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ABSTRACT

Data from the Current Population Surveys of October 1984, October 1989, and January 1991 were used to examine the role of computer and mathematical skills in the U.S. labor market from 1984-91. Particular attention was given to their actual and potential effect on the economic status of women. Data confirmed the overall increase in the education level of workers in the U.S. economy. Findings were as follows: college-educated women and men were equally likely to use computer skills on the job; at any other level of education, women were much more likely to use computer skills at the workplace; and the gap between men and women in the rate of computer use widened between 1984-91. The higher rate of computer use among women was a reflection of the continuing segregation of men and women across occupations and industries. Use of computers was highly correlated with use of math on the job. Regression analysis showed that the economy-wide returns to computer use ranged from 13.1 to 18.8 percent in 1991 or about 2 percentage points higher than in 1984 and that, at the level of individual workers, computer skills rewarded men and women equally well. Because women used computers at a higher rate, the gap in average earnings between men and women narrowed slightly with the spread of computers at the workplace. (Appendixes include the following: 24 references, alternative classifications of occupations, job training requirements and skill upgrades, definition of regression variables, and standard errors of parameter estimates.) (YLB)

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Mathematical and Computer Skills and Workplace Literacy in Labor Markets: An Analysis of Their Actual and Potential Effect on the Economic Status of Women

FINAL REPORT

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by

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EXECUTIVE SUMMARY

The previous decade was one of significant developments in the U.S. labor market. It was a period in which the wage premium for high-skill workers increased despite an overall increase in the supply of college graduates. This shift in the wage structure has been attributed, in part, to an increase in the demand for workers capable of utilizing new information-processing technologies such as those that are computer based. The labor market of the future will continue to require more educated workers skilled in the use of these technologies. These high-performance workers will complement the ongoing movement at the workplace away from routine production and towards more analytical activities.

This report examines the role of computer and mathematical skills in the U.S. labor market over the period 1984 to 1991. In particular, the report focuses on the actual and potential effect of the use of these skills at the workplace on the economic status of women by occupation, industry, and level of education. The research documents the distribution of workers with computer and math skills with particular regard to gender and occupations that are either expanding rapidly or are considered nontraditional for women. In addition, the research estimates the returns to using computers and math on the job by gender, occupation, industry, and level of education. Thus, the insights provided by the research are valuable for the formulation of policies designed to advance the opportunities for women in the emerging labor market.

This report finds that college-educated women and men are equally likely to use computer skills on the job. However, at any other level of education, women are much more likely than men to use computer skills at the workplace. Among those with less than a high school education, women are twice as likely as men to use a computer in today's workplace. Further, the gap between men and women in the rate of computer use widened between 1984 and 1991.

The higher rate of computer use among women is, in fact, a reflection of the continuing segregation of men and women across occupations and industries. Women are more likely than men to be employed in information-processing occupations, such as, Administrative Support, Teachers, and Computer Equipment Operators. Men, on the other hand, are more likely to be employed in traditional routine-production occupations, such as, Handlers, and Transportation and Material Moving occupations. At the same time, the disparity in the rate of computer use between information-processing and routine-production occupations is large. The 1991 data indicated, for example, that information-processing occupations require computer use at a rate four times as high as the rate required in routine-production occupations.

The outlook for computer use among women in the near future is somewhat ambiguous. Almost 60 percent of women are employed in occupations projected to grow faster than average between the years 1990 and 2005 by the Bureau of Labor Statistics (BLS). However, the probability that a woman will use a computer in these occupations is not as high as the probability that she will use one in the below-average-growth occupations. In contrast, men are just as likely as women to be employed in the fast-growing occupations, and are much more likely to use a computer in these occupations than in the slow-growing occupations. Thus, the rate of computer use among men ought to increase by more than among women in the near future if occupational growth proceeds according to BLS projections.

The use of computers was found to be highly correlated with the use of math on the job. As an older workplace skill, the use of math is much more uniform and prevalent across occupations and industries. Like computer skills, however, the use of math on the job is more prevalent among the more educated. Further, 93 percent of those using a computer on the job were also found to use mathematical skills. Thus, math and computer skills are complementary skills frequently used in tandem.

A principal goal of this research was the estimation of the economic returns to computer and math use in the U.S. labor market. Regression analysis showed that, depending upon the estimation strategy, the economy-wide returns to computer use ranged from 13.1 percent to 18.8 percent in 1991. These estimates were about two percentage points higher than the corresponding returns in 1984. The increase in the returns to computer use suggests some of both continuing excess demand for these skills and increasing productivity gains from computers. In terms of the future, the occupations projected to grow the fastest by the BLS were also found to yield a significantly higher return to computer skills than the slower growing occupations. Thus, the probability of continuing high returns to computer use remains high.

Another important question addressed in this research was whether men and women have shared equally in the benefits of computer use. The broader issue is whether the introduction of computers has contributed to the observed reduction in the gender wage gap during the 1980s. The principal finding of the regression analysis was that, at the level of individual workers, computer skills reward men and women equally well. However, because of their present distribution by occupation, women use computers at a higher rate than men. As a result, more women than men have enjoyed the benefits of the productivity gains associated with computers. On average, therefore, the earnings of women as a group have increased by more than the earnings of men as a group due to the introduction of computers. In that sense, computer use was found to have reduced the gender gap in earnings by about one to one and one-half percentage points.

The overall similarity in the returns to computer use across men and women, however, conceals considerable variations across occupations, industries, and education levels. In some occupations, Precision Production and Crafts, for example, women were found to receive much higher returns to computer use than men. The opposite was true in some other occupations, such as, Professional and Technical occupations. Similar variations were present in the returns to computer use across industries, with Nondurable Goods Manufacturing proving the most likely to yield higher returns to women relative to men. On the whole, regression analysis suggests that computers have helped reduce the gender wage gap most in occupations and industries in which women are still in the minority.

The basic findings of this report concerning the overall returns to computer use are in accordance with recently published research by Alan Krueger. In one important respect, though, the conclusions of this report differ from those of Krueger's. Krueger finds that the returns to computer use are greater for the better educated. However, this report finds that, for both sexes combined, the returns to computer use are fairly constant across education levels. For women alone, the returns to computer skills appear to be higher for the less educated, while no clear pattern emerges for men. On balance, this report concludes that the productivity gains and higher wages associated with computer use are equally accessible to all individuals, without regard to their education level. Among women. those with less than a high school level of education may stand to benefit the most from training in computers.

In summary, using computer skills benefits men and women equally well. But, because women use computers at a higher rate, the gap in average earnings between men and women has narrowed slightly with the spread of computers at the workplace. While computers have helped improve work and pay in occupations women traditionally take, the returns to computer use for women were found to be higher in occupations generally considered nontraditional for women. This suggests that if the gender gap in earnings is to narrow further, it will take a combination of policies to improve work and pay in occupations women have traditionally taken as well as to continue to improve the access of women to other occupations. Part of that effort might require the training of women in more advanced analytical computer skills.

The findings of this report suggest several avenues for further research. The returns to computer use for women were found to diminish with the level of education, while they remained more or less constant across education levels for men. This result is most likely symptomatic of more fundamental differences in the wage structure for men and women across education levels and deserves further exploration. The relative experiences for men and women with respect to computer use also need to be compared for more detailed occupational categories than considered in this report, and by type and frequency of computer use. Finally, further research is necessary to determine whether the spread of computers has had a positive impact on other labor market outcomes for women, such as employment and career stability. The effect of computer use on these outcomes may prove as important as its effect on wages.

1. Introduction

A growing body of recent economic research has noted a secular shift in the U.S. labor market towards jobs requiring greater education and analytical skills of their workers. As noted by Katz (1992/93), Krueger (1993) and Bound and Johnson (1992), the introduction of new information-processing technologies, such as computers, has contributed to the higher wage gains for the better educated workers during the 1980s.[1] Reich (1992) has studied the policy implications of the shift in the wage structure in favor of the higher-skill workers. In particular, Reich notes that global competition has different implications for workers depending upon their level of skill. High-skill workers, classified by Reich as "symbolic-analysts," have fared well, but lower-skill workers engaged in routine production have suffered from global competition. One implication of Reich's research is that the competitive advantage of a nation in the future probably rests on its ability to provide symbolic-analytic services.

This paper examines the role of mathematical and computer skills in the U.S. labor market with particular regard to their actual and potential effect on the economic status of women. Mathematical and computer skills are important examples of the symbolic-analytic skills increasingly in demand in the U.S. labor market. However,

[1]Other research of note in this area includes that by Katz and Murphy (1992), Murphy and Welch (1992), and Berndt, Morrison, and Rosenblum (1992).

except for Krueger (1993), the economic literature has paid scant attention to the issue of the returns to using these skills on the job. The rising importance of computer skills in the job market has been documented by the U.S. Department of Commerce (see Kominiski, 1988, 1991). But those reports do not address the importance of mathematical skills nor do they attempt to determine the economic returns to using computer skills. The seminal work on the returns to using computer skills is by Krueger and some aspects of this paper parallel his research. However, Krueger is not concerned with how these returns may vary across industries, occupations, and gender groups, and this report extends his work in these directions. Krueger does study the variation in the returns to computer use by level of education, but it will be shown below that his results are sensitive to the choice of an estimation strategy. Also, Krueger does not examine the role of mathematical skills in the job market. Finally, neither the Department of Commerce reports nor Krueger are specifically concerned with the importance of computer and mathematical skills in emerging jobs or in jobs that are considered nontraditional for women.

The overall research objectives of this paper are achieved by analyzing the relevant economic and demographic characteristics of the work force and the education and skill requirements by occupation and industry. The data for the research are taken from the Current Population Surveys of January 1991, October 1989, and October 1984. The use of 1991 data further extends the literature described in the preceding paragraph. Another element of the present research is the use of alternative occupational classifications that focus on emerging jobs and jobs that are considered nontraditional for women. The paper explores the importance of mathematical and computer skills in these jobs. In addition, the paper describes the economic returns to using these skills on the job and the manner in which these returns differ across occupations, industries, education level, and gender groups.

The specific issues that are addressed in the paper include the following: the extent to which mathematical and computer skills are used by occupation and industry; the economic returns to mathematical and computer skills and the variation in those returns between college and noncollege graduates and across occupations, industries, and gender groups; the contribution of mathematical and computer skills to the reduction in the gender wage gap; the characteristics of workers upgrading their job skills and the timing of the upgrading; and the types of training taken by workers to upgrade their skills.

The paper uses a two-pronged strategy to accomplish the foregoing research objectives. First, the research reports on detailed tabulations regarding specific job market attributes of women at different points in time over the last ten years. While the distribution of women by industry and occupation may be well known, less is known about how the distribution varies for women further classified by their ability to utilize new computer-based technologies or by their training in mathematics or by their level of education or by their age or job market experience. Combining these skill attributes with the occupation and industry distribution of young women, for example, leads to an understanding of whether women are prepared for the labor market of the future. Further, in comparison to similar distributions for older women and for men, it is possible to gauge the advances made by women in these directions and the areas in which further advances need to be made. The tabulations also provide insights into the extent to which mathematical and computer skills are used by industry and occupation, especially in emerging and nontraditional occupations.

Second, the research uses regression analysis to explore the impact of new technologies, such as computers, on the wages of women. The wage advantages of acquiring mathematical training are also determined via regression analysis. The regression analysis answers two types of questions. One issue is whether women skilled in the use of new technologies and possessing other technical skills, such as the ability to use mathematics, are better able to increase their earnings to a level on par with men. An affirmative answer would be evidence that the emerging technologies are a window of opportunity for women and that the labor force status of women can be considerably improved by the appropriate training. The regression analysis is also used to determine how the returns to using new technologies or related technical skills vary by industry, occupation, and the level of education of an individual. That serves to pinpoint where the best opportunities lie with respect to the acquisition of new skills and whether the returns to those skills are dependent on the general level of a worker's education.

The research bears a clear relationship to the mandate and objectives of the Women's Bureau. The labor market of the future will require more skilled and educated workers able to complement the new information-processing technologies such as those that are computer based. This research provides fresh insights into the structure of the distribution of women in the labor market, particularly with regard to their math and computer skills and whether the distribution is compatible with the emerging structure of the labor market. The research also documents the extent to which the acquisition of new skills is able to improve the economic status of women in the labor market. Further, the research ascertains the industries and occupations that are likely to yield the highest returns with respect to these skills. Thus, the insights provided by the research are valuable for the formulation of policies designed to advance the opportunities for women in the labor market.

This paper is organized as follows: a description of the data used is given in Section 2; the results of the data tabulations with respect to the use of computer and math skills are presented in Section 3; and the findings from the regression analysis regarding the returns to computer and math skills are discussed in Section 4. The main conclusions from the research are summarized in Section 5. Appendix A discusses the demarcation of commonly used occupational categories into alternative occupational classifications for the study of emerging job market skills. Appendix B contains a description of the main findings with respect to job training requirements and upgrades on the job. Appendix C provides definitions of the variables used in the regression analysis, and Appendix D reports the standard errors of the parameter estimates obtained from the regression analysis.

2. Data

The data for the research were taken from the Current Population Survey (CPS). The CPS, conducted every month by the Census Bureau, covers a sample of approximately 60,000 households every month and includes detailed data on the demographic characteristics of individuals and their current wage and employment status. In addition, the industry and occupation of an individual can be determined up to the three digit level of detail.

The CPS data used in this project are for the months of January 1991, October 1989, and October 1984. The October 1984 and 1989 CPS data contain information pertaining to the use of computers at work. The 1989 data also include information on the types of computer skills used by individuals. The January 1991 data contain information on the use of computer skills as well as the use of mathematical skills on the job. In addition, the January 1991 data include detail on the frequency with which these skills are used at work. In sum, the influence of computers in the job market can be traced through three points of time over the previous decade while the role of mathematics can only be studied for 1991.

The January 1991 CPS data also include supplemental information on job training and occupational tenure that is of value for the objectives of this project. For example, using the January 1991 CPS data, it is possible to determine the timing with which individuals upgrade their skills during the course of their careers. Information on the type of training received by individuals is also available. The January 1991 CPS data can also provide insight into the issue of workplace literacy because they contain information on the educational and skill requirements for different jobs. In addition, information is also available on whether individuals feel they are adequately trained with respect to the reading, writing, mathematical and computer skills required on their current jobs.

The CPS data for October 1984, October 1989 and January 1991 were found to contain 119,405, 113,478, and 114,234 observations respectively. The samples were trimmed to retain only those individuals of age 16 or more, and those with a job (whether or not they were at work). Further, members of the armed forces, private household workers, and those who had never worked were excluded. Data tabulations were also done to ensure that data were coded properly and/or were read properly. The final sample sizes for 1984, 1989, and 1991 are 67,982, 69,305, and 67,374 observations respectively. Those data samples form the basis for most of the tabulations reported below.

The regression analysis covers each of the three time periods separately. In other words, the data are not pooled. The sample sizes for the regression analysis are 14,217, 14,258, and 14,604 observations respectively for 1984, 1989, and 1991. These sample sizes are considerably smaller than the ones used for the tabulations.

That is because earnings data are only obtained from about one-quarter of the CPS sample (the outgoing rotation groups). Another sample of 12,999 observations was also used for analysis of the 1991 data. This (smaller) sample consists of individuals for whom information on job tenure was recorded.

In all time periods, records of individuals with unusually high or low hourly wages were eliminated from the regression sample. Hourly wages were computed as the ratio of usual weekly earnings to usual hours worked per week. If the resulting hourly wage was less than $2.50 per hour or greater than $100 per hour, that record was deleted from the sample.[2] Similarly, individuals of age greater than 65 years were not included in the regression sample. The overall result of using these criteria was the elimination of 493 observations in 1984, 350 observations in 1989, and 333 observations in 1991. The sample sizes reported above include the effect of these deletions.

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[2]In the 1984 CPS, individual weekly earnings are top coded at $999, while the top code in 1989 and 1991 is $1,923. This means that for individuals working 40 hours in a week, the effective top code on hourly wages is $25 in 1984 and $48 in 1984 and 1989. Thus, imposing a limit of $100/hour for the selection of the regression sample led to no deletions in 1984, only five deletions in 1989, and only two deletions in 1991. The choice of a lower bound of $2.50/hour was more subjective. This number is below both the current minimum wage and the minimum wage of $3.35/hour in effect during October 1984 and October 1989, and the $3.80/hour minimum in effect during January 1991. However, it is possible that in practice some individuals do work at below the minimum wage. The choice of $2.50/hour was designed to allow for that possibility without straying too far from the minimum wage or deleting too many observations. Using the minimum wage as the cutoff point would have led to the deletion of an additional 518 observations in 1984, 204 observations in 1989, and 320 observations in 1991.

3. Data Tabulations

The purpose of this section is to discuss the findings from the tabulations of the CPS data. The section first describes the overall demographic and economic characteristics of the individuals in the data samples. That is followed, in Section 3.B., by the construction of alternative occupational classifications and a discussion of how women are distributed across nontraditional and emerging occupations. Section 3.C. forms the heart of this part of the paper. That section examines the importance of computer and mathematical skills by occupation, industry, and education level. The distribution of these skills by gender and age group is also considered. The 1991 CPS data also provide an opportunity to examine the characteristics of workers according to other training requirements and skill upgrading on the job. These aspects of job requirements are described in Appendix B.

3.A. Economic and Demographic Characteristics of Sample Individuals

This section describes the basic economic and demographic characteristics of the individuals contained in the data samples extracted from the larger sets of CPS data. Since the samples are restricted to those with jobs, some sample characteristics differ from those of the overall population. On the whole, though, the sample characteristics reflect what is generally known about the composition of the labor force and the changes in that composition over time.

Tables 1 to 4 below show some broad demographic characteristics of the data samples.[3] Table 1 shows that the composition of the employed in the labor force has gradually shifted towards more women. Between 1984 and 1991, the share of women among the employed (age 16 and over) increased from 43.9 percent to 46.3 percent. Ethnic minorities also increased their share among the employed, but not by as much. Table 2 shows that the combined share of Blacks and Others increased only from 11.3 percent in 1984 to 12.6 percent in 1991.[4] Table 3 shows a significant reduction in the share of younger individuals (age 34 or less) in the employed among the labor force. Their share falls from 47.5 percent in 1984 to 42.6 percent in 1991.

The reduction in the share of the young in the labor force is consistent with the fact that individuals are spending more time in school. Tables 4(a) and 4(b) show that both males and females have increased their level of education between 1984 and 1991. Interestingly enough, while women are more likely to have a high school degree or some college education, men are more likely to have four or more years of college education. However, the percentage of women with a least four years of college has increased significantly (by 4 percentage points) between 1984 and 1991. The increase in college enrollment is, in part, in response to the increase in the wage premium for college graduates during the 1980s (Katz, 1992/93). It remains to be

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[3]The frequency distributions in all tables are based on unweighted data.

[4]In Table 2, individuals of Hispanic origin are not considered separately from Whites and Blacks. If Hispanics are moved into the Other group, Blacks and Others combine for a 16.3 percent share in 1984 and an 18.5 percent share in 1991.

TABLE 1
SAMPLE DISTRIBUTION BY GENDER (%)

	Male	Female
1984	56.1	43.9
1989	54.0	46.0
1991	53.7	46.3

TABLE 2
SAMPLE DISTRIBUTION BY RACE (%)

	White	Black	Other
1984	88.7	8.0	3.3
1989	87.8	8.7	3.5
1991	87.5	8.5	4.1

TABLE 3
SAMPLE DISTRIBUTION BY AGE GROUP (%)

	Age Group (Years)					
	16-24	25-34	35-44	45-54	55-64	65+
1984	18.6	28.9	22.9	15.7	11.0	2.9
1989	15.5	28.5	26.1	16.9	9.9	3.1
1991	14.7	27.9	27.2	17.6	9.7	2.9

TABLE 4(a)
PERCENT DISTRIBUTION OF MALES BY LEVEL OF EDUCATION

	Less than High School	High School	1-3 Years College	4+ Years College
1984	18.9	38.4	19.3	23.3
1989	16.5	38.0	20.4	25.2
1991	15.5	38.0	20.3	26.3

TABLE 4(b)
PERCENT DISTRIBUTION OF FEMALES BY LEVEL OF EDUCATION

	Less than High School	High School	1-3 Years College	4+ Years College
1984	14.5	44.6	21.4	19.5
1989	12.5	42.0	23.4	22.1
1991	11.7	41.6	23.4	23.4

Note: The level of education is defined as the highest grade completed.

seen whether the increase in college enrollment to date has offset the relative increase in demand for higher-skill workers.

Tables 5 and 6 below show the share of women in employment in broad occupational and industrial categories. Table 5 reveals that while women are just as likely as men to be in Professional Specialty occupations, that broad categorization conceals some important variations. Women are very poorly represented in Engineering and are not very likely to be Mathematical or Computer Scientists. Similarly, women are much more likely to be in Health Assessment and Treating than in Health Diagnosing. College and University Teachers are also disproportionately male while the opposite is true of Other Teachers. While women did increase their employment shares in some high skill occupations between 1984 and 1991, for example, in Health Diagnosing, the overall picture is that of little change.

The occupational segregation noted in Table 5 spills over into the share of women in industry employment (see Table 6). Thus, women are poorly represented in Agriculture, Mining, and Construction, but well represented in Retail Trade, and Hospitals and Health Services. The employment shares of women in the various industries remain unchanged between 1984 and 1991.

In summary, the data collected for this research reflect what is generally known about the characteristics of the overall labor force. The overall stability in the gender composition of occupations and industries between 1984 and 1991 is somewhat surprising. However, the gains women have made in their employment shares in Executive, Administrative, and Managerial occupations, and Professional Specialty occupations are notable.

TABLE 5
PERCENTAGE SHARE OF WOMEN IN OCCUPATIONAL EMPLOYMENT

	1984	1989	1991
Executive, Administrative, and Managerial	34.8	40.6	42.0
Professional Specialty	48.4	52.1	52.2
Engineers	6.3	8.3	7.8
Math and Computer Scientists	31.3	37.5	36.6
Health Diagnosing	11.1	19.7	18.5
Health Assessment and Treating	86.8	84.9	86.6
College and University Teachers	33.7	39.8	39.6
Other Teachers	70.4	74.3	73.0
Technicians and Related Support	48.1	49.3	51.0
Engineering and Science Technicians	20.3	20.4	21.8
Sales Occupations	49.3	49.9	49.6
Sales, Retail, and Personal Services	70.4	69.5	67.3
Administrative Support	80.7	81.3	80.3
Protective Service	13.1	15.4	12.8
Service, other than Protective	66.2	66.8	64.9
Precision Production, Craft, and Repair	8.7	8.9	8.9
Machine Operators, Assemblers, and Inspectors	42.0	41.8	41.5
Transportation and Material Moving	8.2	9.5	9.4
Handlers, Helpers, Laborers, etc.	18.8	21.3	19.3
Farming, Forestry, and Fishing	16.6	17.9	17.6

TABLE 6
PERCENTAGE SHARE OF WOMEN IN INDUSTRY EMPLOYMENT

	1984	1989	1991
Agriculture, incl. Forestry and Fisheries	20.0	23.0	22.3
Mining	12.8	16.3	15.8
Construction	8.7	9.5	9.6
Manufacturing	33.1	33.4	33.6
Durable Goods	27.2	27.6	27.8
Nondurable Goods	41.9	41.8	41.6
Transportation	22.1	25.5	26.2
Communications	44.8	44.9	48.2
Utilities and Sanitary Services	18.3	19.9	20.4
Wholesale Trade	28.1	30.0	30.0
Retail Trade	53.6	53.1	52.2
Finance, Insurance, Real Estate	58.6	59.9	60.0
Business Services	49.9	50.2	49.4
Repair Services	13.6	16.3	13.5
Personal, Entertainment, and Recreation Services	59.7	60.8	59.2
Hospitals and Health Services	77.3	78.9	78.2
Educational, Social, and Other Services	61.0	64.3	63.8
Public Administration	39.9	43.9	43.4

3.B The Distribution of Women by Alternative Occupational Classifications

This section outlines the construction of alternative occupational classes and the principal characteristics of the individuals in those occupations. The focus of the section is on occupations that are either considered nontraditional for women or are considered to be "emerging."

In this paper, nontraditional and emerging occupations are defined in three different ways. In one classification, two-digit occupations from the CPS are grouped into three broad groups based on the employment share of women in those occupations. These three occupational groups are termed "Traditionally Male," "Traditionally Female," and "Gender Neutral." Based on 1991 CPS data, Traditionally Female occupations were defined as those in which the employment share of women exceeded 50 percent, Gender Neutral occupations were those in which women had a 40 to 50 percent share in employment, and if an occupation's employment was less than 40 percent female, it was considered to be Traditionally Male. It should be noted that the overall share of women in employment was 46.3 percent in 1991. Further details on these classifications are provided in Appendix A.

A second classification groups two-digit occupations into four broad groups based on the expected growth in employment in those occupations between the years 1990 and 2005.[5] These occupational groups are termed "Fast Growth," "Above Average Growth," "Below Average Growth," and "Slow Growth." In a moderate growth scenario, the Bureau of Labor Statistics (BLS) expects economy-wide employment to increase by 20 percent between 1990 and 2005. Fast Growth occupations were defined as those in which employment growth is expected to equal or exceed 30 percent, Above Average Growth occupations are expected to grow between 20 and 29 percent, Below Average Growth occupations are expected to expand by only 10 to 19 percent, and Slow Growth occupations are expected to grow less than 10 percent, or perhaps, even shrink from their current size. Appendix A contains further details on this issue.

The final classification regroups three-digit CPS occupations into three broad groups based on their compatibility with emerging information-processing technologies. Based on the work of Porat (1977), and Osberg, Wolff, and Baumol (1989), these occupational groups are termed "Information Processing," "Information and Production," and "Production." The primary purpose of Information Processing occupations is the creation, gathering, and dissemination of knowledge and/or information. For example, Teaching is an information-processing occupation. Production occupations involve activities that directly result in the creation of a good or a service. Retail Sales and Construction Trades are examples of Production

[5]The employment projections are those of the Bureau of Labor Statistics and are described in Kutscher (1991) and Silvestri and Lukasiewicz (1991).

occupations. Some occupations, such as Lawyers, are a mixture of Information and Production activities and are classified as such. These classifications are closely related to those used by Reich (1992). For example, the symbolic-analytic occupations discussed by Reich would mostly fall into the information-processing category used here. Further details on the construction of these alternative occupational classification are also given in Appendix A.

Table 7 shows how men and women were distributed across these alternative occupational categories in 1984 and 1991. Two-thirds of women--66.4 percent--were employed in Traditionally Female occupations, whereas 64.8 percent of men were in Traditionally Male occupations in 1984. In 1991, women were more likely to be in Traditionally Male occupations, but only slightly more so. Compared to 17.2 percent in 1984, 19.5 percent of women were employed in Traditionally Male occupations in 1991. Similarly, men were slightly more likely to be found in Traditionally Female occupations in 1991.

The slight shift from Traditionally Male to Traditionally Female occupations between 1984 and 1991 is mirrored in a shift away from Production occupations and toward Information occupations. Both men and women were more likely to be found in Information occupations in 1991 with 55.3 percent of women, along with 37.2 percent of men, finding employment in that group in 1991. These two figures were up from 52.2 percent and 35.0 percent respectively in 1984.

In terms of expected growth in occupational employment, women are somewhat better positioned than men. In 1991, 29.4 percent of women were employed in Fast Growth occupations while only 17.8 percent of men were similarly employed. However, 42.4 percent of men were to be found in Above Average Growth occupations compared to only 29.1 percent of women. Therefore, in the aggregate, men and women are similarly positioned with respect to occupations expected to grow at rates exceeding 20 percent, but women are much more likely to be found in the most rapidly growing occupations.

TABLE 7
PERCENTAGE DISTRIBUTION OF MEN AND WOMEN BY ALTERNATIVE OCCUPATIONAL CATEGORIES, 1984 AND 1991

Occupation	1984			1991		
	Women	Men	Total	Women	Men	Total
Traditionally Female	66.4	16.9	38.6	64.2	18.7	39.8
Gender Neutral	16.4	18.3	17.5	16.3	17.7	17.1
Traditionally Male	17.2	64.8	43.9	19.5	63.6	43.2
Information	52.2	35.0	42.5	55.3	37.2	45.6
Information/Production	10.2	13.5	12.0	11.2	12.9	12.1
Production	37.6	51.5	45.4	33.5	49.9	42.3
Fast Growth	28.4	16.1	21.5	29.4	17.8	23.2
Above Average Growth	26.7	41.1	34.8	29.1	42.4	36.3
Below Average Growth	19.0	23.8	21.7	20.2	23.4	21.9
Slow Growth	25.9	19.0	22.0	21.2	16.4	18.6

Is the occupational distribution of younger women any different from that of older women? The answer is, yes, but not in the expected direction. Tables 8(a) and 8(b) show that, in both 1991 and 1984, younger women of age 16-24 years were much more likely to be found in Traditionally Female occupations than women of age 25 years or more. For example, in 1991, 84.3 percent of women age 16-19 years were in Traditionally Female occupations, compared to 63.6 percent of women age 25-29 years. Similarly, compared to older women, younger women were such more likely to be in Production occupations than in Information related occupations. A woman of age 25-29 years was more than twice as likely to be in an Information occupation than a woman of age 16-19 years. The most likely explanation is that Production occupations that are also Traditionally Female, such as, Health Services, Food Services, and Related Sales, serve as entry points for women into the labor force. By age 25 years, however, a "final" shape of the occupational distribution of women seems to establish itself with little, if any, change thereafter.

TABLE 8(a)
PERCENTAGE DISTRIBUTION OF WOMEN BY AGE GROUP AND ALTERNATIVE OCCUPATIONAL CATEGORIES, 1991

Occupation	Age Group										
	16-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-64	65+	All Women
Traditionally Female	84.3	72.5	63.6	61.0	60.9	63.0	62.0	61.8	61.9	62.1	64.2
Gender Neutral	7.3	13.1	15.8	17.0	16.5	16.3	18.1	18.2	19.6	19.2	16.3
Traditionally Male	8.4	14.5	20.6	22.0	22.6	20.8	19.9	20.0	18.5	18.8	19.5
Information	26.1	51.2	57.6	57.1	58.2	61.5	59.4	56.5	53.4	44.4	55.3
Information/Production	3.7	7.7	11.4	13.1	14.0	11.7	11.5	11.6	10.7	9.8	11.2
Production	70.2	41.1	31.0	29.8	27.7	26.8	29.1	32.0	35.9	45.9	33.5
Fast Growth	30.6	29.3	31.4	31.7	30.1	28.8	27.2	26.8	27.3	28.9	29.4
Above Average Growth	38.5	27.4	27.9	27.2	29.2	31.0	30.3	30.0	26.9	27.2	29.1
Below Average Growth	19.9	24.0	20.5	19.4	19.8	19.2	19.8	19.4	20.1	20.9	20.2
Slow Growth	10.9	19.3	20.3	21.8	21.0	21.0	22.7	23.9	25.8	23.0	21.2

TABLE 8(b)
PERCENTAGE DISTRIBUTION OF WOMEN BY AGE GROUP AND ALTERNATIVE OCCUPATIONAL CATEGORIES, 1984

Occupation	Age Group										
	16-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-64	65+	All Women
Traditionally Female	81.5	73.0	66.5	64.9	64.3	61.8	62.7	63.3	63.8	61.8	66.4
Gender Neutral	8.9	12.9	16.3	16.4	17.2	19.5	18.7	17.7	18.6	19.4	16.4
Traditionally Male	9.7	14.1	17.3	18.7	18.5	18.7	18.6	19.0	17.7	18.8	17.2
Information	26.4	48.5	54.8	56.2	57.1	55.9	55.3	53.6	51.6	47.9	52.2
Information/Production	2.1	7.3	12.4	13.4	11.4	11.3	10.2	9.6	9.5	9.2	10.2
Production	71.4	44.2	32.8	30.4	31.5	32.9	34.6	36.8	38.9	42.9	37.6
Fast Growth	33.1	29.5	31.9	29.5	27.6	26.6	25.5	25.0	24.8	27.3	28.4
Above Average Growth	31.9	24.9	23.8	27.8	28.8	26.8	28.3	26.9	26.4	29.4	26.7
Below Average Growth	17.9	21.5	19.2	18.9	17.9	18.6	18.3	19.1	19.7	16.2	19.0
Slow Growth	17.1	24.1	25.1	23.8	25.8	28.1	28.0	29.1	31.1	27.1	25.9

Tables 9(a) and 9(b) show a strong correlation between a woman's level of education and the probability that she will be employed in an Information occupation. In 1991, 71.1 percent of women with at least a college degree were employed in Information occupations, compared to only 20.3 percent of women with less than a high school level of education. Similarly, college-educated women are much better positioned with respect to Fast Growth and Above Average Growth occupations. Indeed, almost all college educated women--82.5 percent--were in those two groups of occupations in 1991 compared to only 49.7 percent of women with less than a high school education. Subsequent regression analysis (see Section 4 below) indicates that, the returns to computer use are also higher in the fast-growing occupations. Clearly, entry into these groups of occupations appears to be easier with a college degree. The picture with respect to Traditionally Female occupations is less straightforward. Greater education enhanced the probability of entry by women into Traditionally Male occupations in 1991 but not by much: 17.0 percent for women with less than a high school education versus 22.4 percent for women with a college degree. On the other hand, the probability of participation in Traditionally Female occupations increased for a woman up to the third year of college, where it peaked at 70.2 percent in 1991. Women who graduate from college, though, are much more likely to be in Gender Neutral or Traditionally Male occupations than women with a high school degree or only one to three years of college.

TABLE 9(a)
PERCENTAGE DISTRIBUTION OF WOMEN BY LEVEL OF EDUCATION AND ALTERNATIVE OCCUPATIONAL CATEGORIES, 1991

Occupation	Level of Education				
	Less than High School	High School	1-3 Years College	4+ Years College	All Women
Traditionally Female	53.3	67.1	70.2	58.5	64.2
Gender Neutral	29.6	14.0	10.8	19.1	16.3
Traditionally Male	17.0	19.0	19.0	22.4	19.5
Information	20.3	53.0	61.3	71.1	55.3
Information/Production	4.0	5.9	14.4	21.1	11.2
Production	75.7	41.2	24.3	7.8	33.5
Fast Growth	28.0	24.3	32.0	36.8	29.4
Above Average Growth	21.7	23.6	26.1	45.7	29.1
Below Average Growth	23.6	24.7	20.5	10.4	20.2
Slow Growth	26.8	27.4	21.4	7.2	21.2

TABLE 9(b)
PERCENTAGE DISTRIBUTION OF WOMEN BY LEVEL OF EDUCATION AND ALTERNATIVE OCCUPATIONAL CATEGORIES, 1984

Occupation	Level of Education				
	Less than High School	High School	1-3 Years College	4+ Years College	All Women
Traditionally Female	52.6	69.2	73.9	62.1	66.4
Gender Neutral	29.7	14.2	10.3	18.4	16.4
Traditionally Male	17.7	16.7	15.8	19.4	17.2
Information	19.2	50.9	59.5	71.5	52.2
Information/Production	4.0	6.1	13.9	20.1	10.2
Production	76.8	43.0	26.5	8.3	37.6
Fast Growth	29.2	24.1	30.5	35.3	28.4
Above Average Growth	19.5	22.3	24.1	45.4	26.7
Below Average Growth	20.8	22.1	19.3	10.4	19.0
Slow Growth	30.6	31.5	26.1	9.1	25.9

In sum, women have made only limited progress between 1984 and 1991 with respect to their participation in nontraditional and emerging occupations. Entry level opportunities for young women continue to be in traditional, noninformation occupations. The key for equality in terms of employment opportunities appears to be a higher level of education. In particularly, college-educated women are very well positioned with respect to occupations that are information related or expected to grow rapidly. College-educated women are also more likely to have access to Traditionally Male occupations.

3.C. The Distribution of Computer and Mathematical Skills

This section describes the economic and demographic characteristics of individuals using computer and mathematical skills at their place of work. The use of computer skills is traced over all three time periods--1984, 1989 and 1991. Data on the use of mathematics are available only for 1991. Estimates of the returns to using these skills are given in Section 4.

3.C.1. The Use of Computer Skills

Table 10 reveals that women are more likely than men to use a computer on the job.[6] That is true for any age group in any year. The higher rate of use of computers by women is in the main a reflection of the gender composition of the work force by occupation and industry (see the discussion on Tables 12 and 13 below). What is more interesting is that the gap between men and women in the rate of computer use has widened by almost 4 percentage point since 1984. The most likely explanation for this fact is the rapid spread of computers in information-related occupations (see Table 14 below). As shown in Section 3.B. above, women are much more likely than men to be employed in those occupations. A second issue that arises in this context is whether the increased use of computers by women, particularly in relation to the use of computers by men, has played a role in the narrowing wage gap between men and women over the previous decade. This issue is examined more carefully in Section 4 below.

[6]Not all individuals responded to the question on computer use. The nonresponse rate was 5 percent in 1984 and 1989 and 22 percent in 1991. The very high nonresponse rate in 1991 is probably due to the phrasing of the question. In 1984 and 1989, individuals were only asked whether or not they used a computer at work. In 1991, the question referred to frequency of use, something the interviewed person is less likely to know with regard to other working members of the household. The percentage rates of computer (and math) use reported in this paper have not been adjusted (i.e., renormalized) to reflect the nonresponse rate.

TABLE 10
PERCENT OF SAMPLE USING A COMPUTER AT WORK BY GENDER AND AGE GROUP

Age Group	Male			Female		
	1984	1989	1991	1984	1989	1991
16-19	4.0	8.3	10.6	13.5	18.5	21.7
20-24	14.0	21.0	23.8	29.6	43.7	42.0
25-29	22.2	30.7	33.2	35.5	47.3	51.6
30-34	24.0	34.4	37.3	33.1	46.9	50.6
35-39	26.5	37.0	40.4	30.6	45.4	50.5
40-44	24.5	37.5	41.6	25.9	43.8	50.7
45-49	20.1	34.8	39.3	23.0	39.8	46.1
50-54	18.5	28.3	33.2	22.2	35.7	41.5
55-64	13.9	22.3	28.8	19.0	28.2	34.8
65+	5.1	10.3	16.4	7.1	15.3	19.9
All Ages	19.3	29.5	33.6	27.0	40.3	45.1

TABLE 11
PERCENT OF SAMPLE USING A COMPUTER AT WORK BY GENDER AND YEARS OF EDUCATION

Schooling	Male			Female		
	1984	1989	1991	1984	1989	1991
Less than high school	3.6	5.4	7.3	6.5	9.8	14.2
High school	11.3	18.5	23.0	25.5	36.8	40.0
College: 1-3 years	24.5	35.9	40.1	33.9	50.1	52.9
College: 4+ years	40.8	56.6	59.5	37.9	53.8	61.6

Computer use is directly related to an individual's general level of education (Table 11). The 1991 data show that women are almost twice as likely to use a computer than men among those with no more than a high school education. It is only among college graduates that women and men use computers at a similar rate. One possible implication of this fact is that any reductions in the gender wage gap due to computer use may be unevenly spread across groups with different levels of education.

Table 12 shows that the occupational segregation of men and women is an important reason why women use computers at a much higher rate.[7] Two points emerge from Table 12. First, the use of computers depends considerably upon the type of occupation. Second, men are disproportionately located in occupations with a rate of computer use less than 25 percent in 1991. Indeed, 50.3 percent of men were working in those occupations compared to only 27.4 percent of women. The occupational distribution of men also helps explain why men with no more than a high school education use computers at a dramatically lower rate than women. While not to the same extent of the occupational distribution, men also appear to be more concentrated in industries where computer use is not as important. The relevant data are shown in Table 13.

[7]For the sake of brevity, Tables 12 and 13 present data for 1991 only, the latest of the three time periods. The same pattern holds for 1984 and 1989.

TABLE 12
THE RATE OF COMPUTER USE AND GENDER DISTRIBUTION BY OCCUPATION, 1991

	% Rate of Computer Use	% Distribution	
		Male	Female
Executive, Administrative & Managerial	59.2	14.1	11.8
Professional Specialty	58.3	12.6	16.0
Technicians and Related Support	62.7	3.0	3.7
Sales Occupations	40.2	11.4	13.0
Administrative Support	61.1	5.9	27.7
Protective Service	31.7	2.7	0.5
Service, other than Protective	9.3	7.5	16.0
Precision Production, Craft & Repair	21.5	19.1	2.2
Machine Operators, Assemblers & Inspectors	16.8	7.1	5.9
Transportation and Material Moving	10.3	6.9	0.8
Handlers, Helpers, Laborers, etc.	11.4	5.5	1.5
Farming, Forestry and Fishing	10.3	4.2	1.0
		100.0	100.0

Note: The rate of computer use is the percent of individuals within an occupation reporting the use of a computer. The gender distribution shows how men and women are distributed across occupations.

TABLE 13
THE RATE OF COMPUTER USE AND GENDER DISTRIBUTION BY INDUSTRY, 1991

	% Rate of Computer Use	% Distribution	
		Male	Female
Agriculture, incl. Forestry & Fisheries	15.1	4.1	1.4
Mining	31.8	1.1	0.3
Construction	15.4	9.9	1.2
Manufacturing	38.2	21.6	12.6
Transportation	30.9	6.1	2.5
Communications	67.7	1.3	1.4
Utilities & Sanitary Services	48.5	2.1	0.6
Wholesale Trade	43.4	4.9	2.4
Retail Trade	27.8	15.0	19.0
Finance, Insurance, Real Estate	64.6	5.1	8.9
Business Services	45.9	4.2	4.7
Repair Services	19.0	2.9	0.5
Personal, Entertainment & Recreation Services	19.1	3.5	5.8
Hospitals & Health Services	43.3	3.4	14.2
Educational, Social & Other Services	49.9	9.8	20.0
Public Administration	60.1	5.1	4.5
		100.0	100.0

Note: The rate of computer use is the percent of individuals within an industry reporting the use of a computer. The gender distribution shows how men and women are distributed across industries.

It should be noted, however, that while women are concentrated in occupations with a high rate of computer use, these occupations are often support-type occupations rather than primary decision-making occupations. For example, almost 28 percent of women are located in Administrative Support occupations. Similarly, 16 percent of women are in Professional Speciality occupations, but as noted earlier in Table 5, women in this broad occupational group are more likely to be found in supportive roles, such as, Health Assessment, rather in primary activities, such as, Health Diagnosing.[8]

The gender segregation of occupations was also noted in Section 3.B. above in the context of a discussion of nontraditional and emerging occupations. Table 14 shows the rate of computer use in 1984 and 1991 in these alternative occupational groups. The data in Table 14 show clearly that computer use is much more likely in Traditionally Female occupations and in Information occupations. The information-related occupations also registered the largest percentage-point increases in the rate of computer use between 1984 and 1991. Because women are better represented in these occupations, the data in Table 14 also help explain why the gap in the rate of computer use between men and women has widened since 1984.

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[8]Another implication of the gender segregation of occupations is that computers may be used in different ways by men and women. In other words, men may be more likely to use computers for sophisticated analytical needs while women may use computers more for routine functions, such as, word processing. Whether or not the returns to computer use vary by type of computer skill is a worthy subject for future research

Tables 12 and 14 make clear that the rate of computer use varies significantly across occupations. Computer skills are clearly in greatest demand in information-related occupations and in occupations expected to grow rapidly in the near future. However, just as the type of job affects computer use, so does the industry in which that job is located. Table 15 shows the rate of computer use by occupation and industry. If a job has a high rate of computer use, for example, Executive and Managerial jobs, the probability of using a computer in that job remains high within any industry but not uniformly so. While 78 percent of Executives in Communications industries are using computers, only 37 percent of Executives in Construction are likely to use a computer. That is because as an industry, Communications, is more than four times as likely to require computer use than the Construction industry. Thus, just as occupations, industries also vary in their intensity of information processing and that affects the rate of computer use in similar occupations across industries.

TABLE 14
THE PERCENTAGE RATE OF COMPUTER USE BY ALTERNATIVE OCCUPATIONAL CATEGORIES, 1984 AND 1991

Occupation	1984			1991		
	Women	Men	Total	Women	Men	Total
Traditionally Female	29.9	27.4	29.3	47.7	40.8	46.0
Gender Neutral	18.3	19.5	19.0	33.8	33.7	33.8
Traditionally Male	23.8	17.1	18.3	45.7	31.5	34.5
Information	43.1	38.6	41.1	62.7	55.8	59.7
Information/Production	22.8	20.3	21.3	47.6	41.5	44.1
Production	5.6	5.9	5.8	15.0	15.1	15.1
Fast Growth	20.3	28.1	23.6	37.8	42.3	39.7
Above Average Growth	24.8	23.5	24.0	47.3	39.8	42.6
Below Average Growth	38.8	13.8	23.4	51.1	24.5	35.9
Slow Growth	27.9	9.5	19.0	46.2	21.1	34.4

TABLE 15
COMPUTER USE BY INDUSTRY AND OCCUPATION, 1991
(Percent)

	Exec.	Prof.	Tech.	Sales	Admin. Support	Prot. Serv.	Other Serv.	Prodn., Craft	Operators	Trans.	Other Labor	Farm	Total
Agriculture	37.1	40.4	*27.3	*25.0	50.8	*0.0	*0.0	2.9	*0.0	*0.0	*0.0	10.5	13.4
Mining	60.6	66.7	59.1	*60.0	56.3	*0.0	*0.0	18.5	*20.0	4.4	14.3	*0.0	31.8
Construction	36.7	54.9	52.5	36.1	49.6	*0.0	*5.3	8.2	3.3	3.1	3.7	*0.0	15.4
Manufacturing: Durable Goods	61.4	75.5	75.7	52.4	64.0	41.7	11.6	32.0	17.5	9.6	14.0	4.7	39.8
Manufacturing: Nondurable Goods	66.4	72.2	69.2	40.9	60.5	14.3	6.3	28.9	17.4	17.3	9.6	*14.3	36.0
Transportation	60.1	58.0	63.5	52.1	43.5	*26.3	28.0	28.3	15.6	11.3	13.9	*0.0	31.0
Communications	77.7	64.8	64.2	67.2	76.6	*0.0	*20.0	54.4	*66.7	*40.0	*33.3	—	67.7
Utilities	74.0	68.5	65.0	*55.6	70.8	*0.0	*21.1	33.7	25.7	7.5	7.8	*0.0	48.5
Wholesale Trade	60.0	64.3	*58.8	47.4	58.7	*0.0	20.0	26.9	7.8	15.4	22.8	*0.0	43.4
Retail Trade	40.9	57.1	63.9	32.7	53.2	18.4	9.5	21.5	13.7	11.6	12.4	*14.3	27.8
Finance, Insurance, Real Estate	67.0	77.1	78.2	65.3	71.0	17.9	5.2	20.9	*25.0	*10.0	*7.1	6.3	64.6
Business & Repair Services	57.6	63.1	65.3	47.8	57.6	10.8	4.2	15.8	18.5	7.7	4.8	*20.0	38.2
Personal Services	42.7	26.2	*37.5	16.2	50.7	*21.4	7.6	12.9	7.1	8.0	*0.0	*0.0	17.2
Entertainment & Recreation Services	51.1	22.6	*22.2	24.6	56.3	*0.0	7.7	11.4	*11.1	*0.0	*28.6	7.8	24.4
Hospitals	71.1	60.5	61.3	*40.0	72.4	23.8	17.8	43.4	28.6	*50.0	*16.7	*0.0	53.8
Other Medical Services	53.0	34.8	43.9	*33.3	54.4	—	12.1	18.2	5.9	*9.1	*0.0	*0.0	32.9
Educational Services	67.5	63.2	64.6	22.2	57.6	14.9	4.9	18.2	*25.0	3.7	*27.8	*5.9	52.8
Social Services	42.3	30.5	*56.3	*38.5	54.5	*0.0	6.5	*25.0	2.1	*5.6	*0.0	*0.0	25.8
Other Services	71.7	52.2	64.2	36.7	63.3	*6.3	6.3	*31.3	*28.6	*16.7	*0.0	*0.0	56.1
Forestry & Fisheries*	70.0	60.0	*100.0	*100.0	*85.7	*33.3	*33.3	*0.0	*33.3	*50.0	*0.0	18.3	39.3
Public Administration	69.1	69.6	70.1	*53.3	70.3	43.0	13.2	36.1	*55.6	8.8	26.1	*20.0	60.1
Total	59.2	58.3	62.7	40.2	61.1	31.7	9.3	21.5	16.8	10.3	11.4	10.3	38.9

Note: Asterisks indicate that fewer than 20 observations were available for that cell.

3.C.2. The Use of Mathematical Skills

Unlike the use of computers, data on the use of mathematical skills are available only for 1991. Not surprisingly, math use is far more prevalent than computer use. Table 16 shows that more than 60 percent of men and women reported using math on their jobs. Women are only slightly more likely than men to use math. Like computer use, the need to use mathematical skills is highest for persons between ages 25 and 54. Similarly, math use was found to increase with an individual's overall level of education (see Table 17). Three-quarters of those with a college degree are likely to use math on their jobs, compared to only 40.1 percent of those without a high school degree. There is also a high degree of correlation between math and computer use. Table 18 shows that 39 percent of the 1991 CPS sample reported using a computer at work. Virtually all of them--36 percent of the sample--also reported using math on the job. In other words, 93 percent of those using a computer on the job are also likely to need mathematical skills. Similarly, 58 percent of those using math on their jobs also use computers.

TABLE 16
PERCENT OF SAMPLE USING MATH AT WORK
BY GENDER AND AGE GROUP, 1991

Age Group	Male	Female
16-19	36.5	49.9
20-24	48.8	59.7
25-29	62.1	67.5
30-34	65.2	69.6
35-39	66.2	68.4
40-44	66.1	68.1
45-49	62.7	66.7
50-54	61.0	63.0
55-64	59.6	59.9
65+	55.1	51.4
All Ages	60.7	64.8

TABLE 17
PERCENT OF SAMPLE USING MATHEMATICS ON THE JOB
BY GENDER AND YEARS OF EDUCATION, 1991

Schooling	Male	Female	Total
Less than high school	38.5	42.7	40.1
High school	58.6	62.3	60.4
College: 1-3 years	66.0	69.6	67.8
College: 4+ years	72.8	75.6	74.1

TABLE 18
PERCENT DISTRIBUTION OF SAMPLE BY MATHEMATICS AND COMPUTER USE, 1991

Math Use	Computer Use: No	Yes	No Response	Total
No	13.14	2.67	0.03	15.84
Yes	26.26	36.13	0.24	62.63
No Response	0.15	0.15	21.24	21.54
Total	39.55	38.95	21.51	100.00

Tables 19 and 20 show how math use varies across occupations and industries. As expected, math use is highest among professional occupations. Somewhat unexpected is the finding that even occupations such as Handlers, Helpers and Laborers require a fairly high rate of math use. Similarly, Table 20 shows that math use permeates all industries. Most industries require over 60 percent of its employees to use math. As is the case with computers, math use is highest among information-processing occupation (see Table 21). However, there is little difference between men and women in the rate of math use across Traditionally Female and Traditionally Male occupations. Somewhat surprisingly, the rate of math use is relatively low in the Fast Growth occupations. That is most likely due to the presence of Production occupations such as Health Services, Personal Services, and Food Services in the Fast Growth category.

A limitation of the data on math use is that it is not possible to trace changes in the requirements for math skills over time. The data also do not permit precise controls for the quality of math skills required on the job. However, the regression analysis is able to make some correction for the quality issue by controlling for an individual's overall level of education.

TABLE 19
THE RATE OF MATH USE BY OCCUPATION, 1991

	% Rate of Math Use
Executive, Administrative & Managerial	76.5
Professional Specialty	73.2
Technicians and Related Support	73.6
Sales Occupations	70.8
Administrative Support	67.7
Protective Service	48.4
Service, other than Protective	38.5
Precision Production, Craft & Repair	62.8
Machine Operators, Assemblers & Inspectors	48.3
Transportation and Material Moving	49.5
Handlers, Helpers, Laborers, etc.	40.3
Farming, Forestry and Fishing	56.0

TABLE 20
THE RATE OF MATH USE BY INDUSTRY, 1991

	% Rate of Math Use
Agriculture, incl. Forestry & Fisheries	61.0
Mining	59.1
Construction	62.7
Manufacturing	61.0
Transportation	56.4
Communications	66.4
Utilities & Sanitary Services	71.3
Wholesale Trade	68.6
Retail Trade	61.3
Finance, Insurance, Real Estate	72.6
Business Services	58.1
Repair Services	58.6
Personal, Entertainment & Recreation Services	48.1
Hospitals & Health Services	60.2
Educational, Social & Other Services	66.7
Public Administration	69.2

TABLE 21
THE PERCENTAGE RATE OF MATH USE BY
ALTERNATIVE OCCUPATIONAL CATEGORIES, 1991

Occupation	Women	Men	Total
Traditionally Female	66.8	60.1	65.1
Gender Neutral	51.6	55.7	53.9
Traditionally Male	69.2	62.3	63.8
Information	73.5	72.3	72.9
Information/Production	70.7	69.4	70.0
Production	48.6	50.0	49.4
Fast Growth	61.1	57.7	59.7
Above Average Growth	75.1	68.7	71.1
Below Average Growth	57.2	51.2	53.8
Slow Growth	63.1	56.9	60.2

4. The Returns to Using Computer and Mathematical Skills

This section discusses the results of the regression analysis designed to estimate the economic returns to using computer and mathematical skills on the job. The first issue addressed by the regression analysis is the overall size of the return to using computer and math skills at work. Since most individuals who use math on the job also use computers, the regression analysis is also used to isolate the gains from using any one of these skills from the returns to using the other skill. Next, the regression analysis is used to determine how the returns to using math and computer skills vary by industry, occupation, and level of education. The final issue addressed by the regression analysis is whether the returns to using computer and math skills vary by gender. Do women receive the same returns as men from the use of computer and math skills or is there a gender gap implicit in the emerging workplace technologies? If returns to these skills vary by industry, occupation, and level of education, do they vary in the same fashion for both men and women? These important issues are analyzed in Section 4.D. The discussion of the basic regression analysis begins in Section 4.B, while preliminary evidence on the returns to math and computer use is presented first in Section 4.A.

4.A. Preliminary Evidence on the Returns to Computer and Mathematical Skills

This section describes preliminary evidence on the returns to using computer and math skills at work. The evidence is only indicative of the actual returns because controls are not maintained for all of the demographic and economic characteristics that influence earnings. More precise results on the returns to computer and math skills are obtained from the regression analysis. Nonetheless, the qualitative aspect of the evidence presented in this section is striking.

Charts 1 to 3 show the hourly wage for persons using computers versus those not using computers on the job for 1984, 1989 and 1991.[9] The hourly wages were computed by age group. For example, age 30 on the chart corresponds to the age group 30-34 years. Chart 1 shows clearly that regardless of age or gender, computer users earned more than noncomputer users in 1984. Exactly the same pattern is revealed for 1989 and 1991 by Charts 2 and 3.

Charts 1 to 3 are derived from cross-section data, but the age of individuals can be used as a proxy for the passage of time. In other words, the difference in wages between age groups 20-24 years and 30-34 years may be taken to represent what

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[9]Hourly earnings of those who did not respond to the question on computer use correspond closely to the earnings of those who reported not using a computer. That is evidence, albeit limited, that nonresponse to the question is indicative of nonuse of computers.

Chart 1

1984
HOURLY WAGE BY AGE, GENDER AND COMPUTER USE

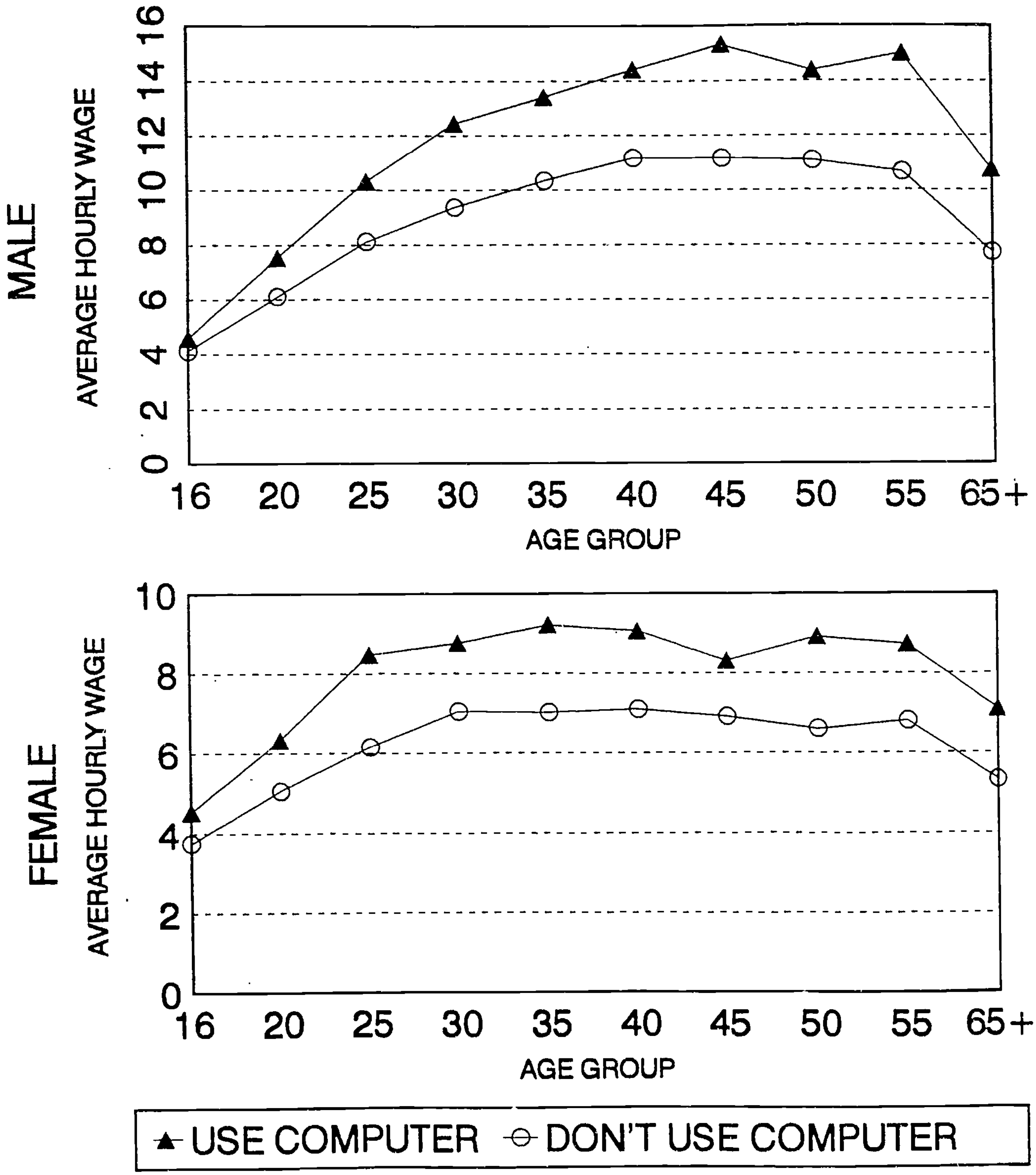


Chart 2

1989
HOURLY WAGE BY AGE, GENDER AND COMPUTER USE

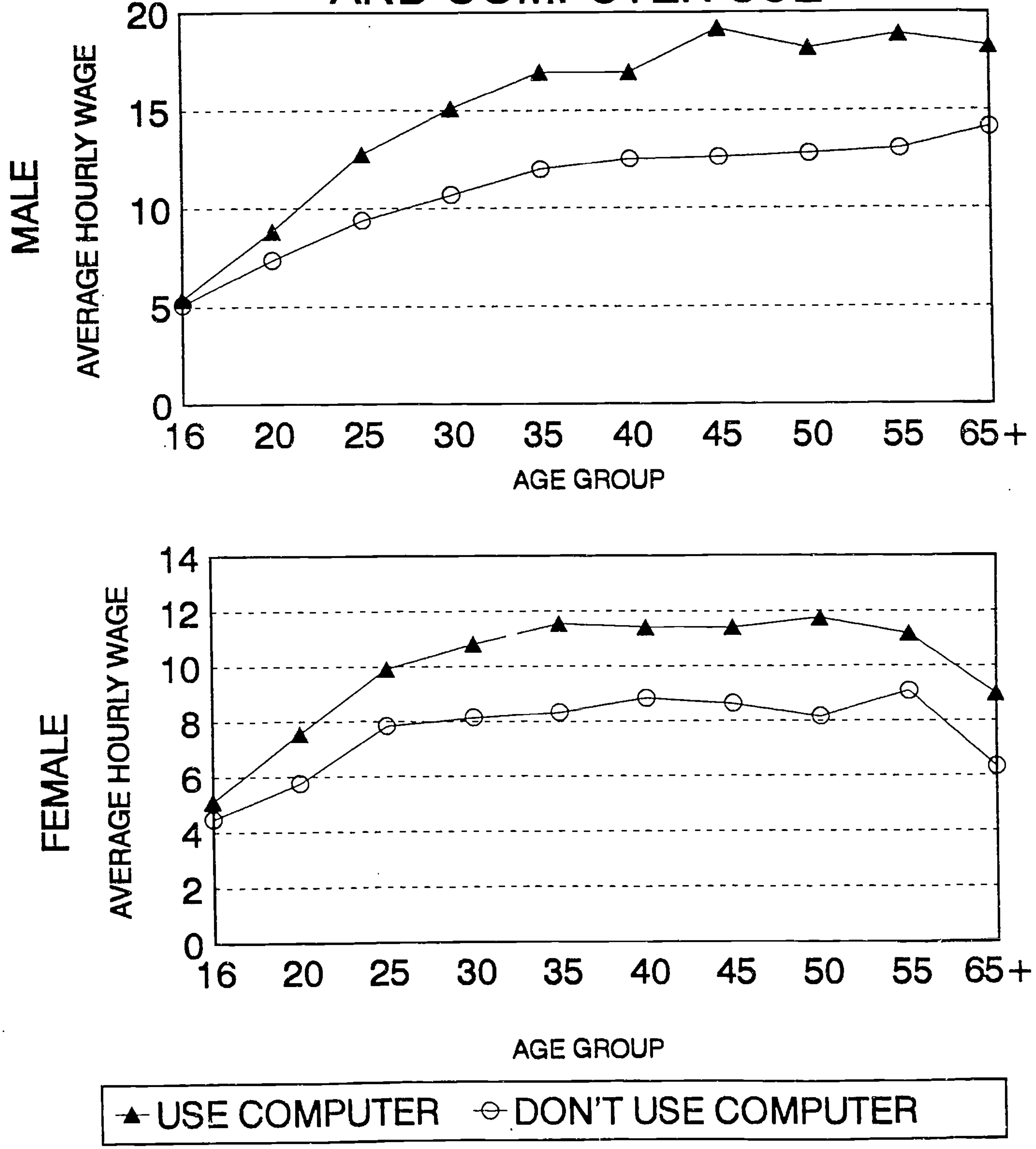
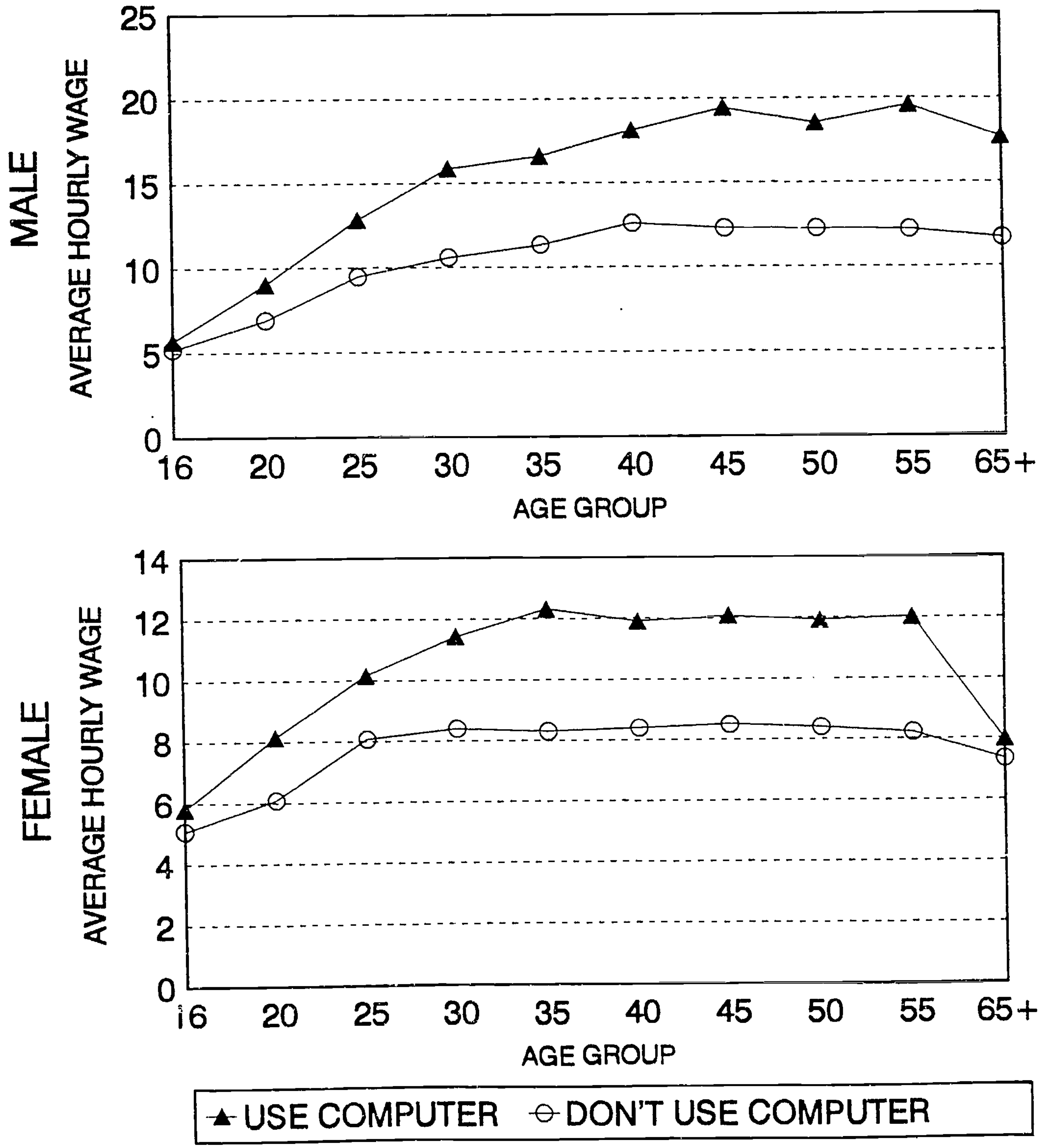


Chart 3

1991

HOURLY WAGE BY AGE, GENDER AND COMPUTER USE



might happen to the wage of a single individual over the course of 10 years as that individual ages from, say, 20 to 30 years. By that token, the evidence in Charts 1 to 3 shows that while the initial returns to using computers are low, the wages of those who use computers on the job increase at a much faster rate over time than the wages of those without computer skills. The 1991 data in Chart 3 indicate, for example, that wages of women who use computers rise faster for about 20 years--from age 16 to 35 years--into the career path.

The percentage increase in wages associated with computer use is fairly large. Further, the gap in wages between computer and noncomputer users has increased over time. The evidence is presented in Table 22. In 1984, women who used computers on their jobs earned an average of 31.6 percent more than women who did not use a computer. That gap had increased to 35.6 percent by 1989 and 40.9 percent by 1991. Men using computers earned an average of 39.3 percent more than noncomputer users in 1984. That gap stood at 46.8 percent in 1989 and 55.9 percent in 1991. Thus, the raw data indicate that men earn a higher return to computer use than women. This issue is explored in greater detail in Section 4.D.

Because the gap in wages between computer and noncomputer users has grown over time, the possession of those skills proved to be a good hedge against inflation over the period 1984-91. As Table 23 shows, only computer users were able to maintain their real income between 1984 and 1991.[10] Women experienced better wage growth than men, whether or not they used computers. The relatively fair wage performance of women who did not use computers may explain in part why computer using women did not increase their advantage in earnings at the same pace as men.

TABLE 22
PERCENTAGE DIFFERENCE IN WAGES BETWEEN COMPUTER USERS AND NONCOMPUTER USERS

	Male			Female		
Age Group	1984	1989	1991	1984	1989	1991
16-19	11.2	5.3	8.9	20.5	14.1	14.4
20-24	23.1	20.1	30.4	25.2	31.5	33.9
25-29	27.3	36.4	35.4	37.7	26.4	25.9
30-34	32.8	41.4	49.9	24.1	33.0	36.2
35-39	29.7	41.7	46.4	31.2	38.7	48.4
40-44	28.9	35.7	43.6	27.5	29.3	41.9
45-49	37.1	52.5	58.4	20.1	32.2	42.1
50-54	29.5	42.2	51.2	35.0	44.2	42.1
55-64	40.4	44.9	60.3	28.1	23.1	46.5
65+	39.3	29.4	51.3	33.2	42.1	8.7
All Ages	39.3	46.8	55.9	31.6	35.6	40.9

[10]Inflation was measured by the CPI-U.

TABLE 23
REAL WAGE GROWTH, 1984-1991
(Average Annual Growth in %)

Age Group	Male: Computer Users	Male: Noncomputer Users	Female: Computer Users	Female: Noncomputer Users
16-19	-0.81	-0.51	-0.03	0.44
20-24	-1.26	-2.06	-0.27	-1.23
25-29	-0.74	-1.62	-1.27	0.00
30-34	-0.39	-2.09	-0.08	-1.39
35-39	-0.83	-2.53	0.27	-1.48
40-44	-0.60	-2.11	0.03	-1.49
45-49	-0.45	-2.48	1.48	-0.92
50-54	-0.21	-2.39	0.28	-0.45
55-64	-0.04	-1.91	0.71	-1.21
65+	3.30	2.09	-2.21	0.67
All Ages	-0.13	-1.71	0.29	-0.68

Chart 4 and Table 24 appear to indicate that strong wage gains are associated with the use of math on the job. For example, Table 24 shows that, in 1991, men who used math earned an average of 50.2 percent more than men who did not use math. Similarly, women who used math made an average of 34.2 percent more. However, recall that there is a high degree of correlation between the use of math and computers on the job (Table 18 above). Therefore, it is possible that a large share of the wage gain attributed to the use of math may actually be due to the use of computers on the job. The data in Table 25 provide evidence on this point.

Chart 4

1991

HOURLY WAGE BY AGE, GENDER AND MATH USE

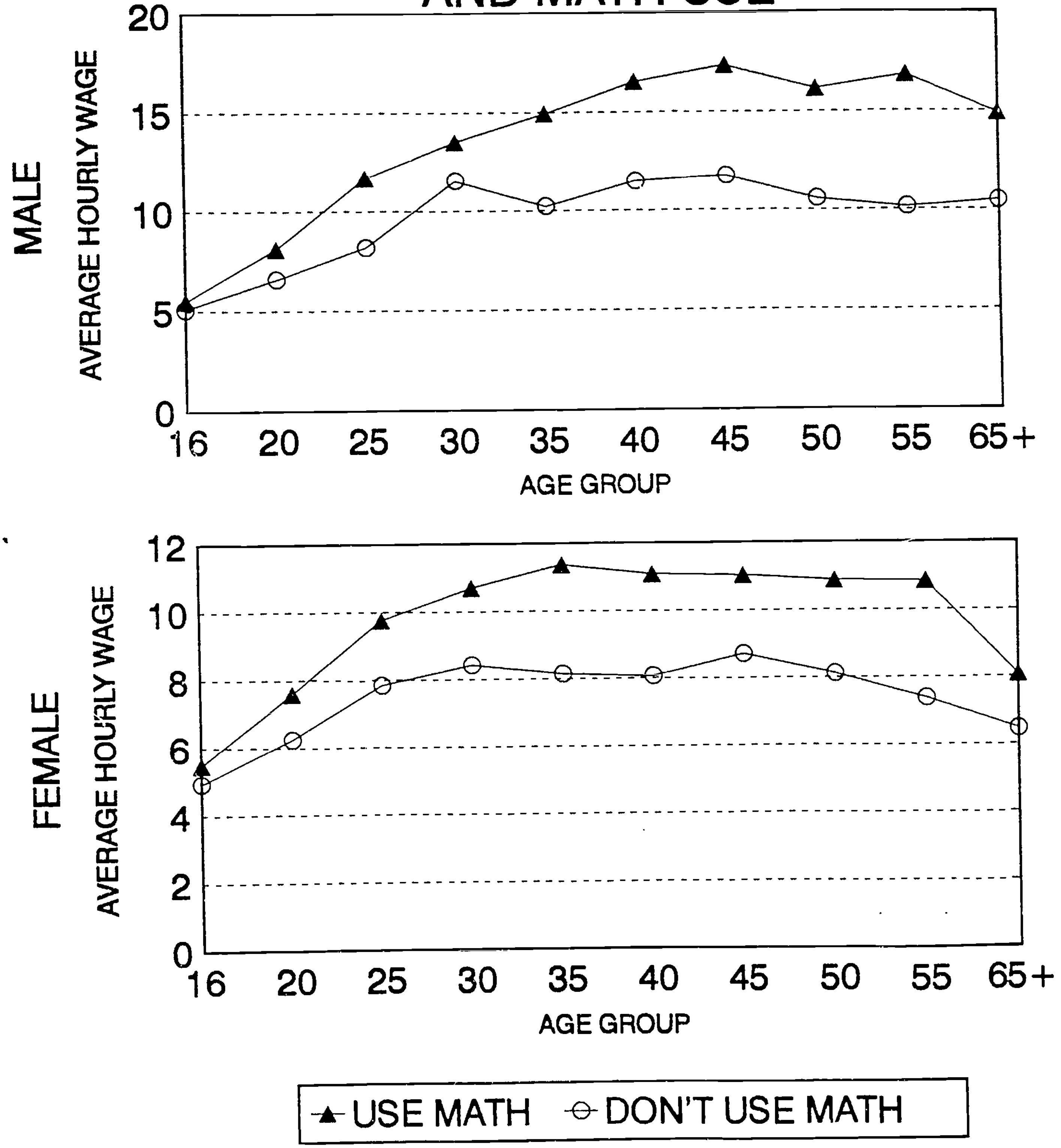


TABLE 24
PERCENTAGE DIFFERENCE IN WAGES BETWEEN MATH USERS AND NONMATH USERS, 1991

Age Group	Male	Female
16-19	8.1	11.2
20-24	23.0	21.3
25-29	42.7	24.5
30-34	17.3	27.0
35-39	46.2	39.5
40-44	44.2	37.5
45-49	47.7	26.8
50-54	53.0	34.0
55-64	66.0	46.8
65+	42.7	24.7
All Ages	50.2	34.2

Table 25 is based on the division of the 1991 sample according to whether individuals used both computers and math, computers only, math only, or neither.[11] As expected, the highest wages are earned by those who used both computers and math on their jobs. Those women who used both skills earned an average of 39.4 percent more than those who used neither skill on the job. For similar men, the wage gain was 52.8 percent. Those using computers only also earned impressive returns--25.5 percent for women and 33.6 percent for men. However, the gains to using

[11]The "neither" group includes those who did not respond to the question since the wages of nonrespondents were very similar to those who used neither math or computers.

math only are relatively small--5.6 percent for women and 7.0 percent for men. In summary, the data in Table 25 indicate that math and computer use are complementary skills and when used in combination have the potential of delivering large wage gains. Even when used in isolation, computer and math skills remain valuable, but the former is far more rewarding than the latter. This issue is also explored further as part of the regression analysis.

TABLE 25
THE PERCENTAGE DIFFERENCE IN WAGES ASSOCIATED WITH MATH AND/OR COMPUTER USE, 1991

	Male			Female		
Age Group	Computer & Math	Computer Only	Math Only	Computer & Math	Computer Only	Math Only
16-19	11.4	-4.3	3.5	18.7	44.6	13.1
20-24	28.6	20.1	4.0	28.4	22.0	0.8
25-29	34.8	-12.0	4.1	20.6	8.0	0.2
30-34	37.9	73.2	0.3	32.3	27.2	2.4
35-39	39.6	32.9	3.7	39.3	26.9	0.7
40-44	41.4	37.7	7.3	41.5	25.7	7.0
45-49	44.5	21.6	-3.3	32.4	23.2	-2.3
50-54	42.4	37.6	2.8	37.6	26.6	3.0
55-64	54.3	17.1	5.2	47.2	21.6	12.3
65+	89.6	-5.6	27.5	2.0	-4.2	2.5
All Ages	52.8	33.6	7.0	39.4	25.5	5.6

Note: The percentage gains were computed relative to the group of individuals who used neither math nor computers in their jobs.

4.B. Regression Analysis of the Overall Returns to Computer and Math Skills

This section presents the results of the regression analysis designed to estimate the overall returns to computer and math skills. The preceding section had noted the presence of large wage gains associated with the use of these skills on the job. However, part of the wage difference between computer and math users and those who do not use those skills is undoubtedly due to differences in the economic and demographic characteristics of the two groups of individuals. For example, computer and math users are more likely to be better educated. Thus, the wage differences noted in Section 4.A are partly a reflection of the difference in education levels between the users and nonusers of computers and math skills. The regression analysis controls for all observable differences across individuals with respect to the economic and demographic attributes that are known to affect earning levels. In this manner, it is possible to isolate that part of the wage difference across individuals that is due to computer and/or math use at the place of work.

The question addressed in this section is whether men and women who use math and computer skills on their jobs earn more than otherwise-similarly-qualified men and women in the same jobs.[12] The regression design chosen to explore this question

[12]The bulk of Section 4.B complements the research of Krueger (1993). The regression strategy in this section is also similar to that used by Krueger. Krueger has researched the possibility that computer users may differ from noncomputer users in a systematic way across unobservable human capital characteristics. In other words, it may be the case not only that computer and/or math use leads to higher wages, but

is similar to that used in related literature (see, for example, Asher and Popkin, 1984). The regression consists of a single equation with the logarithm of the hourly wage serving as the dependent variable and a set of human capital variables serving as the independent variables.[13] Estimates of the returns to using math and computer skills are obtained by the technique of inserting dummy variables on the right-hand side of the regression equation.

The basic regression equation can be written as follows:

(1) $\ln Wage = A + B*X + C*COMPUSE$

where, WAGE is the hourly wage, COMPUSE is a dummy variable indicating the use of computers (or MATHUSE in the case of math skills), and X is a vector including a set of observable human capital and demographic attributes that are known to be related to earnings. These variables include schooling, labor force experience, union membership, part-time status, marital status, race, gender, region, size of metropolitan

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also that individuals using these skills are generally of higher calibre. If that is the case, the OLS regression estimates of the returns to computer use would be biased upwards. However, Krueger finds little evidence of a "self-selection" bias. For that reason, the issue of self-selection is not explored in this paper.

[13]A regression equation in which the dependent variable is in logarithmic form is known as a "semi-log" regression. The theoretical basis for using a semi-log function is related to the relationship between earnings and investment in human capital (see Becker, 1964, Mincer, 1974, Mincer and Polachek, 1974, and Smith, 1977). In practical terms, the semi-log function yields a set of coefficients that measure the proportionate change in wages due to a unit change in right-hand side variables.

area, occupation, and industry. A complete listing of these attributes is given in Table 26. Definitions of the variables are given in Appendix C.

The results of the basic regression analysis are shown in Table 26. Parameter estimates from six regressions--two each for 1984, 1989, and 1991--are shown in Table 26. The first regression in each year omits the industry and occupation dummies, while the second regression includes eleven industry dummies and nine occupational dummies.[14] In the simpler version of the regression, the coefficient of the computer use dummy variable ranges from 0.1626 in 1984, to 0.1793 in 1989, and to 0.1726 in 1991 (see the last row in Table 26). This means that relative to otherwise identical individuals, computer users earned 17.7 percent more in 1984, 19.6 percent more in 1989, and 18.8 percent more in 1991.[15] Thus, the returns to computer use are sizable and even as computer use spread rapidly through the economy during the 1980s, the returns to computer use increased over the same time

[14]As described in Appendix C, the regression sample was divided into 12 industrial and 10 occupational categories. The regression omits Farming industries and Farm occupations. Thus, the coefficients for the industry and occupation dummies should be interpreted relative to these base categories.

[15]It should be recalled that the dependent variable is lnWAGE. For a computer user, the estimated earnings are $\ln WAGE_1 = A + B*X + C$. For a noncomputer user, estimated earnings are $\ln WAGE_0 = A + B*X$, because for noncomputer users COMPUSE = 0. Therefore, the difference in wages = $\ln WAGE_1 - \ln WAGE_0 = \ln(WAGE_1/WAGE_0) = C$. In other words, the ratio of the wages of computer users to the wages of noncomputer users--$WAGE_1/WAGE_0$--is equal to exp(C) and the percentage difference is equal to (exp(C) - 1). For example, the coefficient of the computer use dummy, C, is equal to 0.163 in 1984. This means the percentage return to computer use equals (exp (0.163)-1) = 0.177).

TABLE 26
REGRESSION ANALYSIS OF THE RETURNS TO COMPUTER USE: 1984, 1989, AND 1991
DEPENDENT VARIABLE: ln(HOURLY WAGE)

VARIABLE DESCRIPTION	PARAMETER ESTIMATES 1984 (A)	1984 (B)	1989 (A)	1989 (B)	1991 (A)	1991 (B)
Intercept	0.8563 *	0.7334 *	0.9730 *	0.8529 *	1.1220 *	1.0287 *
Region						
North East	0.0221 *	0.0126	0.0850 *	0.0698 *	0.0618 *	0.0546 *
South	-0.0044	-0.0160	0.0087	-0.0066	-0.0148	-0.0216 *
West	0.0777 *	0.0764 *	0.0809 *	0.0742 *	0.0763 *	0.0698 *
SMSA Size						
1-3 million	0.0907 *	0.0785 *	–	–	–	–
3 million or more	0.0936 *	0.0747 *	–	–	–	–
1-2.5 million	–	–	0.0940 *	0.0858 *	0.0821 *	0.0779 *
2.5-5 million	–	–	0.1662 *	0.1529 *	0.1999 *	0.1798 *
5 million or more	–	–	0.1916 *	0.1731 *	0.2012 *	0.1942 *
School	0.0107	0.0105	-0.0016	0.0010	-0.0078	-0.0032
School Squared/100	0.2249 *	0.1563 *	0.2989 *	0.2147 *	0.3273 *	0.2301 *
Total Experience	0.0252 *	0.0214 *	0.0257 *	0.0224 *	0.0235 *	0.0204 *
Total Experience Squared/100	-0.0384 *	-0.0322 *	-0.0407 *	-0.0353 *	-0.0367 *	-0.0319 *
Union Member	0.1752 *	0.1724 *	0.1636 *	0.1628 *	0.1562 *	0.1573 *
Part-time Worker	-0.2355 *	-0.1700 *	-0.2147 *	-0.1586 *	-0.2199 *	-0.1551 *
Marital Status						
Married, Spouse Present	0.0851 *	0.0627 *	0.1096 *	0.0894 *	0.0978 *	0.0739 *
Married, Spouse Absent	0.0264	0.0216	0.0085	-0.0045	0.0002	-0.0106
Widowed or Divorced	0.0631 *	0.0488 *	0.0529 *	0.0387 *	0.0550 *	0.0490 *
White	0.0877 *	0.0579 *	0.0948 *	0.0769 *	0.0743 *	0.0564 *
Male	0.2643 *	0.2108 *	0.2576 *	0.2114 *	0.2304 *	0.1989 *
Occupation						
Professional & Technical	–	0.2976 *	–	0.3408 *	–	0.3783 *
Managerial & Administrative	–	0.3381 *	–	0.3752 *	–	0.4099 *
Sales	–	0.1465 *	–	0.1574 *	–	0.1872 *
Clerical	–	0.0836 *	–	0.1068 *	–	0.1526 *
Precision Prodn & Crafts	–	0.2151 *	–	0.2429 *	–	0.2619 *
Operators	–	0.0312	–	0.0800 *	–	0.1148 *
Transport Occupations	–	0.0966 *	–	0.1199 *	–	0.1543 *
Handlers	–	0.0294	–	0.0869 *	–	0.0499
Service, Ex. Private Household	–	-0.0104	–	0.0768 *	–	0.0983 *
Industry						
Mining	–	0.4750 *	–	0.4216 *	–	0.2767 *
Construction	–	0.3299 *	–	0.2512 *	–	0.1932 *
Manufacturing, Durable	–	0.2941 *	–	0.2482 *	–	0.1631 *
Manufacturing, Nondurable	–	0.2567 *	–	0.2060 *	–	0.1234 *
Transportation & Utilities	–	0.3841 *	–	0.2720 *	–	0.2090 *
Trade	–	0.0868 *	–	0.0322	–	-0.0491
Fire	–	0.2637 *	–	0.1896 *	–	0.1167 *
Service	–	0.1857 *	–	0.1241 *	–	0.0521
Federal Government	–	0.2949 *	–	0.2482 *	–	0.1713 *
State Government	–	0.1357 *	–	0.1229 *	–	0.0803
Local Government	–	0.1408 *	–	0.0691	–	0.0173
Computer Use	**0.1626 ***	**0.1113 ***	**0.1793 ***	**0.1350 ***	**0.1726 ***	**0.1264 ***
R-Squared	0.4480	0.5206	0.4719	0.5269	0.4672	0.5247
N	14217	14217	14258	14258	14604	14604

* Significantly different from zero at either the 5 percent or 1 percent level.

See Appendix D for standard errors of parameter estimates.

period. The slight decline in the returns between 1989 and 1991 may, however, indicate that the excess demand for these skills in the job market during the 1980s may be leveling off.

The introduction of occupation and industry dummies in the regression results in a considerable drop in the size of the computer use coefficient. As pointed out by Krueger, that is indicative of the fact that computer users are not randomly allocated across industries and occupations. Tables 12, 13, and 14 had previously noted considerable differences in the rate of computer use across occupations and industries. Thus, some part of the estimated return to computer use must be due to the choice of occupation and industry made by individuals. When dummies are used to control for these factors, the return to computer use is found to be 11.8 percent in 1984, 14.5 percent in 1989, and 13.5 percent in 1991. These returns are roughly 5 percentage points less than those found by the simpler regression.[16]

[16]The regression results indicate that workers who use computers on the job are more productive than otherwise similar individuals. To some extent, it is possible that the computer use variable is indicative of other, more general, analytical attributes of workers that are correlated both with computer skills and higher wages. As noted earlier, Krueger (1993) finds little evidence in favor of this hypothesis. Thus, it is more likely the case that computers make workers more productive. In other words, the returns to computer use are indicative of higher productivity at the workplace due to the investment in computer equipment. Workers who acquire the skills to work with computers share in these productivity gains.

Table 27 reports on the results concerning the use of mathematics on the job. The regressions used are the same as those described above, except for the use of a math-use dummy variable in place of the computer-use variable.[17] The basic regression shows that using math leads to a wage that is 11.4 percent higher than those of otherwise similar individuals. If occupation and industry dummies are added to the regression, the estimated returns to math use drop to 7.6 percent.

A worthwhile experiment that is possible with 1991 data is to include a variable that controls for the length of tenure on an individual's current job as opposed to overall labor market experience. The inclusion of a job tenure variable is important because the returns to additional years in the same job can differ from the returns to years spent in the labor force regardless of the job. The importance of maintaining this distinction has been noted by Topel (1991). Table 28 shows the effect of using a job tenure variable in the regressions. The returns to computer use are estimated to be 17.2 percent or 13.1 percent depending upon whether or not industry and occupation dummies are used. These returns are slightly lower than those found in the earlier regressions. The returns to math use are also affected only slightly, falling to 10.7 percent or 7.4 percent depending upon the regression. Thus, while tenure on the job may affect overall earnings differently than general labor market experience, that distinction has little bearing on the returns to math and computer use.

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[17]Results concerning the use of math on the job are limited to 1991 because similar data indicating the use of math were not available for 1984 and 1989.

TABLE 27
REGRESSION ANALYSIS OF THE RETURNS TO MATH USE, 1991
DEPENDENT VARIABLE: ln(HOURLY WAGE)

VARIABLE DESCRIPTION	PARAMETER ESTIMATES (A)	(B)
Intercept	1.1137 *	1.0178 *
Region		
North East	0.0631 *	0.0545 *
South	-0.0115	-0.0195 *
West	0.0812 *	0.0735 *
SMSA Size		
1-2.5 million	0.0887 *	0.0808 *
2.5-5 million	0.2107 *	0.1839 *
5 million or more	0.2088 *	0.1965 *
School	-0.0112	-0.0071
School Squared/100	0.3623 *	0.2524 *
Total Experience	0.0237 *	0.0205 *
Total Experience Squared/100	-0.0375 *	-0.0327 *
Union Member	0.1490 *	0.1553 *
Part-time Worker	-0.2387 *	-0.1635 *
Marital Status		
Married, Spouse Present	0.0981 *	0.0733 *
Married, Spouse Absent	-0.0027	-0.0108
Widowed or Divorced	0.0540 *	0.0494 *
White	0.0766 *	0.0574 *
Male	0.2128 *	0.1974 *
Occupation		
Professional & Technical	--	0.4068 *
Managerial & Administrative	--	0.4402 *
Sales	--	0.2033 *
Clerical	--	0.1926 *
Precision Prodn & Crafts	--	0.2620 *
Operators	--	0.1109 *
Transport Occupations	--	0.1464 *
Handlers	--	0.0550
Service, Ex. Private Household	--	0.1052 *
Industry		
Mining	--	0.2871 *
Construction	--	0.1832 *
Manufacturing, Durable	--	0.1806 *
Manufacturing, Nondurable	--	0.1387 *
Transportation & Utilities	--	0.2305 *
Trade	--	-0.0456
Fire	--	0.1390 *
Service	--	0.0616
Federal Government	--	0.1851 *
State Government	--	0.0925 *
Local Government	--	0.0250
Math Use	**0.1080**	**0.0736 ***
R-Squared	0.4550	0.5188
N	14604	14604

* Significantly different from zero at either the 5 percent or 1 percent level.

See Appendix D for standard errors of parameter estimates.

TABLE 28
RETURNS TO COMPUTER USE AND MATH USE:
REGRESSION ANALYSIS WITH JOB TENURE VARIABLE, 1991
DEPENDENT VARIABLE: ln(HOURLY WAGE)

VARIABLE DESCRIPTION	COMPUTER USE (A)	COMPUTER USE (B)	MATH USE (A)	MATH USE (B)
Intercept	1.0666 *	0.9788 *	1.0561 *	0.9670 *
Region				
North East	0.0802 *	0.0705 *	0.0819 *	0.0708 *
South	-0.0042	-0.0119	-0.0007	-0.0096
West	0.1104 *	0.1005 *	0.1168 *	0.1052 *
SMSA Size				
1-2.5 million	0.0878 *	0.0839 *	0.0945 *	0.0867 *
2.5-5 million	0.2124 *	0.1946 *	0.2245 *	0.1995 *
5 million or more	0.2074 *	0.2006 *	0.2156 *	0.2032 *
School	0.0011	0.0041	-0.0019	0.0003
School Squared/100	0.2857 *	0.2047 *	0.3177 *	0.2271 *
Tenure	0.0327 *	0.0295 *	0.0342 *	0.0303 *
Tenure Squared/100	-0.0587 *	-0.0549 *	-0.0627 *	-0.0575 *
Other Experience	0.0118 *	0.0105 *	0.0110 *	0.0100 *
Other Experience Squared/100	-0.0265 *	-0.0234 *	-0.0254 *	-0.0228 *
Union Member	0.1206 *	0.1324 *	0.1103 *	0.1290 *
Part-time Worker	-0.1911 *	-0.1335 *	-0.2094 *	-0.1427 *
Marital Status				
Married, Spouse Present	0.1262 *	0.0995 *	0.1274 *	0.0999 *
Married, Spouse Absent	0.0457 *	0.0291	0.0454 *	0.0306
Widowed or Divorced	0.1005 *	0.0869 *	0.1009 *	0.0885 *
White	0.0747 *	0.0606 *	0.0760 *	0.0611 *
Male	0.2217 *	0.1898 *	0.2030 *	0.1876 *
Occupation				
Professional & Technical	--	0.3474 *	--	0.3760 *
Managerial & Administrative	--	0.3694 *	--	0.4003 *
Sales	--	0.1851 *	--	0.2018 *
Clerical	--	0.1326 *	--	0.1751 *
Precision Prodn & Crafts	--	0.2449 *	--	0.2443 *
Operators	--	0.1119 *	--	0.1069 *
Transport Occupations	--	0.1748 *	--	0.1666 *
Handlers	--	0.0485	--	0.0523
Service, Ex. Private Household	--	0.0943 *	--	0.1007 *
Industry				
Mining	--	0.2677 *	--	0.2792 *
Construction	--	0.2120 *	--	0.2011 *
Manufacturing, Durable	--	0.1399 *	--	0.1580 *
Manufacturing, Nondurable	--	0.1118 *	--	0.1273 *
Transportation & Utilities	--	0.1887 *	--	0.2105 *
Trade	--	-0.0575	--	-0.0537
Fire	--	0.1168 *	--	0.1409
Service	--	0.0551	--	0.0657 *
Federal Government	--	0.1365 *	--	0.1501 *
State Government	--	0.0734	--	0.0861
Local Government	--	-0.0061	--	0.0015
Computer Use	**0.1589 ***	**0.1228 ***	--	--
Math Use	--	--	**0.1019 ***	**0.0710 ***
R-Squared	0.4999	0.5499	0.4894	0.5442
N	12999	12999	12999	12999

* Significantly different from zero at the 5 percent or 1 percent level.

See Appendix D for standard errors of parameter estimates.

TABLE 29
A SUMMARY OF THE RETURNS TO USING COMPUTERS AND MATHEMATICS ON THE JOB: 1984, 1989 AND 1991

REGRESSION TYPE	PERCENTAGE RETURNS		
	1984	1989	1991
Returns to Computer Use:			
Basic regression	17.7	19.6	18.8
Regression with industry & occupation	11.8	14.5	13.5
Basic regression with job tenure	--	--	17.2
Regression with job tenure, industry & occupation	--	--	13.1
Returns to Math Use:			
Basic regression	--	--	11.4
Regression with industry & occupation	--	--	7.6
Basic regression with job tenure	--	--	10.7
Regression with job tenure, industry & occupation	--	--	7.4

Because of the variety of regressions used, and the presence of three time periods, Table 29 summarizes the main findings of the regressions shown in Tables 26 to 28. Table 29 shows that the returns to computer use are found to range from 13.1 percent to 19.6 percent depending upon the time period and the type of regression. By any account, those are sizable returns. The returns to math use are found to range from 7.4 percent to 11.4 percent.

It was noted earlier in this paper (see Table 18) that 93 percent of those using a computer on the job also use math on the job. Similarly, 58 percent of those using math on their jobs also report using computers. As a result, the possibility that some of the estimated return to math use is due to the use of computers at the same time (and vice versa) was alluded to in Section 4.A. Thus, it is of interest to apply the regression analysis to isolate the returns from using one kind of skill from the returns to using the other type of skill.

The technique used to accomplish this task was to insert a computer use*math use interactive dummy variable in the regression. Thus, the estimated regression looks as follows:

$$(2)\quad \ln WAGE = A + B^{*}X + C^{*}COMPUSE + D^{*}MATHUSE + E^{*}(COMPUSE^{*}MATHUSE)$$

In equation (2), the sum of coefficients C, D, and E estimates the return to using both math and computers on the job. The coefficient C estimates the return to using computers only and D the return to using math only. If D and E are small, while C is large, that would indicate that most of the additional wage received by math and computer users is due to the use of computer skills.

The results of estimating equation (2) are shown in Table 30. The coefficient of the COMPUSE dummy variable is 0.1067, that of the MATHUSE variable is 0.0236, and the COMPUSE*MATHUSE coefficient is 0.0092. The COMPUSE and MATHUSE coefficients are significantly different from zero, but the COMPUSE*MATHUSE coefficient is not. In percentage terms, the regression estimates indicate an 11.2 percent return to computer use alone, a 2.4 percent return to math use alone, and a 15.0 percent return to the use of math and computers combined.[18] These results indicate that the use of math skills alone does not offer a sizable return. However, using computer skills alone offers a return that is three-quarters (11.2/15.0) the size of the return earned by those using both math and computers on their jobs.[19] It is possible that those individuals who report using only a computer on the job do possess some degree of training in math that offers them some indirect rewards. If so, the estimate of the return to using computers alone may be biased upwards.

[18]The 15 percent return is based on the sum of the MATHUSE, COMPUSE, and MATHUSE*COMPUSE coefficients. The results of this regression do not change by much when a job tenure variable is used instead of the total labor force experience variable.

[19]It should be noted that the estimate of the difference between returns to math use alone and computer use alone may also be affected by the self-selection problem.

TABLE 30
ISOLATING THE RETURNS TO COMPUTER USE FROM THE RETURNS TO MATH USE:
REGRESSION ANALYSIS WITH MATH USE AND COMPUTER USE INTERACTION TERM, 1991
DEPENDENT VARIABLE: ln(HOURLY WAGE)

VARIABLE DESCRIPTION	PARAMETER ESTIMATES
Intercept	1.0299 *
Region	
North East	0.0551 *
South	-0.0209 *
West	0.0702 *
SMSA Size	
1-2.5 million	0.0787 *
2.5-5 million	0.1814 *
5 million or more	0.1960 *
School	-0.0045
School Squared/100	0.2345 *
Total Experience	0.0203 *
Total Experience Squared/100	-0.0317 *
Union Member	0.1571 *
Part-time Worker	-0.1545 *
Marital Status	
Married, Spouse Present	0.0728 *
Married, Spouse Absent	-0.0109 *
Widowed or Divorced	0.0479 *
White	0.0545 *
Male	0.1994 *
Occupation	
Professional & Technical	0.3754 *
Managerial & Administrative	0.4069 *
Sales	0.1833 *
Clerical	0.1519 *
Precision Prodn & Crafts	0.2581 *
Operators	0.1128 *
Transport Occupations	0.1521 *
Handlers	0.0492
Service, Ex. Private Household	0.0983 *
Industry	
Mining	0.2797 *
Construction	0.1936 *
Manufacturing, Durable	0.1658 *
Manufacturing, Nondurable	0.1257 *
Transportation & Utilities	0.2124 *
Trade	-0.0479
Fire	0.1191 *
Service	0.0553
Federal Government	0.1745 *
State Government	0.0827
Local Government	0.0192
Math Use	**0.0236 ***
Computer Use	**0.1067 ***
Math Use and Computer Use	**0.0092**
R-Squared	0.5251
N	14604

* Significantly different from zero at either the 5 percent or 1 percent level.
See Appendix D for standard errors of parameter estimates.

4.C. The Variation in the Returns to Math and Computer Skills Across Industries, Occupations, and Education Level

Do the returns to computer use and math use vary across occupations, industries, and level of education? To answer these questions, the computer use (and math use) dummy was interacted, in turn, with occupation, industry, and education level dummies. Thus, the following type of equation was estimated:

(3) lnWAGE = A + B*X + C*(COMPUSE*OCC)

In equation (3), the computer use dummy has been interacted with dummy variables representing all 10 occupational classes.[20] Thus, the coefficient C in equation (3) represents a vector of 10 coefficients, each giving an estimate for the returns to computer use within an occupation. The design of equation (3) also makes it possible to test the statistical significance of the observed differences in returns to computer use across occupations. However, no single occupation emerges as a natural choice to serve as the base for comparisons.[21] Therefore, it was decided

[20] A perfect collinearity problem does not arise because the interaction terms merely divide computer users into ten occupational groups. Note that the computer use dummy is not included by itself in equation (3). The vector X continues to include nine occupational dummies only, omitting Farm occupations as before.

[21] The returns to computer use in any one occupation could have been tested against the others in a pair-wise fashion, but that would have led to a large and unwieldy number of tests of significance.

that an economy-wide average return to computer use should be used to serve as the basis of comparison. The economy-wide return to computer use was estimated as the weighted sum of the returns in individual occupations. The weights reflect the distribution of computer users across occupations. A similar methodology was followed to test for differences in returns to math use across occupations.

The method of equation (3) was also used to test for differences in returns to computer and math use across nontraditional and emerging occupations, 12 industry groups, and four education levels. The education levels were defined as less than high school, high school, one to three years of college, and four or more years of college.

The findings with respect to differences in the returns to computer and math use across the standard occupational groups are summarized in Table 31. Only the parameter estimates of the computer use*occupation and math use*occupation terms are reported in Table 31. All other coefficient estimates are omitted for the sake of brevity. The parameter estimates indicate that the highest returns to computer use were to be found in Service occupations in all three time periods. in two occupations--Operators and Handlers--the returns to computer use have increased dramatically since 1984. The high returns to computer use in these occupations are probably a reflection of the scarcity of computer skills among individuals working in these occupations. Generally, however, the returns to computer use have remained fairly

TABLE 31
REGRESSION ANALYSIS OF THE RETURNS TO COMPUTER AND MATH USE BY OCCUPATION, INDUSTRY, AND EDUCATION LEVEL: 1984, 1989, AND 1991

PARAMETER ESTIMATES

	Returns to Computer Use			Returns to Math Use
OCCUPATION	1984	1989	1991	1991
Professional & Technical	0.0961	0.1282	0.0745 *	0.0410
Managerial & Administrative	0.1028	0.1147	0.1052	0.0453
Sales	0.1528	0.1474	0.1698 *	0.0922
Clerical	0.0805 *	0.1006	0.0911	0.0461
Precision Prodn & Crafts	0.1563	0.1715	0.1667 *	0.0970
Operators	0.1417	0.2056 *	0.2309 *	0.1216 *
Transport Occupations	0.1017	0.1507	0.1013	0.0514
Handlers	0.0314	0.1092	0.1232	0.1035
Service Ex Private Household	0.2697 *	0.2264 *	0.2526 *	0.1174 *
Farm	-0.0056	0.1160	0.0256	-0.0380
Average: All Occupations	0.1060	0.1256	0.1124	0.0659
INDUSTRY				
Mining	0.0465	0.0310	0.0885	0.0630
Construction	0.0816	-0.0491 *	0.0723	0.0805
Manufacturing, Durable	0.1458 *	0.1798 *	0.1398	0.0751
Manufacturing, Nondurable	0.1520	0.2096 *	0.2172 *	0.1448 *
Transportation & Utilities	0.1562 *	0.1345	0.1358	0.1100
Trade	0.1450 *	0.1458	0.1424	0.0551
Fire	0.0428 *	0.1093	0.1240	0.0762
Service	0.1516 *	0.1822 *	0.1467	0.1017 *
Federal Government	0.1246	0.0379 *	0.0620	0.0088
State Government	-0.0169 *	0.0719 *	0.0936	0.1170
Local Government	0.0295 *	0.0605 *	0.0252 *	-0.0288 *
Farming	-0.0132	0.0072	0.0316	-0.0677
Average: All Industries	0.1073	0.1325	0.1241	0.0715
EDUCATION LEVEL				
Less than High School	0.1436	0.1486	0.1330	0.0662
High School	0.1131	0.1294	0.1285	0.0796
College: 1-3 years	0.1173	0.1372	0.1307	0.0676
College: 4+ years	0.1046	0.1390	0.1272	0.0885
Average: All Education Levels	0.1120	0.1358	0.1287	0.0782

* Significantly different from the category average at either the 5 percent or 1 percent level.

See Appendix D for standard errors of parameter estimates.

The averages over all occupations, industries, and education levels are weighted averages of the parameter estimates of the returns to computer and math use by individual occupation, industry, and education level.

steady within most occupations and in the economy as a whole. Also, except in 1991, most occupations provided a return to computer use that is statistically not significantly different from the economy-wide average.[22] These findings with respect to computer use are echoed in the findings regarding the returns to math use across occupations. Math users earn the highest returns in Service, Operator, and Handler occupations. The returns to math use in these occupations are almost twice as high as the overall average return. Of course, since most math users also use computers and vice versa, it is not surprising that the returns to math use are found to vary in a similar fashion across occupations.

Table 32 shows how the returns to computer and math use were found to vary across nontraditional and emerging occupations. In all years, the returns to computer use are found to be significantly lower in Traditionally Female occupations in comparison to Traditionally Male occupations.[23] This may indicate that different types of computer skills are used across these two occupational groups and the returns to computer use vary by type of computer skill. Further research on this issue is necessary. A related finding is that Production occupations yield a higher return to

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[22]The economy-wide average is a weighted average of the estimates for the individual coefficients. An F-test was used to test for statistically significant differences between individual coefficients and the weighted average of all coefficients. This method was applied with respect to all occupation, industry, and education level coefficients.

[23]This does not mean that women receive a lower return to computer use than men. Within an occupation, men and women may receive the same return. This issue is discussed in Section 4.D.

TABLE 32
REGRESSION ANALYSIS OF THE RETURNS TO COMPUTER AND MATH USE BY NONTRADITIONAL AND EMERGING OCCUPATIONAL CLASSES: 1984, 1989, AND 1991

PARAMETER ESTIMATES

OCCUPATION	Returns to Computer Use			Returns to Math Use
	1984	1989	1991	1991
Traditionally Female	0.1110*	0.1397*	0.1252*	0.0811*
Gender Neutral	0.2005	0.1882	0.2163	0.1440
Traditionally Male	0.1779	0.2100	0.2001	0.1201
Information	0.0934	0.1071	0.1010	0.0731
Information/Production	0.0733	0.1182	0.1173	0.0536
Production	0.1741*	0.1587+	0.1568+	0.0921
Fast Growth	0.2372*	0.2352*	0.2286*	0.1628*
Above Average Growth	0.1492**	0.1694**	0.1477	0.0636++
Below Average Growth	0.0890	0.1030	0.1295	0.0905
Slow Growth	0.1106	0.1711	0.1584	0.1109

*Significantly different from all other occupational groups.
**Significantly different from Below Average Growth occupations.
+Significantly different from Information occupations.
++Significantly different from Slow Growth occupations.
All tests of significance were conducted at the 5 percent level.

See Appendix D for standard errors of parameter estimates.

computer use than Information occupations. However, the gap between Information and Production occupations has narrowed considerably since 1984. As shown in Table 14, above the rate of computer use in Information occupations was four times as high as the rate in Production occupations in 1991. Therefore, the disparity in the return to computer skills across Information and Production occupations may be an indication of the rarity of these skills in the latter group. The rate of computer use is fairly similar across occupations grouped by their expected rate of growth in employment, but Fast Growth occupations are found to yield a significantly higher return to computer use than other occupations. In other words, occupational employment is expected to grow most rapidly in occupations that also value computer skills the most. This finding underscores the importance of computer skills in the labor market of the future. Table 32 also shows that the returns to math use vary in the same way as the returns to computer skills across nontraditional and emerging occupations.

Returning to Table 31, one can see the findings from regressions featuring computer use*industry and math use*industry interaction terms. The industry providing consistently high returns to computer and math use is the Nondurable Goods Manufacturing industry. The returns to computer use have increased rapidly in Finance, Insurance and Real Estate, and in State Government. On the other hand, the Federal Government industry has provided diminishing returns to computer use over time. In contrast to the situation with occupations, most industries were not statistically distinguishable from the overall average in the size of their return to computer use in 1991. There were, however, significant distinctions across industries in 1984 and 1989.

While the returns to computer and math use show considerable variation across occupations and industries, they are fairly consistent across education levels. The results shown in Table 31 indicate that those with the least education stand to gain the most, in comparison to otherwise similar persons, from acquiring computer skills. This result makes intuitive sense because computer skills are relatively scarce among the group of individuals with less than a high school education. However, the gains are almost as high in other educational classes. This indicates that computer skills have a value that is more or less independent of an average individual's stock of general human capital. An individual need not possess a minimum level of human capital to capture the full benefits of computer skills, and these benefits do not generally dissipate as individuals acquire greater levels of schooling.

The issue of returns to computer use by level of education has also been researched by Krueger (1993). However, his results are at odds with the results reported above. Krueger finds that the returns to education increase steadily with the level of education. The reason for this disparity is a difference in the specification of the regression equation. The results shown in Table 31 are based on the estimation of an equation that interacted four education level dummy variables with the computer use dummy variable. Krueger, however, estimates an equation in which the computer use dummy variable is interacted with a continuous years of schooling variable. In other words, Krueger estimates the following equation:

(K1) lnWAGE = A + B*X + C*COMPUSE + D*(COMPUSE*EDUC)

where, EDUC = years of schooling, and X, as before, is a vector of human capital variables, including years of schooling.

In the Krueger model, the returns to computer use are given by the sum C + D*EDUC. For example, the returns to computer use for an individual with 12 years of schooling equal C + D*12. If D is positive, the returns to computer use increase with the level of education.[24] Note that the Krueger model assumes a linear relationship between the returns to computer use and the level of education. In other words, if D is different from zero, the returns to computer use must always increase or decrease with changes in the level of education. It is possible that the linearity assumption may be the reason for the difference between his results and those reported above. Thus, the following equation was estimated to resolve the differences between the two sets of results:

[24] Krueger's estimates for C and D were 0.073 and 0.007 respectively in 1984 and 0.005 and 0.013 respectively in 1989.

$$\text{(4)} \quad \ln WAGE = A + B^*X + C^*COMPUSE + D1^*(COMPUSE^*EDUC) + D2^*(COMPUSE^*(EDUC^2/100))$$

where, the vector X also includes a quadratic term in years of schooling. The quadratic relationship between wages and years of schooling allows for the possibility that the returns to computer use may initially increase (or decrease) with the level of education and then decrease (or increase) at higher levels of education.[25] The results from estimating equation (4) are shown in Table 33.

The first column in Table 33 replicates, from Table 31, the findings from the regressions using dummy variables for the four education level groups. The second column, column (B), shows the results from estimating equation (4).[26] The results shown in columns (A) and (B) are fairly similar. The estimates in column (A) show that, going from high school to four or more years of college, the returns to computer

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[25] The quadratic relationship between wages and schooling was maintained through all the regressions estimated in this paper, except for those in which four education level dummy variables were used. See Willis (1986) for a survey of a variety of human capital earnings functions.

[26] The estimates of coefficients C, D1, and D2 were as follows: -0.048, 0.026, and -0.102 in 1984; 0.089, 0.006, and -0.022 in 1989; and -0.087, 0.034, and -0.031 in 1991. The average years of schooling of computer users with less than a high school level of education in 1984 was 9.02 years. That mean level of education was inserted as the value for EDUC in equation (4) to estimate the returns to computer use for that group of individuals in 1984. Similarly, the returns for other groups in 1984, and in other years, was derived by inserting the appropriate mean years of schooling for those groups of computer users in equation (4), and in equation (K1).

TABLE 33
ALTERNATIVE ESTIMATES OF THE RETURNS TO COMPUTER USE BY LEVEL OF EDUCATION: 1984, 1989, AND 1991

	Difference in lnWAGE: Computer User Minus Noncomputer User		
	(A)	(B)	(Krueger)
1984			
Less than High School	0.1436	0.1039	0.1361
High School	0.1131	0.1176	0.1570
College: 1-3 Years	0.1173	0.1170	0.1697
College: 4+ Years	0.1046	0.1023	0.1899
1989			
Less than High School	0.1486	0.1292	0.1230
High School	0.1294	0.1346	0.1610
College: 1-3 Years	0.1372	0.1360	0.1845
College: 4+ Years	0.1390	0.1354	0.2226
1991			
Less than High School	0.1330	0.1159	---
High School	0.1285	0.1330	---
College: 1-3 Years	0.1307	0.1326	---
College: 4+ Years	0.1272	0.1137	---

Note: See text for explanations of columns (A), (B), and (Krueger).

use generally stay the same or decrease slightly in 1984 and 1991. In 1989, the returns increase, but only slightly. The methodology of column (B) fails to find that those with less than a high school education earn the highest returns to computer use, but it does show very little difference in returns across the four education level groups. In no year does the return to computer use vary by more than two percentage points across education levels. In sum, the data in column (B) reinforce the earlier finding that the returns to computer use are generally independent of an individual's level of education. That finding is in sharp contrast to Krueger's findings shown in the last column of Table 33. For example, in 1989, Krueger's estimates imply that college graduates earned a return to computer use that was over 10 percentage points higher than the return earned by those with less than a high school level of education. However, given the results in columns (A) and (B), it is reasonable to suppose that Krueger's findings are influenced by his assumption of linearity.

Other than the level of education, years of experience are another indicator of the level of human capital possessed by an individual. Table 34 shows how the returns to computer use vary with a person's overall experience in the labor market. The methodology used was to replace the variable EDUC in equation (4) with a variable representing years of experience. The data in Table 34 show that in the early years of the computer revolution--1984--years of experience bore little relationship to the returns to computer use. However, in subsequent years, the returns to computer use are found to increase by a fair amount with years of experience. Of course, by 1991,

TABLE 34
RETURNS TO COMPUTER AND MATH USE BY YEARS OF EXPERIENCE: 1984, 1989, AND 1991

Years of Experience	Difference in lnWAGE: Skill Users Minus Nonskill User			
	Computer Use			Math Use
	1984	1989	1991	1991
5	0.1151	0.1101	0.1076	0.0704
10	0.1186	0.1344	0.1276	0.0815
15	0.1192	0.1507	0.1405	0.0874
20	0.1169	0.1589	0.1463	0.0883
25	0.1116	0.1590	0.1450	0.0840
30	0.1034	0.1511	0.1366	0.0747
35	0.0922	0.1351	0.1211	0.0602

those using computers in 1984 had acquired another seven years worth of experience in the use of computers. Therefore, these (more experienced) users no doubt receive a higher return to computer use than the more novice users in 1991. In contrast to the returns to computer use, the returns to math use are found to be fairly equal across individuals with varying amounts of experience in the labor market.

4.D. Differences Across Gender Groups in the Returns to Computer and Mathematical Skills

This section examines the important issue of whether women receive the same returns to using computer and math skills as men. A related issue discussed in this section is, if returns to math and computer skills vary across industries, occupations and education levels, do they vary in the same fashion for both men and women? The broader issue is whether the introduction of computers has contributed to the observed reduction in the gender wage gap during the 1980s.[27]

To determine whether men and women receive different returns from the use of computer skills, a multiplicative dummy variable--gender*computer use--was inserted into the regression. Thus, the following type of regression was estimated:

$$(5)\ \ln WAGE = A + B*X + C*COMPUSE + D*MALE + E*(COMPUSE*MALE)$$

In equation (5), the vector X denotes the various human capital and demographic variables that have been alluded to earlier in this report. In addition to the dummies indicating the use of computers (COMPUSE = 1) and gender (MALE = 1 for men),

[27]Evidence on the gender wage gap is summarized in Gunderson (1989), and Horrigan and Markey (1990). The spread of computer and math skills may also have a positive effect on the employment and career stability of women. That would also contribute, albeit indirectly, to a reduction in the gender wage gap.

COMPUSE and MALE have been interacted to isolate any additional benefits flowing to male computer users. Coefficient D measures the wage gap between men and women who do not use computers on the job. The sum of coefficients D and E represents the gender wage gap among computer users. Coefficient D is the common element in the gender wage gap between computer users and noncomputer users and represents the traditional notion of the gender wage gap. Coefficient E measures the contribution of computer use to the overall gender wage gap. Thus, if E is less than zero, it would indicate that using computers on the job lowers the wage gap between men and women. In essence, it would indicate that women who use computers earn a higher return for that skill than otherwise similar men. The size of coefficient E alone is also enough to measure how much more or less of a return to computer use is received by men in comparison to women.

The evidence on this issue is given in Table 35. The coefficient of the variable MALE is 0.2089, 0.2162, and 0.1913 in 1984, 1989, and 1991 respectively. This indicates that, among noncomputer users, men received about 20 percent more in wages than otherwise similarly qualified women during the period 1984 to 1991.[28] The coefficient of the interactive term (computer use*male) is positive in 1984 and 1991, but negative in 1989. This means that, among computer users, the gender

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[28]Thus, even after controlling for computer use and other relevant variables, a large part of the wage gap between men and women remains unexplained. Identifying the reasons and evaluating the relative importances of the contributing factors are necessary steps towards achieving parity among men and women in the labor market.

wage gap was about 0.7 percent higher than among noncomputer users in 1984. Similarly, the gender wage gap among computer users was roughly 1.2 percent lower in 1989, and about 1.8 percent higher in 1991.[29] Not only are these numbers small, they are, in all years, not significantly different from zero. The conclusion that can be drawn from these estimates is that computer technology is gender neutral in the sense that the acquisition of computer skills rewards men and women equally well.

It should be noted that the inferences drawn from the data in Table 35 pertain to single individuals. For example, the data show that, in 1991, a single computer user, compared to an otherwise similar individual who did not use a computer, earned approximately 12 percent more in wages. Gender was not found to be a significant factor in this estimate of the earning differential.[30] Women, however, are more likely than men to use a computer. In 1991, 45.1 percent of women used computers compared to only 33.6 percent of men (see Table 10 above). If the return to

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[29]These estimates represent the size of the computer use and gender interaction term.

[30]At the level of the individual, the effect of computer use on the gender wage gap can also be approximated by estimating two regressions--one with a computer use variable and one without. Removing the computer use variable affects the size of several coefficients, including that of the MALE dummy variable. The change in the size of the coefficient for MALE can be taken as an indication of the effect of computer use on the gender wage gap. The result of conducting this experiment was that computer use was found to lower the gender wage gap in all three time periods, but by no more than 0.5 percentage points. Of course, as is the case in Table 35, this type of estimate fails to take into account the fact that many more women than men use computers and, even if they receive the same returns, the average earning of women increases by more than the increase in the average earning of men.

TABLE 35
GENDER DIFFERENCES IN THE RETURNS TO COMPUTER USE AND MATH USE: REGRESSION ANALYSIS WITH SKILL AND GENDER INTERACTION TERMS
DEPENDENT VARIABLE: ln(HOURLY WAGE)

VARIABLE DESCRIPTION	COMPUTER USE 1984	COMPUTER USE 1989	COMPUTER USE 1991	MATH USE 1991
Intercept	0.7354 *	0.8484 *	1.0358 *	1.0346 *
Region				
North East	0.0126	0.0698 *	0.0545 *	0.0542 *
South	-0.0160	-0.0067	-0.0215 *	-0.0193 *
West	0.0764 *	0.0742 *	0.0698 *	0.0734 *
SMSA Size				
1-3 million	0.0785 *	–	–	–
3 million or more	0.0746 *	–	–	–
1-2.5 million	–	0.0857 *	0.0779 *	0.0808 *
2.5-5 million	–	0.1529 *	0.1798 *	0.1841 *
5 million or more	–	0.1730 *	0.1943 *	0.1967 *
School	0.0105	0.0009	-0.0032	-0.0076
School Squared/100	0.1560 *	0.2151 *	0.2296 *	0.2538 *
Total Experience	0.0213 *	0.0224 *	0.0204 *	0.0206 *
Total Experience Squared/100	-0.0322*	-0.0353 *	-0.0319 *	-0.0328 *
Union Member	0.1726 *	0.1625 *	0.1574 *	0.1555 *
Part-time Worker	-0.1702 *	-0.1580 *	-0.1556 *	-0.1632 *
Marital Status				
Married, Spouse Present	0.0626 *	0.0896 *	0.0737 *	0.0731 *
Married, Spouse Absent	0.0214	-0.0042	-0.0108	-0.0112
Widowed or Divorced	0.0487 *	0.0389 *	0.0489 *	0.0493 *
White	0.0579 *	0.0769 *	0.0563 *	0.0573 *
Male	0.2089 *	0.2162 *	0.1913 *	0.1774 *
Occupation				
Professional & Technical	0.2968 *	0.3428 *	0.3761 *	0.4052 *
Managerial & Administrative	0.3374 *	0.3768 *	0.4079 *	0.4385 *
Sales	0.1458 *	0.1594 *	0.1844 *	0.2011 *
Clerical	0.0836 *	0.1072 *	0.1519 *	0.1916 *
Precision Prodn & Crafts	0.2149 *	0.2437 *	0.2610 *	0.2598 *
Operators	0.0308	0.0811 *	0.1131 *	0.1082 *
Transport Occupations	0.0967 *	0.1200 *	0.1542 *	0.1454 *
Handlers	0.0293	0.0874 *	0.0495	0.0545
Service, Ex. Private Household	-0.0111	0.0789 *	0.0957 *	0.1022 *
Industry				
Mining	0.4750 *	0.4216 *	0.2770 *	0.2884 *
Construction	0.3303 *	0.2504 *	0.1947 *	0.1841 *
Manufacturing, Durable	0.2938 *	0.2486 *	0.1626 *	0.1809 *
Manufacturing, Nondurable	0.2566 *	0.2066 *	0.1229 *	0.1392 *
Transportation & Utilities	0.3842 *	0.2722 *	0.2090 *	0.2311 *
Trade	0.0866 *	0.0323	-0.0492	-0.0447
Fire	0.2641 *	0.1890 *	0.1174 *	0.1403 *
Service	0.1856 *	0.1241 *	0.0521	0.0621
Federal Government	0.2949 *	0.2486 *	0.1709 *	0.1854 *
State Government	0.1358 *	0.1227 *	0.0805	0.0927 *
Local Government	0.1409 *	0.0690	0.0176	0.0263
Computer Use	**0.1078 ***	**0.1410 ***	**0.1179 ***	–
Computer Use and Male	**0.0074**	**-0.0124**	**0.0176**	–
Math Use	–	–	–	**0.0568 ***
Math Use and Male	–	–	–	**0.0318 ***
R-Squared	0.5206	0.4719	0.5248	0.5190
N	14217	14258	14604	14604

* Significantly different from zero at the 5 percent or 1 percent level.

See Appendix D for standard errors of parameter estimates.

computer use in 1991 is assumed to be 13.5 percent (see Table 29), the increase in the average wage for all women equals 6.1 percent. Similarly, the increase in the average wage for all men equals 4.6 percent. Thus, in the aggregate, the introduction of computers has increased the average earnings of women by more than it has increased the earnings of men. The result, in 1991, was a reduction in the gap in the average earnings of men and women by about one and one-half percentage point. Similarly, the reduction in the earnings gap was estimated to be about one percentage point in 1984 and one and one-half percentage point in 1989.[31]

Unlike computer use, the use of mathematics on the job is not found to be gender neutral. The last column of Table 35 shows the results on this issue. The coefficient of the math use*male interaction term equals 0.0318. That means that men earn a return to math use that is 3.2 percentage points higher than that of comparable women. Moreover, this difference is statistically different from zero at the 95 percent level of significance. Unfortunately, the evidence on the use of math is limited to 1991.

The final intent of the regression analysis is to determine how the gender wage gap varies across occupation, industry, and education level groups, and whether the

[31]These estimates are based on the regression results in Table 29. If the results of Table 35 are used, the average earning gap was found to have been reduced by one percentage point in 1984 and 1991, and over two percentage points in 1989 due to computer use.

use of computer and math skills impacts on the wage gap in a similar fashion across these groups. The basic regression design used to achieve this objective was as follows:

$$(6) \quad \ln WAGE = A + B*X + C*OCC + D*MALE*OCC + E*COMPUSE*OCC + F*MALE*COMPUSE*OCC$$

In equation (6), the variable OCC refers to vector of dummy variables representing 10 occupational categories. When interacted with the dummy variable MALE, the result is a set of parameter estimates, represented by the coefficient D, indicating the size of the gender wage gap in each of those occupations. The set of coefficients E estimates the returns to computer use by occupation for women. The coefficient F measures the size of any additional returns to computer use received by men by occupation. Thus, the sum of E and F estimates the returns to computer use by occupation for men. Regression equations similar to equation (6) were also used to determine how the returns to computer use vary by gender across industries and education levels. Similarly, variations in the returns to math use were determined by replacing the COMPUSE variable with a MATHUSE dummy variable indicating the use of math on the job.

The principal results from estimating equation (6), and its variants, are shown in Tables 36 and 37. Table 36 reports the findings concerning computer use in 1984 and 1989, whereas Table 37 reports the estimates for both computer and math use in 1991. The first two columns in Table 36 show how the gender wage gap varied across occupations, industries, and education levels in 1984 and 1989. The data in these columns are the regression estimates of coefficient D in equation (6). The corresponding data for 1991 are shown in column (A) in Table 37. With regard to occupations, the gender wage gap is found to be generally the lowest in Professional and Technical, Clerical, and Transport occupations in all years. In 1991, the gender wage gap was about nine percent in Professional and Technical occupations and only about seven percent in Transport occupations. At the high end of the scale are male-dominated occupations such as Precision Production and Crafts, and Operators. In these occupations the gender wage gap is in the neighborhood of 30 percent in all three years. However, the gender wage gap is also very high in some occupations in which women are well represented, such as, Managerial and Administrative, and Sales occupations. The gap in these occupations is also in the order of 30 percent.

As noted earlier in this paper (see Table 31), the returns to computer use vary considerably across occupations. The third and fourth columns in Table 36 show the estimates of coefficient E in equation (6). Similarly, the last two columns in Table 36 report the estimates of coefficient F. These estimates (of coefficient F) show how much more (or less) of a return to computer use was received by men in the various occupational categories. The returns to computer use for women are highest in Precision Production and Crafts, and Operator occupations. These are also the occupations with a high gender wage gap. However, computer use in these occupations has provided women with an opportunity to make a sizeable dent in that gap. For example, in 1989, the return to computer use in Precision Production and Crafts was about 30 percent. But the last column in Table 36 shows that, for men, the corresponding return was about 14 percent lower than that figure. In other words, women using computers in Precision Production and Crafts occupations were able to reduce the gender wage gap in that occupation by 14 percent in 1989. This benefit to women from computer use in Precision Production and Crafts was present also in 1984 and 1991, although by 1991 the benefit had fallen to about 11 percent (see Table 37). Similarly, computer use has helped reduce the gender wage gap in Operators, Farm, and Managerial and Administrative occupations in all three years. Men have consistently received a higher return to computer use in Transport occupations, thereby reinforcing the gender wage gap in that occupation. However, as noted earlier, the gender wage gap in this occupation is on the lower end of the scale. Also, the additional return to computer use received by men had virtually dissipated by 1991.

The gender wage gap shows less variation across industrial groups than across different occupations. In most industries, the gender wage gap was 20 percent or more in 1984 and 1989. However, the gap was generally lower in most industries in 1991. The industry with generally the highest gender wage gap is the Nondurable Goods Manufacturing industry and Mining is the industry with generally the lowest gender wage gap. At the same time, not only were the returns to computer use for women generally the highest in the Nondurable Goods Manufacturing industry, it is also the one industry in which women received a higher return to computer use than men in all three years. Compared to men, women are also apt to receive a higher return to computer use in Durable Goods Manufacturing.

The findings with respect to educational groups show a revealing pattern. Evidence presented in Table 31 had indicated that the returns to computer use are generally equal across different levels of education, but with a tendency to be highest among the least educated. The data in Tables 36 and 37 show that the returns to computer use are steady across education levels only for men. For women, the returns to computer use were found to fall with the level of education in 1984 and 1991. Consider the evidence for 1991. The third column of Table 37 shows that the return to computer use was over 17 percent for women with less than a high school level of education, but was only 10 percent for women with a college degree. The data for 1984 (see Table 36) show that the returns for women with less than a high school education were over 15 percent, but only about 9 percent for college graduates. In 1989, however, women of all levels of education earned a rate of return in the neighborhood of 13 to 15 percent.

For 1984 and 1991, the returns to computer use by education level for men are determined by the sum of the numbers in the third and fifth columns in Tables 36 and

37. For 1989, it is necessary to sum across columns four and six in Table 36. Performing that exercise shows that, with the exception of those with less than a high school education in 1991, men of any education levels in any year received a rate of return to computer use in the range of 12 to 16 percent. This is similar to the experience of women in 1989, but unlike the experience of women in 1984 and 1991. Clearly, the different experiences of men and women with respect to the returns to computer use by education level is a subject worthy of future research.[32]

Tables 38 and 39 show the gender wage gap in nontraditional and emerging occupational groups. Not surprisingly, the gender wage gap tends to be high in Traditionally Male and Production occupations. The high level of the gender wage gap in Information occupations--almost 30 percent is somewhat unexpected, but it is encouraging to note that the gap is low in Fast Growth occupations. Computer use does help to reduce the gender wage gap in Traditionally Male and Gender Neutral occupations, but conversely, it increases the gender wage gap in Traditionally Female occupations where men receive a higher return to computer use than women. It is

[32]The findings concerning the returns to computer use by education level by gender were confirmed by regressions in which a continuous years of schooling variable, instead of education level dummy variables, was used. However, in these regressions the decline in the rate of return to computer use with higher education for women was not as pronounced. That is because, in regressions with a continuous years of schooling variable, the rate of return to computer use for women with less than a high school education was estimated to be about three percentage points lower. As a result, in 1989, the return to computer use for women was found to first increase slightly with education and then decrease slightly. For men, the rate of return to computer use was found to be even more alike across education levels in regressions using a continuous years of schooling variable.

notable that women receive a significantly higher rate of return to cmputer use in Traditionally Male occupations in comparison to Traditionally Female occupations. The returns to computer use for men are similar across these two occupational groups.[33] No clear pattern emerges with respect to the returns to computer use in any other of the alternative occupational categories.

[33]For women, the returns to computer use are given by columns 3 and 4 in Table 38 and column 3 in Table 39. For men, the returns are given by the sum of columns 3 and 5, and 4 and 6, in Table 38 and the sum of columns 3 and 5 in Table 39.

TABLE 36
THE GENDER WAGE GAP AND THE RETURNS TO COMPUTER USE FOR MALES AND FEMALES BY OCCUPATION, INDUSTRY, AND LEVEL OF EDUCATION: 1984 AND 1989

	Gender Wage Gap		Returns of Computer Use		Additional Return to Computer Use for Males	
OCCUPATION	1984	1989	1984	1989	1984	1989
Professional and Technical	0.1171*	0.1648*	0.0652*	0.1471*	0.0730*	-0.0221
Managerial and Administrative	0.2418*	0.2846*	0.1057*	0.1411*	-0.0015	-0.0415
Sales	0.3068*	0.2962*	0.1432*	0.1494*	0.0103	-0.0270
Clerical	0.1165*	0.1543*	0.0692*	0.1000*	0.0269	-0.0438
Precision Prodn. and Crafts	0.3690*	0.3320*	0.4090*	0.2935*	-0.2828*	-0.1358
Operators	0.2864*	0.3172*	0.2500*	0.2098*	-0.1697*	-0.0190
Transport Occupations	0.1313*	0.1410*	-0.3233	0.0635	0.4647	0.0975
Handlers	0.2032*	0.1232*	0.1928	-0.0601	-0.2577	0.2320
Service Ex. Private Household	0.1859*	0.1583*	0.2800*	0.2035*	-0.0081	0.0597
Farm	0.2373*	0.1855*	0.0510	0.3095	-0.0816	-0.2778
INDUSTRY						
Mining	0.0679	0.1703	-0.0009	0.0209	0.0083	-0.0057
Construction	0.2210*	0.2520*	0.0205	-0.0522	0.1135	0.0291
Manufacturing, Durable	0.2372*	0.2702*	0.1406*	0.2308*	0.0130	-0.0651
Manufacturing, Nondurable	0.2967*	0.3123*	0.2478*	0.2278*	-0.1663*	-0.0291
Transportation and Utilities	0.1230*	0.2946*	0.0981*	0.1759*	0.0645	-0.0353
Trade	0.2196*	0.1998*	0.1526*	0.1256*	-0.0137	0.0389
FIRE	0.2499*	0.2379*	0.0311	0.1060*	0.0646	0.0278
Service	0.1603*	0.1424*	0.1461*	0.1850*	0.0164	-0.0152
Federal Government	0.2158*	0.2529*	0.1341*	0.1061	-0.0151	-0.1205
State Government	0.1474*	0.2178*	-0.0090	0.1123*	-0.0362	-0.0957
Local Government	0.2158*	0.2024*	0.0303	0.0573*	0.0016	0.0069
Farming	0.1149*	0.1463*	-0.1582	-0.0326	0.2459	0.0535
EDUCATION LEVEL						
Less than High School	0.2188*	0.2083*	0.1522*	0.1513*	-0.0208	-0.0120
High School	0.2343*	0.2584*	0.1101*	0.1368*	0.0178	0.0020
College: 1-3 Years	0.1914*	0.1676*	0.0965*	0.1296*	0.0394	-0.0007
College: 4+ Years	0.1785*	0.2021*	0.0888*	0.1395*	0.0282	-0.0005

*Significantly different from zero at the 5 percent level.

Note: All data are parameter estimates from regression equations. See Appendix D for standard errors of parameter estimates.

TABLE 37
THE GENDER WAGE GAP AND THE RETURNS TO COMPUTER USE FOR MALES AND FEMALES BY OCCUPATION, INDUSTRY, AND LEVEL OF EDUCATION: 1991

	Gender Wage Gap		Returns to:		Additional Return to Computer Use for Males	
OCCUPATION	(A)	(B)	Computer Use	Math Use	Computer Use	Math Use
Professional and Technical	0.0883*	0.1242*	0.0511*	0.0341	0.0688*	0.0165
Managerial and Administrative	0.3014*	0.2600*	0.1535*	0.0602*	-0.0781*	-0.0184
Sales	0.2812*	0.2218*	0.1430*	0.0434	0.0339	0.1229*
Clerical	0.1412*	0.1475*	0.0757*	0.0411*	0.0531	0.0061
Precision Prodn. and Crafts	0.2844*	0.2026*	0.2662*	0.0317	-0.1097*	0.0726
Operators	0.2791*	0.2528*	0.3087*	0.1202*	-0.1297*	-0.0057
Transport Occupations	0.0655	0.1073	0.0914	0.1507	0.0160	-0.1055
Handlers	0.1521*	0.1007	0.0664	-0.0016	0.0766	0.1308
Service Ex. Private Household	0.1545*	0.1522*	0.2374*	0.0980*	0.0395	0.0449
Farm	0.1939*	0.2453*	0.7834*	0.2081	-0.9426*	-0.2886
INDUSTRY						
Mining	0.0989	0.4871	-0.1316	0.3025	0.2785	-0.2464
Construction	0.1661*	0.1939*	-0.0122	0.0410	0.1219	0.0452
Manufacturing, Durable	0.2786*	0.2393*	0.2210*	0.0916	-0.1076*	-0.0229
Manufacturing, Nondurable	0.2577*	0.2336*	0.2326*	0.1380	-0.0168	0.0154
Transportation and Utilities	0.1545*	0.1913*	0.0924	0.1251	0.0601	-0.0238
Trade	0.1962*	0.1695*	0.1082*	0.0124	0.0737*	0.0876*
FIRE	0.2373*	0.1920*	0.1207*	0.0502	0.0366	0.0790
Service	0.1099*	0.0894*	0.1305*	0.0749	0.0354	0.0648*
Federal Government	0.1688*	0.1763*	0.0443	0.0055	0.0242	0.0042
State Government	0.1316*	0.1955*	0.0779	0.1582	0.0202	-0.0835
Local Government	0.2537*	0.2469*	0.0464	-0.0189	-0.0453	-0.0129
Farming	0.1759*	0.2747*	0.1722	0.1380	-0.2592	-0.2654*
EDUCATION LEVEL						
Less than High School	0.1430*	0.1183*	0.1724*	0.0365	-0.1083	0.0430
High School	0.2361*	0.2177*	0.1284*	0.0655*	0.0152	0.0307
College: 1-3 Years	0.1723*	0.1776*	0.1120*	0.0619*	0.0310	0.0081
College: 4+ Years	0.1615*	0.1604*	0.0962*	0.0579*	0.0594*	0.0569

*Significantly different from zero at the 5 percent level.

Note: All data are parameter estimates from regression equations. See Appendix D for standard errors of parameter estimates.

TABLE 38
THE GENDER WAGE GAP AND THE RETURNS TO COMPUTER USE FOR MALES AND FEMALES IN NONTRADITIONAL AND EMERGING OCCUPATIONS: 1984 AND 1989

OCCUPATION	Gender Wage Gap		Returns to Computer Use		Additional Returns to Computer Use for Males	
	1984	1989	1984	1989	1984	1989
Traditionally Female	0.1414*	0.1057*	0.0939*	0.1265*	0.0710*	0.0565
Gender Neutral	0.2227*	0.2629*	0.2414*	0.2480*	-0.0692	-0.1063*
Traditionally Male	0.2091*	0.1947*	0.2213*	0.2152*	-0.0552	-0.0059
Information	0.2621*	0.3042*	0.0799*	0.1115*	0.0340	-0.0064
Information/Production	0.1133*	0.1085*	0.0834*	0.1729*	-0.0009	-0.0772
Production	0.2707*	0.2331*	0.1800*	0.1432*	-0.0075	0.0268
Fast Growth	0.1363*	0.1499*	0.2249*	0.2581*	0.0394	-0.0336
Above Average Growth	0.2349*	0.2461*	0.1326*	0.1694*	0.0255	-0.0013
Below Average Growth	0.2407*	0.2092*	0.1069*	0.0890*	-0.0361	0.0300
Slow Growth	0.2595*	0.2624*	0.1216*	0.1799*	-0.0142	0.0175

*Significantly different from zero at the 5 percent level.

Note: All data are parameter estimates from regression equations. See Appendix D for standard errors of parameter estimates.

TABLE 39
THE GENDER WAGE GAP AND THE RETURNS TO COMPUTER AND MATH USE
FOR MALES AND FEMALES IN NONTRADITIONAL AND EMERGING OCCUPATIONS: 1991

OCCUPATION	Gender Wage Gap		Returns to Computer Use		Additional Returns to Males for	
	Noncomputer Users	Nonmath Users	Computer Use	Math Use	Computer Use	Math Use
Traditionally Female	0.0959*	0.0886*	0.1090*	0.0670*	0.0618*	0.0477
Gender Neutral	0.2045*	0.1994*	0.2369*	0.1616*	-0.0363	-0.0336
Traditionally Male	0.1839*	0.1599*	0.2165*	0.1213*	-0.0195	-0.0005
Information	0.2773*	0.2710*	0.0980*	0.0693*	0.0148	0.0122
Information/Production	0.0062	0.0386	0.0942*	0.0576	0.0456	-0.0129
Production	0.2210*	0.1935*	0.1505*	0.0551*	0.0129	0.0590*
Fast Growth	0.1179*	0.1221*	0.2270*	0.1543*	0.0110	0.0156
Above Average Growth	0.2295*	0.2099*	0.1453*	0.0510*	0.0054	0.0236
Below Average Growth	0.1849*	0.1516*	0.1066*	0.0614*	0.0478	0.0486
Slow Growth	0.2268*	0.2034*	0.1555*	0.1109*	0.0333	0.0038

*Significantly different from zero at the 5 percent level.

Note: All data are parameter estimates from regression equations. See Appendix D for standard errors of parameter estimates.

5. Conclusions

This paper has examined the role of computer and mathematical skills in the U.S. labor market over the period 1984 to 1991. Particular attention was given to the actual and potential effect of these workplace skills on the economic status of women. The time period studied in this paper was one of significant developments in the U.S. labor market. It was a period in which the wage premium for higher skill workers increased despite an overall increase in the supply of college graduates. This shift in the wage structure has been attributed, in part, to an increase in the demand for workers capable of utilizing the newer technologies in use in the workplace. Computer technologies are the leading example of these new technologies.

The data for this project were collected from the Current Population Surveys of October 1984, October 1989, and January 1991. These data confirmed the overall increase in the education level of workers in the U.S. economy. The percentage share of college graduates among women, for example, increased by four percentage points between 1984 and 1991. The corresponding figure for men was three percentage points. At the same time, computer use spread rapidly in the workplace. In 1991, 45 percent of women used computers on the job compared to only 27 percent in 1984. Men increased their rate of computer use from 19 percent to 34 percent. Among the college educated, computers are currently used by over 60 percent of both men and women. The higher rate of computer use among women is prevalent at all other levels of education.

In sum, the data show that women are much more likely than men to need computer skills in the labor market. Further, the gap in the rate of computer use among men and women widened between 1984 and 1991. The main reason for the higher rate of computer use among women appears to be the gender segregation of occupations and industries. When occupations were classified according to whether they are primarily information-processing occupations or production occupations, 55 percent of women in 1991 were found to be employed in information-processing occupations, compared to only 37 percent of men. Conversely, 50 percent of men were employed in production occupations compared to only 37 percent of women. Information-processing occupations are, of course, the most likely to require computer skills. The 1991 data indicated, for example, that information-processing occupations require computer use at a rate four times as high as the rate required in production occupations.

The outlook for computer use among women in the near future is ambiguous. Almost 60 percent of women are employed in occupations projected to grow faster than average between the years 1990 and 2005 by the BLS. However, the probability that a woman will use a computer in these occupations is not as high as the probability that she will use one in the below-average-growth occupations. On the other hand, while men are just as likely as women to be employed in the fast-growing occupations, they are much more likely to use a computer in these occupations compared to men in the slow-growing occupations. Thus, the gap in the rate of computer use among men and women ought to narrow in the near future if occupational growth proceeds according to BLS projections.

The use of computers was found to be highly correlated with the use of math on the job. As an older workplace skill, the use of math is much more uniform and prevalent across occupations and industries. Like computer skills, however, the use of math on the job is more prevalent among the more educated. Further, 93 percent of those using a computer on the job were also found to use mathematical skills. Similarly, 58 percent of math users reported utilizing computers on the job. Thus, math and computer skills are complementary skills frequently used in tandem.

A principal element of this research was the estimation of the economic returns to computer and math use in the U.S. labor market. The regression analysis showed that, depending upon the estimation strategy, the economy-wide returns to computer use ranged from 13.1 percent to 18.8 percent in 1991. These estimates were about two percentage points higher than the corresponding returns in 1984. The increase in the returns to computer use suggests some of both continuing excess demand for these skills and increasing productivity gains from computers. In terms of the future, the occupations projected to grow the fastest by the BLS were also found to yield a significantly higher return to computer skills than the slower growing occupations. Thus, the probability of continuing high returns to computer use remains high.

The economic returns to math use were found to range from 7.4 percent to 11.4 percent in 1991. However, because of the close relationship between computer and math use, further regression analysis was done to sort the economic returns from the use of one skill from the returns due to the other skill. It was found that the returns to math use alone are low--only 2.4 percent in 1991. However, the returns to computer use alone are as high as 11.2 percent, and those who use both math and computers earn a return of 15 percent. Thus, even as the computer revolution enters its second decade, the ability to use computers remains a valued skill. It may be a while before information-processing technologies saturate the labor market to the point where the returns to computer use fall to the level of the returns to math use.

An important question addressed in this research was whether men and women have shared equally in the benefits of computer use. The broader issue is whether the introduction of computers has contributed to the observed reduction in the gender wage gap during the 1980s. The principal finding of the regression analysis was that, at the level of individual workers, computer skills reward men and women equally well. However, since women use computers at higher rate than men, relatively more women than men have enjoyed the benefits of the productivity gains associated with computers. On average, therefore, the earnings of women as a group have increased by more than the earnings of men as a group due to the introduction of computers. In that sense, computer use was found to have reduced the gender gap in average earnings by about one percentage point in 1984 and one and one-half percentage points in 1991. Thus, not only has the computer revolution reduced the gap in average earnings between men and women at any given point in time, it has done so with greater impact in recent times.

The overall similarity in the returns to computer use across men and women, however, conceals considerable variations across occupations, industries, and education levels. With regard to occupations, the highest average returns to computer and math use were found to be in Service occupations. For women, though, the highest returns to computer use were in Precision Production and Crafts, and Operator occupations. Further, women received considerably higher returns to computer skills in these occupations than men. As a result, computer use contributed significantly to a reduction in the high gender wage gap in these traditionally male occupations. A similar pattern emerged with respect to the variation in the returns to computer use across industries and gender groups. Computer skills were rewarded the most in the Nondurable Goods Manufacturing industry. That was also the industry with the highest gender wage gap, but again computers contributed to the reduction in that gap by yielding women a higher return than men.

In the case of nontraditional and emerging occupations, it was found that women receive higher returns to computer use in Traditionally Male and Gender Neutral occupations than in Traditionally Female occupations. For men, the returns to computer use were generally alike across these occupations. This may indicate that women in Traditionally Female occupations use the computer for more routine, support type purposes rather than for potentially more rewarding analytical purposes. Further research on the issue of the returns to computer use by type of computer skill is warranted.

Variations in the returns to computer use across education levels showed different patterns across men and women. For both sexes combined, the returns to computer use were found to be fairly constant across education levels. However, for women alone, the returns to computer skills appear to diminish with higher levels of education, while the returns to computer use are generally even across education levels for men. The differences across gender groups in this context may be, in part, due to differences in the underlying wage structures between men and women. Discovering the full extent of the causal factors is a subject worthy of future research.

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Appendix A

Alternative Classifications of Occupations

The purpose of this appendix is to detail the construction of the alternative occupational classifications used in Section 3.B. of the main text.

Table A.1. lists the two-digit occupational classes used in the CPS. However, the occupations are sorted according to the share of women in the total employment in each occupation in 1991. Overall, women comprised 46.3 percent of the employed labor force in that year. In the occupations grouped together as "Traditionally Female," the share of women in occupational employment ranges from a low of 52.1 percent in Management Related occupations to a high of 98.3 percent in the group of Secretaries, Stenographers, and Typists. The Traditionally Female occupations comprise 14 of the 44 occupational class listed in Tabie A.1. Another eight occupations are equally composed of men and women. In this "Gender Neutral" occupational group, the employment share of women ranges from 39.6 percent in the Teachers, College and University, and Fabricators, etc. groups to 50.6 percent in the Other Professional Specialty occupations. The remainder of the occupations, 22 out of the 44 occupations, are assigned to the "Traditionally Male" group. In this group, the employment share of women ranges from 2.2 percent in Construction Trades to 38.9 percent in Mail and Message Distribution occupations.

Table A.1. also shows the shares of women in occupational employment in 1989 and 1984. Those data indicate that with one or two exceptions, the classifications based on 1991 data are the same as those that would have emerged from the 1989 or 1984 data. For example, in 1984, Management Related occupations would have been considered Gender Neutral. Similarly, Administrators and Officials and College and University Teachers would have been considered Traditionally Male in 1984. The reclassification of these occupations in 1991 is indicative of the advances, albeit limited, made by women into male-dominated occupations between 1984 and 1991.

Table A.2. shows how occupations are classified according to the projected growth rate in their employment between 1990 and 2005. The projected growth rates shown in Table A.2. were derived from data reported by Silvestri and Lukasiewicz (1991). The projections refer to the moderate growth scenario used by the BLS. Overall, employment in the U.S. economy is expected to increase by 20 percent between 1990 and 2005. However, 12 occupations are expected to have growth equal to or in excess of 30 percent and are classified here as fast growing. Similarly, expected growth of 20-29 percent is referred to here as Above Average Growth, and growth between 10 and 19 percent is classified as Below Average Growth. Slow Growth occupations are expected to grow at rates below 10 percent.

A question worth asking is whether employment growth is expected to favor the Traditionally Male or Traditionally Female occupations. The answer is, on the whole, neither. A closer examination of Tables A.1 and A.2 reveals that 13 of the 22 Traditionally Male occupations are expected to grow at rates in excess of 20 percent. Similarly, 9 out of the 14 Traditionally Female occupations are expected to grow at rates exceeding 20 percent. However, Traditionally Female occupations do have an edge in the group of Fast Growing occupations. Six of the 12 Fast Growing occupations are Traditionally Female, two are Gender Neutral, and four are Traditionally Male. The six Traditionally Female occupations that are expected to grow fast are Management Related, Health Assessment and Treating, Health Technologists and Technicians, Food Services, Health Services, and Personal Services occupations. The Traditional Male occupations that are also expected to grow fast are Mathematical and Computer Scientists, Lawyers and Judges, Protective Services, and Forestry and Fishing occupations. Notably, women have increased their employment share in the Mathematical and Computer Scientist group from 31.3 percent in 1984 to 36.6 percent in 1991.

A classification of occupations by their primary activity is shown in Table A.3. Information Processing occupations are defined as those in which the primary activity is the creation, gathering, and/or dissemination of information or knowledge. Production occupations involve activities that directly result in the creation of a good or a service. Information and production occupations are a blend of the two activities.

The classifications follow the work of Porat (1977), and Osberg, Wolff, and Baumol (1989). A closely related system of classification is to be found in Reich (1992). It should, however, be noted that the classification of occupations by primary activity remains subjective. For example, Mail and Message Distribution occupations also involve the production of a service, but are classified here among Information occupations because their primary function is the distribution of information.

TABLE A.1.
PERCENTAGE SHARE OF WOMEN IN OCCUPATIONAL EMPLOYMENT

	1984	1989	1991
Traditionally Female			
Secretaries, Stenographers and Typists	97.7	98.3	98.3
Financial Records Processing	91.2	93.0	91.9
Health Services	91.0	90.1	90.9
Health Assessment and Treating	86.8	84.9	86.6
Health Technologists	83.3	85.8	83.6
Personal Service	82.7	84.5	81.4
Other Administrative Support	74.6	76.2	75.1
Other Teachers	70.4	74.3	73.0
Computer Equipment Operators	70.4	64.9	70.5
Sales Workers, Retail and Personal Services	70.4	69.5	67.3
Sales Related	71.9	70.3	60.5
Food Service	65.3	62.4	60.1
Supervisors-Administrative Support	50.7	58.8	58.8
Management Related	45.4	50.4	52.1
Gender Neutral			
Other Professional Specialty	44.1	49.2	50.6
Administrators and Officials, Public Administration	33.3	43.1	45.8
Sales Representatives, Finance and Business Service	39.2	43.8	45.1
Cleaning and Building Service	41.6	45.1	43.7
Machine Operators and Tenders, Except Precision	43.0	42.8	42.5
Technicians, Except Health Engineering and Science	37.3	36.4	41.8
Teachers, College and University	33.7	39.8	39.6
Fabricators, Assemblers, Inspectors and Samplers	40.0	39.9	39.6

TABLE A.1. (contd.)

Traditionally Male	1984	1989	1991
Mail and Message Distributing	29.0	36.4	38.9
Other Executives, Administrators, and Managers	30.8	36.7	38.0
Mathematical and Computer Scientists	31.3	37.5	36.6
Supervisors and Proprietors, Sales	31.3	34.5	35.0
Natural Scientists	18.8	27.6	28.7
Other Handlers, Equipment Cleaners, and Laborers	22.7	27.8	23.6
Other Precision Production Occupations	22.3	23.6	22.9
Engineering and Science Technicians	20.3	20.4	21.8
Sales Representatives, Commodities Except Retail	17.1	21.0	21.1
Lawyers and Judges	20.1	23.6	20.3
Freight, Stock and Material Handlers	20.4	19.3	19.3
Farm Workers and Related	21.8	20.6	19.2
Health Diagnosing	11.1	19.7	18.5
Farm Operators and Managers	12.3	16.6	17.5
Protective Service Occupations	13.1	15.4	12.8
Motor Vehicle Operators	9.9	11.5	11.4
Engineers	6.3	8.3	7.8
Forestry and Fishing	6.0	4.7	5.6
Construction Laborer	3.9	4.2	3.7
Other Transportation and Material Moving	4.3	3.9	3.7
Mechanics and Repairers	3.3	4.1	3.7
Construction Trades	2.1	2.1	2.2

TABLE A.2
PROJECTED GROWTH IN OCCUPATIONAL EMPLOYMENT, 1990-2005

	Projected Growth (%)
All Occupations	20
Fast Growing	
Mathematical and Computer Scientists	73
Engineering and Science	46
Health Services	44
Personal Service	44
Health Assessment and Treating	43
Health Technologists and Technicians	42
Lawyers and Judges	34
Protective Service	32
Forestry and Fishing	31
Management Related	30
Food Service	30
Other Professional Specialty	30
Above Average Growth	
Other Teachers	29
Health Diagnosing	29
Other Executives, Administrators, and Managers	27
Administrators and Officials, Public Admin.	27
Motor Vehicle Operators	26
Engineers	26
Supervisors and Proprietors, Sales	24
Sales Representatives, Commodities Except Retail	24
Engineering and Science Technicians	24
Sales Representatives, Finance and Business	24
Sales Related	24
Personal Services	24
Construction Trades	21
Natural Scientists	21
Below Average Growth	
Teachers, College and University	19
Cleaning and Building Service	18
Other Administrative Support	18
Supervisors, Administrative Support	18
Mechanics and Repairs	16

TABLE A.2. (contd.)

	Projected Growth %
Mail and Message Distributing	15
Construction Laborer	15
Computer Equipment Operators	13
Freight, Stock and Material Handlers	12
Other Handlers, Equipment Cleaners and Laborers	11
Other Transportation Occupations	10
Slow Growing	
Secretaries, Stenographers and Typists	9
Other Precision Production	4
Fabricators, Assemblers, Inspectors and Samplers	0
Financial Records, Processing	-4
Machine Operators and Tendors, Except Precision	-7
Farm Workers and Related	-8
Farm Operators and Managers	-16

TABLE A.3

OCCUPATIONAL CATEGORIES BY PRIMARY FUNCTION

(Numbers in parentheses are CPS three-digit occupation codes)

Information Processing

Executives, Administrative and Managerial (3-37)
Engineers, Architects and Surveyors (43-63)
Mathematical and Operations Research (64-68)
Computer Programmers (229)
Computer Operators (308)
Peripheral Equipment Operators (309)
Natural Scientists (69-83)
Social Scientists and Urban Planners (166-173)
Teachers, and Vocational and Educational Counselors (113-163)
Librarians, Archivists and Curators (164-165)
Editors, Reporters, Announcers and Public Relations (195-198)
Air Traffic Controllers (227)
Broadcast Equipment Operators (228)
Legal Assistants (234)
Technical Writers (184)
Supervisors and Proprietors, Sales Occupations (243)
Sales Representatives and Related Occupations (253-259, 283-285)
Supervisors, Administrative Support Occupations (303-307)
Secretaries, Stenographers and Typists (313-315)
General Office and Information Clerks (316-323)
Financial and Other Record Processing Clerks (325-344)
Mail and Message Distributing (354-357)
Duplicating, Mail and Other Office Machine Operators (345-347)
Communications Equipment Operators (348-353)
Material Recording, Scheduling and Distributing Clerks (359-374)
Adjusters and Investigators (375-378)
Misc. Administrative Support (379-389)
Precision Inspectors, Testers and Related Workers (689)
Production Inspectors, Testers, etc. (796-798)

TABLE A.3 (contd.)

Information/Production

Social, Recreation and Religious Workers (174-177)
Lawyers and Judges (178-179)
Health Diagnosing Occupations (84-89)
Health Assessment and Treating Occupations (95-106)
Writers, Artists, Entertainers and Athletes (183, 185-194, 199)
Health Technologists and Technicians (203-208)
Science, Engineering and Related Technicians (213-225)
Airplane Pilots and Navigators (226)
Technicians, n.e.c. (235)
Supervisors, Protective Service Occupations (413-415)
Supervisors, Food Preparation (433)
Supervisors, Cleaning and Building Services (448)
Supervisors, Personal Service (456)
Farm Operators and Managers (473-476)
Supervisors, Farm Workers (477)
Supervisors, Related Agriculture Occupations (485)
Supervisors, Forestry and Logging (494)
Supervisors, Mechanics and Repairers (503)
Supervisors, Construction and Extractive Occupations (553-558, 613)
Supervisors, Production Occupations (633)
Supervisors, Motor Vehicle Operators (803)
Supervisors, Material Moving Equipment Operators (843)
Supervisors; Handlers, Equipment Cleaners, etc. (863)

Production

Tool Programmers, numerical control (233)
Sales Workers, Retail and Personal Services (263-278)
Private Household Occupations (403-407)
Protective Service Occupations (416-427)
Other Service Occupations (434-447, 449-455, 457-469)
Other Agricultural and Related Occupations (479-484, 486-489)
Forestry and Logging Operations (495-496)
Fishers, Hunters and Trappers (497-499)
Mechanics and Repairers (505-549)
Construction Trades (563-599)
Extractive Occupations (614-617)
Precision Production Occupations (634-688, 693)
Plant and System Operators (694-699)

TABLE A.3 (contd.)

Machine Operators and Tenders (703-779)
Fabricators, Assemblers and Hand Working Occupations (783-795)
Graders and Sorters, ex. agricultural (799)
Transportation Occupations (804-834)
Material Moving Occupations (844-859)
Helpers (864-873)
Handlers, Equipment Cleaners and Laborers (875-889)

Appendix B

Job Training Requirements and Skill Upgrades

Computer and math skills are, of course, only two among the various skills required to obtain a job and t‸ perform satisfactorily in that job. Other principal job skills include the ability to read and write adequately. This appendix describes the pattern of training requirements by occupation, industry, education level, and gender. The relationship between initial training and subsequent training to improve job skills is also examined. The discussion is based only on January 1991 CPS data because similar data were not available for 1984 and 1989.[34]

Table B.1. shows that computer use is now as important a skill as reading or writing among those who use these skills at least once a week. On the other hand, Table B.2. reveals that a significantly higher number of individuals felt that they were inadequately prepared in the use of computers as opposed to reading, writing, and math. With no more than two percent of individuals reporting inadequacy with respect to reading, writing, or math skills, lack of workplace literacy in the "three R" skills does not appear to be a problem, at least from the point of view of workers. It should also be noted that this result is based on a sample of the employed.

[34]This appendix complements a pair of BLS reports on the training of workers. See U.S. Department of Labor, 1985 and 1992.

Workplace literacy may be lacking at a much higher rate among the unemployed. However, a significant number of employed individuals--14.4 percent--feel unprepared in the use of computer skills. Thus, it appears that literacy efforts may need to pay more attention to the problem of inadequacy in emerging technologies. Not surprisingly, an individual's feeling of inadequacy with respect to computer skills is directly related to that individual's overall level of education. Table B.3 shows that only about 12 percent of college-educated men or women feel inadequately prepared for computer use compared to almost 20 percent of those without a high school degree. Conversely, over 60 percent of college graduates report adequate preparation, compared to only about 30 percent of those without a high school degree. On the whole, women seem better prepared in the use of computer than men, especially among those with a high school degree or only one to three years of college.[35] However, the high rate of nonresponse, especially among men, to this question in the CPS dataset may have a bearing on this finding.

The data in Table B.4 show, by major occupation, the percentage of individuals who were required to have some training to obtain a job. The table also shows the percentage of individuals taking training to improve their occupational skills.[36] One

[35]In the aggregate, 15.6 percent of men and 13.1 percent of women reported inadequate skills in computers, while 44.1 percent of men and 54.2 percent of women reported adequate skills. The nonresponse rate was 40.4 percent of men and 32.7 percent for women.

[36] The data in all tables on training and skill upgrades in this appendix are based on the sample of individuals who responded to the questions on training. The

pattern that emerges from Table B.4 is the strong association between entry level training requirements and subsequent training to improve skills. Occupations that are more likely to require training prior to entry are also more likely to require additional training at some point in the career path. For example, Executives and Managers are not only trained at a high rate prior to entry but also take further training at a high rate. On average, men and women are equally likely to possess initial training and enter subsequent training to improve their skills. However, the overall similarity conceals some significant variation at the occupational level. For example, men are much more likely than women to have initial and subsequent training in Sales occupations, while the opposite pattern holds for Administrative Support occupations.

Table B.5 looks at the pattern of training requirements and skill upgrades by industry. As is the case with occupations, industries that require entry level training are also more likely to require follow-up training. Somewhat notable is the very high rate of retraining reported in the Public Administration industry.

The association between initial and subsequent training is also evident in a breakdown of the data by the level of education. Table B.6 shows that the most educated are also the most likely to take additional training to improve their occupational skills. About 34 percent of college graduates who responded to the questions on training are in jobs with entry-level training requirements. Further, over

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nonresponse rate was approximately 24 percent for men and 18 percent for women.

60 percent of college graduates take training to improve their skills compared to a rate of less than 20 percent for those with less than a high school level of education. Clearly, college education is valuable not just for initial entry into jobs but also for subsequent advances in the career path.

Tables B.7 and B.8 address the issue of the timing with which people take training to improve their occupational skills. Table B.7 shows the percentage of individuals taking training to upgrade their skills by age group. The data in Table B.7 may be interpreted as a cumulative distribution of skill upgrades. For example, 19 percent of individuals in the age group 16-19 years reported having taken training to improve their skills. The rate for the age group 20-24 years is 29 percent. These data can be interpreted to mean that of those in the age group 20-24 years, 19 percent took some training before age 20 and another 10 percent took their training after age 20. On that basis, Table B.7 indicates that if individuals take training to improve their skills, they do so mostly before age 40. By that age, almost one-half of women, as well as men, have taken training to improve their job skills. However, the greatest likelihood of taking training occurs between ages 16-29 years.[37]

Table B.8 considers the question of the timing of training by looking at the occupational tenure of individuals. Occupational tenure refers to the number of years

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[37] The data for ages 55 and above are affected by the small number of observations and a very low response rate.

individuals report to have spent in the same occupation, if not necessarily in the same job. The data in Table B.8 show that the likelihood of taking training to improve skills peaks about 10 years into a person's occupational career path. Compared to men, the peak occurs somewhat later for women.

Table B.9 details the types of training taken by individuals to upgrade their skills. Four broad categories of training were defined on the basis of available CPS data--reading, writing, and math; computer; other technical; and other training, including managerial and supervisory. Individuals may report having taken only one type of training or any other combination of the four types of training. All told, there are 15 possible combinations of training types. The first two columns in Table B.9 show that individuals are most likely to take some form of technical training in isolation. About 40 percent of men who took some training, took technical training alone. The similar rate for women is 33 percent. Managerial and related training is the next most likely form of training. Computer training, taken in isolation, is far more significant for women than for men. That is in accordance with the higher rate of computer use among women. However, when computer training is taken in combination with other types of training, the rate is about the same for men and women.

The last two columns of Table B.9 show whether or not men and women are equally likely to take different types of training to upgrade their skills. The data show that, when taken in isolation, women form a significant majority of individuals taking computer, and reading, writing, and math training. Men form the majority of those taking technical training alone, and men and women share equally in taking other types of training, including managerial training. This basic pattern holds even when training in any one of these basic skills is taken in combination with other skills.

Tables B.10, B.11, and B.12 consider the question of the types of training individuals are required to obtain a job. Table B.10 shows the percentage distribution of men and women across occupations by their level of education in 1991. If individuals generally obtain only the level of education necessary to obtain a job, the data in Table B.10 can also be interpreted to show the educational requirements by occupation. College degrees are especially in demand in Professional Specialty, and Executive, Administrative, and Managerial occupations. In the latter occupation, however, there are considerably more men than women with college degrees--52 percent of men versus 37 percent of women. Similarly large disparities also exist in Sales and Administrative Support occupations.[38] Table B.11 shows that, in virtually every industry, men are more likely to possess a college degree than women. Surprisingly enough, the exceptions are Agriculture, Mining, and Construction. This type of disparity is a strong indicator of the fact that in most industries and occupations women are still more likely to be found in supporting jobs.

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[38]For the sake of brevity, data for 1984 and 1989 are not included in this part of the report. However, it can be reported that educational requirements went up in virtually every occupation and industry between 1984 and 1991. In a typical occupation, for example, the percentage of individuals with a college degree went up by 2 to 3 percentage points.

The January 1991 CPS questionnaire asked individuals about several types of training they may have needed to obtain their jobs. Principal among these were formal education, formal company training, and informal on-the-job training. Other types of training included armed forces training, correspondence courses, etc. Thus, based on CPS data, individuals were defined to have received one or more of four principal types of training: formal education; company training; informal job training; and other training. These four types of training lead to 15 possible combinations of training that may be possessed by individuals. The gender distribution of these various types of training required to obtain a job is shown in Table B.12.

The data in Table B.12 show that, of those individuals required to have training to obtain a job, formal education is the most likely form of requirement. Taken in isolation, formal schooling was required of 27 percent of men and 39 percent of women. Next in importance to formal education is informal on-the-job training, followed by a combination of both formal education and informal on-the-job training. Generally speaking, formal education is more likely to be required of women than men. Also, even though it is of secondary importance, men are more likely to possess formal company training.

The data in Table B.12 reveal that about two-thirds of both men and women were required to possess only one of the four basic types of training to obtain a job. Similarly, Table B.9 indicates that over 60 percent of men and women took only one of four types of training to upgrade their job skills. Table B.13 shows how these four types of principal requirements to obtain jobs or to improve skills vary by occupation. The occupational groupings used in the table are the alternative categories defined in Appendix A. With respect to training requirements to obtain a job, the data in Table B.13 provide clear evidence of the importance of formal schooling in Fast Growth occupations. Informal job training is the more likely form of training requirement in Slow Growth occupations. Similarly, informal job training is more likely to be satisfactory in Production and Traditionally Male occupations. In fact, in Traditionally Male occupations, informal job training is almost as important a requirement as formal schooling. Traditionally Female and Information occupations are much more likely to require formal schooling.

With respect to skill upgrades, Technical training is the most likely form of requirement in all occupations, followed by Other types of training, including managerial training. Computer training is more prevalent in Traditionally Female and Information occupations, and, surprisingly, in the occupations expected to grow more slowly in the near future. The latter result may be an indication that the slower growing occupations are attempting to catch up with emerging workplace technologies. Finally, regardless of occupation, very few individuals needed to upgrade their skills with respect to reading, writing, and math.

TABLE B.1
USE OF SKILLS AT JOB BY FREQUENCY OF USE, 1991
(% of sample)

Skill	Use of Skill: At Least Once a Week	Less Than Once a Week	Never Using	No Response
Read or use				
Articles or reports	30.9	8.1	39.5	21.5
Forms	51.6	6.5	20.3	21.6
Letters	36.8	9.0	32.1	22.0
Diagrams or plans	33.5	9.0	45.3	22.2
Manuals or rules	37.3	15.2	25.5	22.0
Write memos or reports	41.9	8.6	27.8	21.6
Use math or arithmetic	57.2	5.4	15.8	21.5
Use computer	35.4	3.6	39.6	21.5

TABLE B.2
SKILL ADEQUACY, 1991
(% of sample)

Skill	Adequate Skills	Not-adequate Skills	No Response
Reading	76.9	1.2	21.9
Writing	75.6	2.1	22.3
Math or Arithmetic	75.9	1.7	22.5
Computer	48.8	14.4	36.8

Note: Those who never use a skill may report that they are adequately "trained" in that skill if their job does not require them to use that skill. Thus, for example, more people (48.8 percent of the sample) felt that they were adequately trained in the use of computers than actually used a computer at work (39 percent of the sample).

TABLE B.3
ADEQUACY IN COMPUTER SKILLS BY SCHOOLING AND GENDER, 1991

(% of sample)

	Male			Female		
LEVEL OF EDUCATION	Adequate Skills	Not-adequate Skills	No Response	Adequate Skills	Not-adequate Skills	No Response
Less than High School	26.6	19.0	54.4	32.4	19.8	47.8
High School	37.5	17.6	44.9	51.3	13.6	35.1
College: 1-3 Years	48.3	14.3	37.4	60.2	10.4	29.4
College: 4+ Years	60.5	11.6	28.0	64.2	11.8	24.1

TABLE B.4
PERCENTAGE OF INDIVIDUALS REQUIRED TO HAVE TRAINING TO OBTAIN JOB AND TAKING TRAINING TO UPGRADE SKILLS BY OCCUPATION AND GENDER, 1991

OCCUPATION	Percentage Required to Have Training to Obtain Job		Percentage Taking Training to Upgrade Skills	
	Male	Female	Male	Female
Executive, Administrative, and Managerial	75.0	68.9	53.8	55.3
Professional Specialties	93.3	91.7	66.9	69.6
Technicians and Related Support	85.4	86.4	62.1	60.8
Sales Occupations	51.0	36.0	42.0	29.8
Administrative Support	45.1	56.9	38.4	41.3
Protective Services	62.2	47.5	62.8	55.1
Other Services	29.1	36.5	19.4	27.6
Precision Production, Craft, and Repair	63.8	44.0	38.6	34.3
Machine Operators, Assemblers, and Inspectors	44.0	29.0	28.8	20.0
Transportation and Material Moving	40.5	50.9	23.4	35.3
Handlers, Equipment Cleaners, Helpers, and Laborers	19.7	21.2	16.8	14.3
Farming, Forestry, and Fishing	27.5	29.0	22.2	24.4
All Occupations	58.2	56.6	41.5	42.8

TABLE B.5

PERCENTAGE OF INDIVIDUALS REQUIRED TO HAVE TRAINING TO OBTAIN JOB AND TAKING TRAINING TO UPGRADE SKILLS BY INDUSTRY AND GENDER, 1991

INDUSTRY	Percentage Required to Have Training to Obtain Job		Percentage Taking Training to Upgrade Skills	
	Male	Female	Male	Female
Agriculture	29.0	34.7	22.7	26.0
Mining	63.4	63.9	43.8	52.5
Construction	59.7	57.1	26.1	30.1
Manufacturing--Durable	59.8	45.7	42.9	36.9
Manufacturing--Nondurable	50.9	44.4	38.9	30.2
Transportation	51.3	55.0	35.7	42.8
Communications	72.8	64.6	64.5	59.4
Utilities	65.3	67.8	61.0	53.9
Wholesale Trade	47.7	46.5	36.0	33.7
Retail Trade	36.4	30.1	28.4	22.0
Finance, Insurance, and Real Estate	71.6	64.6	55.3	55.9
Business and Repair Services	64.2	56.9	36.7	32.4
Personal Services	51.2	47.3	26.2	29.2
Entertainment	62.9	49.0	35.1	30.3
Hospitals	72.5	81.3	55.5	62.0
Other Medical	82.2	69.9	64.2	49.5
Education	80.9	76.2	59.4	60.9
Social Services	64.2	56.7	49.5	50.1
Other Professional	85.6	70.8	57.1	42.4
Forestry and Fisheries	59.8	68.0	47.4	76.0
Public Administration	76.8	70.8	71.9	65.0
All Industries	58.2	56.6	41.5	42.8

TABLE B.6

PERCENTAGE OF INDIVIDUALS REQUIRED TO HAVE TRAINING TO OBTAIN JOB AND TAKING TRAINING TO UPGRADE SKILLS BY LEVEL OF EDUCATION AND GENDER, 1991

LEVEL OF EDUCATION	Percentage Required to Have Training to Obtain Job		Percentage Taking Training to Upgrade Skills	
	Male	Female	Male	Female
Less than High School	29.6	25.8	17.4	19.4
High School	48.3	44.7	33.5	35.3
College: 1-3 years	62.8	63.9	46.9	47.5
College: 4+ years	83.6	84.3	61.0	62.3
All Levels of Education	58.2	56.6	41.5	42.8

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TABLE B.7
PERCENTAGE OF INDIVIDUALS TAKING TRAINING TO UPGRADE SKILLS BY AGE GROUP AND GENDER, 1991

Age Group	Male	Female
16-19	19.4	18.9
20-24	29.0	32.5
25-29	38.8	42.0
30-34	42.4	44.7
35-39	48.4	48.7
40-44	49.3	49.9
45-49	49.5	48.9
50-54	45.2	45.6
55-64	37.4	39.4
65 +	26.4	24.3
All Ages	41.5	42.8

TABLE B.8
PERCENTAGE OF INDIVIDUALS WITH TRAINING TAKEN TO UPGRADE SKILLS BY OCCUPATIONAL TENURE AND GENDER, 1991

Occupational Tenure in Years	Male	Female
0-4	33.9	34.3
5-9	45.0	46.8
10-14	47.5	52.5
15-19	48.0	53.6
20-24	47.1	53.5
25-29	48.5	52.2
30+	58.4	40.3
All Tenure Groups	41.5	42.8

TABLE B.9
TYPE OF TRAINING TAKEN TO UPGRADE SKILLS BY GENDER, 1991

TYPE OF SKILL UPGRADE	Gender Distribution by Type of Skill Upgrade		Gender Composition of Type of Skill Upgrade		
	Male	Female	Male	Female	Total
Read, Write, Math	1.29	2.43	35.52	64.48	100.00
Computer	5.13	13.21	28.64	71.36	100.00
Technical	39.79	32.69	55.68	44.32	100.00
Other, inc. Managerial	17.14	17.21	50.69	49.31	100.00
3R + Computer	0.99	2.22	31.55	68.45	100.00
3R + Technical	1.62	1.70	49.59	50.41	100.00
3R + Other	0.92	1.13	45.81	54.19	100.00
Computer + Tech	5.75	6.78	46.69	53.31	100.00
Computer + Other	3.50	4.37	45.25	54.75	100.00
Technical + Other	9.61	6.78	59.40	40.60	100.00
3R + Comp + Tech	1.78	2.55	41.88	58.13	100.00
3R + Comp + Other	1.16	1.27	48.52	51.48	100.00
3R + Tech + Other	1.26	0.78	62.56	37.44	100.00
Comp + Tech + Other	5.63	3.96	59.46	40.54	100.00
3R + Comp + Tech + Other	4.41	2.92	60.91	39.09	100.00
Total	100.00	100.00			

Note: The term "3R" refers to reading, writing, and math.

TABLE B.10
PERCENTAGE DISTRIBUTION OF WORKERS BY OCCUPATION AND LEVEL OF EDUCATION, 1991

OCCUPATION	Male				Female			
	Less Than High Sch.	High School	1-3 Years College	4+ Years College	Less Than High Sch.	High School	1-3 Years College	4+ Years College
Executive, Administrative, and Managerial	4.33	22.39	20.91	52.36	3.15	32.27	27.79	36.78
Professional Specialties	1.07	7.35	13.16	78.42	1.22	8.66	17.77	72.34
Technicians and Related Support	2.28	28.40	37.17	32.15	1.85	28.12	41.12	28.91
Sales Occupations	8.83	33.27	26.41	31.50	15.09	45.72	23.55	15.64
Administrative Support	8.21	42.08	29.06	20.66	5.09	53.94	29.79	11.18
Protective Services	8.19	43.19	35.11	13.51	16.67	46.53	27.08	9.72
Other Services	34.15	42.80	17.17	5.88	26.25	51.12	17.78	4.85
Precision Production, Craft, and Repair	19.00	53.55	21.32	6.13	21.35	53.76	16.49	8.39
Machine Operators, Assemblers, and Inspectors	25.19	54.88	15.35	4.57	34.99	53.14	9.13	2.73
Transportation and Material Moving	25.48	54.40	15.11	5.01	18.29	59.92	17.90	3.89
Handlers, Equipment Cleaners, Helpers, and Laborers	33.72	48.08	14.41	3.79	31.39	53.64	13.10	1.87
Farming, Forestry, and Fishing	31.88	43.56	15.18	9.37	21.36	47.37	22.91	8.36
All Occupations	15.46	37.95	20.32	26.28	11.65	41.59	23.38	23.38

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TABLE B.11
PERCENTAGE DISTRIBUTION OF WORKERS BY INDUSTRY AND LEVEL OF EDUCATION, 1991

INDUSTRY	Male				Female			
	Less Than High Sch.	High School	1-3 Years College	4+ Years College	Less Than High Sch.	High School	1-3 Years College	4+ Years College
Agriculture	30.65	42.12	15.18	12.05	17.33	43.32	25.99	13.37
Mining	18.78	45.61	15.85	19.76	5.19	37.66	37.66	19.48
Construction	22.06	50.24	18.24	9.46	6.86	53.83	26.91	12.40
Manufacturing--Durable	15.17	43.95	20.43	20.45	17.40	51.71	17.61	13.28
Manufacturing-Nondurable	17.46	45.09	17.56	19.89	22.75	46.92	15.53	14.79
Transportation	14.87	48.34	22.21	14.59	7.85	46.46	27.54	18.15
Communications	3.76	38.27	28.98	28.98	2.38	50.12	32.30	15.20
Utilities	10.05	44.71	24.34	20.90	3.09	46.91	26.29	23.71
Wholesale Trade	12.89	39.25	21.51	26.35	8.01	45.01	26.90	20.08
Retail Trade	22.83	40.59	22.37	14.22	19.42	50.14	20.87	9.56
Finance, Insurance, and Real Estate	5.96	23.17	21.12	49.76	3.68	46.86	29.62	19.83
Business and Repair Services	15.50	37.40	22.29	24.81	11.48	39.10	23.20	26.21
Personal Services	21.18	40.13	23.16	15.53	20.16	53.20	19.29	7.35
Entertainment	17.47	32.13	26.71	23.69	15.25	39.88	24.34	20.53
Hospitals	8.86	25.82	22.86	42.46	6.14	28.78	33.18	31.90
Other Medical	8.86	13.04	11.87	66.22	11.05	38.62	28.59	21.74
Education	6.24	16.04	11.83	65.88	4.90	22.26	16.31	56.53
Social Services	20.92	22.34	18.09	38.65	11.89	37.05	23.87	27.19
Other Professional	3.04	12.73	15.04	69.20	4.81	32.15	27.27	35.78
Forestry and Fisheries	17.89	34.74	16.84	30.53	3.70	37.04	40.74	18.52
Public Administration	3.37	30.11	28.59	37.93	3.26	43.44	27.11	26.19
All Industries	15.46	37.95	20.32	26.28	11.65	41.59	23.38	23.38

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TABLE B.12
TYPE OF TRAINING REQUIRED TO OBTAIN JOB BY GENDER, 1991

TYPE OF TRAINING	Gender Distribution by Type of Training		Gender Composition of Type of Training		
	Male	Female	Male	Female	Total
Formal Schooling	27.14	38.89	43.42	56.58	100.00
Company Training	7.79	5.94	59.07	40.93	100.00
Informal Job Training	21.04	19.76	53.93	46.07	100.00
Other	7.82	5.00	63.21	36.79	100.00
School + Company	3.21	2.79	55.86	44.14	100.00
School + Informal	9.86	13.81	43.99	56.01	100.00
School + Other	2.43	1.74	60.56	39.44	100.00
Company + Informal	4.40	3.33	59.21	40.79	100.00
Company + Other	0.74	0.18	82.07	17.93	100.00
Informal + Other	4.22	2.07	69.18	30.82	100.00
School + Company + Informal	4.63	3.55	58.95	41.05	100.00
School + Company + Other	0.50	0.23	70.80	29.20	100.00
School + Informal + Other	2.97	1.77	64.81	35.19	100.00
Company + Informal + Other	1.21	0.33	80.25	19.75	100.00
School + Company + Informal + Other	2.04	0.62	78.42	21.58	100.00
Total	100.00	100.00			

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TABLE B.13
PERCENTAGE OF INDIVIDUALS ACROSS OCCUPATIONS BY MAJOR CATEGORIES OF TRAINING AND SKILL UPGRADES, 1991

OCCUPATION	Type of Training				Type of Skill Upgrade			
	Formal Schooling	Company Training	Informal Job Training	Other	Read, Write, Math	Computer	Technical	Other, inc. Managerial
Traditionally Female	42.3	5.3	18.7	4.9	2.6	13.3	33.9	15.2
Gender Neutral	31.9	7.0	20.5	7.0	1.9	8.0	38.5	17.8
Traditionally Male	23.9	8.5	22.0	7.8	1.1	5.4	38.0	18.9
Information	38.4	5.0	15.8	4.2	2.1	13.5	23.8	17.2
Information/Production	46.7	3.9	9.3	5.2	1.0	3.3	45.5	17.0
Production	13.3	12.5	36.0	11.8	1.9	3.3	57.7	17.3
Fast Growth	41.7	6.1	12.7	6.1	1.3	6.2	42.2	16.3
Above Average Growth	34.6	6.5	18.3	6.0	2.1	5.4	31.3	20.7
Below Average Growth	22.7	9.6	28.8	7.3	2.0	14.0	38.4	14.2
Slow Growth	23.1	6.7	30.3	7.6	2.0	18.9	36.3	12.9

Note: The datum in a cell shows the number of individuals in a given occupational class who were required to obtain a particular type of training as a percentage of all individuals in that occupation who were required to have some type of training and who responded to the survey question. The rows do not add to 100 because lesser categories of training and skill upgrades are not included in the table.

Appendix C

Definitions of Regression Variables

Hourly Wage: The hourly wage was estimated as the ratio of usual weekly earnings to usual hours worked per week. The dependent variable in all regressions is the log of the hourly wage.

Region: Dummy variables for three regions--Northeast, South, and West--are included in the regression. The Midwest is the omitted region.

SMSA Size: Dummy variables for size of SMSA (in 1984) and MSA (in 1989 and 1991). Smaller metropolitan areas, of size less than 1 million or coded as not identified in the CPS data, are the omitted class.

School: Years of schooling, defined by the highest grade completed. If an individual did not complete the highest grade attended, the highest grade completed is defined as the highest grade attended less one. The variable is top coded at 18 years.

In some regressions, the schooling variable is defined by dummy variables representing four possible education levels: Less than High School (0-11 years of schooling); High School (12 years of schooling); College: 1-3 years (13-15 years of schooling); and College: 4+ years (16 or more years of schooling). Regressions using dummy variables for schooling omit the Less than High School category.

Total Experience: This variable equals potential, not actual, labor force experience in years. It is defined as age minus years of schooling minus six. It should be noted that actual experience need not equal potential experience if an individual has had occasion to spend time out of the labor force. In 1991, individuals also reported their tenure in their current job. Thus, for 1991, another variable, Other Experience, was defined as age minus tenure minus years of schooling minus six.

Tenure: Years spent with the current employer. Available for 1991 only.

Union Member: A dummy variable set equal to one if an individual reported being a member of a union or being covered by a union contract.

Part-time Worker: A dummy variable set equal to one for part-time workers, including those who are usually full-time workers but were working part-time during the survey week for economic reasons.

Marital Status: Dummy variables for marital status. The Married, Spouse Absent, category includes Separated individuals. The Never Married individuals are the omitted class.

White: A dummy variable equal to one for individuals classified as White, whether or not they are of Hispanic origin.

Male: A dummy variable equal to one for males.

Occupation: The two-digit occupational categories in the CPS data were aggregated into 10 occupational groups for the regression analysis. Table C.1 details the composition of these 10 occupational groups. The group of farm workers is the omitted class of workers. Alternative occupational groups used in some regressions are defined in Appendix A.

Industry: The two-digit industry categories in the CPS data were aggregated into 12 industrial groups for the regression analysis. Table C.2 details the composition of these 12 industrial groups. Farming activities represent the omitted industrial class.

The CPS data do not explicitly define Federal, State, and Local Government industrial categories. Thus, these industrial categories were defined using the Class of Worker variable in the CPS data. All other industry categories include private-sector workers only.

Computer Use: A dummy variable set equal to one if a person reported using a computer at work. Some individuals who use a computer at work but did not respond to the survey question may have been classified as noncomputer users by this definition.

Math Use: A dummy variable set equal to one if a person reported using math on the job. This variable is available for 1991 only. As in the case of computers, math users failing to respond to the survey question may have been classified as nonmath users.

Table C.1

Occupational Categories Used in Regression Analysis

Professional and Technical

Engineers
Mathematical and Computer Scientists
Natural Scientists
Health Diagnosing Occupations
Health Assessment and Treating Occupations
Teachers, College and University
Teachers, except College and University
Lawyers and Judges
Other Professional Specialty Occupations
Health Technologists and Technicians
Engineering and Science Technicians
Technicians, except Health, Engineering and Science

Managerial and Administrative

Administrators and Officials, Public Administration
Other Executives, Administrators, and Managers
Management Related Occupations
Supervisors and Proprietors, Sales Occupations
Supervisors, Administrative Support

Sales

Sales Representatives, Finance and Business Services
Sales Representatives, Commodities, except Retail
Sales Workers, Retail and Personal Services
Sales Related Occupations

Clerical

Computer Equipment Operators
Secretaries, Stenographers, and Typists
Financial Records Processing Occupations
Mail and Message Distributing
Other Administrative Support, including Clerical

Table C.1 (contd.)

<u>Precision Production and Crafts</u>

Mechanics and Repairers
Construction Trades
Other Precision Production Occupations

<u>Operators</u>

Machine Operators and Tenders, except Precision
Fabricators, Assemblers, Inspectors, and Samplers

<u>Transport Occupations</u>

Motor Vehicle Operators
Other Transportation Occupations and Material Moving

<u>Handlers</u>

Construction Laborer
Freight, Stock, and Material Handlers
Other Handlers, Equipment Cleaners, and Laborers

<u>Service, except Private Household</u>

Protective Service Occupations
Food Service Occupations
Health Service Occupations
Cleaning and Building Service Occupations
Personal Service Occupations

<u>Farm Occupations</u>

Farm Operators and Managers
Farm Workers and Retail Occupations
Forestry and Fishing Occupations

Table C.2

Industrial Categories Used in Regression Analysis

Mining

Construction

Manufacturing, Durable

SIC Codes 24, 25, 32-39

Manufacturing, Nondurable

SIC Codes 20-23, 26-31

Transportation and Utilities

Transportation
Communications
Utilities and Sanitary Services

Trade

Wholesale Trade
Retail Trade

FIRE

Banking and Other Finance
Insurance and Real Estate

Service

Business Services
Repair Services
Personal Services, except Private Household
Entertainment and Recreation Services
Hospitals
Health Services, except Hospitals
Educational Services
Social Services
Other Professional Services

Table C.2 (contd.)

Federal Government

State Government

Local Government

Farming

Agriculture Service
Other Agriculture
Forestry and Fisheries

Appendix D

Standard Errors of Parameter Estimates

This appendix reports the standard errors of the regression parameter estimates that are presented in the main text. The first table in this appendix, Table 26A, corresponds to Table 26 in the main text. Table 26 presents the parameter estimates from wage regressions including a dummy variable for computer use. Table 26A presents the standard errors of these parameter estimates. Table 26 and Table 26A are organized in the same fashion for easy comparability. Similarly, Table 27A in this appendix corresponds to Table 27 in the main text, Table 28A corresponds to Table 28, and so on.

TABLE 26A
REGRESSION ANALYSIS OF THE RETURNS TO COMPUTER USE: 1984, 1989, AND 1991
DEPENDENT VARIABLE: ln(HOURLY WAGE)

STANDARD ERRORS OF PARAMETER ESTIMATES

VARIABLE DESCRIPTION	1984 (A)	1984 (B)	1989 (A)	1989 (B)	1991 (A)	1991 (B)
Intercept	0.0444	0.0473	0.0489	0.0524	0.0485	0.0525
Region						
North East	0.0094	0.0088	0.0101	0.0096	0.0099	0.0093
South	0.0092	0.0087	0.0093	0.0088	0.0092	0.0087
West	0.0095	0.0089	0.0102	0.0097	0.0101	0.0096
SMSA Size						
1-3 million	0.0102	0.0096	--	--	--	--
3 million or more	0.0140	0.0131	--	--	--	--
1-2.5 million	--	--	0.0098	0.0094	0.0099	0.0093
2.5-5 million	--	--	0.0110	0.0105	0.0110	0.0104
5 million or more	--	--	0.0103	0.0098	0.0096	0.0092
School	0.0064	0.0062	0.0070	0.0069	0.0070	0.0067
School Squared/100	0.0251	0.0247	0.0271	0.0271	0.0267	0.0265
Total Experience	0.0010	0.0010	0.0011	0.0010	0.0011	0.0010
Total Experience Squared/100	0.0022	0.0021	0.0024	0.0022	0.0024	0.0023
Union Member	0.0082	0.0082	0.0091	0.0093	0.0086	0.0088
Part-time Worker	0.0093	0.0089	0.0098	0.0095	0.0093	0.0090
Marital Status						
Married, Spouse Present	0.0095	0.0089	0.0098	0.0093	0.0097	0.0092
Married, Spouse Absent	0.0203	0.0190	0.0202	0.0192	0.0203	0.0192
Widowed or Divorced	0.0137	0.0128	0.0139	0.0132	0.0136	0.0129
White	0.0100	0.0094	0.0103	0.0099	0.0100	0.0096
Male	0.0069	0.0074	0.0071	0.0076	0.0069	0.0073
Occupation						
Professional & Technical	--	0.0367	--	0.0383	--	0.0457
Managerial & Administrative	--	0.0367	--	0.0381	--	0.0456
Sales	--	0.0374	--	0.0389	--	0.0463
Clerical	--	0.0363	--	0.0381	--	0.0456
Precision Prodn & Crafts	--	0.0364	--	0.0382	--	0.0456
Operators	--	0.0372	--	0.0391	--	0.0464
Transport Occupations	--	0.0378	--	0.0396	--	0.0471
Handlers	--	0.0382	--	0.0399	--	0.0471
Service, Ex. Private Household	--	0.0364	--	0.0379	--	0.0455
Industry						
Mining	--	0.0478	--	0.0535	--	0.0591
Construction	--	0.0407	--	0.0423	--	0.0472
Manufacturing, Durable	--	0.0390	--	0.0406	--	0.0453
Manufacturing, Nondurable	--	0.0397	--	0.0412	--	0.0459
Transportation & Utilities	--	0.0400	--	0.0416	--	0.0463
Trade	--	0.0389	--	0.0401	--	0.0450
Fire	--	0.0399	--	0.0412	--	0.0459
Service	--	0.0386	--	0.0398	--	0.0448
Federal Government	--	0.0419	--	0.0429	--	0.0475
State Government	--	0.0404	--	0.0419	--	0.0465
Local Government	--	0.0393	--	0.0408	--	0.0456
Computer Use	0.0080	0.0079	0.0076	0.0079	0.0073	0.0074

TABLE 27A
REGRESSION ANALYSIS OF THE RETURNS TO MATH USE, 1991
DEPENDENT VARIABLE: ln(HOURLY WAGE)

VARIABLE DESCRIPTION	STANDARD ERRORS OF PARAMETER ESTIMATES (A)	(B)
Intercept	0.0491	0.0528
Region		
North East	0.0100	0.0094
South	0.0093	0.0088
West	0.0102	0.0096
SMSA Size		
1-2.5 million	0.0100	0.0094
2.5-5 million	0.0111	0.0105
5 million or more	0.0097	0.0092
School	0.0070	0.0068
School Squared/100	0.0270	0.0266
Total Experience	0.0011	0.0010
Total Experience Squared/100	0.0024	0.0023
Union Member	0.0087	0.0089
Part-time Worker	0.0093	0.0091
Marital Status		
Married, Spouse Present	0.0098	0.0092
Married, Spouse Absent	0.0205	0.0193
Widowed or Divorced	0.0138	0.0130
White	0.0102	0.0096
Male	0.0069	0.0074
Occupation		
Professional & Technical	--	0.0460
Managerial & Administrative	--	0.0458
Sales	--	0.0466
Clerical	--	0.0458
Precision Prodn & Crafts	--	0.0459
Operators	--	0.0467
Transport Occupations	--	0.0474
Handlers	--	0.0474
Service, Ex. Private Household	--	0.0458
Industry		
Mining	--	0.0595
Construction	--	0.0474
Manufacturing, Durable	--	0.0456
Manufacturing, Nondurable	--	0.0461
Transportation & Utilities	--	0.0465
Trade	--	0.0453
Fire	--	0.0462
Service	--	0.0451
Federal Government	--	0.0478
State Government	--	0.0468
Local Government	--	0.0459
Math Use	0.0073	0.0070

TABLE 28A
RETURNS TO COMPUTER USE AND MATH USE:
REGRESSION ANALYSIS WITH JOB TENURE VARIABLE, 1991
DEPENDENT VARIABLE: ln(HOURLY WAGE)

	STANDARD ERRORS OF PARAMETER ESTIMATES			
	COMPUTER USE		MATH USE	
VARIABLE DESCRIPTION	(A)	(B)	(A)	(B)
Intercept	0.0517	0.0555	0.0522	0.0558
Region				
North East	0.0102	0.0097	0.0103	0.0097
South	0.0094	0.0090	0.0095	0.0090
West	0.0104	0.0099	0.0105	0.0100
SMSA Size				
1-2.5 million	0.0101	0.0096	0.0102	0.0097
2.5-5 million	0.0115	0.0110	0.0116	0.0111
5 million or more	0.0100	0.0096	0.0101	0.0096
School	0.0074	0.0072	0.0075	0.0072
School Squared/100	0.0282	0.0280	0.0285	0.0282
Tenure	0.0014	0.0013	0.0014	0.0013
Tenure Squared/100	0.0048	0.0046	0.0048	0.0046
Other Experience	0.0010	0.0010	0.0010	0.0010
Other Experience Squared/100	0.0029	0.0027	0.0029	0.0027
Union Member	0.0090	0.0092	0.0091	0.0092
Part-time Worker	0.0097	0.0095	0.0097	0.0095
Marital Status				
Married, Spouse Present	0.0096	0.0092	0.0097	0.0093
Married, Spouse Absent	0.0210	0.0200	0.0212	0.0201
Widowed or Divorced	0.0138	0.0131	0.0139	0.0132
White	0.0105	0.0101	0.0107	0.0102
Male	0.0072	0.0076	0.0072	0.0076
Occupation				
Professional & Technical	--	0.0460	--	0.0462
Managerial & Administrative	--	0.0459	--	0.0461
Sales	--	0.0467	--	0.0469
Clerical	--	0.0459	--	0.0460
Precision Prodn & Crafts	--	0.0459	--	0.0462
Operators	--	0.0468	--	0.0471
Transport Occupations	--	0.0475	--	0.0478
Handlers	--	0.0477	--	0.0480
Service, Ex. Private Household	--	0.0458	--	0.0461
Industry				
Mining	--	0.0594	--	0.0598
Construction	--	0.0474	--	0.0477
Manufacturing, Durable	--	0.0454	--	0.0457
Manufacturing, Nondurable	--	0.0459	--	0.0462
Transportation & Utilities	--	0.0463	--	0.0466
Trade	--	0.0450	--	0.0453
Fire	--	0.0459	--	0.0462
Service	--	0.0448	--	0.0451
Federal Government	--	0.0476	--	0.0479
State Government	--	0.0465	--	0.0468
Local Government	--	0.0456	--	0.0459
Computer Use	0.0076	0.0077	0.0079	0.0077

TABLE 30A
ISOLATING THE RETURNS TO COMPUTER USE FROM THE RETURNS TO MATH USE:
REGRESSION ANALYSIS WITH MATH USE AND COMPUTER USE INTERACTION TERM, 1991
DEPENDENT VARIABLE: ln(HOURLY WAGE)

VARIABLE DESCRIPTION	STANDARD ERRORS OF PARAMETER ESTIMATES
Intercept	0.0525
Region	
North East	0.0093
South	0.0087
West	0.0096
SMSA Size	
1-2.5 million	0.0093
2.5-5 million	0.0105
5 million or more	0.0092
School	0.0068
School Squared/100	0.0265
Total Experience	0.0010
Total Experience Squared/100	0.0023
Union Member	0.0088
Part-time Worker	0.0091
Marital Status	
Married, Spouse Present	0.0092
Married, Spouse Absent	0.0192
Widowed or Divorced	0.0129
White	0.0096
Male	0.0073
Occupation	
Professional & Technical	0.0457
Managerial & Administrative	0.0456
Sales	0.0463
Clerical	0.0456
Precision Prodn & Crafts	0.0456
Operators	0.0464
Transport Occupations	0.0471
Handlers	0.0471
Service, Ex. Private Household	0.0455
Industry	
Mining	0.0591
Construction	0.0471
Manufacturing, Durable	0.0453
Manufacturing, Nondurable	0.0459
Transportation & Utilities	0.0463
Trade	0.0450
Fire	0.0459
Service	0.0448
Federal Government	0.0475
State Government	0.0465
Local Government	0.0456
Math Use	0.0085
Computer Use	0.0191
Math Use and Computer Use	0.0205

TABLE 31A
REGRESSION ANALYSIS OF THE RETURNS TO COMPUTER AND MATH USE BY OCCUPATION, INDUSTRY, AND EDUCATION LEVEL: 1984, 1989, AND 1991

STANDARD ERRORS OF PARAMETER ESTIMATES

	Returns to Computer Use			Returns to Math Use
OCCUPATION	1984	1989	1991	1991
Professional & Technical	0.0156	0.0156	0.0154	0.0175
Managerial & Administrative	0.0172	0.0170	0.0167	0.0194
Sales	0.0258	0.0242	0.0215	0.0235
Clerical	0.0148	0.0166	0.0159	0.0165
Precision Prodn & Crafts	0.0271	0.0253	0.0230	0.0198
Operators	0.0383	0.0384	0.0314	0.0236
Transport Occupations	0.0787	0.0563	0.0493	0.0304
Handlers	0.0846	0.0586	0.0474	0.0317
Service Ex Private Household	0.0376	0.0296	0.0261	0.0180
Farm	0.1392	0.1470	0.1231	0.0571
INDUSTRY				
Mining	0.0622	0.0746	0.0825	0.0802
Construction	0.0630	0.0455	0.0466	0.0311
Manufacturing, Durable	0.0195	0.0205	0.0198	0.0198
Manufacturing, Nondurable	0.0268	0.0252	0.0233	0.0231
Transportation & Utilities	0.0260	0.0270	0.0262	0.0263
Trade	0.0184	0.0169	0.0152	0.0146
Fire	0.0245	0.0286	0.0262	0.0281
Service	0.0165	0.0146	0.0139	0.0138
Federal Government	0.0362	0.0349	0.0335	0.0353
State Government	0.0298	0.0288	0.0286	0.0309
Local Government	0.0222	0.0212	0.0202	0.0217
Farming	0.0988	0.0893	0.0854	0.0568
EDUCATION LEVEL				
Less than High School	0.0338	0.0327	0.0280	0.0180
High School	0.0127	0.0123	0.0112	0.0105
College: 1-3 years	0.0149	0.0139	0.0137	0.0145
College: 4+ years	0.0133	0.0138	0.0135	0.0152

TABLE 32A
REGRESSION ANALYSIS OF THE RETURNS TO COMPUTER AND MATH USE BY NONTRADITIONAL AND EMERGING OCCUPATIONAL CLASSES: 1984, 1989, AND 1991

STANDARD ERRORS OF PARAMETER ESTIMATES

OCCUPATION	Returns to Computer Use			Returns to Math Use
	1984	1989	1991	1991
Traditionally Female	0.0109	0.0107	0.0103	0.0107
Gender Neutral	0.0184	0.0178	0.0169	0.0161
Traditionally Male	0.0129	0.0117	0.0111	0.0109
Information	0.0097	0.0102	0.0099	0.0109
Information/Production	0.0222	0.0202	0.0198	0.0220
Production	0.0188	0.0164	0.0134	0.0100
Fast Growth	0.0161	0.0145	0.0140	0.0140
Above Average Growth	0.0130	0.0121	0.0115	0.0126
Below Average Growth	0.0152	0.0146	0.0140	0.0135
Slow Growth	0.0163	0.0165	0.0160	0.0158

TABLE 35A
GENDER DIFFERENCES IN THE RETURNS TO COMPUTER USE AND MATH USE:
REGRESSION ANALYSIS WITH SKILL AND GENDER INTERACTION TERMS
DEPENDENT VARIABLE: ln(HOURLY WAGE)

STANDARD ERRORS OF PARAMETER ESTIMATES

VARIABLE DESCRIPTION	COMPUTER USE			MATH USE
	1984	1989	1991	1991
Intercept	0.0475	0.0526	0.0527	0.0532
Region				
North East	0.0088	0.0096	0.0093	0.0094
South	0.0087	0.0088	0.0087	0.0088
West	0.0089	0.0097	0.0096	0.0096
SMSA Size				
1-3 million	0.0096	–	–	–
3 million or more	0.0131	–	–	–
1-2.5 million	–	0.0094	0.0093	0.0094
2.5-5 million	–	0.0105	0.0104	0.0105
5 million or more	–	0.0098	0.0092	0.0092
School	0.0062	0.0069	0.0067	0.0068
School Squared/100	0.0247	0.0271	0.0264	0.0266
Total Experience	0.0010	0.0010	0.0010	0.0010
Total Experience Squared/100	0.0021	0.0022	0.0023	0.0023
Union Member	0.0082	0.0093	0.0088	0.0089
Part-time Worker	0.0089	0.0095	0.0091	0.0091
Marital Status				
Married, Spouse Present	0.0089	0.0093	0.0092	0.0092
Married, Spouse Absent	0.0190	0.0192	0.0192	0.0193
Widowed or Divorced	0.0128	0.0132	0.0129	0.0130
White	0.0094	0.0099	0.0095	0.0096
Male	0.0083	0.0094	0.0093	0.0111
Occupation				
Professional & Technical	0.0367	0.0383	0.0458	0.0460
Managerial & Administrative	0.0367	0.0382	0.0456	0.0458
Sales	0.0374	0.0389	0.0464	0.0466
Clerical	0.0363	0.0381	0.0456	0.0458
Precision Prodn & Crafts	0.0364	0.0382	0.0456	0.0459
Operators	0.0372	0.0391	0.0464	0.0467
Transport Occupations	0.0378	0.0396	0.0471	0.0474
Handlers	0.0382	0.0399	0.0471	0.0474
Service, Ex. Private Household	0.0364	0.0380	0.0456	0.0458
Industry				
Mining	0.0478	0.0535	0.0591	0.0595
Construction	0.0407	0.0423	0.0472	0.0474
Manufacturing, Durable	0.0390	0.0406	0.0453	0.0456
Manufacturing, Nondurable	0.0397	0.0412	0.0459	0.0461
Transportation & Utilities	0.0400	0.0416	0.0463	0.0465
Trade	0.0389	0.0401	0.0450	0.0453
Fire	0.0399	0.0412	0.0459	0.0462
Service	0.0386	0.0398	0.0448	0.0451
Federal Government	0.0419	0.0430	0.0475	0.0478
State Government	0.0404	0.0419	0.0465	0.0468
Local Government	0.0393	0.0408	0.0456	0.0459
Computer Use	0.0106	0.0104	0.0098	–
Computer Use and Male	0.0147	0.0140	0.0133	–
Math Use	–	–	–	0.0099
Math Use and Male	–	–	–	0.0132

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TABLE 36A
THE GENDER WAGE GAP AND THE RETURNS TO COMPUTER USE FOR MALES AND FEMALES BY OCCUPATION, INDUSTRY, AND LEVEL OF EDUCATION: 1984 AND 1989

STANDARD ERRORS OF PARAMETER ESTIMATES

	Gender Wage Gap		Returns to Computer Use		Additional Return to Computer Use for Males	
OCCUPATION	1984	1989	1984	1989	1984	1989
Professional and Technical	0.0197	0.0243	0.0228	0.0207	0.0312	0.0317
Managerial and Administrative	0.0239	0.0270	0.0276	0.0259	0.0351	0.0340
Sales	0.0242	0.0277	0.0344	0.0339	0.0511	0.0479
Clerical	0.0241	0.0307	0.0161	0.0185	0.0405	0.0421
Precision Prodn. and Crafts	0.0335	0.0377	0.0791	0.0828	0.0841	0.0869
Operators	0.0221	0.0251	0.0681	0.0655	0.0822	0.0807
Transport Occupations	0.0511	0.0535	0.2603	0.1635	0.2730	0.1741
Handlers	0.0380	0.0394	0.1409	0.1077	0.1761	0.1282
Service Ex. Private Household	0.0180	0.0194	0.0578	0.0416	0.0757	0.0587
Farm	0.0660	0.0787	0.2175	0.2793	0.2839	0.3282
INDUSTRY						
Mining	0.1418	0.1430	0.1600	0.1632	0.1765	0.1863
Construction	0.0548	0.0615	0.1100	0.0886	0.1361	0.1055
Manufacturing, Durable	0.0226	0.0279	0.0353	0.0377	0.0413	0.0437
Manufacturing, Nondurable	0.0239	0.0268	0.0392	0.0400	0.0531	0.0501
Transportation and Utilities	0.0358	0.0469	0.0435	0.0506	0.0557	0.0602
Trade	0.0156	0.0170	0.0258	0.0237	0.0363	0.0330
FIRE	0.0372	0.0491	0.0307	0.0379	0.0515	0.0583
Service	0.0167	0.0188	0.0204	0.0176	0.0336	0.0298
Federal Government	0.0470	0.0542	0.0570	0.0543	0.0741	0.0708
State Government	0.0358	0.0409	0.0420	0.0395	0.0599	0.0575
Local Government	0.0229	0.0278	0.0281	0.0264	0.0456	0.0437
Farming	0.0692	0.0760	0.1437	0.1283	0.1996	0.1771
EDUCATION LEVEL						
Less than High School	0.0172	0.0189	0.0456	0.0436	0.0678	0.0657
High School	0.0120	0.0135	0.0161	0.0160	0.0256	0.0241
College: 1-3 Years	0.0168	0.0188	0.0202	0.0191	0.0296	0.0273
College: 4+ Years	0.0177	0.0215	0.0204	0.0200	0.0267	0.0274

TABLE 37A

THE GENDER WAGE GAP AND THE RETURNS TO COMPUTER USE FOR MALES AND FEMALES BY OCCUPATION, INDUSTRY, AND LEVEL OF EDUCATION: 1991

STANDARD ERRORS OF PARAMETER ESTIMATES

	Gender Wage Gap		Returns to:		Additional Return to Computer Use for Males	
OCCUPATION	(A)	(B)	Computer Use	Math Use	Computer Use	Math Use
Professional and Technical	0.0248	0.0304	0.0204	0.0236	0.0310	0.0349
Managerial and Administrative	0.0269	0.0349	0.0252	0.0301	0.0335	0.0393
Sales	0.0292	0.0408	0.0283	0.0301	0.0434	0.0480
Clerical	0.0275	0.0309	0.0182	0.0188	0.0388	0.0394
Precision Prodn. and Crafts	0.0405	0.0563	0.0710	0.0676	0.0750	0.0707
Operators	0.0261	0.0331	0.0505	0.0369	0.0643	0.0480
Transport Occupations	0.0490	0.0618	0.1748	0.0909	0.1821	0.0964
Handlers	0.0434	0.0537	0.0838	0.0700	0.1019	0.0785
Service Ex. Private Household	0.0187	0.0222	0.0367	0.0240	0.0519	0.0361
Farm	0.0779	0.0977	0.2761	0.1419	0.3081	0.1546
INDUSTRY						
Mining	0.1954	0.2764	0.2269	0.2921	0.2453	0.3041
Construction	0.0703	0.0956	0.0985	0.1093	0.1136	0.1140
Manufacturing, Durable	0.0281	0.0342	0.0363	0.0368	0.0423	0.0434
Manufacturing, Nondurable	0.0288	0.0365	0.0347	0.0350	0.0459	0.0461
Transportation and Utilities	0.0455	0.0471	0.0491	0.0485	0.0586	0.0577
Trade	0.0174	0.0230	0.0207	0.0208	0.0297	0.0287
FIRE	0.0438	0.0496	0.0346	0.0359	0.0539	0.0576
Service	0.0181	0.0212	0.0171	0.0172	0.0280	0.0278
Federal Government	0.0547	0.0603	0.0566	0.0586	0.0703	0.0732
State Government	0.0415	0.0512	0.0399	0.0423	0.0568	0.0615
Local Government	0.0278	0.0356	0.0259	0.0289	0.0407	0.0432
Farming	0.0745	0.0994	0.1349	0.1186	0.1721	0.1335
EDUCATION LEVEL						
Less than High School	0.0194	0.0233	0.0388	0.0278	0.0559	0.0362
High School	0.0133	0.0166	0.0148	0.0148	0.0219	0.0206
College: 1-3 Years	0.0194	0.0241	0.0194	0.0209	0.0271	0.0288
College: 4+ Years	0.0216	0.0264	0.0194	0.0222	0.0268	0.0302

TABLE 38A
THE GENDER WAGE GAP AND THE RETURNS TO COMPUTER USE FOR MALES AND FEMALES IN NONTRADITIONAL AND EMERGING OCCUPATIONS: 1984 AND 1989

STANDARD ERRORS OF PARAMETER ESTIMATES

OCCUPATION	Gender Wage Gap		Returns to Computer Use		Additional Returns to Computer Use for Males	
	1984	1989	1984	1989	1984	1989
Traditionally Female	0.0136	0.0162	0.0124	0.0120	0.0248	0.0240
Gender Neutral	0.0167	0.0190	0.0287	0.0263	0.0366	0.0344
Traditionally Male	0.0153	0.0166	0.0264	0.0232	0.0298	0.0264
Information	0.0129	0.0160	0.0126	0.0132	0.0192	0.0202
Information/Production	0.0235	0.0270	0.0343	0.0290	0.0448	0.0401
Production	0.0107	0.0115	0.0308	0.0276	0.0387	0.0341
Fast Growth	0.0164	0.0185	0.0221	0.0186	0.0314	0.0284
Above Average Growth	0.0141	0.0157	0.0206	0.0188	0.0261	0.0240
Below Average Growth	0.0161	0.0183	0.0207	0.0206	0.0311	0.0298
Slow Growth	0.0156	0.0191	0.0197	0.0208	0.0356	0.0358

TABLE 39A
THE GENDER WAGE GAP AND THE RETURNS TO COMPUTER AND MATH USE
FOR MALES AND FEMALES IN NONTRADITIONAL AND EMERGING OCCUPATIONS: 1991

STANDARD ERRORS OF PARAMETER ESTIMATES

OCCUPATION	Gender Wage Gap		Returns to Computer Use		Additional Returns to Males for:	
	Noncomputer Users	Nonmath Users	Computer Use	Math Use	Computer Use	Math Use
Traditionally Female	0.0157	0.0191	0.0117	0.0124	0.0231	0.0240
Gender Neutral	0.0195	0.0236	0.0248	0.0239	0.0327	0.0317
Traditionally Male	0.0170	0.0221	0.0218	0.0239	0.0249	0.0266
Information	0.0158	0.0190	0.0130	0.0142	0.0197	0.0218
Information/Production	0.0277	0.0371	0.0277	0.0310	0.0392	0.0436
Production	0.0115	0.0143	0.0215	0.0161	0.0272	0.0202
Fast Growth	0.0181	0.0215	0.0179	0.0180	0.0274	0.0278
Above Average Growth	0.0162	0.0224	0.0174	0.0203	0.0227	0.0257
Below Average Growth	0.0180	0.0203	0.0203	0.0207	0.0285	0.0271
Slow Growth	0.0196	0.0245	0.0206	0.0216	0.0335	0.0313