), the number of full-time equivalent scientists and engineers engaged in R&D per 1,000 employees, investment in new equipment and machinery per full-time equivalent employee (FTEE), and investment in office, computing, and accounting equipment (OCA) per FTEE.

The institutional factors included the presence of unions, the minimum wage, and three aspects of unemployment insurance: the percentage of all employees covered by unemployment insurance; the replacement rate, or the ratio between unemployment benefits and the average previous wage; and the percentage of unemployed workers receiving benefits (no benefits may be due to failure to meet eligibility requirements, exhaustion of benefits, or not being covered by unemployment insurance). The demographic factors included the gender, age, and racial composition of the labor force.

The results provide strong support for the central thesis of our paper, that the duration of unemployment increases when the rate of technological change rises. The mean duration of unemployment remained largely

unchanged over the 1950s, 1960s, and 1970s, at about 11.5 weeks; it then jumped to 14.6 weeks in the 1980s and to 15.6 weeks in the first half of the 1990s. All five technology indicators were positively correlated with unemployment duration. A 1 percentage point increase in the annual rate of TFP growth is associated with a 12 percent increase in the mean duration of unemployment. Computerization is the most significant factor and has the strongest effect, implying that the major reason for the growth in the duration of unemployment is the incredible growth in computerization over the last quarter century. An increase of $1,000 (in 1987 dollars) of OCA investment per employee is associated with a 53 percent increase in the mean duration of unemployment. The other technology variables--R&D intensity and number of scientists and engineers engaged in R&D--were positively correlated, although they were not statistically significant.

The results also support our second hypothesis, that technological change affects older workers more adversely than younger workers in terms of duration of unemployment. The correlation between TFP growth and length of unemployment rose with the age group (from zero correlation for the youngest to 0.22 for the oldest). The same is true of computerization. The coefficient of OCA investment rose directly with age and is actually negative for the youngest age group (indicating that it reduces their duration of unemployment).

Social Consequences of Unemployment

There is a well-documented body of materials in the literature of sociology and social psychology that describe effects of unemployment not widely mentioned in the economic discussions (Mallinckrodt and Fretz 1988). They indicate that joblessness has a variety of consequences, such as increased suicide, divorce, psychosomatic illness, and criminal activity, whose social cost must surely be added to the forgone output that results from unemployment. Though much of the literature makes little distinction between lengthy and brief unemployment, it is reasonable to assume that a short spell of unemployment causes little lasting psychological or social damage. However, when the unemployment goes on and on and the worker begins to fear that he or she will never hold a job again, various forms of socially damaging behavior may emerge.

Policy Implications

What can the government do to offset the side effects of technological progress? How can it lighten the burden on the unemployed, make it easier for them to find jobs, and reduce the duration of unemployment?

Two changes in the unemployment insurance system could help the unemployed during extended periods of joblessness. First, and foremost, consideration should be given to increasing the 26-week cap on unemployment benefits to 39 weeks or a year. The growth in unemployment duration has caused the number of workers who are still unemployed after their benefits have been exhausted to grow by two-thirds (as a proportion of the total unemployed population) from 1975 to 1995. The exhaustion of benefits has been the major cause of the decline in the percentage of unemployed workers who receive unemployment benefits, which fell from a peak of 62.3 percent in 1975 to 35.7 percent in 1995. The benefit period now is extended under extraordinary circumstances (such as a deep recession) and only temporarily, but given the rising duration of unemployment, it seems appropriate to write the extension into legislation and make it permanent.

Second, there is good reason to increase the unemployment insurance replacement rate. It has not budged over the last quarter century; the rate in 1995, 36.5 percent, was the same as it was in 1970. In addition to the trend of increased unemployment duration, there has been a trend of declining real wages over this period that has caused real unemployment insurance benefit levels to fall. It is therefore appropriate to increase the unemployment insurance benefit formula to provide higher real benefit levels.

An objection might be raised that increasing both the level and length of unemployment insurance benefits might cause people to choose to remain on unemployment longer and therefore it would make the problem of unemployment duration worse rather than solving it. The argument goes that by reducing the cost to an individual of being jobless, the extra amount of unemployment coverage will generally prolong the duration of

unemployment for many workers. The original architects of the unemployment insurance system explicitly countered this objection, arguing that the added security individuals had while unemployed would enable them to select a job more compatible with their skills and interests. We believe that this is the case and feel that the extra coverage might give unemployed workers adversely affected by the introduction of new technology added time for retraining and acquiring new skills. Moreover, it should be stressed that the secular rise of unemployment duration over the last two decades cannot be attributed to rising unemployment benefits or length of coverage, since these have not risen over this period.

To shorten the duration of unemployment, increased government participation in retraining programs is needed. Acceleration of the obsolescence of skills with the increased pace of technological change, especially in the areas of computer and information technology, means that many unemployed workers have been left without the requisite skills to find suitable employment. Government training efforts have a long history of limited success, but part of the reason for this is that little of the retraining has been targeted to emerging technology. A targeted retraining program promises to be more effective than one aimed at old and, in many cases, obsolete skills.

Another more specific issue should be addressed: the problem of aiding the workers who are most at risk--poorly educated young people and older workers who are suspected of being unable to keep up with the job demands of technological progress. We must confess that we can give much less concrete policy recommendations on this issue. Little is known about what works to improve the educational achievements of these groups, and further research is needed. However, educators have formulated promising modifications of current teaching approaches, and the adoption of these modifications should be encouraged as an interim measure until more systematic evidence and analysis become available.

Incentives that help reduce dropping out, rewards to students and teachers for improved student performance, revision of curricula to make them more pertinent to prospective employment, and curricula designed to develop flexibility in students so that they will adapt more easily to changing job requirements are some of the steps that have been recommended by thoughtful educators. The fact that the less-educated, younger workers are so seriously affected by technological change leads to the conclusion that improving education is the approach that is most likely to have substantial and lasting results.

The prescription for older workers is similar. Adult education can prepare them to adapt to technological change and mitigate the fear of departing from long-followed work programs and practices. There is evidence that older persons can be helped to acquire the flexibility required for adaptation to change and that inflexibility on their part is as much a response to social prejudices as to the physiological and psychological effects of aging. Also, since older workers' job problems are related to employers' preconceptions, perhaps, in addition to education, incentives for the provision of jobs to older workers should be considered.

If greater retraining efforts are coupled with longer unemployment insurance coverage and higher benefits, unemployed persons will have both the means and the opportunity to acquire the new skills. The combined effect may be not just to aid workers who suffer joblessness because of technological change but to offset rising unemployment duration in this country.

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