Explaining the Growing Inequality in Wages across Skill Levels

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During the 1980s, the gap between the earnings of low-skilled and high-skilled workers grew substantially in the United States. Researchers have advanced a number of arguments to explain the increasing disparity. This article uses descriptive and statistical evidence to evaluate two of the most prominent arguments: increased competition from low-wage developing countries—the "trade" argument—and technological advances favoring high-skilled workers. We also consider other proposed explanations of growing wage inequality, although in less detail.

We conclude that technological change, combined with overall growth in the capital stock, is the most important factor driving the growing wage inequality between low-skilled and high-skilled workers. Increased competition from abroad, both from developing and industrialized countries, appears to explain a significant but much more modest portion of the growing gap. A third substantial source of growth in the wage differential is the shift in demand for the products of different industries.[1]

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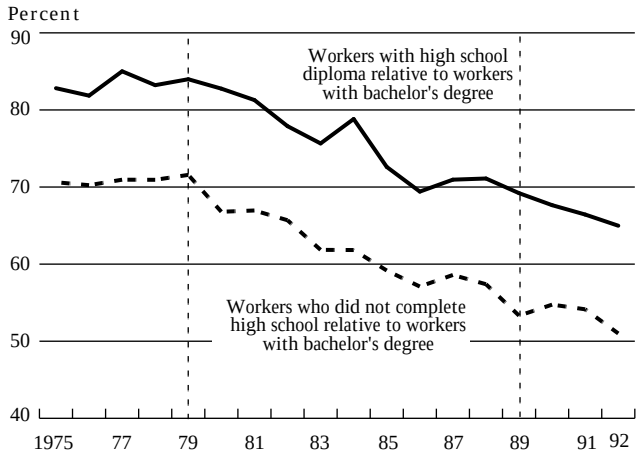
Wage Trends in the 1980s

During the 1980s, there were several striking developments affecting wages in the United States. By at least some measures, real hourly earnings stagnated or declined for most groups of workers, and at best they increased at a far slower rate in this decade than in the 1960s and early 1970s.[2] The stagnation in real wages mostly reflected much slower productivity growth than in earlier decades. Although benefits increased more rapidly than wages, broader compensation measures also showed little or no real growth during the 1980s.

Another significant development of the period, and the focus of this article, is the sharp rise in wage inequality across skill levels. Decomposing earnings data by

Chart 1

Relative Earnings, by Education Level
Male Year-Round, Full-Time Workers, age 25 to 34



Source: Census Bureau tabulations of data from Current Population Survey.

educational attainment, our primary indicator of skill, shows that for male year-round full-time employees aged 25 to 34, the ratio of annual earnings for those with only a high school diploma relative to those with four years of college fell from 88 percent in 1979 to 68 percent in 1989 (Chart 1). For those with less than twelve years of schooling, the ratio relative to college graduates fell from 72 percent to 54 percent over the same period. Census data show that between 1979 and 1989, median annual wage and salary income for year-round full-time manufacturing workers with at least some college education fell 2.1 percent, while for those with no more than a high school diploma it fell 11.3 percent.[3] A similar pattern is evident within other broad industry categories. Likewise, occupational breakdowns show a rising disparity by skill level: between 1982 and 1989, real white-collar earnings rose 7 percent, while real blue-collar wages fell 2 percent.[4]

Prominent Explanations for the Wage Gap

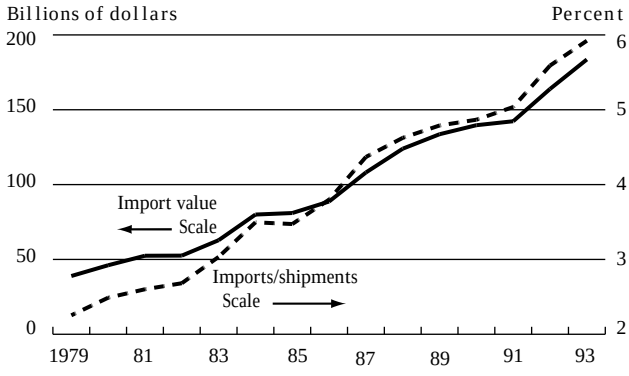
Two explanations for the widening skill differentials of the 1980s have drawn particular attention: international trade and technological improvement.[5] According to the first, cheap imports produced by mostly unskilled workers in less developed countries have depressed the wages of unskilled U.S. workers who produce competing goods. According to the second, technological change has increased the demand for skilled workers relative to the less skilled. The next two subsections discuss each of these arguments in turn, noting what other researchers have to say about each one.

Trade Effects

Trade theory suggests that imports from developing countries could indeed have worked to depress unskilled U.S. workers' wages. The factor price equalization theorem in its most stringent form predicts that if goods sell for the same price regardless of where they are produced, then workers who produce them will earn equal wages. If, more realistically, we allow nonnegligible transportation costs and production techniques to vary across countries, we would still expect to see a tendency toward equalization of prices and wages as international trade expands. Thus, with increased imports of unskilled-labor-intensive goods from developing countries we would expect to observe downward pressure both on the prices of U.S.-produced goods subject to competition from these imports and on the wages of the (mostly unskilled) U.S. workers who produce them. In fact, as Chart 2 shows, imports from developing countries have increased sharply both in constant dollar terms and as a percent of manufacturing shipments. The

Chart 2

U.S. Manufactured Goods Imports from Developing Countries



Source: U.S. Department of Commerce.

existence of capital mobility could, by permitting greater equalization of techniques, enhance the tendency of wages to equalize.

Although the theoretical case for factor price equalization is compelling, the verdict on the actual effects of trade on wages has not yet been reached. One major study captures this ambiguity. Katz and Murphy (1992) conclude that increases in import penetration ratios could not explain wage developments during the 1963-87 period as a whole. They do, however, find somewhat stronger trade effects near the end of this period.

Lawrence and Slaughter (1993), who focus on the 1980s, make the strongest case against the trade argument. They contend that prices of low-skill manufactured goods did not fall relative to those of high-skill manufactured goods. Thus, they conclude, international trade could not have put downward pressure either on prices of low-skill goods or on wages of unskilled workers. They also argue that factor price equalization implies a rise in the percent of unskilled workers within industries.[6] This rise did not occur during the 1980s, although, as they point out, other developments may have prevented the rise from occurring.

Krugman and Lawrence (1994) dismiss imports from developing countries as an explanation of 1980s wage trends simply on the grounds that these imports were quantitatively small. Sachs and Shatz (1994) question this reasoning but do not find significant empirical evidence of an effect on wages. They do, however, find that imports from developing countries significantly reduced employment of unskilled production workers. This result suggests that imports may have indirectly depressed the earnings of unskilled workers through displacement into lower paying industries or through crowding effects. Furthermore, Borjas and Ramey (1993) conclude that imports had a significant effect on unskilled workers' earnings in highly concentrated industries such as autos and steel.[7] Their findings primarily involve imports from other industrialized countries, and consequently do not fit easily into the theoretical framework outlined above. These findings do, however, point out the need to examine trade effects in a broader, global context.

Technological Improvement Effects

Skill-biased technological advances, especially those linked to the computer revolution, may have increased demand for skilled workers by enhancing their productivity. In addition, technological change may have reduced demand for unskilled workers, perhaps because they lack the ability to use technically advanced methods. In support of this view, Bartel and Lichtenberg (1987) have shown that as new technology is adopted, the demand for highly educated workers increases relative to the demand for less educated workers. The authors suggest that the more educated workers' advantage derives from problem-solving ability and receptiveness to change in the working environment rather than from specific skills acquired in school. A simpler explanation holds that computers and other advanced machinery have replaced less skilled workers in the performance of certain tasks.

Most authors who have examined the issue have concluded that the observed changes in the wage structure can be linked to technological change. However, the tests in these studies tend to be indirect or to cover only a particular aspect of technological improvement, and few explicitly address possible trade effects. For instance, Bound and Johnson (1992, 1995) conclude that the relative increase in demand for skilled labor triggered by technological change could explain most of the change in observed skill differentials during the 1980s. They reach this conclusion, however, only by ruling out other possible explanations. Berman, Bound, and Griliches (1994) find that the increase in demand for skilled workers relative to unskilled workers within manufacturing industries during the 1980s could be linked to investment in computers and in research and development. Krueger (1993) demonstrates that workers who used computers earned 10 to 15 percent more than observationally equivalent workers who did not. Because highly educated workers were more likely to work with computers, the growing use of computers alone could account for as much as 40 percent of the increase in the return to education between 1984 and 1989.[8] Both Mincer (1991) and Allen (1993) show a positive link between research and development activity and the relative earnings of college-educated workers.

Thus most of the literature supports the view that technological improvement, or at least some aspect of it, can explain a good part of the widening skill differentials. However, several authors, including Howell (1993) and Mishel and Bernstein (1994), point out that technological advances were by several measures at least as rapid during the 1970s and earlier decades as in the 1980s. Since wage differentials did not begin to widen significantly until the late 1970s, they argue that some other factor or set of factors must have driven the widening in wage differentials by skill level. These articles, however, tend to overlook the presence of supply shifts, which worked to narrow differentials during the 1970s but were less potent in the 1980s.

Descriptive Evidence

This section evaluates the trade and technological improvement arguments by examining trends in the U.S. economy during the 1980s. Since each argument implies that the economy should have evolved in specific directions, we can assess its validity by considering how the economy actually developed during the last decade.

As noted above, imports from developing countries surged during the 1980s. If import growth was an important influence on wage differentials by skill level, this surge should have been concentrated in relatively low-skill industries. We would also expect prices of import-competing products in the United States to have declined relative to prices of goods and services not affected by international trade. Following the factor price equalization theorem, we would then expect to see declining relative wages in these industries. As imports gained market share, we would also expect to observe falling employment shares in affected industries.

As for technological change, we noted substantial investment in computers and other sophisticated equipment in the 1980s. If such investments were concentrated in industries employing a large number of skilled workers, and if they in fact enhanced productivity, we would expect productivity to have risen most rapidly in skilled-labor-intensive industries. In the absence of significant demand shifts favoring skilled-labor products, the productivity increase should have reduced prices in these industries relative to prices in industries using less skilled labor. An increase in productivity should also have led to relative wage increases in high-skill industries, but may have reduced the industries' employment share because fewer workers are needed to produce a given quantity of output.

Table 1 summarizes the implications of the trade and technology arguments. As the table indicates, in each case we must have a catalyst. In addition, because both arguments imply relative price declines in directly affected industries, we need to compare these industries with a control group of industries unaffected by trade or technological change. The technological change argument implies more rapid productivity growth in high-skill industries; the trade argument has no strong direct implications for productivity. In both cases we would expect to see declining employment shares, at least relative to the control group. Most important, within the high-skill industry group we would expect to see a direct correspondence between wage growth and the degree of technological improvement. Within the low-skill industry group we would expect a negative relationship between wage growth and the degree of competition from imports. If workers are mobile across industries, then we might see some of the general trends predicted by the trade and technology arguments, but direct correspondences within each industry group would offer more definitive, "smoking gun" evidence.

To test these implications, we focus on developments in manufacturing between 1979 and 1989. Chart 3 shows changes in the import penetration ratio from devel-

Table 1
Implications of the Trade and Technology Arguments

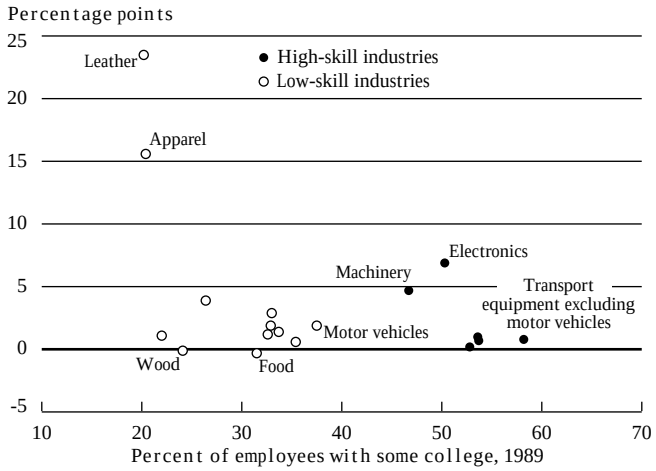
	International Trade	Technological Improvement
Catalyst	Imports surge	High-tech investments increase
Relative price	Down in low-skilled industries	Down in high-skilled industries
Productivity growth	_____	Up for high-skilled industries
Employment share	Down for low-skilled industries	Down for high-skilled industries
Relative wage	Down in industry with largest import surge	Up in industry with largest increase in high-tech investment

oping countries, by industry, as a function of industry skill level. We measure skill level as the percent of employees in each industry with at least some college education.[9] We define the import penetration ratio as imports from developing countries divided by total domestic demand (shipments minus exports plus imports from all source countries). The chart shows a substantial surge of imports from developing countries in two of the lowest skill industries—apparel and leather. In other industries we see increases as well, but of a much more modest magnitude. Note that such imports increased significantly in two high-skill industries—machinery and electronics. These increases apparently involved microprocessor production and computer assembly, low-skill segments of what are otherwise high-skill industries. Thus, we see a strong catalyst for the trade hypothesis in two industries and at least a modest one in others.

Chart 4 shows that there was indeed a catalyst for the technological improvement argument as well. Here we plot the change in the net high-tech capital stock per worker, in 1987 dollars, as a function of industry skill level.[10] While technological upgrading was clearly rapid in many industries, the high-skill segment showed much more high-tech investment per worker.[11]

Chart 3

Imports from Developing Countries, by Industry Skill Level
Change in Import Penetration Ratio, 1979-89

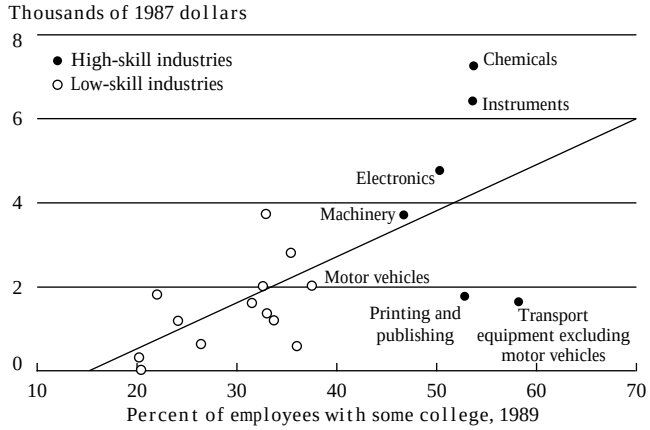


Sources: U.S. Department of Commerce for trade data; authors' tabulations of 1990 Census data for industry skill level.

Note: Chart does not show tobacco products, petroleum and coal products, and miscellaneous manufacturing.

Chart 4

Net High-Tech Investment, by Skill Level 1979-89
Change in Net High-Tech Capital Stock per Worker



Sources: National Income and Product Accounts for capital stock data; authors' tabulations of 1990 Census data for industry skill level.

Notes: High-tech equipment consists of office machinery, communication equipment, instruments, and photocopy machines. The line represents the estimated regression relationship between industry skill level and high-tech investment. The chart does not show tobacco products and petroleum and coal products.

Turning to relative price effects, we examine the path of implicit value-added deflators for three industry categories—high-skill manufacturing, low-skill manufacturing, and all other private industries excluding mining and agriculture (Table 2). As Chart 5 shows, over the decade as a whole, low-skill manufacturing prices did not decline relative to high-skill manufacturing prices, a result consistent with that of Lawrence and Slaughter. However, both high-skill and low-skill manufacturing prices fell relative to the rest of the economy, so we can rule out neither the trade nor the technological explanation on the basis of this test.

The pattern of productivity growth (Chart 6) appears to offer strong support for the technological change argument. Clearly, productivity during the 1980s grew more rapidly in high-skill manufacturing, where technological change was most rapid, than in either low-skill manufacturing or the rest of the economy. Finally, employment shares and absolute levels of both high-skill and low-skill manufacturing declined during the decade (Chart 7).

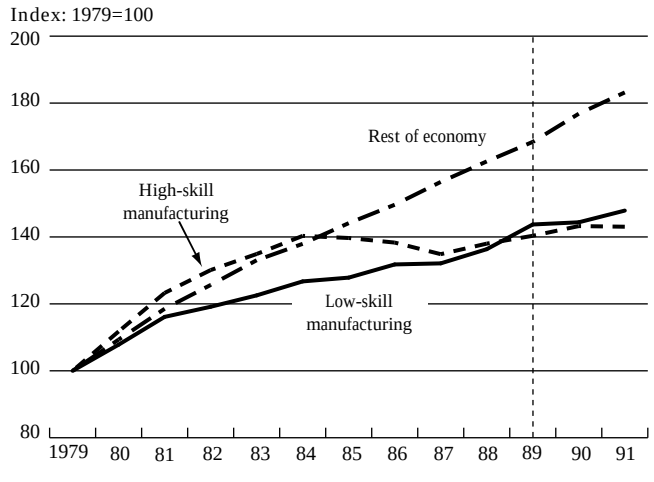
Thus, the evidence presented so far is consistent with the implications of both arguments outlined in Table 1. To complete the analysis, however, we would need to observe a direct one-to-one correspondence between wages and changes in the ratio of import penetration from developing countries, or between wages and our measure of technological improvement. In the top panel of Chart 8 we plot, for low-skill industries, the change in real average hourly earnings between 1979 and 1989 as a function of the change in the import penetration ratio from developing countries. Although apparel and leather showed significant earnings declines, some industries that did not face such a surge (primary metals, food, wood) also experienced large real wage reductions.

Table 2
BREAKDOWN OF MANUFACTURING INDUSTRIES BY SKILL LEVEL

High-Skill	Low-Skill
Industrial machinery and equipment	Lumber and wood products
Electronic and other electric equipment	Furniture and fixtures
Transportation equipment (except motor vehicles)	Rubber and miscellaneous plastic products
Instruments and related products	Stone, clay, and glass products
Printing and publishing	Primary metal industries
Chemicals and allied products	Fabricated metal industries
Petroleum and coal products	Motor vehicles and equipment
	Miscellaneous manufacturing
	Food and kindred products
	Tobacco products
	Textile mill products
	Apparel and other textile products
	Paper and allied products
	Leather and leather products

Chart 5

Output Prices, by Industry Category

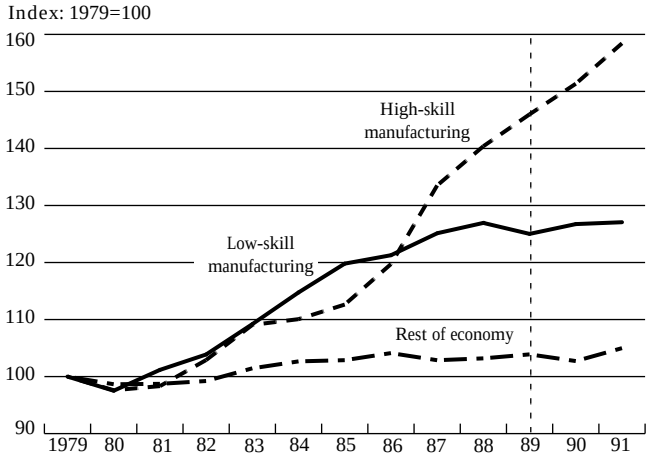


Source: National Income and Product Accounts.

Notes: Prices are measured using implicit value-added output deflators. "Rest of economy" excludes agriculture, mining, and government.

Chart 6

Productivity, by Industry Category

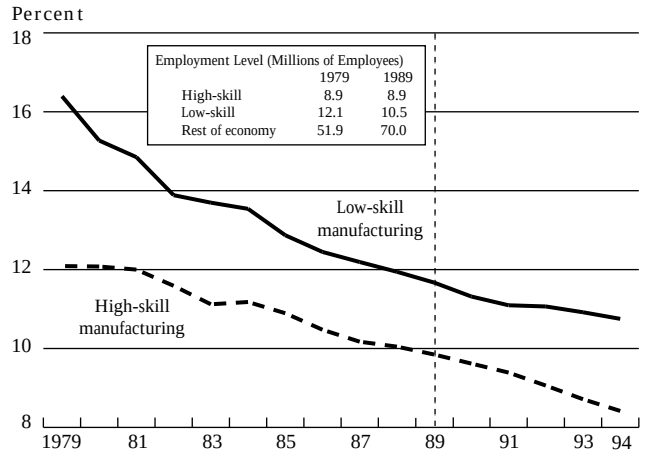


Source: National Income and Product Accounts.

Notes: Productivity is measured as real output per full-time equivalent employee. "Rest of economy" excludes agriculture, mining, and government.

Chart 7

Manufacturing Employment Shares, by Skill Level
As Percent of Private Nonagricultural Employment



Source: Bureau of Labor Statistics Establishment Survey.

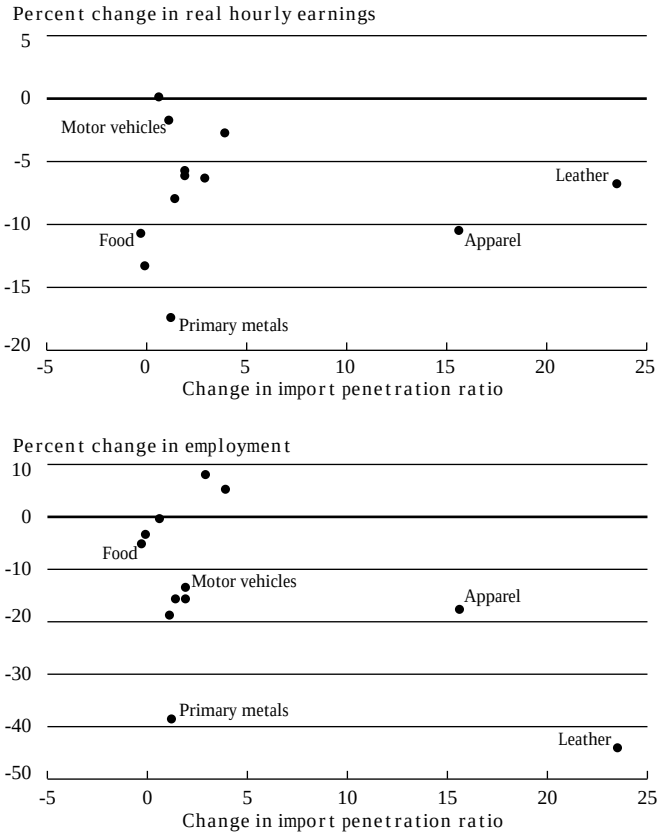
Note: "Rest of economy" excludes agriculture, mining, and government.

One possible reason that apparel and leather did not fare worse is that their import surge translated more into employment losses than into declining wages. Indeed, the bottom panel of Chart 8 shows a somewhat stronger link between imports from developing countries and employment than between imports and wages. Nevertheless, because several industries that did not experience an import surge also showed significant employment declines, the evidence on the effect of imports is inconclusive at this stage.[12]

The evidence supporting the technological change hypothesis is stronger. Chart 9 illustrates, for all industries, the pattern of real compensation growth as a function of our measure of technological change.[13] Clearly, there is a strong positive relationship between the two, with each

Chart 8

Low-Skill Manufacturing: Wages, Employment, and Imports from Developing Countries 1979-89

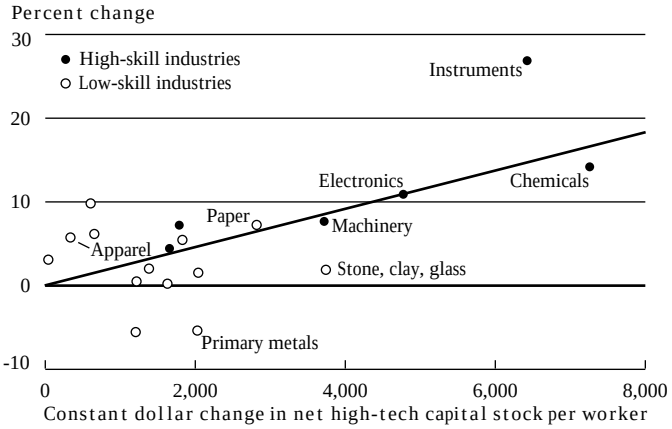


Sources: U.S. Department of Commerce for trade data; Bureau of Labor Statistics Establishment Survey for other data.

Note: Chart does not show tobacco products and miscellaneous manufacturing.

Chart 9

Compensation and High-Tech Investment 1979-89
Real Compensation per Full-Time Equivalent Employee



Source: National Income and Product Accounts.

Notes: High-tech equipment consists of office machinery, communication equipment, instruments, and photocopy machines. The line represents the estimated regression relationship between high-tech investment and compensation growth. The chart does not show tobacco products and petroleum and coal products.

$1000 increase in the high-tech capital stock per worker associated with an increase in compensation of approximately 2.3 percent. This evidence supports the hypothesis that the greater the investment in high-tech equipment in an industry, the greater the increase in productivity, and, especially in the high-skill industries, the greater the rewards for workers.

In sum, although the trade argument passes four out of five of our proposed tests, the direct evidence of an impact on relative wages is ambiguous. By contrast, the technology argument passes all five tests, pointing strongly to the conclusion that technological improvement contributed to the widening earnings disparity by educational attainment.

Other Proposed Explanations

Before applying more formal statistical tests to the trade and technology arguments, we briefly assess other explanations for the observed widening in wage differentials. Katz and Murphy argue that shifts in product demand were fairly important in explaining wage developments between 1963 and 1987. Other researchers, however, have found demand shifts to be relatively unimportant during the

1980s. Most of these researchers measure shifts in demand by changes in employment across industries. This method, however, does not capture the potential impact of demand changes on wages through concessions intended to save jobs.[14] To account for the effect of demand shifts on wages as well as employment levels across industries, we therefore look at changes in an industry's nominal value-added.[15] Chart 10 shows a clear positive relationship between demand growth measured in this way and wage changes. Shifts in demand, consequently, are a possible factor underlying recent wage trends.

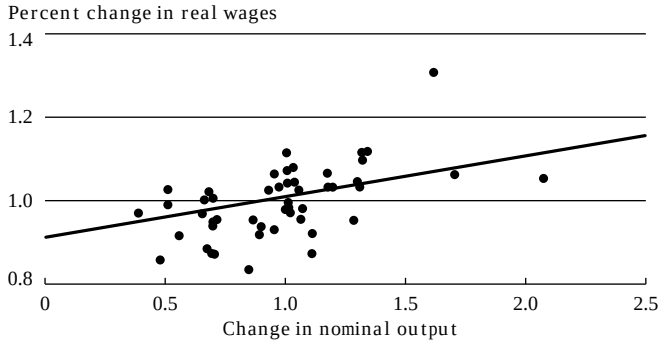
A second area worthy of examination, following Borjas and Ramey (1993), is the effect of imports from industrialized countries. These imports are likely to have had their greatest impact in highly concentrated, heavily unionized industries such as automobiles and steel, where U. S. workers had extracted a significant wage premium. Indeed, we have noted that the primary metals industry did experience a sharp decline in wages. As shown in Chart 11, imports from industrialized countries increased significantly during the 1980s. Consequently, we do not rule out increased competition from industrialized countries as another factor driving wage trends.

A further area to investigate is the effect of changes in labor supply on wage developments by skill level. Blackburn, Bloom, and Freeman (1990) find that a substantial portion of the widening in the wage gap by education level during the 1980s stems from a deceleration in the growth of the college-educated work force from the 1970s to the 1980s. Certainly, as young college-educated workers entered the labor force in large numbers during the 1970s while the supply of new workers without any college fell sharply, wage differentials by skill level narrowed. In fact, dramatic changes in the relative supply of labor of different skill levels appear to explain why wage inequality decreased in the 1970s despite large demand shifts favoring skilled workers. During the 1980s the supply of college-educated labor continued to increase relative to less-educated labor, albeit at a much slower pace than during the 1970s. By itself, this development should have led to a further, but less rapid, narrowing in wage differentials across skill levels.[16] Given that these differentials in fact increased, labor supply changes cannot readily explain the wage trends of the 1980s.[17]

Some researchers contend that institutional factors such as declining unionization and the failure to adjust the minimum wage for inflation during the 1980s also played a significant part in widening differentials. Historically, union members received a 15 to 25 percent premium relative to observationally equivalent workers not represented by a union. Many of the beneficiaries of

Chart 10

Demand Growth and Wage Change by Industry 1979-89

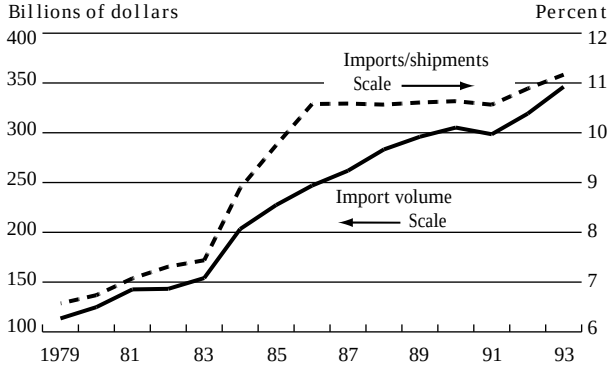


Sources: National Income and Product Accounts; Bureau of Labor Statistics.

Notes: Change in output is percent change in value added, by industry, relative to nominal gross product originating in all private industries. The line represents the estimated regression relationship between demand growth and wage growth.

Chart 11

U.S. Manufactured Goods Imports from Industrialized Countries



Source: U.S. Department of Commerce.

this premium were men with no more than a high-school education. Blackburn, Bloom, and Freeman (1990) find that falling union density explains about 20 percent of the increase in wage differentials among men during the 1980s. We believe that the decline in unionization during the 1980s at least in part reflects the other factors already discussed, although exogenous political changes may have contributed to the decline. We also believe that the effect of a lower real minimum wage has been limited, largely because few workers are directly affected.[18] Consequently, we do not consider either of these factors in our analysis.[19]

Regression Results

This section supplements the descriptive evidence presented earlier with statistical estimates of the effects of trade, technological change, and other factors on changes in the wage gap between 1979 and 1989. To estimate the long-run impact of structural developments while minimizing cyclical influences, we concentrate on long-term wage changes within industry and educational groupings over the entire ten-year period. Our results are based on reduced-form regressions derived from underlying labor supply and demand relationships across industries and educational attainment levels.[20] That is, each observation in our regressions refers to average wage developments for a given education level within a given industry (such as high school dropouts in the apparel industry).

We have two basic regression specifications. Our first focuses on changes in hourly wage rates for workers with different degrees of educational attainment in different industries. Because this specification ignores the possibility that workers displaced from their jobs by either trade or technological change may be forced to take jobs in lower paying industries, indirectly increasing the wage differential, we estimate a second regression in which the dependent variable is the change in the real wage bill (hourly wage rate times employment) by industry and educational attainment.

In both regressions, we estimate the impact of several industry-specific factors. The first is the percentage point change in an industry's import penetration ratio, calculated separately for developing country imports and industrialized country imports. Other factors are the constant dollar change in an industry's stock of high-tech capital equipment per employee, the percent change in an industry's overall real net stock of equipment (an indicator of newness as well as capital deepening, and thus an alternative measure of technological change), and growth in demand (nominal value-added) for an industry's output. These variables are permitted to have a differential impact on the wages or wage bills of each of four different educational groups—high school dropouts, high school graduates, persons with some college, and college graduates. For our wage bill regression, we also include the economy-wide change in the available supply of labor of each educational group as an explanatory variable because a supply-induced change in employment of any educational group would, all else equal, directly alter the wage bill of that educational group.

Our results show clearly that all of these influences contributed to widening wage differentials by educational attainment. We found a strong positive link between both measures of technological change and increases in the wage *rates* of high-skill workers, and a much weaker connection at lower skill levels. Technological change, moreover, is estimated to have reduced the wage *bill* for all groups except college graduates, suggesting significant displacement of low-skilled workers in some industries. Changes in product demand likewise tended to favor high-skill groups.

Somewhat surprisingly, we found a positive link between import penetration (both from developing and industrialized countries) and skilled workers' wage *rates*, but little effect on less skilled workers. In other words, wages of workers with at least some college education were actually higher, all else equal, in industries that experienced greater increases in import penetration. We found that trade did have the expected negative impact on the wage *bill* at all skill levels, suggesting the presence of displacement effects.[21] Imports from developing countries depressed the wage bill of low-skill workers significantly more than the wage bill of high-skill workers. The negative impact of import penetration from already industrialized countries on the wage bill was somewhat more evenly spread across educational groups.

Table 3 summarizes the contribution of the various factors to the widening wage gap between college graduates and dropouts, and between college graduates and high school graduates, during the 1980s. The figures in the top panel represent the differential impact of each variable on wage rates of college graduates relative to the two other educational groups. As the table suggests, we were able to account for about 35 to 40 percent of the increase in the wage gap. The technological improvement variables were together responsible for more than half of the explained portion of the widening gap. The trade variables accounted for roughly 15 percent of the increase in the gap. Interestingly, increased import penetration from already industrialized countries explained somewhat more of the impact on wage rates than did imports from developing countries. We also found that shifts in product demand across industries accounted for about 30 percent of the explained portion of the gap's widening.

The bottom panel of Table 3 illustrates the contribution of our variables to the differential growth in the wage bill for college graduates relative to both high school dropouts and high school graduates. These results appear to be much stronger.[22] Not surprisingly, much of the difference is attributable to the sharp decline in the proportion of adults who had not attended college, together with the increase in the number of college graduates during the 1980s. These labor supply changes alone would directly reduce the aggregate wage bill for those who had not attended college while raising the aggregate wage bill for college graduates. Our wage bill regression results, however, suggest that our earlier explanatory factors—technological change, import penetration, and demand shifts—also played an important role in the widening wage bill gap. Encouragingly, our results for the wage bill are qualitatively similar to those in the wage rate regression. That is, after abstracting from labor supply changes, technological change combined with growth in the capital stock explains roughly half of the widening wage bill differential. Import penetration accounts for a little over 10 percent, while industry demand shifts explain roughly one-third of this differential's growth.

Table 3
EXPLAINING WIDENING DIFFERENTIALS, 1979-89

	College Graduates versus Dropouts			College Graduates versus High School Graduates		
	Predicted Growth in Gap (Percentage Points)	Percentage of Total Gap	Percentage of Explained Portion of Gap	Predicted Growth in Gap (Percentage Points)	Percentage of Total Gap	Percentage of Explained Portion of Gap
HOURLY WAGE RATES						
Actual	16.9	100		13.3	100	
Explained	6.6	39	100	4.7	35	100
Technology + capital	4.0	24	60	2.5	18	53
Imports	0.8	5	12	0.8	6	17
Demand	1.8	11	28	1.4	11	30
WAGE BILL						
Actual	90.0	100		65.0	100	
Explained	75.0	83		56.1	86	
Change in supply	50.1	56		36.2	56	
Other factors	24.9	28	100	19.9	31	100
Technology + capital	12.2	14	49	9.3	14	47
Imports	2.7	3	11	3.0	5	15
Demand	10.0	11	40	7.7	12	39

Note: Values are based on regressions in Brauer and Hickok (1994).

How have the wages of different skill groups evolved in recent years? Our answer must be tentative since we cannot yet observe wage patterns over an entire business cycle or distinguish structural from cyclical changes. Nonetheless, our examination of the limited available information suggests that many of the trends observed during the 1980s have continued into the 1990s.

Between 1989 and 1993 the median real annual earnings of male year-round full-time workers declined 4.0 percent.* Our examination of data for 1992 from the March 1993 Current Population Survey, summarized in the table, reveals no significant change in the earnings premium of college graduates relative to high school graduates, but a substantial absolute and relative deterioration in the position of high school dropouts. Bound and Johnson's (1995) preliminary analysis of 1993 data, however, indicates that the gap between college-educated and high-school-educated workers continued to widen between 1988 and 1993, though at a slower pace than during the previous decade.

An inspection of wage developments by industry shows substantial real wage declines between 1989 and 1992 in a number of low-skill industries, including wholesale and retail trade, lodging and personal services, and food, but also in some high-skill industries. In general, however, high-skill industries tended to show smaller losses than did low-skill industries. Within manufacturing, average hourly wages fell 2.4 percent in high-skill industries, compared with 6.1 percent in low-skill industries (and 6.2 percent in all other industries excluding agriculture and public administration).† Nonetheless, high-skill manufacturing industries suffered greater employment losses than did low-skill manufacturing industries.

The relationship of these facts to the technological improvement and trade arguments is complicated both by cyclical effects and by the impact of defense-related cutbacks. Not surprisingly, many of the employment losses occurred in traditionally cyclical industries. Meanwhile, two high-skill industries with a substantial defense-related component—electrical equipment and transportation equipment other than motor vehicles—experienced 15 percent employment declines. Still, high-skill, technology-intensive industries not subject to either of these influences (for example, computers, chemicals, and communications) tended to perform fairly well, and technological improvement continued at a rapid pace.

Trade developments are harder to judge. In general, with the exception of leather and apparel, the rates of import penetration from all countries showed little further increase from 1989 levels. But because most import-sensitive industries tend to be cyclical, it is difficult to draw wage and employment implications from these trade developments.

WAGES AND EMPLOYMENT
By Education Level, 1989-92

Education Level	Percent Change in Real Hourly Earnings	Employment Share 1989	Employment Share 1992
High school dropout	-15.9	18.2	14.3
High school graduate	-6.4	31.1	34.2
Some college, less than bachelor's degree	-6.8	29.7	28.2
Bachelor's or higher degree	-6.9	20.9	23.4
Total	-5.8		

Sources: 1990 Census Public Use Microdata Set; March 1993 Current Population Survey. Sample consists of wage and salary workers who worked at least 200 hours. Earnings are deflated using the consumer price index.

*U.S. Department of Commerce, Bureau of the Census. "Income, Poverty, and Valuation of Noncash Benefits: 1993." Current Population Reports, Series P60-188.

†These figures are based on our tabulations of data from the March 1993 Current Population Survey for 1992 and the 1990 Census Public Use Microdata Set for 1989.

CONCLUSION

Our analysis suggests that technological progress, combined with an increase in the capital stock, was the most important demand-side influence on the growing inequality between the earnings of low-skill workers and high-skill workers. International trade was also a significant, albeit relatively modest, factor. Trade with industrialized countries contributed as much to the growing wage gap as did trade with developing countries, contrary to the assumptions of the most commonly expressed trade argument. Shifts in demand for the output of different industries surpassed trade in importance but fell short of technological progress as a cause of the growing wage gap.

We may take some encouragement from these results, since technology and capital deepening raise economy-wide output and, hence, economy-wide welfare. Nevertheless, all workers must be able to share in the economy's gain. A good case can be made for policy initiatives that focus on education and training.[23] Efforts should be made at every education level to enhance the ability of all laborers to work with technologically advanced equipment. Moreover, we need to consider seriously what worker attributes will be valued in an economy where routine tasks are increasingly carried out by sophisticated machines. Only then can we take the necessary steps to foster these attributes, again across education levels.

ENDNOTES

1. Note that in this study we concentrate on developments affecting the demand for labor of different skill levels. During the 1980s the supply of unskilled labor declined relative to that of skilled labor. By itself, this development should have operated to narrow wage differentials by skill level. Blackburn, Bloom, and Freeman (1990) note that the supply of skilled labor grew even more rapidly in the 1970s than in the 1980s, while actual wage differentials narrowed. They argue that one major difference between the two decades was the weakening of these supply factors.

2. For a discussion of measurement issues, see Bosworth and Perry (1994).

3. In this article, unless noted, we construct real wage measures using the CPI-U-X, a variant of the consumer price index that is based on a historically consistent treatment of homeownership costs.

4. These figures are based on the employment cost index. Data by occupational category are only available since 1982.

5. For a comprehensive survey of the literature, see Levy and Murnane (1992).

6. The reason is that the resulting increase in the relative wages of skilled workers would, in the absence of skill-biased technological change, induce employers to economize on skilled labor.

7. This argument is summarized in Borjas (1995).

8. It is possible that workers who are "better" in ways not captured by observable measures of skill, and consequently better paid, are more likely than "inferior" workers to use computers.

9. This variable was calculated from the 1990 Census Public Use Microdata Set. Although average educational attainment tended to rise within all industries during the 1980s, the industries' relative positions on the skill spectrum would have been essentially the same had we used data from the beginning of the decade.

10. We chose the dollar change rather than the percent change because an increase from twenty-five to fifty computers per hundred employees would have far greater impact than an increase from one to two per hundred, even though in percentage terms these are equivalent.

11. We cannot rule out reverse causation: wage increases within an industry could stimulate investment by lowering the cost of capital relative to labor. Still, productivity-enhancing investment would be expected to result in higher wages.

12. Even if we could demonstrate that trade was important, we might not observe a stronger link between import penetration and declining wages and/or employment. A clearer link might emerge only at a more disaggregated level of analysis. In addition, an import surge could have depressed unskilled workers' wages not only in directly affected industries, but also in other industries as workers displaced from an affected industry sought employment elsewhere. Third, the industries most affected by the import surge from developing countries were already paying low wages, so they may have been unable to cut wages much further. In 1989 the average wage in apparel on a year-round, full-time basis would have provided barely enough income for a family of four to reach the poverty line. A fourth possibility is that part of the effect was masked because the relatively high value-added segments of an industry were most likely to survive an import surge. Finally, special factors such as corporate restructuring or demand shifts could have explained developments in the other low-skill industries that fared poorly.

13. We use compensation here because of data limitations affecting average hourly earnings measures for electronics and instruments.

14. Bluestone makes this point in comments accompanying Blackburn, Bloom, and Freeman (1990).

15. Changes in nominal value-added could pick up some supply shifts as well as demand shifts.

16. See Blanchard (1995).

17. As Borjas (1995) observes, one particular aspect of supply that may have been important was immigration.

18. For a contrasting view, see DiNardo, Fortin, and Lemieux (1994).

19. Another argument, expressed in Bishop (1991), is that the declining quality of less-educated workers, as evidenced by falling SAT scores, could account for part of the widening of wage differentials. This view is criticized by Freeman and Katz (1994), who point out that during the 1980s wage differentials by level of education rose within all age groups, including those who attended school well before the alleged deterioration in quality took place.

20. Full details of the regression specification, data sources and definitions, and results are in Brauer and Hickok (1994).

21. This displacement effect probably explains the positive link between import penetration and skilled workers' wage rates. Import penetration likely displaced the weaker, lower paid segment of the affected

ENDNOTES (*Continued*)

Note 21 continued
industries, raising the reported average wage rate within those industries.

22. Once we eliminate the impact of changes in labor supply, our other variables explain about two-thirds of the widening of wage bill differentials between college graduates and high school dropouts or high school graduates. The unexplained residuals account for the other third. In contrast, these same nonsupply variables only explain about one-third of the widening in the wage rate differentials, with unexplained residuals accounting for two-thirds of the growing gap.

Note 22 continued

23. See Lynch (1995).

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