COMPUTER ADOPTION PATTERNS OF U.S. SMALL BUSINESSES

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Abstract

This paper analyzes computer adoption patterns of U.S. small businesses. First, the association between computer use and firm performance is investigated with a linear model while controlling for various characteristics of the firm and its owner. Then an ordered probit model is used to model small business compute adoption decision. Computer adoption portfolios of U.S. small businesses are also analyzed at the end of the paper.

Key words: small business, performance, computer adoption, ordered probit model

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Computer adoption trends by small businesses and the link between firm performance and computer adoption are an emerging research issues. Internet companies who are not directly involved with entrepreneurs are interested in targeting computer applications that are used by small businesses. Google is unveiling a new e-mail system, recognizing that e-mail is among the most profitable and stickiest services. Users of email are frequent and heavy users of computer technology and can be targeted for additional services with subscriptions, sales, and advertising. Business Week (2004) commented on Microsoft's push into providing more a powerful and diverse set of computer applications for small businesses. The business is growing at 20% for Microsoft with revenues of $567 million in fiscal 2003. The applications for small businesses are expanding beyond Windows and Office products to provide accounting, software and customer relationship management, along with software for handling sales forces and customer service staffs. These developments confirm that providers of business software will become increasingly interested in factors that influence computer adoption by small businesses, the issue that is addressed in our research.

Small businesses are becoming more and more important to U.S. economy. Baldwin et. al. (2002) finds that small plants in U.S. increased their share of employment up to the 1990s steadily their share remained stable in the 1990s at around 37%. Facilitated by the new computer-based technologies that permit improved co-ordination of arm's-length transactions, large firms have been outsourcing more functions that they once found it advantageous to perform internally. The increasing disintermediation of

production process brings more and more opportunities to small businesses. In spite of the increasing importance of small businesses, systematic research in technological changes and performance of small businesses in all industries is rather limited.

Compared with big companies that are generally more sophisticated in technology resulting from a large variety of capital investments, small businesses usually do not have much financial resource for high technology. For small firms, computer is one of most important technology applications on average due to its wide and flexible applications in different industries. Study of small business computer adoption patterns and its effect on firm performance can give us much insight to technology attitudes of small businesses so that we could provide most-needed and effective computer solutions for our small businesses.

I. Literature Review

Over the past several decades, many empirical studies have been focused on the causational relationship of technology adoption and firm performance. Though the main findings are in support of the hypothesis that technology is associated with better firm performance or higher efficiency, the effect of technology adoption on firm performance varies across industries and with firm size. Different measures of firm performance also lead to different results. Among those studies, firm wage differentials, sales revenue and growth, profit level, and productivity are the most explored performance measures. Most studies focus either on large firms or on firms in a particular industry.

For example, Liu, Tsou, and Hammitt (2000) studied the effect of technology adoption on wage structures using dataset on more than nine thousand manufacturing firms and found that technology premiums for wages of non-production workers and

production workers are around 10% and than 7% respectively than those who don't adopt any technology. In another paper on effect of computer use on wage differentials, Liu, Tsou, and Hammitt (2004) conclude that computer use on the job rather than computer use in general is the main source of higher earnings. Individuals who use a computer at work earn about 14% more per hour than those who don't use a computer at all. Controlling for endogeneity of computer use on the job, the effect of computer adoption at work is reduced to half though still significant in explaining wage difference. In study of computer effect of firm performance, Jorgenson & Stiroh (2000) have found that the effects of computers on productivity growth have been large and significant, while Gordon (2000) suggests that recent productivity growth may be isolated to the highly technology sectors.

Some studies also show that the effect of technology adoption is not as evident for smaller firms compared to larger firms. Freel (2000) argued that technical innovation in small firms usually leads to sales and productivity growth, but may have negative impact on absolute profit level due to large cost of innovative investment compared with their relatively small assets level. Tests of his model on a small sample of 228 small manufacturing firms categorized by level of innovation showed innovators are marginally superior to their counterparts in productivity level but the results failed to support his profit-reduction hypothesis.

Bitler (2001) confirmed that the association of computer use with firm performance and particularly with costs is stronger for larger small firms than for the smallest of those businesses. However, Bitler found little or no evidence of link between computer use and firm performance when measured by profits or sales. In her study,

computer use dummy variable, different computer uses, are regressed with different measures of firm performance respectively while controlling for industry dummy variables and employment.

This paper contributes to the above research by studying computer adoption of U.S. small businesses from all industries and its relationship with firm performance. First, the paper uses the level of computer uses as the measure of technology adoption intensity, and tries to find its relationship with firm performance measured by sales volume by controlling for firm and owner characteristics. Then using an ordered probit model, we identify the characteristics of the computer adopters. In addition, this paper analyzes portfolio of computer uses for all firms in 1998 Survey of Small Businesses Finances across the United States.

II. Data and Descriptive Analysis

The primary data of this study comes from 1998 Survey of Small Business Finance (1998 SSBF). 1998 SSBF is the third in a series of surveys sponsored by the Board of Governors of the Federal Reserve System. The target population of this survey is all for-profit, nonfinancial, nonfarm, nonsubsidiary business enterprises that had fewer than 500 employees and were in operation as of year-end 1998. Drawn from the Dun's Market Identifier file as of May 1999, the sample contains 3,561 firms, representing 5.3 million small businesses in the United States.

Along with detailed information about the owners of the firms and the firms themselves, data are also collected on the firm’s financial relationships, credit experiences, lending terms and conditions, income statement and balance sheet, and the location of the financial institutions used. Other than the above-mentioned small business

demographic and financial information covered in the previous surveys, 1998 SSBF also contains some information on computer adoption and applications of those small businesses, which allows us to study the effect of computer adoption to small business performance and characteristics of computer adopters.

First, we investigate the computer adoption situation of the small businesses in our sample, results shown in Table 2 and Figure 1. Table 2 provides information on the percentage of small businesses using computer for any purpose and also individual purposes broken out by two-digit SIC industry codes. Those purposes include use of computer for banking, email communication, sales through Internet, online credit application, inventory management, administration, accounting and other purposes. Looking across all the industries, we find that small businesses in manufacturing industry use computer more often than those in other industries, and more than 90% of those small businesses in manufacturing industry use computer, followed by the industry of finance, insurance, and real estate. Small firms in retail industry are least likely to use computer, with only 68% of them using computer.

Looking across all computer adoption categories, we find that the primary purpose of computer adoption for firms in all industries is very similar, either administration or accounting, followed by email in popularity. For those less popular computer applications, we observe the following phenomena. For computer use for banking, smaller firms in the category of transportation, communication, and utilities industries are the more likely adopters. For sales through Internet, the small firms in wholesale industry are the most likely adopters, followed by those firms in manufacturing, and service industries. Small firms in mineral industries are the most

likely computer users for credit application online, followed by small firms in finance, insurance, and real estate industries. Much to our expectation, computer inventory management is most likely to be adopted by firms in wholesale, retail and manufacturing industries.

Figure 1 presents the percentage of firms that adopt different level of computer applications. There are 8 computer applications in the survey, including use of computer for other purposes. In figure 1, the number of different computer applications is classified into 5 levels, 0 use as the first level, 1-2 applications as the second level, 3-4 as the third level, 5-6 as the fourth level, and 7-8 as the fifth level. Therefore, figure 1 shows the frequency or popularity of computer adoption levels. We can see that 4-use computer adopters are the largest group, with 21% of all small businesses. 20% of small businesses do not use computer for any purpose, ranking the second, followed by 3-use adopters, taking 15% share. Very few firms use computer more than 7 purposes listed in the survey. After breaking down the computer adoption levels by SIC industries, we found that small firms in all industries except those in manufacturing industry usually adopt computers for 3 or 4 purposes. Almost 40% of small firms in manufacturing industry tend to adopt computer for 5-6 purposes.

To see if the number of computer uses is associated with firm performance, we also tabulated the sales amount in $1000 by size class of those small firms and the level of computer use intensity (as measured by the total number of computer uses in four levels). As is shown in Table 3, number of workers in small businesses has strongly increasing relationship with sales, which is consistent with our intuition. But when it comes to the level of computer uses, its impact to sales is not monotonically increasing

except for the firms in size 2 category (with 20-49 employees). For small businesses in other size categories, the level of 5—6 computer uses is related with the highly sales volume. Beyond that, the table shows that the marginal effect of number of computer uses becomes negative.

III. Econometric Models

Computer adoption may be just a proxy for other characteristics of the firm and its owner that have a real impact on firm performance. For example, firm size, age, firm owner education or even other characteristics, which have a positive relationship with computer uses, may play a decisive role on firm performance. So first we investigate the relationship between firm performance and computer adoption levels with an OLS model while controlling for those possible covariates.

(a) The ordinary least square (OLS) equation – log sales

A basic empirical model of small business performance and computer adoption levels is first written as:

Ln(sales) = *f* (SIC industry, size class, organization type, firm owner demographic characteristics, firm characteristics-X1, computer adoption level) (1)

In the above OLS model, we investigate the relationship between sales volume (in natural log) with computer uses while controlling those firm and its owner characteristics. The computer adoption level is coded into five levels, 0, 1—2, 3—4, 5—6, and 7—8. Table 1 lists the firm and its owner characteristics we controlled for. Firm size is coded into four levels according to the number of employees, from 2-5, with 2 representing the lowest size (less than 20 employees). Among all those small businesses, more than half of them (74%) have not more than 20 workers. So we can see that the size of U.S. small

business is heavily skewed to the left. Among the 5 organization types (sole proprietorship, partnership, limited liability partnership, S-corporation and C-corporation, and limited liability companies), the sole proprietorship and S-corporation and C-corporation are the most popular types, with about 90% of small businesses falling into those two categories. In OLS model, we used four dummy variables for the first four organization types while leaving out the last category.

For small firms, owner demographic characteristics play an important role in firm performance and also the firm's tendency in adopting computers. We have two variables on the firm owner's demographic characteristics, owner education levels, which are coded into 7 levels from 1 to 7, and owner's experience, with average experience at 19 years. Correlation analysis shows owner's education and experience are highly correlated with log sales at 0.16 and 0.30 respectively. For small business computer adoption decisions, correlation coefficients indicate that owner's education is highly relevant with correlation coefficient at 0.27 while the owner experience is not so relevant, only related with computer adoption level at 0.03. The effect of firm owner's demographic characteristics will be further investigated in the next part.

Apart from the above general variables we controlled for in our OLS model, we also considered the following firm characteristics which probably influence firm performance but are unlikely to have impact on computer adoptions: firm age, dummy variables for the way how the firm is acquired or established (established by the owner, purchased by the owner, and inherited by the owner, with the third category as the omitted category in the model), and dummy variable for family owned business. Our data shows that the average age of those firms is as high as 14 years instead of their average

small size. There are about 75% of the firms established by the current owner, another 20% purchased from somebody else, and the rest inherited. 86% of small firms are primarily family businesses. Those variables are very unlikely to have a direct impact on firm computer adoption decisions, but are closely related to firm performance.

(b) The ordered probit model – computer adoption level

In this part, we used an ordered probit model to model the computer adoption decisions of small businesses. This decision is measured by the number of computer adoptions. We recode the number of computer adoption into five levels, same as the above linear model, to indicate the computer adoption intensity. This method is also used by Gale (1998) in measuring the extent of technology use in rural and urban manufacturing plants.

NCOMPTOT = *f* (SIC industry, size class, organization type, firm owner demographic characteristics, firm characteristics-X2) (2)

The specification of equation (2) is the same as (1) except that we use another set of firm characteristics which we think will only affect firm computer adoption decision while not directly related with firm performance. Firm characteristics variables -X2 include dummy variable for firms with financial constraint (FINCST), dummy variable for firms having more than one site (DUMSITE), dummy variable for firms with more than one owner (MULTOWNR), and dummy variable for young firms (5 years or older) but with experienced owner (no less than 5 years experience) (FRMYMGRE). The data shows that the average number of sites of U.S. small businesses is 2.2. Here in our model, we include it as a dummy variable, DUMSITE, which is coded as 0 if the small business has only one site and 1 as it has more than one site. We use it as a potential factor that

may affect computer uses considering the fact the more widely the firm is dispersed, the more necessary for different sites to contact with each other using computers. Same reasoning also holds for our selection of MULTOWNR, with the assumption that having many than one owner necessitates the electronic connection among owners and other outside resources. Considering the fact that an experienced owner will keep up with most advanced facilities when purchasing or setting up a new firm, we use a firm-young-manager-experienced variable, FRMYMGRE to measure this effect.

Equation (2) is estimated as an ordered probit. The dependent variable, $NCOMPTOT_i$, is estimated is ordinal and has 5 response categories, $R_0, \ldots, R_5$, representing 0, 1-2, 3-4, 5-6, and 7-8 five levels of computer uses. Each of the N small businesses is assigned to one level if the computer use intensity, $NCOMPTOT_i$, falls within given bounds. More formally,

$$COMPTOT_i = R_j \text{ if } \mu_j \le COMPTOT_i < \mu_{j+1} \qquad \text{for } 0 \le j \le 4 \tag{3}$$

where μ_j is a real number corresponding to a threshold parameter. The ordinal computer adoption variable is defined as

$$COMPTOT_{i,j} = 1 \text{ if } COMPTOT_i < R_j;\ 0 \text{ otherwise,}$$

$$\text{for } 0 \le i \le N,\ 0 \le j \le 4 \tag{4}$$

For (2), (3) and (4), and the assumption that the residuals in (2) are normally distributed, the probability that a firm's computer adoption density belongs to the jth response group is

$$\Pr[COMPTOT_i = R_j] = \Phi[(\mu_j - \Pi' Z / \sigma)] - \Phi[(\mu_{j-1} - \Pi' Z / \sigma)], \tag{5}$$

where $\Pi'Z$ represents the right-hand side of the computer adoption equation (2), σ is a parameter to be estimated, and Φ is the standard normal distribution function. The resultant likelihood function that will be estimated is

$$\text{Log}L = \sum_{i=1}^{N} \sum_{j=0}^{4} COMPTOT_{i,j} \log(\Phi_{i,j} - \Phi_{i,j-1}) \quad (6)$$

Following this procedure, we estimate the effect of various firm and its owner's characteristics to small business computer adoption decision. Maximum likelihood estimates of the parameters of the ordered probit model obtained using LIMDEP (Greene, 2000) are asymptotically efficient and asymptotically normal. The results are reported in the following section.

IV. Empirical Results

The result of our OLS regression, equation (1), is reported in Table 4. Though none of SIC industry dummy variables are significant, they jointly explain a significant portion of variations in ln(sales). Our F-test shows that we cannot reduce those industry dummy variables in our model at the significance level of 5%.

Since our OLS model is a semi-logarithmic form, we used Kennedy's technique (1981) in calculating the marginal effect of our dummy variable and class variables on the firm performance measure of sales in logarithmic form. The marginal effect of k^{th} variable (dummy variable or class variable) is calculated as

$$\text{Exp}(\beta_k - 0.5 * \text{variance}(\beta_k)) - 1 \quad (7)$$

The results show that even controlling for all possible covariates, the computer use intensity is still positively related with sales volume to a very significant extent. When the level of computer adoption level goes up by one level, the firm sales volume will increase by 46% on average. This result is at odds with Bitler's conclusion (2001) that

there is no evidence of a link between computer use and firm performance measured by sales. The difference may be due to the fact that Bitler didn't control for all owner and firm characteristics when measuring the effect of total number of computer adoptions to performance.

Our OLS model also generates interesting results for other covariates. As is shown in Table 4, when the size of small businesses goes up one level, the sales volume will increase by 218% on average. This result echoes most research results that confirm firm employment level is significant in explaining performance measured by wage differentials (Liu, Tsou, and Hammitt, 2000 & 2003) or sales and profit level (Bitler, 2001). Among all five types of organization, sole proprietorship businesses have the lowest sales volume on average, about 68% less than the left-out category, limited liability companies, followed by partnership, which is higher in average sales volume, but still 46% less than the limited liability companies. The educational level of firm owner does help to improve firm performance. Our results show that one level higher is the firm owner's education, the sales volume of his or her firm will be 3% higher. So is the firm age, older firm usually performing better than the younger one. Owner experience is also found to be important in improving small business performance, with one more year of owner experience related with nearly 2% higher sales volume. Compared with effect owner education, this result indicates that firm owner's experience seems more important in effectively improving sales, owners having two more years of experience being more effective than those with one level higher in education.

The way that the owner becomes involved in the small business also matters for firm performance. According to our OLS model results, the firms purchased by the

current owner perform best on average, about 26% higher in sales than those inherited by the owner, while those established by the current owner are the poorest market players, 33% lower in expected sales volume. This maybe due to the fact that the owners of self-established small businesses are usually less motivated and pressured than those who purchase firms from others. Our results also show that small family businesses perform worse than non-family businesses, which roughly matches the findings of Westhead and Cowling (1997), who found that family businesses in U.K. don't perform better in terms of sales revenue size and growth through the study of independent family and non-family unlisted limited liability companies in U.K.

Our ordered probit model investigates the determinants of small business computer adoption decision. Maximum likelihood estimates for the probit model of computer adoptions are reported in Table 4. Estrella's (1998) pseudo-R^2 measure evaluates the fit of the estimated ordered probit model and is defined as

$$\Phi_0 = 1 - \left[\frac{\log L_u}{\log L_c} \right]^{(-2/n)\log L_c} \tag{8}$$

where L_c is the value of the constrained likelihood function and L_u is the value of the unconstrained likelihood function. The measure, which is consistent with the classical R^2 as it is contained in the unit interval and in its interpretation, indicates that the model explains about 24% of the variability of the probability of adoptions across each category. The statistically significant and positive estimates μ_1 and μ_2 confirmed that the computer adoption categories reflect an underlying ordering of preferences by small businesses and provide preliminary validation of the specification of the ordered probit model.

As in our linear model, industry effects are together significant in explaining computer adoption levels. The null hypothesis that the industry effects in the ordered probit model are jointly equal to zero is soundly rejected at $\alpha = 0.05$ as the calculated value of the χ^2 statistic is 100.51 which exceeds the critical χ^2 value of 15.51 for 8 degrees of freedom. Firm owner's educational level is found to be positively and significantly related to high level of computer adoption. This is in contrast with the effect of firm owner's experience, which is negatively related with computer adoption to a significant degree. The result of owner's experience in our ordered probit model is comparable to the findings of Dunne (1994), who finds that plant age is not related to technology use among U.S. manufacturing plants, and also Gale (1998), who finds a negative effect.

The dummy variable indicating whether a firm has multiple establishments is significantly negative in the ordered probit model of computer adoptions. Close to 80% of all firms have only one site for their offices, plants or stores. Firms which have only one site tend to have smaller total sales as over half of these enterprises are below the sample median sales level of $411,000. By contrast, firms with multiple locations are typically larger with almost 80% of these firms generating sales that exceed the median sales. The distribution of computer adoptions for the multiple site and the single site firms is also examined. Here there are only slight differences in the adoption rates as for both types of firms the most frequently observed category is the 3-4 portfolio of computer uses.

The financial constraints variable is not a significant factor influencing computer adoptions. The variable records the most important problems facing the business and

includes economic factors such as taxes, financing and interest rates, cash flow, cost and availability of labor, or other input costs. Firms which face any of the set of financial constraints achieve smaller sales levels, averaging about $2.54 million dollars which is about 70% of the sales recorded by the firms without any identified constraints. The constrained firms do tend to record higher levels of computer adoptions than their counterpart firms, adopting an average of 3.25 applications which is higher than the 2.95 adoptions for the unconstrained firms. It is interesting to compare the financial constraints that are identified by the top performing firms with the low performing firms as measured by their sales levels. We define a high sales firm as a firm with sales above the mean level and note that 39% of firms achieve this ranking. Enterprises which are intensive adopters of computer technology are identified as those who use more computer applications than the mean adoption level in the survey. This definition records 63% of firms as intensive users of computer technology. Relating performance with individual financial constraints, we find that the problem of labor cost and availability is significantly different in seriousness for high and low sales firms. Results show that high sales firms are more likely to be constrained by the problem of labor cost and availability than low sales firm, with 9% and 3% facing this problem respectively. Same results are also found for intensive adopters of computer technology and those with lower adoption levels. About 7% of intensive adopters face the problem of labor cost and availability while only 4% of low-level adopters feel it as a problem. Restricted by our data availability, we cannot include variables on labor in our models directly. But analysis of the problems faced by small businesses shows that it might be a key variable affecting firm performance and technology adoption.

V. Analysis of Computer Use Portfolio

First we investigated computer use portfolio for small businesses in all industries. As is shown in Figure 1, 80% of small businesses use computer. Among different uses, accounting, administration and email are the most popular uses, used by more than half of all the small businesses.

To see what uses are most likely adopted together, we run a correlation analysis to the different computer use. The correlations show that computer uses for selling/buying on the Internet and Email are the highest correlated pair (correlation coefficient at 0.32), followed by the correlation between PC administration and PC accounting at 0.21, selling/buying on the Internet and credit application online at 0.21, PC banking and selling/buying on the Internet at 0.20, PC inventory management and PC administration at 0.19, PC administration and email at 0.17, credit application online and PC banking at 0.16, PC accounting and PC inventory management at 0.16.

Analysis of computer adoption portfolio shows that if the computer is used for only one purpose, most likely (42% of all firms) it will be used for accounting. Small businesses are most likely to use computer for four and three purposes. The following is our focused study on those two categories.

Among all the businesses with 4 computer uses, Email (94%), PC administration (94%), PC accounting (94%) and PC inventory management (50%) are the most popular uses. The above correlation analysis also shows that the four uses are most likely to be correlated. This portfolio takes 38% among all 70 possible combinations, which is the most popular portfolio.

Among all the businesses with 3 computer uses, PCACCT (88%), PCADMIN (88%), PCEMAIL (71%) and PCBANK (36%) are the most popular uses. Compared with

computer use portfolio of 4, PCBANK is more popular when the computer has three uses. Analysis of computer use portfolio shows that PCACCT-PCEMAIL-PCADMIN is the most likely portfolio (adopted by 54% of firms).

Things are little different for those firms in retail industry due to the different natures in business technology. Our data show that smaller percentage of firms in retail industry use computer compared with small businesses overall. 68% of them uses computers for any purpose, while this number is 80% for all small firms in 1998 SSBF data. As is consistent with our intuition, small businesses in retail industry use computer more often in inventory management than those in other industries, 67% of them use computer for inventory management, while only 42% of firms in other industries use computer for this purpose.

Small businesses in retail industry are also most likely to use computers for 4 and 3 purposes (24% and 23% respectively). Computer use portfolio analysis shows that among all the businesses in retail industry with 4 computer uses, PC Email, PC administration, PC accounting and PC inventory management are the most popular uses. This portfolio takes 56% among all possible possibilities. For those firms in retail industry with 3 computer uses, PC inventory management, PC administration and PC accounting is the most preferred combination, adopted by 44% of all retail firms with 3 computer uses.

VI. Conclusion

Using data on the 1998 National Survey of Small Business Finances, this paper analyzes the computer adoption patterns of U.S. small businesses and their effect on small business performance. Our linear model between computer use and firm performance measured with log sales shows that when computer goes up by one level (2 uses), the firm sales volume will increase by 46% even after controlling other possible covariates. The demographic characteristics of the firm, educational level and owner's experience, are both positively related with firm performance, but owner's experience plays a more important role than owner's educational level in improving firm sales. Firms purchased by the current owner perform best on average, followed by those firms inherited by the current owner, while those established by the current owner are the poorest market players. Linear model results also show that family businesses perform worse than non-family businesses.

The various characteristics of the firm and its owner model the firm's computer adoption decision quite well. Firms having more than one site or multiple owners do not adopt computer for more applications than those just having one site or one owner. Firm whose owner has a high educational level tends to be an intensive computer adopter as well, while firm with experienced owner doesn't adopt computer for more uses except that when he or she runs a new firm. Intensive computer adopters tend to feel the problem of labor cost and availability more than those small firms with lower adoption levels, suggesting that labor is also an important factor in firm computer adoption decision.

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Table 1: Descriptive Statistics of the Selected Variables:

Variables	Definition	MEAN	S. E.
LSALE	Ln(total assets)	12.6521	2.3348
MINL	Mineral industry dummy	0.0037	0.0608
CONST	Construction industry dummy	0.1010	0.3013
MANUF	Manufacturing industry dummy	0.1092	0.3120
TRANS	Transportation, Communication, and Utilities industry dummy	0.0399	0.1958
WHSL	Wholesale industry dummy	0.0685	0.2526
RETL	Retail industry dummy	0.1979	0.3985
FIRE	Financial, insurance, and real estate industry dummy	0.0593	0.2363
SRVC	Service industry dummy	0.4187	0.4934
MISSSIC	Other industries	0.0017	0.0410
	2: Below 20 employees	73.82%	0.4397
	3: 20—49 employees	10.50%	0.3065
	4: 50—99 employees	8.13%	0.2733
	5: 100-499 employees	7.56%	0.2644
SZCLSS	Firm size class variable, based on number of employees	2.4943	0.9308
SOLEPR	Sole proprietorship	0.4099	0.4919
PARTNR	Partnership	0.0573	0.2325
LLP	limited liability partnership dummy	0.0288	0.1673
SCCORP	S-corporation and C-corporation dummy	0.4909	0.5000
LLC	Limited liability company dummy	0.0046	0.0674

OWNEDUC	Education of the owner (from 1, the lowest to 7, the highest)	4.6449	1.9584
OWNEXP	Owner's experience	19.2450	11.7640
FIRMAGE	Age of the firm	14.5305	12.1290
ESTABL	Dummy variable for the firm established by the owner	0.7493	0.4335
PURCHD	Dummy variable for the firm purchased by the owner	0.1951	0.3963
INHERT	Dummy variable for the firm inherited by the owner	0.0556	0.2292
FAMOWND	Dummy variable for family business	0.8577	0.3494
INHERT	Dummy variable for inherited firm	0.0556	0.2292
FINCST	Financial constraint dummy	0.2744	0.4463
MULTOWNR	Dummy variable for firms having more than one owner	0.6113	0.4875
DUMSITE	Dummy variable for firms having more than one site	0.7975	0.4019
FRMYMGRE	Young firm (< 5 years) but with experienced manager (>5 years)	0.1289	0.3352
NCOMPTOT	Level of computer uses, recodes into 5 levels	1.7008	1.0830
	0: 0 use	19.62%	
	1: 1—2 uses	17.09%	
	2: 3—4 uses	38.99%	
	3: 5—6 uses	22.19%	
	4: 7—8 uses	2.11%	

Table 2: Percentage of Firms Using Computers for Specified Purposes

Applications 2-digit industry (SIC code)	Use computer for any purpose	Banking	Email	Sales through Network	Credit application online	Inventory management	Administration	Accounting	Other uses	No. of Firms
Mineral Industries	85.71	25.00	83.33	25.00	8.33	58.33	100.00	75.00	25.00	14
Construction Industries	74.86	16.97	74.54	18.45	2.95	37.64	83.03	90.41	14.39	362
Manufacturing	93.06	25.41	82.60	42.82	5.25	67.40	86.46	90.33	25.97	389
Transportation, Communication, and Utilities	86.11	34.68	83.87	37.90	4.84	41.94	86.29	89.52	12.90	144
Wholesale Trade	88.26	26.15	77.98	44.50	4.13	73.85	90.37	88.07	11.01	247
Retail Trade	68.18	17.50	68.13	38.96	5.42	66.67	80.42	84.79	8.54	704
Finance, Insurance, and Real Estate	91.08	18.56	85.05	38.14	6.19	25.26	86.60	81.96	8.76	213
Service Industries	80.77	17.04	79.11	39.10	5.43	31.83	84.71	83.63	16.88	1482
Miscellaneous	83.33	0.00	100.00	60.00	0.00	60.00	80.00	100.00	20.00	6

SOURCE: 1998 National Survey of Small Business Finances

Table3: Total Sales in $1000 by the Number of Workers and the Computer Uses

	0	1--2	3--4	5--6	7--8	Sample Mean
Below 20	132	324	518	1167	561	484
	663	514	964	409	38	2588
20—49	927	2662	3858	4775	9872	4172
	16	43	165	128	16	368
50—99	20772	10305	8401	11184	10656	10044
	6	19	129	118	13	285
100-499	17682	10745	18446	33194	25261	24794
	3	23	109	123	7	265
Sample Mean	407	1209	3095	8343	6684	3486
Number of Firms	688	599	1367	778	74	3506

The first number in a cell is the mean of total sales in $1000; the second number is the number of firms falling into that category. The column dimension is the level of total employees and the row dimension is the number of total computer uses.

Table 4: OLS Analysis of Log Sales and Ordered Probit Analysis of Computer Adoption

	OLS model		Ordered probit model
Variables	Coefficient	Marginal Effect* (OLS)	Coefficient
Constant	9.7721 (0.6252)		0.3100 (0.4828)
SZCLSS	1.1574 (0.0299)	2.1803	0.2328 (0.0245)
SOLEPR	-1.1169 (0.2087)	-0.6798	-0.3132 (0.1645)
PARTNR	-0.5976 (0.2275)	-0.4639	-0.2916 (0.1767)
LLP	-0.0732 (0.2459)		0.0935 (0.1910)
SCCORP	0.0983 (0.2063)		0.1468 (0.1606)
OWNEDUC	0.0307 (0.0129)	0.0310	0.1066 (0.0100)
OWNEXP	0.0187 (0.0026)	0.0189	-0.0065 (0.0016)
FIRMAGE	0.0082 (0.0025)	0.0082	
ESTABL	-0.3840 (0.1046)	-0.3226	
PURCHD	0.2357 (0.1132)	0.2577	
FAMOWND	-0.3930 (0.0723)	-0.3267	
NCOMPTOT	0.3799 (0.0246)	0.4617	
FINCST			0.0690 (0.0412)
DUMSITE			-0.2299 (0.0510)
MULTOWNR			-0.1329 (0.0480)
FRMYMGRE			0.1858 (0.0549)
Mu(1)			0.6185 (0.0193)
Mu(2)			1.8227 (0.0262)
Mu(3)			3.3075 (0.0520)

* Marginal effect here means the percentage changes in sales when the explanatory variables go up by l level.

Figure 1: Small Business Computer Adoption Levels and Popularity of Each Computer Application