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Opening the Box: Information Technology, Work Practices, and Wages

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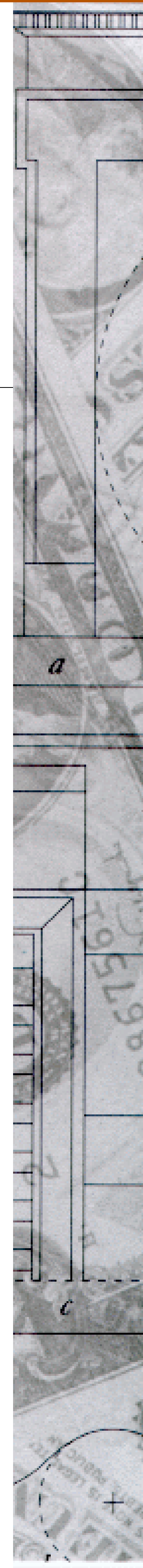
98-02-C



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The Working Paper Series is made possible by a generous grant from the Alfred P. Sloan Foundation

Opening the Box:

Information Technology, Work Practices, and Wages

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June 1999

Thanks to the Sloan Foundation and to the Wharton Financial Institutions Center for funding this research. We received helpful comments on earlier versions from Peter Cappelli, Anne Cummings, Lorna Doucet, Susan Eaton, Marta Elvira, John Paul MacDuffie, Marc Weinstein, and Steffanie Wilk. Sidath Gunawardena provided excellent research assistance. Frances Frei, Patrick Harker, and Lorin Hitt also provided collegial assistance.

Data and Replication

The data in this study were gathered through field research and an original survey by a research team working with the support of the Wharton Financial Institutions Center. The survey and codebook, the data, and the Stata programs used to analyze the data may be made available to other researchers with the approval of the WFIC.

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Abstract

There is substantial debate about the effects of technological change on wages. We argue that the relationship between technology and wages is context-dependent. To test this proposition, we use data gathered from 303 U.S. bank branches and examine empirically the association between different kinds of information technology (IT), work practices, and wages for the job of customer service representative in bank branches. We also test for interaction effects between IT and work practices. Our results suggest that context *sometimes* matters: the wage outcomes for IT that automates basic tasks are moderated by high-involvement work practices, while IT that improves the quality of organizational information is related positively to wage outcomes independently of context.

Opening the Box:

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There are several competing claims about the relationship between technology and wages. One argument suggests that greater use of technology is associated with higher wages, while a counterargument contends the opposite. Both of these arguments assume implicitly that technology is deterministic by downplaying or ignoring the existence of variations in the implementation of technology. Still another argument posits that organizational contexts influence this relationship just as much, if not more so, than technology itself. Arguments for each of these claims, however, rely chiefly on small sample studies that do not allow for multivariate comparisons, or upon data that “are too crude to give us much insight into the actual nature of the changes that are occurring” (Bound 1996: 155).

Our paper draws on data from an industry-level study of US banking that includes survey information on information technology (IT), work practices, and wages in a large sample of bank branches. These data, which are supported and informed by a qualitative comparison of jobs in two banks, enable us to investigate empirically the association between technology and wages for a specific job. This job, the customer service representative (CSR) or “platform” position in a bank branch, is typically associated with account openings, routine servicing of accounts, and sales activities. Our job-based approach (Lazear 1995) allows us to explore whether technologies may be deployed to construct high-wage or low-wage jobs in roughly similar settings. We are able to employ detailed, highly reliable, and easily comparable measures of technology in use across branches. We can also compare the effects of different work practices governing a job that comprises a reasonably standard array of tasks.

We investigate four related questions. First, is the extent to which IT supports the functions performed by a CSR associated with higher or lower wages for this job? Second, are the effects associated with IT used to *automate* tasks different from those associated with IT used to "*informate*," or create new kinds of information? Third, are forms of work organization that give employees greater discretion and control over their work associated with higher wages? Fourth, how, if at all, are these phenomena related?

Technology, Jobs, and Wages

The research evidence indicates that advances in technology are, in the aggregate, associated with higher wages for workers. Goldin and Katz (1996) show that for most of the 20th century, technologically advanced firms have had a disproportionate number of highly educated workers. Other research shows that plants using the most advanced production technology pay the highest wages and employ more skilled workforces (Dunne and Schmitz, 1995; Doms, Dunne, and Troske 1997). The demand for skilled workers and the skill requirements for many jobs also appear to be increasing on average even as the wages paid for these skills have risen (Cappelli 1993, 1996; Jensen and Troske 1997). Similarly, Cappelli (1993) shows that the skills of production workers have been upgraded over time as manufacturing technology has become more sophisticated. Finally, the literature on income distribution attributes much of the increase in inequality of the 1980s and 1990s to "skill-biased technological change" (e.g. Lawrence and Slaughter 1993; Bound and Johnson 1995), implying that technology increases both the wages of and the demand for more highly educated workers.

This evidence, while persuasive as to the aggregate effects of technological changes, leaves a puzzle: scholars associated a "deskilling" perspective do not agree that the effects of new technologies can be interpreted so positively. For example, case studies associated with deskilling, including Braverman (1974), Glenn and Feldberg (1977), and Noble (1984), each demonstrate that new technologies may be associated with reductions in skill, autonomy, and wages for workers. Deskilling arguments emphasize how managers use technology to extend their control over the workplace, and that this pursuit of control comes at the expense of workers' earnings.

Debates between upgrading and deskilling perspectives can be resolved in part by understanding that technology can affect wages through two routes (Cappelli 1996). First, technology can contribute to shifts in the distribution of workers across jobs that command different wage levels. The evidence suggests that the net effect of technological change is to shift the aggregate distribution of workers from lower- to higher-paying jobs. For example, Attewell (1987) provides a critique of Braverman's deskilling thesis that focuses on the redistribution of workers across jobs.

Technology can also affect wages through a second route, by altering the content of particular jobs and thus the wages those jobs command. Research which draws from surveys of individual workers implies that jobs in higher-technology workplaces require higher levels of skill and thus command higher wages (e.g. Krueger 1993), but the ways in which technology affects wages for particular jobs are not well understood. We know that deskilling of particular jobs is not necessarily inconsistent with overall skill upgrading (Adler 1992). For example, skill-biased change could be consistent with advances in technologies that deskill jobs held by lower-skilled workers, even while the net effect of technological change is to upskill and increase the number of relatively high-paying jobs.

The empirical research which investigates effects of technology typically focuses on aggregate effects, rather than on particular jobs, and does not consider in detail the technologies underlying shifts in wages. Many of the studies of changes in the distribution of income attribute an unmeasured residual term to technology. Even the empirical studies of workers or of firms that have examined technological change more directly (Krueger 1993; Dunne and Schmitz 1995; Adler and Borys 1995; Doms, Dunne, and Troske 1997; Autor, Katz, and Krueger 1998) do not measure specific features of new technology. The fact that a worker uses a computer, for example, or that an organization invests more in technology, typically serves as a proxy for a relatively high-technology workplace.

Information technology (IT) seems unlikely to have simple effects on wages for particular jobs because computers can be used in a variety of ways (Attewell and Rule 1984; Rule and Attewell 1989). It is not clear *a priori* how the automation of routine tasks through the use of IT, for example, might affect the skills required and thus wages for a job. A computer may be a more complex machine than the technology it replaces, but it is not necessarily more complex for the user. To take one example, applications like word processing may decrease some kinds of substantive complexity: typists who use only word processors require less sophisticated pagination skills than those who use typewriters (Cappelli 1993). Glenn and Feldberg (1977) show that when record keeping for clerical jobs was computerized, the jobs of the associated workers became less complex. On the other hand, as Adler (1986) and Attewell (1987) show, computer-driven automation can require employees who interact with these systems to possess higher levels of abstract understanding of their work.

IT can also be used by organizations to go “beyond mechanization” (Hirschhorn 1984) or to “informate” (Zuboff 1988) as well as to automate operations. IT may reveal previously hidden relationships between different kinds of information in ways that would not have been possible had the information not been stored electronically. Informating technology has the potential to change the nature of work substantially. A customer information database used by sales and service workers, for example, may remind or encourage workers to pursue specific sales opportunities, or suggest particular avenues for dealing with customers, relieving the worker from the responsibility of remembering how and when to do so. Although such innovations may seem to reduce the skills required for jobs (Attewell and Rule 1989), Zuboff (1988) suggests that the transition to such technology is difficult for many workers, and is made more easily by individuals who are more comfortable with manipulating abstract patterns of data. Further, Leidner (1993) shows that the effective deployment of scripted routines that support interactive service and selling – one key function of informating IT – requires a high-level understanding of the products and services being sold.

Existing literature does not clearly predict the associations between technology and wages for an affected job for either automating or informating IT. With respect to automation, the prior evidence from case studies is mixed. The effects of informating IT are even less well studied. One way to address these questions is to take a specific job that commands different wages in different organizations, and to compare the accompanying technologies in these different settings. This approach leads us to a pair of research questions:

(1) Is the extent to which tasks are automated through IT associated with higher or lower wage levels for a given job?

(2) Is the extent to which a given job is supported by "informating" IT associated with higher or lower wage levels for that job?

These research questions do not completely encompass the debate, however, for they imply a deterministic view that does not fully reflect the research on the effects of technology. Case study findings suggest, and some large-sample evidence is consistent with, the possibility that a contextual view (Adler 1992; Adler and Borys 1995) might best address the tension between job upgrading and deskilling perspectives. The contextual view suggests that deployment of identical technologies may yield divergent results. For example, Barley's (1986) case study comparison of two identical radiology departments shows that placement of CT scanners in each resulted in work roles changing in different ways in the two organizations. Similarly, Kelley (1990) shows that the effects of programmable machines on job content are not determined solely by the nature of this technology: rather, these effects are contingent on several local institutional mediating forces.

The association between technology and wages may similarly depend on these contextual differences in workplaces. The literature suggests that wage effects associated with technology result not only from the ways in which the technology itself changes the substantive complexity of particular jobs, but also through how different technologies influence the extent to which jobs must be performed autonomously. Deployment of new technologies, for example, may require "skill" that encompasses both mastery of the technology itself and the effective exercise of autonomy in the job (Attewell 1990; Spenner 1990). Adler (1986) similarly analyzes both abstract understanding and "responsibility" as dimensions of skill that may be affected by technology. Technologically-occasioned changes in the required exercise of judgment or responsibility may be understood as changes in required skills, or as situations which require payment of efficiency wages to induce diligence.[1] Under either interpretation, the expectation regarding wage effects is the same: new technologies are likely to command higher wages in particular work contexts. For example, higher wages will be observed where technology and work practices interact to shift sets of decisions to workers that were formerly the province of higher-positioned employees.

Differences in work practices for similar jobs across organizations are therefore contextual

[1] Akerlof and Yellen (1986) summarize the efficiency wage approach by arguing that managers may find it effective to pay above-market wages to induce discretionary effort or conversely, to discourage shirking.

factors that could moderate the associations between particular technologies and wage levels. Both upgrading and deskilling perspectives are consistent with this position. As Vallas (1990) has noted, although some see Braverman (1974) and other advocates of the deskilling perspective as arguing that technology is deterministic, the typical deskilling argument is contingent. Braverman (1974), Noble (1984), and Glenn and Feldberg (1977) posit that managers are likely to take advantage of new technologies in order to reduce workers' discretionary power, not that the technologies themselves compel this approach. Technology gives managers the opportunity to further centralize decision-making authority and to simplify work; it does not guarantee that they will do so. It is the interaction between new technologies and restrictive work practices that produces deskilling effects. On the other hand, job upgrading may result where work practices used in conjunction with new technology reorient employees' activity away from routine processes and toward tasks requiring higher levels of skill, engagement, and discretionary effort.

Contextual considerations include "high-involvement" work practices, which can be separated into on-line and off-line practices (Appelbaum and Batt 1994). On-line practices give workers increased discretionary authority over their immediate work activity. Off-line practices are structures for employee involvement in which employees meet to discuss work and to suggest changes in processes. Further, although the above discussion suggests that interactions between technology and both kinds of high-involvement practices may be positively associated with wages, these high-involvement approaches to work organization may also have direct relationships with wages.[2] High-involvement approaches require employees to take on new and wider sets of tasks

[2] It is possible, for example, that skill-biased technological change could comprise largely changes in the "soft" technologies of work practices. Skill-biased change is typically associated with changes in residual terms that are attributed to changes in technology. Both the use of IT and the use of high-involvement practices have increased substantially over the past few decades.

and decisions, increasing the substantive complexity of jobs. The encouragement of discretionary effort by employees is also an important component of these systems (Bailey 1992; MacDuffie 1995). The discussion of work practices leads us, then, to the following further questions:

(3) Are high-involvement work practices associated with higher wages for a given job?

(4) Is there an interaction between technology and work practices that is associated with wage levels?

Research Context: A Comparison of Jobs in Two Banks

American bank branches provided the setting for our study.[3] One comprehensive review of the banking industry notes that the 1980s and early 1990s were "undoubtedly the most turbulent period in banking since the Great Depression" (Berger, Kashyap, and Scalise 1995). A series of regulatory changes and financial innovations catalyzed reorganization of the industry, and the rate of technological innovation accelerated during this same period. The rapid introduction of IT dramatically decreased the costs associated with handling and processing individual transactions and servicing of accounts. This turbulence provided us with a natural experiment, as different banks introduced technologies with different characteristics under differing regimes of workplace practices.

We focused our study on the job of platform worker or customer service representative (CSR). This position is fairly comparable across most bank branches: CSRs interact with customers to perform a range of tasks somewhat more complicated than the routine transactions accomplished by tellers. The array of basic tasks performed by CSRs, such as account openings and closings, is further standardized across banks by the extensive regulatory regime that circumscribes the range of financial services provided in bank branches and thus limits the range

3 For more detail on this context see Keltner and Finegold (1996) or Hunter (1999).

of activities performed by CSRs.

Banks continue to automate the basic servicing processes associated with CSR activities in the branch. Implementing such automation is deceptively complicated. For example, moving from pencil-and-paper to on-line address changes for customers is not trivial. It involves changes in a number of different processes, and often requires a comprehensive review of internal fraud prevention procedures, as well as the linking of databases that were previously not connected. Further, there is seldom one clearly superior way to effect these changes.

The work of CSRs may also be supported by "informating" IT. By linking account information, IT can give CSRs a clearer picture of each customer's financial position and profit potential. Such data enhance sales efforts, enabling CSRs to suggest matches between customers and services, and to refer the customers to other employees with expertise in specific products. Increasingly sophisticated systems also allow workers in banks to share computer screens with customers, transforming a formerly arcane display of product and customer information into a common reference point with which both employee and customer can work.

A comparison of branches of Second Bank and Third Bank[4] illustrates how crucial context may be in influencing the relationship between technology and wages. These banks are direct competitors, operating in many of the same customer and labor markets. Each operates between ten and fifteen branch offices in a large midwestern city in which we visited several branches. Each branch employed CSRs in its branches. The compensation grid at Second Bank banded CSRs at $23,000 - $29,000 annually, while CSRs at Third Bank started at $19,000 annually and could earn up to $25,000.

4 These are pseudonyms.

The technology in use for the CSRs' jobs was nearly identical in the two banks. Each bank had put a number of the basic platform tasks on-line, thus removing pen-and-paper steps that had once been required for opening and closing of accounts, and making changes to account information. Neither bank, however, had automated balance transfers on the platform: while these could be accomplished by a customer at an automatic teller machine, customers who sat with a platform representative in either bank and decided to transfer balances had to work with forms that the CSRs then completed and submitted. Each bank had also automated the process of adjusting or removing fees charged to accounts (for example, for bounced checks or minimum balance service charges). Personnel in each bank indicated that the basic platform system with these features had been in place for about three years.

The current technological development efforts in each bank were targeted toward the use of sales-supporting software, and database mining, but neither bank had made much progress in this area at the time of our visits to these branches. The system at Second Bank was a bit better at drawing on this linked information. For example, it featured a small box in the corner of the customer's account screen (visible to, but rarely noticed by, the customer) which contained either an X, an N, or a $. Employees were instructed to treat "$" customers with the utmost courtesy, while "X" patrons were most unlikely to receive friendly responses to complaints or requests for fee waivers. Third Bank had not implemented a similar system, but claimed to have something quite similar in development. At the time of our visits, each bank also had in development a set of "cross-sell prompts," but neither had deployed these prompts. These functions specifically reminded CSRs to suggest products such as home equity loans to customers prone to large credit card balances, or mutual funds for customers who keep large amounts in cash accounts.

In these two banks, IT had profoundly affected jobs in the branch. Employees in each bank with substantial tenure who had experience before and after the introduction of a number of improvements in the systems described the changes similarly. Prior to the system improvements, platform workers had spent considerable time literally hiding in the backs of branches in order to accomplish the required paperwork. In each bank, the system improvements enabled CSRs to spend more time with customers, and less time on paperwork. Executives in each bank also described how administrative functions had been centralized, automated, and removed to the back office, with considerable savings in labor costs at the branch level.

The key factors shaping the CSR jobs at Second and Third Bank were less the supporting technologies than the work practices. Each branch at Second Bank had a formal Quality Circle, and CSRs were required to participate in regular meetings intended to find ways to improve the bank's ability to serve customers. No such formal structures existed at Third Bank. Further, CSRs at Second Bank were granted discretion over a number of customer service decisions that CSRs at Third were not. For example, CSRs at Second Bank were authorized to waive fees and service charges on checking and savings accounts if they thought the customer's request was warranted (for example, if the bank had made an error or been slow to deposit a check). At Third Bank, CSRs had to receive approval from their local branch manager before waiving a fee or charge. At Second Bank, CSRs were authorized to use their own judgment with respect to error correction. If it was obvious to them that the bank had made an error (if for example, a CD had been issued with the wrong rate or term, and the customer discovered this only upon leaving the branch), they could simply correct it. At Third Bank, similar situations required the CSR to seek approval from the branch manager.

The work practices at Third Bank were consistent with a command-and-control culture that has long been associated with the banking industry (Hunter 1999). Giving CSRs discretionary authority to perform tasks such as error correction actually takes on heightened importance when the function is automated. In an on-line system, changes are immediate rather than lagged, and are made in the front office with the customer watching rather than submitted to a back office for processing (Adler 1986). Similarly, Second Bank's approach of giving CSRs the authority to waive fees or adjust rates would be quite costly should the CSRs overuse these waivers.

Local executives at each bank were acutely aware of the wage differentials between the two banks, not least because they profoundly affected recruiting and staffing. At Third Bank, executives told us that Second was overpaying its platform staff, and would not be able to sustain its cost structure -- in short, one told us, the local approach at Second indicated that the bank was fat with expenses and likely to be acquired. Second Bank executives, on the other hand, believed that their CSRs were more knowledgeable, effective, and diligent than those at Third Bank. The better-paid CSRs of Second Bank spent very little time seeking approval or specific instructions from their local branch manager, while scurrying back and forth to the manager's office was a constant feature of the CSR job at Third. At Second, IT had allowed the job to be upgraded, as the labor-saving features of the new systems allowed workers to focus their efforts in new areas. At Third, on the other hand, the IT was implemented in a deskilling fashion. Combined with limits on discretionary behavior of CSRs, it allowed the bank to accomplish its basic tasks at considerably lower labor costs.

Survey Data

The comparison of Second and Third Banks indicated relationships between technology, work practices, and wages that were consistent with the contextualist perspective. The investigation of these relationships, however, was necessarily limited by its method. Comparison of these two banks did not enable us to consider how variation in the levels of automation affected the jobs, since both banks had used automation in roughly similar amounts. We also could not separate the effects of work practices from the effects of the slightly more extensive sales-supporting technologies at Second Bank.

Complementing this case study, therefore, we draw on data from a sample survey of bank branches in many banks to provide us with a large sample of CSR jobs under varying technological and work practice regimes.. Participation in the survey was confidential but not anonymous (which enabled surveys to be matched with data from other sources), and required substantial time and effort from banks. A research team therefore sought commitment to participation by approaching the 70 largest U.S. bank holding companies (BHCs) directly, and in the second half of 1994 requested the participation of one retail bank from each BHC. 47 BHCs agreed to participate. Of these, seven BHCs engaged the participation of two or more retail banks within the BHC, yielding a total of 64 retail banks. Each organization in this group received multiple questionnaires, including questionnaires for six bank branches in the retail bank. The researchers requested that one of the six branches be the branch closest to the “head office” of the bank, and that the other five be geographically diverse.

The sample was broadened through a mailed questionnaire that was identical to those distributed directly. In late 1994, the team sent surveys to top executives of the next largest 265 BHCs, and followed the mailing with a telephone call requesting the participation of one of their retail banking organizations. 64 of these BHCs agreed to participate in the study, and four engaged the participation of two or more retail banks in the BHCs so that there were 71 retail banks participating in the mailed survey. Each of the banks in the mailed survey provided data from one local branch, the branch closest to the head-office. This approach, while yielding a sample that was not fully representative of the industry, which comprises some 8,000 banks, did produce substantial coverage: banks holding over 75% of the total assets in the industry as of year-end 1994 participated in one or the other version of the survey.

The unit of analysis in question for this study was the CSR job, to which the survey gave a standard definition.[5] Questionnaires targeted the "most informed respondent" (Huber and Power 1985) for a variety of questions. The team followed the strategy outlined by MacDuffie (1995), developing contextualized questions based on extensive fieldwork, and focusing where possible on identification of specific practices and technologies rather than on perceptions of practice or on general policies and approaches.

With regard to work organization, technology, and wages in bank branches, pilot surveys suggested that the best respondent was the local branch manager.[6] Collecting data at the job level from individual employees as well as from managers would have been prohibitively costly and would have added little to the study. Managers typically had access to the compensation schedule for CSRs, whom they supervised, and were able to identify precisely the work practices and IT capabilities for this job category. Relying solely on the manager for information did allow for the possibility of common method variance, but such bias does not pose a strong threat in this case for two reasons. First, almost none of the data collected here are perceptual in nature. Relative to other data gathered from self-reports, such as personality data or psychological states, these kinds of data are less problematic (Podsakoff and Organ 1986). Second, there is no coherent underlying

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5 "Consider your platform employees. If there is more than one job title on the platform, consider the platform job with the most people involved. For simplicity we will refer to this position as a customer service representative or a 'CSR.' Your bank may call this position something different."

6 Personnel managers, in contrast, found it difficult to produce accurate branch-level wage data and to report work organization accurately. Similarly, branch managers reported the functionality of technology in use far more accurately than did centrally based technology managers and developers.

rationale (such as a halo effect) for there to be systematic bias that inflates correlations between the different variables of interest. Even if managers systematically over- or under-reported technology capabilities, for example, such bias would not necessarily be associated with similar over- or under-reporting of work practices or wage levels.

Our analyses also include several control variables drawn from secondary sources. We excluded supermarket branches, kiosks, and telephone banking centers from the analysis to ensure relative homogeneity among the sample of branches: each branch in the sample was staffed by both tellers and platform employees and served customers in person. After eliminating bank branches with missing data on the study variables, we were left with a sample of CSR jobs in 303 branches from 110 retail banks in 91 BHCs.

Measures: Independent and Dependent Variables

We measure the level of *automation* governing the CSR job in each branch with an eleven-item additive index[7] (Cronbach's α=0.84)[8] in which each item is a no-or-yes question (scored 0 or 1) assessing the capability of the branch platform computer system to perform a particular task (e.g. open accounts, transfer funds) "on-line." The complete list of items appears in the appendix; each item received equal weight. Scores on the automation index can range from 0 to 1, indicating the share of answered items that received a "yes" answer. Higher scores therefore indicate that the branch has automated a higher share of these tasks.

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[7] We refer to these measures as "indices" rather than scales. An index comprises cause indicators; a scale comprises effect indicators (DeVellis 1991). In this case, we believe that while having a particular function on line indicates the extent of automation in the branch, it is not caused by an underlying latent variable that could be termed "automation."

[8] Some researchers prefer the Kuder-Richardson formula 20 score for evaluating the reliability of indices composed of dichotomous items. Cronbach's α is equivalent to this measure, and calculation of reliability using the KR-20 formula yields the same result (Nunnally 1978).

We measure the "*Informating*" capacity of the CSR-supporting technology with a five-item additive index (Cronbach's α=0.72) comprising no-yes (0-1) questions assessing the use of software that supports sales and effective customer service (e.g. does the system provide cross-sell prompts?). Again, the scores range from 0 to 1, the complete list of items is given in the appendix, and each item gets equal weight. More extensive use of this software is consistent with Zuboff's (1988) view of the potential of technology to create new kinds of information and new ways of connecting different sorts of data. Such software can suggest sales opportunities to its users, provide information that enables users to link financial services and accounts that might have been previously unrelated, and help the CSR to engage the customer more fully in the sales and servicing processes.

We operationalize "high-involvement" work practices in two ways. First, we consider on-line practices by looking at the level of *discretion* given to CSRs in their jobs. We employ an eight-item additive index (Cronbach's α=0.70) in which each item is a no-yes (0-1) measure indicating if the CSR has the authority to perform various functions as part of the sales and service role (e.g. correct a check posted twice, waive fees on a checking account). The complete list of items is given in the appendix, the scores again range from 0 to 1, each item gets equal weight, and higher scores indicate more discretion.

We also look at formal structures for off-line programs of employee involvement in decision-making. Here we construct a binary variable, "*Q.C.s*," which takes a value of 1 if the branch CSRs participated in a program of Quality Circles. Wording on the survey questionnaire was identical to that of Osterman (1994). It asked, "Are any full-time platform representatives involved in Quality Circles? (These are quality programs with employees engaged in ongoing meetings for problem-solving.)”[9]

Our dependent variable is the *typical wage* of a customer service representative in the branch as indicated by the branch manager in his or her response to the following question: “A typical full-time CSR with two years experience earns $_____/hour OR $______ / year.” We focus on wages of typical employees rather than those of new employees in order to net out the differences in hiring and initial training strategies across banks. Typical wages give the best picture of the branch’s wage policy.[10] As with most studies of wages, we use the natural logarithm of the wage measure as the dependent variable in our regression analyses.

Control variables

We control for several characteristics of bank branches that might be associated with work

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[9] Quality circles are not the only way we measured off-line participation, but emerged as our preferred indicator. We explored two other possibilities. First, Osterman (1994) suggests that a “transformed” workplace may also be characterized by the use of self-directed work teams (SDWTs). Interviews and pilot surveys suggested that in this context the quality circle measure would be a more precise, albeit limited, measure. Managers interpreted questions about SDWTs as defined by Osterman’s (1994) survey (“employees supervise their own work, they make their own decisions about work flow, and occasionally the best way to get work done”) inconsistently. We nevertheless included a question on SDWTs in the survey. The results confirmed our suspicions, as over half of the respondents indicated that their branches had such teams. This result was far higher than we expected given our field work and review of the industry literature, suggesting that the question led managers to overstate the use of SDWTs.

Second, because Quality Circles are a limited and very specific form of off-line involvement, we also asked the branch manager to assess the level of employee influence over decisions regarding the way the work is done in the branch. Here we constructed a nine-item scale measuring *Informal Off-Line Employee Involvement* (Cronbach’s alpha=0.84) with questionnaire items adapted from MacDuffie (1991). Results (available on request) for models using this variable rather than the existence of quality circles to indicate off-line involvement were generally consistent with those for quality circles. We focus here on the Q.C. measure because it relies less on the vagaries of individual managers’ perceptions.

[10] Some branch managers reported hourly wages, while others reported annual salaries (the pilot survey suggested that giving this option was helpful in minimizing missing responses). We therefore transformed all hourly wage figures into annual salary figures by multiplying the hourly wage by the product of the average number of hours worked per week by a typical CSR (derived from data from the 1993 Current Population Survey) times 50 (weeks per year). Our results were robust to a number of different assumptions about how best to annualize wages (e.g. 50 weeks versus 52 weeks). In addition, the inclusion of a dummy variable indicating whether or not we had made this transformation did not suggest statistically significant differences by reporting form in any of the models we estimated.

practices, wages, and technology. First, we control for firm and establishment size. Some evidence suggests that large firms have distinct patterns of technological implementation (Dunne and Schmitz, 1995). Large firms and establishments also tend to pay more than do small firms (Brown and Medoff, 1989) and establishments (Rebitzer, 1986). In addition, large and/or multi-site firms may be able to effect economies of scale in administration that lead to qualitative differences in the types and levels of technologies employed. Jensen and Troske (1997) suggest, for example, that such firms may be more oriented toward providing sophisticated, high value-added products and services than are small, less technologically intensive firms, and more flexible in responding to some strategic initiatives (Jensen and Troske, 1997). We measure the size of the bank holding company that owns the branch by taking the natural logarithm of the total 1994 assets of the bank, *LnAssets*, as indicated by FDIC data. *LnSize* indicates the size of the local branch as measured by the natural log of the (self-reported) number of branch employees.

Autor (1995) suggests that one reason positive relationships between computer use and wage levels have been documented (e.g. Krueger 1993) is that successful firms are able both to pay high wages and to buy computers. We therefore control for munificence by using the natural logarithm of the 1994 return on assets of the bank holding company, *lnROA* (from FDIC data) to measure munificence. We also employ controls for variation in local geography. *LnBranches* is the natural log of the total number of bank branch offices in the county in which the branch is located, as reported by the Census Bureau. This measure gives a sense of the size of the local metropolitan area as well as the demand for branch banking and, correspondingly, for bank branch employees. *Midwest*, *South*, and *West* are regional dummy variables (*Northeast* is the omitted category).

Although our informating index is specifically focused on technology questions, we have operationalized it to capture a particular form of this technology: its use in supporting sales and customer service. The CSR job is relatively homogeneous across bank branches. It is possible, however, that the informating index reflects variation in the extent to which the CSR job is either oriented toward sales activity rather than the characteristics of the technology or has begun to fold in responsibility for selling a more extensive array of financial products. We control for these factors by including two binary variables. "*Sales focus*" takes a value of 1 if the CSR is required to telemarket (place outbound sales calls). "*Investment products,*" takes a value of 1 if the CSR sells investment products (such as mutual funds) in the branch.

Correlations between Use of Technology and Work Practices

As outlined above, we hope to capture not only the direct associations between different types of IT and work practices and wages but also the associations between the interaction of these variables and wages. Table 1 shows that although all of our categories of IT and work practices are positively associated, none of them are correlated with each other at conventional levels of statistical significance. It bears emphasizing that banks may score high on the informating index without scoring high on automation, as some banks have chosen to implement sales-supporting technologies without automating many of the routine servicing tasks. Table 2 illustrates this point more concretely with an example that draws on one item from each of the indices. Branch systems in our sample are about as likely to have instituted technology to support cross-selling as they are to have automated a simple funds transfer, and the two bear little relationship to one another (Chi-square=1.36, p=0.24).

Similarly, off-line involvement through Quality Circles may be associated with both low and high levels of discretion and of informating and automating technologies. 20% of the branches have Q.C.s. Osterman's (1994) survey, which used an identical measure, found a higher overall share of service sector establishments employing Q.C.s. This result suggests that the large banks surveyed are more likely than are firms in other sectors to use more traditional command-and-control forms of work organization. Table 3 shows that although bank branches with Q.C.s may be slightly more likely to report higher levels of worker discretion or technology in use, these differences are not statistically significant: T-tests do not allow us to reject the hypotheses that the means across the groups are equal.

Discretion and automation are the most strongly correlated of our study variables, at levels approaching traditional levels of significance (r=0.11, p=. 052). Tables 4a and 4b show that although there appear to be some relationships between automation of basic tasks and the discretion employees have over those same tasks, these relationships are not overwhelming. It is possible to automate without increasing discretion, and to do the reverse. We observed all four combinations of approach in our sample.

Relationships between Technology, Work Practices, and Wages

In order to analyze the relationships between IT, work practices, and wages, we estimated a series of regression models. Because some of the branches in our sample belonged to the same retail bank and to common BHCs, we could not make the standard OLS regression assumption that observations across branches were independent. Thus, we employed the Huber-clustering technique (Rogers, 1993), which requires only that the variance be independent across clusters. We estimated models in which we clustered branches both by BHC and by retail bank. We report the more conservative tests here, clustering by BHC (the results for clusters by bank are nearly identical). All confidence intervals and significance tests are reported with this correction.

Employing this technique also requires that F-tests be based on Wald test statistics (Judge et al., 1985) rather than on sums of squares.

We estimated models that adopted the “centering” strategy suggested by Jaccard, Turrisi, and Wan (1990), transforming the continuous study variables by subtracting their mean value from each score before computing the interaction term. “Centering” reduces multicollinearity without altering the structure of the relationship between the variables of interest. Since it establishes interaction terms with mean 0, it in effect allows direct interpretation in the interaction equation of the coefficients of the original variables of interest.

The first column of Table 5 displays the model with control variables only. As expected, larger banks, branches with more employees, and branches in counties with many branches (generally, densely populated urban areas) paid their CSRs more.[11] These findings, consistent with prior literature, suggest the basic structure of our model is sound and that the earnings data reported by branch managers are reasonably accurate; if the data were so noisy as to be uninformative we would be unlikely to find wages correlated with these secondary-source data.

The results in Column 2 of Table 5 do not suggest an association between automating IT and wage levels. Marginal support exists for a positive relationship between informating IT and wages ($p = .06$). Column 2 of Table 5 also indicates that although discretion is not strongly associated with wages, Q.C.s are, and that this effect is substantial. Its magnitude can be interpreted directly by exponentiating the estimated coefficient for Q.C.s and then multiplying the result by a given wage level. For example, at the mean annual earnings level of $19,533, the

[11] We also estimated models (available on request) in which an additional dummy variable indicated whether or not the branch was located in a Standard Metropolitan Statistical Area and models with more detailed local labor market characteristics, such as the county unemployment rate. Such measures added no explanatory power beyond the controls we report here and did not alter our results.

existence of a Q.C. in the branch implies $1,063 more in annual earnings. Because automation and discretion were correlated with each other, we also estimated models (available on request) in which each term was entered individually; the results did not change. An F-test shows that as a group, the four study variables contribute significantly to an explanation of variation in CSR wages.

Column 3 in Table 5 reports estimates of models that include interaction terms. Because we hypothesized that work practices would moderate the effects of technology on wages, we test for bilinear (multiplicative) interactions, in which the effect of one variable on wages varies with the value of another. To be confident that we had specified the effects properly, we also estimated models with interactions between the technology variables; between the work practice variables, and with 3- and 4-way interactions. In no cases did inclusion of these terms contribute to the fit of the model.

As Column 3 of Table 5 shows, automating IT is not significantly associated with wages. Estimates for informating IT, however, are made more precise when the moderating effects of work practices are considered. Informating is revealed to be statistically significant at the .05 level and CSRs in branches with the full range of informating technologies are predicted to earn over 7% more than CSRs in branches with none of these capabilities. Evaluated at the mean level of earnings, this amounts to a difference of nearly $1,500 annually. The effects of Quality Circles remain positive and significant in this model.

Both interaction terms involving automation are positive and significant at conventional levels. This finding strongly supports the contextualist view of the technology-wage relationship for automating IT. Q.C.s moderate the relationship between automation and wages. The estimates associated with these off-line involvement structures are consistent with a job upgrading argument. Because *Q.C.s* is a dichotomous variable, the statistical interpretation here is straightforward. In addition to the main effect that *Q.C.s* have on wages, they are associated with still higher wages in the presence of more extensive automation. Where there are no *Q.C.s*, the interaction term is equal to 0, and automation has no significant effects on wages.

Evaluating the relationship between automation and wages as moderated by discretion is slightly more complex because discretion is a continuous variable. Here we performed the analysis suggested by Jaccard, Turrisi and Wan (1990), calculating the effects of automation on wages at differing levels of employee discretion. Table 6 evaluates the effect of automation on wages at five levels of discretion. For each estimated coefficient, we also calculated an associated standard error. Table 6 shows that for low levels of discretion, higher levels of automation are associated with significantly lower wages. This finding is consistent with a deskilling interpretation for automation. At higher levels of discretion, technology and wages are associated positively, but the effects within the observed range are insignificant. The results in Table 6 are consistent with the absence of a main effect for automation in Column 2 of Table 5.

The effects of the interaction terms are both significant in a statistical sense and meaningful in terms of effect sizes. A comparison between job upgrading, neutral, and deskilling scenarios reveals the extent of these effects. When evaluated at the mean level of earnings, a job upgrading scenario, under which discretion and automation are at their respective maxima, and the branch has quality circles, predicts that CSRs will earn an additional $2,992 annually, other things equal. A neutral scenario, with discretion and automation at their centered means of 0, and no quality circles, leaves earnings at the mean of $19,533. Under a deskilling scenario, in a branch with no quality circles, discretion set at its minimum value, and automation at its maximum, the model predicts that CSRs will earn $1,299 less than the mean. Put slightly differently, the range between the extremes of job upgrading and deskilling is $4,291 in annual earnings around the mean level.

Work practices do not appear to moderate the effects of informating IT. The coefficients on both interaction terms are statistically insignificant. More use of this technology is apparently associated with higher wages regardless of the work context in which it is deployed. If the differences between the extremes in informating technologies are considered together with the scenarios outlined above, the model in Column 3 predicts up to $5,770 in annual earnings differences between the extreme cases of job upgrading and deskilling.

Worker Skills

Our empirical approach is focused on the job rather than on the worker, and thus stands as a complement to most empirical studies of the relationships between technology and wages, which consider characteristics of workers but not of jobs. The logic of our argument suggests that individual worker attributes may mediate the relationships between technology, work practices, and wages. For example, high-technology, high-involvement workplaces may employ workers with higher levels of skill.

To complement our job-based approach, we used the survey data to examine whether jobs which had substantially higher formal skill requirements commanded higher wages, and to consider whether these formal skill requirements mediated the relationships between technology, work practices, and wages. Although our cross-sectional survey data focused on jobs rather than on the characteristics of individual workers in these jobs, the data allowed us to address some questions regarding these characteristics. The survey asked for the numbers of branch CSRs in four educational categories (not finished high school, finished high school but no college, have attended or are attending college, have finished college). Because the wage data are for a "typical" CSR while the education variables indicate shares of CSRs that fall into particular categories, the education measures indicate roughly the probability that the CSR earning the "typical" wage has a given level of education. Table 7 shows that, as expected, education levels are positively associated with wages regardless of the measure. Column 1 indicates that the greater the share of CSRs that have finished college, the higher the typical wage, while Column 2 indicates that the greater the share of CSRs that have never attended college, the lower the typical wage.[12] Nonetheless, the estimates for technology and work practices from Table 5 are not substantially affected by inclusion of the measures of education. Although formal skill requirements are positively and significantly related to wages, they do not account for the differences in wages between CSR jobs with different levels of technology and high-involvement work practices. Thus, to the extent that different regimes of technology and work practices require different levels of skill, measures of formal education appear to be an imperfect proxy for such skills.

A further point regarding workers' skills is that our cross-sectional evidence demonstrates associations rather than causation. Thus our use of the terms "deskilling" and "upgrading" from the literature may be slightly misleading. The findings here indicate that particular combinations of IT and work practices are related to wage outcomes. They do not necessarily show that IT creates skill requirements. While such processes are documented in other research, processes that reverse the causal arrow are also consistent with our results. Managers, observing workers' skill levels, may choose configurations of technology or practices that are consistent with those skills.

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[12] Including both measures in the same model yields poor estimates of the effects of those measures, which are highly negatively correlated.

Most likely, as Cappelli (1993) notes, the relationships between technologies, work practices, skills, and wages emerge as the products of systems of decisions. This conjecture is consistent with qualitative evidence from Second and Third Bank. At Second Bank, the relatively high-wage CSR job is an entry-level job for which a college degree is a prerequisite. Third Bank also prefers college graduates for its CSR positions, but, perhaps not surprisingly, has some difficulty filling these positions with such workers given the low starting salaries. Third will settle for new hires who have not finished college if they have sales or customer service experience, and will also occasionally promote tellers without college degrees into the position. The sequencing of decisions around work practices, the deployment of technology, formal skill prerequisites, and wage setting for the CSR job was not readily apparent from the interviews at either bank. In both banks, wages and practices seemed to have emerged more or less contemporaneously as an outgrowth of the broader organizational strategies for the branch systems, which emphasized sales and customer service in Second Bank and cost control in Third Bank.

Discussion

Our data and analyses suggest that neither deterministic nor context-dependent accounts of technology are completely accurate. First, we argued that IT is not unidimensional. Our evidence indicates that distinct uses of IT in the workplace have different kinds of associations with wages.

We found that informating technology, in the form of data base systems designed to support more effective interactions with customers, was associated with higher wages. This finding may not be intuitive, since some features of these technologies appear to script and thereby restrict CSRs' interactions with customers. However, here it is worth reviewing what

Leidner (1993) showed: even as managers may envision scripts guiding employees' interactions with customers as instruments of control over workers, workers themselves tend to deploy these scripts as instruments through which they exercise control over customers. Such technologies may therefore require a high level of understanding if they are to be used effectively, and require high levels of responsibility or discretionary effort on the part of users. This would be consistent with findings from studies such as Noble (1984) and Brown and Duguid (1991), which demonstrate how the use of technology can result in increases in worker skill and autonomy even when it is intended to do the opposite.

The informating technology we measured was related positively to wages for CSRs regardless of the work context in which it was implemented. Our identification of this relationship may contribute to an explanation of some of the wider-ranging wage effects that previous empirical research has found for IT. It seems likely that IT that creates information is more likely to be implemented around jobs which required higher skill levels to begin with, at least in comparison with automation-focused IT. If this conjecture is true, then the net effect of the introduction of IT in the workplace will be consistent with observations of skill-biased change, as the earnings of higher-skilled workers will increase more quickly than those with lower skills.

Our evidence also suggests that work practices moderate the effects of IT designed to automate basic tasks. Automation was associated with significantly lower wages where workers have little discretionary decision-making authority. The relationship between automation and wages was not significantly positive for any observed values of discretion: the relatively limited range of discretion granted to most bank CSRs may have restricted the extent to which automation was associated with job upgrading. Where branches had off-line structures for employee involvement (here signaled by the existence of Q.C.s), however, job upgrading was associated with automation. In branches with these off-line structures, CSRs' efforts may have been directed furthest away from the mundane tasks that were replaced by automation, and toward jobs comprising more complex tasks.

More generally, our findings imply that theories regarding the impact of technology on workers should consider work practices as potentially relevant variables. The extent to which automation deskills work, for instance, may be dependent upon other choices that managers make as they deploy IT. This finding provides empirical support not only for the deskilling literature but also for contextualist ideas advanced by those more sympathetic to the upgrading argument (e.g. Hirschhorn 1984; Adler 1986; Zuboff 1988). It also suggests that further research (as in Rule and Attewell 1989) into the sources of these managerial choices is warranted.

Single-job and industry studies like this one cannot give answers to broader questions regarding the direction, magnitude, and causes of changes in the earnings distribution. Changes in wages for individual jobs are but one of two routes through which technological change is likely to have distributional implications. We have not addressed the other route here: how technology affects the distribution of jobs. The technology we studied in this context, for example, may affect employment levels most sharply in back office, data processing jobs (Adler, 1986) even as it affects the content of work in the branches where the technology is actually deployed.

Despite the limits of our study, we believe this research complements analyses of aggregate, more broadly representative data sets. We focus here on a single job in one industry, but neither the jobs nor the firms are particularly unusual. Our particular measures are context-specific, but the phenomena and relationships we have described and analyzed here could be observed in other sectors. We hope our research will spark further inquiry at both more aggregated, economy-wide levels, with more precise measures, and at more detailed levels, with richer accounts of the processes through which technology and work practices come to be associated with the effects we have identified.

During the past two decades, earnings inequality in the American labor market has increased strikingly (Freeman, 1997). Our results suggest that descriptions of "skill-biased technological changes" in the economy actually beg the questions of the drivers of those changes. Further, this term suggests a determinism that is far less consistent with our results than is an interpretation that focuses on the underlying drivers of skill biases. Policy approaches to inequality might consider these drivers. When managers adopt technologies that improve the quality of organizational information, and implement work practices in which success depends upon workers' discretionary efforts, workers are likely to earn significantly more than workers in settings where IT is used to automate basic tasks and work practices are more restrictive.

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Table 1

Descriptive Statistics and Correlations

Variable	*Mean*	*S.D.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
1. Automation	.52	.29							
2. Informating	.53	.32	.03						
3. Discretion	.53	.24	.11	.07					
4. Quality Circles	.20	.40	.01	.02	.09				
5. CSR Wage	19533.61	3807.30	-.06	.18**	-.03	.06			
6. Ln (CSR Wage)	9.86	.19	-.07	.17**	-.05	.07	.99***		
7. Ln (Assets)	15.53	1.44	.03	.30***	.18**	-.03	.33***	.32***	
8. Ln (Size)	1.95	.51	-.06	-.10	-.08	.01	.22***	.22***	-.04
9 Ln (Branch)	4.69	1.20	-.11	.03	-.08	-.11	.36***	.36***	.20***
10. Ln (ROA)	.75	.32	.01	-.04	-.12*	.04	-.11	-.08	-.06
11. Northeast	.30	.46	-.01	.16**	-.17**	-.06	.12*	.12*	.28***
12. Midwest	.31	.46	-.01	-.04	-.03	.02	.12*	.13*	-.20***
13. South	.29	.45	.05	-.15**	.12*	.01	-.19***	-.18**	-.08
14. West	.10	.29	.02	.04	.13*	.04	-.09	-.10	.00
15. Sales Focus	.36	.48	.04	.00	-.05	-.02	.13*	.13*	.19***
16. Investment Prod.	.17	.38	-.02	-.06	.08	-.01	.03	-.03	-.02

Variable	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
8. Ln (Size)								
9 Ln (Branch)	.10							
10. Ln (ROA)	-.01	-.09						
11. Northeast	-.02	.13*	.08					
12. Midwest	-.02	.12*	-.10	-.44***				
13. South	.10	-.16**	-.01	-.42***	-.43***			
14. West	-.08	-.16*	.05	-.21***	-.22***	-.21***		
15. Sales Focus	.01	.20***	-.18**	.02	.07	-.04	.08	
16. Investment Prod.	.01	.01	.07	.04	-.15	.13*	.06	.06

* p<.05; ** p<.01 *** p<.001

Table 2
Informating vs. Automating in Bank Branches

	Informate:	Does platform system support cross-selling (with prompts)?		
Automate:		NO	YES	TOTALS
Do platform terminals have capability to transfer funds from checking to savings on-line?	NO	68 Branches (22.4%)	89 Branches (29.4%)	157 Branches (51.8%)
	YES	73 Branches (24.1%)	73 Branches (24.1%)	146 Branches (48.2%)
	TOTALS	141 Branches (46.5%)	162 Branches (53.5%)	303 Branches

Figures in parentheses denote the percentages of the total number of branches that responded to these questions.

Chi-squared=1.36, p=0.24

Table 3
Comparison between branches with Quality Circles and branches without Quality Circles

Quality Circles?	Mean Automation Score	Mean Informating Score	Mean Discretion Score	Total # of Branches
No	.517	.527	.523	243 (80.2%)
Yes	.528	.540	.575	60 (19.8%)
Average Automation, Informating, and Discretion Scores for All 303 Branches	.519	.530	.533	303

All differences between groups insignificant at p<0.05.

Table 4
Automation and Discretion in Bank Branches

Table 4a
Checking Account Fees

	Discretion:	Can CSR waive fees on a checking account?		
Automate:		NO	YES	TOTALS
Do platform terminals have capability to remove fees from checking accounts on-line?	NO	75 Branches (25.1%)	91 Branches (30.4%)	166 Branches (55.5%)
	YES	44 Branches (14.7%)	89 Branches (29.8%)	133 Branches (44.5%)
	TOTALS	119 Branches (39.8%)	180 Branches (60.2%)	299 Branches

Chi-square=4.51, p=0.03

Table 4b
CD Rates

	Discretion:	Does CSR have the authority to correct a CD sold at an incorrect rate or term?		
Automate:		NO	YES	TOTALS
Do platform terminals have capability to correct a CD issued incorrectly?	NO	40 Branches (13.6%)	138 Branches (46.9%)	178 Branches (60.5%)
	YES	23 Branches (7.8%)	93 Branches (31.7%)	116 Branches (39.5%)
	TOTALS	63 Branches (21.4%)	231 Branches (78.6%)	299 Branches

Chi-square=0.29, p=0.59

Figures in parentheses denote the percentages of the total number of branches responding to these questions.

Table 5
Ordinary Least Squares Regression Results with Interactions
Dependent Variable: Ln (Typical Wage)
N=303 Retail Bank Branches

	1	2	3
Ln (Assets)	0.038*** (0.008)	0.037*** (0.008)	0.037*** (0.009)
Ln (Size)	0.079*** (0.020)	0.079*** (0.018)	0.086*** (0.020)
Ln (Branch)	0.038** (0.012)	0.039** (0.012)	0.039** (0.012)
Ln (ROA)	-0.016 (0.051)	-0.021 (0.055)	-0.022 (0.054)
Midwest	0.042 (0.040)	0.046 (0.038)	0.049 (0.037)
South	-0.043 (0.043)	-0.032 (0.040)	-0.032 (0.041)
West	-0.025 (0.056)	-0.018 (0.055)	-0.016 (0.054)
Sales Focus	0.001 (0.023)	0.002 (0.021)	0.006 (0.020)
Investment Products	-0.012 (0.030)	-0.01 (0.029)	-0.008 (0.029)
Automation		-0.018 (0.029)	-0.048 (0.036)
Informating		0.055 (0.029)	0.073* (0.030)
Discretion		-0.051 (0.048)	-0.050 (0.048)
Quality Circles		0.053** (0.020)	0.053** (0.018)
Automation X Discretion			0.283* (0.119)
Automation X Quality Circles			0.151* (0.065)
Informating X Discretion			-0.180 (0.114)
Informating X Quality Circles			-0.047 (0.050)
Constant	8.952	8.954	8.944
R-squared	0.267	0.291	0.319
F value for Wald test (comparison with previous model)		3.74*	2.76*
Prob > F		0.011	0.039

* p<.05; ** p<.01, *** p<.001

Table 6
Slope of Ln(Wages) on Automation at Varying Levels of Discretion

Level of *Discretion*	Estimated Slope of *LnWage* on *Automation*†	Associated Standard Error†††	T-statistic	P > | t |†††
Minimum -0.533	-0.199	0.075	-2.65	0.004
Low -0.240	-0.116	0.047	-2.47	0.007
Mean 0.000	-0.048	0.036	-1.33	0.185
High 0.240	0.020	0.044	0.45	0.327
Maximum 0.467	0.084	0.064	1.31	0.096

† The formula for the slope coefficient, determined by evaluating $\beta_{automation}$ at different values of discretion, is given by $\beta_{automation}$ at X = $\beta_{automation} + \beta_{(automation\ x\ discretion)}X$, where X takes on particular chosen values of *discretion*. We evaluate X at the minimum, maximum, mean, and one standard deviation below ("low") and above ("high") the mean for *discretion*.

†† As Jaccard, Turisi, and Wan (1990) show, the standard error for the coefficient at each level is given by this equation:

$$s(\beta_{automation} \text{ at } X) = [(var(\beta_{automation}) + X^2 var(\beta_{(automation\ x\ discretion)}) + 2X cov(\beta_{automation}, \beta_{(automation\ x\ discretion)}))]^{1/2}$$

††† Consistent with the hypotheses, T-tests are one-tailed (negative) for negative levels of discretion, two-tailed for discretion=0, and one-tailed (positive) for positive levels of discretion.

Table 7
Ordinary Least Squares Regression Results with Measures of Education Included
Dependent Variable: Ln (Typical Wage)

N=301 Retail Bank Branches

	1	2
Ln (Assets)	0.035*** (0.009)	0.038*** (0.010)
Ln (Size)	0.082*** (0.018)	0.084*** (0.020)
Ln (Branch)	0.036** (0.012)	0.037** (0.012)
Ln (ROA)	-0.020 (0.053)	-0.018 (0.054)
Midwest	0.048 (0.036)	0.044 (0.038)
South	-0.030 (0.040)	-0.036 (0.040)
West	-0.003 (0.051)	-0.012 (0.054)
Sales Focus	0.011 (0.021)	0.006 (0.020)
Investment Products	-0.015 (0.028)	-0.009 (0.029)
Automation	-0.041 (0.038)	-0.041 (0.038)
Informating	0.068* (0.027)	0.072* (0.027)
Discretion	-0.055 (0.048)	-0.055 (0.050)
Quality Circles	0.052** (0.019)	0.049** (0.019)
Automation X Discretion	0.267* (0.124)	0.260* (0.122)
Automation X Quality Circles	0.120 (0.068)	0.135* (0.068)
Informating X Discretion	-0.195 (0.131)	-0.172 (0.137)
Informating X Quality Circles	-0.043 (0.056)	-0.049 (0.055)
Share of CSRs that have finished college	0.094* (0.040)	-----
Share of CSRs that have never attended college	------	-0.056* (0.027)
Constant	8.961	8.961
R-squared	0.333	0.326

* p<.05; ** p<.01, *** p<.001

APPENDIX: Measures of Technology and Work Organization

All of the questions in these scales have “yes” or “no” answers. The number in parentheses besides each question denotes the percentage of “yes” responses to that question.

1) Automation Index (Cronbach’s Alpha = 0.81):

Please indicate the capability to perform each of the following functions on-line at the branch terminals:

- Open checking account (73%)
- Add name to checking account (47%)
- Account transfer from checking to savings (48%)
- Close checking account (61%)
- Stop payment on a check (67%)
- Correct a check posted incorrectly (12%)
- Remove fees from a checking account (45%)
- Change a Personal ID number (37%)
- Open CD account (69%)
- Premature Redemption of a CD (72%)
- Correct a CD issued incorrectly (39%)

2) Informating Index (Cronbach’s Alpha = 0.73):

Please indicate which of the following are available, on line, at the platform representative’s terminal:

- Cross-sell support with prompts (53%)
- Product information and pricing display (63%)
- Household inquiry (multiple accounts) (80%)

Do customers typically view their customer information on the platform representative’s terminal (42%)
Do customers typically view product features on the platform representative’s terminal (26%)

3) Customer Service Representative Discretion Index (Cronbach’s Alpha = 0.73):

Please indicate whether the platform representative has the authority to correct the following types of errors:

- Check posted twice (76%)
- CD sold at incorrect rate or term (79%)
- Incorrect ATM order information (83%)
- Loan payment not credited to an account (77%)

Can your platform representatives, at the point of sale, change rates for the following products:

- CD (22%)

Can your platform representative, at the point of sale, waive fees for the following products:

- Checking account (60%)
- Home equity loan (18%)
- Small business loan (15%)