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Relevance of intangible assets to evaluate financial health

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Abstract

Purpose – The purpose of this paper is to examine the relevance of asset composition of a firm (tangible versus intangible properties), when evaluating its financial health. The paper argues that relevance of any asset is a function of how effectively it is used.

Design/methodology/approach – The paper uses two distinctive samples: a sample of traditional firms holding primarily traditional physical assets and a sample of technology service firms holding primarily intangible assets and examines the ability of intangible assets to surrogate as financial health signals.

Findings – The results show that when evaluating firms with significant intangible assets, using information about intangible assets to improve financial health evaluation. However, fundamental financial variables continue to be important in signaling financial health, regardless of asset composition.

Practical implications – The results highlight the importance of both objectively-measured and reported fundamental financial information and subjectively measured intangible asset values. The results would help managers and markets in using greater caution when evaluating firms with intangible assets.

Originality/value – Unlike prior studies, this paper uses both fundamental financial variables and surrogates for intangible asset values in the model. The paper contributes by highlight the importance and limitations of intangible asset values.

Keywords Intangible assets, Intellectual capital, Financial performance, Business failures

Paper type Research paper

With the advent of information systems and related technologies, the growth in technology firms, have been significant during the last ten years. Technology service firms or firms that use computer and communication technologies to extract information components and offer products and services that substitute knowledge and intellectual capital in the place of tangible and physical capital have become common place. These firms own more intellectual assets such as human resources, knowledge bases, research and development and patents than traditional assets such as plant and machinery and equipment. By deploying intellectual capital to create competitive advantage and by obtaining knowledge-creating resources from across the world, the firms have successfully created competitive advantage for themselves. This "value chain" strategy has also enabled these firms to coordinate and control globally dispersed operations.

However, because technology firms create and use intangible assets with "perceived values," it does not mean that their long-term growth and survival is assured. Long-term growth and survival depends on how far the firms could raise much needed capital from its investors to sustain intangible asset creation and how far they could use the intangible assets to generate future revenues and profits. This is because,

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creating intellectual assets and eventually using them to earn much needed revenues and profits takes time, sometimes several years. During this long-gestation period, venture capitalists and other investors must continue to have confidence in the managers of these firms and in their ability to create and obtain value from the intangible assets for several more years (Booth, 1998). Therefore, the ultimate proof of the value of intellectual assets would be shown by fundamental performance indicators such as revenues, net income and return on equity. If, such value is not forthcoming, investors will run out of patience and would no longer supply much needed capital, leading to the demise of a technology firm.

The recent history of dot com firms, provide ample evidence of the interrelationship between intangible asset value and fundamental financial performance. Many of the dot com firms were started by young entrepreneurs. (Subramani and Walden, 1999; Yoffie and Cusumano, 1999) and the products that they offered were mostly intangible in nature – information processing, software development, and services that depended mostly on knowledge and skills. These young entrepreneurs were technically savvy, but lacked business experience or strategic focus. Since venture capitalist trusted these entrepreneurs and their innovative ideas, they were willing to support them by giving them much-needed capital and expected them develop and implement a good business model.

But, the entrepreneurs failed to meet the expectations of the venture capitals or the customers who expected a product or service that they required (*Business Week*, 2003). Consequently, customers began to leave them and this hurt revenue generation. The trouble with revenue generation was exacerbated further by wasteful expenditures that these firms were making on items such marketing, well-furnished offices and expensive consultants (Weil, 2001). The burn rate, the rate at which they were spending cash relative to the inflow from revenues, raised the odds of failure even higher. For example, Boo.com, the London-based seasonal clothing firm, was spending 23 million per month of its cash without earning commensurate revenues or cash inflows (Lorek, 2000). Eventually, the venture capitalists and the rest of the capital markets lost their confidence in these firms and withdrew capital support leading to the failure of many of these firms. The lesson: unless the intangible assets created by a firm truly generate value and unless such value is reflected through financial performance, failure is a high probability.

The illustration of dot com failures raises two important questions:

(1) Does asset composition of a firm – greater proportion of intangible assets than physical assets in the asset portfolio or vice versa – improve financial health signals? In other words, are intangible asset values significant indicators of financial health more so than other financial indicators when evaluating firms with sizeable intangible assets in their portfolios? Or

(2) Is the relevance of asset composition more a function of how effectively these assets are managed – that is, their contribution to long-term financial performance?

To find answer to the first question – does asset composition make a difference – the study compares two sets of firms – firms that own more intangible assets to firms that own more physical or traditional assets, and reports the improvement in financial health signals when intangible asset values are included. Since there is no requirement to report intangible assets in the published financial statement, the study uses

surrogate values for intangible and other intellectual assets (e.g. market capitalization and market return on assets). To find answer to the second question, is the relevance of any asset, tangible or intangible, a function of how effectively they are used, this study examines the signals provided by fundamental financial information on its own without including asset surrogates when evaluating financial health.

The study uses two distinctive samples: a sample of traditional firms with greater proportion of their assets in physical assets and a sample of technology service firms that predominantly rely on the strength of their intangible assets. Each distinctive sample includes two sets of firms: firms that filed for bankruptcy and firms that continued to function as healthy institutions. Data on financial ratios and intangible asset surrogates are included for each firm in the two distinctive samples.

The results of this study would contribute to enhancing our understanding of the importance of intangible assets and how far information about such assets improves financial health signals. The study would also point to the relevance of fundamental financial indicators in the new business environment where firms rely more and more on knowledge assets. The study would highlight the importance of fundamental financial performance and why managers should continue to bestow greater attention to such fundamental factors for long-term survival and growth. To investors, the study would point out that they need not be taken by surprise when firms fail, and if they do their homework in advance, they could avoid another dot come surprise.

Asset composition – relevance to financial health evaluation

Technology firms differ from traditional firms both in their internal and external environments. Unlike traditional manufacturing or retail firms, technology firms may not offer tangible products for sale. Compared to traditional firms, technology firms are relatively younger and would not have a long history of management. On the average, technology firms own relatively fewer physical assets than their traditional manufacturing counterparts. They derive future economic benefits primarily from the strength of their intangible assets – patents, research and development, human resources, or knowledge-bases. Since these intangible assets take long time to develop, their ability to contribute to the bottom line profits of a technology firm would also take a long time. Consequently, in the initial years of a technology firm, the earnings, profitability, or return on assets would be low and using these indicators to assess their financial strength is likely to lead to misleading conclusions. A primary assessment of a technology firm's strength could be derived only from the value of the intangible assets that it owns. However, such values are rarely reported in published financial statements.

The principal reason that published financial statements do not report intangible asset values is because, measuring the value of these assets is subjective and is prone to measurement errors (Lous and Sougiannias, 1996; Gaum *et al.*, 2000; Taylor, 2001; Upton, 2001; Lev, 2001). Intangible assets do not fit the definition of an "accounting asset" and reporting their monetary worth is likely to provide unreliable information to investors. But, regardless of whether such values are reported in published financial statements or not, investors do seem to consider the strength of these assets when making investment decisions. They infer the value of the intangible assets owned by a firm by observing the data on market capitalization of a firm's stock (Barron *et al.*,

2002; Kothari *et al.*, 2002; Reilly, 2002). For example, a few years ago, when Dell Corp. implemented a well-working supply chain system, the markets recognized the intangible value of the supply chain to Dell by making adjustments to the market value of Dell's stocks (Schwartz, 2000).

Analysts and others caution that market capitalization of a firm's stock is not a true reflection of a firm's intangible asset values and investors must use prudence while using such subjective values (Gu and Lev, 2005). While conceding that market capitalization is subjective and must be used with caution, we must acknowledge that it nevertheless helps a technology firm with high-market capitalization to obtain much needed equity from the market (Reilly, 2002; Raghunanandan and Subramanyam, 2003; Trueman *et al.*, 2003). We must also recognize that while high-market capitalization may help a firm with raising equity, market capitalization data may not necessarily be a reflection of the long-term financial stability of a firm.

Long-term financial stability depends not only on the ability to raise equity but also on the ability to effectively and efficiently manage a firm's assets – tangible as well as intangible assets. Therefore, the long-run value of any asset, whether it is tangible or intangible would depend on an asset's ability to provide future benefits and its ability to influence future financial performance. To most investors, evidence of future benefits and performance are indicated by growth in revenues, profits, and repayment of debts. Currently, investors can find such performance indicators only by analyzing the data reported in published financial statements.

The premise of this discussion is that, while a market's perception of intangible assets is relevant for short-term pricing of a stock; it should not be used to evaluate long-term financial health (Reilly, 2002; Raghunanandan and Subramanyam, 2003; Trueman *et al.*, 2003). While perception gained from market capitalization of a stock could be used to supplement the assessment of long-term financial health, the primary data for such evaluation should come from fundamental financial indicators culled from published financial statements. Therefore, this study uses a financial distress model that uses fundamental financial indicators supported by surrogates for intangible assets owned by a firm to assess financial health of a firm. The study also examines a secondary question: whether such intangible asset surrogates are more relevant when examining a firm with significant intangible assets in its portfolio than when evaluating a firm with greater proportion of its assets in tangible, physical assets. The study expects to contribute by highlighting the relevance of both publicly available information and subjectively-measured asset values when evaluating financial health.

Understanding firm failure – financial distress models

While there is no consensus on the relationship between financial performance and health, there is agreement that business failure causes losses to creditors and stockholders (Deakin, 1972; Opler and Titman, 1994). Since investors mostly rely on accounting disclosures to assess financial health (Opler and Titman, 1994), researchers have been using published accounting data when building financial distress models (Beaver, 1966; Altman, 1968; Altman *et al.*, 1977; Zmijewski, 1984; Ohlson, 1980; Casey and Bartczak, 1985; Dopuch *et al.*, 1987; Jones, 1987; Gentry *et al.*, 1985; Teresa, 1993; Etheridge *et al.*, 2000). Published accounting data is also useful because it is measured objectively and it evolves from acceptable and recognized accounting practices

(Dopuch *et al.*, 1987; Koh and Killough, 1990; Chen and Church, 1992). An advantage of using financial ratios is that they surrogate for important attributes of a firm's financial condition such as liquidity, solvency, or profitability.

In the past, almost all the bankruptcy studies used only traditional manufacturing firms as their sample subjects. The benefit of using such a sample is that these firms were from established industries with traditional business models. Consequently, using performance measures such as current ratio, debt to equity ratio, return on assets and other ratios that surrogate for liquidity, solvency, or profitability made sense and the ratios provided reliable signals of financial health. But, whether such ratios are also appropriate when evaluating a technology firm that mostly offers services and whose assets are primarily intangible assets in nature, is not evident. The products and services offered by a technology firm requires heavy customization and years of development before the products and services generate viable revenues. In this scenario, using only traditional parameters such as revenues and profits reflecting past performance and ignoring future potential is unlikely to reveal the complete financial status of technology firms.

The principal reason why prior studies used financial ratios to evaluate financial strength is because, such ratios pointed out whether:

- a firm has a feasible business model; and
- the model is helping the firm in earning adequate revenues and profits.

A workable business model is essential whether a firm offers products or services or whether it owns physical assets or intangible assets. But, in the case of non-traditional technology firms with short histories, the existence of a business model may not be supported by indicators such as revenues or profits. Therefore, it becomes essential to augment the short-term performance indicators with longer term indicators of strength. For example, indicators such as market capitalization and market returns, although short-term, are derived based on long-term expectations of strength. They point to how upbeat a market is about a firm's future earnings potential. Therefore, when evaluating firms with significant intangible assets, it is essential that we consider both publicly reported past performance data and subjective perceptions of future earnings potential and strength.

This study, therefore, uses two financial health models: a traditional financial health model designed by Altman *et al.* (1977) and a hybrid model constructed by the author of this study, which includes both past performance indicators and subjective values of intangible assets to indicate future potential. The Altman model was designed years ago and applied to manufacturing firms with traditional assets in their portfolio. The predictor variables only included financial ratios of past performance and was tested and validated on traditional manufacturing firms. The hybrid model constructed for the purpose of this study includes not only the variables from the Altman model but also two additional variables that surrogate for intangible asset values – excess of market capitalization over book value of assets and market return on assets.

The Altman and hybrid models would be tested on samples of both traditional manufacturing firms and technology service firms that represent firms with different asset compositions. The statistical methodology used for the analysis is Logit analysis. Traditionally, financial distress models have been evaluated using statistical techniques such as Logit or multiple discriminant analysis (MDA).

These techniques are founded on mathematical concepts and are usually robust in their performances. The dependent variable would be bankrupt (coded 1) or healthy (coded 0). The two models used in this study are briefly discussed in the following paragraphs.

Altman model

One of the earliest and most popular bankruptcy prediction models was developed by Altman *et al.* (1977). Altman *et al.* (1977) identified five financial ratios (out of a group of 22 financial ratios) as important predictors of bankruptcy. The ratios were: working capital/total assets; retained earnings/total assets; earnings before interest and taxes/total assets; market value of equity/book value of total debt; sales/total assets.

Altman *et al.* used MDA as the methodology to test a matched pair sample of healthy and failed manufacturing firms. From their results, they developed a measure called the *Z*-score. The *Z*-score is a cut off measure that separates healthy firms from failing firms. On the average, firms with *Z*-scores 2.99 or above were generally healthy while firms with *Z*-scores below 1.81 were in the failed category. If a firm's *Z*-score fell between 1.89 and 2.99, a grey area, it was considered difficult to predict the financial health.

The hybrid model

While several studies found the Altman *et al.* model to be a good predictor of financial health, a few years ago, Shumway (2001) wrote that Altman model could be improved further by using market-based information. Shumway (2001) stated that unless financial variables are used along with market-based information, they are not likely to provide useful signals of financial health. Shumway's view is also supported by other studies. For example, Raghunanandan and Subramanyam (2003) report that firms that received a going-concern audit opinion to generally have lower market values, lower stock returns, and higher volatility. While Shumway's argument that stock prices provide additional information about the future prospects of a firm appears valid, the issue has received only limited attention in financial distress studies (Beaver, 1966; Shumway, 2001).

To observe whether concurrently using fundamental financial information along with market-based information improves future financial health, the hybrid model study includes all of the variables used in Altman (1968) study, and also two additional market variables – excess of market capitalization over book value of assets (intangible) and market Return to represent market's perception of future prospects.

The hybrid model will be constructed as follows:

$$\text{BANKRUPTCY} = \beta_0 + \beta_1 \frac{\text{WC}}{\text{TA}} + \beta_2 \frac{\text{RE}}{\text{TA}} + \beta_3 \frac{\text{EBIT}}{\text{TA}} + \beta_4 \frac{\text{SALES}}{\text{TA}} + \beta_5 \frac{\text{TL}}{\text{TA}} + \beta_6(\text{RETURN}) + \beta_7(\text{INTANGIBLE}) + \varepsilon$$

where: Loss – net losses; WC – working capital/total assets; RE – retained earnings/total assets; EBIT – earnings before income and taxes/total assets; SALES – sales/total assets. The two market variables used are, MVE – natural log of the market value of equity; Sales and Return – stock return over the prior 12 months.

The two models will be tested using two distinctive samples: a matched pair sample of healthy and bankrupt traditional firms and a matched pair sample of healthy and bankrupt technology firms. Using two distinctive samples would help answer the following questions:

(1) How far a financial ratio model developed decades ago and tested on traditional firms is relevant when used on firms with non-traditional assets?

(2) Does including surrogates for intangible asset values (the hybrid model) improve financial health evaluation and does the surrogate variables provide additional and meaningful signals of financial health specifically in the cases of firms with significant intangible asset holdings?

The data

The data for the study were collected from Bankruptcy Almanacs. Using 1999-2003 Almanacs, the bankrupt firms were identified. A bankrupt firm was included in the final sample only if data were available for all three years prior to the year of bankruptcy. Firms with missing data or firms that had merged with another firm or had otherwise changed their names were excluded from the sample. Applying these criteria, 457 bankrupt firms were selected. The sample was divided into two groups: bankrupt firms from the high-technology sectors and bankrupt firms from the traditional sectors. Using the Francis and Schipper (1999) study's approach, a firm was identified as belonging to the technology sector with high-intangible assets if it is three-digit SIC code belonged to one of the following: 357, 504, or 7371-7379.

The firms listed under these SIC codes were mostly software and computer service firms that depended on fewer physical assets compared to their manufacturing counterparts. The firms that did not belong to these SIC codes, by default, were treated as traditional firms. Each bankrupt firm was matched with a healthy firm using the bankrupt firm's three-digit SIC code and revenue size or asset size. As reported in Table I, this provided a sample of 134 bankrupt high-technology firms and 323 bankrupt traditional firms for a total of 457 bankrupt firms and a matching sample of 134 high-technology firms and 323 traditional firms for a total of 457 healthy firms and a combined sample of 914 firms.

Results

Table II shows the asset size comparison for the firms[1]. When compared to traditional firms, technology firms owned fewer physical assets and owned more

Type of firm	Sample of Firms		
	Bankrupt	Healthy	Total
Technology firms	134	134	268
Traditional firms	323	323	646
Total	457	457	914

Note: Each bankrupt firm was matched with a financially healthy firm by SIC code, and revenue or, asset size and financial statement ending period

Table I.
Sample of firms

intangible assets. Table III provides descriptive statistics for the variables used in this study. The working capital ratio reflecting short-term liquidity was generally low for technology firms than for traditional firms. This could be because technology firms have higher burn rates and require longer product development time, during when a technology firm may be spending more on short-term expenses such as salaries and office maintenance without commensurate revenue generation. In contrast, most healthy traditional firms had positive working capital ratios while bankrupt traditional firms reported negative working capital.

Some of the other ratios that were noteworthy included: earnings-related ratios such as retained earnings and earnings before income and taxes and long-term capital ratio such as market value of equity to long-term debt. The earnings ratios were negative for both bankrupt technology and traditional firms pointing to the importance of earnings for continued survival. The capital ratio, market value of equity to debt was significantly different between technology and traditional firms showing that technology firms with fewer physical assets also have lesser need for significant debt.

Table II.
Asset size comparison

Asset Size	Physical assets owned (in millions) Tech firms	Physical assets owned (in millions) Traditional firms	Intangible assets owned (in millions) Tech firms	Intangible assets owned (in millions) Traditional firms
1999	355.02	476.11	734.43	240.66
2000	404.21	643.05	446.24	220.47
2001	512.34	1,171.29	836.03	445.94
Mean	423.86	763.48	672.23	302.36

Table III.
Descriptive statistics – healthy (bankrupt) firms

Variable	Firm	Mean	Median	Standard deviation
Working capital/total assets (WC/TA)	HT	0.190 (0.057)	0.286 (0.127)	1.555 (0.691)
	TR	0.270 (−0.233)	0.281 (0.078)	0.241 (3.157)
Retained earnings/total assets (RE/TA)	HT	1.464 (−1.231)	0.015 (−0.567)	19.00 (3.715)
	TR	0.193 (−1.375)	0.215 (−0.139)	0.400 (9.628)
Earnings before income and taxes/total assets (EBIT/TA)	HT	−0.145 (−0.473)	0.072 (−0.163)	2.382 (1.658)
	TR	0.089 (−0.258)	0.088 (−0.020)	0.104 (3.868)
MR (Average market return during last three years)	HT	2.927 (2.370)	1.257 (0.772)	8.208 (4.657)
	TR	1.232 (0.548)	0.893 (0.284)	1.206 (0.758)
Sales/total assets (S/TA)	HT	0.958 (0.761)	0.803 (0.490)	0.747 (0.857)
	TR	1.181 (1.707)	0.960 (1.096)	0.936 (4.655)
Total liabilities/total assets (TL/TA)	HT	0.858 (0.775)	0.371 (0.722)	6.954 (0.689)
	TR	0.433 (1.087)	0.397 (0.781)	0.285 (2.852)
Intangibles (excess of market capitalization over book value of assets)	HT	4.846 (3.924)	4.786 (4.217)	2.172 (2.829)
	TR	1.659 (1.735)	1.815 (1.993)	1.905 (1.395)

Notes: HT – technology firms; TR – traditional firms

Results for the Altman's model

One of the objectives of this study is test whether a financial health model designed years ago (the Altman's model) with only fundamental financial indicators and tested and validated on traditional firms owning only physical assets is appropriate when evaluating financial health of firms that predominantly derive strength from their intangible assets and that sell services instead of tangible products. This study, therefore, first used the Altman model on both traditional manufacturing firms and non-traditional technology firms. Later, the indicators that signaled financial health were compared to ascertain the adequacy of the Altman model when evaluating firms with different asset compositions.

Table IV reports the results for the Altman's model. In the case of traditional firms, the variables that were significant in signaling financial health (one year prior to bankruptcy) were: the working capital ratio, retained earnings ratio, and earnings ratio. For technology service firms, only the working capital and earnings ratios were significant and that too, only for two years and one year prior to actual failure. These results are somewhat similar to the results obtained by Altman (1968). However, two variables that Altman *et al.* reported as significant predictors of financial health: market value of equity to debt and sales were not significant for either traditional or technology firms. The results support the view that regardless of asset composition, fundamental performance indicators such as working capital (short-term liquidity) and earnings (growth and performance) to play an important role in indicating financial health.

Table V reports the predictive accuracy of Altman's model. The model's prediction rate was reasonably similar for both traditional and technology firms. The model, one year prior to actual failure, was able to predict 78 per cent of bankrupt traditional firms and 74 per cent of failed technology service firms and 79 per cent of the healthy traditional firms and 83 per cent of healthy technology firms. The prediction results were reasonably similar to prior bankruptcy studies. However, three years prior to bankruptcy, the Altman model was more accurate in predicting traditional firms than in predicting technology firms. In the case of technology firms, three years prior to bankruptcy, the Altman model was successful in identifying only 58 per cent of the bankrupt firms and 43 per cent of the healthy firms.

Results for the hazard model

The hybrid model, unlike the Altman's model, included variables that reflected the value of intangible assets owned by a firm. The hybrid model is useful in testing the improvement in prediction when a model also included surrogate variables of intangible asset value and to note whether there were differences among firms with different asset compositions.

The results for the hazard model are reported in Table VI. The hazard model includes two surrogates for intangible assets – market return and excess of market capitalization over book value of equity. The results show that for both traditional and technology firms, the significant variables were: working capital, earnings before income and taxes, and liabilities to total assets and intangible assets. As expected, one of the intangible variables, excess of market capitalization over book value of assets, was significant for all three years and when predicting financial health of technology firms. This variable was not significant when predicting a traditional firm's

Table IV.
Identifying bankrupt firms – model results

Variable	Traditional firms			Technology firms		
	One year before bankruptcy χ^2 (Sig.)	Two years before bankruptcy χ^2 (Sig.)	Three years before bankruptcy χ^2 (Sig.)	One year before bankruptcy χ^2 (Sig.)	Two years before bankruptcy χ^2 (Sig.)	Three years before bankruptcy χ^2 (Sig.)
Altman's model – variable significance						
Working capital/total assets (WC/TA)	−2.68 (0.00)	−1.53 (0.00)	−2.68 (0.00)	−3.02 (0.00)	−1.76 (0.01)	0.08 (0.73)
Retained earnings/total assets (RE/TA)	3.37 (0.00)	2.34 (0.00)	2.83 (0.00)	0.72 (0.34)	0.94 (0.28)	0.67 (0.38)
Earnings before income and taxes/total assets (EBIT/TA)	−5.43 (0.00)	−5.61 (0.00)	−5.45 (0.00)	−4.11 (0.00)	5.26 (0.00)	−0.10 (0.52)
Market value of equity/book value of debt (MVE/BTD)	−0.96 (0.12)	−0.47 (0.24)	−0.99 (0.14)	−0.18 (0.44)	−0.03 (0.46)	−0.02 (0.39)
Sales/total assets (SALES/TA)	−0.06 (0.53)	−0.15 (0.42)	−0.10 (0.42)	−0.13 (0.57)	−0.16 (0.38)	−0.11 (0.43)

		Prediction accuracy traditional firms Predicted			Prediction accuracy technology firms Predicted	
	Actual	Bankrupt (per cent)	Healthy (per cent)	Actual	Bankrupt (per cent)	Healthy (per cent)
Altman model's – predictive accuracy						
One year before bankruptcy	Bankrupt	77.71	21.05	Bankrupt	73.88	17.16
	Healthy	22.29	78.95	Healthy	26.12	82.84
Two years before bankruptcy	Bankrupt	73.99	28.17	Bankrupt	69.40	15.67
	Healthy	26.01	71.83	Healthy	30.60	84.33
Three years before bankruptcy	Bankrupt	78.64	20.12	Bankrupt	58.21	57.46
	Healthy	21.36	79.88	Healthy	41.79	42.54

Table V. Identifying bankrupt firms – model results

financial health. The second surrogate for intangible values, market return, was not significant either for technology or for traditional firms. While, like the Altman's model, the hazard model also pointed to the importance of fundamental performance variables, it also highlighted the importance of an intangible variable when a firm primarily derived strength from its intangible assets.

Table VII reports the predictive accuracy of the Hazard model. One year prior to bankruptcy, the model's prediction rate was reasonably similar for both traditional and technology firms. The model was able to correctly predict 82 per cent of bankrupt traditional firms and technology service firms and 86 per cent of the healthy traditional and technology firms. However, two years prior to bankruptcy, unlike the Altman's model, the hazard model was somewhat more accurate in predictive ability. It was able to predict 85 per cent of bankrupt firms accurately. This supports the view that a model that includes intangible asset values would send stronger signals of health in the case of firms that own significantly greater amount of intangible assets.

Conclusions

The purpose of this study is observing how far traditional financial health models designed to evaluate manufacturing firms with traditional physical assets is capable of signaling financial health of non-traditional technology firms that own more intangible assets than physical assets. This issue is important because technology firms take longer to develop the intangible assets and even longer to earn revenues, profits, and provide adequate return to its stockholders. As such, using financial health models and business models that were more appropriate to evaluate traditional firms may or may not be appropriate when evaluating technology firms.

This study argued that, while considering the value of intangible assets, we must also bear in mind that the eventual value of such assets would be reflected through their contribution to revenue generation, profitability, and future earnings potential. As such, financial health models must include not only subjective variables that reflect the value of intangible assets but also objectively measured and reported fundamental financial variables that point to the assets' performance.

Table VI.
Hazard model

Variable	Traditional firms			Technology firms		
	One year before bankruptcy χ^2 (Sig.)	Two years before bankruptcy χ^2 (Sig.)	Three years before bankruptcy χ^2 (Sig.)	One year before bankruptcy χ^2 (Sig.)	Two years before bankruptcy χ^2 (Sig.)	Three years before bankruptcy χ^2 (Sig.)
Working capital/total assets (WC/TA)	−4.91 (0.00)	−16.97 (0.00)	−7.15 (0.00)	−8.01 (0.00)	−3.32 (0.00)	−3.57 (0.05)
Retained earnings/total assets (RE/TA)	1.37 (0.28)	2.34 (0.03)	−2.83 (0.00)	5.43 (0.02)	2.89 (0.00)	1.12 (0.13)
Earnings before income and taxes/total assets (EBIT/TA)	4.33 (0.03)	−24.21 (0.00)	−14.24 (0.00)	−14.89 (0.00)	−2.56 (0.10)	0.03 (0.96)
Market value of equity/book value of debt (MVE/BTD)	−2.31 (0.12)	1.10 (0.29)	−2.77 (0.09)	0.90 (0.34)	0.13 (0.71)	−0.05 (0.82)
Sales/total assets (Sales/TA)	−2.98 (0.00)	−2.28 (0.08)	−2.65 (0.42)	−7.10 (0.00)	1.31 (0.25)	2.59 (0.10)
Market return (MR)	−0.87 (0.80)	−1.06 (0.68)	−0.10 (0.72)	−0.03 (0.86)	0.01 (0.98)	0.08 (0.77)
Excess of market capitalization over book value of assets (INTANGIBLE)	0.38 (0.28)	0.71 (0.83)	0.47 (0.81)	4.65 (0.03)	8.96 (0.00)	9.19 (0.00)

		Prediction accuracy traditional firms			Prediction accuracy technology firms	
		Predicted			Predicted	
	Actual	Bankrupt (per cent)	Healthy (per cent)	Actual	Bankrupt (per cent)	Healthy (per cent)
One-year before bankruptcy	Bankrupt	82.35	13.93	Bankrupt	82.60	18.75
	Healthy	17.65	86.07	Healthy	17.40	81.25
Two-years before bankruptcy	Bankrupt	75.85	21.98	Bankrupt	85.07	21.64
	Healthy	24.15	78.02	Healthy	14.93	78.36
Three-years before bankruptcy	Bankrupt	80.80	12.69	Bankrupt	81.10	64.93
	Healthy	19.19	87.31	Healthy	18.90	35.07

Table VII. Predictive accuracy of hazard model

To test these arguments, this study selected two distinctive financial health models – the Altman's model designed, tested, and validated over 40 years ago on traditional firms and a hybrid model developed for the purposes of this study and that included both fundamental variables and surrogates for intangible asset values. The two models were tested on two separate samples of traditional firms and non-traditional technology firms. The results highlighted the importance of using two different models when evaluating firms with distinctively different asset compositions and business models. The results pointed to the importance of using surrogate values for intangible assets, when evaluating firms with more intangible assets in their portfolio.

Specifically, the results showed that many of the fundamental financial variables reported by Altman *et al.* to continue to play an important role in predicting financial health, regardless of a firm's asset composition. The predictive accuracy was comparable to the prediction rates reported years ago in the Altman model. This supports the contention that objectively measured and published fundamental financial variables are very important when evaluating financial health and that regardless of asset composition or business model of a firm, the indicators of fundamental financial performance should not be ignored.

The hazard model also provided some interesting results. While the two surrogate variables for intangibles – market return and excess of market capitalization over book value of assets (intangible) – were not significant when predicting financial health of traditional firms, the intangible variable, market capitalization over book value of assets, was significant when predicting financial health of non-traditional technology firms. The results support the premise of this study that, when evaluating firms with greater proportion of intangible assets in their portfolio, it is essential to include information about intangible assets, even if such information is subjective and even if such information is not reported in published financial statements.

The study is cautious in pointing out that all firms, regardless of whether they are from the traditional or non-traditional sectors, must strive towards improving its fundamental financial performance and that proof of the value of intangible assets is eventually in "their contribution to fundamental financial strength". From the perspective of investors, considering both fundamental performance indicators and value of intangible assets would prevent them from being surprised about the true

performance and strength of technology firms and another dot com bust could be avoided.

The study and the results are subject to certain limitations. The intangible asset values used as surrogate variables represented only one approach to measuring intangible asset values. Prior studies also report other ways of measuring intangible assets and depending on how these assets are measured, the value may differ and consequently, the contribution of these variables. Regardless of how one measures intangible assets, at this time, they are subjective measures and as such, certain measurement error is likely to be present and could influence the results.

There are also other limitations. The technology firm sample included many dot com firms and these dot com firms could have failed because of a few additional reasons such as the inexperience of the young entrepreneurs, the sudden drying up of funds from venture capitalists and the economy itself. The study did not represent these factors in the hazard model. Also, the study did not include technology manufacturing firms that own both physical assets and intangible assets. A sample of such firms could lead to a different result than reported in this study.

Note

1. On the average, bankrupt firms were smaller by size (below the mean). This was true for both high technology firms and traditional firms.

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