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Market Valuation of Technology Stocks Before and After the Crash

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ABSTRACT

In this paper, we use the NASDAQ100 to test whether the crash in technology stock prices in 2000 represents a transition towards the use of recognized evaluation paradigms, including those that reflect growth options, for determining technology firm values. We find that recognized proxies for future cash flows are generally insignificant with almost no explanatory power for technology stock prices over the period 1994 to 1999. However, over the period 2000-2003, three traditional explanatory variables, book value of equity, sales growth and net income, are significant and the explanatory power of the model rises to 10%, thereby suggesting the crash reflects a move towards traditional evaluation criteria. A Chow test confirms that there was indeed a structural break in 2000. Importantly, and contrary to what we expected, the proxies for future growth options of the real options literature - research and development and advertising expenditures - are never significant at conventional levels.

JEL Classification: *G12, G13*

Keywords: Market valuation; Technology firms; Financial variables; Real options

I. INTRODUCTION

The explosion of technology stock prices in the latter half of the 1990s above and beyond the levels suggested by traditional evaluation techniques led analysts to question the relevance of traditional evaluation techniques for evaluating technology stocks[1]. According to some, the high market valuations commanded by technology stocks were the result of collective irrationality on the part of investors, and were not indicative of the underlying value of these firms[2]. According to others, using arguments based on real options pricing theory, these valuations were reasonable and the high prices were nothing more than recognition of the large growth potential of these firms[3].

The stock market crash of 2000 and the devastation it wreaked on the technology sector seem to have settled the issue with respect to the overvaluation. In this paper we build on the growing literature that shows that the technology stock prices of the late 1990s cannot be explained within the context of recognized evaluation criteria, including those that reflect growth options, which is evidence for the argument of new or as yet unknown evaluation criteria and/or of collective investor irrationality. We then ask whether the stock market crash was a simple price correction within the prevailing technology pricing paradigm of the late 1990s or whether it represents a fundamental change towards more conventional criteria in how technology stocks are evaluated by the market. The question is important. A simple price correction would suggest that technology stock prices are still being driven by collective irrationality at the worst or by forces that are completely unknown or at least imperfectly understood at best. A fundamental change towards more conventional criteria, including real options criteria, in how technology stocks are evaluated would suggest that the financial community is coming to grips with the technology sector and the challenges it holds for financial analysis.

To answer this question, we present a model of firm valuation that includes the recognized explanatory variables as well as proxy variables for growth options, which we apply to the stock prices of firms appearing on the NASDAQ100 index over the period 1994 to the end of 2003. The NASDAQ100 represents the 100 largest U.S. technology firms in terms of market capitalization. We find that conventional proxies for future cash flows included in the model are generally insignificant with almost no explanatory power over the period 1994 to 1999. However, over the period 2000-2003, three conventional explanatory variables, book value of equity, sales growth and net income, are significant and the explanatory power of the model rises to 10%, thereby suggesting a move toward traditional evaluation criteria. Importantly, and contrary to what we expected, the proxies for future growth options, research and development and advertising expenditures, are never significant at conventional levels. A Chow test confirms that there was indeed a structural break in 2000. This paper makes two contributions to the literature. First, we provide evidence that the crash of 2000 represents a fundamental change in the evaluation of technology firms towards criteria based on traditional financial analysis and, second, that the value of real growth options reflected in our proxy variables are not priced independently.

The rest of the paper is organized as follows. Section 2 outlines the model and describes the data. Section 3 reports the empirical results and section 4 concludes.

II. MODEL AND DATA

A. The Model

A large empirical literature has documented the ability of financial variables such as cash flows, income, book value and other balance sheet items to explain equity values (e.g. Collins et al. (1997), Dechow et al. (1999), Barth et al. (1998), Frankel and Lee (1998), and Lee et al. (1999))[4]. However, where technology stocks are concerned, the traditional relations between financial variables and equity values have been called into question. It seems that the nature of technology firms with losses one period after another, high growth, high expenses for intangible investments, etc., makes it especially complicated to apply traditional firm valuation methods. In this section, we test whether or not this is true. To determine the variables in our model, we build on Collins et al. (1997), Brown et al. (1999), Francis and Schipper (1999), and Core et al. (2001) that examine the value relevance of recognized variables, including those suggested by the real options literature.

Consistent with this empirical research, we model the market value of equity as a function of the book value of equity, current earnings and proxies for expected earnings growth. For current earnings we use net income before extraordinary items. Following Collins et al. (1997) and Hand (2000a), who have documented differences in the valuation of profits and loss, we separate earnings into positive and negative net income. Sales growth in the previous period is the proxy for short term expected earnings growth. Following Demers and Lev (2000) and Trueman et al. (2000), we include advertising expenditures as well as Research and Development (R&D) expenditures to capture expected growth in earnings due to growth options and investments in intangible assets.

To addresses potential problems with heteroscedasticity and the intertemporal stability of the model's coefficients and explanatory power, we follow Trueman et al. (2000) and Core et al. (2001) and deflate the model by the book value of equity. This also has the advantage of giving the earnings variables the interpretation of a return on book equity. Since young firms do not have sales data available from the previous year, we set sales growth equal to zero when data are missing and include a dummy variable equal to one if sales growth data is unavailable. The final model has the following form:

$$\frac{\text{MVE}}{\text{BVE}} = \beta_0 + \beta_1\left(\frac{1}{\text{BVE}}\right) + \beta_2\left(\frac{\text{Pos\_NI}}{\text{BVE}}\right) + \beta_3\left(\frac{\text{Neg\_NI}}{\text{BVE}}\right) + \beta_4\left(\frac{\text{RD}}{\text{BVE}}\right) + \beta_5\left(\frac{\text{ADVERT}}{\text{BVE}}\right) + \beta_6\left(\frac{\text{SALES\_gr}}{\text{BVE}}\right) + \beta_7(\text{Gr\_miss}) + \varepsilon \quad (1)$$

Where:

- MVE : Market Value of Equity
- BVE : Book Value of Equity
- Pos_NI : Net Income before extraordinary items if >0 ; zero otherwise
- Neg_NI : Net Income before extraordinary items if <0 ; zero otherwise
- RD : Research & Development Expenditures

- ADVERT: Advertising Expenditures
- SALES_gr : One year change in sales, if available; zero otherwise
- Gr_miss : Dummy variable equal to one if sales growth data is unavailable ; zero otherwise

Using a dependent variable scaled by book value of equity suggests that book value should enter the equation as an inverse. Given that the market to book equity ratio is highly correlated with Tobin's Q and the inverse relation between Tobin's Q and firm size (e.g. Core et al. 2001 and McConnell and Servaes 1990), we expect a positive coefficient for the inverse of BVE[5]. We also predict positive coefficients for net income and the growth variables.

B. The Data

Our initial sample covers the period 1994 to 2003 and consists of all those firms appearing on the NASDAQ100 index (the 100 largest U.S. technology market capitalizations) as of *31 October 2003*. Of the 100 firms originally listed on the NASDAQ100, 8 firms were excluded because we did not have access to the financial information necessary for our analysis. We did, however, include firms that were not quoted over the entire period of analysis. This results in a final full sample size of 805 firm-year observations between 1994 and 2003. There are 448 observations in the sub-period 1994-1999 and 357 observations in the sub-period 2000-2003.

The financial information was compiled directly from *http://www.morningstar.com.* Data were taken annually and variables measured at the end of fiscal year (31/12). Table 1 shows the annual number of firms and the descriptive statistics of the average financial data included in the analysis.

Table 1
Descriptive statistics for financial variables (in thousand $)

	Obs	*MVE*	*BVE*	*Pos_NI*	*Neg_NI*	*RD*	*ADVERT*	*SALES_Gr*
1994	51	3242.627	665.392	126.112	-5.486	74.231	267.760	275.162
1995	69	4216.638	756.968	153.075	-16.065	83.249	269.634	330.024
1996	76	5489.965	886.284	192.7724	-23.406	104.900	279.814	355.917
1997	77	7667.735	1050.140	259.54	-39.954	146.279	389.333	399.203
1998	86	11191.840	1248.729	268.731	-27.693	153.920	429.385	369.986
1999	89	22642.610	1845.128	357.537	-42.950	186.086	515.409	586.193
2000	89	26257.410	3121.792	553.0157	-85.248	263.511	649.307	888.624
2001	90	17303.460	3128.219	270.337	-933.650	290.870	747.744	181.467
2002	89	13328.290	3700.974	328.714	-321.248	297.382	742.985	47.150
2003	89	17235.460	4189.252	490.733	-66.687	308.787	832.255	506.180
Total Period	**805**							
	Mean	13734.240	2195.777	314.336	-172.161	201.422	536.121	401.552
	St. Dev.	42734.410	5789.416	1023.019	2081.902	583.606	980.143	1212.763
	Maximum	477758.400	61020	10535	0	4777	8625	7802.500
	Minimum	5.98	2.6	0	-9824.800	0	0	-9824.800

III. EMPIRICAL RESULTS

Tables 2, 3 and 4 summarize the results of the testing. Table 2 reports the estimated coefficients of the regression over the full sample period 1994-2003. We can see that although net income and sales are significant, the explanatory power of the model is very low (below 1.5%). The real option variables, RD/BVE and ADVERT/BVE, are not significant at any conventional level.

Table 2
Estimated coefficients for the total period 1994-2003 (805 observations)

	Intercept	$\frac{1}{BVE}$	$\frac{Pos\_NI}{BVE}$	$\frac{Neg\_NI}{BVE}$	$\frac{RD}{BVE}$	$\frac{ADVERT}{BVE}$	$\frac{SALES\_gr}{BVE}$	Gr_miss
Coefficients	4.157*	-7.500	17.669*	2.843*	2.055	1.205	1.576*	-1.623
t student	5.345	-0.245	4.655	2.726	0.642	0.988	2.174	-0.393
p-value	0.000	0.806	0.000	0.007	0.521	0.323	0.030	0.695

R-Squared value = 0.0037

*: denotes significance at the 5% level.

To determine whether there has been a fundamental change towards recognized criteria, we divide the total analysis period into two sub periods with a breakpoint corresponding to the year's crash occurrence (2000). The idea is to fit the equation separately for each sub period and see whether there are significant differences in the estimated equation.

In tables 3 and 4, we report the regression results for the two sub periods: from 1994 to 1999 and from 2000 to 2003. For the sub-period 1994-1999 the results reported in table 3 are no better than those of the whole sample period. Only net income is significant and the overall explanatory power of the model is less than 1%.

Table 3
Estimated coefficients of the regression for the sub period 1994-1999
(448 observations)

	Intercept	$\frac{1}{BVE}$	$\frac{Pos\_NI}{BVE}$	$\frac{Neg\_NI}{BVE}$	$\frac{RD}{BVE}$	$\frac{ADVERT}{BVE}$	$\frac{SALESgr}{BVE}$	*Gr _ miss*
Coefficients	4.321*	-55.634	21.910*	3.106	5.305	2.702	-0.716	-1.240
t student	3.459	-1.467	4.190	1.638	1.301	1.459	-0.779	-0.307
p-value	0.001	0.143	0.000	0.102	0.194	0.145	0.436	0.759

R-Squared value =0.0048

*: denotes significance at the 5% level.

Table 4
Estimated coefficients of the regression for the sub period 2000-2003
(357 observations)

	Intercept	$\frac{1}{BVE}$	$\frac{Pos\_NI}{BVE}$	$\frac{Neg\_NI}{BVE}$	$\frac{RD}{BVE}$	$\frac{ADVERT}{BVE}$	$\frac{SALES\_gr}{BVE}$	*Gr _ miss*
Coefficients	0.949	32.718*	20.008*	0.480	-10.276	-1.938	3.106*	-
t student	0.780	5.484	3.954	0.418	-1.361	-0.951	2.864	-
p-value	0.436	0.000	0.000	0.677	0.175	0.343	0.005	-
R-Squared value = 0.0998								

*: denotes significance at the 5% level.

The results for sub-period 2000-2003 are much better and suggest that traditional explanatory variables are playing a role in the valuation process. The three traditional variables, 1/BVE, Pos_NI/BVE and SALES_gr/BVE, have the expected sign and are highly significant, and the explanatory power of the model rises to 10%. Interestingly, the proxies for future growth options - research and development and advertising expenditures – have the wrong sign and are still not significant at conventional levels.

A comparison of the coefficients from the two sub-periods shows that most of them differ in magnitude and/or sign. The coefficients of 1/BVE, RD/BVE, and SALES_gr/BVE differ in both magnitude and sign. The coefficients for NEG_NI/BVE differ in magnitude and the coefficients for ADVERT/BVE differ in sign. Only the coefficients for Pos_NI/BVE are similar in both magnitude and sign. A Chow test gives a value of 7.79 and a p-value of 0.0000, which is strong evidence for a structural break in 2000. Thus, we conclude that the crash of 2000 represents a fundamental change in the evaluation of technology firms towards criteria based on traditional financial analysis.

IV. CONCLUSION

In this paper we build on the growing literature that shows that the technology stock prices of the late 1990s cannot be explained within the context of conventional models of financial analysis, including those that reflect growth options. The absence of a relationship is evidence for the argument of collective investor irrationality. However, we also show that the technology crash of 2000 represents a transition towards the use of recognized evaluation paradigms for determining technology firm values. Over the period 1994-1999, we find that recognized proxies for future cash flows are generally insignificant with almost no explanatory power for technology stock prices. However, over the period 2000-2003, the three traditional explanatory variables, book value of equity, sales growth and net income, are significant and the explanatory power of the model rises to 10%, which suggests the crash reflects a move towards traditional evaluation criteria.

A Chow test confirms that there was indeed a structural break in 2000. We find, however, no support for the real options approach to technology stock valuation. The proxies for future growth options of the real options literature - research and development and advertising expenditures - are never significant at conventional levels.

ENDNOTES

1. In contrast to other studies of new economy's equity valuation such as Hand (2000a, b), Trueman and al. (2000a, b), Martinez and Clemente (2002), our analysis does not focus exclusively on Internet related firms, and considers a larger broad sample of firms representing highly innovative industries.
2. The *Wall Street Journal* 12/27/99 says that the pricing of Net stocks is "a chaotic mishmash defying any rules of valuation". See also, Bagnoli et al. (2001), Damodoran (2000), Cooper et al. (1999) and Wysocki (1999 a, b).
3. See for example, Stern and al. (2000); Barneto (2001) and Chérif (2001). For applications of this methodology see Willner (1995), Schwartz and Zozaya-Gorostiza (2000), Schwartz and Moon (2000; 2001), Schwartz (2002), and Maya (2004).
4. Variables such as these are also suggested in the theoretical models. See for example, Ohlson (1995) and Feltham and Ohlson (1995).
5. If we consider the unscaled version of our model as an empirical application of the Ohlson (1995) model with an intercept, the coefficient β_0 can be interpreted as the coefficient on book value in an undeflated equation and the inverse of book value, (1/BVE), is a control variable for firm size.

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