Main Street in the Digital Age:

How Small and Medium-Sized Businesses Are Using the Tools of the New Economy

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EXECUTIVE SUMMARY

Robust investment in information technology (IT) played a major role in the acceleration of output and productivity growth from 1996 to 2000. Until now, however, very little was known about the extent to which small and medium size enterprises (SMEs) were taking part in the digital economy. This report examines new evidence of how small and medium-sized businesses are faring in the new economy—their IT investment, their online activities, and the computer experience of their employees.

Small businesses are indeed investing in and using the tools of the new economy. Small and medium-sized firms invest about a quarter of their total capital expenditures on computers and communications equipment. A Federal Reserve Board study found that over 70 percent of small and medium-sized firms use computers in their businesses and our best evidence from a combination of Census and private sector data suggests that a majority of SMEs are also Internet subscribers.

Yet, the evidence also shows that while SMEs and larger firms spend roughly the same proportion of their investment budget on IT, SMEs invest less on a per employee basis. In two IT categories, computers and communications, enterprises with more than 500 employees invested roughly $8,700 per employee in 1998, those with between 100 and 499 employees $3,700, and those with fewer than 100 employees less than $2,500. As a result, firms with more than 500 employees invested twice as much per worker in IT as the 100 to 499 group and four times as much as the below 100 employee firm.

SMEs are also less likely than larger firms either to buy and sell over the Internet. And finally, employees of SMEs are much less likely than those at larger firms to regularly use a computer at work.

However, these general facts paint too simple a picture, obscuring the differences that arise from industry and occupational variations—differences that explain much of the disparity that exists at the aggregate level. SMEs are a very heterogeneous group and some of the differences observed in capital spending arise from the fact that smaller firms are more prevalent in industry sectors such as retail, services and construction that have overall lower levels of capital equipment. For example, in construction where firms with fewer than 25 employees account for almost one-half

of total employment, average industry expenditures on computers and peripherals were only $151 per employee. In durable manufacturing, on the other hand, where firms of 500 or more employees account for over 60 percent of total employment, average industry expenditures on computers and peripherals were $1,088 per employee.

Despite their lower investment per employee, SMEs in every industry are investing and exploring new business uses of information technologies. The Internet aids this process by offering businesses of every size a low cost entry point to examine the possibilities for themselves and businesses of all sizes are increasingly connected. For example, 84 percent of all manufacturing plants responding to a Census survey had Internet access in 1999. Over 75 percent of manufacturing plants with between 20-49 employees (still small for a manufacturer) reported having Internet access.

Census Bureau data indicate, that as early as 1999, selling goods and services online was taking place in almost all sectors of the economy, but at low levels relative to overall sales, revenues, or shipments in most industries. In manufacturing (where we have data by plant size), e-commerce transactions (e.g., Internet sales, EDI, etc.) accounted for a smaller proportion of the shipments made by small manufacturing plants than those made by large manufacturing plants. A National Association of Purchasing Managers/Forrester Research report based on more recent data confirm the Census Bureau's findings: although, large volume purchasers (firms purchasing more than $100 million per year) are the furthest along, most firms are in the early stages of incorporating Internet technologies into their purchasing processes.

And, even though employees of smaller firms are less likely to use a computer at work, a substantial proportion of the SME employees who do not use a computer at work, regularly use a computer at home or some other location. This means that with their current workforce, SMEs have a pool of workers capable of using computers at work should the business need arise.

INTRODUCTION

Robust investment in information technology (IT) played a major role in the acceleration of growth and productivity from 1996 to 2000. However, until now, very little was known about the extent to which small and medium size enterprises (SMEs) were taking part in the IT investment boom. This report examines how small and medium sized businesses were faring in the digital economy before the beginning of the economic slowdown—their IT investment, their online activities, and the computer experience of their employees.

The report finds that firm size matters. SMEs, in general, were investing far less in IT than larger enterprises, on a per employee basis. In terms of using information technology in their business practices, SMEs were less likely than larger firms either to buy and sell over the Internet or to have interactive websites. And finally, employees of SMEs were much less likely than those at larger firms to regularly use a computer at work.

However, these general facts paint too simple a picture. SMEs are a very heterogeneous group, including firms from the software start-up, to the small credit union and the mom-and-pop grocery store. These differences help to explain some of the variations in IT investment by firm size, but not all of it.

THE DIFFUSION OF INFORMATION TECHNOLOGY[1]

Real business investment in information technology (IT) has increased rapidly through the end of 2000. Little, however, is known about the distribution of that investment among firms of various sizes. Using a special previously unpublished tabulation of Census data, this section considers the capital expenditure patterns for two categories of IT investment, computers and peripherals (computers), and communications, audio, and video equipment (communications), by four company size categories. The analysis shows that, on average, smaller companies tend to invest less heavily on a per employee basis in these tools of the new economy than do their larger counterparts.

Some of the variation in IT investment by company size stems from smaller firms investing less in capital equipment in total when compared to larger firms. This would make their expenditures on any given category less, if investments across categories were proportional.[2]

In addition, some of the variation in IT investment by company size is explained by industry characteristics. Some industries are less capital intensive than others. Variations in capital expenditures among firms of different sizes, therefore, could reflect the fact that smaller firms are

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[1] The authors would like to thank Charles Funk and John Seabold of the Bureau of the Census, Company Statistics Division for their assistance with this section.

[2] If, however, smaller firms spend a higher proportion of their total equipment expenditures on computers and communications equipment, this would tend to lessen the differences observed among the various size groups, relative to the differences in total equipment expenditure. Similarly, if smaller firms make less than proportional expenditures on these categories, the variations would be exacerbated relative to the total.

concentrated in those less capital-intensive industries. The data reveal that this is indeed the case; smaller firms are more prevalent in industries that have lower average rates of per employee capital equipment expenditure.

However, even when industry differences are taken into account, smaller firms invest less in total equipment and in both the computers and communications equipment categories.

Annual Capital Expenditure Survey: A Note on the Data

In the Census Bureau's 1998 Annual Capital Expenditure Survey (ACES), firms with employees were asked for the first time to provide detailed information on their capital expenditures by type of equipment. The published survey results include information on capital expenditures by industry and broad equipment type. These data show that while the manufacturing sector accounted for the largest share of total capital equipment expenditures (28.5 percent), the communications industry accounted for the largest share of expenditures on information processing equipment (27.8 percent).[3]

The ACES information processing equipment category is quite broad, including computer and peripheral equipment; office equipment (other than computers and peripherals); communications, audio, and video equipment; navigational, measuring, electromedical, and control instruments; medical equipment and supplies; and capitalized software purchased separately. For the purpose of this study, only three components of this category were considered "IT": computer and peripheral equipment; communications, audio, and video equipment; and purchased software. However, this level of equipment detail is only reported in the published data at the most aggregate level (i.e., expenditures by all companies with employees). Of the $574.4 billion this group spent on equipment in 1998, about one-fourth was for computers and peripheral equipment ($82.5 billion) and communications, audio, and video equipment ($59.5 billion). Purchased software accounted for only a very small proportion of the total ($11.8 billion or 2.0 percent). [4]

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[3] Bureau of the Census, U.S. Department of Commerce, Annual Capital Expenditures Survey: 1998, April 2000. Revisions to the 1998 ACES were published with the release of the 1999 ACES in May 2001. However, these revisions were not carried through to the detail levels used in this report, therefore the unrevised data are used unless specifically noted otherwise.

[4] This accounting of software expenditures greatly underestimates the actual software investment that occurred because prior to 1999, companies did not generally treat software investment as a capital expenditure. To illustrate the extent of the understatement, in 1998, the Bureau of Economic Analysis estimated that private fixed investment in software was $140 billion as compared to their estimate of $84.2 billion for investment in computers and peripherals (http://www/bea.doc.gov/bea/dn/nipaweb). This example also points out that the ACES data differ substantially from other estimates of capital investment. For example for the National Income and Product Accounts, BEA estimates that Equipment and Software investment totaled $818.9 in 1998, while ACES estimates that figure at $606.2 (revised, new equipment expenditures by companies both with and without employees). This considerable difference arises because BEA estimates are derived from the production-side, while ACES is from the consumption-side, using company respondents. In addition, there are many types of equipment expenditures that companies expense rather than capitalize.

Published ACES data do not include measures that enable analysis by firm size. However, the underlying survey data contain information on the number of employees for each of the sample firms. With a simplifying adjustment, these data can be used to create estimates of expenditures per employee for firms in different industries and size categories. Based on such estimates, this section offers an examination of IT investment by firm size using "expenditure per employee" as the measure of investment intensity.[5]

Investment by Size of Company

In 1998, total U.S. capital equipment expenditures averaged $5,585 per employee, with $801 of that total being spent on computers and peripherals (computers) and $579 being spent on communication, audio, and video equipment (communications).[6] As shown in Table 1, however, investment per employee varied substantially by size of the employing firm, with large firms investing considerably more per employee than small firms.

Table 1 indicates that per employee expenditures for computers and communications equipment, specifically, and total equipment, more generally, are positively related to firm size. Size-of-firm variations in communications equipment expenditures are particularly pronounced, with firms of fewer than 25 employees undertaking only 11 percent of the national average investment in that category and firms in the 500 and above employee category undertaking 178 percent of the average investment. Over half of the employees of companies covered by ACES[7] worked for companies of less than 500 employees, with the smallest size category (less than 25) accounting just over 20 percent of total employment.

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[5] When ACES data are collected, respondents are asked to distribute their capital expenditures by industry. Therefore a single company can submit expenditure data for several industries. The expenditures by industry sector in the published results reflect this distribution. The employment data, however, are only available on a company basis. When the Census Bureau created the special tabulation of unpublished data used for this report, all capital expenditures and employment were assigned to the primary industry of the company. Because of this adjustment, the industry totals in this report may differ from the published results. In addition to differences stemming from this adjustment, it should be noted that the ACES sample was not designed to provide reliable estimates at these unpublished levels and may contain high sampling error. These data are also subject to the same sources of error as exist in the published data. These include nonsampling errors, such as errors of coverage, measurement, missing data, and classification. However, the Census Bureau makes every effort to minimize these errors.

[6] The other equipment category identified as IT equipment, capitalized software purchased separately, is not discussed further in this report because it provides only very limited coverage of actual software expenditures (See footnote 2).

[7] ACES does include investment data for companies without employees, but since the focus here in on investment by size of firm as measured by number of employees, the analysis is limited to data gathered on firms with employees.

Table 1: Capital Expenditures Per Employee by Size of Company, 1998

Employment Size Category	Computers & Peripherals	Communications, Audio, Video	Total Equipment	Total Employment (1,000s)
All Firms	$801	$579	$5,585	102,837
Less than 25	$367	$64	$2,133	21,774
25 to 99	$432	$90	$2,363	16,256
100 to 499	$681	$345	$3,701	14,818
500 and above	$1,147	$1,031	$8,698	49,989

Source: Bureau of the Census, U.S. Department of Commerce, *Annual Capital Expenditures Survey: 1998*, unpublished data.

The composition of a firm's IT expenditures also varies by firm size (Table 2). In 1998, companies with employees devoted an average of 14.3 percent of their total capital equipment expenditures to computers and 10.4 percent to communications equipment. In the computer category, firms of all sizes devoted roughly the same share of their total investment to IT, though the largest firms invested proportionally less per employee (13.2 percent). In the communications category, the proportion of capital invested varied positively with firm size. In effect, large firms spent more on communications equipment proportionally, as well as, absolutely.

Table 2: Investment in Computer and Communication, Audio, and Video Equipment as a Percent of Total Investment by Size of Company, 1998

Employment Size Category	Computers & Peripherals (Percent)	Communication, Audio, and Video (Percent)
All Firms	14.3	10.4
Less than 25	17.2	3.0
25 to 99	18.3	3.8
100 to 499	18.4	9.3
500 and above	13.2	11.9

Source: Bureau of the Census, U.S. Department of Commerce, *Annual Capital Expenditures Survey: 1998*, unpublished data.

Investment, Size of Company, and Industry Sector

Lower rates of total investment by smaller firms are only one possible source of the differences in the aggregate distributions of IT investment by size of company evident in Table 1. Another possibility is that smaller firms are more prevalent in industry sectors with lower overall levels of capital investment.

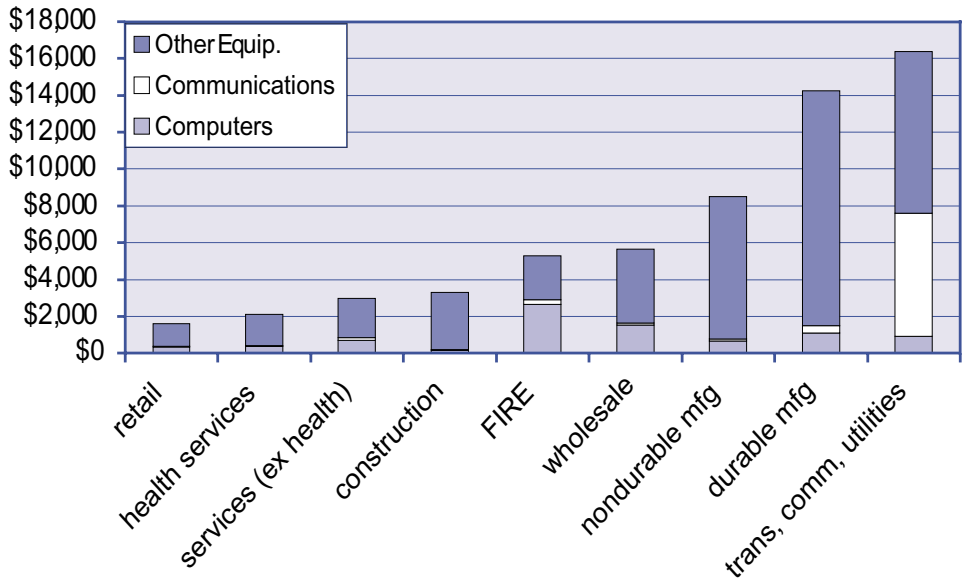
Investment intensity, as measured by expenditure per employee, varies substantially among industry sectors, both in total and in the type of investment undertaken. As shown in Figure 1, the Transportation, Communications, Electric, Gas, and Sanitary Services sector spent the highest amount per employee on capital equipment in 1998 of any sector listed, $16,394 per employee. Retail and Health Services are at the opposite end of the spectrum with total 1998 capital equipment expenditures of $1,609 and $2,124, respectively, per employee.

A comparison of Figure 1 with Figure 2 reveals that in industry sectors with high per employee capital expenditures, large firms tend to predominate. In the three industry sectors with the highest levels of capital expenditures per employee—Nondurable Goods Manufacturers, Durable Goods Manufacturers, and Transportation, Communications, Electric, Gas, and Sanitary Services industries (Figure 1)—more than 50 percent of the industry's total employment is accounted for by largest firm category (Figure 2).

These three industrial sectors are also remarkable in that virtually all of the individual industries that comprise each sector, large firms also dominate. Smaller firms are present in substantial numbers only in a very few of the individual industries.

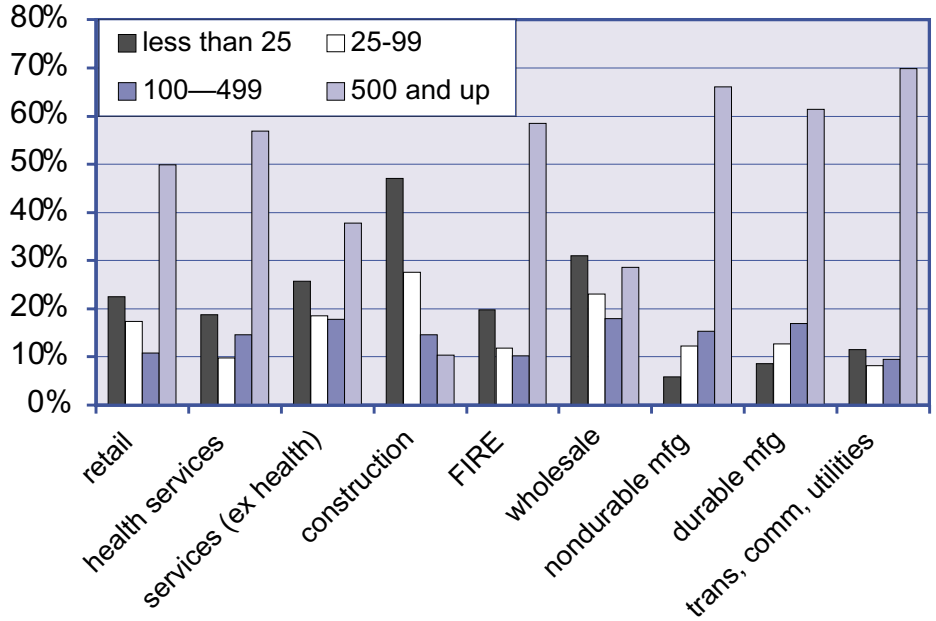
Exceptions to this pattern are evident in the case of Retail, Health Services, and FIRE, where per employee capital expenditures are low although large firms dominate. In this second group, firm size distributions at the industry level vary from the sectoral pattern in many cases. Further, smaller firms are more prevalent in the industries that have per employee capital expenditures well below the sectoral average. For example, in the FIRE sector, small firms are more prevalent in industries, such as Insurance and Real Estate, that have relatively low per employee capital equipment expenditures while large firms dominate industries such as Commercial Banks and Savings Institutions that have relatively high per employee capital expenditures.

Figure 1: Capital Equipment Expenditures Per Employee by Industry, 1998



Note: FIRE is Finance, Insurance, and Real Estate and trans, comm, utilities is transportation, communications, and public utilities.
Source: Bureau of the Census, U.S. Department of Commerce, *Annual Capital Expenditure Survey: 1998*, Unpublished data

Figure 2: Employee Distribution by Size of Company in Major Industry Groups, 1998



Note: FIRE is Finance, Insurance, and Real Estate and trans, comm, utilities is transportation, communications, and public utilities.
Source: Bureau of the Census, U.S. Department of Commerce, *Annual Capital Expenditure Survey: 1998*, Unpublished data

Table 3 presents per employee capital expenditures for computers, communications, and total equipment by industry sector and size of company. Though investment intensity generally continues to vary positively with firm size even when industry sector is accounted for, this does not hold true in all cases. In Health Services, for example, the smallest firms have higher per employee total capital expenditures and computer expenditures than do the two intermediate size categories. This variation is due, again, to variations in size distribution at the industry level. According to an unpublished Census Bureau tabulation, in Health Services sector, one half of the firms that comprise the 100 to 499-employee category are in Nursing and Personal Care facilities—an industry with very low investment intensity. Three-fourths of the smallest firms are doctors and dentist offices, industries that undertake much higher investment per employee.

These data, when taken together, support the notion that, on average, smaller firms tend to invest less heavily in capital equipment in general and in the two IT equipment categories specifically. However, the data also confirm that, although they may invest less than their larger counterparts, small firms are nonetheless making substantial investments in the tools of the new economy.

Some Possible Explanations

Variations in IT spending by firm size could arise from a variety of possible sources, and most likely a combination of sources. For example, there may be inherent differences between the business models employed by small firms and larger firms that make high levels investment in computers and communications equipment unnecessary. Alternatively, smaller firms may wish to invest more, but do not because of difficulty in financing additional investment. Small firms may also limit their investment in information technology because they find it too difficult or too expensive to hire people with the technical expertise needed to make the best use of IT investments. Smaller firms may also invest less because they find it more cost effective to outsource IT activity. Work performed by an outside contractor would be counted as an increase in purchased services not capital investment. Further study is required to determine what role, if any, these various factors play in the distribution of capital equipment expenditures by firms of various sizes.

Table 3: Capital Expenditures Per Employee by Industry Sector and Size of Company, 1998

Industry Sector And Firm Size	Computers & Peripherals	Communications, Audio, and Video	Total Equipment	Total Employment (in 1,000s)
Construction	**$151**	**$17**	**$3,300**	**5,186**
Less than 25	83	14	3,124	2,463
25 to 99	113	15	3,329	1,432
100 to 499	204	31	3,512	753
500 and above	493	16	3,731	538
Durable Manufacturing	**$1,088**	**$397**	**$14,224**	**10,767**
Less than 25	388	11	4,187	965
25 to 99	504	21	3,933	1,364
100 to 499	539	133	5,232	1,820
500 and above	1,463	604	20,291	6,618
Nondurable Manufacturing	**$667**	**$91**	**$8,502**	**8,333**
Less than 25	457	29	2,458	526
25 to 99	343	19	4,171	1,023
100 to 499	398	78	5,847	1,280
500 and above	809	113	10,502	5,504
Finance, Insurance, and Real Estate	**$2,639**	**$244**	**$5,297**	**7,362**
Less than 25	1,384	68	2,716	1,434
25 to 99	2,069	270	3,769	861
100 to 499	2,412	327	4,581	756
500 and above	3,213	283	6,592	4,311
Health Services	**$370**	**$30**	**$2,124**	**10,133**
Less than 25	256	18	1,448	1,904
25 to 99	179	11	1,251	989
100 to 499	233	27	1,095	1,476
500 and above	476	39	2,760	5,764
Retail Trade	**$349**	**$26**	**$1,609**	**21,173**
Less than 25	180	24	896	4,647
25 to 99	106	10	779	3,684
100 to 499	221	22	1371	2,283
500 and above	537	33	2263	10,560

Table 3: Capital Expenditures Per Employee by Industry Sector and Size of Company, 1998, Continued

Industry Sector And Firm Size	Computers & Peripherals	Communications, Audio, and Video	Total Equipment	Total Employment (in 1,000s)
Services excluding Health Services	**$694**	**$163**	**$2,973**	**25,680**
Less than 25	435	113	1,761	6,632
25 to 99	456	104	1,616	4,765
100 to 499	875	140	2,321	4,576
500 and above	902	237	4,773	9,707
Transportation, Communications, Electric, Gas, and Sanitary Services	**$919**	**$6,674**	**$16,394**	**7,026**
Less than 25	149	399	5,020	880
25 to 99	854	952	7,127	571
100 to 499	1,059	5,558	14,148	668
500 and above	1,046	8,623	19,820	4,906
Wholesale Trade	**$1522**	**$114**	**$5,629**	**5,927**
Less than 25	434	23	2,589	1,804
25 to 99	529	34	2,399	1,368
100 to 499	917	69	4,222	1,063
500 and above	3,862	302	12,360	1,693

Source: Bureau of the Census, U.S. Department of Commerce, *Annual Capital Expenditures Survey: 1998*, unpublished data.

SMALL & MEDIUM-SIZED FIRMS, THE INTERNET, AND E-COMMERCE: CURRENT BUSINESS PRACTICES

Available data on the penetration of technologies associated with electronic commerce (broadly defined) and the adoption of various online activities suggest that on average larger firms may be faster to adopt the latest technologies or online activities. However, these data also suggest that many SMEs have nonetheless adopted many of the basic tools of the information economy. The penetration of computers among small firms is high and many small firms are Internet subscribers.

The data suggest that SMEs have been somewhat slower than larger firms to adopt more sophisticated information technology tools like online buying and selling. However, firms across the economy are still in the early stages of integrating the Internet's capabilities into their business processes and our understanding of what constitutes "best practices" is not fully developed.

Moreover, SMEs are incredibly diverse and what works for one firm could be inappropriate for another firm. A venture capital funded applications software development start-up in Silicon Valley that has five people on staff is a fundamentally different type of firm than a 15-year-old small town antique shop with a five person staff. Both firms have the potential to use and benefit from the Internet, but they face different opportunities and different constraints.

No single benchmark describes effective business use of the Internet or other information technology tools. Whether the Internet matters to SMEs (or large firms for that matter) depends on how effectively they use Internet applications to achieve business goals. With respect to the take-up of Internet technologies by SMEs, a common misperception is that there is a linear progression from Internet access, to a brochure Web page, to a transaction capable Web site, to a Web site fully integrated with back office computers. Take-up and use surveys often reinforce this misperception by implying that firms deploying more complex technologies, which require a greater degree of technological sophistication, are somehow more in tune with the digital economy than other firms. However, investing in the most technically sophisticated tool is not necessarily the best strategic decision.

Computers

Businesses have been using computers in their operations over the last 50 years. It was not until the early 1980s, however, that relatively affordable desktop computers were first introduced. Since that time, businesses across the economy have adopted this technology. Although computers are not ubiquitous in U.S. businesses, computer use appears to be prevelant. A 1998 survey of firms

with 500 or fewer employees (one of the commonly used definition of SME[8]) found that about 76 percent of firms had computers. About 71 percent of firms with 0 to 4 employees had computers at that time.[9]

Market research confirms that computer penetration rates are high among small firms. Dun & Bradstreet reports that by May 2001 over 80 percent of small firms (25 or fewer employees) had a computer on site that was used for business purposes.[10]

Connectivity

We have no direct measure of how many of the roughly 7.6 million business establishments in the United States have Internet access; nonetheless, Internet penetration in businesses of all sizes is likely high.[11] Market research estimates suggest that the majority of small firms have Internet access.[12] Dun & Bradstreet survey results suggest that about 67 percent of firms with 1-25 employees had Internet access. Since, as shown below, these firms in these size classes likely have the lowest rates of Internet penetration, we can infer that overall Internet access is likely high.

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[8] This section relies on data reported from surveys of SME's from many sources; the "SME definition" used by those who conducted the survey will accompany cited statistics.

Any analysis of existing data on SMEs faces the challenge posed by the lack of a single, commonly accepted statistical definition. Often SMEs are defined in terms of employment size. In this case, however, differences in industry structure factor into whether a certain employment size category is really "small" relative to other firms in the industry. For example a 100 employee auto parts manufacturer would indeed be small relative to other auto parts manufacturers, while a florist with 100 employees would be a large firm compared to the average florist. SMEs are also sometimes defined in terms of annual revenues.

Another factor is that as firms get very small (measured by both employment and revenue size), it becomes statistically difficult to determine whether the business activity underway is sufficient to warrant definition as a firm. For example, an engineer with a full time job might have a "business" doing home inspections in his free time. Analyses of SMEs, often, although not always, exclude very small firms, such as firms with zero employees, because of this difficulty.

[9] Marianne P. Bitler, Alicia M. Robb, and John D. Wolken, "Financial Services Used by Small Businesses: Evidence from the 1998 Survey of Small Business Finance," April 2001 (http://www.federalreserve.gov/pubs/oss/oss3/nssbftoc.htm).

[10] Dun & Bradstreet, "20th Annual Small Business Survey Summary Report," August 14, 2001 (www.dnb.com/smallbusiness).

[11] The number of private establishments in 2000 is from Bureau of Labor Statistics, Covered Employment and Wages Series (http://www.bls.gov/cew/home.htm#data).

[12] Specific estimates from private sources and company-specific examples are included in this report to be illustrative of developing trends and their inclusion does not signify Department of Commerce validation or approval of any particular private sector estimate or example. Disparities among private estimates can result from differences in definitions, methods, data, model and sampling error, and product coverage. Variations also reflect the research needs of customers. While data used for estimates and forecasts are based on a combination of surveys and interviews, the survey questions and answers are typically not made public, sample sizes vary considerably across surveys, and little information is available about respondents.

Surveys of specific industries, such as the Census Bureau's survey of e-commerce and e-business processes at manufacturing plants tells a similar story of generally high levels of Internet subscribership.[13] In 2000, 83.9 percent of responding U.S. manufacturing plants reported having Internet access. However, larger plants are more likely to have Internet access than small plants.[14] (Table 4)

Table 4: Internet Access for Manufacturing Plants, 2000
(Percent)

Employment Size	With Internet Access
1-4	47.1
5-9	52.1
10-19	64.7
20-49	76.2
50-99	84.9
100-249	91.5
250-499	94.1
500 +	94.9
Total	**83.9**

Notes and Source: Data for the 38,985 manufacturing plants responding the survey. This is a plant level survey and is not comparable with firm or company level data; a give firm may own multiple plants. The Annual Survey of Manufactures (ASM) uses a probability-proportionate-to-size sample design that results in a sample primarily comprised of larger manufacturing plants. While a number of small plants are included in the ASM, the number is disproportionately small in comparison to the entire manufacturing population. Thus, these comparisons are suggestive, but not definitive. Detail may not add to total due to rounding. U.S. Bureau of the Census, çE-Stats Manufacturing 1999 and Mid-2000é, Table 7, June 8, 2001 (http://www.census.gov/estats).

13 The Census Bureau also found that among plants with Internet access the smaller the plant, the larger the share of employees with Internet access. (U.S. Bureau of the Census, "E-Stats Manufacturing 1999 and Mid-2000," Table 7, June 8, 2001 (http://www.census.gov/estats)) Similarly, Dunn & Bradstreet found that 53 percent of small firms (fewer than 25 employees) provided Internet access to all of their employees. (Dun & Bradstreet, "20th Annual Small Business Survey Summary Report," August 14, 2001 (www.dnb.com/smallbusiness).)

14 This is a plant level survey and is not comparable with firm or company level data; a give firm may own multiple plants.

The Census Bureau's results are mirrored by an earlier survey of manufacturing *firms* done by KPMG Consulting for the Manufacturing Extension Partnership. This survey found that 89 percent of manufacturing firms (1-499 employees) had Internet access in 2000 and that Internet penetration increased with firm size. (KPMG Consulting & U.S. Department of Commerce, Manufacturing Extension Partnership, "Study of U.S. Small Manufacturing eBusiness Needs," Washington, D.C., June 2000.)

Connection Speed

Although Internet penetration is generally high among businesses, all Internet access is not equal. Some companies have high-speed (broadband) access while others rely on relatively slow dial-up connections. Broadband access, such as that provided by fiber optics, digital subscriber lines and certain wireless technologies, make it possible for a business to conduct a greater variety of online activities. IDC estimates that nearly 15 percent of small businesses had broadband communications capabilities in 2000.[15] Dun & Bradstreet found that about 28 percent of small firms (with 25 or fewer employees) had high speed Internet access while that 57 percent used telephone modems for their Internet access. [16]

Cost and availability are key factors in whether a business has broadband access. Large firms can typically afford the broadband Internet connections, such as T1 lines that cost $500 to $1,000 or more a month.[17] Small and mid-sized firms may not have the communications volume to justify such an investment.

Or, broadband may simply not yet be available in the businesses geographic location. Availability of high-speed lines is, however, increasing. Communications companies are in the process of deploying a variety of broadband alternatives to dial-up Internet access (e.g., cable modems, digital subscriber lines, wireless local loop). But, these options are not yet universally available. The Federal Communications Commission reports that during the second half of 2000, the number of high-speed lines connecting residences and businesses increased by 63 percent, to a total of 7.1 million. The growth rate for the full year was 158 percent.[18]

Online Activities

As businesses and people have gained access to the Internet, the market potential of the online world has grown. The Census Bureau reports that e-commerce (defined in terms of whether the commitment to sell was made online) is taking place across the economy.

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15 IDC, "Small Businesses Are Tightening Their Belts on Technology Spending but Not Too Tightly," Press Release, June 11, 2001 (www.idc.com:8080/Hardware/press/PR/ES/GES061101pr.stm).

16 Dun & Bradstreet, "20th Annual Small Business Survey Summary Report," August 14, 2001 (www.dnb.com/smallbusiness).

17 Gregg Keizer, "More Cures for the Broadband Blues," Zdnet Small Business, May 21, 2001 (http://www.zdnet.com/filters/printerfriendly/0,6061,2763730-81,00.html).

18 Federal Communications Commission, "Federal Communications Commission Releases Data on High-Speed Services for Internet Access," Press Release, August 9, 2001 (www.fcc.gov/Bureaus/Common_Carrier/News_Releases/2001/nrcc0133.txt).

Levels of activity are, however, low and uneven across industries. Online sales account for a relatively substantial portion of total shipments by manufacturers (12.0 percent) and total sales by wholesale merchants (5.3 percent), but they account for a very small proportion of total sales made by retailers and selected service providers (0.5 percent and 0.6 percent, respectively).[19]

Some industries, such as manufacturing, also have a long history of using computer networks for sales (e.g., some firms have used electronic data interchange since the 1960s), which explains manufacturing's levels of e-commerce shipment. But, even in sectors with low average e-commerce sales, almost all of the component industries have at least some online transactions.

Dun & Bradstreet reports that 27 percent of small firms (1-25 employees) with Internet access used the Internet for sales in 2001. [20]

The same Dun & Bradstreet survey found that 44 percent of small firms (1-25 employees) with Internet access used the Internet for business purchases.[21] This finding is somewhat counter to broader surveys indicating that all businesses are in the early stages of integrating Internet tools into purchasing. The National Association of Purchasing Managers (NAPM)/Forrester Research survey found that as of September 2001 most of the NAPM members surveyed were in the early stages of adopting online purchasing.[22]

Researchers are at the beginning of understanding how firms of all sizes are using the Internet for activities that go beyond the selling and buying associated with e-commerce. For example, businesses use the Internet for marketing, customer service, human resources and so forth. Recent research suggests large companies have been more aggressive in implementing some of the more sophisticated "Internet business solutions" than small firms such as Internet-based supply chain management. However, the same research suggests that firms of all sizes are using the Internet for business activates, such as "e-marketing", customer service and support, finance and accounting, human resources, sales force automation, and supply chain management, etc.[23]

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[19] Data on manufacturers were collected on a special supplement to the Annual Survey of Manufactures. The Census Bureau collected data on wholesale merchants, retail establishments, and services by adding questions to existing annual surveys. Total and e-commerce estimates from the various survey programs should not be added together because they are not collected on the same basis: Manufacturing is based on shipments, wholesale merchants and retailers are based on sales, and services are based on revenues. E-Stats, a Census Bureau publication can be found at www.census.gov/estats.

[20] Dun & Bradstreet, "20th Annual Small Business Survey Summary Report," August 14, 2001 (www.dnb.com/smallbusiness).

[21] Dun & Bradstreet, "20th Annual Small Business Survey Summary Report," August 14, 2001 (www.dnb.com/smallbusiness).

[22] National Association of Purchasing Managers/Forrester Research, "NAPM/Forrester Research Report on eBusiness October 2001," October 16, 2001 (http://www.napm.org/ISMReport/Forrester/FROB102001.cfm).

[23] Hal Varian, Robert E. Litan, Andrew Elder, Jay Shutter, The Momentum Research Group, "The Net Impact Study," Preliminary Report, December 10, 2001 (www.netimpactstudy.com).

EMPLOYEE SKILLS IN SMALL AND MEDIUM-SIZED FIRMS

Challenges facing SMEs in the United States appear to be less about access to the technology than whether firms have the information and resources necessary to make the most effective, strategic use of the tools offered by the Internet. Census data indicate that although a lower proportion of employees of small firms report regularly using a computer at work, the difference among employees of firms of various sizes narrows if computer use from any location is considered. A substantial proportion of employees in smaller firms appear to possess knowledge-base skills necessary for exploiting the tools of the new economy, even if these skills are not currently being used in their workplace.[24]

The Survey of Income and Program Participation

Conclusions in this section are based on the Survey of Income and Program Participation (SIPP), a panel survey of households in which respondents are asked about their employment status, including their occupation and the industry and size (in terms of total number of employees) of their employer. For the survey conducted between August and November 1999, questions about Internet access and computer use were included for the first time.[25]

According to the SIPP, in the latter part of 1999, 127.7 million people held paid jobs in the United States.[26] Approximately 65 percent of these people worked for an employer that had 100 or more employees. Only 22 percent worked for a firm of fewer than 25 employees and 13 percent worked for a firm of between 25 and 99 employees.[27]

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[24] The survey used in this section contains some limited information on Internet access. Because the questions related to Internet access offer no information on Internet access or use at work, these data are not reported here.

[25] See the U.S. Census Bureau at http://ferret.bls.census.gov/cgi-bin/ferret. For more information on the SIPP see http://www.sipp.census.gov/sipp/.

[26] The employment base derived from the SIPP (127.7 million) is substantially higher than the 102.8 million employees used as the base in the previous section that uses employment estimates derived from ACES. Aside from the fact that the SIPP data are for 1999 and the ACES data are for 1998, differences arise because the ACES data used in Section 1 was limited to companies with employees, while SIPP includes all persons with paid employment, including household workers and the self-employed that would not be measured by ACES.

[27] The SIPP includes information only on these three employer size breakouts. This is approximately the same percentage distribution as measured in the ACES data used earlier except that the two larger employer categories are combined.

The personal computer (PC) is currently the primary mechanism by which people access the Internet and other private computer networks.[28] Overall, 55.2 percent of the employed population reports regularly using a PC with 40.6 percent reporting that they regularly use a PC at work.[29]

Regular Computer Use by Size of Employer

People who work for an employer with fewer than 25 employees are less likely to use a PC at work than people who work for larger employers (Table 5). However, among those who do not use a computer at work, a higher proportion of individuals who work for employers with less than 25 employees regularly use a PC at home or some other location (16.9 percent) than do individuals who work for medium (15.2 percent) or large (13.6 percent) employers. Therefore, although people who work for smaller companies generally are less likely to be PC users, whether at work or anywhere else, the differences are less than exist when only considering computer use at work.[30]

Table 5: Personal Computer Use Experience of Employed Individuals by Size of the Employer, 1999

Employment Size Category	Regularly Uses a PC* (Percent)	Regularly Uses a PC at Work (Percent)	Regularly Uses a PC, but not at Work (Percent)	Total employed (1,000s)
All Employees	55.2	40.6	14.6	127,677
Less than 25 employees	47.5	30.6	16.9	28,695
25 to 99 employees	50.9	35.7	15.2	16,378
100 and over employees	58.7	45.1	13.6	82,605

* Respondents were asked whether they regularly used a computer at home, work, or other location

Source: Bureau of the Census, U. S. Department of Commerce, Survey of Income and Program Participation, research data file (August-November 1999, Wave 11)

28 The term "personal computer" or PC is used in this section rather than a more generic term that would include devices such as Apple Corporation's computers, because this is how the question was posed in the SIPP. Because of this specification, other types of computers, such as mainframes and computers involved in operating other types of machinery are also excluded. Thus, there is a possibility that the SIPP results understate actual computer use.

29 For the remainder of this section "computer use" should be read as "regular computer use."

30 The trends observed in Table 5 are supported by logistic regression analysis of computer use as a function of firm size. Size is significantly and monotonically related to "regular computer use at work" and "regular use from any location," although the coefficients of the size variables are smaller in the "from any location" estimations than they are in the "at work" estimations. However, when individuals who use computers at work are dropped from the estimation, the size of the firm size coefficients falls by an order of magnitude but remain significant at the 0.05 level.

Regular Computer Use by Size of Employer and Industry Sector

Within industry sectors (except for agriculture), employees of smaller firms are less likely than those of larger firms to be "regular computer users at work[31]." The proportion of employees using a computer at work also varies across industry sectors—from a high of 68.0 percent in the Communications sector to a low of 13.2 percent in Agriculture (Table 6 at the end of this section).

Again, however, variations by firm size and variations across industry are less pronounced, if one considers *computer use from any location*. Further, in several industry sectors, the positive relationship between computer use anywhere and firm size does not hold. Employees in firms of less than 25 employees working in Agriculture, Public Utilities, Entertainment and Recreation Services, and Health Care are more likely to be PC users than their counterparts in larger firms.

The gap between computer use at work and computer use at any location is particularly wide in those industry sectors where on-the-job computer use is less prevalent. Three industry sectors among those that have the lowest proportion of employees using a computer at work (Retail, Personal Services, and Entertainment and Recreational Services) have the largest proportion of employees that use a PC from someplace other than work. That differential is very pronounced for employees working in the Entertainment and Recreational Services sector where PC use on the job is substantially below average (28.7 percent compared to 40.6 percent for all employees). PC use from any location in this sector is above average (59.1 percent compared to 55.2 percent for all employees).

Regular Computer Use by Size of Employer and Occupation

Occupation appears to be a significant determinant of computer use at work. For employees in most occupations, PC use at work varies with firm size (Table 7). However, variations by firm size within occupational categories are less pronounced than differences across the occupational categories themselves. In two occupations, Managerial and Professional Specialty and Technical, Sales, and Administrative Support, over 45 percent of employees use a PC at work, irrespective of firm size. These two categories account for just under 60 percent of total employment. When the broader category of regular PC use from any location is considered, there is some narrowing of the differences between employees of the top two occupational categories and the others, but a fairly substantial difference remains.

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[31] The differences between regular computer use at work by individuals working for employers with less that 25 employees and those working for employers with between 25 and 99 employees are not significantly different in Nondurables and FIRE. Other anomalies include individuals working in health care services industries the middle size category (25-99 employees) are significantly less likely to regularly use a computer at work, than health care employees of smaller employers and retail employees working for mid-size firms are more likely to use a computer at work than employees working for the largest employers.

Table 6: Employed Individuals Who Regularly Use A Personal Computer At Work By Industry and Size of the Employer, 1999

Industry	Regularly Uses a PC (Percent)	Regularly Uses a PC at Work (Percent)	Regularly Uses a PC, but not at Work (Percent)	Total employed (1,000s)
Agriculture	**31.0**	**13.2**	**17.8**	**2,597**
Less than 25	35.2	14.5	20.7	1,848
25 to 99	28.1	13.1	15.0	324
100 and over	15.2	7.7	7.5	425
Construction	**31.4**	**18.0**	**13.4**	**7,015**
Less than 25	27.5	14.7	12.8	3,073
25 to 99	32.3	18.4	13.9	1,531
100 and over	36.0	22.0	14.0	2,411
Durable Manufacturing	**50.6**	**38.9**	**11.7**	**12,449**
Less than 25	44.4	28.9	15.5	1,276
25 to 99	44.0	29.6	14.4	1,667
100 and over	52.7	41.8	10.9	9,505
Nondurable Manufacturing	**46.2**	**35.3**	**10.9**	**7,876**
Less than 25	39.8	29.2	10.6	862
25 to 99	39.1	29.1	10.0	1,113
100 and over	48.4	37.3	11.1	5,901
Transportation	**47.9**	**32.3**	**15.6**	**5,468**
Less than 25	44.4	27.7	16.7	838
25 to 99	44.6	31.8	12.8	594
100 and over	49.2	33.3	15.9	4,036
Communications	**75.9**	**68.0**	**7.9**	**1,870**
Less than 25	61.1	48.4	12.7	120
25 to 99	63.9	51.7	12.2	180
100 and over	78.5	71.3	7.2	1,569
Public Utilities	**60.0**	**49.8**	**10.2**	**1,331**
Less than 25	62.7	41.3	21.4	108
25 to 99	51.6	42.9	8.7	148
100 and over	60.9	51.6	9.3	1,075
Wholesale Trade	**57.6**	**44.9**	**12.7**	**4,921**
Less than 25	52.5	39.3	13.2	1,316
25 to 99	52.7	41.1	11.6	887
100 and over	61.8	48.9	12.9	2,719

Table 6: Continued

Industry	Regularly Uses a PC (Percent)	Regularly Uses a PC at Work (Percent)	Regularly Uses a PC, but not at Work (Percent)	Total employed (1,000s)
Retail Trade	**48.3**	**25.3**	**23.0**	**21,967**
Less than 25	43.2	20.7	22.5	5,831
25 to 99	50.9	28.4	22.5	2,337
100 and over	50.0	26.8	23.2	13,799
Finance, Insurance And Real Estate	**75.1**	**66.5**	**8.6**	**7,873**
Less than 25	67.9	58.1	9.8	1,578
25 to 99	65.5	58.1	7.4	846
100 and over	78.6	70.3	8.3	5,450
Business and Repair Services	**59.1**	**46.1**	**13.0**	**7,877**
Less than 25	50.9	36.9	14.0	2,495
25 to 99	60.6	43.6	17.0	1,163
100 and over	63.5	52.1	11.4	4,219
Personal Services	**38.0**	**21.3**	**16.7**	**3,676**
Less than 25	31.3	13.9	17.4	1,779
25 to 99	46.0	19.7	26.3	390
100 and over	43.8	30.4	13.4	1,507
Entertainment and Recreation Services	**59.1**	**28.7**	**30.4**	**2,733**
Less than 25	62.0	25.8	36.2	826
25 to 99	56.5	27.3	29.2	518
100 and over	58.4	31.0	27.4	1,389
Health Care Services	**56.2**	**42.9**	**13.3**	**11,342**
Less than 25	58.2	43.1	15.1	2,057
25 to 99	46.7	31.6	15.1	1,464
100 and over	57.4	45.0	12.4	7,822
Other Professional Services	**68.0**	**54.9**	**13.1**	**20,286**
Less than 25	63.0	47.5	15.5	3,988
25 to 99	64.4	51.9	12.5	2,646
100 and over	70.2	57.6	12.6	13,651
Public Administration	**67.3**	**58.4**	**8.9**	**7,589**
Less than 25	57.4	49.8	7.6	460
25 to 99	69.6	55.2	14.4	483
100 and over	67.8	59.2	8.6	6,645

Source: Bureau of the Census, U. S. Department of Commerce, Survey of Income and Program Participation, research data file (August-November 1999, Wave 11)

Table 7: Employed Individuals Who Regularly Use A Personal Computer By Occupation and Size of the Employer, 1999

Occupation	Regularly Uses a PC (Percent)	Regularly Uses a PC at Work (Percent)	Regularly Uses a PC, but not at Work (Percent)	Total employed (1,000s)
Managerial& Professional Specialty	**76.8**	**66.4**	**10.4**	**34,622**
Less than 25 employees	68.9	56.2	12.7	5,507
25 to 99 employees	73.1	60.9	12.2	4,059
100 and over employees	79.1	69.5	9.6	25,056
Technical, Sales, & Admin. Support	**64.8**	**50.1**	**14.7**	**39,196**
Less than 25 employees	61.7	45.5	16.2	8,767
25 to 99 employees	65.3	51.4	13.9	4,533
100 and over employees	65.7	51.4	14.3	25,895
Service Occupations	**37.8**	**16.2**	**21.6**	**18,385**
Less than 25 employees	35.3	11.5	23.8	5,264
25 to 99 employees	40.7	15.5	25.2	2,484
100 and over employees	38.4	18.6	19.8	10,638
Farming, Forestry, & Fishing	**28.2**	**9.7**	**18.5**	**3,136**
Less than 25 employees	31.2	10.1	21.1	1,966
25 to 99 employees	21.4	5.1	16.3	447
100 and over employees	24.4	11.3	13.1	722
Precision Production, Craft, & Repair	**36.7**	**23.2**	**13.5**	**12,743**
Less than 25 employees	27.8	13.8	14.0	3,394
25 to 99 employees	31.1	17.4	13.7	1,978
100 and over employees	42.4	29.1	13.3	7,371
Operators, Fabricators, & Laborers	**27.7**	**14.9**	**12.8**	**8,058**
Less than 25 employees	25.4	10.8	14.6	1,170
25 to 99 employees	18.5	9.3	9.2	1,249
100 and over employees	30.2	17.0	13.2	5,638
Transportation & Material Moving	**30.2**	**15.4**	**14.8**	**5,393**
Less than 25 employees	22.2	10.7	11.5	1,159
25 to 99 employees	28.4	12.8	15.6	854
100 and over employees	33.3	17.6	15.7	3,380
Handlers, Equipment Cleaners, Helpers, & Laborers	**33.1**	**13.9**	**19.2**	**5,863**
Less than 25 employees	30.2	11.4	18.8	1,466
25 to 99 employees	26.8	8.3	18.5	772
100 and over employees	35.6	16.1	19.5	3,625

Source: Bureau of the Census, U. S. Department of Commerce, Survey of Income and Program Participation, research data file (August-November 1999, Wave 11)

CONCLUSION

In investing in and using the tools of the new economy, firm size matters. Smaller firms tend to invest less on a proportional basis on capital equipment, in general, and on computers and communications, specifically. Smaller firms are also less likely to buy and sell over the Internet, to have interactive websites, and to engage in other types of electronic business processes. Employees of smaller firms are also less likely to use a computer at work

However, general observations of this type overstate the degree of variation that actually exists—differences that are reduced when industry and occupation are accounted for. Further, the existence of differences, in and of themselves, are not necessarily indicative of the existence of problems or barriers in the spread of information technology into small and medium-sized firms.