Small businesses and computers: Adoption and performance[1]

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Abstract

Until recently, little evidence suggested that the computer revolution of recent decades has had much impact on aggregate economic growth. Analysis at the worker level has found evidence that use of computers is associated with higher wages. Although some research questions whether this finding is solely due to unobserved heterogeneity in worker quality, others point to such results as evidence that the wage premia for skilled workers have increased over time. Adoption of new technologies is associated with higher productivity and higher productivity growth. As in the worker literature, firms adopting computers may simply be more productive firms. Using new data from the 1998 Survey of Small Business Finances, I examine the determinants of computer adoption by small privately-held firms and analyze whether computer use affects profits, sales, labor productivity, or other measures of firm success. I am able to control for many firm characteristics not available in other data sets. I find that computer adoption is more likely by larger firms, by younger firms, by firms whose markets are national or international, and by limited liability firms. Adoption is also more likely by firms founded or inherited by a current owner and by firms whose primary owners are more educated. Firms with more than 50% of their ownership shares held by African Americans or Asians, and, in some specifications, firms with more than 50% of their shares held by Hispanics are less likely to have adopted computers, echoing results for households in the literature. Evidence concerning the link between computer use and firm performance is mixed. Current performance as measured by profits or sales is not associated with current computer use in the full sample. In some specifications, use of computers for specific tasks is associated with higher costs. Estimates of the effects of computer use on costs are larger (in absolute value) when the sample is restricted to manufacturing or wholesale trade firms or to larger small businesses. Estimates using the more parsimonious set of control variables widely available in other firm level data show large and positive effects of computer use on firm costs, sales, and profits, suggesting that controlling for managerial, firm, and owner characteristics is important.

1 Introduction

Until recently, little evidence suggested that the computer revolution of recent decades has had much impact on aggregate economic growth. Analysis at the worker level has found evidence that use of computers is positively associated with wages (Krueger (1993)). Further work has found that only recently have workers begun to upgrade their skills to use new technologies (Lowe (1997), Autor, Katz & Krueger (1998), and Haskel & Heden (1999)). Some research questions whether this computer use wage premium is solely due to unobserved heterogeneity in worker quality (DiNardo & Pischke (1997)) while others point to such findings as evidence that wage premia for skilled workers have increased over time or that use of new technologies leads to an increased demand for skilled workers (e.g. skill-biased technological change (Bound & Johnson (1992))). Research performed at the firm, establishment, or plant level has a similar flavor. Adoption of new technologies is associated with higher productivity and higher productivity growth.

While earlier research found small effects of computer investment on productivity growth, in more recent work using aggregate data, Oliner & Sichel (2000), Whelan (2000), and Jorgenson & Stiroh (2000) have found that the effects of computers on productivity growth have been large and significant, while Gordon (2000) finds that recent productivity gains are isolated to the high technology sector. As in the worker literature, adopters may simply be more productive firms. Unfortunately, much of the firm level work is limited to the manufacturing sector, to small samples of often publicly traded firms, to larger firms, or is at the establishment or plant level.[1] The manufacturing sector is an important part of the economy but may not be representative of the entire economy. Publicly traded firms may differ in important ways from privately held firms and larger firms from smaller firms. Establishment or plant level studies often do not control for firm-wide characteristics that can affect productivity. Additionally, most firm level data sets used in previous work lack detailed information on firm's balance sheets or firm and owner demographics.[2]

New data from the 1998 Survey of Small Business Finances allow me to examine the determinants of computer adoption by small privately-held firms and to analyze whether computer use affects profits, sales, labor productivity, or other measures of firm success. I am able to control for many firm and owner characteristics not available in other data sets.

Evidence suggests that computer adoption is more likely by larger firms, by younger firms, by firms whose markets are national or international, and by limited liability firms. Adoption is also more likely by firms founded or inherited by a current owner and by firms whose primary owners are more educated. Similar to findings from household surveys, firms

[1] Much of the research using U.S. Census data is restricted to establishments of plants with more than 20 employees. In contrast, the 1998 Survey of Small Business Finances is representative of all non-financial, non-farm, for-profit firms with fewer than 500 employees.

[2] Since large firms with many establishments or plants may make different products using different production technologies at the different sites, using firm level measures to analyze the effects of computer use for these larger firms could yield misleading conclusions. In contrast, smaller firms are more likely to only have one location and only produce one type of good or service, making firm level data more useful for analyzing their performance.

with more than 50% of their ownership shares held by African Americans or Asians and, in some specifications, firms with more than 50% of their shares held by Hispanics are significantly less likely to have adopted computers for specific tasks.

Evidence concerning the link between computer use and firm performance is mixed. Current performance as measured by profits or sales is not associated with current computer use in the full sample of firms. Use of computers is associated with higher costs in some specifications. Two-sample estimates of the effects of computers combining information on computer adoption from the 1998 Survey of Small Business Finances with performance measures from the 1993 National Survey of Small Business Finances suggest that firms predicted to adopt computers have higher profits, costs, and sales than those predicted not to adopt computers. Restricting the sample of firms to manufacturing firms, to wholesale trade firms, or to firms with 20 or more employees yield larger (in absolute value) estimates of the effects of computer use on firm costs than those using the full sample of firms. Estimates using the more parsimonious set of control variables widely available in other firm level data show positive and significant effects of computer use on firm costs, sales, and profits, suggesting that controlling for managerial, firm, and owner characteristics is important.

Section 2 discusses the relevant literature on computer adoption and on firm performance and computer use. Section 3 describes the 1998 Survey of Small Business Finances and the 1993 National Survey of Small Business Finances, the data sets used in this analysis. Section 4 presents the empirical models. Section 5 presents the computer adoption results. Section 6 presents the results relating computer use and firm performance. Section 7 discusses the robustness of the performance results. Finally, section 8 concludes.

2 Literature

There is a large literature at the household level and a lesser literature at the firm or plant level on the effects and determinants of computer use. Research at the firm and household level finds that use of computers is tied to higher wages (e.g. Krueger (1993), Doms, Dunne & Troske (1997)), Black & Lynch (2000), and Cappelli & Carter (2000)), higher productivity (e.g. McGuckin, Streitwieser & Doms (1998), Doms et al. (1997), and Greenan & Mairesse (2000)) and higher productivity growth (e.g. Lehr & Lichtenberg (1998) and Brynjolfsson & Hitt (2000*a*)). Some aggregate level work also finds computers are associated with higher productivity growth (e.g. Oliner & Sichel (2000), Jorgenson & Stiroh (2000), and Whelan (2000), although Gordon (2000) and others question whether the higher growth of the late 1990s can be attributed to the use of information technology. Some research suggests that performance gains associated with "new technology" may shift employment toward more educated workers. Other work suggests that "new technology" may be complementary with adoption of other "new" work practices.[3] An unresolved question is how much of the observed

[3]Examples from the large literature on whether new technology has increased demand for skilled workers or whether there have simply been changes in the relative rewards for skill include Bound & Johnson (1992), Berman, Bound & Griliches (1994), and Autor et al. (1998).

effects of computer use are due to unobserved heterogeneity (DiNardo & Pischke (1997)).

This paper focuses on both modeling which small firms adopt computers and how their use of computers affects their performance. This paper adds to the existing empirical literature on computer adoption by extending it to cover small privately-held firms.[4] Additionally, it analyzes the association between computer use and several measures of firm performance including costs, costs per employee, sales, labor productivity, and profits.[5] Because the data are a single cross section, I cannot address the question of how computers affect productivity growth nor can I systematically parse out unobserved heterogeneity among firms from the actual contribution of computer use to productivity. The presence of rich demographics about the firm and its primary owners and the fact that the data is nationally representative of the vast majority of small firms allow me to control for many other factors (not available in other surveys) plausibly related to these performance measures. Detailed data on SIC code, size, total assets, sales last year, employment, number of sites, age of the firm, credit risk of the firm, use of financial services by the firm, and a measure of how local the firm's geographic market is are available in the SSBF and are some of the key characteristics associated with profits and productivity (see Bartelsman & Doms (2000)). Information about the firm such as the ownership share of the largest shareholder or primary owner; the age, experience and education of the primary owner; whether one family owns a majority of shares in the firm; how many owners work in the firm; the number of owners of the firm; and the balance sheet are also included in the data set and are important characteristics affecting firm performance, according to the corporate governance literature (see Murphy (2000) and Harris & Raviv (1991)).

2.1 Who uses computers?

Since 1984, periodic October supplements to the Current Population Survey (CPS) have asked individuals if they use computers at work.[6] Ownership and use of computers at home and at school has risen rapidly during this period, yet Krueger (2000) finds that there are persistent racial and ethnic differences in access to computers in the home and at school, while Kominski & Newburger (1999) also find significant socioeconomic differences. While only 25% of employed adults used computers at work in 1984, almost 50% used them at work in 1997 (Newburger (1999)). Data on computer use by individuals permits one to model the effects of computer use on individual outcomes. However, in the absence of corresponding

[4]In this analysis, computers are defined rather narrowly as computer equipment used mainly in office settings in the private sector as in Sichel (1997), rather than more broadly. Thus, for example, use of robots for manufacturing is not expected to be included as firm use of computers for business purposes. While this restriction is imposed by the questionnaire, this narrow definition encompasses the most likely uses of computers by these very small firms.

[5]Since no detailed information is available on how much these firms invest in computer equipment, no rate of return to computers in small businesses can be calculated.

[6]The CPS also asked about computer use and ownership in October 1989, October 1993, and October 1997.

information about firms, it does not allow one to model similar questions at the firm level.[7]

U.S. Census surveys such as the 1988 or 1993 Surveys of Manufacturing Technology and the Annual Surveys of Manufacturers capture detailed information about high-tech investment (hardware and software) and adoption in the manufacturing sector (Atrostic, Gates & Jarmin (2000)), while others such as the Business Expenditures Survey canvass service sector and wholesale and retail trade firms. Researchers have linked these surveys to the Worker-Employer Characteristics Database and the Standard Statistical Establishment List, allowing them to model the effects of technology adoption and spending on wages, employment growth, and the skill level of employees (for an example, see Doms et al. (1997)). Some of these data were collected only for the manufacturing sector or only from establishments with 20 or more employees and measured adoption of a wide variety of high technology practices not commonly used by small businesses (e.g. Computer Aided Design or Numerically Controlled Tools). Therefore, results from these data are unlikely to be representative of the effects of technology adoption on small businesses (most of which have fewer than 5 employees). For many small businesses (as for most individuals), technology adoption means use of a personal computer to track expenses, manage inventory, access the Internet, or do other administrative work.

Using the 1988 Survey of Manufacturing Technology, Dunne (1994) found little correlation between technology adoption and firm age although he does find that larger firms are more likely to use new technologies than are smaller firms. Baldwin & Saboirin (1998) find that technology adoption in Canada increased markedly with size among firms with 20 or more employees.

2.2 Computers and firm performance

Using a Cobb-Douglas specification, Greenan & Mairesse (2000) find (for all French industries but banking and insurance) that computer use is associated with significantly higher levels of firm labor productivity, total factor productivity, capital intensity, and average wages, with the effects on total factor productivity smaller than the others. When the total factor productivity results control for the quality of labor, the coefficient shrinks and is no longer significant.[8]

In a series of papers, Black and Lynch explore the effects of workplace innovations and computer use by non-managers on labor productivity and wages using both cross-sectional and panel data. They find that their measure of computer use is associated with labor

[7] Greenan & Mairesse (2000) match worker data to data about the firm in which they work.

[8] Because they construct their data from a population survey of individuals matched to Census information about the individual's employers, Greenan & Mairesse (2000) restrict their sample to firms with 20 or more employees. Because computers are almost uniformly present in the banking and insurance sector, they expect to find no effects of computerization and indeed find no effects. Finally, they note that because their measure of computer use is use by one employee at the firm, their results are biased downwards because of the measurement error introduced by using computer use by the single employee to proxy computer use at the firm.

productivity in both the cross section and in the panel and with wages in the cross section.[9] Cappelli & Carter (2000) find similar results of computer use by subordinates on wages. Neumark & Cappelli (1999), using a single cross section of the same data as Black and Lynch and purging possible unobservable firm heterogeneity, find computer use by non-managers both increases productivity and raises unit labor costs.[10] Finally, a broad range of articles at the micro and macro level study the effect of computers on productivity growth (for papers from both sides of this literature see Oliner & Sichel (2000), Brynjolfsson & Hitt (2000*a*), Gordon (2000), or Brynjolfsson & Yang (1996)).[11]

This paper contributes to the above in several ways. It supplies evidence about computer adoption and use by small, privately-held firms, a population not studied in most of the previous literature due to lack of data. The analysis controls for many owner and firm characteristics not available in many other data sets. The results are representative for almost all firms with fewer than 500 employees rather than simply for the manufacturing sector.

Although, a priori, I expect that more productive firms are more likely to have adopted computers by 1998, I test whether there is evidence of this among a cross section of small firms. Using regression based estimates of computer adoption from the 1998 Survey of Small Business Finances (SSBF), I also explore whether firms from the 1993 National Survey of Small Business Finances (NSSBF) who are predicted to be computer users are more or less productive than those predicted not to adopt computers. Finally, I analyze the robustness of my findings to the choice of sample and control variables.

3 The 1998 Survey of Small Business Finances and 1993 National Survey of Small Business Finances

The 1998 Survey of Small Business Finances is the third in a series of surveys of small firms sponsored by the Board of Governors of the Federal Reserve System.[12] The SSBF and NSSBF were intended to allow researchers to assess the availability of credit for small and minority owned businesses, to assess the effects of bank mergers on small business access to credit, and to aid in revising the Federal Reserve Board's Flow of Funds statistics.[13]

[9] See Black & Lynch (1998), Black & Lynch (2000), and Black & Lynch (2001).

[10] They estimate their regressions two ways, in the cross section and in a restricted sample. The latter sample consists of establishments also present in the 1977 Longitudinal Research Database and examines the effects of workplace practices on productivity growth by comparing adopters of these practices as compared with non-adopters, assuming that no firms had adopted any of these practices in 1977.

[11] Work at the firm level includes Lichtenberg (1995), Lehr & Lichtenberg (1998), Brynjolfsson & Hitt (1995), and Brynjolfsson & Hitt (2000*b*).

[12] For further information on this round of the survey see Bitler, Robb & Wolken (2001). For information on the other two rounds of the survey (then called the National Survey of Small Business Finances) see Cole & Wolken (1995) and Elliehausen & Wolken (1990). The public use data sets and documentation are available at http://www.federalreserve.gov/pubs/oss/oss3/nssbftoc.htm.

[13] Small businesses are defined as non-financial, non-farm, for-profit, privately-owned businesses with fewer than 500 employees. In the SSBF and 1993 NSSBF, owners are considered employees; thus in these surveys

Along with detailed demographic information about the owners of the firms and the firms themselves, data are collected on the firms' financial relationships, credit experiences, lending terms and conditions, income statement and balance sheet, and the location of the financial institutions used. Almost none of the data about the financing of small businesses collected in the SSBF or its predecessors are available elsewhere.[14] Minority owned businesses and larger small businesses were oversampled in order to ensure reliable subgroup comparisons could be made.[15]

Businesses were first screened for eligibility and then asked about the primary activity of the business, the number of owners working in the firm, the number of other employees, where the firm was located, and where it sold most of its goods. In addition to asking the race, ethnicity, and sex of the holders of a majority of shares in the business, the survey asked about the primary owner's ownership share, the net worth of the primary owner, whether the firm was owner managed, the number of owners, and how the firm was founded. Firms were queried in detail about their use of financial services and sources of financing as well as about their balance sheet and income statement. The 1993 NSSBF is similar to the 1998 SSBF. However, the 1993 NSSBF did not ask firms about their use of computers.

Table 1 contains means for firm and owner characteristics from the 1998 SSBF.[16] The means are in $1000 for dollar amounts, in years for age variables, and are shares otherwise. The firms surveyed are small and closely-held. Average sales in fiscal-year 1998 were slightly less than $1 million and the average number of employees is 8.6 employees, of whom an average of 1.6 are firm owners.[17] Most of the firms' primary geographic markets are their

all firms are considered employee firms. This differs from many U.S. Census surveys where firms whose only workers are owners not being paid salaries are considered non-employee firms.

[14]The U.S. Census Bureau carries out a survey of the Characteristics of Business Owners every five years. However this Census survey does not contain information on credit availability nor does it survey C corporations. Smaller membership surveys by private sector groups are not representative of the whole universe of small businesses.

[15]The list frame for drawing the sample was Dun & Bradstreet's "Dun's Market Identifier File". Firms are added to the "Dun's Market Identifier File" when someone requests a credit rating for the firm or less commonly when the firm contacts Dun & Bradstreet to be added. Thus, both the Dun's file and the survey may underrepresent the smallest and youngest of small businesses.

[16]All statistics and regressions are calculated using weights that adjust for non-response and ineligibility and using Taylor series linearization techniques that account for the complex sampling nature of the survey (Kish (1995)). The survey was carried out in two stages. In the first stage, firms were screened for minority and ethnic status of the holders of a majority shares, number of employees, and SIC code. Once eligibility had been determined, minority-owned and larger businesses were oversampled. Businesses screened were chosen to be representative of the regional and urban-rural distribution of firms of their size as reported by Dun & Bradstreet. Missing items were fully imputed using methods similar to those in the Survey of Consumer Finance, although only one implicate was imputed in the final round (Small Business Survey Group (2001) and Kennickell (1997)). The firms in the 1998 SSBF data represent almost 5.3 million firms in business in December of 1998.

[17]Average sales in 1998 for all employer firms were $329,175 (author's own calculation from U.S. Small Business Administration Office of Advocacy (2001)). Since the frame (and thus the SSBF) may underrepresent the smallest and youngest firms, it is not surprising that the mean of sales for 1998 SSBF firms is larger than that calculated from U.S. Small Business Administration Office of Advocacy (2001). All measures of employees in the SSBF and NSSBF include owners working in the firm who do not receive separate salaries.

local metropolitan area (62%) and most have only one site (88%). Nearly half the firms are organized as sole-proprietorships, with most of the rest being S corporations (24%) or C corporations (20%).[18] The firms are concentrated in the service sector–43% listed their primary activity (by 1987 SIC code) as being business or professional services. The primary activity of a further 19% is retail trade, of 7% is wholesale trade, and of 8% is manufacturing.

Most were founded by a current owner. The vast majority are managed by an owner (92%) and have more than 50% of their shares held by a single family (89%). Nearly half of the firms' largest shareholders have completed a four-year college degree and another 24% attended college at some point. Only 4% of the firms have more than half of the shares held by African Americans and a similar share have more than half their shares held by Asians or Pacific Islanders. 6% have more than half their shares held by Hispanics, who can be of any race. Almost one-fourth of the firms had more than half of their shares held by women. For the first time, this round of the survey asked the primary owners whether they owned their own home and what their housing equity and net worth were. Nearly 90% of the owners own their own homes, and average net worth (exclusive of housing equity and equity in the business) is less than $500,000.

This round of the survey also asked firms whether they used computers for business purposes. Firms answering yes were asked for which specific tasks they use computers. The tasks are:

- for banking via personal computer,
- for an E-mail or Internet connection,
- to purchase or sell business products and services via the Internet,
- to apply for loans or other forms of credit on the Internet,
- to manage inventory,
- for administrative support or functions,
- to manage the firms' accounts/bookkeeping,
- or for other purposes (a catch-all category).

Firms whose only workers are non-salaried owners are considered non-employer firms in U.S. Census and Small Business Administration statistics.

[18]The different organizational forms chosen by firms carry different legal rights and responsibilities. Sole proprietors receive all the income from their business and bear all legal liability. Partnerships have more than one owner. Like the owners of sole-proprietorships, the owners of partnerships receive all the income and bear all the liability of the firm. Corporations are separate legal entities from their owners and thus limited in their liability. S corporations are not taxed at the corporate level but instead pass all the income to their stockholders while C corporations are taxed at the corporate and individual level. However, S corporations are legally limited in both the number of owners and type of entities that can be owners.

Means for these computer use variables are presented in table 2 for all firms and for some major sectors (as defined by SIC code). Column 1 of table 2 contains means and standard errors of the computer use variables for all firms, column 2 for manufacturing firms, column 3 for service sector firms, column 4 for wholesale trade firms, column 5 for retail trade firms.[19] Slightly more than three-fourths of all firms reported using computers for business purposes. Nearly 50% of all workers in the 1997 CPS used computers at work (Newburger (1999)).[20]

Firms in different industries use computers in different ways. While more than 60% of the firms reported using computers for administrative tasks and for bookkeeping tasks, a much smaller share use them for banking by personal computer (11%) or to apply for loans (4%). Less than one-third of the firms use computers to buy or sell on the Internet or to manage inventory. These numbers correspond well with CPS measures for use of computers for various tasks at work, although as noted above, the numbers are not directly comparable. Friedberg (2001) finds that 66% of those using computers in the 1997 CPS used them for accounting—in the 1998 SSBF 83% of those using computers used them for bookkeeping. Slightly more than 12% of the firms reported using computers for some "other" purpose than the specific tasks listed in the questionnaire. The average number of uses of a computer (counting use for "other" purposes as one use) is 2.7, with almost 20% of the firms using computers for one or two tasks, a further 38% using them for three or four purposes, and 19% of the firms using computers for five or more tasks (the remaining firms did not use computers for business purposes).

Firms in different industries also used computers differently. Tests for the equality of these means across groups (not reported in the tables) show that firms in manufacturing, the service sector, and wholesale trade are more likely to use computers than were other firms while retail trade firms were less likely to use computers than other firms. There were few differences across industry in the share of firms using computers for banking or to apply for loans with one exception; retail trade firms were less likely to use computers for banking than were firms in other industries. Manufacturing and service sector firms were statistically significantly more likely than other firms to use computers for E-mail while retail trade firms were less likely to use computers for E-mail. Service sector and wholesale trade firms were

[19]Firms were assigned to industry group according to their 2 digit SIC code. The manufacturing sector includes firms with SIC codes of 20–39. The service sector includes firms with SIC codes of 70–89. Wholesale trade includes firms with SIC codes of 50 or 51, while retail trade includes firms with SIC codes of 52–59. The excluded category is all other firms within the scope of the survey, primarily mineral industries (SIC codes of 10–14), construction (SIC codes of 15–17), insurance agents or real estate (SIC codes of 64 or 65), and transportation, communications and utilities (SIC codes of 41–49). Agricultural firms and most financial institutions were excluded from the sampling frame. Nine firms could not be classified to an SIC code based on their primary activity; these were grouped with service sector firms.

[20]The October CPS includes workers at firms of all sizes and asks the respondents only about their personal use of computers at work. Unless all workers at firms of all sizes are equally likely to use computers, the means for computer use in the 1998 SSBF should be higher than corresponding ones from CPS data. Having any worker use a computer for business purposes makes the firm a computer-using one. Moreover, these numbers are not directly comparable since the CPS is a household survey while the SSBF is representative of firms; thus the CPS report is representative of the experience of the average worker while the SSBF response is representative of computer use at the average firm with fewer than 500 employees.

more likely to use computers for buying or selling on the Internet while retail trade and other firms were less likely to use computers for these purposes. Manufacturing, wholesale trade, and retail trade firms were more likely to use computers to manage inventory while service sector firms and other firms were less likely to use computers for this task. Manufacturing firms, service sector firms, and wholesale trade firms were more likely to use computers for administrative purposes while retail trade firms were less likely than other firms to use computers for these purposes. Manufacturing and wholesale trade firms were more likely and retail trade firms less likely to use computers for bookkeeping. Manufacturing firms were also more likely to use computers for any other purpose while retail trade firms were less likely to use computers for this purpose. Overall, these simple means suggest that computers are used more intensively by manufacturing firms, service sector firms, and wholesale trade firms than by retail trade or other firms.

Table 3 contains simple correlation coefficients for the computer use variables, calculated using survey weights. The correlations among these various uses are the highest for administrative uses and bookkeeping, for loan applications and administrative uses, and for loan applications and bookkeeping. The number of uses of computers is highly correlated with use of computers for loan applications, for administrative purposes, and for bookkeeping, suggesting that most of the firms with a large number of uses used computers for one of these three purposes.

A common assumption in some strands of the productivity literature is that more productive firms make "better" investments. Whether computers are only adopted by the more productive firms or whether using computers causes firms to be more productive, computer-adopting firms should differ from non-adopting firms along observable dimensions. Table 4 tests the equality of means for various firm characteristics for computer users and non-computer users.

Clearly, the simple means suggest that that firms that have adopted computers differ from those that have not. Firms using computers for any business purpose are larger by any measure of size, are younger, have younger primary owners who have higher total net worth, and vary along other dimensions.[21]

4 Empirical models

Computer use may merely be a signal of underlying firm productivity. Nonetheless, it is of interest to see if patterns of computer adoption by small businesses mirror those of households. I model computer adoption as a function of firm characteristics related to profits and productivity from the productivity literature (see Bartelsman & Doms (2000)) or from the corporate governance literature (see Murphy (2000) and Harris & Raviv (1991)). I model firm performance as a function of computer use and these covariates. I also use two-sample techniques combining information on computer adoption from the 1998 SSBF with performance measures from the 1993 NSSBF to calculate the association between being predicted

[21] This measure of net worth includes equity in the business and home equity.

to be a computer user and firm performance. Finally, I investigate the sensitivity of these findings to the choice of sample and controls.

4.1 Which firms use computers?

The typical adoption regression has the form

$$c_{irs} = \gamma_r + \nu_s + b' X_{irs} + \epsilon_{irs} \ ,$$

where i indexes the firm, r the geographic region, and s the SIC two-digit grouping for the firm. In this equation, c_{irs} measures whether the firm has adopted computers (or uses them for a specific purpose). X_{irs} is a vector of demographic characteristics of the firm and its primary owner and of the credit worthiness of the firm.

Demographic variables related to the firm include the log of total assets, the log of total employment, the log of sales last year, a quadratic in the age of the firm, a dummy variable for whether the firm's geographic market is primarily local or regional, a dummy variable for whether the firm has only one location, a dummy variable for the firm being located in an urban area (MSA), dummy variables for the firm having more than two owners and having exactly two owners, dummy variables for organizational form (S corporation, C corporation, or partnership with sole-proprietorship being the omitted category), and dummy variables for how the firm was obtained by the current owners (bought or inherited, with established by a current owner being the omitted category).[22]

They also include controls for the race (African American, Asian or other Pacific Islander, with other—including whites—being the omitted category), ethnicity (Hispanic or non-Hispanic), and sex of persons holding a majority of the shares in the firm.[23]

Region and two-digit SIC code fixed effects (γ_r are the region fixed effects and ν_s are the SIC code fixed effects) are also included.[24]

Covariates related to corporate control and governance include a dummy variable for more than 50% of the firm being held by a single family, a dummy variable for the firm being owner-managed, and a quadratic in the ownership share of the primary owner.

Demographic controls related to the primary owner include dummy variables for the primary owner's educational attainment being exactly a high school degree or less (or equivalent including a GED or vocational training), for the owner having some college experience (including an associate degree) but not a four-year degree (having completed at least a four-year college degree is the omitted educational attainment category), a quadratic in the primary owner's age, a quadratic in the primary owner's business experience, and dummy variables

[22] All logs of dollar amounts are the log of the value in question plus one to avoid dropping the zero values from the regressions. The results are not sensitive to this transformation.

[23] Firms are coded as African American or Asian or other Pacific Islander if the respondent said persons from that racial group held at least 51% of the shares of the firm. Firms are coded as Hispanic if the respondent said that Hispanic individuals owned at least 51% of the shares of the firm. Firms are coded as male-owned if the respondent said that women did not hold at least 51% of the shares in the firm.

[24] Two-digit SIC code categories with fewer than 20 firms are combined with other two-digit categories in the same major one-digit SIC code group. Wholesale trade, durable goods is the omitted category.

for the complete net worth of the primary owner (including her home equity and equity in the firm).

Credit risk variables include controls for the credit score of the firm (obtained from Dun & Bradstreet), dummy variables for the firm and/or the owner having been late on an obligation at least three times in the last three years, and a dummy variable for a judgment having been rendered again the owner in the last three years. ϵ_{irs} represents all unobserved determinants.

The SIC code (region) fixed effects control for unobserved factors that differ across regions and not over industries (vice versa).[25]

4.2 Are firms that use computers better performers?

The typical performance regression is

$$y_{irs} = \delta' C_{irs} + \gamma_r + \nu_s + b' X_{irs} + \epsilon_{irs} \; .$$

where y_{irs} is the relevant performance measure and C_{irs} is a a vector of variables for the firm having used computers for the various tasks. The performance measures I examine include the ratio of costs to sales, the log of costs, the log of costs per employee, the ratio of profits to sales, the log of profits, the log of sales, and the log of sales per employee.[26] The specifications with logs represent a Cobb-Douglas production function; those with sales per employee are a crude measure of the determinants of labor productivity.[27]

The adoption regressions are run as probits and the performance regressions as least squares; all standard errors and regression estimates use the survey weights and account for the complex nature of the sample. All performance regressions exclude the top and bottom 1% of observations to exclude the effects of outliers.[28]

4.3 Are firms who later adopt computers more productive?

Next, I use coefficient estimates from predicting adoption in the 1998 SSBF to see if firms from the 1993 NSSBF who are predicted to adopt computers are more or less productive than those not predicted to adopt computers. The first stage regression here predicts computer

[25]Results using a preliminary version of the data and using state fixed effects are qualitatively similar to those reported here.

[26]For the rest of this paper, when discussing regressions, I will refer to costs, costs per employee, profits, sales, sales per employee, assets, and assets per employee when I mean the natural log of one plus these values unless otherwise noted. Similar references to total employment when discussing regressions should be understood to refer to the log of total employment.

[27]Ideally, I would use overall profitability or the return on investment as measures of firm performance. However, there are very limited measures of investment collected in the SSBF, and 24% of the firms report values for total assets and total liabilities that imply negative book equity. Moreover, the vast majority of these firms are privately held, so there are no market valuations of the firm available. This lack of reliable information on investment or the market value of the firm make it difficult to construct reliable performance measures other than the ones reported above.

[28]Estimates of the effects of computer use are not sensitive to this choice of sample.

adoption using a linear probability model and 1998 SSBF data (the equation estimated is similar to the computer adoption one above), estimated on the firms that are at least 5 years old (and thus could have appeared in the 1993 survey). The coefficients from this adoption regression are used to predict computer adoption in the 1993 NSSBF, after adjusting the age of the 1993 firms to reflect the implicit assumption that these firms will have survived until 1998. Then, 1993 firm productivity is regressed on predicted computer adoption and possible other controls.[29] Controls include all those in the performance and adoption regressions above except for net worth of the primary owner, which was not asked in the 1993 NSSBF, and the Dun & Bradstreet credit risk variables, which are not publicly available for the 1993 data. Because it is unlikely that any of the owner or firm demographic variables are both plausibly related to computer adoption and unrelated to underlying firm "quality", I do not characterize these estimates as being purged of underlying unobserved heterogeneity. However, if computer adoption only serves as a signal of underlying firm quality (more productive firms adopt computers), then firms with characteristics predicting computer adoption as of 1998 should be more productive in 1993 data than firms predicted not to adopt computers. In contrast, a finding instead that firms predicted to adopt computers perform no better than other firms does not support this notion.

4.4 Robustness to choice of sample and controls

Finally, I test the sensitivity of the results to choice of sample and control variables. First, I restrict the sample to certain sectors of the economy or to firms of certain sizes to see if that affects the results, as much of the previous literature has focused on manufacturing firms or large firms. I also examine whether the results are sensitive to the choice of control variables, using only the subsets of the available controls that have been widely used in the previous literature. Finally, I restrict the sample to firms that have adopted computers for some purpose to see if there are performance effects of using computers for specific tasks, conditional on having adopted computers at all.

5 Computer use

Tables 5 and 6 contain the results of multivariate probit regressions of the probability of using computers for various purposes as a function of firm characteristics. Coefficients and standard errors are presented for most controls. All regressions also include region, two-digit SIC code group, and Dun & Bradstreet credit score fixed effects. Regressions are weighted and standard errors adjusted for the complex nature of the sample.

The first column of table 5 presents regression coefficients (standard errors) for the determinants of any computer use for business purposes and columns 2–5 of table 5 and 1–4 of

[29]Standard errors for the predicted computer use variable are adjusted for the fact that it is predicted and not actual computer use in the second stage regression as in two-stage least squares (see Angrist & Krueger (1992) or Angrist & Krueger (1995)).

table 6 contain coefficients for the determinants of each of the specific uses of computers.[30] The household literature suggests that employees at larger firms, more educated employees, and white non-Hispanic employees are more likely to use computers.[31] Most of the firms in the data are owner-run with very few employees. Thus, I expect that larger firms, firms with more educated owners, and firms with a majority of shares held by non-Hispanic whites should be more likely to have adopted computers. The means in table 4 and the regression coefficients in tables 5 and 6 provide support for many of these predictions. First I discuss determinants of any computer use in the firm and then I examine differences in the determinants of use across tasks.[32]

5.1 Any computer use

Use of computers for business purposes is more common for larger firms, whether measured by assets or number of employees, although it is not more common for larger firms as measured by sales last year. Younger firms are more likely to have adopted computers. Firms whose primary market is in their MSA or region are much less likely to use computers. Computer use is associated with neither the region nor the urban/rural nature of the firm's headquarters location. Both S and C corporations are more likely to have adopted computers than are sole-proprietorships. How the firm was obtained by the current owners matters for computer use—firms purchased by current owners are less likely than firms established by current owners to use computers.

Firms whose primary owners have completed at least a four-year college degree are more likely to use computers than those whose primary owners did not complete a four-year college degree. Age and business experience of the primary owner are not significantly related to computer use. Firms whose primary owners has positive net worth below the 50th percentile of net worth are less likely to use computers for business purposes—otherwise net worth of the primary owners is unrelated to computer use. Variables related to control of the firm are not important for predicting computer use; whether a majority of the firm's shares are owned by a single family, whether the firm is managed by an owner, and the ownership share of the primary owner are all insignificant.

In results that mirrors household findings, firms with a majority of shares held by African Americans and Asians are significantly less likely to use computers than those with a majority of shares owned by white non-Hispanics. The coefficient for firms with a majority of shares held by Hispanics is also negative but it is only statistically significant at the 10% level. Firms with at least 50% of their shares held by men are not significantly less likely to use computers than firms with 51% or more of their shares held by women although the coefficient is also negative.

[30] Regressions concerning these specific uses model the unconditional probability of a firm's having adopted computers for this purpose.

[31] See Krueger (2000), Friedberg (2001), or Kominski & Newburger (1999) for more details.

[32] In general, coefficients are described as statistically significant only if they are significant at the 5% level or less.

Credit worthiness of the firm is unrelated to computer use. None of the dummy variables for the Dun & Bradstreet credit score are significantly related to computer use and all these coefficients are small in magnitude. None of the other variables measuring credit worthiness of the firm or owner are significant.

5.2 Specific uses

The SSBF asked about the various tasks for which firms use computers. Columns 2–5 of table 5 and 1–4 of table 6 present coefficients and standard errors from regressions of the probability of using computers for these tasks as a function of firm characteristics. As banks do not universally offer Internet banking, many of these firms may not have access to Internet banking. In contrast, there is easy access to computer software that can perform the other six specific tasks. Since there is no information on what the catch-all "other" uses of computers are, there is no way to tell whether firms easily have access to computer software for these "other" purposes.

Larger firms as measured by assets are more likely to use computers for every specific task except the catch-all "other" category. Firms with more employees are no more likely to use computers for PC banking, to apply for loans, or for "other" uses than other firms while they are more likely to use computers for all of the other tasks. Sales are generally unrelated to computer adoption for any of these tasks. Younger firms are statistically significantly more likely than older firms to use computers for E-mail, for buying or selling on the Internet, for managing inventory, and for administrative purposes and the coefficient is negative for all of the other uses.

Firms with a local or regional geographic market are much less likely to use computers for every task except for loan applications and for "other" purposes. There is no statistically significant association between having only one location and any of the specific uses of computers. Although urban location is not significantly related to the "any computer use" variable, urban firms are more likely to use computers for PC banking; this is not surprising since most banks offering Internet banking are large national banks.[33] Urban firms are also more likely to use computers for administrative tasks and "other" purposes; urban location is otherwise unrelated to computer use for specific tasks.

The number of owners is unrelated to adoption of computers for specific tasks. S corporations are more likely than sole-proprietorships to use computers for managing inventory, for administrative tasks, for bookkeeping, and for "other" purposes. C corporations are more likely than sole-proprietorships to use computers for E-mail, for managing inventory, for administrative tasks, and for bookkeeping. Partnerships are no more or less likely to use computers for any specific task than are sole-proprietorships except that they are less likely to use computers to buy or sell on the Internet. Firms bought by current owners are less likely than those founded by current owners to use computers for E-mail, for buying or selling on the Internet, for administrative tasks, for bookkeeping, and for "other" purposes.

[33]Unlike every other specific use except for loan applications, use of computers for PC banking also varied statistically significantly by the region of the country in which the firm's headquarters was located.

Firms inherited by their current owners are less likely than those founded by current owners to use computers for buying or selling on the Internet or for administrative tasks.

Firms whose primary owners have at most a high school education are less likely to use computers for any specific task except for "other" purposes, and even that coefficient is negative. Firms whose primary owners have attended college but who have not completed a four-year degree are less likely to use computers for E-mail, for buying or selling on the Internet, and for bookkeeping. The age of the primary owner is not associated with adoption of computers for any specific task. Net worth of the primary owner is associated with computer use for managing inventory, for administrative tasks, and for bookkeeping; firms whose primary owners have higher net worth are more likely to use computers for all three tasks. Generally, variables measuring control of the firm are not related to use of computers for specific tasks. However, firms with more than half the shares held by one family are more likely to manage inventory using a computer. Owner-run firms are less likely to use computers for loan applications and more likely to use computers for "other" purposes. The primary owner's share of the firm is generally unrelated to use of computers for any specific purpose.

Firms with more than 50% of their shares held by African Americans or Asian or other Pacific Islanders are less likely than firms majority-held by white non-Hispanics to use computers for E-mail, for administrative tasks, and for bookkeeping. Asian or other Pacific Islander majority-held firms are also less likely than those with a majority of shares owned by white non-Hispanics to use computers for buying or selling on the Internet. Firms with more than 50% of their shares held by Hispanics are less likely then those with a majority of shares held by white non-Hispanics to use computers for E-mail and for administrative tasks. The only tasks for which the sex of the owners of a majority of shares matters are for managing inventory and "other purposes"—there firms with a majority of shares held by women are more likely to use computers for managing inventory and less likely to use them for "other" purposes.

The firms' Dun & Bradstreet credit ratings matter only in predicting use of computers for managing inventory; less credit worthy firms (firms with higher default risks) are more likely to use computers for this task. The other credit worthiness measures—owner or firm late on a bill three or more times in the last year and any judgement against the owner in the last three years—are unrelated to use of computers for all of these tasks with one exception, firms that have been late on on obligation three or more times in the last year are more likely to have adopted computers for administrative tasks.

6 Computer use and firm performance

Use of computers has been found to be associated with higher productivity in larger firms; here I investigate this relationship among smaller firms. For the smallest businesses, many of which have only one employee, computers are less likely to be substitutable for employees than they are for larger businesses. Moreover, the different tasks for which firms report using computers may vary in the ease with which firms can obtain software to do them.

Use of computers for "other" purposes is a catch-all category; there is no clear prediction as to whether it would be positively or negatively associated with firm performance. If computer use is merely a proxy for unobservable (to the econometrician) firm quality, one might expect computer use in general and "other" use in particular to be associated with better firm performance.

The least specific measure of computer use by the firm is any use at all for business purposes. The count of separate uses of computers is a measure of intensity of use. The most disaggregated examination of the effects of computers includes separate dummy variables for use of computers for any of the above specific tasks. I present results for all of these measures of computer use.

For comparison purposes, table 7 contains estimates of the effect of any computer use on the various performance measures with no controls except for fixed effects for two-digit SIC code group. While this is a flawed (or at least non-causal) measure of the association between computer use and firm performance, it provides a benchmark for later comparisons. If computer use is merely a proxy for unobserved firm quality, then these estimates should be upper bounds for the magnitude of the effects of computers on firm performance and the estimates should shrink in magnitude as more controls are added to the regressions. Tables 8 and 9 contain the results of regressions of various measures of firm performance on various measures of computer use by the firm with a full set of controls. Tables 8 and 9 only report the coefficients on the computer use variables.[34]

Table 7 shows that there is a strong and positive relationship between any computer use and total expenditures, total sales, and total profits. Expenditures per dollar of sales and profits per dollar of sales are not significantly related to computer use. Both costs per employee and sales per employee are positively associated with any computer use. Taking the most naive interpretation of these results, one would conclude that computer use is associated with about a 55% increase in sales per employee and as much as a 147% increase in total expenditures, although these are not interpretable as causal relationships.

The regressions in each panel of table 8 contains a different measure of computer use: in panel A, the computer use variable is any computer use by the firm; in panel B, the computer use measure is the simple count of the number of different types of uses listed by the firm (a measure of the intensity of computer use); and in panel C, the computer use variables are a dummy variable for any use of computers and the count of the number of different uses.[35] Each of the regressions in table 9 contains all of the specific computer use dummy variables including the "other" use dummy.

First I discuss the coefficients on the other controls in the performance regressions (see appendix table A-1). Then, I turn to the association between computer use and firm performance.

[34]Coefficients for the other controls for regressions with total expenditures last year, profits last year, and sales last year as the dependent variables are in columns 1, 2, and 3 of appendix table A-1—these correspond to the regression results in table 9, columns 2, 5, and 7, respectively.

[35]Since these two variables are collinear by definition, panel C also contains the F statistic for their linear combination being significantly different from zero.

6.1 Other controls

The coefficients on other controls are fairly consistent across regressions for each measure of performance (expenditures, profits, and sales) in tables 8 and 9. In general, size as measured by total assets is positively associated with costs, profits, and sales. Total employment is also positively associated with costs, profits, and sales.[36] The age of the firm is positively associated with total costs and total sales but not with total profits. Whether the firm's geographic market is local, whether it operates only at one site, whether it is located in an MSA, the region in which it is located, and the number of owners of the firm show no consistent association with performance measures.

Organizational form is closely tied to performance measures; costs and sales are consistently higher for both S and C corporations while profits are lower. There is little difference between partnerships and sole-proprietorships in these performance measures, conditional on the other controls.

How the firm was acquired by the current owners is also important; firms that were purchased by current owners have higher costs and higher sales while inherited firms have higher sales than do firms founded by their current owners.

The educational attainment, age, and experience of the primary owner have no significant relationship to firm performance with a sole exception; firms whose primary owners attended some college have higher sales than those whose primary owners completed a four-year college degree. Consistently across the regressions, firms with medium or low but still positive net worth have lower costs, lower profits, and lower sales than those with either negative net worth or the highest net worth. Variables related to the control and corporate governance of the firm have no significant relationship to the performance measures.

The race, ethnicity, and sex of the holders of a majority of shares in the firm all have some association with firm performance. Firms with a majority of shares held by African Americans have statistically significantly lower costs and lower sales. Firms with a majority of shares held by Asians have statistically significantly higher costs and higher sales. Firms with a majority of shares held by Hispanics have higher profits than those with a majority of shares held by non-Hispanic whites. Finally, firms with at least 50% of their shares held by men have significantly higher costs and sales than firms majority-held by women. There is no significant difference in profits associated with the sex of a majority of shareholders.

The credit worthiness of these firms is associated with firm performance. Firms with "medium" Dun & Bradstreet credit ratings (neither highest nor lowest default risk) have lower costs and lower sales. Profits are not significantly associated with the credit ratings. None of the other credit risk variables are related to costs, profits, or sales with one exception; firms that have been late three or more times in the last three years have higher costs.

[36] I do not include total employment in the performance per employee regressions; assets in those regressions are assets per employee. One might worry that employment and total costs, profits, and sales are determined jointly, however, regression estimates of the effects of various computer uses on total costs, profits, and sales when total employment is excluded are qualitatively similar to those reported here and are available from the author on request.

6.2 Computer use

Table 8 presents evidence about any computer use, the number of distinct uses, and both of these variables on firm performance. The results in panel A show that any computer use is positively associated with both higher expenditures and higher expenditures per employee. Any use of computers is not significantly associated with any of the other performance measures. The results in panel B are similar to those in panel A; namely using computers for more specific tasks is associated with both higher costs and higher costs per employee. Finally, panel C presents results when both of these measures are included in the performance regressions. Only the coefficient on the number of uses is significant in the regression predicting expenditures per dollar of sales. However the coefficient on any use and on the number of uses are opposite in sign (and by definition correlated). The F-test for their linear combination being zero has an F statistic of 1.33 (p-value of 0.25). While the coefficients on the two variables are not individually significant in regressions predicting total expenditures, they are both positive and an F-test that they are jointly significant yields an F statistic of 3.62 (p-value of 0.06) suggesting that computer use is associated with higher total costs. These two coefficients are also jointly significant in regressions predicting costs per employee, but only at the 10% level (F statistic of 3.06 with a p-value of 0.08).[37] Neither coefficient is individually significant in any of the other performance regressions nor is their linear combination significant. A simple comparison of panel A of table 8 with table 7 shows that including other controls reduces the magnitude of the coefficient on computer use in the cost regressions by a factor of between 3 and 9.

Table 9 presents regressions predicting performance as a function of dummy variables for the specific uses of computers to attempt to detect which uses of computers may be driving the costs results from table 8. As in table 8, there is little evidence that computer use for specific tasks is associated with better firm performance, conditional on the other controls. The only use of computers statistically significantly associated with better firm performance (as measured by lower costs per dollar of sales or higher profits per dollar of sales) is use of computers for "other" purposes, a catch-all category for uses that do not fit into one of the specific task categories. One could interpret this "other" use measure as a proxy for the same unobservable (to the econometrician) aspects of the firm as the any use of computers variable captures in productivity regressions. None of the other specific computer use measures is ever significantly associated with a performance measure with

[37] Alternate regressions not reported here predict total costs and costs per employee as a function of an alternative set of computer use and intensity variables (a dummy for any computer use, a dummy for more than one use, and the number of uses minus one when the firm uses computers for more than one task. In this specification, the coefficient on the any-use dummy is the effect of using computers for one task, and the linear combination of that for any use, for more than one use, and for the number of uses is the effect of adding a use, conditional on being at the mean number of uses. In the total costs regressions, all three computer use coefficients are positive and both the coefficient for any computer use and the coefficient for the number of uses if there are two or more uses are significant at the 1% level, suggesting that both whether the firm uses computers at all and the number of different uses of computers are important for predicting total costs. In regressions predicting costs per employee, all three of these variables have positive coefficients although none are significant at even the 5% level.

the exception of the use of computers to manage inventory which is associated with higher costs per employee. Furthermore, F-tests for joint significance of the computer use variables show that they are jointly significantly different from zero only for the regressions predicting total costs (F statistic of 2.01, p-value of 0.04) and costs per employee (F statistic of 1.97, p-value of 0.05). They are nearly significant at standard levels for the regression predicting expenditures per dollar of sales (F statistic of 1.88, p-value of 0.06) but this is driven by the coefficient on "other" use of computers.

The overall pattern of the signs of the coefficients does not tell any consistent story except that they tend to be positive in the cost regressions.

Overall, there is little evidence here that computer use for any of these tasks is associated with lower costs or higher profits or sales. Some previous work has found that computer use is associated with higher unit costs; table 9 does not provide strong support for those findings. This finding of little or no association between computer use and firm performance is also at odds with some of the literature about larger firms. It may not be too surprising considering the smaller opportunities for substitution between employees and computers in small firms, many of which only have one employee—the owner. Another possible explanation is that I have controlled for many observable characteristics of the firm not available in other data sets. With fewer controls available for analysis, computer use may become a proxy for characteristics of the firm or the quality of its managers that are correlated with firm performance.

6.2.1 Two-sample estimation

I use a two-sample technique to test whether firms from the 1993 NSSBF who are predicted to have adopted computers by 1998 (using coefficients estimated on the 1998 data) are more productive than those predicted not to use computers. None of the candidate instruments available are convincingly related to computer adoption but unrelated to firm performance. The best candidates–were they highly correlated with computer adoption–are region or urban/rural location of the firm. Thus, I make no claims that these two-sample estimates are purged of unobservable heterogeneity which may be driving computer adoption and firm performance. However, I can still use the two-sample technique to predict which firms in the 1993 data are likely to be computer adopters based on 1998 findings. A finding that firms predicted to have adopted computers based on adoption coefficients from the 1998 data are better performers in 1993 is consistent with the idea that computer adoption is merely a signal of underlying firm productivity.

I carry out this procedure in two ways; the first exercise uses all the available controls to predict computer use and the second uses the region and urban/rural location of the firm to predict computer use.

The first stage of this process involves regressing one of the measures of computer use in the 1998 survey on all the controls available in both the 1998 and 1993 surveys. Unfortunately, net worth was not asked in the 1993 survey, so this linear regression does not include net worth of the primary owner. The Dun & Bradstreet credit rating dummies are

not publicly available for the 1993 NSSBF, so they are also omitted. The adjusted R-squared for the first stage regressions ranges from 0.27 to 0.30, suggesting that the controls are a relatively good predictor of any computer use.[38] The coefficients on the controls are quite similar in sign and patterns of significance to those in table 5, column 1.

In the second stage, the coefficients estimated from the 1998 data for any computer use are used to predict computer use for the 1993 data. Then, firm performance in 1993 is regressed on this predicted computer use variable for the 1993 data in the first exercise and on predicted computer use and other controls in the second exercise. Standard errors are adjusted for the two stage nature of the estimation.[39]

Using this procedure, I estimate the association between predicted computer use and firm performance, where firm performance is measured by the logs of costs, costs per employee, profits, sales, and sales per employee. All of the performance measures are positively associated with predicted computer use in both exercises. This suggests that firms who would later adopt computers have higher costs but also higher profits and sales.

When all controls are omitted from the second stage (the first exercise), the coefficient on predicted computer use in the total cost regression is 1.04 (standard error of 0.11). Costs per employee are also positively associated with predicted computer use (coefficient of 0.85, standard error of 0.10). Profits are also positively associated with computer use, with a coefficient of 1.01 (standard error of 0.17). Total sales are also strongly positively related to predicted computer use, with a coefficient of 0.96 (standard error of 0.11), close to the coefficient estimate for total costs. Finally sales per employee are positively associated with predicted computer (coefficient of 0.73, standard error of 0.09). Clearly the magnitude of some of these estimates is too large to be plausible, as they suggest that firms who adopt computers more than double their sales (costs, profits). They are similar in magnitude and sign to the unadjusted estimates from table 7 when computer use and two-digit SIC code group dummies are the only predictors of firm performance.

When the region and urban/rural location of the firm are used to predict computer use, the coefficients on the performance variables are positive but smaller for all outcomes but profits and very imprecisely estimated (none are significant at even the 10% level).

Clearly, this exercise is less valuable that one which included from the 1993 data only firms who were still in business in 1998, but the cross-sectional nature of the data makes it impossible to tell which of the 1993 firms is surviving to 1998. However, taken as a whole, these two-sample estimates do not contradict the hypothesis that computer adoption is a signal of underlying firm quality for these firms.

[38] Joint significance of all the variables in the regression is the analog of the F statistic for significance of the controls in the first stage for the first exercise. A test of whether the region and urban/rural dummy variables are jointly significant is the relevant test for these variables being strong predictors in the first stage for the second exercise; this F statistic ranges from 3.7 (p-value of 0.0001) to 3.0 (p-value of 0.001).

[39] Unlike the rest of the regressions reported in this paper, these regressions do include weights but are not adjusted for the complex nature of the sample using Taylor series linearization methods. While in general, this could mean the standard errors are overestimated or underestimated, here it should mean they are overestimated them since the sample is a stratified random sample with no clustering.

7 Robustness of performance results

Another possible explanation for differences between my findings and some others in the literature is simply that I estimate performance regressions on a different sample of firms with a different set of controls than does much of the previous literature.[40] To investigate the possibility that this is driving the findings that computers are weakly associated with higher costs for firms but not with higher sales or profits, I estimate a variety of regressions in different sub-samples with different controls.

Much of the previous literature is restricted to the manufacturing sector or to firms or plants with 20 or more employees. Thus, I run regressions similar to those reported in table 9 with all the various task specific dummy variables included in the regression for sub-samples of only manufacturing firms, only service sector firms, only wholesale trade firms, only retail trade firms, all firms with 20 or more employees, and all firms with fewer than 20 employees. Results for the manufacturing sector and for all firms with 20 or more employees are presented in tables 10 and 11. Table 2 shows that manufacturing firms, service sector firms, and wholesale trade firms are relatively heavy computer users while retail trade firms are less intensive computer users. Thus, it will be interesting to see if the more intensive use of computers is associated with better performance.

7.1 Stratifying the sample by SIC code

Table 10 shows that when the sample is restricted to manufacturing firms, many of the coefficients for specific uses of computers are individually significant at the 5% level or below. The computer use variables are jointly significantly different from zero in all of the regressions although their linear combination (the effect of using computers for all of the purposes) is never significant. For total costs, the linear combination of the statistically significant coefficients (those for use of computers for PC banking, for E-mail, for buying or selling on the Internet, and for managing inventory) is 0.89 (standard error of 0.35). For costs per employee, the linear combination of these coefficients is 0.89 (standard error of 0.32). Both of these linear combinations are significant at the 1% level. Use of computers for PC banking is associated with higher costs and higher costs per employee. E-mail use is associated with higher costs, higher costs per employee, higher sales, and higher sales per employee but not with the other performance measures. Selling or buying on the Internet is associated with lower costs, lower costs per employee, lower sales, and lower sales per employee. Use of computers to manage inventory is associated with higher costs and higher costs per employee. Finally, "other" use of computers is associated with lower costs per dollar of sales, higher profits per dollar of sales, higher sales, and higher sales per employee. None of the specific uses of computers is associated with higher overall profits when the sample is restricted to manufacturing firms.

When the sample is restricted to service sector firms, few of the computer use variables are

[40]The SSBF excludes from the sampling frame most financial firms and all firms that are non-profit, government-owned, or engaged in agriculture.

individually significant. One exception is that selling or buying on the Internet is associated with lower profits, lower sales, and lower sales per employee. Another is that use of computers to manage inventory and use of computers for bookkeeping are both associated with higher costs and higher costs per employee. The computer use variables are jointly significant only in the total costs and costs per employee regressions at even the 10% level and never jointly significant at the 5% level.

Restricting the sample to wholesale trade firms yields the following results; firms that used computers to apply for loans had lower expenditures per dollar of sales, lower overall expenditures, lower expenditures per employee, and higher profits per dollar of sales. However, wholesale trade firms that used computers for PC banking had higher overall expenditures, higher expenditures per employee, and higher sales. Wholesale trade firms that used computers to buy or sell on the Internet had lower overall costs and lower costs per employee. The computer use variables were jointly significantly different from zero for total expenditures, expenditures per employee, and profits. However, the linear combinations of all the coefficients were never significant, and the sum of the significant coefficients in the total costs and costs per employee regressions (the coefficients for use of computers for PC banking, to apply for loans, and to buy or sell on the Internet) were also insignificant.

When the sample is restricted to firms in retail trade, however, the computer use variables are never significant at standard levels nor are they jointly significant at even the 10% level.

These results suggest that the association between computer use and the performance of small firms is larger in magnitude in the manufacturing sector and the wholesale trade sector than for other small firms. Computer use in the manufacturing sector is primarily associated with higher costs. In contrast, some computer uses in wholesale trade are associated with lower costs and some with higher costs. Computer use is not associated with performance measures for firms in the service sector or in retail trade.

7.2 Stratifying the sample by number of employees

Table 11 shows that when the sample is restricted to larger small businesses (as when restricted to the manufacturing or wholesale trade firms), many of the coefficients on specific uses of computers are individually significant at the 5% level or below. Moreover, the coefficients on the computer use variables are jointly significantly different from zero in all of the cost regressions and in the profits per dollar of sales regression. Their linear combination is positive and significant for total costs, costs per employee, and sales per employee (the coefficient is 0.76 with a standard error of 0.32 for the total costs regression, 0.74 with a standard error of 0.32 for the costs per employee regression, and 0.52 with a standard error of 0.25 for the sales per employee regression).

Coefficients on the use of computers for PC banking, for loan applications, to buy or sell on the Internet, and for administrative purposes are never individually significant in the performance regressions for larger small businesses.

Use of computers to manage inventory is again associated with higher costs and higher costs per employee. Bookkeeping is associated with higher costs per dollar of sales, lower

profits per dollar of sales, and lower profits. Here, "other" use of computers is associated with higher costs, higher costs per employee, and higher sales per employee. The only use of computers associated with higher overall profits is use for E-mail.

When the sample is restricted to firms with fewer than 20 employees, none of the computer use coefficients are individually significant except for "other" use of computers. The computer use coefficients are jointly significant at the 5% level only for costs per dollar of sales, driven by the negative and very significant coefficient on "other" use. The "other" use coefficient is also positive and significant in regressions predicting profits per dollar of sales. The linear combination of the computer use coefficients is never significant in any of the performance regressions.

These results suggest that the association of computer use with firm performance and particularly with costs may be stronger for larger small firms than for the smallest of these businesses.

7.3 Restricted set of controls

Another possible explanation for differences between results found here and those in some previous work is that these results include a much richer set of controls potentially associated with underlying managerial or firm quality than are available in many other data sets. To see if the choice of controls is driving my results, I run regressions using only the subsets of the controls available in most other data sets.

The first set of reduced controls includes log of total employment; dummies for the race, ethnicity, and sex of the owners of more than 50% of shares in the firm; a quadratic in firm age; a dummy variable for the urban/rural location of the firm; region fixed effects; and one-digit SIC code fixed effects. This set of controls includes many of those widely available in large U.S. Census data sets. With this restricted set of controls, the computer use variables are jointly significant in the regressions for total costs, costs per employee, total profits, total sales, and total sales per employee. PC banking is associated with higher profits. Use of computers to manage inventory is associated with higher costs, higher costs per employee, and higher sales per employee. Use of computers for administrative purposes is associated with higher costs, higher costs per employee, higher profits, and higher sales per employee. Bookkeeping is associated with higher costs, higher costs per employee, higher sales, and higher sales per employee. Finally, "other" use of computers is associated with lower expenditures per dollar of sales and higher profits per dollar of sales. The linear combination of the computer use variables is positive, large, and significant in the cost and costs per employee regressions (the coefficient is 0.97 with a standard error of 0.25 in the total costs regression and the coefficient is 1.10 with a standard error of 0.25 in the costs per employee regression). The coefficient for this linear combination is larger than that computed with the unrestricted set of controls in either the sub-sample of manufacturing firms or the sub-sample of larger small businesses, although the relevant confidence intervals overlap.

The second and more restricted set of controls includes an assets measure (either assets per employee or fixed assets per employee), one-digit SIC code fixed effects, and in some

specifications, the log of total employment.[41]

The simplest regressions with these restricted controls are those where an asset measure and the one-digit SIC code fixed effects are the only controls and the measure of computer use is any use of computers. In these regressions, estimates of the effects of computer on costs per employee range from 0.61 (standard error of 0.10) when I include total assets and one-digit SIC fixed effects as controls to 0.77 (standard error of 0.10) when I include fixed assets and SIC fixed effects as controls. Adding total employment as another control variable reduces the magnitude of the computer use coefficient to 0.46 (standard error of 0.10) when I include total assets and SIC code fixed effects as controls and to 0.63 (standard error of 0.11) when I include fixed assets and SIC fixed effects as controls. These estimates of the computer use coefficient in the cost regressions are at least 1.7 times as large and as much as 2.9 times as large as the coefficient of 0.27 in table 8, panel A, column 3, estimated with the full set of controls, although the confidence intervals do overlap.

Estimates of the effects of computer use on sales per employee are similar in sign to and smaller in magnitude than those in regressions predicting costs per employee. They are significant at the 1% level or below except when the controls are total assets, SIC code fixed effects, and total employment, in which case the computer use coefficient shrinks to 0.16 (standard error of 0.10, p-value of 0.10). Even this smallest estimate is almost twice as large as that of 0.06 estimated in table 8, panel A, column 7, although again the confidence intervals are overlapping.

These results suggest that it may be the choice of controls that is driving these results; results from work such as Greenan & Mairesse (2000) are similar in sign and magnitude, even though they have a better measure of output (value added rather than sales) and their sample includes financial institutions (not included in the SSBF) and is also restricted to firms with 20 or more employees.

7.4 Restricted the sample to computer users

Finally, I estimate performance regressions similar to those in table 9 but restricted to the sample of firms who have adopted computers for some business purpose. This regression allows me to see if certain specific uses of computers are more or less performance enhancing than others, conditional on having adopted computers at all. In general, these regressions show few effects of any specific computer use except for the catch-all "other" use category. Firms who used computers for some "other" purpose have statistically significantly lower costs per dollar of sales and higher profits per dollar of sales. None of the specific uses of computers seems to have significantly affected any of the performance measures, and the computer use variables are only jointly significant in the regressions predicting expenditures

[41] Here, fixed assets are defined as the sum of the book value of land, the net book value of equipment and intangibles, and the value of longer term investments. Clearly, one would prefer to omit intangibles from this definition, however the three categories listed above are those reported in the SSBF. The results reported here are not sensitive to this definition of fixed assets; omitting equipment and intangibles from the definition of fixed assets did not substantively change the coefficients in the regressions.

per dollar of sales.

8 Conclusion

The 1998 SSBF is one of few data sets with information about the use of computers by small firms. This paper presents the first evidence specifically about the use of computers by small, privately-held firms. Results here suggest that larger firms, younger firms, firms competing in a wider geographic market, and limited liability firms are more likely to use computers, controlling for other firm characteristics. As in the household-based literature about computer use, there are racial and ethnic differences in adoption. Firms with more than 50% of their shares held by African Americans, Asians, or, in a few specifications, Hispanics, are significantly less likely to use computers for business purposes than those with at least 50% held by white non-Hispanics. However, there seems to be no difference in patterns of computer use between firms with at least 51% of their shares held by women and those with less than 51% of their shares held by women. In contrast to some findings for large firms, I find little or no evidence of a link between computer use and firm performance when measured by profits or sales. In some specifications, I find that computer use is associated with higher costs. When the sample is restricted to the manufacturing sector or to larger small businesses, there is evidence that use of computers, particularly for managing inventory, increases costs. Estimates for wholesale trade firms are more mixed with some uses of computers being associated with higher costs and some with lower costs. Firms in other sectors besides manufacturing and wholesale trade showed no systematic association between computer use and performance. Finally, regressions using a less rich set of control variables show larger effects of computer use, suggesting controlling for variables measuring managerial, firm, and owner characteristics is important.

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Table 1: Means of firm characteristics, 1998 SSBF

	Mean	SE	Max.	Min.
Profits	127	13	94241	-38076
Profits are positive	0.8	0.0	1.0	0.0
Book equity of the firm	165	16	86977	-69227
Sales	984	60	624000	0
Sales per employee	95.18	5.01	38021.00	0.00
Total assets	413	19	99912	-4829
Fixed assets (land, equip., and long term investment)	170	11	58636	0
Total expenditures)	867	57	576333	0
Employees (includes owners working in firm)	8.57	0.25	482.00	1.00
Number of owners working in the firm	1.63	0.12	300.00	0.00
Age of firm (under current ownership)	13	0	104	0
Firm's market local or regional	0.62	0.01	1.00	0.00
Firm in an MSA	0.80	0.00	1.00	0.00
Firm has only one location	0.88	0.01	1.00	0.00
Number of owners	2.52	0.30	2500.00	1.00
Owner manages firm	0.92	0.01	1.00	0.00
Manufacturing (SIC 20-39)	0.08	0.01	1.00	0.00
Service sector (SIC 70-89 and unclassifiable)	0.43	0.01	1.00	0.00
Wholesale trade (SIC 50-51)	0.07	0.01	1.00	0.00
Retail trade (SIC 52-59)	0.19	0.01	1.00	0.00
Sole proprietorship	0.49	0.01	1.00	0.00
S corporation	0.24	0.01	1.00	0.00
C corporation	0.20	0.01	1.00	0.00

Means, standard errors, maximum and minimum values for all firms in 1998 SSBF. SE adjusted for non-response, eligibility, and complex nature of sample. Dollar amounts are in thousands of dollars, ages are in years, and other variables are shares.

Table 1: Means of firm characteristics, 1998 SSBF, continued

	Mean	SE	Max.	Min.
Partnership	0.07	0.01	1.00	0.00
Hispanics own more than 50 percent of firm	0.06	0.00	1.00	0.00
African Americans own more than 50 percent of firm	0.04	0.00	1.00	0.00
Asians or Pacific Islanders own more than 50 percent of firm	0.04	0.00	1.00	0.00
Men own 50 percent or more of firm	0.76	0.01	1.00	0.00
One family owns more than 50 percent of firm	0.89	0.01	1.00	0.00
Ownership share of primary owner	0.85	0.00	1.00	0.01
Firm purchased by current owners	0.18	0.01	1.00	0.00
Firm inherited by current owners	0.04	0.00	1.00	0.00
Firm established by current owners	0.78	0.01	1.00	0.00
Age of primary owner	50	0	95	19
Experience of primary owner	18	0	72	0
Education of primary owner high school or less	0.28	0.01	1.00	0.00
Education of primary owner some college	0.24	0.01	1.00	0.00
Education of primary owner at least college degree	0.48	0.01	1.00	0.00
Primary owner owns home	0.88	0.01	1.00	0.00
Primary owner's equity in house	129	4	15000	-22
Net worth of primary owner (excluding home and business)	476	29	100200	-6000
Dun & Bradstreet risk rating lowest risk	0.05	0.00	1.00	0.00
Dun & Bradstreet risk rating highest risk	0.07	0.00	1.00	0.00
Owner more than 60 days late on three or more payments	0.07	0.01	1.00	0.00
Firm more than 60 days late on three or more payments	0.08	0.01	1.00	0.00
Any legal judgement against owner in last three years	0.04	0.00	1.00	0.00

Means, standard errors, maximum and minimum values for all firms in 1998 SSBF. SE adjusted for non-response, eligibility, and complex nature of sample. Dollar amounts are in thousands of dollars, ages are in years, and other variables are shares.

Table 2: Means of computer use variables for all firms and for various sectors, 1998 SSBF

	All industries	Manufact-uring	Services	Wholesale trade	Retail trade
Used computers for any business purposes	0.76	0.88	0.78	0.85	0.61
	(0.01)	(0.02)	(0.01)	(0.03)	(0.02)
Used computers for PC banking	0.11	0.14	0.12	0.15	0.06
	(0.01)	(0.02)	(0.01)	(0.03)	(0.01)
Used computers for E-mail	0.57	0.66	0.61	0.61	0.41
	(0.01)	(0.03)	(0.01)	(0.04)	(0.02)
Used computers for selling/buying on the Internet	0.27	0.33	0.30	0.36	0.23
	(0.01)	(0.03)	(0.01)	(0.04)	(0.02)
Used computers for loan applications	0.04	0.03	0.05	0.04	0.04
	(0.00)	(0.01)	(0.01)	(0.02)	(0.01)
Used computers for managing inventory	0.31	0.51	0.23	0.58	0.39
	(0.01)	(0.03)	(0.01)	(0.04)	(0.02)
Used computers for administrative purposes	0.63	0.70	0.65	0.75	0.47
	(0.01)	(0.03)	(0.01)	(0.03)	(0.02)
Used computers for bookkeeping	0.63	0.73	0.64	0.72	0.50
	(0.01)	(0.03)	(0.01)	(0.04)	(0.02)
Used computers for any other purpose	0.12	0.25	0.14	0.12	0.07
	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)
Number of different computer uses	2.70	3.36	2.74	3.34	2.16
	(0.04)	(0.13)	(0.06)	(0.15)	(0.09)

Means and standard errors for computer use variables for all firms and for selected major SIC code groupings as identified by column heading. Column 1 is the mean for all firms, column 2 for manufacturing firms, column 3 for service firms, column 4 for wholesale trade firms, and column SE adjusted for non-response, eligibility, and complex nature of sample.

Table 3: Correlation among computer use variables, 1998 SSBF

Used computers for:	PC banking	Loan appl.	E-mail	Sell/buy on Internet	Invent.	Admin.	Book-keeping	Other purpose
PC banking	1.00							
E-mail	0.24	1.00						
Selling/buying on the Internet	0.22	0.45	1.00					
Loan applications	0.17	0.16	0.25	1.00				
Inventory	0.13	0.26	0.25	0.11	1.00			
Admin. purposes	0.18	0.55	0.33	0.14	0.38	1.00		
Bookkeeping	0.19	0.52	0.29	0.11	0.35	0.62	1.00	
Other purpose	0.06	0.17	0.12	0.06	0.08	0.15	0.13	1.00
Number of distinct uses	0.42	0.76	0.63	0.32	0.58	0.77	0.74	0.34

Correlations among computer use variables (using sampling weights) for all firms in 1998 SSBF.

Table 4: Tests of equality of means between computer users and non-users

	Mean of variable for: Computer users	Non-computer users	T-stat. for equality of means	P-val. for equality of means
Total assets	511.34	96.71	14.94	0.00
Employees (includes owners working in firm)	10.02	3.94	10.12	0.00
Sales	1241.54	160.11	13.51	0.00
Sales per employee	110.39	46.53	9.13	0.00
Age of firm (under current ownership)	12.81	15.04	3.78	0.00
Age of primary owner	49.40	52.39	5.47	0.00
Experience of primary owner	17.89	19.07	1.97	0.05
Education of primary owner high school or less	0.20	0.53	14.63	0.00
Education of primary owner some college	0.24	0.23	0.28	0.78
African Americans own more than 50 percent of firm	0.03	0.06	4.07	0.00
Asians/Pacific Islanders own more than 50 percent of firm	0.04	0.06	2.88	0.00
Hispanics own more than 50 percent of firm	0.05	0.07	1.95	0.05
Men own 50 percent or more of firm	0.77	0.73	1.91	0.06
One family owns more than 50 percent of firm	0.87	0.93	4.52	0.00
Firm in an MSA	0.83	0.70	5.96	0.00
Firm's market local or regional	0.56	0.80	11.90	0.00
Firm has only one location	0.86	0.94	6.51	0.00
Ownership share of primary owner	0.83	0.91	8.21	0.00
Owner manages firm	0.92	0.94	2.26	0.02

Each row contains the means and results of T-tests for equality of means of the variable among computer users and non-computer users. The first column contains the mean for computer users, the second for non-computer users, the third the T-statistic for the test of equality of means, and the fourth the relevant P-value. Statistics adjusted for non-response, eligibility, and complex nature of sample. Dollar amounts are in thousands of dollars, ages are in years, and other variables are shares.

Table 4: Tests of equality of means between computer users and non-users, continued

	Mean of variable for: Computer users	Non-computer users	T-stat. for equality of means	P-val. for equality of means
Net worth of primary owner (total)	825.28	321.12	9.62	0.00
S corporation	0.28	0.11	10.04	0.00
C corporation	0.23	0.09	9.13	0.00
Partnership	0.06	0.08	1.42	0.16
Sole proprietorship	0.43	0.71	12.74	0.00
Firm purchased by current owners	0.16	0.21	2.59	0.01
Firm inherited by current owners	0.04	0.04	0.53	0.60
Firm established by current owners	0.79	0.75	2.21	0.03
Firm more than 60 days late on three or more payments	0.08	0.05	2.74	0.01
Owner more than 60 days late on three or more payments	0.07	0.08	0.89	0.37
Any legal judgement against owner in last three years	0.04	0.04	0.25	0.80

Each row contains the means and results of T-tests for equality of means of the variable among computer users and non-computer users. The first column contains the mean for computer users, the second for non-computer users, the third the T-statistic for the test of equality of means, and the fourth the relevant P-value. Statistics adjusted for non-response, eligibility, and complex nature of sample. Dollar amounts are in thousands of dollars, ages are in years, and other variables are shares.

Table 5: Determinants of computer adoption for various purposes

Firm used computers for:	Any business purposes	PC banking	E-mail	WWW buying or selling	Loan appl.
Ln(sales)	0.02	-0.01	0.01	-0.03	-0.04
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Ln(total assets)	0.06**	0.05*	0.05**	0.06**	0.07**
	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Ln(employees)	0.30**	0.04	0.19**	0.10**	0.05
	(0.05)	(0.04)	(0.04)	(0.04)	(0.05)
Age of firm (under current ownership)	-0.020*	-0.011	-0.027**	-0.021**	-0.020
	(0.009)	(0.008)	(0.008)	(0.007)	(0.011)
Age of primary owner	-0.044	-0.023	-0.024	0.024	-0.061
	(0.024)	(0.025)	(0.022)	(0.023)	(0.036)
Experience of primary owner	0.009	0.021	0.018	0.005	0.016
	(0.011)	(0.012)	(0.010)	(0.010)	(0.016)
Education of primary owner high school or less	-0.75**	-0.25*	-0.70**	-0.46**	-0.41**
	(0.09)	(0.10)	(0.08)	(0.08)	(0.14)
Education of primary owner some college	-0.29**	-0.07	-0.21**	-0.15*	0.03
	(0.09)	(0.09)	(0.07)	(0.07)	(0.12)
African Americans own more than 50 % of firm	-0.30*	-0.13	-0.22*	-0.15	0.27
	(0.12)	(0.14)	(0.11)	(0.11)	(0.20)
Asians/Pacific Islanders own more than 50 % of firm	-0.60**	0.11	-0.62**	-0.30**	-0.29
	(0.13)	(0.13)	(0.12)	(0.11)	(0.22)
Hispanics own more than 50 % of firm	-0.21	0.15	-0.22*	0.15	0.01
	(0.12)	(0.12)	(0.10)	(0.10)	(0.17)
Men own 50 % or more of firm	-0.12	0.15	-0.06	-0.03	0.07
	(0.08)	(0.09)	(0.07)	(0.07)	(0.12)
One family owns more than 50 % of firm	0.21	-0.02	0.20	-0.03	-0.17
	(0.16)	(0.12)	(0.12)	(0.11)	(0.16)
Firm in an MSA	0.12	0.19*	0.00	0.02	-0.16
	(0.08)	(0.09)	(0.07)	(0.08)	(0.12)
Firm's market local or regional	-0.40**	-0.15*	-0.34**	-0.35**	0.03
	(0.08)	(0.07)	(0.06)	(0.06)	(0.10)
Firm has only one location	-0.06	-0.18	-0.10	-0.10	-0.18
	(0.13)	(0.09)	(0.09)	(0.08)	(0.15)

Each column represents one regression. Coefficients (standard errors) for variables in probit regressions of likelihood of adopting computer use for the purpose specified. All regressions also include fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF. Dollar amounts in thousands of dollars. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table 5: Determinants of computer adoption for various purposes, continued

Firm used computers for:	Any business purposes	PC banking	E-mail	WWW buying or selling	Loan appl.
Ownership share of primary owner	1.44	-0.05	0.15	2.07	-0.98
	(1.42)	(0.98)	(1.18)	(1.06)	(2.09)
Owner manages firm	0.09	-0.20	0.17	0.15	-0.34*
	(0.14)	(0.12)	(0.11)	(0.11)	(0.16)
Net worth <= 0	-0.22	0.20	-0.01	0.08	0.24
	(0.19)	(0.16)	(0.15)	(0.15)	(0.25)
Net worth > 0 and <= 25th %ile	-0.28*	-0.07	0.02	-0.10	0.01
	(0.13)	(0.12)	(0.11)	(0.11)	(0.17)
Net worth > 25th and <= 50th %ile	-0.22*	-0.13	-0.02	-0.04	0.13
	(0.11)	(0.11)	(0.09)	(0.09)	(0.15)
Net worth > 50th and <= 75th %ile	-0.05	-0.04	0.01	0.10	0.09
	(0.12)	(0.10)	(0.09)	(0.08)	(0.14)
More than two owners	-0.60	0.29	-0.06	0.19	-0.72
	(0.33)	(0.24)	(0.24)	(0.23)	(0.46)
Exactly two owners	-0.43	0.28	0.03	0.02	-0.19
	(0.32)	(0.23)	(0.23)	(0.23)	(0.46)
S corporation	0.30**	-0.12	0.13	-0.04	-0.10
	(0.11)	(0.11)	(0.09)	(0.09)	(0.15)
C corporation	0.26*	-0.05	0.23*	0.01	-0.18
	(0.13)	(0.11)	(0.10)	(0.09)	(0.16)
Partnership	-0.14	-0.26	-0.25	-0.31*	-0.34
	(0.19)	(0.17)	(0.15)	(0.15)	(0.25)
Firm purchased by current owners	-0.25**	0.04	-0.28**	-0.20*	-0.26
	(0.09)	(0.09)	(0.08)	(0.08)	(0.16)
Firm inherited by current owners	-0.09	0.17	-0.11	-0.31*	-0.05
	(0.16)	(0.15)	(0.14)	(0.16)	(0.25)
Firm more than 60 days late on 3 or more payments	0.19	0.05	0.08	-0.09	-0.27
	(0.13)	(0.13)	(0.12)	(0.11)	(0.17)
Owner more than 60 days late on 3 or more payments	-0.15	0.26	-0.07	0.01	-0.03
	(0.13)	(0.14)	(0.12)	(0.13)	(0.21)
Any legal judgement against owner in last 3 years	0.20	0.05	0.02	-0.08	0.06
	(0.18)	(0.17)	(0.15)	(0.16)	(0.21)

Each column represents one regression. Coefficients (standard errors) for variables in probit regressions of likelihood of adopting computer use for the purpose specified. All regressions also include fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF. Dollar amounts in thousands of dollars. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table 6: Determinants of computer adoption for various purposes

Firm used computers for:	Managing inventory	Admin. Tasks	Bookkeeping	Any other purpose
Ln(sales)	0.01	0.01	0.02	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)
Ln(total assets)	0.07**	0.06**	0.07**	0.03
	(0.02)	(0.01)	(0.01)	(0.02)
Ln(employees)	0.09**	0.21**	0.22**	0.03
	(0.03)	(0.04)	(0.04)	(0.04)
Age of firm (under current ownership)	-0.017*	-0.016*	-0.014	-0.008
	(0.008)	(0.008)	(0.008)	(0.009)
Age of primary owner	-0.035	-0.000	-0.029	-0.024
	(0.022)	(0.022)	(0.022)	(0.026)
Experience of primary owner	0.014	0.002	0.010	-0.008
	(0.010)	(0.010)	(0.010)	(0.012)
Education of primary owner high school or less	-0.28**	-0.59**	-0.55**	-0.15
	(0.08)	(0.08)	(0.08)	(0.10)
Education of primary owner some college	0.01	-0.08	-0.20*	0.17
	(0.07)	(0.08)	(0.08)	(0.09)
African Americans own more than 50 % of firm	-0.02	-0.24*	-0.36**	-0.26
	(0.11)	(0.11)	(0.11)	(0.14)
Asians/Pacific Islanders own more than 50 % of firm	-0.20	-0.43**	-0.44**	-0.02
	(0.12)	(0.12)	(0.12)	(0.13)
Hispanics own more than 50 % of firm	-0.08	-0.24*	-0.13	0.01
	(0.10)	(0.10)	(0.11)	(0.12)
Men own 50 % or more of firm	-0.15*	-0.08	-0.10	0.19*
	(0.07)	(0.07)	(0.07)	(0.09)
One family owns more than 50 % of firm	0.24*	0.13	0.15	0.03
	(0.11)	(0.12)	(0.12)	(0.13)
Firm in an MSA	-0.04	0.17*	0.10	0.25**
	(0.07)	(0.07)	(0.07)	(0.09)
Firm's market local or regional	-0.23**	-0.22**	-0.17**	-0.10
	(0.06)	(0.07)	(0.07)	(0.07)
Firm has only one location	-0.14	-0.05	-0.08	0.20
	(0.09)	(0.10)	(0.10)	(0.11)

Each column represents one regression. Coefficients (standard errors) for variables in probit regressions of likelihood of adopting computer use for the purpose specified. All regressions also include fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF. Dollar amounts in thousands of dollars. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table 6: Determinants of computer adoption for various purposes, continued

Firm used computers for:	Managing inventory	Admin. Tasks	Bookkeeping	Any other purpose
Ownership share of primary owner	-0.62	2.30	0.73	-0.16
	(1.15)	(1.22)	(1.26)	(1.53)
Owner manages firm	0.05	-0.09	-0.07	0.43**
	(0.10)	(0.12)	(0.12)	(0.14)
Net worth <= 0	-0.19	-0.35*	-0.29	-0.04
	(0.15)	(0.15)	(0.15)	(0.20)
Net worth > 0 and <= 25th %ile	-0.27*	-0.28*	-0.35**	-0.03
	(0.11)	(0.11)	(0.11)	(0.12)
Net worth > 25th and <= 50th %ile	-0.27**	-0.19*	-0.31**	0.04
	(0.09)	(0.09)	(0.10)	(0.11)
Net worth > 50th and <= 75th %ile	-0.15	-0.04	-0.21*	0.05
	(0.08)	(0.09)	(0.09)	(0.10)
More than two owners	0.02	-0.51	-0.09	-0.14
	(0.24)	(0.28)	(0.26)	(0.25)
Exactly two owners	-0.12	-0.47	-0.12	-0.10
	(0.23)	(0.26)	(0.25)	(0.26)
S corporation	0.21*	0.25**	0.30**	0.33**
	(0.09)	(0.09)	(0.09)	(0.10)
C corporation	0.21*	0.25*	0.31**	0.20
	(0.09)	(0.10)	(0.10)	(0.11)
Partnership	0.14	-0.04	-0.00	0.07
	(0.14)	(0.15)	(0.15)	(0.18)
Firm purchased by current owners	-0.07	-0.23**	-0.19*	-0.24*
	(0.08)	(0.08)	(0.08)	(0.10)
Firm inherited by current owners	-0.22	-0.35*	-0.11	-0.02
	(0.14)	(0.14)	(0.15)	(0.18)
Firm more than 60 days late on 3 or more payments	0.05	0.26*	0.14	-0.02
	(0.11)	(0.12)	(0.12)	(0.14)
Owner more than 60 days late on 3 or more payments	-0.06	-0.08	-0.09	0.08
	(0.12)	(0.12)	(0.12)	(0.15)
Any legal judgement against owner in last 3 years	0.11	0.14	0.12	-0.01
	(0.14)	(0.17)	(0.15)	(0.17)

Each column represents one regression. Coefficients (standard errors) for variables in probit regressions of likelihood of adopting computer use for the purpose specified. All regressions also include fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF. Dollar amounts in thousands of dollars. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table 7: Computer use and firm performance, only controlling for 2 digit SIC group, 1998 SSBF

Used Computers for:	Expenditures per $sales	Ln(expend.)	Ln(expend. per employee)	Profits per $sales	Ln(profits)	Ln(sales)	Ln(sales per employee)
Any business purpose	0.03	1.47**	0.80**	-0.05	0.85**	1.21**	0.55**
	(0.03)	(0.11)	(0.10)	(0.03)	(0.14)	(0.10)	(0.09)

Each column within a panel represents one regression. Each panel presents the coefficients (standard errors) for regressions of performance measure as a function of any computer use. The only controls in these regressions are fixed effects for 2 digit SIC code group. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF for which relevant performance measure is defined. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table 8: Computer use and firm performance, 1998 SSBF

Used Computers for:	Expenditures per $sales	Ln(expend.)	Ln(expend. per employee)	Profits per $sales	Ln(profits)	Ln(sales)	Ln(sales per employee)
A:							
Any business purpose	-0.01	0.29**	0.27*	-0.01	0.22	0.07	0.06
	(0.03)	(0.11)	(0.11)	(0.03)	(0.16)	(0.10)	(0.10)
B:							
Number of different computer uses	0.01	0.06**	0.05*	-0.01	0.04	-0.00	-0.00
	(0.01)	(0.02)	(0.02)	(0.01)	(0.03)	(0.03)	(0.02)
C:							
Any business purpose	-0.05	0.21	0.20	0.02	0.20	0.15	0.12
	(0.04)	(0.14)	(0.14)	(0.04)	(0.20)	(0.15)	(0.15)
Number of different computer uses	0.01*	0.03	0.02	-0.01	0.00	-0.03	-0.02
	(0.01)	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)	(0.03)
F-test, sum equals 0	1.33	3.62	3.06	0.07	1.38	0.95	0.64
	(0.25)	(0.06)	(0.08)	(0.79)	(0.24)	(0.33)	(0.42)
Controls for employment:	Y	Y	N	Y	Y	Y	N

Each column within a panel represents one regression. Each panel presents the coefficient(s) (standard errors) for regressions with different measures of computer use. Panel A presents the coefficient on any computer use in regressions only controlling for any computer use; panel B presents the coefficient on the number of different computer uses when the dummy for any computer use is excluded; and panel C presents the coefficients for both when both measures are included in the regressions. Panel C also contains F-tests (p-values) for the sum of the computer variables being zero. Last row of table indicates whether employment was a control variable. Regressions include other controls as listed in text. All regressions also include fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF for which relevant performance measure is defined. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table 9: Computer use and firm performance, 1998 SSBF

Used Computers for:	Expenditures per $sales	Ln(expend.)	Ln(expend. per employee)	Profits per $sales	Ln(profits)	Ln(sales)	Ln(sales per employee)
PC banking	0.03	0.12	0.07	-0.00	0.23	-0.07	-0.08
	(0.04)	(0.11)	(0.10)	(0.03)	(0.15)	(0.15)	(0.15)
Loan Applications	-0.02	0.00	0.05	-0.01	-0.10	-0.28	-0.25
	(0.04)	(0.18)	(0.18)	(0.04)	(0.33)	(0.27)	(0.27)
E-mail	0.01	0.09	0.08	-0.01	0.13	0.06	0.05
	(0.03)	(0.09)	(0.08)	(0.03)	(0.16)	(0.10)	(0.10)
Selling/buying on the Internet	0.02	-0.08	-0.10	-0.03	-0.15	-0.15	-0.18
	(0.02)	(0.09)	(0.09)	(0.02)	(0.15)	(0.11)	(0.10)
Managing inventory	0.02	0.13	0.15*	-0.01	-0.17	0.05	0.09
	(0.02)	(0.08)	(0.08)	(0.02)	(0.14)	(0.09)	(0.09)
Administrative purposes	0.01	0.11	0.12	-0.01	0.24	0.03	0.04
	(0.03)	(0.11)	(0.11)	(0.03)	(0.17)	(0.13)	(0.13)
Bookkeeping	0.01	0.08	0.04	-0.02	0.01	0.08	0.06
	(0.03)	(0.10)	(0.10)	(0.03)	(0.16)	(0.12)	(0.12)
Any other purpose	-0.09**	-0.15	-0.13	0.07**	0.01	-0.06	-0.05
	(0.03)	(0.12)	(0.12)	(0.03)	(0.18)	(0.13)	(0.13)
F-test, joint significance	1.88	2.01	1.97	1.62	1.08	0.84	0.93
	(0.06)	(0.04)	(0.05)	(0.11)	(0.38)	(0.57)	(0.49)
F-test, sum equals 0	0.06	1.76	1.63	0.02	0.24	1.18	1.00
	(0.80)	(0.18)	(0.20)	(0.88)	(0.63)	(0.28)	(0.32)
Controls for employment:	Y	Y	N	Y	Y	Y	N

Each column represents one regression. Coefficients (standard errors) for variables in regressions of firm performance measures on computer use variables and other controls listed in text in top panel, F-tests (p-values) for joint significance of all computer variables and sum of all computer variables being zero in bottom panel. Last row indicates whether employment was a control variable. Regressions include other controls as listed in text. All regressions also include fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF for which relevant performance measure is defined. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table 10: Computer use and firm performance, manufacturing firms only, 1998 SSBF

Used Computers for:	Expenditures per $sales	Ln(expend.)	Ln(expend. per employee)	Profits per $sales	Ln(profits)	Ln(sales)	Ln(sales per employee)
PC banking	-0.00	0.43*	0.41**	0.00	-0.53	-0.09	-0.15
	(0.09)	(0.17)	(0.16)	(0.09)	(0.57)	(0.34)	(0.34)
Loan applications	-0.15	-0.50	-0.46	0.14	-0.70	-0.88	-0.84
	(0.09)	(0.43)	(0.45)	(0.09)	(0.91)	(1.15)	(1.16)
E-mail	0.01	0.49**	0.54**	-0.00	0.77	0.86**	0.91**
	(0.08)	(0.18)	(0.18)	(0.08)	(0.44)	(0.32)	(0.31)
Selling/buying on the Internet	0.21	-0.49**	-0.51**	-0.21	-0.37	-0.95**	-0.94**
	(0.12)	(0.16)	(0.14)	(0.12)	(0.53)	(0.30)	(0.29)
Managing inventory	-0.10	0.46*	0.46**	0.10	-0.95	0.46	0.48
	(0.08)	(0.19)	(0.18)	(0.08)	(0.54)	(0.31)	(0.30)
Administrative purposes	0.17	0.06	0.02	-0.18	0.48	-0.48	-0.51
	(0.09)	(0.22)	(0.21)	(0.09)	(0.47)	(0.33)	(0.33)
Bookkeeping	0.07	-0.12	-0.13	-0.09	0.09	0.37	0.37
	(0.10)	(0.20)	(0.19)	(0.10)	(0.49)	(0.31)	(0.32)
Any other purpose	-0.35**	0.07	0.08	0.39**	0.48	0.50*	0.52*
	(0.09)	(0.17)	(0.16)	(0.10)	(0.52)	(0.23)	(0.23)
F-test, joint significance	2.69	4.29	4.84	2.69	2.11	4.02	4.18
	(0.01)	(0.00)	(0.00)	(0.01)	(0.03)	(0.00)	(0.00)
Controls for employment:	Y	Y	N	Y	Y	Y	N

Each column represents one regression. Coefficients (standard errors) for variables in regressions of firm performance measures on computer use variables and other controls listed in text in top panel, F-tests (p-values) for joint significance of all computer variables in bottom panel. Last row indicates whether employment was a control variable. Regressions restricted to manufacturing firms only (2 digit SIC code between 20 and 39). All regressions also include fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF for which relevant performance measure is defined. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table 11: Computer use and firm performance, firms with at least 20 employees, 1998 SSBF

Used Computers for:	Expenditures per $sales	Ln(expend.)	Ln(expend. per employee)	Profits per $sales	Ln(profits)	Ln(sales)	Ln(sales per employee)
PC banking	0.02	0.17	0.16	-0.02	0.04	0.12	0.12
	(0.02)	(0.09)	(0.09)	(0.02)	(0.22)	(0.08)	(0.07)
Loan applications	-0.09	-0.12	-0.11	0.08	-0.43	0.08	0.08
	(0.06)	(0.21)	(0.20)	(0.06)	(0.54)	(0.19)	(0.16)
E-mail	0.03	-0.01	0.05	-0.02	0.74*	-0.03	0.05
	(0.04)	(0.12)	(0.12)	(0.04)	(0.36)	(0.09)	(0.10)
Selling/buying on the Internet	0.02	0.01	0.02	-0.01	-0.22	0.05	0.04
	(0.03)	(0.09)	(0.09)	(0.03)	(0.28)	(0.08)	(0.08)
Managing inventory	0.05	0.24*	0.24*	-0.05	-0.35	0.08	0.09
	(0.03)	(0.10)	(0.11)	(0.03)	(0.23)	(0.08)	(0.08)
Administrative purposes	-0.06	-0.09	-0.06	0.05	0.25	-0.00	0.00
	(0.04)	(0.16)	(0.16)	(0.04)	(0.40)	(0.12)	(0.12)
Bookkeeping	0.11*	0.21	0.17	-0.11*	-0.94*	-0.02	-0.04
	(0.05)	(0.17)	(0.18)	(0.05)	(0.37)	(0.12)	(0.13)
Any other purpose	0.05	0.35**	0.28**	-0.04	0.12	0.15	0.17*
	(0.03)	(0.10)	(0.10)	(0.03)	(0.28)	(0.09)	(0.09)
F-test, joint significance	2.57	2.46	2.18	2.24	1.63	0.87	1.21
	(0.01)	(0.01)	(0.03)	(0.02)	(0.11)	(0.54)	(0.29)
Controls for employment:	Y	Y	N	Y	Y	Y	N

Each column represents one regression. Coefficients (standard errors) for variables in regressions of firm performance measures on computer use variables and other controls listed in text in top panel, F-tests (p-values) for joint significance of all computer variables in bottom panel. Last row indicates whether employment was a control variable. Regressions restricted to firms with at least 20 employees. All regressions also include fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF for which relevant performance measure is defined. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table A-1: Computer use and costs, profits, and sales last year, other controls

	Ln(costs)	Ln(profits)	Ln(sales)
Ln(total assets)	0.258**	0.251**	0.266**
	(0.029)	(0.038)	(0.032)
Ln(employees)	0.69**	0.41**	0.72**
	(0.05)	(0.07)	(0.05)
Age of firm (under current ownership)	0.021*	0.007	0.037**
	(0.009)	(0.016)	(0.010)
Age of primary owner	0.058	0.032	0.057
	(0.033)	(0.050)	(0.034)
Experience of primary owner	0.011	0.024	0.011
	(0.014)	(0.022)	(0.015)
Education of primary owner high school or less	-0.07	-0.15	0.07
	(0.11)	(0.15)	(0.10)
Education of primary owner some college	-0.08	-0.08	0.22*
	(0.11)	(0.15)	(0.10)
African Americans own more than 50 percent of firm	-0.43**	-0.09	-0.61**
	(0.16)	(0.22)	(0.19)
Asians/Pacific Islanders own more than 50 percent of firm	0.36**	0.35	0.28*
	(0.11)	(0.19)	(0.14)
Hispanics own more than 50 percent of firm	-0.17	0.35*	0.09
	(0.14)	(0.17)	(0.10)
Men own 50 percent or more of firm	0.30**	0.22	0.22*
	(0.09)	(0.15)	(0.10)
One family owns more than 50 percent of firm	-0.02	-0.37	-0.10
	(0.14)	(0.26)	(0.16)
Firm in an MSA	-0.05	0.08	0.03
	(0.09)	(0.14)	(0.08)
Firm's market local or regional	-0.15	0.15	-0.13
	(0.08)	(0.13)	(0.09)
Firm has only one location	-0.09	0.04	-0.15
	(0.08)	(0.18)	(0.11)

Each column represents one regression. Contains coefficients (standard errors) for variables in regression of the dependent variable as a function of firm characteristics and computer use. Dependent variable in column label. Corresponding computer use coefficients in table 7 (column 2 for ln(costs), column 5 for ln(profits), and column 7 for ln(sales)). Regressions also includes fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF for which performance measure is defined. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.

Table A-1: Computer use and costs, profits, and sales last year, other controls, continued

	Ln(costs)	Ln(profits)	Ln(sales)
Ownership share of primary owner	0.21	3.80	3.93
	(1.24)	(3.79)	(3.25)
Owner manages firm	-0.14	-0.23	-0.01
	(0.10)	(0.22)	(0.17)
Net worth <= 0	0.14	-0.46	0.08
	(0.23)	(0.35)	(0.18)
Net worth > 0 and <= 25th %ile	-0.37**	-0.55*	-0.33*
	(0.13)	(0.22)	(0.14)
Net worth > 25th and <= 50th %ile	-0.37**	-0.56**	-0.39**
	(0.12)	(0.18)	(0.14)
Net worth > 50th and <= 75th %ile	-0.11	-0.16	-0.02
	(0.10)	(0.17)	(0.11)
More than two owners	0.12	0.21	-0.21
	(0.29)	(0.49)	(0.32)
Exactly two owners	0.27	0.25	0.11
	(0.24)	(0.52)	(0.33)
S corporation	0.53**	-0.57**	0.38**
	(0.11)	(0.20)	(0.12)
C corporation	0.59**	-1.12**	0.32*
	(0.12)	(0.24)	(0.12)
Partnership	0.14	-0.29	0.06
	(0.17)	(0.30)	(0.19)
Firm purchased by current owners	0.20*	0.14	0.28**
	(0.09)	(0.14)	(0.09)
Firm inherited by current owners	-0.09	0.36	0.32**
	(0.25)	(0.21)	(0.12)
Firm more than 60 days late on three or more payments	0.34**	-0.30	0.02
	(0.09)	(0.26)	(0.17)
Owner more than 60 days late on three or more payments	-0.02	0.39	0.14
	(0.12)	(0.24)	(0.13)
Any legal judgement against owner in last three years	0.01	-0.52	0.01
	(0.23)	(0.36)	(0.23)

Each column represents one regression. Contains coefficients (standard errors) for variables in regression of the dependent variable as a function of firm characteristics and computer use. Dependent variable in column label. Corresponding computer use coefficients in table 7 (column 2 for ln(costs), column 5 for ln(profits), and column 7 for ln(sales)). Regressions also includes fixed effects for region of country, 2 digit SIC code and credit score. SE are adjusted for non-response, eligibility, and complex nature of sample. Sample is all firms in 1998 SSBF for which performance measure is defined. $*$ denotes coefficient is significant at the 5% level, $**$ denotes significant at 1% level.