Not all Dot Coms are Created Equal: An Exploratory Investigation of the Productivity of Internet Based Companies

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May 2000

Very early draft. Please do not quote or cite without the authors' permission.
Partial financial support for this research is provided by the National Science Foundation. Anitesh Barua also thanks the Bureau of Business Research at the University of Texas at Austin for providing partial financial support.

Abstract

The emerging literature in Electronic Commerce distinguishes between traditional "bricks-and-mortar", hybrid "clicks-and-mortar" and pure "dot com" organizations, but fails to recognize that not all dot coms are created equal in their ability to leverage the Internet. This paper focuses on the distinction between Internet based digital and physical products companies in terms of the extent of digitization of their products, business models, strategies, processes and channel relationships. Based on the notion that the extent of digitization in a company offering digital products or services is currently and fundamentally higher than that in a business selling physical goods over the Internet, we test the hypothesis that Information Technology (IT) capital contributes more to the performance of digital dot coms than to that of physical dot coms. This hypothesis is supported by a production economics based analysis of one hundred and ninety nine publicly traded Internet based companies. The results of the study emphasize the need for rapid digitization of both internal and external business processes in physical products companies on the Internet, and the holistic adoption of the Internet by all players in their value chain. The results also question the prevailing one-size-fits-all approach to market valuation for dot com companies, and suggest that on an average, digital dot coms should have a higher market capitalization than physical dot coms.

1. Introduction

The emerging Internet economy is made up of a large collection of global Internet Protocol (IP) based networks, applications, electronic markets, producers, consumers and intermediaries (Barua et al. 1999a). This economy is growing rapidly by all accounts, and two recent studies by Barua et al. (1999a, 1999b) suggest that this economy exceeded $500 billion in revenues in 1999, representing a 68% growth from 1998. The studies also find that the Internet is creating unprecedented opportunities for new businesses, and that one out of every three companies surveyed did not exist prior to 1996 (Barua et al., 1999b). While these numbers point to a formidable size and dramatic growth of business on the Internet, big is not necessarily better (Barua, Whinston and Yin, 2000). Accordingly in this paper we ask a set of distinct but related questions: How productive are the players in this new economy? More specifically, since the Internet is the very reason for the existence of "dot com" organizations, does investing more in Information Technology (IT) lead to better dot com performance? Further, does IT contribute equally to the performance of all types of dot coms?

Research in IT productivity has often implicitly assumed that positive IT impacts exist, but that they may have remained elusive due to measurement and methodological limitations (e.g., Brynjolfsson, 1993; Barua, Kriebel and Mukhopadhyay, 1995). The dramatic proliferation of the Internet in the business world since 1995 necessitates a reexamination of this point of view. The Internet and its related technologies and applications are widely available to all types of organizations across the globe. Prior to the Internet revolution, organizations often invested in vendor or technology specific applications that were not open or ubiquitous in nature. For instance, Electronic Data

Interchange (EDI) has been around for over twenty years, and has yet failed to capture a significant volume of business transactions owing to the difficulties and cost of adoption. By contrast, the Internet provides a “level playing field” in terms of a low cost, globally accessible network infrastructure, open standards and applications that are based on the user-friendly universal Web browser. Given this technology equalizing effect of the Internet, does investing more in IT lead to better financial performance in electronic commerce?

For traditional bricks-and-mortar companies, the existing technology infrastructure as well as business processes and channel relationships determine how rapidly and successfully they can switch to electronic business. The relationship between IT investments and firm performance is unlikely to be a straightforward one due to the need to integrate electronic commerce applications and electronic business initiatives with existing systems, processes and strategies. But what about “dot coms”, companies that are based entirely on the Internet? Since they are, by definition, the most direct beneficiaries of the Internet phenomenon[1], can we expect that increasing their IT investments will lead to higher productivity?

We distinguish between two types of “dot com” companies: Digital and physical. Digital dot coms are Internet based companies such as Yahoo, Ebay and America Online, whose products and services are digital in nature, and which are delivered directly over the Internet. The physical dot coms are also based entirely on the Internet, but sell physical products (e.g., books, CDs, jewelry, toys) that are shipped to consumers. They are often referred to as electronic retailers (e-tailers) by the business press. Does IT have the same impact on these two categories of dot coms? We hypothesize that IT investments contribute more to various output measures (e.g., revenue, revenue per employee, gross margin and gross margin per employee) for digital dot coms than for physical dot coms. The rationale is that the level of digitization of business processes is fundamentally higher in digital products companies than in Internet based firms selling physical goods. While the Internet and electronic commerce applications are equally accessible to both types of companies, electronic retailers of physical products often build warehouses, handle inventory, and are subject to many of the physical constraints of bricks-and-mortar companies. By contrast, due to the very nature of their business, most of the processes and delivery mechanisms of digital dot coms are implemented online. Further, the ability of a digital dot com to differentiate itself from its competitors directly depends on being able to translate innovative business strategies into online capabilities.

Currently the physical dot coms also suffer from the lack of complementary digitization in their value chain. That is, while a physical dot com may have digitized its interactions with customers, its value chain partners may not have yet embraced the Internet for their operations. However, the true benefits of electronic commerce will not be harvested until all value chain partners enter the new economy.

[1] That is, their very existence, business and revenue models are attributable to the Internet and the World Wide Web.

We analyze one hundred and ninety nine publicly traded digital and physical dot coms, and show that IT capital (computer hardware, software and networking equipment) contributes significantly to all four output measures for the digital dot coms. However, the IT contribution for physical dot coms is uniformly insignificant across all four measures. This sharp difference in the contribution of IT to firm productivity raises issues regarding the market value of physical products companies on the Internet. Even though the literature has not made a distinction between digital and physical dot coms, our results point to a fundamental difference between the role of IT in these two categories of Internet players.

We also find that the digital dot coms should be investing the marginal dollar in IT, while the physical products companies are better off by investing it in labor. This reflects a relatively high level of manual processes, especially in the fulfillment and logistics areas of e-tailing, and calls for rapid digitization of all business processes both within and outside the firm. Further, physical dot coms must rely more on alliances and partnerships with organizations that specialize in the areas of order fulfillment, and use electronic linkages for coordination and collaboration with such partners. The potential of the Internet economy cannot be realized by only digitizing the front end (customer side) of a business and by relying on physical means to complete order fulfillment.

The balance of the paper is organized as follows: Section 2 reviews the literature on IT productivity paradox and relates it to the emerging Internet economy. Section 3 develops the hypotheses to be empirically tested based on the characteristics of digital and physical products companies on the Internet. Modeling details based on production economics are outlined in section 4, while data and measurement issues are discussed in section 5. Analysis, results and discussions are presented in section 6. Future research and concluding remarks are provided in section 7.

2. Motivation and Prior Literature

Since this study deals with the IT and labor productivity in Internet based companies, it is important to briefly discuss the body of literature in IT productivity assessment and to relate it to the issues brought about by the proliferation of the Internet and the emergence of dot coms. A recent review of this literature can be found in Barua and Mukhopadhyay (2000), and is summarized below.

A series of early studies of IT productivity led to disappointing results. For instance, Roach (1987) found that the labor productivity of “information workers” had failed to keep up with that of “production workers”. Baily and Chakrabarti (1988) found similar results and suggested several possible reasons including incorrect resource allocation, output measurement problems, and redistribution of output within industries. Morrison and Berndt (1990), Berndt and Morrison (1991), Roach (1991) and others found lackluster returns from investments in IT. One of the most widely cited IT productivity studies was that of Loveman (1988), who analyzed the impact of IT and non-IT capital as well as labor and inventory on the productivity of large firms primarily in the manufacturing sector during the 1978-1984 time period. Loveman found that the output elasticity of IT capital was negative, suggesting that the "marginal dollar would have been better spent on non-IT factors of production."

The lack of a positive relationship between IT spending and performance prompted Roach (1988, 1989) to develop the notion of "IT productivity paradox". This sentiment was also reflected in Solow's (1987) remarks regarding IT productivity: "You can see the computer age everywhere but in the productivity statistics." Since the early nineties, the IT productivity paradox has puzzled and challenged researchers, and has often been used to support negative viewpoints and skepticism regarding the role of IT investments (Lohr, 1999).

An exception to the above stream of disappointing results is Bresnahan's (1986) study that found a sizable consumer surplus due to investments in computing technologies in the unregulated parts of the financial services sector. In the nineties, Brynjolfsson and Hitt (1993, 1996) and Lichtenberg (1993) deployed a common data set from International Data Corporation (IDC), and found significant productivity gains from investments in computer capital. Following Bresnahan's (1987) approach, Brynjolfsson (1996) also found significant consumer surplus resulting from IT investments. These findings ushered in a new era in IT productivity research, and was followed by a series of studies that also established the positive impact of IT investments. For instance, with the same data used by Loveman but with different input deflators and modeling techniques, Barua and Lee (1997) and Lee and Barua (1999) found that the IT contributed significantly more to firm performance than either labor or non-IT capital.

While the above studies used different theoretical models, measurement vehicles and analysis techniques, they all focused on IT itself. An assumption implicit in all these studies is that IT will affect all firms in the same way and to the same extent, whether positively or negatively, without regard to the kind of products/services the firms sell or how they conduct their business.

Another point worth mentioning is the time span of the data sets these studies used, which ranges from late seventies to the early nineties. At that time, IT often consisted of expensive proprietary applications used to make firms more efficient in their operations such as forecasting sales, managing inventory, controlling quality, accounting, etc. Since the mid nineties, we have witnessed a rapid increase in the power of personal computers and the proliferation of network technologies characterized by the Internet and the World Wide Web. As a result, there has been a dramatic change from centralized mainframe based computing to a Web based distributed computing environment. Today Internet based IT is not just used to make internal improvements, but also to interact with customers, manage the supply chain, and to coordinate and collaborate with trading partners. The Internet economy provides the opportunity to do business in completely new ways through the innovative use of IT.

The above discussions lead to the following question: Since Internet based IT is easily available to every firm at a relatively low cost, can every firm obtain the same benefit from using IT? We argue that the focus of IT productivity research should be shifted from IT itself to the business processes of the firm. Our objective should be to enumerate decisive criteria or significant characteristics that can be used to distinguish between the ability of players to leverage the new Internet economy. The key criterion we use in this paper is the type of product or service a firm offers on the Internet. Even though the emerging academic literature on Internet based companies (e.g., Cooper, Dimitrov and Rau, 1999) does not distinguish between different types of "dot coms", we take the position that these Internet based companies currently operate in very different ways depending on the nature of the products they sell. As we elaborate in the next section, the dot coms offering digital products and services can be characterized by a much higher level of digitization than those selling physical products. As a result, we expect IT investments to have a significantly different set of impacts for the two categories of Internet players.

3. Hypotheses Development

All dot coms generate their revenues online and interact with customers directly over the Internet. Thus, some of the customer facing features of a digital products business may be similar to that of a physical dot com. The most important distinctions between a digital and a physical dot com, however, involve the degree to which business strategies, processes and relationships can be digitized and the type of inputs used by each company. The complete business model of a digital products company is often reflected in its IT applications. For instance, a strategy of customizing content is implemented through online content personalization engines. Ebay's successful strategy of creating a feedback and rating system for all buyers and sellers is accomplished through Web-database connectivity tools. Intermediary services that find the lowest price and/or a combination of specified criteria for a product on the Internet are based on powerful search and comparison tools. In other words, any business strategy in the digital products world is directly translated into systems capabilities.

By contrast, the differentiation strategies of a physical products company on the Internet (e.g., an e-tailer) are often implemented offline, and may have little to do with IT. For instance, to provide the "highest level" of customer service, Amazon.com has large warehouses around the world that hold books, CDs and other physical products in their inventory. The motivation behind dealing with warehouses and inventory is the ability to provide fast delivery of goods to customers. For instance, if Amazon.com sells 30 copies of a particular book on a given day, it cannot possibly rely on the publisher of the book to ship 30 copies within, say, twenty-four hours. Most publishers themselves have not yet adopted electronic business processes to the extent where they can print any number of copies of a book on demand. As a result, e-tailers often hold inventory to be more responsive to customers. In fact, 34 out of 45 physical dot coms in our sample maintain merchandise inventory, and handle packaging and shipping processes by themselves, citing customer service excellence as the primary reason. In this regard, e-tailers are not significantly different from their bricks-and-mortar counterparts. By contrast, the digital products companies manage content inventory directly through their Web sites and related applications.

As another example of the processes involved in the operation of a physical dot com, consider an online grocery store which uses its Web store front to take customer orders, but which must rely heavily on people and manual processes to fulfill the order efficiently and to the satisfaction of the customer. Thus a differentiation strategy for the online grocery store may call for investment in a faster delivery network.

An examination of the components of cost of sales of digital products companies and physical dot coms suggests some key differences in their operations. For the digital products companies, cost of sales consists of Internet connection, Web hosting, telecommunications, Web site infrastructure and development, networking, computer hardware, software development, payroll for Web site operation, and digital content provided by other companies. The cost of sales of most physical dot coms consists of the cost of merchandise sold and inbound/outbound shipping.

There are other important distinctions between these two categories. For instance, a digital products company can grow by creating more content alliances and by expanding and enhancing its Web presence. By contrast, an e-tailer has to undertake an elaborate and often labor intensive expansion program to grow the volume of business. The above observations are summarized in Table 1, and lead to the hypotheses stated below:

	Digital.com	Physical.com
Interaction with customer	Digital	Digital
Main inputs (products)	Digital	Physical
Business and expansion strategies	Digital	Mainly physical
Business processes	Digital	Mainly physical
Distribution	Digital	Physical

Table 1: Characteristics of Digital and Physical Dot Coms

H1: For digital products companies, IT capital has a significant positive impact on (i) sales, (ii) gross margin, (iii) sales per employee and (iv) gross margin per employee.

H2: For physical dot coms, IT capital does not have a significant positive impact on (i) sales, (ii) gross margin, (iii) sales per employee and (iv) gross margin per employee.

H3: IT capital has a higher contribution to (i) sales, (ii) gross margin, (iii) sales per employee and (iv) gross margin per employee for digital product companies than for physical dot coms.

While H3 may seem to be redundant in the light of H1 and H2, it should be noted that the relative levels of significance of IT contribution in H1 and H2 will jointly determine if the difference in contribution of IT across the two groups is significant.

4. Production Function Based Modeling

The IT productivity study has relied heavily on the production economics literature (e.g., Brynjolfsson and Hitt, 1993, 1996; Lichtenberg, 1993; Barua and Lee, 1997; Dewan and Min, 1997; Lee and Barua, 1999). Following this tradition, to model the IT productivity for digital and physical dot coms, we choose the Cobb-Douglas production function with a disembodied technological change rate λ:

$$q = Ae^{\lambda t} \prod_{i=1}^{N} x_i^{\alpha_i}$$

where q is the output, x_i is the level of input i, α_i is the output elasticity of input i, A is a constant, and where N is the number of inputs. The Cobb-Douglas production function is the most commonly chosen form, although it has some restrictions such as perfect substitution among inputs. More specifically, we use the form

$$OUTPUT = Ae^{\lambda t} IT\_CAP^{\alpha_1} NIT\_CAP^{\alpha_2} LABOR^{\alpha_3}$$

where IT_CAP is the IT capital (computer hardware, software and networking equipment), NIT_CAP is the non-IT capital, LABOR is the number of employees (full time equivalents), and where t is the number of years in business. t is included in the model to control for the maturity of a company. Companies operating in the Internet space are expected to improve the conduct of business over time. Since the companies in our data set are almost all start-ups, we expect to see a positive impact of time on output.

Two measures of output are sales and gross margin (sales minus cost of sales). After a log transformation we obtain:

$$\log SALES = c_s + \lambda_s t + \alpha_{1s} \log IT\_CAP + \alpha_{2s} \log NIT\_CAP + \\ \alpha_{3s} \log LABOR + \varepsilon$$

$$\log GROSS\_MARGIN = c_g + \lambda_g t + \alpha_{1g} \log IT\_CAP + \alpha_{2g} \log NIT\_CAP + \\ \alpha_{3g} \log LABOR + \varepsilon$$

Two additional output measures are sales per employee and gross margin per employee. Assuming constant returns to scale, we get:

$$\frac{OUTPUT}{LABOR} = Ae^{\lambda t} \left(\frac{IT}{LABOR} \right)^{\alpha_1} \left(\frac{nonIT}{LABOR} \right)^{\alpha_2} \left(\frac{LABOR}{LABOR} \right)^{\alpha_3}$$

Taking log on both sides and substituting *OUTPUT* with *SALES* and *GROSS MARGIN* and using subscripts *se* and *ge* for sales and gross margin respectively, we have:

$$\log SALES\_EMP = c_{se} + \lambda_{se} t + \alpha_{1se} \log IT\_CAP\_EMP + \alpha_{2se} \log NIT\_CAP\_EMP + \varepsilon$$

$$\log GROSS\_MARGIN\_EMP = c_{ge} + \lambda_{ge} t + \alpha_{1ge} \log IT\_CAP\_EMP + \alpha_{2ge} \log NIT\_CAP\_EMP + \varepsilon$$

where SALES_EMP is sales per employee, GROSS_MARGIN_EMP is the gross margin per employee, IT_CAP_EMP is the IT capital per employee, and where NIT_CAP_EMP is the non-IT capital per employee.

The justification of using the number of employees as labor input measurement is as follows: The total labor cost can be thought of as a product of the number of employees and an average annual salary plus benefits. Then the log of the average yearly salary and benefits becomes a part of the regression constant. Thus, with the exception of the constant term, the coefficient estimates will not be affected.

In order to test hypotheses 3, we deploy dummy variables (using standardized values without the constant term):

$$\log SALES = \gamma_{1s} D + \gamma_{2s} D * t + \gamma_{3s} D * \log IT\_CAP + \gamma_{4s} D * \log NIT\_CAP + \gamma_{5s} D * \log LABOR + \lambda_s t + \alpha_{1s} \log IT\_CAP + \alpha_{2s} \log NIT\_CAP + \alpha_{3s} \log LABOR + \varepsilon$$

$$\log GROSS\_MARGIN = \gamma_{1g} D + \gamma_{2g} D * t + \gamma_{3g} D * \log IT\_CAP + \gamma_{4g} D * \log NIT\_CAP + \gamma_{5g} D * \log LABOR + \lambda_g t + \alpha_{1g} \log IT\_CAP + \alpha_{2g} \log NIT\_CAP + \alpha_{3g} \log LABOR + \varepsilon$$

$$\log SALES\_EMP = \gamma_{1se} D + \gamma_{2se} D * t + \gamma_{3se} D * \log IT\_CAP\_EMP + \gamma_{4se} D * \log NIT\_CAP\_EMP + \lambda_{se} t + \alpha_{1se} \log IT\_CAP\_EMP + \alpha_{2se} \log NIT\_CAP\_EMP + \varepsilon$$

$$\log GROSS\_MARGIN\_EMP = \gamma_{1ge} D + \gamma_{ge} D * t + \gamma_{3ge} D * \log IT\_CAP\_EMP + \gamma_{4ge} D * \log NIT\_CAP\_EMP + \lambda_{ge} t + \alpha_{1ge} \log IT\_CAP\_EMP + \alpha_{2ge} \log NIT\_CAP\_EMP + \varepsilon$$

where D represents a dummy variable, which has a value of 1 for digital products companies and 0 for physical dot coms. Further, the α's and the corresponding levels of inputs in the last four formulations involving the dummy variable apply only to the physical dot coms.

5. Data and Measurement

The primary source of the data used in this study is Hoover's Online, Inc. (http://www.hoovers.com). The company's Web site offers information on some 14,000 public and private companies (and access to 37,000 additional companies). Users can view free information on the companies covered by Hoover's; subscribers can view additional in-depth coverage of 8,000 of these companies. We are interested in publicly traded companies that generate all of their sales online. From the search page of Hoover's Online, it is possible to search by company type (e.g., public, private, country, industry, etc.). There are nearly 300 industry names. We search for public U.S. companies in every industry that can possibly contain companies generating all of their revenue online. Then we examine the "capsule" of each company in the search results to determine if it should be included in our sample. For example, we search for public U.S. companies in "Accounting, Bookkeeping, Collection & Credit Reporting", which results in a list of 11 companies. By analyzing the capsules of these 11 companies, we decide that only Claimsnet.com Inc. should be included in our sample. We repeat this process for all industry categories. We skip some industries such as airlines, auto manufacturers, etc., which obviously will not contain companies meeting our criteria of generating all sales through the Internet. We also examine all companies in the Hoover's Online IPO Central and select those based purely on the Internet.

These searches provide a list of about 300 companies. Then we begin collecting data from these companies' SEC filings. During the data collection, we take out some companies from the list due to the following reasons:

- They may not generate all of their revenue online (as assessed from their financial reports)
- Some critical data such as IT capital were not available.

We did not include companies selling in both the physical and digital worlds. For example, Wall Street Journal sells both print and online edition to its subscribers, and Charles Schwab offers brokerage services both online and in the traditional way. This approach of exclusion increases comparability and simplifies the measurement process.

At the end of this exercise, we are left with a sample of 199 online companies. We divide these companies into two groups according to whether they sell physical or digital products. There are 154 and 45 digital and physical products companies respectively. In most cases, this dichotomy coincides with distinction made among different industries. And at the time of data collection, we found no company in the sample dealing with digital and physical products at the same time. For example, most companies in "Internet & Online Content Providers" deal exclusively with digital products while most companies in various retailing industries deal exclusively with physical products.

There are a few exception cases that deserve special mention. For example, Emusic.com Inc., which is in "Music, Video, Book & Entertainment Software Retailing & Distribution", sells downloadable music through Internet instead of physical CD. Thus it is classified as a digital products business. On the other hand, even though Alloy Online Inc. is in the "Internet & online content providers" category, it generates almost all of revenue from selling physical items such as CDs and clothing to young people.

Most of the data are for the 1998 financial year. The total sales of these 199 companies is $19.3 billion. The total number of employee is 72,514. Additional summary statistics can be found in Tables 1 and 2 in the Appendix. The industry classification of the firms is provided in Table 4 in the Appendix.

6. Analysis, Results and Discussion

The production functions are estimated using the Ordinary Least Squares (OLS) method. Multicollinearity is a well-known problem in production function estimation using the Cobb-Douglas form (e.g., see Kennedy, 1985, for a general discussion and Prasad and Harker (1996) for issues specific to IT contribution assessment). To test for multicollinearity, we follow the approach of Belsley, Kuh, and Welsch (1980) and report conditional indices for all regressions. All conditional indices are well below the threshold level of 30, even though an index of 30 is considered benign and acceptable for production function estimates.

Ordinary Least Square (OLS) regression assumes homoskedasticity of the error term *u* in a regression model $Y = X\beta + u$. That is, $E(uu') = \sigma^2 I$. However, if there is heteroskedasticity, we have $E(uu') = \sigma^2 \Omega$. Then the OLS estimates are still unbiased, but less efficient. In addition, t-statistics will be invalid for testing hypothesis. We use the White test and find significant heteroskedasticity in our data. Therefore we use Estimated Generalized Least Square (EGLS) regression to adjust for the heteroskedasticity. To use EGLS, we need to know the function form of heteroskedasticity. There are three commonly used forms:

(1) $h(z_i) = z_i'\alpha$

(2) $h(z_i) = (z_i'\alpha)^2$

(3) $h(z_i) = \exp(z_i'\alpha)$

where $h(z_i)$ is the variance of error term u_i, z_i are variables explaining heteroskedasticity, and where α is a parameter to be estimated. Form (1) does not give satisfactory results because it will yield negative variance in some cases. Therefore we use forms (2) and (3) to run EGLS regression. Asymptotically, EGLS will give more efficient estimates when heteroskedasticity exists. Since our data set is only a relatively small sample, the changes in efficiency of estimates are mixed. However, the results have the same pattern as those of the OLS regressions.

The output elasticity estimates with four measures of output for digital product companies are shown in Tables 1, 2, 3 and 4 below.

Dependent variable: Sales
N (Number of observations): 154
Adjusted R-squared = .644716
BKW Index = 17.00570
White Heteroscedasticity Test = 33.7945*** [.002]

Variable	Estimated Coefficient	Standard Error	t-statistic	p-value
Constant	2.30955	.466630	4.94942***	.000
IT Capital	.290281	.092318	3.14437***	.002
Non-IT	.056434	.066583	.847578	.398
LABOR	.645172	.124850	5.16757***	.000
YEAR	.345165	.061557	5.60727***	.000

Estimated General Least Square Results:

Constant	2.41228	0.38812	6.21522***	.00000
IT Capital	0.16642	0.087814	1.89517*	.06001
Non-IT	0.082011	0.065294	1.25603	.21107
LABOR	0.86301	0.10630	8.11876***	.00000
YEAR	0.17546	0.041374	4.24077***	.00004
Constant	2.56841	0.41129	6.24472***	.00000
IT Capital	0.24645	0.092404	2.66707***	.00850
Non-IT	0.16363	0.073797	2.21732**	.02812
LABOR	0.59994	0.11679	5.13684***	.00000
YEAR	0.20591	0.044182	4.66042***	.00001

*** p < .01, ** p < .05, * p < .1

Table 1: Digital Products Companies with Sales as Output

Dependent variable: Gross Margin
N: 118
Adjusted R-squared = .604109
BKW Index: 20.44979
White Heteroscedasticity Test = 23.9144 ** [.047]

Variable	Estimated Coefficient	Standard Error	t-statistic	
Constant	2.23031	.520733	4.28302***	.000
IT Capital	.264339	.116762	2.26392**	.025
Non-IT	-.015507	.073550	-.210842	.833
LABOR	.721834	.166531	4.33453***	.000
YEAR	.251326	.071340	3.52291***	.001

Estimated General Least Square Results:

Constant	2.54094	0.46705	5.44037***	.00000
IT Capital	0.30914	0.11985	2.57953**	.01118
Non-IT	-0.048585	0.049157	-0.98836	.32509
LABOR	0.69007	0.16804	4.10650***	.00008
YEAR	0.13230	0.052482	2.52080**	.01310

Constant	2.22601	0.50338	4.42217***	.00002
IT Capital	0.24225	0.11646	2.08003**	.03978
Non-IT	-0.022368	0.057938	-0.38606	.70018
LABOR	0.78894	0.16319	4.83435***	.00000
YEAR	0.20311	0.060732	3.34440***	.00112

*** $p < .01$, ** $p < .05$, * $p < .1$

Table 2: Digital Products Companies with Gross Margin as Output

Dependent variable: Sales Per Employee
N (Number of observations): 154
Adjusted R-squared = .300419
BKW Index = 5.96012
White Heteroscedasticity Test = 26.9190*** [.001]

Variable	Estimated Coefficient	Standard Error	t-statistic	
Constant	2.34939	.246959	9.51329***	.000
IT Capital	.218302	.095993	2.27414**	.024
Non-IT	-.019014	.076099	-.249861	.803
YEAR	.399545	.057043	7.00430***	.000
Estimated General Least Square Results:				
Constant	2.78739	0.22957	12.14199***	.00000
IT Capital	0.15665	0.093639	1.67292*	.09643
Non-IT	0.026391	0.074789	0.35288	.72467
YEAR	0.26065	0.038577	6.75658***	.00000
Constant	2.83843	0.23957	11.84788***	.00000
IT Capital	0.15533	0.094057	1.65141*	.10075
Non-IT	0.051245	0.074123	0.69135	.49041
YEAR	0.24847	0.038090	6.52332***	.00000

*** $p < .01$, ** $p < .05$, * $p < .1$

Table 3: Digital Products Companies with Sales Per Employee as Output

Dependent variable: Gross Margin Per Employee
N (Number of observations): 118
Adjusted R-squared = .186345
BKW Index = 6.13259
White Heteroscedasticity Test = 21.4074** [.011]

Variable	Estimated Coefficient	Standard Error	t-statistic	
Constant	2.10451	.288050	7.30603***	.000
IT Capital	.265141	.117341	2.25957**	.026
Non-IT	-.024973	.084371	-.295996	.768
YEAR	.245965	.066724	3.68628***	.000

Estimated General Least Square Results:

Constant	2.27118	0.30414	7.46759***	.00000
IT Capital	0.25022	0.12099	2.06816**	.04089
Non-IT	0.022064	0.084538	0.26099	.79457
YEAR	0.17879	0.056459	3.16666***	.00198
Constant	2.39841	0.29494	8.13173***	.00000
IT Capital	0.21553	0.12259	1.75817*	.08140
Non-IT	0.12408	0.090451	1.37179	.17282
YEAR	0.12964	0.048570	2.66919***	.00871

*** $p < .01$, ** $p < .05$, * $p < .1$

Table 4: Digital Products Companies with Gross Margin per Employee as Output

Tables 1, 2, 3 and 4 show that IT capital has a significantly positive impact on sales, gross margin, sales per employee and gross margin per employee. This provides support for all four parts of hypothesis 1. Labor is also seen as having a significantly positive contribution for both sales and gross margin. The number of years in business is highly significant and positive for all four output measures, indicating the ability to become more productive over time. Before we discuss these findings regarding digital products companies in detail, let us consider the corresponding estimation results for the physical products companies. These are shown in Tables 5, 6, 7 and 8 below:

Dependent variable: Sales
N (Number of observations): 45
Adjusted R-squared = .494638
BKW Index = 24.45977
White Heteroscedasticity Test = 26.6788** [.021]

Variable	Estimated Coefficient	Standard Error	t-statistic	
Constant	3.03702	1.16122	2.61537**	.013
IT Capital	.168865	.320318	.527178	.601
Non-IT	-.013151	.174958	-.075164	.940
LABOR	.935456	.384526	2.43275**	.020
YEAR	.398081	.163792	2.43041**	.020

Estimated General Least Square Results:

Constant	3.16891	1.09365	2.89755***	.00607
IT Capital	0.11374	0.31913	0.35641	.72341
Non-IT	0.083059	0.18570	0.44728	.65709
LABOR	0.92392	0.36407	2.53776**	.01516
YEAR	0.25886	0.14153	1.82899*	.07486
Constant	2.70643	1.31450	2.05890**	.04606
IT Capital	0.18686	0.37165	0.50279	.61787
Non-IT	-0.057428	0.17971	-0.31955	.75097
LABOR	1.08168	0.36813	2.93829***	.00546
YEAR	0.25342	0.14874	1.70379*	.09618

*** p < .01, ** p < .05, * p < .1

Table 5: Physical Products Companies with Sales as Output

Dependent variable: Gross Margin
N (Number of observations): 36
Adjusted R-squared = .469957
BKW Index = 24.78692
White Heteroscedasticity Test = 22.0570* [.077]

Variable	Estimated Coefficient	Standard Error	t-statistic	
Constant	2.27751	1.22187	1.86396	.072
IT Capital	.145081	.362953	.399723	.692
Non-IT	.109837	.205267	.535094	.596
LABOR	.653746	.424926	1.53849	.134
YEAR	.419126	.203939	2.05516*	.048
Estimated General Least Square Results:				
Constant	2.14287	0.97385	2.20041**	.03536
IT Capital	-0.14567	0.30423	-0.47881	.63544
Non-IT	0.41044	0.19792	2.07375**	.04650
LABOR	0.80633	0.39012	2.06686**	.04719
YEAR	0.24965	0.14630	1.70636*	.09794
Constant	2.14567	1.03348	2.07616**	.04626
IT Capital	-0.068885	0.32797	-0.21003	.83502
Non-IT	0.35091	0.22724	1.54421	.13268
LABOR	0.75929	0.38676	1.96322*	.05865
YEAR	0.27339	0.15387	1.77680*	.08542

*** p < .01, ** p < .05, * p < .1

Table 6: Physical Products Companies with Gross Margin as Output

Dependent variable: Sales Per Employee
N (Number of observations): 45
Adjusted R-squared = .068437
BKW Index = 7.63479
White Heteroscedasticity Test = 9.29741 [.410]
*Heteroskedasticity correction is not necessary in this case.

Variable	Estimated Coefficient	Standard Error	t-statistic	
Constant	3.52393	.838815	4.20108***	.000
IT Capital	.135312	.352289	.384095	.703
Non-IT	.152119	.217865	.698224	.489
YEAR	.368868	.171246	2.15402**	.037

Estimated General Least Square Results:

Constant	3.82716	0.81024	4.72349***	.00003
IT Capital	0.032241	0.33895	0.095119	.92468
Non-IT	0.37698	0.22395	1.68330*	.09992
YEAR	0.19529	0.13825	1.41253	.16534
Constant	3.76982	0.92831	4.06096***	.00021
IT Capital	0.045749	0.35395	0.12925	.89779
Non-IT	0.27780	0.24341	1.14129	.26037
YEAR	0.27190	0.14569	1.86624*	.06917

*** p < .01, ** p < .05, * p < .1

Table 7: Physical Products Companies with Sales Per Employee as Output

Dependent variable: Gross Margin Per Employee
N (Number of observations): 36
Adjusted R-squared = .125904
BKW Index = 7.72708
White Heteroscedasticity Test = 15.5306* [.077]

Variable	Estimated Coefficient	Standard Error	t-statistic	
Constant	2.12487	.840926	2.52682**	.017
IT Capital	-.039435	.356627	-.110577	.913
Non-IT	.326794	.238244	1.37168	.180
YEAR	.354565	.183113	1.93632*	.062
Estimated General Least Square Results:				
Constant	2.45530	0.68840	3.56666***	.00116
IT Capital	-0.25213	0.28532	-0.88367	.38347
Non-IT	0.54459	0.20588	2.64524**	.01255
YEAR	0.29755	0.13435	2.21479**	.03402
Constant	2.34382	0.80575	2.90885***	.00655
IT Capital	-0.17612	0.29471	-0.59760	.55431
Non-IT	0.52746	0.23930	2.20415**	.03482
YEAR	0.28264	0.12903	2.19041**	.03590

*** p < .01, ** p < .05, * p < .1
Table 8: Physical Products Companies with Gross Margin per Employee as Output

Tables 5, 6, 7 and 8 indicate that in sharp contrast to the case of digital products companies, IT capital is completely insignificant for all four output measures. As in the case of digital products, both labor and year turn out to be highly significant and positive. The absence of any significant IT contribution supports all parts in hypothesis 2.

In order to test hypothesis 3, we estimate the production functions with dummy variables described in section 3. The results with dummy variables are shown in Tables 9, 10, 11 and 12 below.

Dependent variable: Sales
N (Number of observations): 199
Adjusted R-squared = .601925
BKW Index = 17.20073
White Heteroscedasticity Test = 62.4782*** [.000]

Variable	Estimated Coefficient	Standard Error	t-statistic	p-value
Dummy	-.106952	.049653	-2.15401**	.032
Dummy * IT Capital	.372931	.220653	1.69013*	.093
Dummy * Non-IT	-.020949	.163908	-.127810	.898
Dummy * LABOR	-.300658	.192793	-1.55949	.121
Dummy * YEAR	.066616	.121593	.547862	.584
IT Capital	-.133114	.204461	-.651046	.516
Non-IT	.077929	.146691	.531244	.596
LABOR	.662781	.177083	3.74278***	.000
YEAR	.218067	.108327	2.01305**	.046

Estimated General Least Square Results:

Dummy	-0.087572	0.049563	-1.76690*	.07885
Dummy * IT Capital	0.31602	0.22252	1.42022	.15718
Dummy * Non-IT	-0.11275	0.17512	-0.64382	.52047
Dummy * LABOR	-0.19202	0.18986	-1.01137	.31312
Dummy * YEAR	-0.077918	0.11212	-0.69496	.48793
IT Capital	-0.18686	0.20882	-0.89484	.37201
Non-IT	0.19000	0.16207	1.17232	.24254
LABOR	0.67332	0.17819	3.77865***	.00021
YEAR	0.21719	0.10668	2.03598**	.04314
Dummy	-0.077050	0.048121	-1.60118	.11100
Dummy * IT Capital	0.39892	0.21466	1.85836*	.06466
Dummy * Non-IT	-0.14234	0.17869	-0.79655	.42671
Dummy * LABOR	-0.24175	0.19180	-1.26041	.20907
Dummy * YEAR	-0.10124	0.11040	-0.91701	.36030
IT Capital	-0.19806	0.19898	-0.99536	.32083
Non-IT	0.29093	0.16244	1.79094*	.07490
LABOR	0.59185	0.17876	3.31087***	.00111
YEAR	0.25717	0.10374	2.47891**	.01405

*** p < .01, ** p < .05, * p < .1

Table 9: Comparison between Digital and Physical Products Companies with Sales as Output

Dependent variable: Sales Per Employee
N (Number of observations): 199
Adjusted R-squared = .241809
BKW Index = 9.17465
White Heteroscedasticity Test = 24.9008 [.164]

Variable	Estimated Coefficient	Standard Error	t-statistic	
Dummy	-.177569	.070462	-2.52006**	.013
Dummy * IT Capital	.335008	.205536	1.62993	.105
Dummy * Non-IT	-.263031	.175949	-1.49492	.137
Dummy * YEAR	.197701	.164549	1.20147	.231
IT Capital	-.174710	.189647	-.921239	.358
Non-IT	.245587	.157476	1.55952	.121
YEAR	.255054	.147636	1.72759*	.086

Estimated General Least Square Results:

Dummy	-0.15886	0.070625	-2.24929**	.02563
Dummy * IT Capital	0.32440	0.20713	1.56612	.11897
Dummy * Non-IT	-0.36887	0.18769	-1.96533*	.05082
Dummy * YEAR	0.0047702	0.15111	0.031567	.97485
IT Capital	-0.22346	0.19380	-1.15302	.25034
Non-IT	0.35898	0.17366	2.06715**	.04006
YEAR	0.26792	0.14498	1.84800*	.06614
Dummy	-0.12476	0.068451	-1.82264*	.06991
Dummy * IT Capital	0.33705	0.20665	1.63105	.10452
Dummy * Non-IT	-0.36071	0.18926	-1.90595*	.05815
Dummy * YEAR	-0.017862	0.14958	-0.11941	.90507
IT Capital	-0.22043	0.19269	-1.14392	.25408
Non-IT	0.39570	0.17478	2.26396**	.02469
YEAR	0.29047	0.14237	2.04022**	.04270

*** $p < .01$, ** $p < .05$, * $p < .1$

Table 10: Comparison between Digital and Physical Products Companies with Sales Per Employee as Output

Dependent variable: Gross Margin
N (Number of observations): 154
Adjusted R-squared = .575237
BKW Index = 18.05782
White Heteroscedasticity Test = 43.1889** [.044]

Variable	Estimated Coefficient	Standard Error	t-statistic	
Dummy	.012920	.061120	.211379	.833
Dummy * IT Capital	.107353	.291877	.367802	.714
Dummy * Non-IT	-.143795	.212080	-.678022	.499
Dummy * LABOR	.043880	.225538	.194557	.846
Dummy * YEAR	-.162465	.157686	-1.03031	.305
IT Capital	.149829	.265556	.564208	.573
Non-IT	.125462	.190740	.657762	.512
LABOR	.381401	.199806	1.90886*	.058
YEAR	.398055	.140642	2.83026***	.005

Estimated General Least Square Results:

Dummy	0.025344	0.061639	0.41116	.68156
Dummy * IT Capital	0.068409	0.31028	0.22047	.82581
Dummy * Non-IT	-0.12494	0.22852	-0.54675	.58539
Dummy * LABOR	0.063679	0.23055	0.27621	.78278
Dummy * YEAR	-0.23949	0.15616	-1.53364	.12730
IT Capital	0.12741	0.28695	0.44402	.65769
Non-IT	0.15416	0.21121	0.72987	.46665
LABOR	0.41300	0.20963	1.97015*	.05073
YEAR	0.35985	0.14747	2.44017**	.01589
Dummy	0.032347	0.061792	0.52349	.60143
Dummy * IT Capital	0.044541	0.32680	0.13629	.89178
Dummy * Non-IT	-0.079544	0.22435	-0.35456	.72344
Dummy * LABOR	0.040499	0.23173	0.17477	.86150
Dummy * YEAR	-0.22294	0.15786	-1.41226	.16002
IT Capital	0.16574	0.30558	0.54237	.58839
Non-IT	0.076263	0.21215	0.35947	.71976
LABOR	0.44793	0.21135	2.11940**	.03576
YEAR	0.36206	0.14909	2.42836**	.01639

*** $p < .01$, ** $p < .05$, * $p < .1$

Table 11: Comparison between Digital and Physical Products Companies with Gross Margin as Output

Dependent variable: Gross Margin Per Employee
N (Number of observations): 154
Adjusted R-squared = .179698
BKW Index = 9.08092
White Heteroscedasticity Test = 33.9065 ** [.019]

Variable	Estimated Coefficient	Standard Error	t-statistic	
Dummy	.018386	.085502	.215040	.830
Dummy * IT Capital	.210168	.257788	.815276	.416
Dummy * Non-IT	-.376640	.246735	-1.52650	.129
Dummy * YEAR	-.187178	.206657	-.905746	.367
IT Capital	.017629	.234716	.075110	.940
Non-IT	.347230	.223250	1.55534	.122
YEAR	.513843	.184194	2.78968***	.006
Estimated General Least Square Results:				
Dummy	0.032341	0.085920	0.37641	.70716
Dummy * IT Capital	0.16911	0.26778	0.63150	.52869
Dummy * Non-IT	-0.30072	0.26094	-1.15247	.25100
Dummy * YEAR	-0.29122	0.20174	-1.44354	.15100
IT Capital	0.014047	0.24542	0.057238	.95443
Non-IT	0.36660	0.23843	1.53756	.12631
YEAR	0.47147	0.19049	2.47502**	.01446
Dummy	0.038303	0.088514	0.43274	.66584
Dummy * IT Capital	0.18905	0.26775	0.70607	.48126
Dummy * Non-IT	-0.22160	0.26174	-0.84665	.39857
Dummy * YEAR	-0.30572	0.19979	-1.53017	.12812
IT Capital	-0.016686	0.24505	-0.068094	.94580
Non-IT	0.39685	0.23783	1.66858*	.09733
YEAR	0.45421	0.18993	2.39148**	.01805

*** p < .01, ** p < .05, * p < .1

Table 12: Comparison between Digital and Physical Products Companies with Gross Margin Per Employee as Output

Tables 9, 10, 11, and 12 suggest that the dummy variable for IT capital is positive and significant for sales. Further, it is positive and close to 10% significance level for sales per employee. These results provide partial support for hypothesis 3. It is positive but insignificant for gross margin and gross margin per employee. It is interesting to note that even though the average IT capital for a digital products company is higher than that of the physical dot coms (as seen in Tables 2 and 3 in the Appendix), the output elasticity of IT is significantly higher for the digital dot coms.

6.1 Where should the marginal dollar be invested?

Given the output elasticity of different inputs, it is important to analyze the marginal benefits of additional investments in various input factors. Since non-IT capital was insignificant in most of the regressions, the focus in this section is on IT capital and labor. The marginal output obtained by increasing input *i* is given by:

$\frac{\partial y}{\partial x_i} = \frac{y}{x_i}\alpha_i$, where α_i is the output elasticity of input *i*.

On average a digital dot com in our sample can increase its sales by $1045 by investing $1,000 in IT capital. It can also increase its sales by $28,461 by hiring one more employee. However, as long as the unit employee cost is over $27,235 (i.e. $1,000 * 28,461 / 1,045), the digital dot com is better off by investing the marginal dollar in IT capital than in labor. Along similar lines, the company can get an additional $642 gross margin by investing $1,000 more in IT capital, or $20,441 in additional gross margin by adding one more employee. The threshold unit labor cost is $31,840 ($1,000 * 20,441 / 642).

The choice between IT capital and labor depends on the labor cost. While the actual figures are not available from the companies' annual statements, it is very reasonable to assume that the unit labor cost is higher than $31,840. While stock options in these publicly traded high growth digital product companies are likely to result in lower salaries relative to slow growth business sectors, 55 out of the 154 digital dot coms are located in California. Further, 62 others are based in expensive parts of the East Coast, implying that the total unit labor cost (salary plus benefits) will certainly exceed the above threshold. It should also be noted that these numbers represent averages over the entire sample, and that investments in IT capital and labor are not mutually exclusive.

Since IT capital has an insignificant impact on all four output measures for physical dot coms, investing the marginal dollar in IT will not lead to increased benefits with any degree of certainty. On average a physical dot com in our sample can increase its sales by $85,130 by hiring one more employee. Along similar lines, the company can get an additional $13,085 gross margin by adding one more employee. Unfortunately, the cost of hiring an additional employee is likely to be significantly higher than the $13,085 gross margin attributable to the employee.

Note that the labor cost associated with a digital dot com is likely to be significantly higher than that of a physical dot com. The reason is that a physical dot com may have many low paying jobs (e.g., warehouse and delivery related people), while employees in digital dot coms are likely to be more skilled and educated due to the nature of the jobs involved.

6.2 Business Process Digitization and Production Functions

In the absence of high levels of digitization in the fulfillment processes of the physical products companies as well as in the supply chains of their trading partners, it is not surprising that labor is currently a more productive input than IT capital for this group. The production function approach can show the contribution of a given set of inputs toward one or more measures of output; however, it cannot suggest "radical" changes. The implication that the marginal dollar would be better spent on labor than on IT capital for physical dot coms only applies to the status quo – an environment marked by a high level of digitization only at the customer end of the business, but by manual and labor intensive processes on the "back office" side. In the long run, as digitization of business processes becomes more widespread throughout the value web, we should observe a change in the role of IT capital in the production process even for the physical dot coms.

6.3 Should the physical dot coms abandon ship?

The above results do not suggest that physical products firms on the Internet should abandon their current business and start dealing with digital products. Instead they call for digitization of the entire business to be able to fully leverage the Internet. This digitization involves processes and strategies both inside and outside the organization. These firms and their trading partners must deploy new business models, redesign the entire set of business processes including interaction with customers, order taking, coordination in fulfillment and delivery, and quality control. Every aspect of the business other than the actual physical production and delivery must be digitized. Even the product itself may be digitized whenever possible, as witnessed in the online music and entertainment industry.

In addition, organizations need to form new alliances and partnerships to facilitate this move towards digitization. This may suggest outsourcing the delivery to other partners and concentrating on digitally controlling and coordinating the fulfillment and delivery processes. A good example may be the business model of Cisco Systems, even though Cisco cannot be classified as a dot com company. Since 1995, Cisco has reengineered its business process using Web technologies. Now it books 78% of its orders over the Internet and operates 80% of its customer service through the company's Web site. On the manufacturing side, the company outsources most of its production to other manufacturers. Half of the orders placed on its Web site are shipped to customers directly from contractors, while Cisco monitors the entire fulfillment process through the Internet. This type of digitization results in a revenue per employee figure that is 64% higher than the S&P 500 average. (Businessweek, 1999).

7. Conclusions

Given that Internet related technologies and applications are equally available to all businesses today, IT alone cannot make a difference in the performance of the firm. The nature of the business, the ability to implement strategies and processes and manage channel relationships digitally would be important determinants of how much IT can contribute to a firm's business performance. In this paper, we partitioned the world of dot coms into digital and physical types based on the extent of digitization of the business model and processes.

From the results of the study we conclude that in Internet economy, companies selling digital products can obtain greater productivity from IT than those selling physical products. It is not because the digital products companies are using different IT, since the new generation of electronic commerce oriented IT is easily available to all players. The source of higher IT contribution may be explained by the nature of digital products. Digital products and services can be delivered digitally through the Internet at virtually zero cost. Further, once the content of a digital product has been developed, the marginal cost for making an additional copy or an automated modification of the product is basically zero. Therefore, unlike an e-tailer, the seller of digital goods and services does not have to invest in physical resources such as warehouses to increase the scale of operation; instead, it can invest in more productive IT infrastructure and applications.

Another implication of this research is the direction that IT developers will have to pursue. To meet the needs of the businesses moving toward comprehensive digitization, IT developers must concentrate on developing applications that will facilitate the digitization of currently physical business processes. For example, in the furniture retailing industry, current business processes usually involve retailers sending printed catalogs to potential customers or customers visiting local show rooms. To digitize this part of the business, Internet retailers will need new-generation virtual reality applications, which will make it possible for customer not only to see what a product looks like, but also to customize the product on the Internet.

Future research in this area should focus on companies that are undergoing the digitization metamorphosis. It will be important to study how the level of digitization of the business model enables a company to better exploit its IT investments.

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Appendix: Data Related Details

Mean	Digital dot coms (n = 118*)	Physical dot coms (n = 36*)	p-value of t-test
Gross Margin	$ 4,191,009	$ 2,641,952	.141
Revenue	$ 9,431,299	$ 14,867,678	.136
IT Capital	$ 1,723,976	$ 1,159,011	.127
(Coefficient)	(.264339)	(.145081)	
Non-IT Capital	$ 324,007	$ 309,798	.460
Employees	148	132	.325
(Coefficient)	(.721834)	(.653746)	
Years in Business	2.47	1.81	.018**
Gross Margin Ratio	44.4%	17.8%	
IT Capital Intensity	84.2%	78.9%	

* Not including companies with negative gross margin

Table 1: Summary statistics for digital and physical dot coms (with positive gross margin)

Mean	Digital dot coms (n = 154)	Physical dot coms (n = 45)	p-value of t-test
Revenue	$ 5,823,042	$ 11,739,416	.038
IT Capital	$ 1,617,119	$ 1,211,106	.159
(Coefficient)	(.290281)	(.168865)	
Non-IT Capital	$ 294,812	$ 359,068	.307
Employees	132	129	.457
(Coefficient)	(.645172)	(.935456)	
Years in Business	2.15	1.67	.047
IT Capital Intensity	84.6%	77.1%	

Table 2: Summary statistics for digital and physical dot coms (full sample)

Sales	Sales of the most recent financial year. Mostly 1998 financial year. Some are for less than one year since the company has been in business for less than one year.
Gross margin	Sales minus the cost of sales. Where cost of sales is not available (a few cases only), we use gross sales times the average percentage of cost of sales (only in digital.com subset).
Number of years in current business	The year when the company begins to generate revenue from their current online business.
IT capital	Book value of computer hardware and software owned by the company, arithmetic average of beginning and ending balances. Also includes networking equipment.
Non-IT capital	Book value of total fixed assets minus IT assets, arithmetic average of beginning and ending balances.
Number of employees	Number of employees (full time equivalents) at the end of the period.

Table 3: Data Item Definitions

Digital	Count	Employee	Sales (in thousands)
Accounting, Bookkeeping, Collection & Credit Reporting	1	45	$ 155
Advertising	7	959	$ 120,388
Consumer Loans Total	1	100	$ 4,028
Database & File Management Software	1	276	$ 27,204
Education & Training Services Total	1	93	$ 1,716
Gaming Activities	1	57	$ 264
Information Collection & Delivery Services	13	1,618	$ 287,425
Information retrieval service Total	1	128	$ 5,725
Internet & Online Content Providers	55	20,974	$ 6,679,631
Internet & Online Service Providers	34	13,492	$ 1,532,959
Investment Banking & Brokerage	2	867	$ 251,309
Market & Business Research Services	4	387	$ 13,802
Miscellaneous Business Services	10	1,247	$ 130,088
Miscellaneous Real Estate Services	1	540	$ 21,365
Miscellaneous Retail Total	1	210	$ 464
Mortgage Banking & Related Services	3	978	$ 64,936
Music, Video, Book & Entertainment Software Retailing & Dist.	2	22	$ 1,254
Publishing - Other	1	180	$ 12,347
Staffing, Outsourcing & Other Human Resources	2	209	$ 10,518
Telemarketing, Call Centers & Other Direct Marketing	9	847	$ 28,649
Travel Agencies, Tour Operators & Other Travel Services	4	14,234	$ 3,892,376
Subtotal	*154*	*57,463*	*$ 13,086,603*
		79%	*68%*
Physical	Count	Employee	Sales (in thousands)
Agricultural Machinery	1	31	$ 2,476
Apparel - Clothing	0	-	$ -
Building Materials & Gardening Supplies Retailing & Wholesale	1	169	$ 5,394
Computer & Software Retailing	1	200	$ 207,751
Computer Products Retail, Reselling & Wholesale	6	5,759	$ 4,273,596
Drug, Health & Beauty Product Retailing	3	298	$ 7,880
Electric Utilities	1	67	$ 4,150
Grocery Retailing	5	917	$ 77,761
Internet & Online Content Providers	2	120	$ 18,528
Miscellaneous Business Services	1	74	$ 48,232
Miscellaneous Entertainment	1	608	$ 27,873
Miscellaneous Retail	3	1,809	$ 227,358
Music, Video & Book Retailing & Distribution	9	3,522	$ 824,046
Non-Store Retailing	7	827	$ 445,513
Printing, Photocopying & Graphic Design	1	188	$ 3,326
Sporting Goods Retailing Total	1	96	$ 2,577
Toy & Hobby Retailing & Wholesale	2	366	$ 30,346
Subtotal	*45*	*15,051*	*$ 6,206,807*
		21%	32%
Grand Total	***199***	***72,514***	***$ 19,293,410***

Table 4: Industry Classification of the Whole Sample