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Y2K spending by entrepreneurial firms

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Abstract

While public debate leading up to year 2000 focused on the potential negative consequences of Y2K, some writers recognized that Y2K could set in motion a period of intense strategic investment in information technology (IT) of the type characterized by Schumpeter [Capitalism, Socialism, and Democracy, third ed., Harper and Row, New York, 1950, p. 81] as creative destruction. In performing the study presented here, we formulated hypotheses, based on Schumpeter's [The Theory of Economic Development, Harvard University, Cambridge, 1934, p. 57] theory of economic development, about the characteristics of firms that would have responded most aggressively to Y2K and tested these hypotheses using data obtained from Y2K disclosures made in filings with the Securities and Exchange Commission (SEC). Our findings provide striking evidence that Y2K spending increased with economic factors that are characteristic of entrepreneurial firms and with the competitiveness of the firms' industries. This observation of systematic Y2K spending patterns suggests that accounting disclosures of IT spending are informative and illustrates the potential power of economic catalysts for change, particularly with respect to IT resources.

1. Introduction

The Y2K problem has generally been regarded as disruptive to the global economy – having caused companies to divert resources from more productive

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use to fix an annoying problem. In contrast, Y2K may be regarded as an opportunity companies had to redefine business processes, products, and markets by making investments in new combinations of information technology (IT) and other factors of production. This view reflects the type of economic development envisioned by Schumpeter (1934, 1950, pp. 57–94; pp. 81–86) who characterized entrepreneurs as individuals who carry out new combinations in order to achieve economic profits (Schumpeter, 1934, p. 132). The concurrence of the Y2K problem with the availability of a variety of innovative IT applications makes a study of Y2K from the Schumpeterian viewpoint particularly appealing (Gordon and Loeb, 1999, p. 57).

During the approach to the new millennium, businesses had options to migrate from mainframe to client–server computing systems, adopt enterprise resource planning (ERP) and customer relationship management (CRM) systems, and develop e-business applications. Because two-digit dates were pervasive in legacy systems developed during the 1970s and 1980s, most large firms faced significant costs to make existing systems Y2K compliant. Resourceful firms could have taken advantage of the Y2K situation to evaluate and update their IT infrastructure. In fact, reports indicate that many firms made decisions to replace their legacy systems and simultaneously obtain the side benefit of Y2K compliance (see Forman and Hafke, 1999, p. 39; McKendrick, 1999, pp. 48–50; Rankin, 1999, D1).

Gordon and Loeb (1999, pp. 57–59) provided a clear exposition of the benefits of Y2K and denounced the scaremongers who painted a Y2K picture of gloom and doom. Based on survey information, they (1999, pp. 59–62) found that large US firms would be prepared for Y2K and that firms were realizing benefits from Y2K initiatives that included infrastructure investments, upgrades to software systems, and inventorying of their IT assets. Gordon and Loeb (1999, p. 57) suggested that Y2K had set in motion the type of competitive behavior described by Schumpeter (1950, pp. 81–86) as creative destruction.

In Schumpeter's discussion of his theory of economic development, he identified entrepreneurs as the economic players that would lead other firms in trying new combinations of technology and other factors of production (cf. Schumpeter, 1934). If Y2K sparked creative investment in IT, then application of Schumpeter's theory provides a prediction that entrepreneurial firms would have spent more on Y2K than other firms did. In our analysis, we identified economic indicators corresponding to Schumpeter's description of entrepreneurs and empirically tested a hypothesis that Y2K spending increased with these economic factors.

Schumpeter (1934, pp. 132–136) also recognized the dynamic influence of competition in promoting entrepreneurial activity – competition drives away the entrepreneurial profits from old combinations thereby providing the incentive for entrepreneurs to try new combinations. We tested a second hy-

pothesis that Y2K spending was higher in more competitive industries. Since entrepreneurs must move quickly to obtain the economic profits from new combinations, we also performed an analysis that related firms' Y2K completion targets to the various economic factors and available cash resources.

We obtained the data used in our analysis from public disclosures of Y2K spending amounts in 10Q and 10K forms filed by *Fortune 1000* firms with the Securities and Exchange Commission (SEC). During the summer of 1998, the SEC issued an interpretation that directed companies to disclose information about their Y2K preparations in the Management Discussion and Analysis section of their quarterly 10Q and annual 10K reports (SEC, 1998). Previous studies of Y2K spending based on survey data were limited by the voluntary nature of the survey process. The backing of statutory requirement associated with the SEC reporting process lowered the potential for self-selection bias present in survey responses.

The primary items that companies were directed to disclose in their 10K and 10Q reports were the total amount they planned to spend on Y2K (including amounts spent to date), the actual amount that they had already spent, and the date they planned to complete their Y2K projects and testing. The SEC interpretation specified that reported Y2K expenditures were to include costs incurred for new IT initiatives that were accelerated in efforts to achieve Y2K compliance, as well as remediation costs for existing programs (SEC, 1998, p. 10). Therefore, greater Y2K spending, after controlling for remediation costs, would be associated with higher investments in new IT initiatives during the Y2K preparation period.

Our descriptive analysis of the data indicates that there was considerable variation in Y2K spending across and within industries. Our regression results provide strong support for the hypotheses that Y2K spending increased with economic factors characteristic of entrepreneurial firms and with the degree of competitiveness within industries. In our analysis of targeted completion dates for Y2K, we found mixed support for hypotheses that earlier projected completion dates would be associated with entrepreneurial factors, competitiveness, and available cash resources.

Our study has implications for both accounting and public policy. Our evidence indicates that there were systematic patterns to IT spending for Y2K similar to those of R&D spending. This suggests that companies do make strategic investments in IT, meaning that accounting information about IT spending would be informative to investors. [1] In the midst of the Y2K preparation period, much attention was paid to the potential negative consequences of inadequate preparation for Y2K. Public policy determined from this

[1] Present accounting rules do not require companies to separately disclose capital or non-capital spending on IT resources. The SEC guideline (SEC, 1998) applied only to Y2K spending.

perspective might have prescribed remedies or imposed restrictions that would have discouraged companies from making radical changes to their IT infrastructure. Intervention in this type of circumstance could dampen the productive process of creative destruction.

The remainder of this paper is organized as follows. In Section 2, we present hypotheses that relate Y2K spending and completion targets to economic factors that are characteristic of entrepreneurial firms and the degree of competitiveness within industries. In Section 3, we describe our empirical models and the data. In Section 4, we report the results of our empirical analysis including robustness tests. In Section 5, we provide concluding comments including a discussion of the accounting and public policy implications of this study and directions of future research.

2. Economic development and Y2K

Schumpeter (1934, p. 64) characterized economic development as "spontaneous and discontinuous change in the channels of the flow, disturbance of equilibrium, which forever alters and displaces the equilibrium state previously existing." In this light, Y2K may have acted as a stimulus that set in motion the mechanism of economic development – the search for alternative combinations.

In many companies, legacy systems were made up of applications that separately tracked finances, human resources, inventories and sales and distribution (Davenport, 1998, p. 123). These applications were often built at different times using different platforms. In cases where companies had grown through acquisition or merger, different operating systems were patched together. The two-digit date problem was pervasive in legacy systems. By ripping out their legacy systems, and replacing them with integrated systems, companies were able to realize benefits beyond the increased efficiency of their IT. Integration of applications throughout the value-chain enabled companies to improve customer interactions, redesign their business processes and revise their business practices (see Rankin, 1999, p. D1). But there were significant challenges to reorganizing business processes and practices to take advantage of new IT capabilities. Employees were forced to leave systems and ways of doing businesses that they were comfortable with and learn how to interact with new systems (see Connolly, 1999, p. 76).

In the process of economic development, some players lead and others follow. Schumpeter (1934, p. 83) described entrepreneurs as more than "mere managers". They are people with the vision, the will, and the leadership to overcome resistance. Schumpeter's theory suggests variation in firms' responses to Y2K, according to their willingness to try new combinations. Entrepreneurial managers are better able to see the benefits and more willing to bear the costs associated with reorganization. In our analysis, we related firms'

responses to Y2K, as measured by the intensity of their Y2K spending and their targeted Y2K completion dates, to economic factors that are characteristic of entrepreneurial activity.

2.1. Entrepreneurial activity

Schumpeter (1934, pp. 133–135) provided the following examples of entrepreneurial activities: improving the process of production, introducing a new and cheaper source of supply, replacing one production or consumption good by a cheaper good that serves the same purpose, searching for new markets for an existing good, and developing new goods. The objectives of research and development (R&D) activities are to improve production processes and to develop new goods. Therefore, we included *R&D intensity* (research and development costs expressed as a percentage of sales revenue) as an economic indicator characteristic of entrepreneurial firms in our model. The extent of R&D has also been used as an attribute of entrepreneurship in previous studies of Schumpeterian competition (Scherer, 1984, pp. 83–119).

In his analysis, Schumpeter (1934, p. 128) considered the entrepreneurial input to be a fourth factor in addition to the three standard factors of production: materials, labor, and capital. A firm acquires the standard factors of production in the markets for those factors. Thus, the rewards for those factors are their market prices. The reward for the entrepreneurial input is the supernormal or entrepreneurial profit (Schumpeter, 1934, pp. 128–156). Some of the reward to creative activity will flow through to current net profit and some will flow through to future net profit. The actual flow to current net profit is reflected in the net profit margin of the company and increases the book value of equity. The expected flow to future net profit is picked up in the market value of the company but not in the book value. Therefore, we used two financial measures as economic indicators of entrepreneurial activity, the *net profit to sales* and the *market to book* value of common equity. We used the reciprocal ratio, the *book to market*, in the empirical model to avoid the discontinuity that occurs with negative book values (Anderson et al., 2000, p. 536).

To investigate whether entrepreneurial firms did, in fact, spend relatively more on Y2K, we examined the relationship between Y2K spending intensity and these economic indicators of entrepreneurial activity. Our first hypothesis is given below.

Hypothesis 1. Y2K spending intensity increased with economic indicators characteristic of entrepreneurial firms: R&D intensity, net profit to sales, and the market to book ratio.

Schumpeter (1934, pp. 153–154) explained that "entrepreneurial profit is not a rent like the return to differential advantages in the permanent elements of a

business; nor is it a return to capital ... It attaches to the creation of new things, to the realization of the future value system. It is at the same time the child and the victim of development''. Competition provides the stimuli for entrepreneurial behavior, the desire to achieve entrepreneurial profits, and also facilitates the subsequent annihilation of the entrepreneurial advantage as reorganization occurs (Schumpeter, 1934, pp. 131–132). Since entrepreneurial profits may be short-lived, entrepreneurial firms must continuously search for new combinations. This leads to a prediction that entrepreneurial activity increases with the degree of competition. Because more competitive industries have a lower concentration ratio (Scherer, 1984, pp. 249–255), we tested a hypothesis that the level of *Y2K spending intensity* decreased with *industry concentration*.

Hypothesis 2. Y2K spending intensity decreased with industry concentration.

In addition to *Y2K spending intensity*, we also used the *Y2K completion target* (the date when the firm expected to complete testing of its systems for Y2K compliance) as a measure of the firms' aggressiveness in pursuing a resourceful Y2K strategy. Since the entrepreneurial profits associated with new combinations may be short-lived (Schumpeter, 1934, pp. 131–132), entrepreneurial firms may have wanted to initiate and complete their Y2K projects as early as possible. Firms concerned primarily about Y2K remediation would have, on the other hand, had less incentive to complete their remediation and testing much before the December 31, 1999 deadline. We tested hypotheses for the *Y2K completion target* that parallel Hypotheses 1 and 2 for *Y2K spending intensity*.

Hypothesis 3. The Y2K completion target (number of days before December 31, 1999) increased with economic indicators characteristic of entrepreneurial firms.

Hypothesis 4. The Y2K completion target decreased with the industry concentration ratio.

3. Empirical models and data

Hypotheses 1 and 2 relate Y2K spending intensity to economic indicators representative of entrepreneurial firms and industry concentration. These hypothesis are directed at investment in new IT that occurred in response to Y2K. To enable estimation of the relations between investments in IT and these economic indicators, we controlled for other factors that influenced exposure to remediation costs. The size and substance of the software programs underlying the firms' legacy systems affected Y2K exposure. At a basic level, we controlled for the volume of transactions processed by the firm by defining

Y2K spending intensity relative to sales revenue. But other dimensions of size influenced the extent of the Y2K problem.

The amount of property, plant and equipment (fixed assets) governed by the firm affected the size of the Y2K problem because accounting systems that track the acquisition, depreciation, maintenance and disposal of fixed assets are date-sensitive and there are date-sensitive programs in embedded IT. The number of employees also affected the extent of the Y2K problem because payroll and personnel applications that track employee history and benefits are date-sensitive. Therefore, as control variables, we included *fixed assets to sales* and the number of *employees to sales* in our model. Model 1 relates *Y2K spending intensity* to economic indicators characteristic of entrepreneurial firms, industry concentration, and control variables for the extent of Y2K exposure. The model is specified in loglinear form. [2]

Model 1

$$\begin{aligned}\ln(\text{Y2K spending intensity}) = {} & \alpha + \beta_1 \ln(\text{R\&D intensity}) \\ & + \beta_2 \ln(\text{net profit to sales}) \\ & + \beta_3 \ln(\text{book to market}) \\ & + \beta_4 \ln(\text{industry concentration}) \\ & + \gamma_1 \ln(\text{fixed assets to sales}) \\ & + \gamma_2 \ln(\text{employees to sales}) + \varepsilon.\end{aligned}$$

Hypotheses 3 and 4 relate the *Y2K completion target* to entrepreneurial factors and *industry concentration*. Since available cash resources may have influenced the timing of Y2K expenditures, we included *free cash flow to assets* in the specification of model 2 below.

Model 2

$$\begin{aligned}\ln(\text{Y2K completion target}) = {} & \alpha + \beta_1 \ln(\text{R\&D intensity}) \\ & + \beta_2 \ln(\text{net profit to sales}) \\ & + \beta_3 \ln(\text{book to market}) \\ & + \beta_4 \ln(\text{industry concentration}) \\ & + \beta_5 \ln(\text{free cash flow to assets}) \\ & + \gamma_1 \ln(\text{fixed assets to sales}) \\ & + \gamma_2 \ln(\text{employees to sales}) + \varepsilon.\end{aligned}$$

We provide descriptions of the variables in Table 1.

[2] Based on the Davidson and MacKinnon (1981) test, the loglinear form of the model is preferred to the linear form. To avoid negative values, transformation of the independent variables to logarithmic form involves adding one to the R&D intensity, net profit to sales, and free cash flow to assets, and two to the book to market ratio.

Table 1
Description of variables

Planned Y2K spending intensity	Total planned Y2K spending divided by sales revenue
Actual Y2K spending intensity	Total actual Y2K spending divided by sales revenue
Y2K completion target	Number of days before December 31, 1999 that company plans to complete its Y2K projects
R&D intensity	R&D expenditures divided by sales revenue
Net profit to sales	Net income divided by sales revenue
Book to market	Book value per share divided by market value per share
Industry concentration	Fraction of sales accounted for by four largest firms in their respective industry groups
Free cash flow	Sum of cash flow from operating activities and cash flow from investing activities scaled by total assets
Fixed assets to sales	Amount of property, plant and equipment divided by sales revenue
Employees to sales	Number of employees divided by sales revenue

3.1. Data

We extracted the amounts of planned and actual Y2K spending and targeted Y2K completion dates directly from the Management Discussion and Analysis section of 10K and 10Q reports filed by 1998 *Fortune* 1000 companies during the first quarter of 1999. We selected these reports because they were the first calendar year-end 10K reports that provided information about Y2K spending after the SEC interpretation took effect in August of 1998. [3] The information in 10K reports is more reliable than information in other disclosures because it is subject to more careful scrutiny by both managers and external auditors than other disclosures. We accessed the reports through the *EDGAR* database maintained by the SEC.

We obtained *planned Y2K spending* for 716 firms from the 1998 *Fortune* 1000 firms. Information about Y2K could not be obtained for 165 firms that did not make 10K or 10Q filings during the first quarter of 1999. [4] These firms include mutual insurance companies and other firms that do not make 10K or 10Q filings and firms that were acquired or merged with other firms during 1998. The remaining 119 firms did not disclose their planned Y2K spending. Companies' reluctance to make detailed disclosures of their Y2K preparations may

[3] Y2K spending data were also collected from reports filed during the second, third, and fourth quarters of 1999. Estimation of models 1a and 1b with more recent data provided qualitatively similar results.

[4] A limited number of 10Q filings (37 firms) were used for companies that issue 10K reports in other quarters.

be due to uncertainty about the total cost of Y2K or fear that the disclosures may be used in litigation against the company.

In Table 2, we provide descriptive information about *planned Y2K spending intensity* across various industry groups. There was considerable variation in *planned Y2K spending intensity* both across and within industry groups. Median *planned Y2K spending intensity* ranged from a low of 0.179% in merchandising to a high of 1.453% in telecommunications. The industries at

Table 2
Distribution of planned Y2K spending intensity (planned Y2K spending as a percentage of sales revenue) by industry

Industry description	Total number of firms	Number of sample firms	Low	First quartile	Median	Third quartile	High
Merchandising	55	76	0.010	0.114	0.179	0.348	3.445
Wholesale and Specialty Retail	101	40	0.016	0.102	0.236	0.350	0.989
Extraction (mining, crude oil)	39	25	0.009	0.171	0.326	0.555	1.953
Building materials and construction	52	39	0.034	0.220	0.354	0.708	3.434
Chemicals and petroleum refining	60	48	0.058	0.248	0.384	0.877	6.199
Manufacturing, auto. and equip.	87	64	0.033	0.250	0.428	0.693	5.477
Transportation	33	29	0.039	0.180	0.513	0.809	2.323
Hotels, restaurants and services	35	27	0.037	0.146	0.513	1.103	2.454
Consumer (food and beverages)	49	34	0.028	0.250	0.524	0.864	2.638
Consumer (non-food)	29	26	0.027	0.116	0.530	1.489	3.198
Insurance	84	33	0.046	0.278	0.568	0.946	2.042
Healthcare	32	23	0.078	0.384	0.621	1.458	4.936
Electronics and aerospace	112	75	0.089	0.433	0.712	1.336	4.477
Utilities	73	56	0.109	0.485	0.734	1.264	4.805
Media services	26	24	0.220	0.527	0.795	1.286	2.102
Banks and financial services	79	60	0.028	0.651	1.049	1.528	3.269
Pharmaceuticals	14	12	0.063	0.866	1.123	1.508	2.176
Telecommunications	40	25	0.208	0.628	1.453	1.661	4.135
All firms	1000	716	0.009	0.242	0.512	1.019	6.199

Information about planned Y2K spending was obtained from disclosures in the Management, Discussion and Analysis section of annual and quarterly reports filed with the SEC during the first quarter of 1999. The table is organized in ascending order based on the median value of Y2K spending intensity.

the high end include banks and financial services, pharmaceuticals, as well as telecommunications. These technology-driven industries are known for extensive use of IT (Chatterjee et al., 2001, p. 64). But even within these industries, there was a large spread between the lowest and highest intensity scores. In the telecommunications industry, for instance, the *planned Y2K spending intensity* ranged from a low of 0.208% to a high of 4.135%.

In Table 3, we present descriptive information about Y2K completion targets (the number of days between the targeted Y2K completion date and December 31, 1999) for the 482 firms that provided targeted completion dates.

Table 3
Distribution of Y2K completion target (number of days between planned completion and December 31, 1999) by industry

Industry description	Total number of firms	Number of sample firms	Low	First quartile	Median	Third quartile	High
Merchandising	55	14	30	121	184	213	275
Wholesale and specialty retail	101	42	0	121	184	213	305
Extraction (mining, crude oil)	39	22	−31	121	184	213	305
Consumer (non-food)	29	15	30	121	184	213	275
Chemicals and petroleum refining	60	41	0	92	184	213	305
Building materials and construction	52	30	30	121	169	213	276
Consumer (food and beverages)	49	17	−1	121	184	213	275
Healthcare	32	13	30	91	121	213	215
Insurance	84	24	30	30	199	213	305
Manufacturing, auto. and equip.	87	46	0	92	184	213	276
Transportation	33	19	0	92	184	213	275
Hotels, restaurants and services	35	15	30	121	152	213	274
Utilities	73	45	0	183	184	213	330
Media services	26	16	0	137	184	184	276
Electronics and aerospace	112	49	0	92	184	213	305
Banks and financial services	79	41	0	184	184	275	306
Pharmaceuticals	14	11	0	92	184	276	305
Telecommunications	40	22	0	121	184	213	275
All firms	1000	482	−31	121	184	213	330

Information about planned Y2K spending was obtained from disclosures in the Management, Discussion and Analysis section of annual and quarterly reports filed with the SEC during the first quarter of 1999.

In this table, 0 days means that the company anticipated completing remediation and testing of their systems on December 31, 1999. Similarly, 184 days means that they anticipated completing their remediation and testing by June 30, 1999. The median Y2K completion targets were 6 months before December 31, 1999 for 14 of the 18 industry groups. This is consistent with Gordon and Loeb's survey results where most respondents indicated that they planned to complete their Y2K preparations by July 1, 1999 (cf. Gordon and Loeb, 1999, p. 60). While there was a wide range in many industries (from 0 days to over 300 days), the observations tended to be bunched together at monthly or quarterly intervals.

We obtained values of the financial variables from Standard and Poors' Compustat database. For model 1, these variables included net sales revenue (Compustat item #12), R&D expenditures (#46), income before extraordinary items (#18), the book value of common equity (#60), the number of common shares outstanding (#25), the stock price at the close of the fiscal year (#24), fixed assets (#8), and the number of employees (#29). We calculated industry concentration ratios as the fraction of sales accounted for by the four largest companies in their respective four-digit SIC industry groups (Press and Weintrop, 1990, p. 82). The concentration ratios were determined using all of the 1998 Compustat firms. We calculated free cash flow as the sum of cash flow from operating activities (#308) and cash flow from investing activities (#311) scaled by total assets (Dechow et al., 1996, p. 10).

The fact that some firms decided not to report their Y2K costs introduced a potential bias from self-selection, similar in some respects to the self-selection problem encountered with survey research. In Table 4, panel A, we present descriptive information about the firms included in the sample and, in panel B, we present comparative information for the non-reporting firms. Firms are included in panel A if they provided information about either planned Y2K spending or actual Y2K spending in their disclosures. The non-reporting firms were in most respects comparable to the sample firms.

In Table 5, we provide a correlation matrix of the variables used in the analysis. Of the 716 firms making planned Y2K spending disclosures, we excluded 132 firms because either a financial variable was missing or the observation was extreme on some dimension, leaving 584 firms for the analysis. [5] Similarly, of the 482 firms providing targeted completion dates, we excluded 131 firms, leaving 353 firms for the analysis.

[5] We identified influential observations using recommended cutoffs for leverage points, Studentized residuals, the DFFITS measure, and standard influences of observations on the covariance of estimates (Belsley et al., 1980; Krasker et al., 1983). Observations were excluded from the analysis if any one the four cutoffs were exceeded.

Table 4
Descriptive statistics for reporting and non-reporting firms

	n	Mean	Std. Dev.	First quartile	Median	Third quartile
Panel A – Reporting firms[a]						
Sales (millions of dollars)	720	6947.1	12,811.8	1772.5	3017.2	7106.8
R&D to sales	709	0.015	0.040	0.000	0.000	0.009
Net profit to sales	715	0.049	0.081	0.014	0.045	0.086
Book to market ratio	685	0.480	3.475	0.240	0.414	0.627
Industry concentration	703	0.676	0.213	0.476	0.701	0.862
Free cash flow (to assets)	659	0.011	0.111	−0.040	0.012	0.059
Fixed assets to sales	682	0.444	0.549	0.134	0.234	0.472
Number of employees to sales	672	0.006	0.009	0.003	0.004	0.007
Panel B – Non-reporting firms						
Sales (millions of dollars)	117	5936.5	10,894.4	1512.5	2367.6	4424.2
R&D to sales	116	0.022	0.043	0.000	0.000	0.024
Net profit to sales	117	0.034	0.109	0.012	0.041	0.080
Book to market ratio	107	0.463	0.463	0.205	0.395	0.604
Industry concentration	117	0.708	0.207	0.564	0.729	0.885
Free cash flow (to assets)	107	−0.008[b]	0.128	−0.076	−0.008[b]	0.041
Fixed assets to sales	107	0.312[b]	0.452	0.080	0.157[b]	0.308
Number of employees to sales	104	0.006	0.007	0.003	0.004	0.007

[a] This panel includes firms that report either planned Y2K spending or actual Y2K spending.
[b] Denotes significant difference from sample firms at 0.05 level.

4. Estimation results

We present the results of separate ordinary least squares (OLS) estimations of model 1 with ln(*planned Y2K spending intensity*) and ln(*actual Y2K spending intensity*) as the dependent variable in Table 6. Seemingly unrelated regressions (SUR) estimation was not required to accommodate possibly correlated residual terms because the ln(*planned Y2K spending intensity*) equation and the ln(*actual Y2K spending intensity*) equations have the same set of independent variables (Judge et al., 1988, p. 448). White's test indicated that the null hypothesis of homoskedasticity could not be rejected at the 5% level of significance (cf. White, 1980). The Shapiro and Wilk (1965) test did not reject the assumption that the residuals were normally distributed.

With respect to *planned Y2K spending intensity*, Hypothesis 1, that Y2K spending intensity increased with economic indicators characteristic of entrepreneurial firms, is strongly supported by the significantly positive coefficients of 4.7309 (one-tailed p-value = 0.0001) on ln(*R&D intensity*) and 1.5080 (one-tailed p-value = 0.0003) on ln(*net profit to sales*), and the significantly negative coefficient of −0.5633 (one-tailed p-value = 0.0063) on ln(*book to market*).

Table 5
Correlation matrix[a] and description of variables

	ln(planned Y2K spending intensity)	ln(actual Y2K spending intensity)	ln(Y2K completion target)	R&D intensity	Net profit to sales	Book to market	Industry concentration	Free cash flow	ln(fixed assets to sales)	ln(employees to sales)
ln(planned Y2K spending intensity)		0.9292 (0.0001)	−0.0021 (0.9662)	0.1783 (0.0001)	0.1685 (0.0001)	−0.0292 (0.4455)	−0.1834 (0.0001)	0.0434 (0.2651)	0.2185 (0.0001)	0.1177 (0.0022)
ln(actual Y2K spending intensity)	*0.9205 (0.0001)*		−0.0131 (0.7989)	0.1221 (0.0018)	0.1837 (0.0001)	−0.0187 (0.6401)	−0.1508 (0.0001)	0.0588 (0.1494)	0.1701 (0.0001)	0.1128 (0.0051)
ln(Y2K completion target)	*0.03393 (0.5030)*	*0.05029 (0.3269)*		−0.1276 (0.0116)	−0.0013 (0.9789)	0.0422 (0.4097)	−0.303 (0.5530)	0.0086 (0.8693)	0.0277 (0.5950)	−0.0097 (0.8526)
R&D intensity	*0.1402 (0.0002)*	*0.1174 (0.0027)*	*−0.0688 (0.1745)*		−0.0301 (0.3798)	0.0200 (0.5690)	−0.0248 (0.4753)	−0.0418 (0.2408)	0.0576 (0.1003)	0.0149 (0.6735)
Net profit to sales	*0.2882 (0.0001)*	*0.3155 (0.0001)*	*0.1243 (0.0136)*	*0.0430 (0.2096)*		−0.0232 (0.5068)	−0.1601 (0.0001)	0.2100 (0.0001)	0.0311 (0.3760)	−0.0295 (0.4032)
Book to market	*−0.1034 (0.0067)*	*−0.0985 (0.0137)*	*−0.0389 (0.4477)*	*−0.2251 (0.0001)*	*−0.3075 (0.0001)*		0.0374 (0.2906)	−0.0265 (0.4625)	0.0139 (0.6972)	−0.0383 (0.3731)
Industry concentration	*−0.1861 (0.0001)*	*−0.1478 (0.0002)*	*−0.0826 (0.1054)*	*0.2219 (0.0001)*	*−0.2186 (0.0001)*	*−0.1345* (0.0001)		−0.0319 (0.3749)	−0.2562 (0.0001)	0.1503 (0.0001)
Free cash flow	*0.0701 (0.0718)*	*0.1005 (0.0136)*	*0.0297 (0.5719)*	*0.0217 (0.5436)*	*0.2404 (0.0001)*	*−0.1739 (0.0001)*	*−0.0439 (0.2216)*		−0.0879 (0.0156)	0.0332 (0.3602)
ln(fixed assets to sales)	*0.1940 (0.0001)*	*0.1284 (0.0013)*	*0.0491 (0.3458)*	*0.0931 (0.0078)*	*0.1671 (0.0001)*	*0.0471 (0.1885)*	*−0.2356 (0.0001)*	*−0.0420 (0.2488)*		0.0764 (0.0325)
ln(employees to sales)	*0.0419 (0.2769)*	*0.0323 (0.4234)*	*0.0012 (0.9811)*	*0.0372 (0.2922)*	*−0.0770 (0.0292)*	*−0.0876 (0.0143)*	*0.2049 (0.0001)*	*−0.0012 (0.9743)*	*0.0154 (0.6659)*	

[a] Pearson correlations are above the diagonal and Spearman correlations are below the diagonal (p-values are in parentheses).

Table 6
Results of OLS regressions relating Y2K spending intensity to entrepreneurial characteristics and industry concentration

Model 1

$$\ln(\text{Y2K spending intensity}) = \alpha + \beta_1 \ln(\text{R\&D intensity}) + \beta_2 \ln(\text{net profit to sales}) + \beta_3 \ln(\text{book to market}) + \beta_4 \ln(\text{industry concentration}) + \gamma_1 \ln(\text{fixed assets to sales}) + \gamma_2 \ln(\text{employees to sales}) + \varepsilon$$

Variable[a]		Predicted	Planned Y2K spending intensity		Actual Y2K spending intensity	
			Coefficient	p-Value[b]	Coefficient	p-Value[b]
ln(R&D intensity)	β_1	+	4.7309	**0.0001**	3.3339	**0.0022**
ln(net profit to sales)	β_2	+	1.5080	**0.0003**	2.6571	**0.0001**
ln(book to market)	β_3	−	−0.5633	**0.0063**	−0.3467	**0.0946**
ln(industry concentration)	β_4	−	−0.5029	**0.0001**	−0.4181	**0.0007**
ln(fixed assets to sales)	γ_1	+	0.1288	0.0001	0.0915	0.0113
ln(employees to sales)	γ_2	+	0.1241	0.0045	0.1037	0.0296
			$n = 584$		$n = 534$	
			$R^2 = 0.1669$		$R^2 = 0.1168$	
			Adj. $R^2 = 0.1583$		Adj. $R^2 = 0.1067$	
			F-Statistic = 19.27		F-Statistic = 11.62	
			p-Value = 0.0001		p-Value = 0.0001	

[a] Variable descriptions are provided in Table 1.
[b] p-Values are for one-sided tests.

Hypothesis 2, that *Y2K spending intensity* increased with competition within the firm's industry is supported by the significantly negative coefficient of −0.5029 (one-tailed p-value = 0.0001) on ln(*industry concentration*). The coefficients on the control variable for remediation costs, ln(*total asset to sales*) and ln(*employees to sales*) are also significantly positive as expected. Similar results are obtained when ln(*actual Y2K spending intensity*) is used as the dependent variable instead of ln(*planned Y2K spending intensity*).

We present the results of estimating model 2, relating Y2K completion targets to the entrepreneurial factors and industry concentration in Table 7. [6] The left-hand side variable, ln(*Y2K completion target*), is defined as the number of days before December 31, 1999 that firms anticipated completing their Y2K programs, so it is higher for firms that had earlier targeted completion dates. The results provide, at best, moderate support for Hypotheses 3 and 4, that the *Y2K completion target* increased with the entrepreneurial factors and the industry concentration ratio. Each of the signs is the predicted direction but only

[6] We estimated the cross-model correlation coefficients between models 1 and 2 and found that they were not significantly different from zero, making it unnecessary to estimate these models as seemingly unrelated regressions (Judge et al., 1988, p. 448).

Table 7
Results of OLS regression relating Y2K completion target to entrepreneurial characteristics and industry concentration

Model 2

$$\ln(\text{Y2K completion target}) = \alpha + \beta_1 \ln(\text{R\&D intensity}) + \beta_2 \ln(\text{net profit to sales}) + \beta_3 \ln(\text{book to market}) + \beta_4 \ln(\text{industry concentration}) + \beta_5 \ln(\text{free cash flow}) + \varepsilon$$

Variable[a]		Predicted	Coefficient	*p*-Value[b]
ln(R&D intensity)	β_1	+	0.3015	**0.3534**
ln(net profit to sales)	β_2	+	0.0659	**0.4234**
ln(book to market)	β_3	−	−0.3866	**0.0126**
ln(industry concentration)	β_4	−	−0.0853	**0.1707**
ln(free cash flow)	β_5	+	0.3243	**0.1076**
ln(fixed assets to sales)	γ_1	+	0.0580	0.0129
ln(employees to sales)	γ_2	+	0.0302	0.2347
			$n = 353$	
			$R^2 = 0.0495$	
			Adj. $R^2 = 0.0302$	
			F-Statistic = 2.57	
			p-Value = 0.014	

[a] Variable descriptions are provided in Table 1.
[b] p-Values are for one-sided tests.

the ln(*book to market*) variable is statistically significant at conventional levels. This indicates that the Y2K completion target does not discriminate as strongly between the aggressiveness of Y2K responses as the Y2K spending intensity does.

4.1. Short-term profitability and cash resources

Our analysis was directed at *Fortune* 1000 companies, not at rapidly growing new companies. Of the 851 firms included in the Compustat database at December 31, 1998, only 14 firms had been in the database less than 5 years. Almost 75% of the firms (633 of 851 firms) had been in the database for more than 15 years, reflecting the maturity of the companies. If the sample had been drawn from younger, developing companies, the net profit margin would have been a less reliable indicator of entrepreneurial activity because reported profits of emerging companies are reduced by the costs of development including marketing, R&D, and, to some extent, building an IT infrastructure (Stickney and Brown, 1999, pp. 69–71).

Because some portion of the costs of preparing for Y2K was charged against earnings, there is a possibility that the net profit margin on sales was materially affected by Y2K spending. To control for this possibility, we reestimated the

Table 8
Results of OLS regressions relating Y2K spending intensity to entrepreneurial characteristics and industry concentration with profit margin adjusted for Y2K spending

Variable[a]		Predicted	Planned Y2K spending intensity		Actual Y2K spending intensity	
			Coefficient	p-Value[b]	Coefficient	p-Value[b]
ln(R&D intensity)	β_1	+	4.7119	**0.0001**	3.2308	**0.0024**
ln(net profit to sales)	β_2	+	1.8917	**0.0001**	3.2996	**0.0001**
ln(book to market)	β_3	−	−0.4409	**0.0301**	−0.2097	**0.2094**
ln(industry concentration)	β_4	−	−0.4786	**0.0001**	−0.3385	**0.0041**
ln(fixed assets to sales)	γ_1	+	0.1281	0.0002	0.0855	0.0148
ln(employees to sales)	γ_2	+	0.1165	0.0084	0.1183	0.0141
			$n = 525$		$n = 532$	
			$R^2 = 0.1740$		$R^2 = 0.1513$	
			Adj. $R^2 = 0.1645$		Adj. $R^2 = 0.1416$	
			F-Statistic = 18.19		F-Statistic = 15.60	
			p-Value = 0.0001		p-Value = 0.0001	

[a] Variable descriptions are provided in Table 1.
[b] p-Values are for one-sided tests.

model using a measure of net profit margin adjusted for Y2K spending. Since the disclosures did not indicate the actual timing or breakdown of Y2K spending between capital and non-capital items, we added the actual Y2K spending to net income and recalculated the *net profit to sales* based on this adjusted figure. We present the results of this estimation in Table 8. The basic results were robust to this manipulation.

Schumpeter (1934, pp. 71–74) recognized that entrepreneurs must obtain financing for their initiatives and indicated that financing may come either from existing cash resources or from the capital markets with the payment of a risk premium. Firms in more comfortable cash positions may have had more flexibility in financing their Y2K initiatives. We used free cash flow as a measure of the cash available for entrepreneurial investments and reestimated model 1 with *free cash flow to assets* as an additional independent variable. We report the results of this estimation in Table 9. The free cash flow variable has the predicted sign but is not statistically significant (one-tailed p-value = 0.1780), indicating that available cash resources did not strongly influence Y2K spending. Again, this result must be interpreted in light of the sample firms. Companies in the *Fortune* 1000 typically have ready access to capital markets. The basic results were robust to this manipulation as well.

4.2. Other estimation issues

It is possible that Y2K spending acted as a surrogate for capital spending in our analysis. To check whether this were the case, we added, as an independent

Table 9
Results of OLS regressions relating Y2K spending intensity to entrepreneurial characteristics and industry concentration with free cash flow

Variable[a]		Predicted	Planned Y2K spending intensity		Actual Y2K spending intensity	
			Coefficient	p-Value[b]	Coefficient	p-Value[b]
ln(R&D intensity)	β_1	+	5.3760	**0.0001**	5.1024	**0.0001**
ln(net profit to sales)	β_2	+	0.7649	**0.0461**	1.4018	**0.0078**
ln(book to market)	β_3	−	−0.6114	**0.0033**	−0.3224	**0.1112**
ln(industry concentration)	β_4	−	−0.3807	**0.0004**	−0.3528	**0.0038**
ln(free cash flow to assets)	β_5	+	0.3030	**0.1780**	0.3438	**0.1738**
ln(fixed assets to sales)	γ_1	+	0.1669	0.0001	0.1344	0.0004
ln(employees to sales)	γ_2	+	0.1151	0.0081	0.1299	0.0087
			$n = 548$		$n = 500$	
			$R^2 = 0.1721$		$R^2 = 0.1199$	
			Adj. $R^2 = 0.1613$		Adj. $R^2 = 0.1074$	
			F-Statistic = 16.03		F-Statistic = 9.58	
			p-Value = 0.0001		p-Value = 0.0001	

[a] Variable descriptions are provided in Table 1.
[b] p-Values are for one-sided tests.

variable, ln(*total capital expenditure to sales*) to the model specification of Table 9. The basic results were robust to this manipulation and the coefficient on ln(*total capital expenditures to sales*) was not significantly different from zero, indicating that Y2K spending did not act as a surrogate for other non-IT capital spending.

Our analysis was developed for firms in a variety of industries. Because the proxies for entrepreneurial characteristics may differ systematically across industries, it is possible that industry effects influenced our results. For instance, pharmaceutical companies typically spend a much greater percentage of sales on R&D than financial services firms do. Therefore, to the extent that R&D spending influenced estimation of our model, a less innovative pharmaceutical firm may be considered to be more entrepreneurial than a more innovative financial services firm. To control for this possibility, we estimated a fixed effects model with dummy variables for each of the industry groups described in Table 2. We present results of this estimation in Table 10. The main results are robust to this control for industry.

Models 1 and 2 have been treated as separate models in our analysis. Estimation of these models provided evidence that the amount of Y2K spending increased with entrepreneurial factors and that targeted completion dates were earlier for more entrepreneurial firms. But we have not considered relations between the size and timing of Y2K projects. Since it is likely that the size and timing of Y2K projects were jointly determined, the coefficients

Table 10
Results of fixed effects OLS regressions with control for industry effects

Variable[a]		Predicted	Planned Y2K spending intensity		Actual Y2K spending intensity	
			Coefficient	p-Value[b]	Coefficient	p-Value[b]
ln(R&D intensity)	β_1	+	4.2558	**0.0006**	3.3339	**0.0022**
ln(net profit to sales)	β_2	+	0.4682	**0.1368**	2.6571	**0.0001**
ln(book to market)	β_3	−	−0.3023	**0.0826**	−0.3467	**0.0946**
ln(industry concentration)	β_4	−	−0.3202	**0.0064**	−0.4181	**0.0007**
ln(fixed assets to sales)	γ_1	+	0.1359	0.0001	0.0915	0.0113
ln(employees to sales)	γ_2	+	0.2126	0.0010	0.1037	0.0296
			$n = 584$		$n = 534$	
			$R^2 = 0.3254$		$R^2 = 0.3025$	
			Adj. $R^2 = 0.2977$		Adj. $R^2 = 0.2711$	
			F-Statistic = 11.74		F-Statistic = 9.62	
			p-Value = 0.0001		p-Value = 0.0001	

[a] Variable descriptions are provided in Table 1.
[b] p-Values are for one-sided tests.

in the separate model estimations may be biased unless this simultaneity is explicitly considered. For this reason, we specified a recursive model that permits the amount of Y2K spending to influence the targeted completion date.

This recursive model combines the model 1 and model 2 specifications and includes ln(*Y2K spending intensity*) as an independent variable in the second (model 2) equation. In this model, both the amount of Y2K spending and the targeted completion date are related to the entrepreneurial factors as before. The additional feature is that the size of the project may influence the targeted completion date. We present the results of seemingly unrelated regressions (SUR) estimation (Lahiri and Schmidt, 1978) of this recursive model in Table 11. We performed this estimation with the limited sample of firms that disclosed both estimated Y2K spending and estimated Y2K completion target. The main results are generally robust and the coefficient on ln(*Y2K spending intensity*) is significantly negative in the ln(*Y2K completion target*) equation, indicating that larger projects took longer to complete.

4.3. Alternative specification

An important part of our analysis has been the distinction between investment in new IT and remediation. The positive influence of Y2K on investment in new IT was recognized by industry observers (Manchester, 1999, p. 3;

Table 11
Results of seemingly unrelated regression estimations of recursive system

Eq. (1)

$$\ln(\text{Y2K spending intensity}) = \alpha + \beta_1 \ln(\text{R\&D intensity}) + \beta_2 \ln(\text{net profit to sales}) + \beta_3 \ln(\text{book to market}) + \beta_4 \ln(\text{industry concentration}) + \beta_5 \ln(\text{fixed assets to sales}) + \beta_6 \ln(\text{employees to sales}) + \varepsilon$$

Eq. (2)

$$\ln(\text{Y2K completion target}) = \alpha + \gamma_1 \ln(\text{Y2K spending intensity}) + \gamma_2 \ln(\text{R\&D intensity}) + \gamma_3 \ln(\text{net profit to sales}) + \gamma_4 \ln(\text{book to market}) + \gamma_5 \ln(\text{industry concentration}) + \gamma_6 \ln(\text{free cash flow}) + \gamma_7 \ln(\text{fixed assets to sales}) + \gamma_8 \ln(\text{employees to sales}) + \varepsilon$$

Variable[a]		Predicted	Planned Y2K spending intensity		Actual Y2K spending intensity	
			Coefficient	p-Value[b]	Coefficient	p-Value[b]
ln(R&D intensity)	β_1	+	4.7528	**0.0004**	1.6925	**0.1401**
ln(net profit to sales)	β_2	+	0.5155	**0.1705**	0.8043	**0.1419**
ln(book to market)	β_3	−	−0.4542	**0.0637**	−0.4416	**0.0932**
ln(industry concentration)	β_4	−	−0.5054	**0.0004**	−0.3644	**0.0164**
ln(fixed assets to sales)	β_5	+	0.1534	0.0002	0.1013	0.0263
ln(employees to sales)	β_6	+	0.1022	0.0679	0.1089	0.0745
			$n = 306$		$n = 282$	
			$R^2 = 0.172$		$R^2 = 0.077$	
			Adj. $R^2 = 0.155$		Adj. $R^2 = 0.057$	
			F-Statistic = 10.32		F-Statistic = 3.84	
			p-Value = 0.0001		p-Value = 0.0011	
ln(Y2K spending intensity)	γ_1	−	−0.0560	**0.0624**	−0.0331	**0.0900**
ln(R&D intensity)	γ_2	+	0.5650	**0.2618**	0.3753	**0.3447**
ln(net profit to sales)	γ_3	+	−0.0070	**0.4919**	−0.0947	**0.8339**
ln(book to market)	γ_4	−	−0.3378	**0.0358**	−0.3275	**0.0511**
ln(industry concentration)	γ_5	−	−0.1966	**0.0191**	−0.1672	**0.0514**
ln(free cash flow)	γ_6	+	0.0612	**0.4163**	0.3283	**0.1282**
ln(fixed assets to sales)	γ_7	+	0.0571	0.0203	0.0595	0.0290
ln(employees to sales)	γ_8	+	0.0638	0.0690	0.0545	0.1196
			$n = 306$		$n = 282$	
			$R^2 = 0.058$		$R^2 = 0.055$	
			Adj. $R^2 = 0.033$		Adj. $R^2 = 0.027$	
			F-Statistic = 2.29		F-Statistic = 1.99	
			p-Value = 0.0200		p-Value = 0.0480	

[a] Variable descriptions are provided in Table 1.
[b] p-Values are for one-sided tests except where the sign was not as predicted.

Telberg, 2000, p. 4; Xenakis, 2000, p. 75). [7] In this section, we provide an alternative analysis that explicitly models the likelihood that variation in Y2K spending was caused both by a minimum remediation requirement and additional investment in new IT beyond this minimum. Y2K spending intensity is represented as

$$y = \theta * \rho,$$

where y represents Y2K spending intensity, ρ is the component that would have been observed if firms had spent only the minimum required for Y2K remediation and θ is the incremental intensity reflecting investment in new IT, accelerated due to Y2K concerns, that is expected to enhance the firm's productive efficiency. The main driver of remediation costs, sales revenue, is included implicitly in the specification of the dependent variable. Other things that affected the cost of remediation were the assets governed by the firm and the employees coordinated by the firm. Therefore, we model Y2K remediation intensity ρ as a function of the asset intensity and employee intensity

$$\rho = g(\text{fixed assets to sales},\ \text{employees to sales}) * e^{v}$$

where e^{v} is a random variation term and v is normally distributed $(0, \sigma_v^2)$.

If remediation were all that effected Y2K spending, then the model would be completely specified as $y = g(\cdot) * e^{v}$. But, our basic premise is that many firms went beyond remediation and invested in new IT. The variable θ captures this additional entrepreneurial activity. The optimal investment in new IT depends on the entrepreneurial characteristics but the actual investment in new IT may have fallen short of the optimal. We model this shortfall as e^{-u} where u is half-normal $(0, \sigma_u^2)$. Thus,

$$\theta = f(\text{R\&D intensity},\ \text{net profit to sales},\ \text{book to market},\ \text{industry concentration}) * e^{-u}.$$

Combining the equations and taking logarithms, we obtained

$$\ln\ y = \ln f(\cdot) + \ln\ g(\cdot) + \varepsilon,$$

[7] To provide additional support for the claim that greater Y2K spending was related to investment in new IT, we performed a logit analysis of *Fortune* 1000 companies based on whether they were included on the best customer list of a prominent ERP system supplier. The dependent variable in the logit estimation was one if the company was on the best customer list, zero otherwise and the independent variable was planned Y2K spending intensity. We found a significantly positive coefficient on Y2K spending intensity (one-tailed p-value = 0.0040) indicating that being on the best customer list was positively related to Y2K spending intensity. The logistic regression was significant at the 1% level (p-value = 0.0065).

where the error term $\varepsilon = v - u$ has a two-sided component v and a one-sided component u. This is the composed error model (Aigner et al., 1977). In keeping with the composed error literature, we maintained the assumption that f and g were loglinear functions.

Therefore, we obtained

$$\begin{aligned}\ln(\text{Y2K spending intensity}) = \alpha &+ \beta_1 \ln(\text{R\&D intensity}) \\ &+ \beta_2 \ln(\text{net profit to sales}) \\ &+ \beta_3 \ln(\text{book to market}) \\ &+ \beta_4 \ln(\text{industry concentration}) \\ &+ \gamma_1 \ln(\text{fixed assets to sales}) \\ &+ \gamma_2 \ln(\text{employees to sales}) + \varepsilon.\end{aligned}$$

This is the same as the model 1 specification. However, the distribution of ε is the convolution of the normal distribution postulated for v and the half-normal distribution postulated for u. Since the distribution of the error term is different from the distribution assumed in the model 1 estimation of Table 6, we estimated the composed error model using the maximum likelihood criterion based on the postulated distributions. This procedure also provides consistent estimators of σ_u and σ_v. We present results of this maximum likelihood estimation in Table 12.

Table 12
Results of maximum likelihood estimation of composed error model relating Y2K spending intensity to entrepreneurial characteristics and industry concentration

Variable[a]		Predicted	Planned Y2K spending intensity		Actual Y2K spending intensity	
			Coefficient	p-Value[b]	Coefficient	p-Value[b]
ln(R&D intensity)	β_1	+	4.6380	**0.0001**	3.3382	**0.0150**
ln(net profit to sales)	β_2	+	1.4973	**0.0016**	2.6494	**0.0012**
ln(book to market)	β_3	−	−0.5669	**0.0185**	−0.3473	**0.1137**
ln(industry concentration)	β_4	−	−0.5031	**0.0001**	−0.4188	**0.0008**
ln(fixed assets to sales)	γ_1	+	0.1256	0.0002	0.0907	0.0140
ln(employees to sales)	γ_2	+	0.1269	0.0053	0.1040	0.0385
	σ_u		0.5608	0.0400	0.3462	0.3037
	σ_v		0.7887	0.0001	0.9445	0.0001
			$n = 584$		$n = 534$	
			log-likelihood = −739		log-likelihood = −740	
			$\chi^2(6) = 102$		$\chi^2(6) = 65$	
			p-Value < 0.01		p-Value < 0.01	

[a] Variable descriptions are provided in Table 1.
[b] p-Values are for one-sided tests.

The results are consistent with Hypotheses 1 and 2, and are similar to the results obtained in the OLS estimation of Table 6. The coefficients on the entrepreneurial factors and the remediation factors are significantly different from zero with the predicted signs. In addition, σ_u and σ_v are both significant in the *planned Y2K spending intensity* model. Evaluation of these error components indicated that about 16% of the unexplained variation in Y2K spending intensity could be attributed to deviations from the optimal level of investment in new IT and 84% could be attributed to random noise.

5. Conclusion

Schumpeter recognized that the "fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates" (Schumpeter, 1950, p. 83). Innovations in IT made during the closing years of the 20th century made accounting and information systems applications available that, with accompanying organizational changes, could dramatically improve the entire supply chain management process.

Our analysis indicates that the Y2K problem had a catalytic influence on the implementation of these systems. Consistent with Schumpeter's theory of economic development, we documented that higher Y2K spending by leading US firms was linked to economic factors characteristic of entrepreneurial firms – higher research and development activity, greater profit margins on sales, and higher market premiums over the book value of equity. We also documented that Y2K spending by US firms was higher in more competitive industry settings.

Our research has implications for both accounting and public policy. Present accounting rules do not require regular disclosure of IT expenditures. In this regard, regulated disclosure of Y2K expenditures was an anomaly. Our analysis found systematic relations between investment in IT and firm characteristics similar to those observed for R&D expenditures. Researchers have found that information disclosed about R&D expenditures is value-relevant (Lev and Sougiannis, 1996). Researchers have also found that firm value is positively related to various measures of IT expenditures (Bharadwaj et al., 1999; Brynjolfsson et al., 2000; Anderson et al., 2001), further supporting the case for disclosure of IT expenditures.

From a broader public policy perspective, evidence that entrepreneurial firms responded to Y2K in the manner described by Schumpeter (1950,

pp. 81–86) as creative destruction provides a high-tech example that "capitalism includes an intrinsic mechanism for destroying one level of technological achievement and rebuilding it with a higher level of technological achievement" (Gordon and Loeb, 1999, p. 57). While doomsayers were concerned about potential glitches, innovative managers were making changes that would position their companies for competition in the new economy. A potential policy implication is an argument against government intervention in such high-tech settings that might impede the reinventing forces of capitalism.

As data become available, future research might investigate the economic impact of Y2K spending by comparing subsequent performance of companies that spent more during the Y2K period with their peers. Researchers might also investigate whether other types of investments or decisions are manifestations of entrepreneurial activity. For instance, the growth of internet sales or the creation of a chief information officer (CIO) function may be associated with entrepreneurial characteristics.

Schumpeter (1950, p. 85) distinguished between competition in the marketplace and evolutionary competition by noting that it is "the competition from the new commodity, the new technology, the new source of supply, the new type of organization – competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives". An output of our research is to illustrate the increasingly important role of IT in competitiveness and innovation. As governments and economic communities are striving to develop policies that will enhance the competitiveness of their economies (Clark and Guy, 1998), they must recognize the critical role that advanced accounting and information systems play in the post-Y2K business environment and not take steps to discourage deployment of new IT solutions.

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