

Interindustry Factor Mobility and Technological Change: Evidence on Wage and Profit Dispersion Across U.S. Industries, 1820–1990

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Interindustry factor mobility is a crucial determinant of the income-distribution effects of exogenous changes in relative commodity prices. This examination of interindustry variation in wages and profits using data from manufacturing industries from 1820 to 1990 suggests that interindustry factor mobility may be strongly related to the processes of industrialization. Development in the nineteenth century produced a sharp rise in mobility (a decline in interindustry wage and profit differentials) due to rapid improvements in transportation and the introduction of factory production. Twentieth-century industrialization, involving greater reliance on specialized equipment and knowledge, reduced levels of interindustry mobility.

For several decades now economists have been keenly aware that the income-distribution effects of various exogenous changes that alter relative commodity prices are crucially affected by the level of interindustry factor mobility.¹ The ability of owners of labor and capital to move between employment in different industries (or, conversely, the extent to which their assets are “specific” to particular industries) has been a particular concern for trade economists interested in the income effects of trade and industrial policies.² According to the famous Stolper-Samuelson theorem, which assumes that factors are highly movable or mobile between industries, an increase in the relative price of a commodity will increase the real returns to those factors used intensively in its production and decrease returns to other factors, regardless of where those factors are employed in the economy.³ Alternative general-equilibrium models, which allow that factors may be specific to particular industries, generate very different results. Real returns to specific factors are tied closely to the fortunes of the industries in which they are employed. Factors specific to industries favored by an exogenous shift in relative prices receive higher

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¹ For a discussion, see Grossman and Levinsohn, “Import Competition,” p. 1065.

² See Jones, “Three Factor Model”; Mayer, “Short-Run and Long-Run”; and Mussa “Tariffs.”

³ Stolper and Samuelson, “Protection.”

real returns, whereas those employed in other industries lose out in real terms.⁴

Depending upon the assumptions one makes about levels of interindustry mobility, general-equilibrium models thus produce very different predictions about the distributional implications of exogenous changes that affect relative commodity prices—including technological and regulatory changes that alter the geographic scope of product markets (the key components of “globalization”), innovations in production processes, and other types of exogenous shocks to demand and supply. By implication then, interindustry mobility is also crucial for understanding the political-economic origins of a vast range of trade, industrial, and regulatory policies that alter relative prices or mediate the effects on them of other exogenous changes. The motivations of economic actors who enter the political arena to influence all such policies will be shaped by their ability to shift assets between industries. Put crudely, the stakes that individuals have in policies that affect the industry in which they are employed or invested will vary greatly depending upon how easy it is for them to move their assets elsewhere.

It is vexing then, as Gene Grossman and James Levinsohn have pointed out, that very few attempts have actually been made to assess levels of interindustry factor mobility in the American economy, and there has been almost no study of how such levels may have changed over time.⁵ The most direct measures of interindustry labor mobility have been provided in research that examines interindustry wage differentials⁶ and rates of labor turnover among workers in manufacturing industries.⁷ Indicators of interindustry capital mobility have been drawn from analysis of stock-market returns⁸ and from prices in secondary markets for capital equipment.⁹ Less direct inferences about mobility have been made using evidence on the revealed policy preferences of industry lobby groups and voters.¹⁰ With the exception of some longitudinal work on labor turnover, indicating a downward trend in worker mobility since the 1920s, these studies have all aimed at examining characteristics of factor markets at a particular point in time—typically, at some point since the 1970s. All the work suggests significant factor specificity and sizeable industry rents in U.S. manufacturing in recent

⁴ The original model was introduced independently by Jones, “Three Factor Model”; and Samuelson, “Ohlin was Right”: the former christened it the “specific factors” model, and the latter named it the “Ricardo-Viner” model.

⁵ Grossman and Levinsohn, “Import Competition,” p. 1065.

⁶ For example, Krueger and Summers, “Efficiency Wages.”

⁷ For example, Ragan, “Investigating the Decline.”

⁸ Grossman and Levinsohn, “Import Competition.”

⁹ Ramey and Shapiro, “Displaced Capital.”

¹⁰ The most frequently cited example is Magee’s study of testimony by labor unions and management groups before the U.S. House Ways and Means Committee on the Trade Act of 1974. See Magee, “Three Simple Tests.” Irwin has examined county voting patterns in the British general election of 1923. See Irwin, “Industry or Class Cleavages.”

years, but we do not have a historical standard of reference with which to compare these findings. No evidence has been compiled on interindustry mobility (or industry rents) in systematic fashion for extended historical periods.

In contrast, a great deal of empirical work has been done on the *inter-regional* mobility of labor and capital in the American economy aimed explicitly at uncovering historical trends, with much of the attention focused on the geographic integration of the markets for labor and capital during the nineteenth century. A number of recent studies have indicated that the mobility of labor and capital across geographic locations increased in both the antebellum and postbellum periods in line with improvements in transportation and communication, though the speed with which this integration occurred varied with time and from region to region.¹¹ Related work has examined the intersectoral mobility of labor between rural employment and manufacturing jobs in the nineteenth century.¹²

Although levels of geographic factor mobility may have some bearing on levels of interindustry mobility, since industries tend to be concentrated in different geographic locations, the two dimensions of factor-market integration are very separate. Interindustry mobility is related not just to the costs of moving factors and information across geographic space, but to the costs of moving them across product space. The latter are shaped by an array of variables that affect the specificity of human and physical assets to use in particular industries. In the context of industrialization, levels of interindustry factor mobility should be affected not only by improvements in systems of transportation and communication, but by technological changes in the methods of production that affect the value of specific skills and physical capital, and by changes in regulations that impose costs on interindustry factor movement.

This article examines indicators of levels of interindustry labor and capital mobility in the U.S. manufacturing sector over the last two centuries. It measures interindustry variation in wages and profits using data from a range of different sources. The guiding assumption is that, when factors are highly mobile, wage and profit differentials between industries should be arbitrated away by the (actual or potential) movement of labor and capital. The results of the analysis are compared with alternative indicators of

¹¹ On the integration of regional labor markets in the antebellum period, see Lebergott, *Manpower*; Margo and Villafior, "Growth"; Rothenberg, "Emergence"; and Margo, "Wages" and "Labor Market Integration." On labor markets in the late nineteenth century, see Easterlin, "Interregional Differences"; Coelho and Shepherd, "Regional Differences"; Sundstrom and Rosenbloom, "Occupational Differences"; and Rosenbloom, "One Market," "Was there a National Labor Market," and "Extent." On the integration of regional markets for financial capital, see Davis, "Investment Market"; Smiley, "Interest Rate Movements"; James, "Development" and *Money*; and Odell, "Integration of Regional."

¹² See Lebergott, *Manpower*; Williamson and Lindert, *American Inequality*; Adams, "Standard of Living"; and Margo, "Farm–Nonfarm Wage Gap."

interindustry mobility (such as labor turnover, job tenure, and firm spending on research and development) using data that are available for recent periods. The basic findings are consistent across these various indicators.

The evidence indicates that the interindustry mobility of labor and capital appear to be strongly related to the processes of industrialization. Early stages of development in the nineteenth century produced a substantial decline in interindustry wage and profit differentials, signaling a rise in mobility. This was due most likely to rapid improvements in transportation and the introduction of factory production, which increased demand for nonspecific forms of human and physical capital. On the other hand, later stages of industrialization in the twentieth century, involving greater reliance on specialized equipment and knowledge in production, have produced a large increase in measured industry rents for labor and capital, indicating a decline in levels of interindustry factor mobility.

MEASURING INTERINDUSTRY FACTOR MOBILITY

To compare levels of factor mobility in different periods, I have relied here principally on measurements of the difference between returns to factors employed in different industries (specifically, on the coefficient of variation for wage and profit rates across manufacturing industries). Interindustry mobility refers to the ability of owners of productive inputs to move them between different industries: this is best represented formally as the elasticity of substitution along the transformation curve that maps the conversion of a factor located in one industry for use in another industry at increasing opportunity costs.¹³ This elasticity is not directly observable. But when mobility is high, movement between industries (or even just the potential for it) should equalize returns to similar types of labor and capital across industries. This is simply an application of the “law of one price:” if a factor is highly mobile, return differentials should be arbitrated away. Smaller differentials in wages and profits across industries are thus indicators of higher mobility. The magnitude of the differentials will reflect the costs of moving factors between industries, which are influenced by a range of economic and political variables including the firm and industry specificity of human and physical capital, factor market regulations that affect firm entry and exit and hiring and firing, policies that assist relocation and retraining, the geographic dispersion of industries, and the costs of transportation and communication.

Different versions of this type of measure have been used in a wide range of studies of labor and capital mobility. Recent research on labor-market efficiency in the United States and elsewhere has examined interindustry

¹³ See Jones, “Three-Factor Model”; and Hill and Mendez, “Factor Mobility.”

wage differentials for evidence of industry “rents” that are not competed away in equilibrium.¹⁴ Almost all of the major empirical work on the geographic integration of the American labor market, meanwhile, has focused upon interregional wage variance.¹⁵ Historical studies of financial market integration in the United States have similarly examined interregional differences in interest rates.¹⁶ And research on the international mobility of financial capital has studied differences in returns earned by similar types of assets held in different national markets.¹⁷

There are, however, several reasons for exercising much caution when using wage and profit differentials as measures of factor mobility. Variation in wages and profits across industries may persist in equilibrium even at very high levels of mobility if economic agents have objectives other than maximizing real income.¹⁸ Differences in working conditions across industries, for instance, and in the locational attributes of industries that are concentrated in different regions or cities (such as climate, degree of overcrowding, and level of sanitation) may lead to persistent variation in wages and profits across industries in equilibrium. In addition, the measurement and interpretation of differentials must account for short-run shocks to demand in particular industries, differences in the skill levels of workers whose wages are compared, and differences in the riskiness associated with employment and investment in each industry.¹⁹ Each of these problems—discussed in more detail in the following sections—requires that inferences based upon return differentials be made with great care and caution.²⁰

Where possible I have compared evidence on wage and profit differentials with other commonly used indicators of factor mobility or factor specificity, such as the rate of turnover in labor markets (a basic measure of worker

¹⁴ See Krueger and Summers, “Efficiency Wages”; Katz and Summers, “Industry Rents”; Dickens and Katz, “Inter-industry Wage Differences”; Krueger and Summers, “Reflections”; and Gibbons and Katz, “Does Unmeasured Ability.” A comparative study of wage differentials in the United States and in Sweden is provided by Edin and Zetterberg, “Interindustry Wage Differentials.” Older studies of interindustry wage differences are provided by Slichter, “Notes”; Glasser, *Wage Differentials*; and Dunlop, “Task.”

¹⁵ See Lebergott, *Manpower*; Rothenberg, “Emergence”; Margo, “Wages” and “Labor Market Integration” Easterlin, “Interregional Differences”; Coelho and Shepherd, “Regional Differences”; Sundstrom and Rosenbloom, “Occupational Differences”; Rosenbloom, “One Market,” “Was there a National Labor Market,” and “Extent.”

¹⁶ See Davis “Investment Market”; Smiley, “Interest Rate Movements”; James, “Development” and *Money*; and Odell, “Integration.”

¹⁷ See Frankel, “Measuring International Capital Mobility.”

¹⁸ Rosenbloom, “Is Wage Dispersion,” p. 169.

¹⁹ Regulations on wages and collective wage-bargaining arrangements may also affect measured wage differentials. This would seem to be a greater problem for interpreting cross-national evidence on industry wage variance than for tracking long-term trends in the U.S. manufacturing sector. See Edin and Zetterberg, “Interindustry Wage Differentials.”

²⁰ On related problems associated with interpreting regional wage differentials, see Rosenbloom, “One Market,” p. 88.

movement) and spending by firms on research and development and worker training (a general measure of investments in specific forms of physical and human capital). These alternative indicators are less theoretically sound, however, and are also limited in terms of the time span for which data are available. Measures of factor *movement*, such as labor turnover or rates of firm entry to and exit from industries, do not provide a reliable guide to interindustry mobility (the *ability* to move). The problem is that such measures cannot be interpreted without controls for the *incentives* for economic agents to move, which requires assessing return differentials. Factor owners may find movement between industries relatively cheap, but have little incentive to actually move if wage and profit differentials are low.²¹ In such cases, evidence of low levels of factor *movement* is unreliable as an indicator of levels of factor *mobility*.

Other types of indicators of asset specificity, such as amounts invested by firms in the generation of new physical and human capital (via spending on research and development and worker training), address one component of the costs of moving factors between industries, but ignore others. And data on all these variables are only available for recent periods. Examining interindustry wage and profit dispersion thus seems to be the soundest and most comprehensive approach to assessing levels of mobility, while also allowing the broadest historical reach.

MANUFACTURING WAGES AND PROFITS, 1820 TO 1990

Data on Wage Rates in Manufacturing Industries

Comparable and reliable data on wage rates across manufacturing industries are scarce for the period before 1900, and are especially limited for the antebellum years. The two most commonly used sources of data on wages in the nineteenth century are the Weeks and Aldrich reports,²² which provide data on daily wage rates for workers collected from the payroll records of firms in various manufacturing industries for a range of years (from 1801 to 1880, and 1860 to 1890, respectively).²³ Researchers interested in manufacturing wage rates prior to the Civil War have resorted to using payroll re-

²¹ In the highly integrated international bond markets, for instance, returns on securities are equalized with minimal trading activity. See Frankel, "Measuring International Capital Mobility."

²² Weeks, *Reports*; and Aldrich, *Wholesale Prices*. Data from both reports are reproduced in Long, *Wages*, along with a detailed discussion of how they were compiled.

²³ Studies that make use of these reports include Margo, "Wages;" Coelho and Shepherd, "Regional Differences" and "Impact"; Sundstrom and Rosenbloom, "Occupational Differences"; and Rosenbloom, "One Market." Another common source, the Department of Labor's "Bulletin 18," also reports daily wage rates between 1870 and 1898, though it does so by worker occupation rather than by industry.

records available for smaller numbers of firms in particular cities,²⁴ or records of wages paid to civilian workers by the U.S. Army.²⁵

Even the most comprehensive data in the Weeks and Aldrich reports are quite limited in terms of their coverage of workers in the manufacturing sector. They are drawn from the records of a relatively small number of firms in particular locations. The data reported for earlier years are especially suspect, because only a very few firms examined at the time the various reports were compiled had been in business for the entire period in question.²⁶ The Aldrich data are derived from the payroll records of only 78 firms, for example, dating back to 1860; the Weeks data are compiled from records of over 600 firms but are much more fragmentary. In both reports the number of firms reporting data in many individual industries is often very small (only one firm reported data in six of 13 industries examined in the Aldrich report). The Aldrich data cover only the New England and middle Atlantic regions, whereas the Weeks report includes only a small number of firms in the South and West.

An alternative source of early data on wages is the decennial census. Several studies of wages in the nineteenth century use census data on total wage payments and the average number of wage earners employed in each year to calculate average annual earnings for workers in different industries or locations.²⁷ These census data have the advantage that they provide a broad coverage of the manufacturing labor force, with comparable annual data on each major industry, and can be used to construct a long, continuous time series. On the other hand, doubts have been raised about the accuracy of the data collected before 1880, when temporary and poorly trained marshals were employed.²⁸ Inconsistencies in the methods of gathering and reporting data pose some problems.²⁹ One important problem is that the censuses do not consistently report separate data on wage payments or average employment for adult male workers, female workers, and children through the nineteenth century, making it very difficult to control for tempo-

²⁴ See, for instance, Adams, "Wage Rates"; and Zabler, "Further Evidence." The former compiles data on wages for workers in occupations in the construction and shipbuilding industries between 1790 and 1830; the latter examines data from iron-producing firms in eastern Pennsylvania between 1800 and 1830.

²⁵ Margo and Villaflor, "Growth." They compile data on daily wage rates between 1820 and 1856, categorizing workers by occupation but not by industry.

²⁶ On this point see Long, *Wages*, pp. 7–12; also Rosenbloom, "Extent," pp. 5–6.

²⁷ See Long, *Wages*, pp. 39–49; also, Rosenbloom, "Was there a National Labor Market." Atack, Bateman, and Margo, "Rising Wage Dispersion," uses data from the original census manuscripts on a sample of individual firms.

²⁸ See Long, *Wages*, pp. 39–40. In 1880 the Census Bureau assigned the task of data collection to a group of special agents with knowledge of manufacturing cities and towns, and the general view is that the accuracy and coverage of the reports improved significantly thereafter.

²⁹ In different years, for instance, the Census Bureau switched between asking firms for monthly wages and employment figures and asking for annual aggregate figures. See Engerman and Goldin, "Seasonality."

ral changes in the composition of the workforce in each industry when measuring interindustry wage differentials. Data are also not reported separately for skilled and unskilled workers by industry until the turn of the century.

Evidence on industry wage rates for the twentieth century is more readily available. The five-yearly *Census of Manufactures*, and the *Annual Survey of Manufactures*, report data on total wage payments to production workers and the average number of production workers across major industry categories from 1900.³⁰ These series can be used to calculate average annual earnings for workers in each industry, like the data in the earlier censuses, though at more frequent intervals. Hourly earnings for workers in the manufacturing industries, classified at the two-digit SIC level, are calculated from 1947 by the Department of Labor, based upon annual earnings and total man-hours worked in each industry.³¹ In addition, separate data on hourly wage rates for unskilled workers between 1920 and 1937 were compiled by the National Industrial Conference Board (NICB).³²

To offset some of the problems with each of the particular types of data available for different time periods, I have compared evidence on industry wages from all of these different sources.³³ The primary data from the Weeks and Aldrich reports are the industry averages compiled painstakingly by Clarence Long. He drew a continuous time series of data on wages from 67 establishments in 18 industries from the Weeks report, and from 49 establishments in 13 industries from the Aldrich report.³⁴ I have also calculated the average daily wage rates of “common laborers” in 18 industries using the original data in the Weeks report.³⁵ To compile data on a consistent set of industries from the *Census of Manufactures* prior to 1914, I began with the list of 17 categories for which Long extracted data for the period 1860 to 1890.³⁶ I amended this original list to extend the series for 15

³⁰ These data are collected in Department of Commerce, *Historical Statistics of the United States*, and *Statistical Abstract of the United States*. Production workers can be treated as unskilled or low-skilled labor, because the nonproduction category includes all professionals and technicians. See Berman, Bound, and Griliches, “Changes.”

³¹ Department of Labor, *Employment and Earnings*.

³² National Industrial Conference Board, *Wages*. These data are also reported in Glasser, *Wage Differentials*, p. 36.

³³ A full description of the data, including lists of the industries for which wages are reported in each source, and measures of the comparability of wage estimates across sources, is available in an appendix from the author and online at: <http://www.people.fas.harvard.edu/~hiscox/JEHappendix.html>.

³⁴ See Long, *Wages*, pp. 13–17. He first calculated weighted average wage rates across occupations in each establishment from the Aldrich data, and simple averages using the Weeks data (for which employment totals were lacking). Industry averages for each state were then calculated as simple means from the Weeks data and using employment weights for each establishment from the Aldrich data. Finally, industry averages were calculated from each sample by weighting those state industry wages by state employment in each industry (using figures taken from decennial censuses and interpolating).

³⁵ I calculated these as simple averages across establishments in Massachusetts, New York, and Pennsylvania only (because data had to be entered manually for each firm).

³⁶ Long, *Wages*, pp. 72–73.

industries from 1820 to 1910, and then added five more industries for which data were available over that entire period.³⁷ Beginning in 1900 the *Census* and the *Annual Survey of Manufactures* report earnings data in 15 of the two-digit SIC categories, and from 1947 they report data for 19 categories.

Interindustry Wage Variance

Using each of the data series to calculate coefficients of variation across industries yields an interesting set of results. The data, shown in Figure 1, indicate two broad trends: a general decrease in interindustry variation in wages over the course of the nineteenth century, and a general rise in variation beginning sometime between the 1910s and the 1930s. There is considerable volatility in the coefficients calculated from the Weeks and Aldrich data (which supports the case for skepticism about these sources), but a clear downward trend is apparent in the coefficients based on the census statistics, indicating a general rise in interindustry labor mobility over most of the nineteenth century.³⁸ This trend was reversed early in the twentieth century, however, and the steep increase in wage differentials since the 1920s suggests a marked decline in interindustry labor mobility.

The evidence is consistent with findings in a wide range of research on wages. Jeremy Attack, Fred Bateman, and Robert Margo have examined data on wages from a sample of establishments from the censuses between 1850 and 1880 and found a decline in industry differentials during those years.³⁹ Using aggregate industry earnings data, Steven Allen discovered a decline in interindustry dispersion between 1890 and 1920.⁴⁰ He also compared wage dispersion among industries in the 1930s and the 1980s, revealing an increase in dispersion over time. Linda Bell and Richard Freeman used establishment data on wages to show rising interindustry variance in both the manufacturing and service sectors and at all levels of industry aggregation between 1948 and 1986.⁴¹ And using survey data, a variety of recent

³⁷ Specifically, "Liquors, malt" and "Chewing tobacco" were cut from the list used by Long, because separate data on them are not reported in censuses after 1900 and before 1860, respectively. Of the five additions, two are "Boots and shoes" and "Clothing," which Long excluded on the grounds that the censuses include many small custom and repair shops in these industries and statistics on such establishments should be kept separate from statistics from factories (see Long, *Wages*, p. 41). The data for 1820 were entered for New York, Connecticut, New Jersey, Pennsylvania, Massachusetts and Rhode Island, Maryland, and Virginia only (because data in the 1820 census are reported by establishment and industry totals must be calculated manually).

³⁸ The high variance in industry wages in 1820 is evident in individual states for which data were examined as well as in the aggregate. The coefficients of variation in wages in individual states were: 40.0 in New York (16 industries); 43.7 in Connecticut (8); 39.5 in New Jersey (9); 50.5 in Pennsylvania (16); 39.7 in Massachusetts and Rhode Island (8); 42.8 in Maryland (12); and 54.7 in Virginia (14).

³⁹ Attack, Bateman, and Margo, "Rising Wage Dispersion."

⁴⁰ Allen, "Updated Notes."

⁴¹ Bell and Freeman, "Causes."

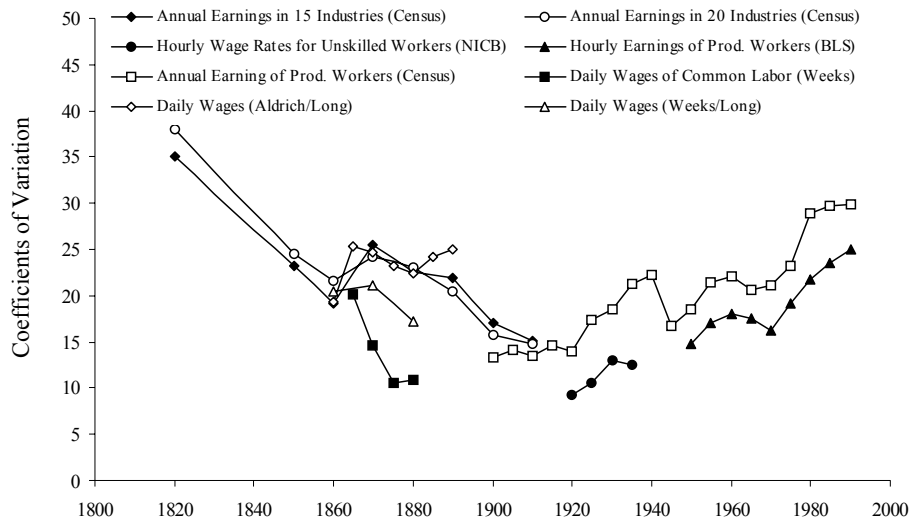


FIGURE 1
INTERINDUSTRY VARIATION IN WAGES IN MANUFACTURING

Sources: Weeks, *Reports*; Aldrich, *Wholesale Prices*; Long, *Wages*; Glasser, *Wage Differentials*; Department of Commerce, *Census, Census of Manufactures, Annual Survey of Manufactures*, and *Historical Statistics of the United States*; Department of Labor, *Employment and Earnings*.

studies have revealed substantial, persistent dispersion in wages across manufacturing industries in the last two decades, even when controlling for wide range of human capital variables and job characteristics. These recent findings have been interpreted as evidence that workers in high-wage industries receive noncompetitive rents, in line with predictions based upon models of rent sharing and efficiency wages.⁴² Interestingly, though, the size of these types of rents appears to have trended downward during earlier stages of industrialization and upward more recently.

The data are limited in important ways that may have a bearing on the results. Most importantly, only very basic controls can be applied to account for heterogeneity in labor across industries. The primary series from the Weeks and Aldrich reports and from the censuses in the nineteenth century lump together workers of all skill levels and ages and both genders. The Weeks data on common laborers provides one check on the results, by controlling for skill levels of workers, as do the data on wages of unskilled workers from the NICB; the data on production workers from recent censuses provide a similar, though cruder, control for skill levels.

The concern is that the measured changes in the variance between wages across industries may reflect, not so much changes in underlying factor

⁴² See Dickens and Katz, "Inter-Industry Wage Differences"; Krueger and Summers, "Reflections" and "Efficiency Wages"; Katz and Summers, "Industry Rents"; Nickell and Wadhvani, "Insider Forces"; and Gibbons and Katz, "Does Unmeasured Ability." For earlier discussions of wage differentials (in the 1950s), see Slichter, "Notes"; and Dunlop, "Task."

mobility or specificity, but changes in the skill composition of the workers employed in different industries or in the wage premium paid to skilled versus unskilled labor. As Edward Leamer has noted, however, there is reason to believe that the *relative* skill composition of workers across different industries is actually rather stable over time, even as the general demand for labor skills has waxed and waned.⁴³ Still, long-term shifts in the relative rewards to high-skilled versus low-skilled workers may be affecting the measured differentials. The much discussed rise in the skill premium since 1970 may pose a particular problem, leading to an overstatement of industry wage variance when only simple controls for skill levels are applied. In past eras, with the exception of the wage compressions during the two world wars (and particularly in the 1940s), the skill premium appears to have been fairly stable over time in U.S. manufacturing, though there is still some debate.⁴⁴ Margo, for example, has shown that real wages of common laborers grew roughly at the same rate as real wages of skilled artisans between 1800 and 1860.⁴⁵ Changes in the skill premium thus appear more likely to raise a problem for interpreting the data on wage variance in recent decades than in past eras.

One approach to this issue involves the use of survey data on individual workers from the *Current Population Survey* (CPS). Comparing data from the 1970s and 1980s, Alan Krueger and Lawrence Summers show that controlling for observable skill differences at the individual level in wage equations reduces the size of the estimated industry rents across-the-board, as one would expect, but does little to alter the *relative* size of measured differentials at different times.⁴⁶ I have replicated their technique, using the earliest CPS data available from 1968 and comparing the size of industry differentials in that year with differentials in 1992. The results support their findings and indicate a clear upward trend in industry rents even when extensive controls are applied for skill, education, occupation, and other differences among workers (the standard deviation of the estimated industry wage differentials was 9.8 percent in 1968, but had risen to 15.4 percent by 1992).⁴⁷

The analysis of CPS data also includes controls for gender and age, two other types of worker heterogeneity not accounted for in the general wage dispersion measures charted in Figure 1. Such gender and age dif-

⁴³ Leamer, "Trade Economist's View." The paucity of historical data on skill composition, especially in the period from 1860 up to the turn of the century, makes this a difficult issue to address.

⁴⁴ Goldin and Margo, "Great Compression." For a recent review of past studies and new evidence, suggesting that the wage compression of the 1940s had been preceded by earlier compressions in the 1910s and 1930s, see Goldin and Katz, "Returns."

⁴⁵ Margo, "Wages," pp. 181–86. Margo's findings run counter to earlier arguments by Williamson and Lindert, based upon a narrower set of data on nominal wages of urban workers in the northeast, that the skill premium was rising in these years. Williamson and Lindert, *American Inequality*, pp. 65–82.

⁴⁶ Krueger and Summers, "Reflections."

⁴⁷ This analysis is available in an appendix from the author or can be accessed online at: <http://www.people.fas.harvard.edu/~hiscox/JEHappendix.html>.

ferences across industries are likely to have had a far greater effect on the general dispersion measures in past eras, when the gap between male and female earnings was greater and when a far larger number of children worked in manufacturing industries (in the textiles and apparel industries, in particular). Unfortunately, neither the Weeks nor the Aldrich reports distinguishes workers in each industry or their wages by gender. There is a little more data to go on in the censuses. The censuses of 1890, 1900, and 1910 categorize data on the number of employees and wages for men over 16, women over 15, and children. The censuses of 1870 and 1880 divide the data on the number of employees similarly, but do not report wages for each category. Using the data from 1890, 1900, and 1910, we can examine the measures of wage variance across industries for men over 16 only and compare these with the measures reported in Figure 1. I have also used the 1890 ratios of adult male to female and adult male to child wages in each industry to extrapolate the wages data for separate categories of workers in 1870 and 1880.⁴⁸ The coefficients of interindustry variation for adult male wages for the various years are shown in Table 1. As expected, controlling for gender and age leads to slightly lower measures of industry wage differentials, but the trend over time during this period remains the same: there is a significant decline in the dispersion of adult male wages.

Controlling for heterogeneity among workers in different industries is one issue; controlling for variation in conditions of work across industries is another. It could be that changes in the relative attractiveness of working in different industries over time are affecting the measured shifts in wage differentials. Figure 1 does report the coefficient of variance for *hourly* earnings of workers in the 1920s and 1930s (from the NICB data) and after 1947, and in the regressions based upon the CPS data it is also a simple matter to control for hours of work. The results appear to be very similar to the coefficients calculated using earnings data without controlling for differences in hours of work across industries.

It is more difficult, of course, to control for such differences in earlier periods for which data on hours are quite scarce. The data on hours gathered in the Weeks and Aldrich reports are fragmentary and, as with their data on wages, have come to be viewed as far from reliable.⁴⁹ Atack and Bateman have compiled much better data on a large sample of firms from the original manuscripts of the 1880 census, and have thereby produced estimates of the

⁴⁸ Goldin has shown that the ratio of male to female earnings was fairly constant over time through this period. See Goldin, *Understanding the Gender Gap*, pp. 66–68. The unweighted average ratio of adult male to female wages across industries was 2.1; the unweighted average ratio of adult male to child wages was 3.1.

⁴⁹ See Atack and Bateman, “How Long was the Workday.”

TABLE I
interindustry VARIATION IN WAGES OF ADULT MALE WORKERS, 1870–1900

Year	Coefficient of Variation
1870	22.73
1880	20.24
1890	18.44
1900	12.83
1910	13.20

Note: Data on total wages of adult male, female, and child workers were extrapolated for 1870 and 1880 (see the explanation in the text).

Source: Department of Commerce, *Census* (1870, 1880, 1890, 1900, 1910).

average daily hours of work in different manufacturing industries.⁵⁰ They find only small differences in hours across industries. I have used their estimates of daily hours, along with their estimates of the number of days of “full time equivalent operation” by firms in each industry in 1880⁵¹ to see whether controlling for hours worked makes a difference to measured inter-industry wage variation calculated using total wages and employees data from the census. The effect of controlling for total man-hours in 1880 is negligible: it reduces the measured coefficient from 23.74 to 22.61.

Other types of differences in working conditions across industries may be more important, particularly in the nineteenth century when the geographic concentration of industries was greater. Previous work on regional differences in wages has tried to account for regional differences in mortality rates, for example, and associated variables such as sanitation and overcrowding.⁵² City size and climate have also been used to help explain variation in wages earned across different geographic locations.⁵³ It would be extremely difficult, however, to make allowance for these kinds of variables in measures of interindustry wage dispersion, because one would have to collect a vast amount of new data on the locational attributes of each industry (essentially, breaking down the employment data for each industry into components located in specific cities and rural areas).

A similar data problem confronts us when thinking about locational differences in the cost of living in the nineteenth century.⁵⁴ The construction of locational price indexes is itself a formidable task given the limited number of commodities and locations covered by the available data on prices and the limited information on the composition of household spending in early

⁵⁰ *Ibid.*

⁵¹ Atack and Bateman, “Irregular Production.”

⁵² See Williamson, “Was the Industrial Revolution.”

⁵³ Clark, Kahn, and Ofek, “City Size”; Roback, “Wages”; and Rosenbloom, “Was the a National Labor Market.” Although city size appears to have significant effects on wages, climate variables do not.

⁵⁴ On this, see Coelho and Shepherd, “Regional Differences” and “Impact”; and Haines, “State and Local Consumer Price Index.”

periods.⁵⁵ Nevertheless, several studies of regional wage dispersion have attempted to employ such indexes to help account for variance in prices across locations.⁵⁶ Again, however, one would need to assemble extensive data on the locational attributes of industries in order make allowances for such price variance in the measures of interindustry wage dispersion.

As with regional variance in working conditions, moreover, the extent to which such variance can have a bearing on measures of interindustry wages depends upon the degree of regional concentration in manufacturing activities: greater concentration implies that locational attributes may widen interindustry wage dispersion. But Sukkoo Kim has shown that the U.S. economy actually became *more* regionally specialized between 1860 and 1900, a period in which the measured levels of interindustry wage dispersion fall markedly, and became much *less* specialized after the 1930s, when levels of interindustry dispersion rose. If anything, this suggests that the measures of the two trends are both understated rather than overstated.⁵⁷

Alternative Evidence on Interindustry Labor Mobility

The findings drawn from the study of wage differentials are strongly supported, at least in the twentieth century, by the available data on labor turnover in American manufacturing. It was the postwar decline in U.S. labor turnover, in fact, that prompted early concern among economists about a “new industrial feudalism” in the 1950s. The concern was discussed by Arthur Ross and dismissed as a temporary development.⁵⁸ However, James Ragan’s analysis of the quit rate among manufacturing workers between 1957 and 1979 revealed a persistent downward trend. I have extended that analysis here, using all the available data for the period 1919 to 1981. The results, shown in Table 2, confirm Ragan’s original findings.

The results indicate a significant downward time trend in the quit rate (quits per 100 employees). When we control for business-cycle effects, as in the first column, the trend is significant at the 0.001 level. When we also control for demographic changes in the workforce (female workers are more likely to quit than males, and younger workers are more likely to quit than older ones) the magnitude of the estimated time trend increases, as shown by the results in the second column. The trend has reduced the quit rate by

⁵⁵ Margo, “Wages,” pp. 182–83.

⁵⁶ Sokoloff and Villafior, “Market”; and Rosenbloom, “Was There a National Labor Market?”

⁵⁷ Although the decline in interregional wage dispersion late in the nineteenth century (consistent with the idea that labor mobility was rising in general) probably cancels out some of this estimation bias for the earlier period. I am grateful to an anonymous reviewer for pointing this out.

⁵⁸ Ross, “Do We Have a New Industrial Feudalism?” Earlier concerns about apparent immobility in the workforce were raised by Brissendon, “Labor Mobility.”

TABLE 2
REGRESSION RESULTS FOR U.S. QUIT RATE, 1919–1981

Independent Variables	Model 1	Model 2
Constant	2.30 (7.87)	-1.18 (-1.90)
<i>Unemployment rate (percentage)</i>	-0.26 (-6.24)	-0.39 (-9.67)
<i>Female employees (percentage)</i>		0.14 (1.41)
<i>Employees aged 16–24 years</i>		0.21 (3.23)
<i>Time</i>	-0.06 (-3.25)	-0.08 (-2.25)
<i>N</i>	63	42
Adj <i>R</i> ²	0.40	0.82
SER	0.92	0.34
<i>p</i>	0.64	0.58

Notes: *t*-statistics are in parentheses. Both equations were adjusted for first-order autocorrelation. *Time* equals 1 for the first observation.

Sources: Data on quits, unemployment, and the gender and age components of the labor force, are from Department of Commerce, *Historical Statistics*, and Department of Labor, *Employment and Earnings*. The quit rate is not reported prior to 1919 or following 1981. Gender and age data are available from 1940.

an estimated 3.2 percentage points over the last 40 years (and the average rate of quits was only 2.5 percent over that same period).

Survey data on job tenure also suggest that American workers have become less mobile in recent decades. The number of years spent on the same job by the average worker, in all age groups, rose substantially between 1950 and 1990. Workers aged 55 to 64 were in their jobs an average of 16.0 years in 1991 compared with 9.5 years in 1951; those aged 45 to 54 had been in their jobs an average of 12.2 years in 1991, up from 7.9 years in 1951; and for those in the 35 to 44 age bracket average tenure rose to 7.9 years in 1991 from 4.3 years in 1951.⁵⁹

Data on Profit Rates in Manufacturing Industries

Data on rates of return to capital in different industries are harder to come by for early periods than are data on wages. There is very little direct data on firm revenues prior to 1914. Federal taxes were not imposed on corporate incomes until 1909, and data from tax records are not available until much later.⁶⁰ In one early study, William Crum used reports on approximately

⁵⁹ Data are from the Labor Department and the Wyatt Company. Research on wage differentials has shown that the relationship between industry wage premia and job tenure is positive and significant, supporting the notion that workers in high wage industries do receive economic rents. See Krueger and Summers, “Efficiency Wages”; Pencavel, *Analysis*; and Freeman, “Exit-Voice Tradeoff.”

⁶⁰ See Epstein and Gordon, “Profits,” p. 122.

455,000 corporations from the U.S. Commissioner of Internal Revenue for the years from 1916 to 1927, but was only able to calculate firm profits as a percentage of total sales rather than as a return on investment, because the reports did not include any data on capital invested in each firm.⁶¹

Published reports for corporations are another potential source of data on profits, but these are very few in number before 1920, and poor in quality.⁶² Edgar Epstein and R. Gordon have examined the balance sheets and income statements of the small group of corporations for which such reports are available between 1900 and 1914 (they judged the reports for only 24 firms to be of sufficient quality to permit calculations of profits over this period).⁶³ Sumner Sloan examined a broader sample of 455 corporations using data from published annual reports for 1926 and 1927.⁶⁴ Beginning in 1933 data from such reports on corporation profits (as percentages of net worth and equity) are available from the Securities and Exchange Commission, categorized according to their main activities into two-digit SIC industry groups.⁶⁵

A significant problem with reliance on such corporation data, of course, is that it does not account for the activities of private firms (a problem that is paralyzing for the period before the 1930s). An alternative, more encompassing source of data on profits is the decennial census. Bateman and Thomas Weiss have used actual census manuscripts to calculate profits (value-added minus wage costs) as a percentage of capital invested for a sample of individual manufacturing firms in the southern states in 1850 and 1860.⁶⁶ Similar calculations can be made using the aggregate industry data on value-added, wage costs, and capital invested to measure average profits in each census year. As with the census data on wages, this has the advantage that it provides a broad coverage of firms in the manufacturing sector, with comparable annual data on each major industry, and can be used to construct a long time series. One important problem, however, is that the early censuses are not very clear about the method of evaluating capital investments.⁶⁷ It seems that the figures reported are undepreciated book values, though whether such values were revalued during periods of substantial inflation or deflation is uncertain.⁶⁸ The capital figures clearly refer to structures and equipment, but exclude evaluations of working capital

⁶¹ Crum, *Corporate Earning Power*.

⁶² Epstein and Gordon, "Profits."

⁶³ Ibid. Epstein also made use of a special Senate report on corporate earnings in 1918, which compiled data on some 26,477 firms for 1917 (though only, for some reason, corporations earning over 15 percent return on capital stock). See Epstein, "Industrial Profits."

⁶⁴ Sloan, *Corporation Profits*.

⁶⁵ Securities and Exchange Commission, *Corporation Profits*; and Department of Commerce, *Statistical Abstract of the United States*.

⁶⁶ Bateman and Weiss, *Deplorable Scarcity*, pp. 103–13. See also, Bateman, Foust, and Weiss, "Profitability."

⁶⁷ See Bateman, Foust, and Weiss, "Profitability," pp. 215–16.

⁶⁸ Creamer, *Capital*; and Easterlin, "Estimates."

(inventories, cash, and accounts receivable), which appear to have represented significant investments in several industries.⁶⁹

After 1919, although the *Census of Manufactures* and the *Annual Survey of Manufactures* continue reporting data on value added and wage costs by industry, they cease reporting data on capital invested. From 1947, however, data on total man-hours consumed per year are available for each industry, and these can be used as a crude proxy for total investments (in both fixed and working capital): that is, profit per man-hour can be regarded as an approximation to profit per dollar invested.⁷⁰ The potential bias here is towards overstating profits in capital-intensive industries and understating profits in labor-intensive industries (because the former consume fewer man-hours relative to unobserved capital investments than do the latter).⁷¹

I have compared evidence on industry profits from each of the different sources.⁷² To compile data on a consistent set of industries from the censuses prior to 1919 I used the same list of 15 and 20 industries constructed for the analysis of wages. For the data from the *Census of Manufactures* and the *Annual Survey of Manufactures* after 1947, I used the full list of 19 industry categories.

Interindustry Profit Variance

Figure 2 charts coefficients of variation in profits across manufacturing industries using these different data series. The results generally seem to match the pattern exhibited in the wages data, although overall interindustry variability is higher. There was a general decline in interindustry variation in profits over most of the nineteenth century, and a rise in variation beginning some time between the 1880s and 1910s.⁷³ There was a rapid increase

⁶⁹ Creamer, *Capital*; and Easterlin, "Estimates." Using data from the 1832 McLane Report, Sokoloff examined assets of manufacturing industries and discovered that most industries had only modest investments in fixed structures and equipment (roughly 50 percent of assets), and much of the investment in the least capital-intensive industries took the form of inventories and accounts receivable. Sokoloff, "Investment."

⁷⁰ The latter follows Alt et al., "Collective Action."

⁷¹ In a separate analysis I have estimated profit equations that control for capital intensity when measuring industry profit differentials using data available for recent years. The results indicate that whereas capital intensity does have a significant, positive effect on profits measured in this fashion, the inferences about the relative size of industry profit differentials in different years reported in this article are robust to inclusion of this control variable (and others). The analysis is available from the author and online at: <http://www.people.fas.harvard.edu/~hiscox/JEHappendix.html>.

⁷² A full description of the data, with measures of the comparability of profit estimates across sources, is available from the author and online at: <http://www.people.fas.harvard.edu/~hiscox/JEHappendix.html>.

⁷³ Note that the high variance in industry profits in 1820 is evident in individual states for which data were examined as well as in the aggregate. The coefficients of variation in profits were: 69.6 in New York (16 industries); 110.9 in Connecticut (8); 104.8 in New Jersey (9); 93.9 in Pennsylvania (16); 111.8 in Massachusetts and Rhode Island (8); 73.4 in Maryland (12); and 83.4 in Virginia (14).

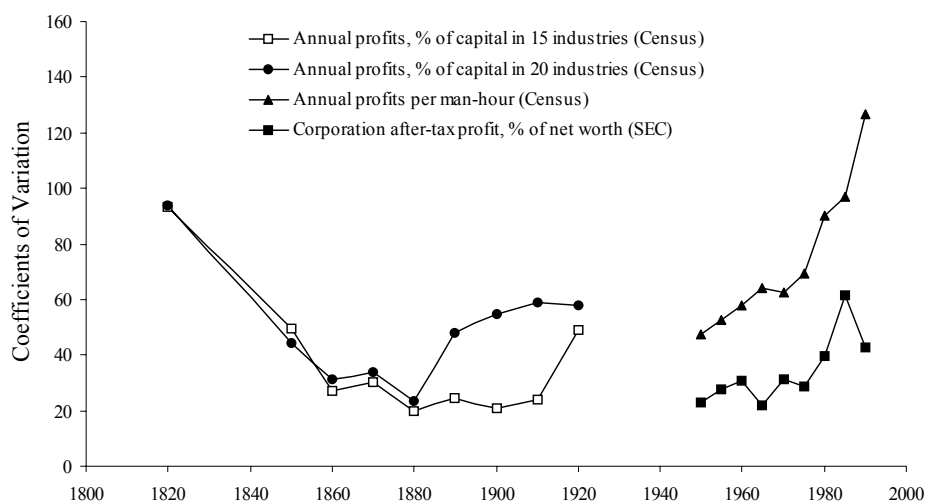


FIGURE 2
INTERINDUSTRY VARIATION IN PROFITS IN MANUFACTURING

Sources: Department of Commerce, *Census, Census of Manufactures, Annual Survey of Manufactures*, and *Statistical Abstract of the United States*; and Securities and Exchange Commission, *Corporation Profits*.

in return differentials after 1945, indicating a significant decline in interindustry capital mobility in recent decades. It is worth noting that the general correspondence between patterns in interindustry wage and profit differentials is broadly consistent with “efficiency wage” theories and “rent sharing” between capital and labor.⁷⁴

Again, although the discovery of these trends is new, the evidence suggesting high levels of capital specificity or immobility across industries in recent years appears quite consistent with findings in several previous studies. Grossman and Levinsohn, for instance, make the same claim after examining stock-market returns in several American industries during the 1970s and 1980s.⁷⁵ They find that the large effects on such returns produced by unanticipated changes in relative commodity prices are consistent with the notion that capital is quite immobile between industries. Valerie Ramey and Matthew Shapiro come to the same conclusion by studying secondary markets for capital equipment.⁷⁶ They find that buyers for such equipment are predominantly firms in the same industry as the seller, and that equipment is sold to firms outside the industry only at highly discounted prices.

Obviously, though, the data on profits need to be treated with a great deal of caution. One cause for concern is the data on capital investments in the

⁷⁴ Katz and Summers, “Industry Rents.”

⁷⁵ Grossman and Levinsohn, “Import Competition.”

⁷⁶ Ramey and Shapiro, “Displaced Capital.”

censuses prior to 1910. As noted previously, these figures almost certainly do not take into account investments in working capital, and ideally we would include some allowance for depreciation in the value of capital assets. Unfortunately, there is little data available on the extent of working capital by industry or the rates of depreciation on different types of assets. The census of 1890 does include data on working capital (called “live assets”), and can be used with rough estimates of depreciation rates to construct alternative measures of profits. This is the approach taken by Bateman and Weiss when measuring profits in southern manufacturing in 1850 and 1860: they used data on working capital in 1890 to estimate working capital invested in each industry (and region) in earlier census years.⁷⁷ To calculate depreciation costs, they assume that structures last 50 years and equipment lasts 20 years, and calculate depreciation on a straight-line basis; the assumption here is that manufacturers made the necessary expenditures to keep assets operating perpetually.⁷⁸ In their calculations of profits they also include estimates of “miscellaneous costs” (expenditures on maintenance, insurance, rent, contract work, taxes, and sundries), which are recorded in the 1890 census but not in earlier years.⁷⁹

I have applied the same approach here, using the 1890 data on working capital and miscellaneous expenses, along with estimates of depreciation, to re-calculate industry profit rates in 1890. The 1890 data are also used to estimate values of working capital and miscellaneous costs using earlier census data and thus to generate new estimates of profits for those earlier years. The coefficients of interindustry variation for profits so measured are shown in Table 3. Adding controls for working capital, miscellaneous expenses, and depreciation leads to slightly lower measures of industry profit differentials than those reported in Figure 2, but the trend over time during this period remains the same: there is a significant decline in the dispersion of profits up until the 1880s.

A fundamental problem with all these estimates of industry profit rates is that they do not reflect the risk associated with investment. In the same way that wage dispersion in part reflects industry differences in working conditions, profit dispersion should reflect industry differences in the riskiness of investment. We might question whether the trends in profit variance reported previously are in fact due to some large, historical changes in the relative riskiness of different industries. To help gauge the extent of this problem I have used data available in recent decades from the *Census of Manufactures* on profits of firms categorized at the four-digit SIC level. I

⁷⁷ Bateman and Weiss, *Deplorable Scarcity*, pp. 103–13.

⁷⁸ The estimates of the life-spans for different assets is based upon evidence in McGouldrick, *New England Textiles*.

⁷⁹ They do not discuss whether the inclusion of expenditures on maintenance (in the estimates of “miscellaneous costs”) and allowance for depreciation introduces a problem of double counting.

TABLE 3
 INTERINDUSTRY VARIATION IN PROFITS: USING ESTIMATES OF WORKING
 CAPITAL, DEPRECIATION, AND MISCELLANEOUS EXPENSES, 1850–1900

Year	Coefficient of Variation
1820	78.34
1850	48.60
1860	25.58
1870	25.44
1880	22.11
1890	24.70
1900	28.95

Notes: Data on working capital, buildings, equipment, and miscellaneous expenses for 1890 were used to estimate similar data unavailable in earlier years. Profits were calculated as value-added minus wages, depreciation, and miscellaneous costs as a percentage of total capital (land, buildings, equipment, and working capital) invested.

Source: Department of Commerce, *Census* (1820–1900).

calculated profits in each of these four-digit categories, then treated these observations in similar fashion to the individual-level data on wages from the CPS already discussed, estimating profit equations and applying controls for risk (measured by year-to-year variability in profits) and several other industry characteristics, then measuring the size of industry profit differentials over time (between 1972 and 1992). The analysis provides strong confirmation of the results based upon the general measures of profit variance: even controlling for interindustry differences in risk, there has been a substantial rise in industry profit differentials over time.⁸⁰

It is also worth asking whether the measures of dispersion in profits (or wages) are significantly affected by industry-specific shocks in demand. Including yearly changes in industry sales in the analysis of profits across four-digit industries actually does not increase the explanatory power of the estimations at all. The same is true for the estimations of wages based upon CPS data.⁸¹ In addition, there is no apparent trend over time in interindustry variability in short-term growth rates, at least over the last hundred years. The coefficient of variation in five-yearly growth rates was 38.4 in 1900–05 (the earliest set of censuses separated by less than 10 years), in 1950–1955 it was 54.3, in 1970–1975 it was 38.7, and it was 52.4 in 1985–1990. That is, changes in interindustry profit (and wage) dispersion do not seem to be functions of any alteration in the incidence of demand shocks or the pace of structural change.

⁸⁰ This analysis is available in an appendix from the author or can be accessed online at: <http://www.people.fas.harvard.edu/~hiscox/JEHappendix.html>.

⁸¹ Bell and Freeman reached the same conclusion about demand shocks in analyzing CPS wage data for the years between 1971 and 1981. Bell and Freeman, “Causes,” pp. 283–85.

Alternative Evidence on Interindustry Capital Mobility

The findings from the profit data do fit well with the available evidence on research and development spending by manufacturing firms. R&D spending is a popular indicator of asset specificity among analysts of industrial organization because it captures the emphasis placed by firms on developing their own production technologies and products.⁸² Owners of more specialized capital, by definition, find it more difficult to adapt their equipment to alternative production and find it more costly to sell their equipment following a decline in the fortunes of the industry to which it is tied. Figure 3 charts the available data on spending by U.S. manufacturing companies on R&D (as a percentage of sales) between 1950 and 1990.⁸³ Spending on R&D rose from around 0.5 percent in 1950 to over 3 percent in 1990.

Two more general, and closely linked, developments also fit with the recent trend in the profit data. The first is the impressive deepening of equity markets this century that has made it far easier to trade ownership of capital assets in different industries. The second is the apparent trend toward portfolio diversification among owners of equities: the rise of the professional fund management industry and mutual funds is perhaps the clearest signal of this change. That the first development might be related to increasing capital specificity is suggested by Oliver Williamson's analysis.⁸⁴ When capital is less mobile between uses, we should expect greater reliance on equity financing rather than borrowing, because lenders are more reluctant to invest in more specific assets and charge premia for the added risks. Regarding the second development, as Michael Mussa has pointed out, when capital is less mobile, so that returns in different industries are more varied, investors have a greater incentive to diversify their portfolios and we can expect to see more diversification in aggregate.⁸⁵

TECHNOLOGICAL CHANGE, INDUSTRIALIZATION, AND FACTOR
MOBILITY

The data presented on interindustry differentials in wages and profits suggest that there have been significant changes over time in levels of interindustry labor and capital mobility. The pattern that emerges—falling differentials (increasing levels of mobility) over most of the nineteenth century, giving way to rising differentials (decreasing mobility) over most of the twentieth century—seems very clear, and appears to make considerable

⁸² Acs and Isberg, "Innovation."

⁸³ The data are from the Department of Commerce, *Historical Statistics of the United States and Statistical Abstract of the United States*.

⁸⁴ Williamson, *Economic Institutions*, pp. 307–09.

⁸⁵ Mussa, "Tariffs."

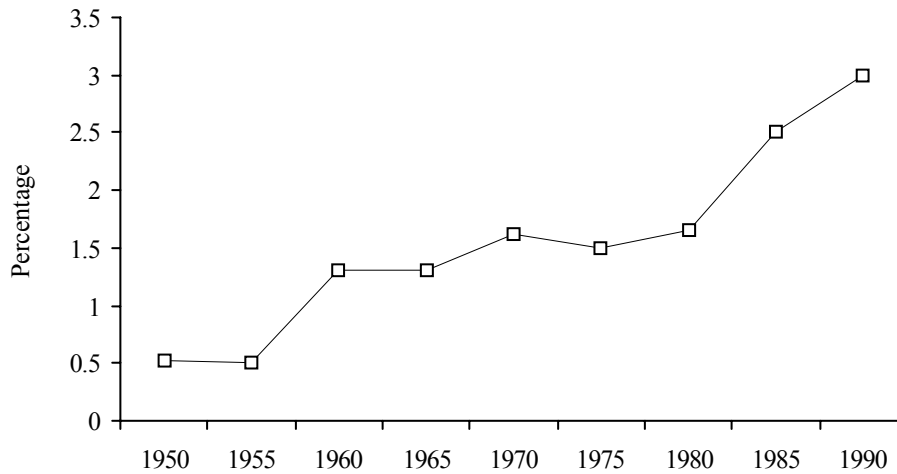


FIGURE 3
COMPANY RESEARCH AND DEVELOPMENT SPENDING IN THE UNITED STATES:
SPENDING AS A PERCENTAGE OF SALES

Sources: Department of Commerce, *Historical Statistics of the United States*, and *Statistical Abstract of the United States*.

sense in the light of the technological transformations associated with different stages of industrialization.

Historical accounts of American economic development have emphasized a range of technological changes that combined to make the economy more fluid during the early stages of industrialization in the nineteenth century.⁸⁶ Major innovations in systems of water, rail, and road transportation drastically lowered the costs of factor movement and lessened the importance of geography to economy.⁸⁷ Inland freight rates began to fall quickly along roads and rivers beginning in the 1820s, along canals beginning in the 1830s, and along the new railroads from the 1850s.⁸⁸ The greatest change came in the 1850s when rail lines crossed the Appalachians and the old Midwest to reach the Mississippi. In 1869 the first transcontinental line began operation.

⁸⁶ See Sokoloff and Villaflor, "Market," pp. 29–30. Historians of European industrialization have more frequently focused on the lifting of legal restrictions on factor movement that was a common, though by no means uniform, concomitant of early industrialization. England's head start in deregulation—traceable as far back as the Statute of Artificers in 1563—is widely cited (see Landes, *Unbound Prometheus*, p. 62). North and Thomas, for instance, contrast rising levels of factor mobility in Britain and the Netherlands, where feudal guilds and regulations were increasingly by-passed in the sixteenth and seventeenth centuries, with continued immobility of productive factors in Spain and France. See North and Thomas, *Rise*.

⁸⁷ See Taylor, *Transportation Revolution*; Davis et al., *American Economic History*, pp. 276–96; and Chandler, *Visible Hand*.

⁸⁸ North, "Role."

Production steadily became less concentrated by region, and more subject to integrated commodity and input markets, as labor migration and capital flows increased.⁸⁹ In manufacturing, the effect was accentuated by the development of stationary steam engines, which freed manufacturing establishments from dependence upon water power and the need to locate along rivers. Studies of the increasing interregional integration of the labor market between 1850 and 1914 have linked decreasing interregional wage differentials to these improvements in transportation and communication, and have revealed high rates of spatial mobility among workers late in the nineteenth century.⁹⁰ There is also clear evidence that these technological improvements corresponded with a convergence in interest rates and the emergence of a national financial market.⁹¹

Agricultural producers were affected too, it is worth noting, as distance from markets and resources became less important for the location of production. Production of meat and perishable farm goods, for instance, could be extended to areas much further from urban markets after the arrival of the railway. Innovations in refrigerated transportation reinforced this trend. General improvements in irrigation and artificial fertilizers, most apparent in the last decades of the nineteenth century, also helped to make agricultural production more flexible. More importantly perhaps, large areas of different types of land were being taken over by a huge stream of settlers flexible about what they would cultivate. The rural population grew by 60 percent between 1870 and 1900, and the number of farms in existence more than doubled: from 2,659,985 to 5,737,372.⁹²

Technological innovations in manufacturing production early in the nineteenth century also had profound implications for interindustry factor mobility. The very heart of the industrial revolution, of course, was the interrelated succession of technological changes that substituted machine manufacture for handicraft production and inanimate power for human and animal force. The series of inventions that revolutionized the manufacture of textiles, iron, and steel, and steam power saw new mills and factories replace craft shops and home manufacture, and the old skills of the artisan class were rendered obsolete.⁹³ A second cluster of innovations in the manufacture of electric power and electrical machinery, and internal combustion engines, brought assembly-line production, precision manufacturing, and the great shift from nodal to linear-flow manufacturing that swept through industry

⁸⁹ See Perloff, *Regions*; also O'Brien, *Railways*.

⁹⁰ For instance, Rosenbloom, "One Market," and "Extent." On spatial movements of labor see Thernstrom, *Other Bostonians*, pp. 222–23.

⁹¹ See Davis, "Investment Market"; and Bodenhorn and Rockoff, "Regional Interest Rates."

⁹² Lake, *Power*, p. 87.

⁹³ Sokoloff and Villaflor, "Market," pp. 32–33.

later in the nineteenth century.⁹⁴ Much of the new technology provided new ways to pipe, pump, lift, convey, shape, press, heat, and measure raw materials and was readily adaptable to use in alternative industries.⁹⁵ Meanwhile, the introduction of labor-saving machinery on a massive scale, and the advent of the production line, created a vast demand for unskilled workers and increased the ease with which industrial workers could shift between manufacturing industries.⁹⁶ Claudia Goldin has argued that, by the turn of the twentieth century, the market for labor in the manufacturing sector was essentially a spot market, with most jobs easily handled by the average worker.⁹⁷

The relationship between labor skills and technology in the first stages of industrialization stands in marked contrast with the well-known complementarity between skills and technology in more recent eras.⁹⁸ This contrast has recently been made apparent in work by Louis Cain and Donald Patterson, John James and Jonathan Skinner, and Goldin and Lawrence Katz.⁹⁹ They point out that the key technological advances of the nineteenth century, and the great shift from the artisanal shop to the factory, effectively substituted new physical capital, raw materials, and unskilled labor, for skilled workers.¹⁰⁰ Yet, in the first years of the twentieth century, this historic shift appears to have been reaching an end. Goldin and Katz argue that the turnaround took place in the 1910s and 1920s with the move from assembly-line to continuous-process technology—the latter requiring more professional and skilled workers in the management and operation of highly-complex tasks.¹⁰¹ Several studies have shown that, from around this time, workers were employed in longer-lived jobs in which they received more training in firm-specific skills.¹⁰²

In particular, dramatic technological advances in the fields of micro-electronics, robotics, telecommunications, chemical engineering, and micro-

⁹⁴ Landes, *Unbound Prometheus*, pp. 305–07.

⁹⁵ *Ibid.*, pp. 293–94.

⁹⁶ Sokoloff, “Productivity Growth.” This period witnessed the birth of “scientific management,” heralded enthusiastically in the 1890s by the American engineer Frederick W. Taylor. The key goal was to raise productivity by standardizing tasks and minimizing worker autonomy. See Aitken, *Taylorism*; and Copley, *Frederick W. Taylor*.

⁹⁷ Goldin, *Understanding the Gender Gap*, p. 115. A similar point is made by Gordon, Edwards, and Reich, *Segmented Work*, pp. 112–28.

⁹⁸ On skill-technology complementarity in the post–World War II period, see Griliches “Capital-Skill Complementarity”; Hammermesh, *Labor Demand*; Bartel and Lichtenberg, “Comparative Advantage”; and Fallon and Layard, “Capital-Skill Complementarity.” Berman, Bound, and Griliches (“Changes in the Demand”), for example, have found that skill-upgrading in American manufacturing in recent decades was positively associated with growth in the capital-output ratio, investment in R&D, and use of computer technology.

⁹⁹ Cain and Patterson, “Biased Technical Change”; James and Skinner, “Resolution”; and Goldin and Katz, “Origins.”

¹⁰⁰ See Sokoloff, “Was the Transition.”

¹⁰¹ Goldin and Katz, “Origins”; see also Chandler, *Visible Hand*.

¹⁰² See Sundstrom, “Internal Labor Markets”; Carter and Savocca, “Labor Mobility”; and James, “Job Tenure.”

biology, made specialized human and physical capital vastly more important in almost all areas of industrial production. Growth in the demand for human capital has been concomitant with continued technological improvements since the 1920s.¹⁰³ And studies have revealed a clear inverse relationship between investments in industry and firm-specific human capital and labor mobility.¹⁰⁴ Because the cost of quitting also increases for employers with greater emphasis on worker training, the rational response for firms has been to encourage longer tenure among employees. The general expansion in the use of fringe benefits tied to seniority, and its negative impact upon mobility, have both been well documented.¹⁰⁵ Between the 1890s and the 1970s, the proportion of workers with jobs of over 20-years duration doubled or even tripled (rising from around 27 percent to between 49 and 82 percent).¹⁰⁶

Concurrent with this growing emphasis on specialized human capital has been the increasing importance placed upon specialized physical capital. There has been a general and substantial rise in the importance placed by firms upon private research and development spending aimed at creating new products and production processes.¹⁰⁷ And Richard Caves and Michael Porter have argued that barriers to exit and entry have risen in this century, not only due to the growing importance of specialized equipment in manufacturing, but also as a function of higher start-up costs and increased investments in physical capital associated with the general growth in the scale of production.¹⁰⁸ Although the evidence that scale economies alone act as powerful barriers to entry in practice is not strong, there is more evidence that

¹⁰³ Mincer, "Human Capital." One crude indicator of the trend is that the ratio of nonproduction to production workers in U.S. manufacturing grew from 0.05 in 1900 to 0.13 in 1929, and to 0.35 in 1970 (Department of Commerce, *Historical Statistics*). Though we might distinguish between general knowledge (which could make workers more adaptable to different activities) and more specialized knowledge, Mincer has shown that the former (measured by levels of education among workers) is strongly correlated with more specialized job training. See Mincer, *Studies*.

¹⁰⁴ Bloch, "Labor Turnover"; Parsons, "Specific Human Capital"; Mincer and Jovanovic, "Labor Mobility"; and Ragan, "Investigating the Decline."

¹⁰⁵ See Block, "Impact"; and Mitchell, "Fringe Benefits."

¹⁰⁶ Jacoby and Sharma, "Employment Duration," pp. 171–72. See also Carter and Savocca, "Labor Mobility." In the 1890s, as Jacoby and Sharma point out, job shopping was common among workers and employers offered few incentives to encourage workers to stay with the firm. Separation rates were high even during recessions. Since then, apart from the effects of technological changes, several other more general developments have been identified as having had a negative effect on labor mobility. Most importantly, the growing number of two-income families, unionization, greater progressivity in taxes, and the introduction of sick-leave and maternity policies, have all been identified as changes that have made job change generally less attractive to workers. See Holmlund, *Labor Mobility*; and Freeman, "Individual Mobility" and "Exit-Voice Tradeoff."

¹⁰⁷ The first industry laboratory in the United States was established by General Electric in 1900 and American Telephone and Telegraph established its own famous Bell lab in 1911. By 1931, however, 1,600 American companies reported research labs. See Reich, *Making of American Industrial Research*, p. 2.

¹⁰⁸ Caves and Porter, "Barriers."

larger capital requirements mean that fewer individuals or groups can secure the funding needed for entry, or that they can obtain such funding only at interest rates that place them at a cost disadvantage due to unequal access to credit.¹⁰⁹ Matityahu Marcus has shown that the heavier a firm's weight of fixed investment, the less likely it is to exit from an industry.¹¹⁰

IMPLICATIONS

Very few attempts have been made to assess levels of interindustry factor mobility in the American economy, and there has been almost no study of how such levels may have changed over time. The evidence presented in this article suggests that levels of interindustry factor mobility are strongly related to economic development and have changed substantially over the last two centuries. Early stages of American industrialization produced a sharp fall in industry wage and profit differentials, indicative of a substantial rise in labor and capital mobility as major innovations in systems of transportation lowered the costs of factor movement and as a cluster of innovations increased demand for unskilled workers. Later stages of industrialization, however, produced a clear upward trend in industry wage and profit differentials, signaling a decline in interindustry factor mobility as new technology required larger investments in specific assets for both capital and labor. This shift is also reflected in data on labor turnover, job tenure, and firm spending on research and development.

These findings carry important implications for work in a variety of fields. They confirm results from recent research on labor and capital markets that suggest that asset specificity has become a major barrier to the rapid re-allocation of labor and capital between industries. Fears raised about a "new industrial feudalism" in manufacturing have become more justified over the course of the century. In contrast to previous eras, and with many industries facing increased exposure to international competition, there seems to be a strong case for increased provision of adjustment assistance to firms and workers in "declining" industries in order to increase efficiency (and mitigate costs imposed upon particular groups by international trade agreements).

Perhaps the most important implications are for the political-economic analysis of the origins of economic policies. The distributional effects of a vast range of trade, industrial, and regulatory policies hinge critically upon levels of factor mobility. The motivations of economic actors who enter the

¹⁰⁹ See Scherer, *Industrial Market Structure*; and Geroski and Jacquemin, "Industrial Change."

¹¹⁰ Marcus, "Firms' Exit Rates." Strategic considerations obviously play a role here. Because exit by one firm can increase the profitability of others when scale economies are large, each firm has an incentive to "out wait" the other, even in the face of persistently low returns (Nalebuff and Ghemawat, "Devolution").

political arena to shape such policies are influenced by their ability to shift assets between industries. If factors are highly mobile between industries, a (policy-induced) rise in the relative price of a commodity will increase the real returns to those factors used intensively in its production and decrease returns to other factors, regardless of where those factors are employed in the economy. Political coalitions formed to shape policies are thus likely to be factor based and quite broad: labor will be pitted against capital, for instance, in debates over trade protection when one factor is relatively scarce and the other abundant. If factors are instead quite specific to particular industries, their real returns are tied closely to the fortunes of the industries in which they are employed: factors specific to industries favored by an exogenous shift in relative prices receive higher real returns, whereas those employed in other industries lose out in real terms. In this case, political coalitions will form along industry lines: labor and capital in each industry will lobby together for policy changes that benefit them both, at the expense of workers and firms in other industries.¹¹¹

As general levels of factor mobility have changed significantly over time in the U.S. economy, we should thus expect substantial changes in the political landscape. In broad terms, “rent-seeking” by narrow industry groups should have been most prevalent when levels of interindustry mobility reached historically low levels—that is, early in the nineteenth century and, perhaps more worrisomely, in recent decades. On the other hand, “class conflict” between broad factor-based coalitions should have been most prevalent in debates over economic policy when levels of mobility were quite high—that is, around the turn of the century. These anticipated effects fit rather well with some stylized facts about American trade politics. According to the standard accounts, trade politics was a predominantly local, group-based affair at the beginning of the nineteenth century, with the emerging political parties split over the tariff issue, and trade legislation largely reflecting the competing pressures placed on Congress by a vast array of groups.¹¹² In the years following the Civil War, however, trade became *the* partisan issue in American politics, as Republicans, drawing broad support from business and labor, supported protectionist tariffs over the vehement opposition of Democrats and their largely rural constituency.¹¹³ More recently, at least since the 1950s, growing rifts have been apparent in both parties over the trade issue, and industry groups again appear to be exercising a powerful role in shaping policy outcomes.¹¹⁴

¹¹¹ On this crucial difference, see Magee, “Three Simple Tests.”

¹¹² Stanwood, *American Tariff Controversies*; and Pincus, *Pressure Groups*.

¹¹³ See Stanwood, *American Tariff Controversies*; also, Taussig, *Tariff History*.

¹¹⁴ See Destler, *American Trade Politics*, for evidence on both intraparty rifts and the growth in group lobbying in trade politics. See also Magee, “Three Simple Tests.”

The implications of the observed shifts in levels of interindustry factor mobility for the character of policy outcomes and for development of political organizations (such as political parties, trade associations, and labor unions) are worth pursuing. It also seems appropriate to link the argument about increased rent-seeking by groups in recent years to Mancur Olson's famous concern about the rising importance of distributional coalitions in the United States and other advanced economies and their negative impact upon economic growth.¹¹⁵

¹¹⁵ Olson, *Rise*.

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