# 7 Productivity growth and the American labor market: the 1990s in historical perspective

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## 7.1 Introduction

Like most academic disciplines, economics has become highly specialized. The purpose of this chapter is to interpret the productivity record of the 1990s in historical context, by drawing together evidence from several lines of research that tend to proceed separately from each other: the economic history literatures on the diffusion of new technologies and institutional change in the labor market; work in labor economics on real wages and wage inequality; and the evidence from growth economics on alternating surges and pauses in the pace of productivity change. Together, these perspectives point towards a linkage between the productivity surge that began during the mid-1990s and the high-pressure labor market conditions that prevailed during the same period.

The objective is not to develop a comprehensive historical interpretation of American technology and productivity, only to suggest that the labor market has been neglected in earlier accounts. I maintain that it deserves a central role in the story of the 1990s and, for that matter, the preceding century.

## 7.2 Conceptual issues

In virtually any reasonable model of the labor market, higher wages will lead to an increase in the marginal and average productivity of workers. The effect may operate through the choice of technique in production, through factor substitution within a given technique, or through compositional shifts towards more productive workers and higher-value activities; but the correlation should definitely be positive. Thus, when we observe that American real wages were 30 to 50 percent higher than those in Britain in the early nineteenth century, it is not surprising to learn that productivity levels in American manufacturing were considerably higher as well, even at those early dates.[1]

A more challenging question is whether higher wages can generate a faster *rate of increase* in productivity as well as a one-time shift in the productivity level. The proposition that America's early development of labor-saving technologies was attributable to labor scarcity was advanced by H. J. Habakkuk in his 1962 classic, *American and British Technology in the Nineteenth Century*. The Habakkuk thesis seems consistent with the evidence *prima facie*, since American productivity grew rapidly in the face of higher labor costs, overtaking the British before the end of the century. But, although subsequent research has identified many features of the emergent "American system of manufactures," it cannot yet be said that a precise analytical linkage between labor scarcity and productivity growth has been established. Perhaps the best brief summary of this literature would be that the developers of American technology – the institutional foundations of which would require a much broader historical discussion – were induced by high labor costs to orient their search for new techniques towards the labor-saving segment of the spectrum of possibilities. Because technological development is intrinsically collective or network-based in character, it tends to follow particular historical "trajectories" that are adaptive to prevailing economic conditions, of which the labor market was one important element. Because new technologies had to save labor to be successful, the pace of technology was correlated with productivity growth, whichever way the causal connection might run. Through mechanisms such as this, economic historians have succeeded in connecting high American wages to rapid productivity growth, but, clearly, the linkages are specific to a particular historical context.[2]

Inspired by these historical narratives (at least in part), some theorists have explored more formalized conceptualizations. In the context of the endogenous growth model that he pioneered, in which knowledge spillovers cause the rate of technological progress to be positively related to the rate of investment, Paul Romer (1987) shows that, when new technologies are strongly labor-saving, a fall in wages may reduce productivity growth by reducing incentives to invest in new knowledge. The implication, as Romer notes, is that a policy that forces up wages and the cost of employment might have a positive effect on the rate of productivity or even output growth, perhaps at the cost of increased unemployment.

The Romer model maintains the assumptions that labor is a homogeneous factor, and that the labor-saving bias of new technology is given exogenously. To address modern concerns about rising inequality, Daron Acemoglu (1998, 2002) focuses on the incentives facing firms that generate new technologies, which may choose to direct their efforts towards augmenting or avoiding the use of different *types* of labor, or different worker attributes. His central argument is that, if the market for new technologies is imperfectly competitive, there will be a "market size effect," channeling innovations in directions that make intensive use of somewhat *more* abundant factors. Thus, an exogenous increase in the supply (or potential supply) of educated workers can generate technologies designed to be used by such workers, because the profit opportunities for technology producers are consequently greater at that end of the spectrum. Acemoglu's approach points out the dangers of interpreting the direction of technological change by analogy to simple models of supply and demand: through the market size effect, an increase in the relative supply of educated workers may generate innovations that raise the relative demand for these workers, perhaps even increasing their relative wage in the new equilibrium.

A prime example of the Acemoglu effect would be the marked increase in the relative supply of American high school graduates between 1909 and 1929, a consequence of the "high school movement" and the end of mass European immigration during and shortly after the First World War. These labor market changes coincided remarkably with what Claudia Goldin and Lawrence Katz call the "origins of technology–skill complementarity." Modern studies generally report that new techniques are relatively intensive in skilled labor, and this property is often taken as an intrinsic feature of advanced technologies. But Goldin and Katz (1998) show that such complementarity was associated with specific new technologies such as electric motors and continuous-process methods, which enjoyed rapid diffusion during the 1920s. Although the Goldin–Katz study has the shortcoming that the new pattern "originated" in the very first year of their data (1909), evidence from the mid-nineteenth century reveals a different relationship between new technology and labor demands at that time. Atack, Bateman, and Margo (2004) find that, between 1850 and 1880, new large-scale establishments were associated with lower median wages and greater use of unskilled labor.[3]

These findings point towards a modified depiction of the Habakkuk phenomenon. Although American industrial technologies may have been labor-saving on balance, they were also designed for a new type of labor force, moving away from skilled craftsmen or artisans in favor of more elastically supplied unskilled workers, predominantly European immigrants in the late nineteenth century. Thus, the routinized, effort-intensive manufacturing jobs of the late nineteenth century may be understood as a technological adaptation to the changing characteristics of the labor force. Indeed, we may say that the pace of immigration was at least partially endogenous to the expansion of such jobs, the two sides of the market being jointly determined. Although these effects may be described as "deskilling," the analysis does not imply that the overall quality of the American labor force was deteriorating. For one thing, firms that generated new technologies (such as machine tools) were much more skill-intensive than the technology consumers, drawing increasingly on employees with advanced training. Further, the trends within manufacturing cannot be extrapolated to the economy as a whole, because the rising volume of commerce generated many positions for which educated, literate employees were required, as well as opportunities for self-employment. In light of these divergent sectoral trends, it is not difficult to see why the *fin de siècle* was an era of widening inequality in the United States.

Taken together, this body of thought and evidence implies that the direction, and perhaps the pace, of American technology has been subject to historical change; and that these shifts may be understood as responses to economic incentives, broadly conceived. But, when we come to apply this perspective to the twentieth century, the discussion also carries some methodological implications. The first is not to assume a tight, non-varying association between productivity change and new technological knowledge. Not only do new techniques require time for diffusion (itself a process governed by incentives) but the productivity implications of new technical applications may vary with labor market conditions. If technological change can be induced by changing factor supplies, and yet also fosters concomitant changes in the growth of those very factors, then there is no good alternative to examining both sides of the labor market simultaneously, with all the indeterminacy and context-specific contingency that such an approach entails.

The common practice of equating the "rate of technological progress" with change in total factor productivity is particularly hazardous. The shortcomings of TFP as a measure of technological change are frequently noted but almost as often overlooked. The core problems go well beyond the observation that TFP is measured as a residual, and hence vulnerable to errors originating in the measurement of all the included inputs and outputs. Even if our measurements were ideal, TFP tracks technological change only if new technology is "neutral" with respect to the factors of production. However convenient such an assumption is for growth accounting, it is refuted by American history. Alan Olmstead and Paul Rhode, for example, show that the vast expansion of US wheat acreage between 1839 and 1909 would not have been possible in the absence of progress in biological knowledge, primarily changes in crop varieties and cultural practices (Olmstead and Rhode, 2002). More broadly, Moses Abramovitz and Paul David's interpretation of nineteenth-century American economic growth relies crucially on the concept of biased technological change, which persistently raised the rate of return on capital and thus helped to sustain high national investment rates (Abramovitz and David, 2000). When one ponders the list of world-class American innovations making their appearance during that era, the low measured TFP growth for the century stands as a *reductio ad absurdum* for the notion that TFP measures the rate of technological change.

## 7.3 Phases of American productivity growth

The patterns to be explained are displayed in table 7.1. Although the time periods may be divided and subdivided in various ways, the periodization shown is relatively standard and adequate for present purposes. Growth rate fluctuations

Table 7.1 *Growth rates of US GDP per capita and GDP per hour worked, 1870–2004*

| | GDP per capita | GDP per hour worked |
|---|---|---|
| 1870–1913 | 1.82 | 1.92 |
| 1913–1950 | 1.61 | 2.48 |
| 1950–1973 | 2.45 | 2.77 |
| 1973–1995 | 1.76 | 1.14 |
| 1995–2000 | 2.87 | 2.10 |
| 1995–2004 | 2.29 | 2.45 |

*Sources*: Maddison (2001, pp. 186, 352); Groningen Growth and Development Centre (2005).

in GDP per capita deviate from those in GDP per hour worked for extended periods, because of changes in standard work hours (1913–1950) and in labor force participation (1973–1995). But, if we focus on GDP per hour worked as the core (albeit drastically simplified) measure of productivity, we see a sixty-year phase of accelerated growth after 1913, followed by a plunge to historic lows after 1973. A breakout from the productivity doldrums occurred in the late 1990s, though the growth rates did not reach those of the 1913–1973 era, labeled by Robert Gordon as the "one big wave" of American economic history (Gordon, 1999).

### *7.3.1 The "new economy" of the 1920s*

The American productivity explosion of the 1920s has been widely discussed. Paul David and I have found that the trend in manufacturing productivity growth jumped from 1.5 percent per year to 5.1 per cent during 1919–1929, a discontinuity that we associate with the diffusion of electric power during that decade (David and Wright, 2003). Although the use of electricity in American factories dates from the 1880s, its impact on power processes was long delayed. This diffusion narrative is multifaceted, including chapters on utilities regulation, capital market innovation, infrastructure investment, and – most fundamentally – the need for new physical structures in order to take advantage of electricity's potential for reorganizing and streamlining the flow of materials through industrial plants. When all these aspects of the technology supply-side are acknowledged, however, we still find that the productivity effect cannot be fully appreciated without also considering the incentives to channel electrification in strongly labor-saving directions.

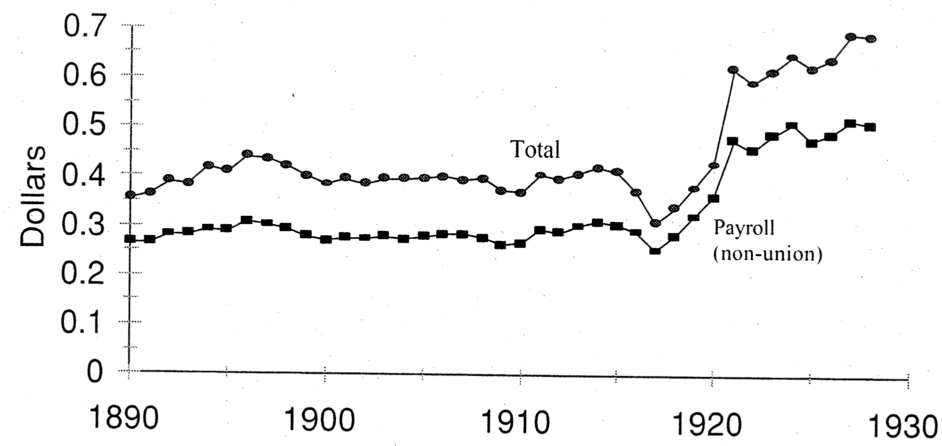


Figure 7.1 Real hourly wages in US manufacturing, 1890–1928
*Sources*: US Bureau of the Census (1975, series D766, D768) (originally from Douglas, 1930), deflated by wholesale price index (series E40); 1927–1928 – from Douglas and Jennison (1930).

Perhaps the single clearest indicator of change in the labor market is the sharp increase in the real hourly manufacturing wage, shown in figure 7.1. The real price of labor in the 1920s (relative to the cost of materials and products in the economy – i.e. from the employer's perspective) was between 50 and 70 percent higher than it had been a decade earlier. The one-time jump could be viewed as an accident of timing, because commodity prices collapsed at the end of 1920 while nominal wages were still on a rapid upward trajectory. A lag in nominal adjustment can hardly be the full explanation, however, because real wages did not decline gradually but remained at this new high plateau, and in fact drifted upwards between 1921 and 1928. Evidently, there were important "real" factors at work as well. The most immediate of these was the end of mass European immigration, which had averaged more than 1 million per year during the decade prior to 1914, but was blocked during the war and then decisively closed by legislation in 1920 and 1924. The rise in real wages ushered in a sweeping change in the functioning of labor markets, reflected in a fall in turnover and an upgrading of hiring standards. In comparison to their prewar counterparts, the manufacturing wage earners of the 1920s were more mature; more likely to be married with dependents; had more years of schooling in America and a better command of English; and were more committed to the United States as a place to live, and to industrial work as a lifetime occupation (Jacoby, 1983; Owen, 1995).

Complementarity between technological change and the high-wage economy is suggested by the fact that both wage increases and productivity change were heavily concentrated in manufacturing. Clerical and service employees did not enjoy comparable real wage jumps, presumably because these labor markets were much less affected by immigration. Nor did these sectors experience a productivity revolution at that time. Within manufacturing, complementarity is shown by the yeast-like character of the acceleration, broadly dispersed across industries, and the marked *positive* correlation between changes in capital productivity and labor productivity. The "general-purpose" character of electrification with respect to the labor market is illustrated by its widespread use in materials handling, an operation common to virtually all manufacturing. According to Harry Jerome's survey of mechanization in American manufacturing, fully half of all reported labor-saving changes were in handling rather than processing operations, even though handlers numbered less than one-fifth of non-supervisory workers (Jerome, 1930, pp. 179–90).

### *7.3.2 The 1930s and the New Deal*

The 1920s have often been seen as prosperous but short-lived, a decade of feast to be followed by the desperate famine of the Great Depression. Alexander Field's recent research, however, shows that the productivity revolution continued through the 1930s, if anything broadened and deepened with the passage of time. Although Field's emphasis is on TFP, the distinction is virtually irrelevant for present purposes, because capital formation was so limited in the Depression years. According to Field, comparisons across roughly comparable business cycle peak years reveal that labor productivity growth in the private sector was slightly faster between 1929 and 1941 than it had been between 1919 and 1929. The pace actually slowed in manufacturing (though still robust at 2.60 percent per year), but rapid productivity gains spread during the 1930s to many other sectors, particularly transportation, public utilities, and wholesale and retail trade (Field, 2003, and this volume, Chapter 5).

What sense can we make of the persistence of productivity growth in the midst of depression, obviously a radical contrast to the labor market conditions of the 1920s? As different as the decades clearly were, there were also important underlying continuities, most importantly the steady rise in the real price of labor. Figure 7.2 displays the evidence for manufacturing. Nominal wages were sticky downwards during the contraction of 1929–1933, perhaps as a consequence of the stronger attachments between firms and workers, so that real wages barely budged even as unemployment rose.[4] Hourly wages then increased across the board between 1933 and 1935, as a result of the hours and wages provisions of the National Industrial Recovery Act (NIRA), which covered virtually all of the private non-farm economy.[5] Although these effects receded when the NIRA was declared unconstitutional in 1935, additional labor measures soon took their place, with similar impact. The Wagner Act restored the provisions encouraging the organization of labor unions, with dramatic success. Expanded federal work-relief programs in effect put a floor under wage

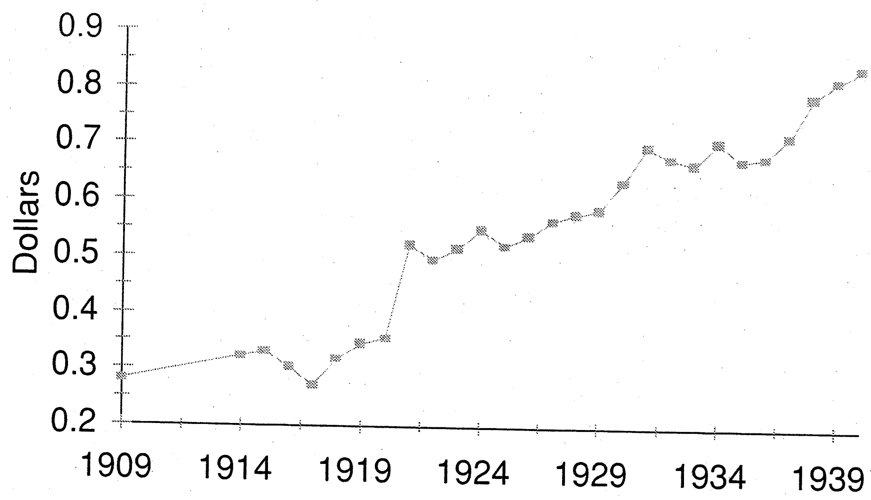


Figure 7.2 Real hourly US manufacturing wages, 1909–1940
*Sources*: Rees (1960, p. 3), deflated by wholesale price index (US Bureau of the Census, 1975, series E40).

levels, a policy that was formalized as the minimum wage in 1938 with the passage of the Fair Labor Standards Act. In short, real hourly wages rose because a steady stream of policy measures put upward pressure on wage rates, primarily (but by no means exclusively) at the low end of the distribution.

Many economists have noted that rising wage rates probably set back the process of recovery from the collapse of 1929–1933, promoting the widespread impression that mass unemployment would have to be accepted as a chronic, intractable feature of advanced capitalism. This critique undoubtedly has merit. But it has been less well appreciated that these high-wage policies also fostered the continuation of the process of labor force upgrading, begun during the 1920s. For example, the employment of scientists and engineers in manufacturing nearly tripled between 1933 and 1940, dwarfing the expansion of earlier years (Mowery and Rosenberg, 1998). Sanford Jacoby reports that the pace of employment reform quickened with the passage of the NIRA, as large corporations established personnel departments, expanded the training of foreman, and instituted centralized hiring and transfer systems, including systematic job evaluations, merit ratings, and promotion charts (Jacoby, 1985). Few of these managerial innovations were truly new, but they were accelerated during the 1930s because of continuing upward pressure on the cost of labor.

Thus, despite the radical contrast in political auspices, there were underlying continuities between the "welfare capitalism" of the 1920s and the pro-labor reforms of the 1930s, the common element being the "progressive" commitment to a high-wage economy. Herbert Hoover himself was a high-wage man, arguing against wage cuts during the downturn. David Fairris reports a strong

1920s association between productivity growth, reduction in injury rates, and the prevalence of company unions – correlations that carried over (albeit with different institutional forms) into the late 1930s (Fairris, 1997, pp. 22–46, 75–88). Pro-labor measures such as the Davis–Bacon Act of 1931 (requiring that "prevailing wages" be paid on federal and state construction projects) and the Norris–LaGuardia Act of 1932 (outlawing "yellow-dog" anti-union contracts) went into effect well before Franklin Roosevelt took office in 1933. Throughout the interwar period restrictions on the use of "child labor" and increases in the compulsory schooling age combined with the expansion of public schools to exclude teenagers from the labor market and raise the age and educational quality of the workforce (Osterman, 1980, pp. 62–74). Progressive labor policies were promoted by the New Deal using a rhetoric of economic recovery (usually some form of the purchasing power theory), but they are better seen as a continuation of the shift to a high-wage national regime, which drew support from many segments of the political spectrum.

An important difference between the decades was that the wage pressure of the 1920s was largely a labor market phenomenon, with an incidence that was mainly in manufacturing (the destination of most European workers). The wage increases of the 1930s were driven much more by legal and regulatory measures, which were felt more broadly throughout the economy. Thus, the spread of productivity change across sectors is quite consistent with the thesis of this chapter.

To be clear, the argument is not that productivity growth can be "reduced" to compositional change in the labor force, in growth accounting terms. These were genuine productivity-enhancing improvements, "technological progress" in the broad sense, including organizational reforms to retain and allocate labor more effectively, taking advantage of its better education and greater maturity. But technological change was "biased" towards human capital, an effect that is obscured if not missed entirely when labor attributes are collapsed into an index of labor force quality.

### 7.3.3 *The postwar "golden age"*

Although New Deal labor market policies may have slowed recovery from the Great Depression, they also set the stage for the high-wage, high productivity growth, human-capital-oriented regime of the postwar years. Decisions by the National War Labor Board confirmed the compression of wage differentials from the 1930s, and the renewal and broadening of minimum wage coverage maintained upward pressure on entry-level wages (Goldin and Margo, 1992). Diffusion of the high school norm continued through the 1950s, finally reaching the southern states at that time. At the other end of the distribution, postwar policies gave major federal support both to science-based technological

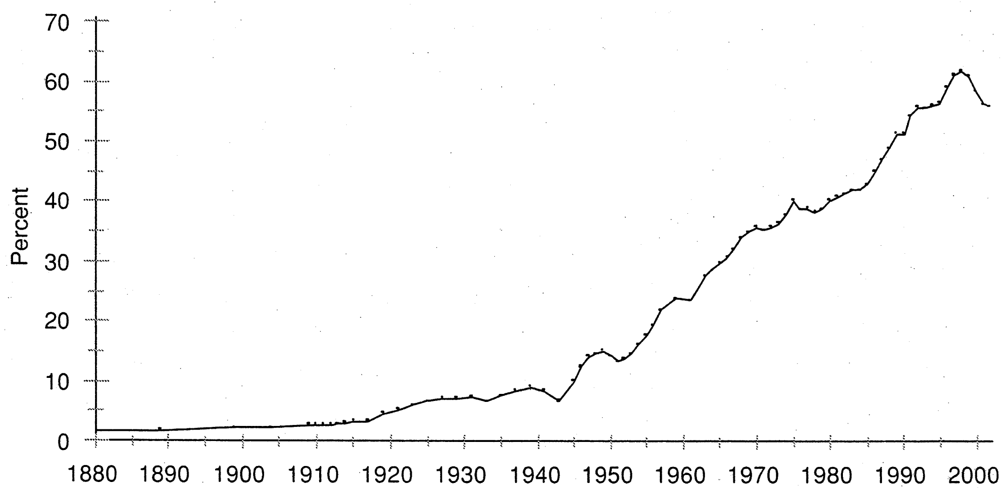


Figure 7.3 US college enrollment as a percentage of the population aged eighteen to twenty-four, 1880–2002
*Sources*: 1880–1988 – US Department of Education (1993, table 24); 1989–2002 – US Department of Commerce (various dates).

development and to expanded higher education. Figure 7.3 displays evidence on the dramatic rise of college enrollments as a share of the eighteen- to twenty-four-year-old population. The surge began in 1946 when the GI Bill of Rights took effect, but the greatest increases occurred between the mid-1950s and the mid-1970s.

These developments have frequently been discussed as aspects of American economic leadership, on the one hand, or the history of inequality on the other (Nelson and Wright, 1992, pp. 1950–4; Goldin, 2001). But presumably they are also relevant for the extraordinary productivity performance of the postwar era: nearly 3 percent per year for a quarter-century. Small wonder that regular annual increases in productivity and real wages seemed to be routinized and technology-driven. Although both sides of the labor market were buttressed by vigorous public policies – federal research support programs channeled through numerous agencies, and financial subsidies for higher education from both national and state governments – the fundamentally positive economic association between human capital and science-based technology was reflected in the expansion of private corporate R&D funding, and in the response of enrollments to the derived demand for technically trained personnel. Many of the institutional specifics were markedly changed from the interwar years. Yet this broad complementarity imparts an essential unity to the "one big wave," extending from the 1920s until the early 1970s.

Can we say, then, that there were inherent limits to the half-century of high productivity growth, that its demise was historically inevitable? Viewing the wave as a complementary coevolution of technology and labor upgrading adds a degree of specificity to the oft-stated but rarely elucidated proposition that the country was "running out of new ideas" by the 1970s. Most often, this possibility is discussed with respect to the development and diffusion of major innovations. In the case of electrification, for example, it is clear that the transition from steam power to electricity was largely complete by the 1950s. Increased utilization of fixed capital – an effect of electrification that augmented both labor and capital productivity – made a substantial contribution to growth from the 1920s through the 1960s, and subsequently receded as an obvious upper limit was approached (Foss, 1981, p. 6; 1985, p. 59). A second set of advances (at least in measured productivity) that may have faced inherent limits was the cluster of complementary innovations associated with the transition to the automobile, such as highways, supermarkets, and suburbs. In this case the constraints on further progress may not have been purely technological, but rising energy costs undoubtedly impinged on further geographic spread during the turbulent 1970s. The same issues arise with respect to a third technology cluster, the stream of new products based on petroleum, flowing from the merger of modern science with America's long-standing strength in minerals, and ranging from petrochemicals to plastics to pharmaceuticals (Gordon, 2000b, pp. 59–60). In all these examples the complementarities are not difficult to identify, but the nature of the learning process and the bases for diminishing returns are more challenging. Such exercises are inherently speculative, because it is in the nature of dynamic technological societies for new trajectories to replace old ones, generally in directions that were unanticipated by scientific and economic experts alike.

Linking new technology to the labor market allows us to use more objective measures. Innovators may not have been "running out of ideas" in an engineering sense, but opportunities for high-pay-off *economic* applications of new technologies may have been diminishing, because a process of upgrading educational standards has built-in limits. If we measure labor force quality as the fraction of the workforce reaching a given level then, obviously, the adjustment must end at some point. The diffusion of the high school norm was largely complete by 1960, and even the return to higher education may have been entering a region of diminishing returns (though clearly not an upper limit) in the 1970s.[6] These measures may seem artificial, since schooling benchmarks are not true limits to human capacities. But they may track real-world co-adaptations between job specifications and worker attributes. Peter Rangazas (2002) notes that the relative size of schooling investments (e.g. the share of GDP, the fraction of teenagers' time spent in school) rose dramatically to around 1970, making the obvious point that such ratios cannot rise indefinitely. Rangazas argues that a significant portion of US productivity growth was thus "transitional" in character and hence unsustainable.[7]

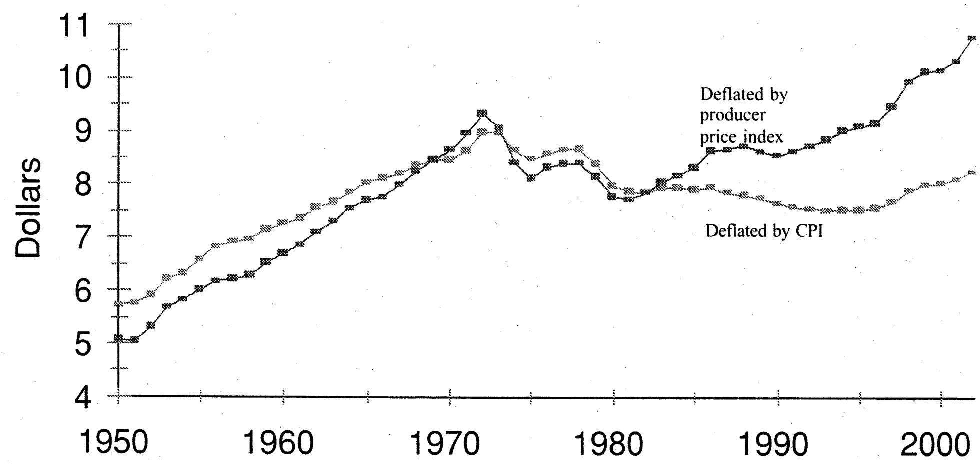


Figure 7.4 Real hourly wages in the United States in 1982 dollars, 1950–2002
*Sources*: US Council of Economic Advisers (2004, table B-47; 1992, table B-42; 1990, table C-44); Producer Price Index for finished goods from US Department of Commerce (various dates).

## 7.4 The productivity slowdown

Whether limited internally by diminishing returns or externally by something else, one can hardly overlook the historical correspondence between the 1970s drop-off in productivity growth and the end of the fifty-year wave of labor force upgrading and rising real wages. The reversal of trend in labor quality was sufficiently dramatic by 1984 for Michael Darby to declare the entire slowdown "a case of statistical myopia," writing that "simple demographic adjustments [age, sex, and educational attainment] eliminate any decline in technical progress" (Darby, 1984). Associating productivity with labor market developments is a valuable insight, too often neglected. But to collapse the labor market in this (exogenous) way is to explain the phenomenon away, not to explain it historically.

But history seldom cooperates with economic science by serving up natural experiments that neatly illustrate the forces at work. The technology–productivity trajectories of the 1920s through the 1960s may have been headed towards endogenous slowdown, but this "soft landing" was not played out because the course of history was interrupted by the dramatic external events of the 1970s. The energy crisis of that decade was acutely disruptive to American technological progress, but not along margins of labor quality, or at least not directly so. The subsequent experience of "stagflation" and social turmoil only added to the dislocation. Nominal wage increases continued, but real wage growth came to an end through inflation, as suggested by figure 7.4. Although the inflation may be characterized as a clash between aspirations and

Table 7.2 *Measures of wage inequality for weekly wages in the United States: full-time, full-year workers*

| | *Percentiles of log wage distribution* | | | |
|---|---|---|---|---|
| | 90–10 | 90–50 | 50–10 | Gini coefficient |
| **Males** | | | | |
| 1963 | 1.19 | 0.51 | 0.68 | 0.250 |
| 1971 | 1.16 | 0.55 | 0.61 | 0.270 |
| 1979 | 1.27 | 0.55 | 0.72 | 0.277 |
| 1987 | 1.47 | 0.65 | 0.82 | 0.313 |
| 1995 | 1.54 | 0.74 | 0.79 | 0.343 |
| **Males and females** | | | | |
| 1963 | 1.27 | 0.57 | 0.70 | 0.272 |
| 1971 | 1.31 | 0.62 | 0.68 | 0.293 |
| 1979 | 1.35 | 0.66 | 0.69 | 0.299 |
| 1987 | 1.44 | 0.70 | 0.74 | 0.320 |
| 1995 | 1.54 | 0.76 | 0.78 | 0.340 |

*Sources*: Katz and Autor (1999), p. 1475; 1963–1995 – US Bureau of the Census (various issues).

economic reality, the new constraints were far from clear at the time. Only with more years of observation than were available to Darby did it become evident that the country had entered into a more lasting period of slower productivity growth.

The literature on labor markets during this era, however, is mainly about inequality. The onset of the productivity slowdown and average real wage decline coincided with a general widening of wage differentials in the economy. Table 7.2 displays summary measures of inequality in weekly wages, all showing a steady increase dating from the 1970s. Discussions of this phenomenon have taken the general form of compiling factors contributing to increased inequality, and then debating estimates or opinions on the relative importance of each one. A standard list includes skill-biased technological change; international trade; immigration; and a sub-folder of "institutional" developments, such as the fall in the real minimum wage and the decline of unions. Of the explanations on the list, skill-biased technology has been most popular among economists. Although it is not possible to review this entire literature here, anyone who has read this far will know that the author does not find claims of an exogenous skill bias in technology either plausible or persuasive. Many studies reporting this finding focus on manufacturing; but most manufactured goods are tradable, so the bias of new technologies adopted in that sector was shaped

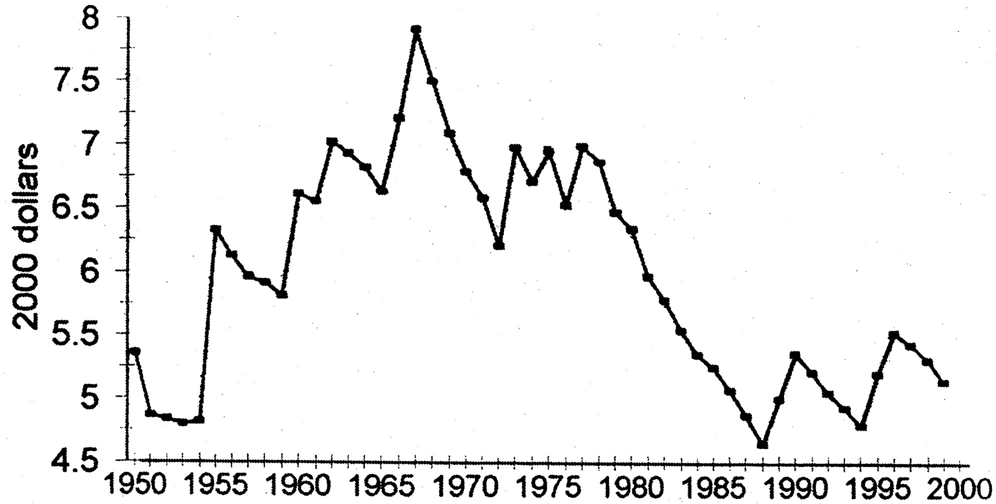


Figure 7.5 Real federal minimum wage in the United States, 1950–2000
*Sources*: US Department of Commerce (2001, p. 405); wage data from US Employment Standards Administration, deflated by the CPI-U.

by the country's changing comparative advantage niche in the world economy, as opposed to imperatives inherent in the technology itself. Because manufacturing had recovered its former productivity pace by the 1980s, it was clearly not representative of the broader economy. David Card and John DiNardo point out that the experience of the 1990s, when wage inequality stabilized despite continuing progress in computer technology, is deeply challenging for the skill-biased technical change thesis (Card and DiNardo, 2002).

Rather than attempt to track down each one of these purportedly separable and independent causal factors, I propose a simpler unifying hypothesis: both the decline in average real wages and the rise of wage differentials are attributable to the advent (perhaps reinstatement would be the more appropriate term) of "flexible labor markets," reversing fifty years of labor market policy. Merely as one illustration of the extent of the policy swing, figure 7.5 displays the change in the real minimum wage between 1950 and 2000. It is common to consign this item to a minor bit role in the drama, on the grounds that a relatively small share of the workforce actually works for the minimum wage and would therefore be directly affected by these changes. But David Lee shows that, when one takes into account the full wage distribution, drawing evidence from cross-state variation in the minimum wage's "bite," this factor alone can account for nearly all the increased dispersion in the lower tail, and up to 80 percent of the increase in "within-group" inequality during the 1980s (Lee, 1999).[8]

One need not take a strong position on the impact of the minimum wage *per se* in order to recognize that an economic "regime change" began in the

1970s. Many, if not all, of the items on the conventional list of contributing factors may be understood as endogenous or complementary components of the larger transition to a new equilibrium package. Thus, the decline in average levels of US unemployment (relative to those in Europe) was associated with the opening of lower-wage jobs that would previously have been prohibited, as well as with reduced coverage of unemployment insurance. The rise of immigration between the 1950s and the 1990s – from 2.5 million to more than 9 million for the decade – clearly put downward pressure on the unskilled wage. But it was not an exogenous development. Most immigrants came to the United States in response to job opportunities with limited entry qualifications, made possible by effective deregulation of the labor market. Much the same can be said for the rise of labor force participation and working hours per capita, both major factors in maintaining income growth in the face of declining real wages per hour (table 7.1).

Obviously, the transformation of women's role in the economy has had many causes and components, social as well as political and economic. But it has also been complementary to the rise of part-time employment and temporary work, one of the fastest-growing segments of the American labor market (Golden, 1996; Autor, 2004). According to Linda Bell and Richard Freeman, the best explanation for Americans' addiction to long hours and hard work is the "inequality hypothesis," the incentives offered by wage differentials to work one's way up the distribution (Bell and Freeman, 2001). John DiNardo, Nicole Fortin and Thomas Lemieux (1996) find that "labor market institutions [particularly the real minimum wage and de-unionization] are as important as supply and demand considerations in explaining changes in the US distribution of wages." But, when we allow that many important changes in supply and demand were themselves attributable to labor market institutions, it is clear that their conclusion is an understatement.

There is nothing particularly novel about depicting American "flexible labor markets" as a package of complementary elements. In labor economics this formulation is known as the "unified theory." As compared to Europe, American labor markets feature less collective bargaining, less generous unemployment insurance benefits, easier lay-offs, and fewer government regulations; with the results that wages are more flexible, wage differentials greater, and average unemployment levels lower (Blau and Kahn, 2002, pp. 3–6, 219–27). What is often missed in these analyses, however, is the fact that these features of the US labor market – or, at least, the extent of their international distinctiveness – are relatively recent, a marked change from the more unionized and regulated labor markets of the 1950s. Blau and Kahn, for example, write that differences in labor market institutions between the United States and Western Europe were "largely the same" in the 1960s and early 1970s, concluding that the difference must not lie in institutional performance *per se* but in the responsiveness of institutions to "shocks." Chief among these shocks, they list the slowdown in productivity growth dating from the early 1970s (p. 5).

It is evident from figure 7.4 that a regime change occurred after 1973. In addition to an historical perspective on labor market institutions, what is offered here is the further suggestion that this regime change was itself an important contributor to the post-1973 productivity slowdown. The much-discussed issue of possible upward bias in the consumer price index is not particularly relevant for the present point. We are not evaluating the well-being of workers but the stimulus to implement labor-saving technology. Even relative to producer price indices (i.e. from the employer's perspective), real hourly wages had not recovered to their early 1970s peak by 1990. American employers had far less incentive to economize on labor after 1973 than in prior decades. The first blows to real wages in the 1970s may have originated in energy markets and inflation. But one does not require advanced expertise in American history to know that a major change in the political landscape set in after 1980, especially where labor was concerned.

## 7.5 The 1990s

Although not as eye-catching for the general public as the dot.com boom, the surge of productivity in the late 1990s has received almost as much attention from economists. Already two important points of consensus have emerged: that the acceleration was broadly dispersed within the economy, including service sector industries long thought to be impervious to productivity growth; and that it was closely linked to the diffusion of computer-based information technology. Thus, William Nordhaus finds that "there has been a substantial upturn in on-new economy productivity growth... It is clear that the productivity rebound is not narrowly focused in a few new economy sectors." Similarly, Kevin Stiroh concludes: "Eight of ten sectors show productivity growth increases, and relatively large sectors like wholesale trade, retail trade, and services all show sizable gains." Jack Triplett and Barry Bosworth announce with enthusiasm that "Baumol's Disease" – the hypothesis that productivity improvements in services are inherently less likely than in goods-producing sectors – has been cured, citing rapid productivity growth in these areas after 1995. Andrew Sharpe and Leila Gharani report that "the productivity renaissance in the service sector is broadly based, with four of the six basic service sector industries showing at least a one percentage point increase in labour productivity growth between the 1989–1995 and 1995–1999 periods."[9]

Why should such a sudden break from the past have cropped up in so many disparate industries at the same historical juncture? Productivity analysts are simply not in the habit of connecting their measurements to the state of the labor market. Stiroh, for example, considers two possible explanations. The first is that some lag was needed in order to implement IT successfully and reap the productivity pay-off, citing firm-level studies emphasizing adjustment costs, learning lags, and delays in complementary innovations. The second is that firms do not focus on the present but invest in IT in anticipation of future productivity gains (Stiroh, 2001, pp. 32–3). No role for labor market conditions either way. For another example, consider Martin Neil Baily's comment on Robert Gordon's econometric work:

> I see nothing in the actual data for the 1990s to suggest that productivity began to accelerate before 1996, but in Gordon's results using filtering methods . . .the productivity acceleration started in the early 1990s. Maybe that is correct. I have to admit there seems to be no smoking-gun explanation of the shift in trend that can account for a sudden trend break in 1996.[10]

If you look to the labor market, you can find a smoking gun in the mid-1990s. Figure 7.4 shows that real hourly wages finally began to rise at precisely that time, after more than two decades of decline. The fall was less marked when wages are deflated by producer prices, but by that measure (representing the cost of an hour's labor relative to goods in the economy) the jump in the late 1990s was particularly sharp. The wage evidence may be buttressed by several supplementary indicators confirming that, despite the deregulated institutional structure of the US labor market, demand pressures began to press against available supplies at that time. Unemployment rates fell below 4 percent – levels reached only briefly in the 1960s and well below the norm for the 1950s. Labor force participation reached a peak, and the ratio of employment to population reached an all-time high in 2000 (figure 7.6). Should it be surprising that employers turned to labor-saving technologies at this time?

Clearly, the productivity surge drew upon new IT technologies, as shown by numerous studies. Stephen Oliner and Daniel Sichel attribute nearly 70 percent of the acceleration in labor productivity (from 1991–1995 to 1996–1999) to the direct and indirect effects of information technology.[11] Stiroh reports that IT-intensive industries experienced productivity growth about one percentage point per year faster than other industries, while non-IT-intensive industries showed essentially no acceleration (Stiroh, 2001, p. 34). Triplett and Bosworth (2003) find, contrary to stereotype, that "the most intensive IT industries in the US economy are overwhelmingly services industries." Although most economic studies take a "black box" approach, proxying IT diffusion with measures of capital investment, there are some indications that organizational restructuring using IT technology was particularly important. Triplett and Bosworth note that intermediate inputs made a substantial contribution to labor productivity growth in the 1990s, reflecting increased reliance on "contracting out." Studies of labor intermediation suggest that the rise of temporary help agencies was significant in improving the efficiency of the labor market, including both employee screening

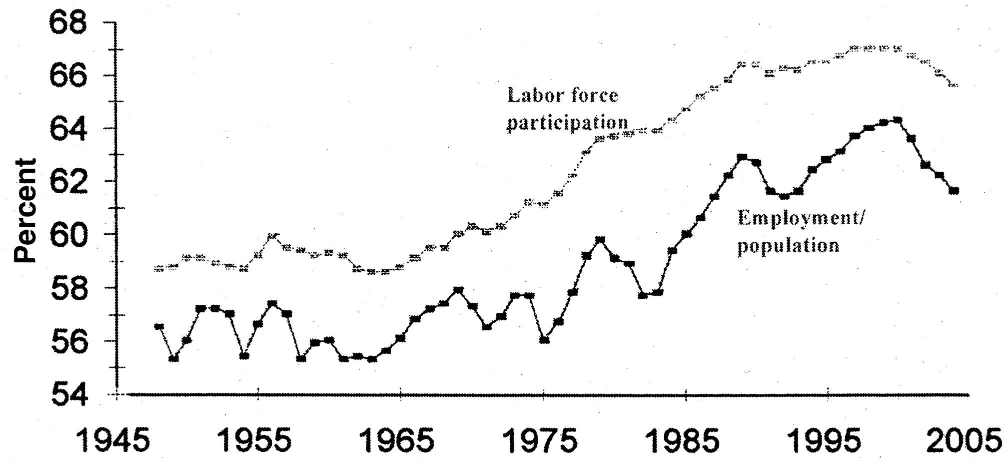


Figure 7.6 Employment ratios in the United States, 1948–2004
*Sources*: US Bureau of Labor Statistics (2005); Labor Force Statistics from the Current Population Survey (http://data.bls.gov/servlet/SurveyOutputServlet).

and flexibility in response to demand fluctuations (Katz and Krueger, 1999, pp. 48–53; Segal and Sullivan, 1997, pp. 127–31).

Such sophisticated managerial systems depended crucially on new information technologies. But was the acceleration *driven* by the progress of that technology? Because of their mutual interdependence, it may be impossible to answer this question definitively, but the timing of the break suggests that the proximate impetus came from labor market pressures. Particularly suggestive is the evidence presented by Jessica Cohen, William Dickens, and Adam Posen (2001, pp. 234–40) in their survey on the diffusion of a new set of practices known as high-performance work organization (HPWO). Examples include job rotation, pay for knowledge, autonomous teams, total-quality management, and quality circles. The central objectives are to increase the firm's ability to move workers between jobs within the firm and to facilitate the matching of new hires to jobs. The adoption of HPWO dates from the 1980s but it accelerated in the late 1990s. Of nine interviews with human resource managers, "two interviewees explicitly denied that advances in IT were an independent motivating force, and all but one of the others either did not mention IT or downplayed its effect, characterizing it as limited to administrative matters . . . The one remaining subject did draw the connection that 'E-commerce has been important in speeding up the business cycle.'" The authors associate the latter comment with competitive product-market pressures, which raised the value of flexibility to the firm.

Similarly, McKinsey's analysis of US productivity growth during 1995–2000 found that the bulk of the acceleration in wholesale and retail trade was directly or indirectly attributable to managerial innovation at one firm, Wal-Mart. IT was important at Wal-Mart, but the McKinsey report (2001) stresses that IT was only one of many management tools; IT was often "a necessary but not sufficient enabler of productivity gains."

## 7.6 The identification problem

Economists reading this account may wonder about the direction of causal effect. We teach our students that wages are determined by productivity in the long run. So, if wage growth and productivity growth are historically associated, how can we say that productivity was driven by wage pressures rather than the other way around?

The earlier historical episodes are particularly helpful in this regard. In the interwar period wages increased for reasons exogenous to productivity. In the 1920s real wages jumped upwards because of a dramatic fall in prices, superimposed on a labor market that was adjusting to a major change in immigration policy. Under the New Deal in the 1930s wages were directly increased by policy, clearly not prompted by surging labor demand. In both decades accelerated productivity growth is best viewed as a lagged response to increased labor costs by employers, who used technology and organizational change to raise productivity to match the new higher wage levels.

In the postwar era real wages were driven less by policy and more by market processes. Even then, market forces were complemented by policies such as the rise in the minimum wage and the extension of its coverage, and wage increases were to some extent "institutionalized" in union contracts. But, when real wages and productivity rise together over an extended period such as this one, we should certainly characterize them as jointly determined. The "end of the era" in the 1970s suggests, however, that a painful adjustment process was required before wage behavior adapted to the new economic reality. The high-growth era really had come to a close, but neither workers nor policymakers realized this, as they continued their efforts to restore real wage gains in the late 1970s, beyond what the economy could deliver (figure 7.4). When recovery materialized in the 1980s the discontinuity in the trajectory of real wages was considerably more marked than in productivity, suggesting that the primary impetus came from the labor market. Acemoglu (2002) portrays the extended absolute decline in the real wages of low-skilled workers as a "puzzle" for economists, and his research survey concludes that the role of technology in this trend is indirect – i.e. in its interaction with changes in labor market institutions and the organization of firms.

The real-wage turning point in the mid-1990s is most plausibly attributed to macroeconomic conditions, when an accommodating Federal Reserve allowed employment to press against labor supply for the first time in a generation. Although the macroeconomy was propelled in part by speculation in technology stocks, we have no evidence that this surge was triggered by a trend break in advance of the underlying technologies themselves. On the contrary, historical studies of applications of computer technologies to the American workplace stress the long-term, incremental, evolutionary character of the process. In retail trade – a prime illustration of mid-1990s discontinuity in productivity – James Cortada lists eleven key IT applications in the retail industry *circa* 1995–2001, including electronic shelf levels, scanning, electronic fund transfer, sales-based ordering, and internet sales. Cortada (2004, p. 307) then notes that, "with the exception of e-business, the list could have come from the 1970s and 1980s, and that is the key point."

To be clear, the emphasis on labor markets here is not intended as an alternative to scenarios highlighting the need for learning and adaptation before the potential from new technologies can be fully realized. Many micro-level studies confirm that productivity gains from IT require a package of complementary adjustments, often quite radical reorganizations of internal communications and new types of interaction with suppliers and customers (Brynjolfsson and Hitt, 2000, pp. 25–30). The example of electrification in the 1920s is often invoked in such studies, and the same analogy applies here. Computer-based technologies may have arrived at new levels of reliability and capability by the 1990s, so that the same effects could not have been expected a decade or so before. But the key point is that the incentive to channel the applications of this potential towards labor productivity is separable from adoption decisions *per se*. Retail operators such as Wal-Mart, J. C. Penney, and Gap were innovative IT adopters for decades, calculating inventory, accounting and delivery costs with increasing precision. They turned their innovative energies towards productivity when the price of labor time began to rise in the mid-1990s. Thus, *both* blades of the scissors are required to account for the productivity surge.[12]

## 7.7 Conclusions

Throughout the twentieth century periods of rapid productivity growth have also been periods of strong upward pressure on real hourly wages. The productivity surge of the late 1990s provides the latest illustration of this empirical regularity. Of course real wages and productivity are mutually interactive, but in each of the major phases one can point to distinct historical circumstances operating in the labor market, suggesting that the primary causal influence ran from the labor market to productivity rather than the other way around. At a minimum, this channel deserves a more prominent place in productivity history than it has received thus far. It has been largely overlooked, perhaps because of prevailing patterns of specialization within the economics profession.

Pursuing this proposition poses a challenge for conventional econometric research, because it is not advanced as a general economic law, valid for all historical times and places. A claim that higher wages always generate productivity-enhancing innovations would be seriously faulty. Within the historical scope of this chapter, such a claim is refuted by the experience of the 1970s, when upward pressures on wages led mainly to higher inflation and unemployment. Perhaps the older technological paths were largely exhausted in the 1970s, and they may not have been well suited for the changed economic situation anyway. Newer technological responses were not then readily at hand. Unfortunately, such diagnoses are far easier to construct after the fact than before, because we lack reliable measures of "technological potential" at a particular point in time and so can only infer potential after observing the technology in practice.

Sometimes we do know, however, that best-practice technology is in flux, and that new methods are emerging that have not yet widely diffused. That is one way to read the extensive discussion of the "productivity paradox" from the 1970s to the mid-1990s. In these situations, history shows that the detailed factor-using properties of new technologies are highly malleable, subject to influence by labor market conditions at the time of adoption. Theorists since John R. Hicks have attempted to understand the linkages among technological progress, factor-saving bias, and labor market conditions. As yet they have not arrived at a satisfactory or consensus model. But that shortfall is no reason to neglect the empirical regularities that gave rise to the theoretical project.

## Notes

For helpful suggestions on an earlier draft, I thank Peter H. Lindert, Howard Pack, Paul W. Rhode, and William Sundstrom. But I am solely responsible for all views expressed.

1. On wage levels, see Adams (1970) and the summary in James and Skinner (1985, pp. 537–9). For a comparison of labor productivity as of 1840, see Broadberry and Irwin (2004).
2. This is a drastically condensed summary of a large literature. For an explicitly search-based interpretation of the Habakkuk thesis, see David (1975, chap. 1). On the network character of American technology, see Wright (1999).
3. An earlier study showing that larger establishments were associated with the greater use of women and children during the "early industrialization" period (1820–1850) is Goldin and Sokoloff (1982).
4. O'Brien (1989). For evidence that downward stickiness was not limited to large manufacturing firms, see Simon (2001).
5. Weinstein (1980, pp. 29, 52, 60) finds that the NIRA increased nominal hourly wages by as much as 26 percent during this period, relative to levels that would otherwise have prevailed.
6. Goldin (2001, p. 285) reports that the return to a year of college education declined between 1970 and 1980, before rising in the 1980s.
7. Rangazas (2002) does not include higher education in his analysis, nor does he consider complementarity between human capital and technology.

8. See also DiNardo, Fortin and Lemieux (1996) on the impact of the real minimum wage.
9. Nordhaus (2002, p. 242); Stiroh (2001, pp. 32–3); Triplett and Bosworth (2003, pp. 23, 30); Sharpe and Gharani (2000, p. 6).
10. Baily (2003, p. 282). According to the published account, none of the discussion of Gordon's paper considered the labor market as a potential cause of "exploding productivity growth" in the 1990s.
11. Oliner and Sichel (2000, p. 19). They also report that the broad picture is similar in three other studies (p. 14).
12. Note that accelerated productivity growth continued beyond the end of the boom, as shown in table 7.1. Although this persistence is at first surprising, one should also note that the rise of real hourly wages costs also continued through 2002 (figure 7.4). Thus, the correlation is quite consistent with the theme of this chapter.