Size, Skill and Sorting

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Abstract. The rise in inequality between the 1970s and the 1990s and the persistent gap in pay between large and small employers are two of the most robust findings in the study of labor markets. Mainstream economists focus on differences in observable and unobservable skills to explain both the overall rising inequality and the size–wage gap. In this paper we model how increasing returns to skill can affect the size–wage gap both with constant sorting and with size-biased, skill-biased technological change (e.g. if large firms always had access to computers, but small firms gained access to computers with the rise of affordable personal computers).

We analyze the Current Population Surveys from 1979 to 1993 to determine whether large and small employers are converging in terms of mean wages (the employer size–wage effect), wage structures by occupation and education, characteristics of employees, and wage structures by region. We find mixed evidence of convergence and no consistent support for any single version of human capital theory.

1. Introduction

One of the enduring regularities of labor economics is that large firms pay more than small firms (Brown and Medoff, 1989). The average pay in large firms (more than 1,000 employees) was 36 per cent higher than pay in small firms (fewer than 100 employees) in 1979 (Brown and Medoff, 1989). Larger employers are also more

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likely to provide benefits and these benefits are typically superior to those provided by smaller firms (Brown *et al*., 1990).

An important research agenda in the social sciences has been understanding the differences in employees' and employers' characteristics that account for this very large pay gap. One explanation, suggested by human capital theory, is that the size–wage gap is the result of large firms' use of production technologies and work organizations which rely disproportionately on highly skilled employees. Large firms pay more for highly skilled employees because, in combination with large firm technologies, such workers are more productive and have higher returns than they would at small firms. At its root the size–wage gap is, then, the result of size serving as a proxy for the skills of the labor force. Controlling for observable skills such as education and potential experience reduce the size–wage gap by roughly a third, which is consistent with large firms hiring highly skilled employees.

The dramatic shift in compensation patterns in the USA between the 1970s and the early 1990s can provide additional tests of the sources of the size–wage gap. Specifically, there has been a very large increase in returns to observable skills, such as education, and the roughly parallel increase in inequality among people with identical observed skills (Katz and Murphy, 1992). Some observers have posited that the rising inequality for apparently similar employees is due to rising returns to unobserved skills (e.g. Juhn *et al*., 1993). Davis and Haltiwanger (1991) build on the rising returns to observable skills to analyze the rising returns to size among manufacturing establishments they document between 1963 and 1986. That is, they note that the rising returns to establishment size is consistent with (a) higher skills in larger establishments, which explains the initial size–wage premium; and (b) rising returns to skills that explain the rising size–wage premium.

At the same time, the factors that led to rising returns to skill may directly affect both the distribution of employer sizes and the sorting of skills by size class. For example, the spread of microcomputers during the 1980s and 1990s greatly reduced the fixed cost of using information technology. Such reductions presumably increased computer use by smaller employers. If skills are complementary to information technology, then the technological shift that increased returns to skills may also have increased the relative use of information technology by small employers.

Below we describe the simplest possible stylized model that permits these two possibilities, and use the model to draw out the

predictions of each set of assumptions. We then develop a new approach to decomposing the wage over firm size and time to examine these predictions in general and for specific types of characteristics. Using the Pension and Benefits supplements to the May 1979 and April 1993 Current Population Surveys, we find little evidence of technological change favorable to skilled workers at large firms. Rather, we find a narrowing of the differences in the characteristics of the labor force of large and small firms, in the returns to the characteristics of those labor forces and in the wages earned by employees in large and small firms. Thus, our evidence is consistent with the hypothesis that the reduction in the costs of computing since 1979 has substantially reduced the historic gaps in skills and wages enjoyed by large firms.

Because some of our results on employer size differ from those that Davis and Haltiwanger (1991) found for manufacturing establishments, we rerun our decompositions just for manufacturing and at the establishment level. Most components of our decomposition have the same sign with comparing establishments instead of firms or looking only at manufacturing instead of at the entire sample. At the same time, the overall size–wage effect rose when we use samples similar to those of Davis and Haltiwanger, reconciling the apparently different results.

2. Literature review

Human capital theory explains the higher wages paid by large employers by assuming that the production technology or work organization at those firms relies more heavily on both measured and unmeasured skills (e.g. Idson and Oi, 1999a). The relationship of firm size to measured skills is consistent with the observed tendency of large firms to employ more workers with higher levels of observable skills such as educational attainment and age. Many studies have confirmed that these observable skills such as age and education are higher at larger employers. In addition, a number of scholars have found that larger firms provide more training (see citations provided by Black *et al.*, 1999). At the same time, even extremely careful controls for employee characteristics rarely explain more than half of the size–wage gap. Brown and Medoff (1989) and more recently Idson and Oi (1999b) review this evidence, and Troske (1999) provides recent careful analysis.

Analysts nonetheless interpret the size–wage differential as evidence that high-wage employers have more highly skilled employees (e.g. Davis and Haltiwanger, 1991). In this view, size serves as a proxy for unmeasured skills. Any differences in wages by firm size that remain after controlling for measured skills are attributable to differences in unmeasured skills.

3. Theory

We are concerned with modeling the interaction between size, skill, technological change, and sorting, and require a model rich enough to incorporate each of these factors. The following model is the simplest model that illustrates the interaction of firm size, employee skill level, and different technologies. Specifically, the model has two size classes, two skill levels, and three possible technologies. Thus, the model is not intended to be realistic but merely to illustrate the possible interactions among technology, employer size, skill, and wages. We then use this illustrative model to study the standard version of skill-biased technological change as well as the alternative that skill-biased technological changes — such as the introduction of personal computers — lowered the fixed costs of a computer and, thus, were favorable to smaller firms.

3.1 Firm size

To model firm size, we permit firms to have either one or two plants.[1] Firms with two plants pay a diseconomy-of-scale cost C_i, where $C_{min} \leq C_i \leq C_{max}$. Firms with high diseconomies of scale have larger values of C_i. There is an exogenous supply of firms with a distribution of C, and free entry of firms with $C_i = C_{max}$.

3.2 Skill

Employees have either low or high skill, with quantities denoted L and H. There are fixed supplies of L and H workers.

In the base case H workers are twice as productive as L workers. In the scenario with skill-biased technological change, the productivity of skilled labor is further enhanced by a factor of technological change, N, where $N = 1$ in the first period and $N > 1$ in the second period.

3.3 Technology

In the first period, firms can operate without advanced technology ($K = 0$) or with a mainframe computer ($K = 1$). Mainframes have a fixed cost p_M. A single mainframe is useful at either one or two plants within a firm. Thus, if a two-plant company has a mainframe, $K = 1$ at both of its plants.

In the scenario with size-biased/skill-biased technological change, PCs become available in the second period. PCs cost p_{pc}, where $p_M > p_{pc} > {}^1/_2 p_M$. While mainframes are useful at both plants of a two-plant firm, a PC is useful (that is, $K = 1$) only at plants with a PC.

3.4 Production function

Computers are complementary to skilled labor. A simple production function with this feature has output (Q) depend on the amount of skilled and unskilled labor (measured in efficiency units) and on access to computer technology:

$$Q = F(L, H, K) = (L + 2NH(1+K))^a (1+K)^{1-a}. \quad [1]$$

Thus, for a firm with only low-skilled labor, L:

$$Q = F(L, 0, K) = L^a (1+K)^{1-a}. \quad [2]$$

For firms with only highly skilled labor, H:

$$Q = F(0, H, K) = (2NH)^a (1+K). \quad [3]$$

With no complementarity between L and H, we assume firms pick only one type of labor. In many equilibria, some or all firms will be indifferent between hiring H or L workers.

We normalize output price equal to unity.

3.5 Profit maximization

In the first period (when only mainframes are possible), firms have eight choices: mainframe user or not ($K = 0$ or 1), a size of one or two plants per firm, and low or high employee skill level (L or H). Some of these eight configurations are never profitable, while others'

profitability depends on the firm's diseconomy of scale costs (C) and the market wages w_L and w_H. The formulas for profitability are:

Profits of a single-plant firm

$$= F(L, H, K) - w_L L - w_H H - p_M K. \quad [4]$$

Profits of a two-plant firm

$$= 2F(L, H, K) - 2w_L L - 2w_H H - p_M K - C. \quad [5]$$

Table 1 summarizes the profitability of each of the eight combinations. Recall that in the first period N is unity.

3.6 Equilibrium

The equilibrium choices of firms depend on the relative supply of L and H, the costs of computers p_M, and the distribution of diseconomy-of-scale costs C. To fix ideas, we examine cases where p_M is high enough that firms with only low-skilled labor do not find a computer profit maximizing, and where there is sufficient highly skilled labor relative to the supply of low-skilled labor that single-plant firms are indifferent between hiring a single H or a single L. The comparative statics results when technology changes are similar in other cases.

Under these assumptions, three types of firms operate in equilibrium: single-plant firms with no computers and low-skilled workers, single-plant firms with no computers and highly skilled workers, and two-plant firms with mainframe computers and highly skilled workers. The zero-profit condition when low-skill, small, computer-less plants operate is

$$\text{Profits} = (a/w_L)^{1/(1-a)}\left[(a/w_L)^a - w_L\right] = 0.$$

This formula implies that the equilibrium wage for low-skilled employees is

$$w_L^* = a^{a/(1+a)}.$$

Single-plant firms with no computers must be indifferent between highly skilled and low-skilled workers. As highly skilled workers without computers are exactly twice as productive as low-skilled workers, their wages also differ by a factor of 2.

Table 1. Summarizing the model

	K	Size	Skill	First period profits and comments	Second period
A	0	1	L	$(a/w_L)^{a/(1-a)} - w_L(a/w_L)^{1/(1-a)}$	Common case
B	0	1	H	$(2^a a/w_H)^{a/(1-a)} - w_H(2^a a/w_H)^{1/(1-a)}$	
C	0	2	L	Never chosen, as paying fixed cost C has no benefit	
D	0	2	H	Never chosen, as paying fixed cost C has no benefit	
E	1	1	L	$2^{1-a}(2^{1-a}a/w_L)^{a/(1-a)} - w_L(2^{1-a}a/w_L)^{1/(1-a)} - p_M$ We assume that mainframe computers are costly enough that it is not profitable to run them in single-plant firms	
F	1	1	H	$(2^{1+a}[2^{1+a}a/w_H]^{1/(1-a)})^a - w_H[2^{1+a}a/w_H]^{1/(1-a)} - p_M$ We assume that mainframe computers are costly enough that it is not profitable to run them in single-plant firms	This case occurs after PCs are introduced
G	1	2	L	$2[[2^{1-a}(a2^{1-a}/w_L)^{1/(1-a)}]^{a-} w_L(a2^{1-a}/w_L)^{1/(1-a)}] - p_M - C$ We assume that mainframe computers are costly enough that it is not profitable to run them with low-skilled labor	
H	1	2	H	$2[[2^{1+a}[2^{1+a}a/w_H]^{1/(1-a)}]^a - w_H[2^{1+a}a/w_H]^{1/(1-a)}] - p_M - C$	Companies with very low diseconomies of scale remain here and keep mainframes

Notes: The text discusses cases where scenarios A, B and H hold in the first period. Results are similar with the values of C, p_M and other parameters such that other equilibria initially hold. In addition, if some firms had economies of scale and scope that made operation as two-plant firms efficient even without the use of computer technology (that is, C_{min} were negative), rows C and D might not be empty. The results are robust to these cases.

$$w_H^* = 2a^{a/(1+a)} = 2w_L^*.$$

Firms with high diseconomies of scale C_i choose to operate a single plant without computers, while firms with low C_i choose to be two-plant firms with a mainframe. The critical value of scale diseconomies is

$$C^* = 2\left\{\left[2^{1+a}\left(2^{1+a}a/w_H\right)^{1/(1-a)}\right]^a - w_H\left[2^{1+a}a/w_H\right]^{1/(1-a)}\right\} - p_M - \left[(a/w_L)^{a/(1-a)} - w_L(a/w_L)^{1/(1-a)}\right],$$

such that firms with diseconomies of scale $C_i > C^*$ operate as single-plant firms, while those with $C_i < C^*$ operate as two-plant firms with a mainframe. The critical value C^* is higher (more firms choose to be two-plant firms) when computers are more productive, computers are less costly (p_M declines), and the relative price of the skilled labor declines (w_H/w_L falls).

3.7 Skill-biased technological change

We model skill-biased technological change as an increase in N, the productivity of highly skilled labor. With higher N, more firms operate two-plant firms, wages for skilled workers rise relative to unskilled workers, average wages of two-plant firms rise relative to those of single-plant firms, and a higher proportion of highly skilled workers are employed at two-plant firms. Allowing for skill-biased technological change, the profit function in two-plant firms using highly skilled labor is

$$2\left[N^{a/(1-a)}\left[2^{1+a}N^{2a}\left[2^{1+a}a/w_H\right]^{1/(1-a)}\right]^a - w_H\left[2^{1+a}a/w_H\right]^{1/(1-a)}\right] - p_M - C.$$

When $N = 1$, as is the case in the first period, the profit function simplifies to the Case H function in Table 1. The change in the cutoff value of C in response to skill-biased technological change is

$$C^* = 2\left[(N)^{a/(1-a)}\left[2^{1+a}(N)^{2a}\left[2^{1+a}a/w_H\right]^{1/(1-a)}\right]^a - w_H\left[2^{1+a}a/w_H\right]^{1/(1-a)}\right] > 0.$$

Some firms whose value of C previously dictated operation as low-skill, single-plant firms without computers now find it profitable to operate as two-plant firms using computers in combination with highly skilled labor.

3.7.1 Introduction of the PC. An alternative hypothesis to size-neutral skill-biased technological change is that of size-biased, skill-biased technological change. Thus, assume that N remains constant and instead assume a new technology arises for low-cost computers that operate in only one plant. (We are discussing PCs in the 1980s and early 1990s here, not networked computers that might have large effects on coordination costs across plants.) We assume that PCs cost less than mainframes but are useful only at a single plant. To ensure that some firms retain the two-plant structure, we assume that

$$\tfrac{1}{2}\, p_{\mathrm{M}} < p_{\mathrm{pc}} < p_{\mathrm{M}}.$$

Profits for a two-plant firm remain as above in equation [5]. In this situation, no single-plant firm would ever choose the more expensive mainframe, while no two-plant firm would choose PCs. Thus, the new profit function for a single-plant firm is

$$\text{Profits of a single-plant firm} = F(L, H, K) - w_{\mathrm{L}} * L - w_{\mathrm{H}} * H - p_{\mathrm{pc}} * K.$$

The maximum profits for a single-plant firm with a PC and low-skilled labor is now

$$\text{Profits} = 2^{1-a}\left(2^{1-a}a/w_{\mathrm{L}}\right)^{a/(1-a)} - w_{\mathrm{L}}\left(2^{1-a}a/w_{\mathrm{L}}\right)^{1/(1-a)} - p_{\mathrm{pc}},$$

while profits for single-plant firms with PCs and highly skilled labor is

$$\text{Profits} = \left(2^{1+a}\left[2^{1+a}a/w_{\mathrm{H}}\right)^{1/(1-a)}\right)^{a} - w_{\mathrm{H}}\left[2^{1+a}a/w_{\mathrm{H}}\right]^{1/(1-a)} - p_{\mathrm{pc}}.$$

As before, we will examine only a single case, where it is profitable to operate with PCs and highly skilled workers, but not with PCs and low-skilled workers. Results are similar in the other equilibria.

In equilibrium the marginal firm with a mainframe is indifferent to becoming a highly skilled firm with PCs. Firms adopt main-

frames only if the mainframe plus the diseconomies of scale cost less than two PCs. Thus, the critical value of economies of scale (C') is:

$$C' = 2p_{\mathrm{pc}} - p_{\mathrm{M}}.$$

Firms with high diseconomies of scale $C > C'$ operate as single-plant firms with a PC, while those with $C < C'$ operate as two-plant firms with a mainframe.

In equilibrium, single-plant firms must be equally profitable using PCs and highly skilled labor or no PCs and low-skilled labor. Low-skilled wages remain equal to their original value. Consistent with the evidence, the introduction of PCs increases the returns to skills, as highly skilled wages rise after the introduction of PCs:

$$w'_{\mathrm{H}} > \left(2^{2a/(1+a)}\right) w'_{\mathrm{L}}.$$

Proof. Before the introduction of PCs, the profits of single-plant firms using low-skilled labor without computers were

$$(a/w_{\mathrm{L}})^{1/(1-a)}\left[(a/w_{\mathrm{L}})^{a} - w_{\mathrm{L}}\right],$$

and these were equal to the profits of single-plant firms using highly skilled labor without computers which were:

$$= \left(2^{a}a/w_{\mathrm{H}}\right)^{1/(1-a)}\left[\left(2^{a}a/w_{\mathrm{H}}\right)^{a} - w_{\mathrm{H}}\right]\Big).$$

PCs become available in the second period. We assume that highly skilled plants find computers profitable, that the profits of a single-plant firm using highly skilled labor and a PC are greater than the profits of a comparable firm that does not use PCs. The profits of a single-plant firm with a PC and highly skilled labor are

$$\left(2^{1+a}a/w_{\mathrm{H}}\right)^{1/(1-a)}\left[\left(2^{1+a}\left[2^{1+a}a/w_{\mathrm{H}}\right]\right)^{a} - w_{\mathrm{H}}\right]\Big) - p_{\mathrm{pc}}.$$

These are again equal to the profits of a single-plant firm using low-skilled labor without computers. This implies that, in the second period, the profits of a single plant with highly skilled labor without a PC are less than the profits of a PC-less, low-skilled firm:

$$(a/w_{\mathrm{L}})^{1/(1-a)}\left[(a/w_{\mathrm{L}})^{a} - w_{\mathrm{L}}\right] > \left(2^{a}a/w_{\mathrm{H}}\right)^{1/(1-a)}\left[\left(2^{a}a/w_{\mathrm{H}}\right)^{a} - w_{\mathrm{H}}\right]\Big).$$

This is only compatible with the first period profit condition if w_H rose relative to w_L in the second period.

QED

Another hypothesis is that the introduction of PCs raises the efficiency of one-plant firms relative to two-plant firms. As a result, $C' > C^*$.

Proof. Consider the marginal two-plant firm with highly skilled labor and a mainframe, which at the old w_H is indifferent between operating in its current incarnation or as a one-plant firm with no computer and with low-skilled labor. We have demonstrated that, still holding w_H at its old level, the profits of a single-plant firm with highly skilled workers and a PC are greater than those of a one-plant firm with low-skilled labor and no PC. It must then be that profits are also higher than operating at a two-plant, highly skilled firm with a mainframe. With the option of buying a PC, it will now cease operating as a two-plant firm and operate as a one-plant firm with highly skilled labor and a PC. Thus, at the original wages, more firms operate as one-plant firms. This effect is amplified by the rise in wages for highly skilled workers, as these workers are employed intensively by large firms with mainframes.

QED

Given the $C' > C^*$, the number of large firms has declined. Coupling this effect with higher w_H, total employment at large firms also declines. Moreover, more highly skilled workers are now employed at small plants, so the correlation of employer size and skill has declined.

3.7.2 Comparing the two models. Whether the skill-biased technological change was size neutral or biased toward smaller firms, we have our first hypothesis:

H1: Returns to skills increased.

When the technological change was size neutral we have:

H2A: Highly skilled workers were increasingly concentrated at large firms.

This is the implicit model of, for example, Davis and Haltiwanger (1991). In addition, size-neutral technological change implies:

H3A: The wage gap between large and small firms increased.

In contrast, when technological change was biased toward single-plant firms we have:

H2B: Highly skilled workers were less concentrated at large firms.

In addition, as large firms with highly skilled workers split to take advantage of new small-scale computing technologies we have:

H3B: The wage gap between large and small firms decreased.

In either model, the returns to skills increased and large firms hired disproportionately skilled workers. Thus, both models predict:

H4: Returns to characteristics common at large firms have risen:

The specific models we examined made a number of strong assumptions and examined only a subset of possible initial configurations. These basic results are robust to wide variations in the initial conditions, provided the introduction of personal computers induces some previously two-plant firms to switch to single-plant operation and provided computers remain complementary to skills.

Most importantly, we are using the model to classify one-plant firms as 'small' and two-plant firms as 'large'. In fact, the model has endogenous employment per plant as well as endogenous plants per firm. The results are unchanged when we account for this additional factor.

Moreover, our model of technological change and rising computer use in small firms (measured as fewer plants per firm) can also be used to study firm size measured as employees per establishment. To see this result, assume there are several vertically integrated departments in large plants. An advantage of the large plants initially is that they permit economical use of a large mainframe, and this advantage outweighs any diseconomies that may arise. Such diseconomies of scale may arise, for example, from lower powered incentives within organizations compared to market transactions. Now when PCs become affordable, two smaller plants (each with a PC) may be more profitable than a single large plant with a mainframe. That is, by reinterpreting 'plant' as 'department' our results generalize directly from operating one large vertically integrated plant versus operating two smaller plants. Thus, our hypotheses about reductions in firm size also apply to establishments.

In a richer model, PCs might increase the efficient scale of small enterprises. Thus, as usual, theoretical models are consistent with a wide array of evidence. We will revisit this issue when we turn to the data.

4. Methods: decomposing changes in the size–wage gap

Several of our hypotheses address the size–wage gap: hypothesis 3A suggests that skill-biased technological change will widen the gap; 3B suggests that size-biased technological change will narrow the gap. Changes in the size–wage gap have typically been measured as the change in relative returns to firm size or as the change in returns controlling for individual characteristics, occupation and industry structure. Using such approaches, Boden (1997), Belman and Groshen (1998), and our analysis (Table 3) have found, consistent with the second hypothesis, a narrowing in the overall gap.

Changes in the size–wage gap are not, however, simply a matter of overall returns to size. Changes in the gap may reflect changes in the characteristics and the rewards to characteristics of the labor forces of large and small firms. Several of our hypotheses address underlying sources of changes in the gap rather than movement in the gap itself. Just as a Oaxaca decomposition provides considerably more information than indicator variable models about differences in the structure of wages between different racial, gender or sectoral groupings, we can learn considerably more about how the size–wage has changed over this period through a decomposition of the structure of wages over time and firm size. As this decomposition is more complex than the typical Oaxaca, we lay out both our approach and the interpretation of the components of the decomposition before presenting our results.

We model the log wage as a function of demographic and human capital factors, occupation, and location, as well as employer size. We estimate separate log wage equations in each year (1979 and 1993) for large and for small firms:

$$W_{ti}^{\mathrm{L}} = \underline{X}_{ti}^{\mathrm{L}} \cdot \underline{b}_{t}^{\mathrm{L}} + e_{ti}^{\mathrm{L}}$$

and

$$W_{ti}^{\mathrm{S}} = \underline{X}_{ti}^{\mathrm{S}} \cdot \underline{b}_{t}^{\mathrm{S}} + e_{ti}^{\mathrm{S}}.$$

In these equations, W_{ti} is the log(wage) for person i, $\underline{X}_{ti}$ is the vector of characteristics for person i, while $\underline{b}_t$ is the vector of coefficients. The superscripts L and S refer to large and small employers, and the subscript t refers to the year 1979 or 1992.

Subtraction across years and size classes yields the change in the average size–wage gap: $(W^{\mathrm{L}}_{93} - W^{\mathrm{S}}_{93}) - (W^{\mathrm{L}}_{79} - W^{\mathrm{S}}_{79})$. For notational simplicity, define the change in the large versus the small gap in mean characteristics as

$$\Delta(X \text{ gap}) = \left(\underline{X}^{\mathrm{L}}_{93} - \underline{X}^{\mathrm{L}}_{79}\right) - \left(\underline{X}^{\mathrm{S}}_{93} - \underline{X}^{\mathrm{S}}_{79}\right) = \left(\underline{X}^{\mathrm{L}}_{93} - \underline{X}^{\mathrm{S}}_{93}\right) - \left(\underline{X}^{\mathrm{L}}_{79} - \underline{X}^{\mathrm{S}}_{79}\right)$$

and define the change in the large–small gap in coefficients as

$$\Delta(B \text{ gap}) = \left(\underline{b}^{\mathrm{L}}_{93} - \underline{b}^{\mathrm{S}}_{93}\right) - \left(\underline{b}^{\mathrm{L}}_{79} - \underline{b}^{\mathrm{S}}_{79}\right).$$

After tedious algebra, the change in the size–wage gap can be rewritten as the sum of four meaningful components:

$$(W^{\mathrm{L}}_{93} - W^{\mathrm{S}}_{93}) - (W^{\mathrm{L}}_{79} - W^{\mathrm{S}}_{79}) =$$

$$\text{(A)}\ \ \underline{X}^{S} \cdot \Delta(B \text{ gap}) + \qquad [6]$$

$$\text{(B)}\ \ \underline{b}^{S} \cdot \Delta(X \text{ gap}) + \qquad [7]$$

$$\text{(C)}\ \ \left(\underline{X}^{\mathrm{L}} - \underline{X}^{\mathrm{S}}\right) \cdot \left(\underline{b}^{\mathrm{L}}_{93} - \underline{b}^{\mathrm{L}}_{79}\right) + \qquad [8]$$

$$\text{(D)}\ \ \left(\underline{X}^{\mathrm{L}}_{93} - \underline{X}^{\mathrm{L}}_{79}\right) \cdot (b^{\mathrm{L}} - b^{\mathrm{S}}). \qquad [9]$$

We discuss each component of this decomposition in turn. For the first term in each component (those without a year subscript), we average 1979 and 1993 values. We discuss the cases where choice of weights affects the results.

4.1 (A) Have returns at large and small firms converged?

The term $\underline{X}^{\mathrm{S}} \cdot \Delta(B \text{ gap})$ measures the changing difference in coefficients between large and small employers. $\underline{X}^{\mathrm{S}}$, the mean characteristics of small firm employees (averaging 1979 and 1993 characteristics), weights the change in the coefficients gap, aggregating the changes of the individual coefficients into a single measure. If this term is negative, large- and small-firm coefficients have converged.

4.2 (B) Are employee characteristics at large and small firms converging?

The term $\underline{b}^{S} \cdot \Delta(X \text{ gap})$ measures the changing gap in characteristics between large and small employers. Here, the small-firm coefficients, b^{S} (averaging 1979 and 1993 coefficients), are weights that aggregate the change in the characteristics gap into a single measure. If this measure is negative, then large- and small-firm characteristics have converged (as in hypothesis 2B, not 2A).

4.3 (C) Are returns rising for characteristics common at large firms?

The term $(\underline{X}^{L} - \underline{X}^{S}) \cdot (\underline{b}^{L}_{93} - \underline{b}^{L}_{79})$ measures the effect of changing coefficients on the characteristics particularly common at large firms. The first component of this term, the 'weights' used to aggregate the coefficients, is the difference between the characteristics of large and small firms. The second element is the change in the returns to large firms' characteristics between 1979 and 1993. If the term is overall negative, returns to characteristics particularly common to large firms have declined.

The point may be illustrated using a single characteristic, education, as an example. Large firms had higher average education than small firms in both 1979 and 1993, so the first element is positive. Given that returns to education rose throughout the economy, the second element is also positive. The education component would then serve to increase this term, and widen the gap between large- and small-firm wages.

If large firms sorted on higher skills and returns to skills rose in the economy, then human capital theory suggests: hypothesis 4, returns to characteristics common at large firms have risen. This hypothesis suggests that this term is positive:

$$\left(\underline{X}^{L} - \underline{X}^{S}\right) \cdot \left(\underline{b}^{L}_{93} - \underline{b}^{L}_{79}\right) > 0.$$

4.4 (D) Do employees at large firms increasingly have the characteristics that large firms reward well?

The term $(\underline{X}^{L}_{93} - \underline{X}^{L}_{79}) \cdot (b^{L} - b^{S})$ measures whether the characteristics at large firms have become more concentrated in areas where large firms pay above-average returns. The first component is the change in the mean characteristics of large firms between 1979 and

1993. The second, the weighting component, measures the excess returns provided by large firms, relative to small firms, in year *t*. If this term is negative, then large firms have hired fewer employees with characteristics that they compensate particularly well. For example, large firms on average pay higher returns to education than do small firms. If the average education levels at large employers have risen, this term will increase.

5. Data

We analyze the pension and benefits supplements to the May 1979 and April 1993 Current Population Surveys (CPS). A requirement for this analysis is the employment size of each respondent's employer. The benefits supplements are the largest micro-data sample of the US labor force with such information.[2] In addition, the benefits supplements collect data on wages, pensions, health benefits, and tenure with the current employer, which is useful to this investigation. We analyze the work force ages 16–75 excluding the self-employed, those employed in business services, those reporting wages of under $1.00 per hour or more than $100.00 per hour and those with missing data. The public sector is excluded from our analysis because their labor markets and career systems operate differently from the private sector. Agriculture is omitted due to concerns about in-kind income. We also omit business service industries. The 1979 wage data have been converted into real dollars using the CPI-U-X1.

There is no universally accepted definition of large and small employer; indeed, there is disagreement over whether size should be measured by employment or by capital stock (Belman and Groshen, 1998). We treat employers with 1,000 or more employees as large and those with fewer than 100 employees as small. In most of our analyses we omit medium-sized employers (100–999); their results are discussed in the robustness checks.

Our typical regression specification incorporates controls for age, its square and education, and indicator variables for marital status, union membership, race, gender, residence in a metropolitan area, and major occupation. The education variable reported in the CPS was changed from a measure of years of education completed to a measure of degree attainment in 1992. We have converted the measure of degree attainment back into a measure of continuous education using an algorithm provided by Jared Bernstein.

5.1 Methodological issues

We present both descriptive statistics and regression to analyze changes in large and small firms between 1979 and 1993. Sample weights are needed to obtain representative descriptive statistics from the CPS. So that decompositions add up correctly, regressions are also weighted. Because we include the factors that are used in stratifying the CPS (race, age, etc.) in our regressions, the weighted and unweighted regressions are essentially identical. The standard errors of the regression estimates are obtained using the Huber–White correction for heteroskedasticity.

6. Results

We first examine the distribution of employment at large and small firms, and then we examine the size–wage effect. Finally, we look at the relation between wages at large and small employers in a region.

6.1 Background: has the typical employee's employer size declined?

The proportion of employment at very large employers rose between 1979 and 1993 (see Table 2).[3] Large employers (over 1,000 employees) employed 41 per cent of the sample in 1979, rising to 45 per cent in 1993. This increase was matched by declining employment in small (under 100) employers from 40 to 34 per cent of the sample. The employment share of middle-sized firms remained stable through this period.[4]

One source of this shift toward larger firms might be a shift in employment toward industries with larger firms. This effect is examined in the last column of Table 2, which weights the 1993 firm size

Table 2. Distribution of employment by firm size

Firm size	1979 (%)	1993 (%)	1993 (%) (1979 industry weights)
Under 100	39.6	34.2	34.9
100–999	19.7	20.9	20.8
1,000 plus	40.8	45	44.1

employment distributions for major SIC industries by their 1979 employment. The results are similar to the estimates in column 2; the shift toward larger firm size is not the result of changing patterns of employment by industry. (A rising share of employment at large employers provides only weak evidence in the debate on whether small employers create a disproportionate number of jobs because the population of employers in the 'large' category changes over time; see Davis *et al*., 1996.)

These results are broadly consistent with the hypothesis that skills were more valuable in the later period, and, thus, that skills-intensive large firms grew as a proportion of the economy.

The stable share of employment holds up in most of the 12 major industries included in this study (see Table A1). The large-employer share declined in mining, durable goods, communications and utilities, and rose in retail trade and in non-business service industries. The results on regression-adjusted wages are also similar if we look at employment by establishment size instead of employer size (see Table A2).

6.2 Has the size–wage effect declined?

We first present the mean wages paid by large and small firms in 1979 and 1993, and then the difference conditional on employee characteristics (age and its square, education, and indicator variables for marital status, union membership, race, gender, residence in a metropolitan area, and 11 major occupations). The real wage at middle-sized and large firms declined between 1979 and 1993, while small firms' wages remained constant (see Table 3). While real wages of small firms remained around $10.20 per hour (in 1993 dollars), the wage at middle-sized firms fell by 50 cents per hour, from $12.57 to $12.05, and the wage at large firms declined from $14.61 to $13.34. This corresponds to a decline in the large firm wage advantage of 9.6 log points between 1979 and 1993, or almost a third of the total pay advantage at large employers.

Regression estimates of the size–wage effects parallel the change in unadjusted means, but are less marked. The wage advantage of middle-sized firms relative to those with fewer than 100 employees fell from 11.3 per cent to 7.8 per cent, from 10.7 to 7.5 log points, between 1979 and 1993. The percentage point drop for employees in the largest firms, from 20.3 per cent to 15.3 per cent, was somewhat larger than that of the workers in middle-sized firms. Although not the emphasis of this paper, a similar decline in the

Table 3. Firm size effects on wages, 1979–93

	1979	1993
Real wage by firm size (1993 dollars)		
Under 100 employees	\$10.19	\$10.24
100–999 employees	\$12.57	\$12.05
Gap in log wage over small firm wage	0.210	0.163
1,000 or more employees	\$14.61	\$13.34
Gap in log wage over small firm wage	0.360	0.264
Regression estimates of medium- and large-firm effects on log(wage) (*t*-statistics in parentheses)		
100–999	0.107	0.075
	(11.1)	(7.9)
1,000 plus	0.185	0.142
	(23.1)	(18.1)

Notes: Control variables are listed in Table A2. Small employers (<100) are the omitted category. Deflation uses the CPI-U-X1.

size–wage effect shows up between large and small establishments as between large and small employers (see Table A3).

6.2.1 Decomposing sources of wage changes. The decomposition from equation [1] permits us to understand whether the changing wage patterns at large and small employers are due to sorting or to changes in sector-specific returns to characteristics. Estimates of regression coefficients by firm size and year are shown in Table A4, and mean characteristics by firm size are shown in Table A5. The specification of the model follows that used in prior models reported in this paper except that the age, education, and tenure variables have been re-centered on their means and a quadratic term has been added for age (age^2).

Table 4 summarizes the decomposition. The returns to large firms declined by between 9.6 and 13.2 percentage points between 1979 and 1993, depending on whether 1979 or 1993 weights are used. The decline was caused by convergence in returns at large and small firms (the gap between B_L and B_S declined between 1979 and 1993) (part (A)) and by a decline in the gap in characteristics of large and small firms (part (B)). Using 1979 characteristics and coefficients as the baseline, the convergence in returns accounted for 78 per cent and the convergence in characteristics accounted for 130 per cent of the 9.6 percentage point decline in the large-firm wage. With a 1993 base, the decline was 64 per cent and 92 per cent, respectively.

Table 4. Decomposing changes in the size–wage gap

	Components of the size–wage decomposition	Description of size–wage component	1979 base		1993 base	
			Size–wage gap	% of gap	Size–wage gap	% of gap
		Overall change in size–wage gap	–9.6pp		–13.3pp	
A	$\underline{X}^{S} \cdot \Delta(B \text{ gap})$	Have returns at small and large firms converged?	–7.5pp	78.3	–8.4pp	63.2
B	$\underline{b}^{S} \cdot \Delta(X \text{ gap})$	Are employee characteristics at large and small firms converging?	–12.5pp	130.2	–12.2pp	91.7
C	$(\underline{X}^{L} - \underline{X}^{S}) \cdot (\underline{b}^{L}_{93} - \underline{b}^{L}_{79})$	Are returns rising for characteristics particularly common at large firms?	8.2pp	–85.4	7.2pp	–54.1
D	$(\underline{X}^{L}_{93} - \underline{X}^{L}_{79}) \cdot (b^{L} - b^{S})$	Do employees at large firms increasingly have the characteristics that large firms reward well?	2.22pp	–23.1	0.1pp	–0.8

Notes: pp = percentage point. The size–wage gap is the wage gap between large firms (more than 1,000 employees) and small firms (fewer than 100). Medium-sized employers are omitted from this analysis. Mean characteristics and coefficients by size class and year are presented in Table A4.

These trends were partially counterbalanced by improvements in the returns to characteristics common at large firms over time (part (C)) and improvements in the characteristics of employees of large firms between 1979 and 1993 (part (D)). The former increased the gap between large- and small-firm wages by between 85 per cent (1979 base) and 54 per cent (1993 base), the latter by between 23 per cent and 0.8 per cent. We now analyze each component of the decomposition in more detail.

6.3 (A) Are large and small employers paying more similar returns?

Overall, the decomposition indicates that the returns have converged between large and small employers. Using the 1979 base, the converging coefficients knocked out 7.5 percentage points of the size–wage effect — almost half of the 18.5 per cent advantage estimated in Table 3.

Appendix Table A4a indicates which coefficients converged. Focusing on the 1979 base (the first three columns), the first column contains the small-firm variable means for 1979, the second column is the change in the large/small gap in coefficients between 1979 and 1993, and the third column is the product of the first two columns. For example, the returns to education rose at both large and small firms from 1979 to 1993, but rose fastest in small firms. Thus, the gap in returns to a year of education in large and small firms declined by 1.44 percentage points between 1979 and 1993. The effect of this convergence in returns to education was to reduce the overall size–wage gap by 0.16 percentage points.

No single relative return of large versus small firms changed substantially. The largest single change between 1979 and 1993 is the decline in the gap between the intercepts of 20.1 percentage points (see Table A4). After allowing for the effect of the intercept, the balance of the shift in the gap is a positive 12.6 per cent (or 11.7 per cent for the 1993 weights). Given how we measured the variables, the intercept indicates the effect of changing returns to size for male employees with mean education, age and tenure living in the West, working as laborers and employed in the retail trade.

The allocation of the effect of the change in the coefficient gap between the intercept and other coefficients varies depending on the chosen omitted category for occupation, region, sex, and industry. Almost any change in the omitted category reduces the size of the change in the gap of the large- and small-firm intercepts over time.

Nevertheless, under almost any characteristics (other than omitting the small occupational group 'Technicians'), the intercepts have converged. These changes suggest that large firms are paying less simply because they are large (the convergence of the intercepts), while increasing their payments for most employee characteristics.[5]

Turning to specific coefficients, the most notable decline in the coefficient gap is a 1.4 percentage point decline in the large-firm education advantage (see Table A4). In contrast, large firms' excess returns rose for being female; living in the Northeast, Midwest and South; being employed as a precision production operative (craft worker) and working in non-durables manufacturing (see Table A4). The change in relative returns is not significant for most individual coefficients; at the same time, many more shifts are positive than negative. These positive shifts substantially outweigh the negative, creating an overall effect of a rising gap between large and small firms (see Table A4). Only the declining difference in intercepts leads to converging coefficients.

6.4 (B) Are employees' characteristics at large and small firms converging?

Table A5 presents tabulations of mean education, tenure, potential experience (age — years of schooling — 6), race, gender and union status by employer size in 1979 and 1993, as well as the change in the gap in large and small means between 1979 and 1993. In 1979, employees of large firms were older (mean age 36.5 years at large employers against 35.4 years at small employers) and more educated (12.7 years of education as opposed to 11.9). Employees at large firms were far more likely to be in a union (33.9 per cent as opposed to 9.5 per cent) and had almost twice the tenure (8.9 years compared to 4.5).

We measure the total effect of changing relative characteristics by weighting characteristics by the coefficients of the wage equations used in the size–wage decomposition. If the weighted sum $\Delta(X \text{ gap}) \cdot \underline{b}^{S}$(see equation [7]) is negative, then characteristics are, on average, converging. On average, the characteristics of employees at large and small firms converged between 1979 and 1993. This convergence would have over-predicted the decline in the size–wage effect, reducing it by 12.2 log wage points. This calculation is presented variable by variable in Table A5.

Most notably, the percentage of workers organized at large firms declined from 33.9 per cent to 19.2 per cent. This decline of 14.7

percentage points was considerably larger than the corresponding decline from 9.5 to 4.8 per cent at small firms. The more rapid absolute decline of unions at large firms lowered the size–wage gap by about 2.4 percentage points (see Table A4b). Before making too much of the change, it is important to note that while the absolute gap declined, at the same time the ratio of union membership at large versus small firms actually increased.

The characteristics that relate most closely to human capital theory are age, tenure and education. None exhibited the increases in sorting coupled with rising returns to skill predicted by human capital theory (hypothesis 2A); instead, sorting declined slightly (consistent with hypothesis 2B). The gap in age between large and small firms fell from 1.2 years to 0.5 years between 1979 and 1993. The difference in education fell more modestly, from 0.8 to 0.7 years. Mean tenure was almost constant at large employers, declining from 8.8 to 8.5 years — well within the sampling error — but rose from 4.5 to 4.9 years at small employers. Relatively small change in levels and patterns of tenure during this time period has been found in the CPS by other researchers such as Diebold *et al*. (1997).

Overall, convergence in factors acted to reduce the gap in wages between large and small firms. The change in age reduced the gap by 0.3–0.4 percentage points, which in tenure reduced the gap by 0.7–0.9 percentage points. The declining gap in education between large and small firms reduced the wage gap by between 0.3 and 0.5 percentage points.

Shifts in occupation and sectoral distribution of employment also influenced the size–wage gap. Although there were only modest changes in the occupational and industry distribution of employment in small firms, the industry distributions at large firms shifted substantially. Most importantly, the proportion of employees in large firms employed in the durable goods industries declined from 32.4 per cent in 1979 to 18.2 per cent in 1993 (see Table A5). Durable goods are a high-wage sector for both large- and small-firm employees. Thus, the decline in employment in durable goods in large firms reduced the large-firm wage advantage by between 2.8 and 3.8 percentage points (see Table A4b).

Small firms remained about 50 per cent female through the 1979–1993 period, but large firms increased from 35 to 46 per cent female. Given the lower wages of women, this convergence lowered the size–wage effect by about 2 percentage points (see Table A4b).

In contrast with most characteristics, employment of black workers diverged. Even in 1979, employees at large companies were

more likely to be black than their counterparts in small companies (8.7 per cent black versus 7.6 per cent). This relatively high employment of blacks at large employers increased somewhat in recent years from 0.9 per cent higher to 2.3 per cent higher than the smallest sized firms.

Thus, these results are consistent with declining barriers to female and minority employment at large firms (consistent with H4), although the 1979 results did not show the lower percentage of black workers at large employers that theories of segmented labor markets predicted. (Holzer, 1998, further discusses the evidence and tests several explanations for the lower representation of blacks in smaller establishments.) Because the wages of black workers are lower than those of other racial groups, the increasing proportion of blacks at large firms causes a 0.4 percentage point decline in the size–wage gap.

In short, with the exception of race, the mean characteristics of employees at large and small employers have either remained constant or have converged substantially between 1979 and 1993. These results run counter to the hypothesis that sorting of worker skills by employer size has increased.

6.5 (C) Are returns rising for characteristics common at large firms?

If large employers specialize in highly skilled workers (relative to small firms) and returns to skills have risen (relative to returns in 1979), we should see rising returns to characteristics that are common at large firms. Formally, this theory implies that term (*C*) from the size–wage decomposition, $(b^{L}_{93} - b^{L}_{79})\cdot(X^{L}_{t} - X^{S}_{t})$, is positive. For example, the combination of rising returns to education (regardless of employer size) coupled with higher average education at large firms increases the gap between large- and small-firm wages.

Overall, rising returns for characteristics common at large firms have widened the wage gap by between 7.2 (1993 weights) and 8.2 (1979 weights) percentage points (see Table A4c). This result supports the hypothesis that large firms specialize in highly skilled workers and that returns to these skills have increased.

Most specific characteristics with rising returns showed the same pattern. Returns to education at large firms rose by 1.4 per cent and widened the gap by 1.1 percentage points, and returns to job tenure increased by 0.6 per cent and widened the gap by 2.7 percentage points. Returns also rose substantially for being a union member

and being employed in the production of non-durable goods (where large firms are over-represented); returns fell substantially for construction employees (where large firms are under-represented).

6.6 (D) Do employees at large firms increasingly have the characteristics that large firms reward well?

Finally, large employers might have become more or less intensive employers of employees whose characteristics they compensate particularly well. In fact, this effect is small, accounting for between a +0.1 and +2.2 percentage point increase in the size–wage gap. This effect is driven by declining unionization of large-firm employees, coupled with the higher returns to unionization at large employers. No other factor is associated with as much as a 1 percentage point change in the size–wage gap.

7. There is more to the story

At this point we have a simple story: the employer size–wage gap declined as characteristics converged, even as returns rose for characteristics common at large firms. An optimistic reader might note that these results follow those predicted by our model of size-biased, skill-biased technical change (where microcomputers are now cost effective at small enterprises) and expect the paper to end here.

In fact, the story is more complex than that simple pattern. In this section we elaborate these results along two dimensions: firms versus establishments and goods-producing versus service sectors. We summarize the decompositions; full results are available on request.

7.1 Establishment size

The only consistent break in the 1979 and 1993 series on establishment size is at 100 employees, so we use this cut point to distinguish large versus small establishments. The size distribution of employees has remained almost identical over this period, with a small rise from 58.9 to 59.6 per cent in establishments employing under 100 employees. The raw wage advantage of large establishments rose slightly from 29.1 to 30.6 per cent (log points, to be precise). When we include standard controls (listed in Table A2), the

wage advantage of large establishments remains almost constant, declining from 10.5 to 10.4 per cent. Slowly rising raw gaps and constant regression-corrected gaps imply that larger establishments have been slowly gaining workers with high-wage characteristics.

We can see that result more carefully with the decomposition of observable worker characteristics and wages over time. Each component of the between-establishment decomposition (see Table 5, column 2) is of the same sign as the between-firm analysis (see Table 5, column 1). Specifically, returns at large and small establishments have converged slightly (part (A)), characteristics at large establishments have converged with those at small firms (term $B < 0$), returns have risen on average for characteristics present at large establishments (term $C > 0$), and large establishments increasingly hire employees with characteristics for which such large establishments pay high wages (term $D > 0$). All but the last effect is much smaller than for the decomposition of the firm-size effect (and the last term was already small). The net result, due largely to slower convergence of characteristics, is the small divergence of wages for observably similar people between large and small establishments; this result is in contrast to the convergence between large and small firms.

The total establishment effect is a combination of the gap between small establishments in large and small firms and between large and small establishments within large firms. (As we use a cut point of 100 employees to define both a small firm and small establishment, by definition there are no large establishments at small firms.) The gap between small establishments in large firms and small firms (see Table 5, column 4) fell substantially, by 20.9 percentage points, between 1979 and 1993. Three of the four components of the decomposition are negative; component B is particularly large in magnitude. In net, small establishments in large firms became more like 'small establishments' in small firms, or, more accurately, like small firms.

In contrast, the gap between large and small establishments in large firms widened by 15.7 percentage points (see Table 5, column 3). All components were positive, suggesting a large change in pay structures and employment structures within the large firm sector. In combination with the column 4 results, this suggests that the cohesion of large-firm pay structures broke down between 1979 and 1993; employees in small establishments were no longer being paid as if they were employees of a large firm.

These results also suggest some limits to our illustrative model. Recall that in our illustrative model the effect of microcomputers

Table 5. Establishments versus firms (combined 1979 and 1993 base)

		Size–wage gap components			
	Description of size–wage component	Large versus small firms	Large versus small establishments	Large versus small establishments within large firms	Small establishments at large firms versus small establishments at small firms
		1	2	3	4
A	Have returns at large workplaces diverged from small workplaces?	–0.079	–0.016	0.039	–0.066
B	Have characteristics at large workplaces diverged from small workplaces?	–0.124	–0.041	0.040	–0.149
C	Have returns risen on average for employees at large workplaces?	0.077	0.051	0.025	0.019
D	Do large workplaces increasingly hire employees with characteristics that large workplaces reward?	0.012	0.021	0.0509	–0.013
	Sum (i.e. change in the size–wage effect)	–0.114	0.015	0.157	–0.209

Notes: Rows A–D are defined in equation [1]; note that in column 1 workplaces are firms, while in columns 2–4 workplaces are establishments. Each column uses a different sample. Column 1 is an estimate combining the 1979 and 1993 results reported in Table 4 using equal weights. Column 2 examines large (over 100) and small establishments. Column 3 examines large and small establishments, but only within large firms (over 100 employees). Column 4 compares small establishments at large versus small firms.

between firms and between establishments at large firms should be identical — lower prices for microcomputers make it cost-effective to put technology (and, thus, more highly skilled workers) in smaller workplaces. The shift of workers with high-wage characteristics out of big firms was not matched by a flow out of big establishments to small establishments at big firms. That is, in Table 5, column 3; row B, the term measuring difference in employee characteristics across establishment sizes, is now a small positive, while it is a large negative number across firms. This result casts doubt on the hypothesis that microcomputers or another size-biased, skill-biased shock explains our results.

7.2 Goods-producing versus service industries

Decomposition results are also of the same sign as overall but generally attenuated if we focus only on the goods-producing sector (see Table 6, column 2). The key difference is much smaller convergence of the characteristics at large and small firms in this sector than in services. The result is that the size–wage gap has risen slightly in goods-producing firms, while it has fallen strongly overall. The differences between the findings for the goods-producing and service sectors may be taken as a warning against economy-wide generalizations; the impact of factors such as computers on industries may be specific rather than general, reflecting differences in technologies as well as other circumstances.

Davis and Haltiwanger (1991) report an increase in the size–wage effect for *manufacturing establishments* while we report a decrease for the *firm*-size effect in the *entire* private sector. Both sets of results are important. When we use our method to examine changes in wage gaps across manufacturing establishments our results are similar to theirs (see Table 6, column 4). Specifically, returns to employee characteristics have diverged slightly across large and small manufacturing *establishments* (the same sign, though of a smaller magnitude than found by Davis and Haltiwanger). There is no specific theory that posits this pattern of results.

7.3 Robustness checks

We performed a few additional robustness checks (results are available on request). The results are as expected for medium-sized firms (100 to 1,000 employees), with changes the same size as but smaller than the changes between the changes between small and

Table 6. Goods-producing versus service industries (combined 1979 and 1993 base)

		Size–wage gap components			
		All firms	**Goods-producing firms**	**Service-sector firms**	**Goods-producing establishments**
		1	**2**	**3**	**4**
A	Have returns at large workplaces diverged from small workplaces?	–0.079	–0.080	–0.072	–0.012
B	Have characteristics at large workplaces diverged from small workplaces?	–0.124	–0.079	–0.105	–0.061
C	Have returns risen on average for employees at large workplaces?	0.077	0.15	0.040	0.063
D	Do large workplaces increasingly hire employees with characteristics that large workplaces reward?	0.012	0.052	0.001	0.035
	Sum (i.e. change in the size–wage effect)	–0.114	0.049	–0.13551	0.025

Notes: Rows A–D are defined in equation [1]; note that in columns 1–3 workplaces are firms, while in column 4 workplaces are establishments. Each column uses a different sample. Column 1 is taken from Table 4, 'Size–wage gap'. Column 4 examines the size–wage gap among establishments in manufacturing; the other columns examine gaps among firms.

large firms. The results are also similar if we choose 1979 or 1993 as a base year, instead of our use of an average of the two.

8. Discussion

The forces underlying the large-firm advantage in wages have remained a topic of discussion and research for more than half a century. One view argues that large firms are better able to use highly skilled workers. The observed wage advantage of large firms is an outcome of both large firms' greater use of more highly skilled workers (sorting) and the fact that large firms generate larger returns to those workers. As not all of the productivity-related traits are observable, a regression will leave some part of the skill-related returns attributed to firm size.

The emerging stylized facts on returns to skill and size challenge this view. Rising returns to observed skills have been well documented. Any model of rising returns to skill implies that returns to observable skills such as age and education rose (hypothesis 1). If size is proxying for skills and skills are sorted by firm size, returns should have risen for characteristics disproportionately present at large firms (hypothesis 4). Consistent with such findings and the hypothesis that firm size proxies for skill, large firms continue to pay more than small firms. Running counter to this view, however, the pay advantage of large firms has declined over the past two decades even as returns to skills have risen.

This article examines this issue through a decomposition of May 1979 and April 1993 CPS data by firm size and year. If technological change affects large and small firms similarly, then the decomposition of these data does not support the view that firm size proxies for skills. Although there is evidence that returns for characteristics common at large firms are rising, we find substantial convergence in the returns and characteristics of large and small firms. These results are only with regard to observed characteristics, but it is unlikely that observed and unobserved characteristics and returns would move in opposite directions.

One possible explanation for this divergence from the 'size as skills' hypothesis is that while skill-biased technological change has proceeded over this period, it has been biased toward smaller firms. Had technological change been size neutral or biased toward larger firms we would have expected to observe an increasing concentration of highly skilled workers at large firms (hypothesis 2A) and a

larger gap between the wages of large and small firms (hypothesis 3A). As noted, we find no evidence of either trend. However, when technological change is biased toward single-plant firms, we expect that highly skilled workers will be less concentrated in large firms (hypothesis 2B) and the wage gap between large and small firms will decrease (hypothesis 3B). This outcome is consistent with the negative shifts in the first two elements of our decomposition. It is also consistent with shifts in some of the important sub-components of these elements. The gaps in tenure, age, and percent female have all narrowed, as has the gap in the percentage of union members in large and small firms. The characteristics that most directly measure human capital — age and education — remained essentially stable.

Taken as a whole, our result suggests that the reduction in the costs of computing since 1979 may have substantially reduced the historic economies of scale in technology use enjoyed by multi-establishment firms. This size-biased and skill-biased technological change, in turn, has resulted in a narrowing of the differences in the characteristics of the labor forces of large and small firms, in the returns to characteristics of those labor forces, and in the wages earned by the employees in large and small firms.

At the same time, these patterns do not show up in goods-producing sectors (where the size–wage gap has been fairly flat) or between large and small establishments at large firms. Thus, no single story appears consistent with all the patterns we observe. It may be that technology, or its impact, is not homogeneous by sector. It may be that goods-producing and service industries use different types of computers or information technologies, that the effect of these technologies is quite different, or that the speed of the effect differs by industry. More disaggregate examination or examination over a longer period may provide further insights into the relationship between skills, size and compensation and how this is changing over time.

Appendix

Table A1. Sectoral distribution of employment by firm size

Industry	1979		1993	
	No. of obs	Distribution of employment (as proportion)	No. of obs	Distribution of employment (as proportion)
Mining	165		113	
1,000 plus		0.694		0.479
100–999		0.173		0.277
Under 100		0.133		0.244
Construction	758		612	
1,000 plus		0.101		0.106
100–999		0.171		0.157
Under 100		0.728		0.737
Non-durables	1,418		1,198	
1,000 plus		0.532		0.537
100–999		0.240		0.233
Under 100		0.227		0.240
Durable goods	2,364		1,597	
1,000 plus		0.652		0.567
100–999		0.177		0.234
Under 100		0.172		0.199
Transportation	535		576	
1,000 plus		0.523		0.569
100–999		0.339		0.132
Under 100		0.138		0.299
Communications	243		204	
1,000 plus		0.806		0.789
100–999		0.075		0.101
Under 100		0.118		0.110
Utilities	160		152	
1,000 plus		0.774		0.721
100–999		0.124		0.147
Under 100		0.102		0.131
Wholesale trade	645		625	
1,000 plus		0.249		0.284
100–999		0.246		0.248
Under 100		0.505		0.468
Retail trade	2,396		2,494	
1,000 plus		0.313		0.465
100–999		0.123		0.118
Under 100		0.565		0.417
Finance, insurance, etc.	916		1,020	
1,000 plus		0.430		0.524
100–999		0.187		0.189
Under 100		0.384		0.288

Table A1. Continued

Industry	1979 No. of obs	1979 Distribution of employment (as proportion)	1993 No. of obs	1993 Distribution of employment (as proportion)
Service industries	428		536	
1,000 plus		0.187		0.323
100–999		0.113		0.176
Under 100		0.700		0.501
Professional services	1,767		2,488	
1,000 plus		0.228		0.327
100–999		0.264		0.252
Under 100		0.509		0.421

Table A2. Distribution of employment by establishment size

Establishment size	1979 (%)	1993 (%)
Under 25	36.7	33.2
25–99	24.0	25.5
100 plus	39.3	41.3

Table A3. Establishment size effects on wages: 1979–93

	1979	1993
Real (1993 dollars) wage by establishment size		
Under 25 employees	$10.43	$9.94
25–99 employees	$11.88	$11.40
Gap in log wage over small firm wage	13.9%	14.7%
100 or more employees	$14.13	$13.69
Gap in log wage over small firm wage	35.5%	37.7%
Regression estimates of medium- and large-firm effects on log(wage) (*t*-statistics in parentheses)		
25–99	0.0645	0.035
	(6.5)	(3.7)
100 plus	0.154	0.111
	(14.9)	(12.2)

Notes: Control variables are listed in Table A4. Small establishments (<25) are the omitted category. Deflation uses the CPI-U-X1. Note that large establishments have 100 or more employees, while large firms have 1,000 or more employees.

Table A4. Coefficients and gap in large- and small-firm coefficients, 1979–93

	1979 coefficients				1993 coefficients					
	Large firm		Small firm		Large firm		Small firm		Change in the gap	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Difference	*t*
Constant	2.3392	73.3	2.1203	62.8	1.9902	60.6	1.9720	50.1	–0.201	–2.9
Education	0.0403	16.6	0.0295	11.3	0.0544	16.6	0.0580	19.0	–0.014	–2.5
Education^2	0.0014	3.0	–0.0002	–0.4	0.0044	6.4	0.0027	4.0	0.000	0.2
Age	0.0053	8.9	0.0056	10.2	0.0065	9.9	0.0074	10.8	–0.001	–0.4
Age^2	–0.0003	–9.9	–0.0004	–15.0	–0.0004	–11.3	–0.0003	–9.5	–0.000	–2.2
Tenure	0.0135	9.5	0.0100	5.7	0.0197	13.6	0.0128	6.5	0.003	1.0
Tenure^2	–0.0003	–4.7	–0.0001	–1.0	–0.0004	–6.3	–0.0002	–2.3	0.000	0.1
Tenure <1 year	–0.0406	–2.4	–0.0399	–2.3	–0.0654	–3.4	–0.0729	–3.5	0.008	0.2
Tenure 1–2 years	–0.0043	–0.2	–0.0510	–2.5	–0.0250	–1.0	–0.0377	–1.5	–0.034	–0.8
Married	0.0476	4.2	0.0544	4.2	0.0562	4.8	0.0493	3.5	0.014	0.5
Union	0.0554	4.5	0.2391	11.9	0.1063	7.1	0.2352	7.6	0.055	1.3
Black	–0.0463	–2.7	–0.0825	–3.9	–0.0671	–4.0	–0.0853	–3.3	–0.018	–0.4
Female	–0.2463	–20.3	–0.2618	–18.2	–0.1331	–11.1	–0.2113	–13.7	0.063	2.3
Metropolitan	0.0760	6.5	0.0831	6.6	0.1248	9.0	0.1391	9.3	–0.007	–0.3
Northeast	–0.0673	–4.5	–0.0374	–2.2	–0.0063	–0.4	–0.0690	–3.6	0.093	2.7
North Central	–0.0535	–3.6	–0.0365	–2.1	–0.0668	–4.4	–0.1341	–7.4	0.084	2.6

South	–0.1095	–7.0	–0.0885	–5.2	–0.0795	–5.3	–0.1461	–8.2	0.088	2.7
Manager	0.2712	9.7	0.3271	10.5	0.3255	10.6	0.3334	8.8	0.048	0.8
Professional	0.2243	7.6	0.2055	5.6	0.3039	9.4	0.1845	4.5	0.101	1.4
Technical	0.1025	2.9	0.3072	4.9	0.2263	6.4	0.2665	5.3	0.164	1.7
Sales	0.1068	3.5	0.2124	6.7	0.1547	5.4	0.2054	5.6	0.055	0.9
Clerical	0.0145	0.6	0.1165	3.9	0.0573	2.0	0.1361	3.7	0.023	0.4
Protective	0.0140	0.2	–0.2549	–1.5	0.1080	1.3	–0.0547	–0.4	–0.106	–0.4
Service occ.	–0.1050	–3.4	–0.0558	–1.9	–0.0627	–2.1	–0.0576	–1.6	0.044	0.7
Craft	0.0961	3.8	0.1942	7.0	0.1564	5.2	0.1436	4.0	0.111	1.9
Operative	0.0240	1.0	0.0557	1.8	–0.0182	–0.6	–0.0579	–1.3	0.071	1.1
Transport. operative	–0.0011	–0.0	0.0854	2.4	0.0259	0.7	0.0178	0.4	0.095	1.3
Mining	0.3971	11.2	0.3481	4.0	0.4779	8.3	0.4049	4.5	0.024	0.2
Construction	0.4906	12.3	0.3273	14.7	0.3459	7.3	0.2917	10.5	–0.109	–1.5
Non-durable mfg	0.2007	10.6	0.1746	6.9	0.2928	13.7	0.1691	5.3	0.098	2.0
Durable mfg	0.2685	15.6	0.2161	9.1	0.3376	16.5	0.2907	9.7	–0.005	–0.1
Transport. ind.	0.3813	15.2	0.1250	3.7	0.4127	16.2	0.1733	4.7	–0.017	–0.3
Communications	0.2673	9.6	0.2891	4.0	0.2939	9.1	0.1606	1.8	0.155	1.3
Utilities	0.2590	7.9	0.2368	2.5	0.3977	10.4	0.3843	4.1	–0.009	–0.1
Wholesale	0.2978	10.4	0.2289	9.4	0.3271	10.8	0.2335	8.3	0.025	0.4
FIRE	0.2046	9.6	0.2484	10.4	0.2918	13.7	0.2809	9.6	0.055	1.1
Service ind.	0.0123	0.3	0.0945	3.8	–0.0016	–0.1	0.0763	2.7	0.004	0.1
Prof. serv.	0.1425	6.5	0.1751	9.1	0.1801	8.8	0.2312	10.8	–0.018	–0.4

Table A4a. Part A: Are returns converging between large and small firms?

	Calculation using 1979 characteristics			Calculation using 1993 characteristics		
	X^S_{79}	Excess *B*	*d*(excess *B*)* X^S_{79}	X^S_{93}	Excess *B*	*d*(excess *B*)* X^S_{93}
Constant	1.0000	–0.2007	–0.2007	1.0000	–0.2007	–0.2007
Education	–0.1092	–0.0144	0.0016	0.7129	–0.0144	–0.0103
Education^2	7.6696	0.0002	0.0018	6.5427	0.0002	0.0016
Age	–0.5075	–0.0005	0.0003	0.8517	–0.0005	–0.0004
Age^2	225.477	–0.0002	–0.0339	166.1998	–0.0002	–0.0250
Tenure	–2.4589	0.0034	–0.0084	–2.0808	0.0034	–0.0071
Tenure^2	53.2425	0.0000	0.0004	44.8787	0.0000	0.0004
Tenure <1 year	0.3174	0.0082	0.0026	0.2489	0.0082	0.0020
Tenure 1–2 years	0.1171	–0.0340	–0.0040	0.0949	–0.0340	–0.0032
Married	0.5773	0.0137	0.0079	0.5705	0.0137	0.0078
Union	0.0952	0.0548	0.0052	0.0484	0.0548	0.0027
Black	0.0790	–0.0181	–0.0014	0.0687	–0.0181	–0.0012
Female	0.4649	0.0626	0.0291	0.4894	0.0626	0.0307
Metropolitan	0.7116	–0.0071	–0.0051	0.7443	–0.0071	–0.0053
Northeast	0.2399	0.0926	0.0222	0.1953	0.0926	0.0181
North Central	0.2759	0.0843	0.0233	0.2610	0.0843	0.0220
South	0.3134	0.0876	0.0275	0.3081	0.0876	0.0270
Manager	0.1026	0.0481	0.0049	0.1186	0.0481	0.0057

Professional	0.0693	0.1006	0.0070	0.0959	0.1006	0.0097
Technical	0.0096	0.1645	0.0016	0.0287	0.1645	0.0047
Sales	0.0896	0.0549	0.0049	0.1369	0.0549	0.0075
Clerical	0.1766	0.0232	0.0041	0.1588	0.0232	0.0037
Protective	0.0010	–0.1062	–0.0001	0.0024	–0.1062	–0.0003
Service occ.	0.1923	0.0441	0.0085	0.1813	0.0441	0.0080
Craft	0.1604	0.1109	0.0178	0.1244	0.1109	0.0138
Operative	0.0978	0.0714	0.0070	0.0595	0.0714	0.0042
Transport. op.	0.0467	0.0945	0.0044	0.0486	0.0945	0.0046
Mining	0.0039	0.0240	0.0001	0.0051	0.0240	0.0001
Construction	0.1122	–0.1091	–0.0122	0.1077	–0.1091	–0.0118
Non-durable mfg	0.0678	0.0976	0.0066	0.0640	0.0976	0.0062
Durable mfg	0.0854	–0.0055	–0.0005	0.0741	–0.0055	–0.0004
Transport. ind.	0.0358	–0.0170	–0.0006	0.0405	–0.0170	–0.0007
Communications	0.0057	0.1551	0.0009	0.0053	0.1551	0.0008
Utilities	0.0033	–0.0088	–0.0000	0.0047	–0.0088	–0.0000
Wholesale	0.0666	0.0246	0.0016	0.0673	0.0246	0.0017
Finance etc.	0.0691	0.0547	0.0038	0.0677	0.0547	0.0037
Service ind.	0.0590	0.0042	0.0002	0.0627	0.0042	0.0003
Prof. serv.	0.1746	–0.0184	–0.0032	0.2309	–0.0184	–0.0043

Notes: Excess B = Coeff. estimated on sample from large firms — Coeff. Estimated on a sample from small firms. Education, age and tenure are centered to have mean = 0 in the entire sample. Omitted occupation is laborer, region is West, and industry is retail trade.

Table A4b. Part B: Are employee characteristics converging between large and small firms?

	Calculation using 1979 coefficients			Calculation using 1993 coefficients		
	Excess X^S	b^S_{79}	Product	Excess X^S	b^S_{93}	Product
Constant	0.0000	2.1203	0.0000	0.0000	1.9720	0.0000
Education	–0.0931	0.0295	–0.0027	–0.0931	0.0580	–0.0054
Education^2	1.7586	–0.0002	–0.0003	1.7586	0.0027	0.0047
Age	–0.5961	0.0056	–0.0033	–0.5961	0.0074	–0.0044
Age^2	37.2089	–0.0004	–0.0156	37.2089	–0.0003	–0.0129
Tenure	–0.7003	0.0100	–0.0070	–0.7003	0.0128	–0.0089
Tenure^2	–5.5199	–0.0001	0.0004	–5.5199	–0.0002	0.0012
Tenure <1 year	0.0475	–0.0399	–0.0019	0.0475	–0.0729	–0.0035
Tenure 1–2 years	0.0039	–0.0510	–0.0002	0.0039	–0.0377	–0.0001
Married	–0.0566	0.0544	–0.0031	–0.0566	0.0493	–0.0028
Union	–0.1004	0.2391	–0.0240	–0.1004	0.2352	–0.0236
Black	0.0476	–0.0825	–0.0039	0.0476	–0.0853	–0.0041
Female	0.0914	–0.2618	–0.0239	0.0914	–0.2113	–0.0193
Metropolitan	–0.0007	0.0831	–0.0001	–0.0007	0.1391	–0.0001
Northeast	–0.0305	–0.0374	0.0011	–0.0305	–0.0690	0.0021
North Central	–0.0237	–0.0365	0.0009	–0.0237	–0.1341	0.0032
South	0.0628	–0.0885	–0.0056	0.0628	–0.1461	–0.0092

Manager	−0.0107	0.3271	−0.0035	−0.0107	0.3334	−0.0036
Professional	−0.0214	0.2055	−0.0044	−0.0214	0.1845	−0.0040
Technical	−0.0006	0.3072	−0.0002	−0.0006	0.2665	−0.0002
Sales	0.0428	0.2124	0.0091	0.0428	0.2054	0.0088
Clerical	0.0012	0.1165	0.0001	0.0012	0.1361	0.0002
Protective	−0.0021	−0.2549	0.0005	−0.0021	−0.0547	0.0001
Service occ.	0.0409	−0.0558	−0.0023	0.0409	−0.0576	−0.0024
Craft	−0.0215	0.1942	−0.0042	−0.0215	0.1436	−0.0031
Operative	−0.0480	0.0557	−0.0027	−0.0480	−0.0579	0.0028
Transport. op.	0.0066	0.0854	0.0006	0.0066	0.0178	0.0001
Mining	−0.0138	0.3481	−0.0048	−0.0138	0.4049	−0.0056
Construction	0.0017	0.3273	0.0006	0.0017	0.2917	0.0005
Non-durable mfg	−0.0325	0.1746	−0.0057	−0.0325	0.1691	−0.0055
Durable mfg	−0.1309	0.2161	−0.0283	−0.1309	0.2907	−0.0380
Transport. ind.	0.0048	0.1250	0.0006	0.0048	0.1733	0.0008
Communications	−0.0066	0.2891	−0.0019	−0.0066	0.1606	−0.0011
Utilities	−0.0048	0.2368	−0.0011	−0.0048	0.3843	−0.0018
Wholesale	0.0006	0.2289	0.0001	0.0006	0.2335	0.0001
FIRE	0.0277	0.2484	0.0069	0.0277	0.2809	0.0078
Service ind.	0.0148	0.0945	0.0014	0.0148	0.0763	0.0011
Prof. serv.	0.0172	0.1751	0.0030	0.0172	0.2312	0.0040

Note: Excess X = mean from large-firm sample firms mean from small-firm sample.

Table A4c. Part C: Are returns rising for characteristics common at large firms?

	1979 base			1993 base		
	$(X^{L}_{79} - X^{S}_{79})$	$(b^{L}_{93} - b^{L}_{79})$	Product	$(X^{L}_{93} - X^{S}_{93})$	$(b^{L}_{93} - b^{L}_{79})$	Product
Constant	0.0000	–0.3490	0.0000	0.0000	–0.3490	0.0000
Education	0.7967	0.0141	0.0113	0.7036	0.0141	0.0100
Education^2	–1.1505	0.0031	–0.0036	0.6082	0.0031	0.0019
Age	1.0546	0.0012	0.0013	0.4585	0.0012	0.0006
Age^2	–63.6661	–0.0001	0.0050	–26.4572	–0.0001	0.0021
Tenure	4.3316	0.0062	0.0269	3.6313	0.0062	0.0226
Tenure^2	38.7962	–0.0001	–0.0055	33.2763	–0.0001	–0.0047
Tenure <1 year	–0.1539	–0.0248	0.0038	–0.1064	–0.0248	0.0026
Tenure 1–2 years	–0.0384	–0.0207	0.0008	–0.0345	–0.0207	0.0007
Married	0.0866	0.0086	0.0007	0.0300	0.0086	0.0003
Union	0.2439	0.0509	0.0124	0.1435	0.0509	0.0073
Black	0.0032	–0.0208	–0.0001	0.0508	–0.0208	–0.0011
Female	–0.1200	0.1132	–0.0136	–0.0286	0.1132	–0.0032
Metropolitan	0.0604	0.0488	0.0029	0.0597	0.0488	0.0029
Northeast	0.0342	0.0610	0.0021	0.0037	0.0610	0.0002
North Central	0.0351	–0.0133	–0.0005	0.0114	–0.0133	–0.0002
South	–0.0528	0.0300	–0.0016	0.0100	0.0300	0.0003

Manager	0.0177	0.0543	0.0010	0.0070	0.0543	0.0004
Professional	0.0417	0.0796	0.0033	0.0202	0.0796	0.0016
Technical	0.0201	0.1238	0.0025	0.0194	0.1238	0.0024
Sales	−0.0295	0.0479	−0.0014	0.0133	0.0479	0.0006
Clerical	0.0244	0.0428	0.0010	0.0255	0.0428	0.0011
Protective	0.0040	0.0940	0.0004	0.0019	0.0940	0.0002
Service occ.	−0.1293	0.0423	−0.0055	−0.0884	0.0423	−0.0037
Craft	0.0005	0.0603	0.0000	−0.0209	0.0603	−0.0013
Operative	0.0767	−0.0423	−0.0032	0.0287	−0.0423	−0.0012
Transport. op.	−0.0143	0.0269	−0.0004	−0.0077	0.0269	−0.0002
Mining	0.0172	0.0808	0.0014	0.0035	0.0808	0.0003
Construction	−0.0961	−0.1447	0.0139	−0.0944	−0.1447	0.0137
Non-durable mfg	0.0866	0.0921	0.0080	0.0541	0.0921	0.0050
Durable mfg	0.2383	0.0692	0.0165	0.1074	0.0692	0.0074
Transport. ind.	0.0211	0.0314	0.0007	0.0258	0.0314	0.0008
Communications	0.0341	0.0266	0.0009	0.0275	0.0266	0.0007
Utilities	0.0223	0.1387	0.0031	0.0175	0.1387	0.0024
Wholesale	−0.0328	0.0293	−0.0010	−0.0322	0.0293	−0.0009
FIRE	0.0105	0.0871	0.0009	0.0383	0.0871	0.0033
Service ind.	−0.0428	−0.0139	0.0006	−0.0280	−0.0139	0.0004
Prof. serv.	−0.0942	0.0376	−0.0035	−0.0770	0.0376	−0.0029

Table A4d. Part D: Do employees at large firms increasingly have characteristics that large firms reward well?

	1979 calculation			1993 calculation		
	$(b^{L}_{93} - b^{L}_{79})$	$(X^{L}_{93} - X^{L}_{79})$	Product	$(b^{L}_{93} - b^{S}_{93})$	$(X^{L}_{93} - X^{L}_{79})$	Product
Constant	0.2189	0.0000	0.0000	0.0182	0.0000	0.0000
Education	0.0108	0.7290	0.0079	–0.0036	0.7290	–0.0026
Education^2	0.0015	0.6317	0.0010	0.0018	0.6317	0.0011
Age	–0.0003	0.7632	–0.0002	–0.0008	0.7632	–0.0006
Age^2	0.0001	–22.0692	–0.0016	–0.0001	–22.0692	0.0017
Tenure	0.0035	–0.3222	–0.0011	0.0069	–0.3222	–0.0022
Tenure^2	–0.0002	–13.8837	0.0029	–0.0002	–13.8837	0.0028
Tenure <1 year	–0.0007	–0.0209	0.0000	0.0075	–0.0209	–0.0002
Tenure 1–2 years	0.0467	–0.0182	–0.0009	0.0127	–0.0182	–0.0002
Married	–0.0068	–0.0635	0.0004	0.0069	–0.0635	–0.0004
Union	–0.1837	–0.1472	0.0270	–0.1289	–0.1472	0.0190
Black	0.0363	0.0373	0.0014	0.0182	0.0373	0.0007
Female	0.0155	0.1159	0.0018	0.0781	0.1159	0.0091
Metropolitan	–0.0072	0.0321	–0.0002	–0.0143	0.0321	–0.0005
Northeast	–0.0299	–0.0751	0.0022	0.0627	–0.0751	–0.0047
North Central	–0.0170	–0.0386	0.0007	0.0673	–0.0386	–0.0026

South	–0.0211	0.0575	–0.0012	0.0665	0.0575	0.0038
Manager	–0.0559	0.0053	–0.0003	–0.0078	0.0053	–0.0000
Professional	0.0188	0.0052	0.0001	0.1195	0.0052	0.0006
Technical	–0.2047	0.0185	–0.0038	–0.0402	0.0185	–0.0007
Sales	–0.1056	0.0902	–0.0095	–0.0507	0.0902	–0.0046
Clerical	–0.1019	–0.0166	0.0017	–0.0788	–0.0166	0.0013
Protective	0.2689	–0.0006	–0.0002	0.1627	–0.0006	–0.0001
Service occ.	–0.0492	0.0299	–0.0015	–0.0051	0.0299	–0.0002
Craft	–0.0981	–0.0574	0.0056	0.0128	–0.0574	–0.0007
Operative	–0.0316	–0.0862	0.0027	0.0397	–0.0862	–0.0034
Transport. op.	–0.0865	0.0085	–0.0007	0.0081	0.0085	0.0001
Mining	0.0490	–0.0126	–0.0006	0.0730	–0.0126	–0.0009
Construction	0.1633	–0.0028	–0.0005	0.0542	–0.0028	–0.0002
Non-durable mfg	0.0261	–0.0362	–0.0009	0.1237	–0.0362	–0.0045
Durable mfg	0.0524	–0.1422	–0.0074	0.0469	–0.1422	–0.0067
Transport. ind.	0.2563	0.0095	0.0024	0.2393	0.0095	0.0023
Communications	–0.0218	–0.0070	0.0002	0.1333	–0.0070	–0.0009
Utilities	0.0221	–0.0033	–0.0001	0.0133	–0.0033	–0.0000
Wholesale	0.0689	0.0013	0.0001	0.0936	0.0013	0.0001
FIRE	–0.0438	0.0264	–0.0012	0.0109	0.0264	0.0003
Service ind.	–0.0822	0.0185	–0.0015	–0.0780	0.0185	–0.0014
Prof. serv.	–0.0327	0.0735	–0.0024	–0.0511	0.0735	–0.0038

Table A5. The gap in characteristics, 1979–93

	1979 means				1993 means				Change in the gap (1979–93)	
	Large firm		Small firm		Large firm		Small firm			
	Mean	*t*	Mean	*t*	Mean	*t*	Mean	*t*	Difference	*t*
Education	12.6875	357.5	11.8937	297.8	13.4165	386.7	12.7129	1207.8	−0.0902	−0.1
Education^2	167.0189	1031.8	149.1125	682.9	185.1459	1292.0	167.6523	640.6	−0.4128	−0.4
Age	36.5471	199.2	35.3541	163.2	37.3103	205.3	36.8517	5372.3	−0.7344	−0.7
Age^2	1,497.2000	592.7	1,469.9030	395.7	1,530.0820	485.7	1,523.5250	15,531.1	−20.7400	−4.5
Tenure	8.8727	65.3	4.4947	45.3	8.5505	95.1	4.9192	90.6	−0.7467	−0.7
Tenure^2	167.2564	65.4	66.0728	36.2	148.8618	97.1	64.7474	51.5	−17.0693	−5.2
Tenure <1 year	0.1635	30.6	0.3174	47.2	0.1425	23.3	0.2489	156.4	0.0475	0.0
Tenure 1–2 years	0.0787	20.2	0.1171	25.2	0.0605	14.6	0.0949	184.0	0.0039	0.0
Married	0.6639	97.4	0.5773	81.0	0.6005	85.9	0.5705	1271.5	−0.0566	−0.1
Union	0.3391	49.6	0.0952	22.5	0.1919	63.3	0.0484	22.5	−0.1004	−0.1
Black	0.0823	20.7	0.0790	20.3	0.1195	33.4	0.0687	90.5	0.0476	0.0
Female	0.3449	50.3	0.4649	64.6	0.4608	65.3	0.4894	1144.5	0.0914	0.1
Metropolitan	0.7720	127.5	0.7116	108.8	0.8040	130.5	0.7443	833.0	−0.0007	−0.0
Northeast	0.2741	42.6	0.2399	38.9	0.1990	35.5	0.1953	3535.9	−0.0305	−0.0
North Central	0.3111	46.6	0.2759	42.8	0.2725	43.9	0.2610	1526.5	−0.0237	−0.0

South	0.2606	41.1	0.3134	46.8	0.3181	48.8	0.3081	2063.0	0.0628	0.1
Manager	0.1203	25.6	0.1026	23.4	0.1256	27.5	0.1186	1135.9	−0.0107	−0.0
Professional	0.1109	24.5	0.0693	18.9	0.1162	27.9	0.0959	317.2	−0.0214	−0.0
Technical	0.0297	12.1	0.0096	6.8	0.0481	20.4	0.0287	98.7	−0.0006	−0.0
Sales	0.0601	17.5	0.0896	21.7	0.1502	30.9	0.1369	686.4	0.0428	0.0
Clerical	0.2010	34.7	0.1766	32.1	0.1844	35.7	0.1588	415.6	0.0012	0.0
Protective	0.0050	4.9	0.0010	2.2	0.0043	6.2	0.0024	85.9	−0.0021	−0.0
Service occ.	0.0630	18.0	0.1923	33.8	0.0929	17.1	0.1813	137.1	0.0409	0.0
Craft	0.1609	30.3	0.1604	30.3	0.1035	22.2	0.1244	397.7	−0.0215	−0.0
Operative	0.1745	31.8	0.0978	22.8	0.0882	26.4	0.0595	138.6	−0.0480	−0.0
Transport. oper.	0.0324	12.7	0.0467	15.3	0.0409	13.5	0.0486	421.6	0.0066	0.0
Mining	0.0212	10.2	0.0039	4.4	0.0085	8.5	0.0051	97.5	−0.0138	−0.0
Construction	0.0161	8.9	0.1122	24.6	0.0133	3.0	0.1077	76.2	0.0017	0.0
Non-durable mfg	0.1543	29.6	0.0678	18.7	0.1181	34.2	0.0640	79.1	−0.0325	−0.0
Durable mfg	0.3236	47.9	0.0854	21.2	0.1815	49.1	0.0741	46.1	−0.1309	−0.1
Transport. Ind.	0.0568	17.0	0.0358	13.3	0.0664	23.8	0.0405	104.9	0.0048	0.0
Communications	0.0398	14.1	0.0057	5.2	0.0329	32.0	0.0053	12.9	−0.0066	−0.0
Utilities	0.0256	11.2	0.0033	4.0	0.0223	23.0	0.0047	18.0	−0.0048	−0.0
Wholesale	0.0338	13.0	0.0666	18.5	0.0351	9.9	0.0673	139.7	0.0006	0.0
FIRE	0.0796	20.4	0.0691	18.9	0.1060	29.9	0.0677	118.2	0.0277	0.0
Service ind.	0.0162	8.9	0.0590	17.4	0.0347	10.1	0.0627	149.6	0.0148	0.0
Prof. serv.	0.0804	20.5	0.1746	31.9	0.1539	25.9	0.2309	200.4	0.0172	0.0

Notes

[1] To simplify the model we measure firm size as the number of establishments, not the size per establishment. Alternative models could assume that PCs reduce the fixed cost of information technology. In such a model computers are adopted at smaller establishments and the highly skilled labor that is complementary to computers also shifts to smaller establishments. Thus, the main results of our model would go through.

[2] The coding of the employer size variable was altered in 1988 by a change in the top coding of establishment size from 1,000 to 250. In both years, individuals were first asked the employment of the establishment in which they work, then whether they work for a multi-establishment firm and then, if they do, the employment of the firm. All questions are reported as discrete categories. In 1979, establishment size was top coded at 1,000 employees, but it was top coded at 250 in 1993. As a result, there are a small number of individuals who worked in large single-establishment firms in 1993 who were classified as being in firms of 100 to 499 employees rather than being properly recorded as working in firms of 500 to 999 or 1,000 or more.

[3] The CPS provides employment-weighted measures of employer size (a 'white pages' view), rather than an employer-weighted measure (a 'yellow pages' view). Employment-weighted statistics result in a higher mean employment size and a firm size distribution more heavily weighted toward large firms. Employer-weighted estimates provide a lower mean and median and a distribution skewed toward small firms because there are large numbers of extremely small firms in the USA. Employer-weighted statistics are computed assigning smaller employers the same weight (importance) as the largest employers.

[4] The shift of employment toward larger firms is the reverse of prediction of the theory that the introduction of PCs would result in a decline in the employment size of firms. The difference between a comparative static exercise and the world may be due to the multitude of factors other than those under study, which affect firm size.

[5] Changes in the interception associated with changing the omitted categories are largely balanced by corresponding shifts in the effect of personal, occupation and industry effects; changing the omitted group results in only modest changes in the contribution of part (A) of the decomposition to the size–wage gap or in the overall size–wage gap.

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