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R&D, Valuation and Non-Debt Tax Shields: Australian Evidence

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Despite high returns, it is commonly believed firms under-invest in R&D activity. Many governments subsidise R&D. The Australian government provides a Non-Debt Tax Shield (NDTS) to firms that undertake R&D. This paper makes three contributions to the literature. First a selectivity corrected model to estimate the value of R&D expenditure is developed. Second, the relationship between NDTS and capital structure in the presence of R&D is explored. Finally the value of the NDTS induced financial flexibility is estimated. While the R&D effect on NDTS appears to be small, it has a large effect on the value of firms undertaking R&D.

Keywords: R&D, Valuation, Non-debt tax shields

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1. Introduction

There is a broad consensus in the literature that R&D activity adds value. Many of the studies that confirm this view are event–study oriented (see for example, Chan, Martin and Kensinger (1990) and Eberhart, Maxwell and Siddique (2004)). Other studies, such as Chan, Lakonishok and Sougiannis (2001), evaluate whether R&D is related to stock returns using asset–pricing theory. Finally some studies, such as Griliches (1981), Hall (1993), Bosworth and Rogers (2001), Chung, Wright and Kedia (2003) and Hall and Orani (2003), employ cross section techniques relating R&D to various measures of market value.

Despite the positive relationship between R&D expenditure and firm value, it is commonly believed that firms underinvest in R&D. This is said to be due to the unique characteristics of R&D, it is long term in nature, high risk in terms of the probability of failure, unpredictable in outcome, labour intensive and idiosyncratic (Holmstrom 1989). Standard economic theory also indicates that R&D has positive externalities associated with it. Under these circumstances firms may undertake privately optimal levels of R&D but still underinvest from a public perspective. The standard solution to this problem would be some form of government subsidy. Many governments do subsidise R&D activity. In Australia that subsidy takes the form of a non-debt tax shield. Firms can earn a 125 percent deduction on some types of R&D expenditure. In some instances that deduction may rise to 175 percent.

To date studies investigating the impact of R&D and tax concessions, at the individual firm level, have not been extensively undertaken. To the best of our knowledge, only three recent Australian studies focus on determinants and valuation of R&D, Rogers (1998, 2002) and Bosworth and Rogers (2001). Bosworth and Rogers (2001) model the link between market value and R&D activity using a Tobin Q framework. While they find a positive relationship between R&D and market value they conclude that the private benefits from R&D are low in Australia. Specifically, they argue the returns to R&D may be low in Australia and/or Australian capital markets may not value R&D very highly. The first argument relates to potential (allocative) inefficiencies in the product market and the second argument relates to potential (informational) inefficiencies in capital markets.

This paper makes three contributions. First, we provide more recent evidence on R&D valuation in Australia than the Bosworth and Rogers paper that uses data from the mid-1990s. Second, we investigate the value of non-debt tax shields (NDTS) for firms undertaking R&D and those that do not. We report the relationship between NDTS and debt ratios to be different for the two types of firm. Finally we relate this relationship (between R&D and NDTS) back to firm value. The tax concession appears to provide some financial flexibility. This flexibility, however, does not appear to be highly valued in the market. The plan of the paper is as follows. In section two we describe our model, the data and present some results of descriptive statistics on R&D activity in Australia. In section three we estimate our model and present our results. Section four contains some concluding comments.

2. Model and Data

(i) Empirical Strategy.

We hypothesise that the relationship between firm value and R&D activity can be described as follows:

$$V_i = \mathbf{x}_i'\beta + \delta RD_i + u_i, \qquad (1)$$

where V_i is a measure of the value of firm i, x_i is a vector of firm characteristics and RD_i is a measure of R&D activity. The problem lies in correctly estimating δ, the coefficient that measures the impact of R&D on firm value. Firms do not undertake R&D activity at random; consequently there is a self-selection problem. The type of firm that undertakes R&D activity may be more valuable than those that do not in any event, or may be concentrated in more valuable industries. This self-selection will result in a biased estimate of δ (Greene 2000, pp. 933-934). We overcome this selectivity bias by employing a ‘treatment effects’ regression model (Wooldridge 2002). In this approach the valuation model is augmented with a second equation that captures determinants of R&D activity.

$$RD_i = \mathbf{z}_i'\gamma + v_i \qquad (2)$$

We employ two measures of R&D activity. First, we employ a binary variable that measures whether a firms reports R&D expenditure or not. In essence this is a measure of the propensity to undertake R&D. In this specification we estimate equation (2) as a Logit model. If the propensity to undertake R&D is defined as RD^*, then our first RD measure is defined as follows:

$$DRD_i = \begin{cases} 1 & \text{if } RD_i^* \geq 0 \\ 0 & \text{if } RD_i^* < 0 \end{cases}$$

As a robustness test, we also employ the fitted probabilities of undertaking R&D from the Logit estimation of equation (2). The results are qualititativily identical and not reported. Wooldridge (2002) shows that this gives a robust estimate of the treatment effect. As our second measure of R&D activity we employ the R&D expenditure to Sales ratio as a measure of R&D intensity. This estimation is performed by standard OLS techniques.

(ii) Operational Model.

Consistent with much of the recent finance literature we employ Tobin Q as a proxy for firm value (see for example LaPorta et al. (1999)). There are well-known difficulties in calculating Q and there is a large literature on how Tobin's Q should be proxied (see the discussion in DaDalt, Donaldson and Garner (2003)). Our proxy is

Q = (Market Capitalisation of Equity + Total Assets – Shareholder Funds)/Total Assets.

Tobin's Q may be related to variables such as capital structure choices (Debt to Asset ratio), profitability (return on assets - RoA) and size (log of Assets). Consequently we use these variables in the regression analysis as control variables. Gujarati (2003: 650) indicates that when N is large, T is small and cross-sectional units not randomly drawn from a larger population (i.e. data like ours), the fixed effects model is appropriate. When we include annual and industry dummies our model has fixed effects (see Wooldridge 2000: 445 - 446).[1] We then estimate the following equation,

$$Q_{it} = \alpha_0 + \alpha_1 \text{Log}(\text{Assets}_{it}) + \alpha_2 \text{RoA}_{it} + \alpha_3 \text{Debt-Assets}_{it} + \alpha_4 \text{RD}_{it} + \text{Industry Dummies} + \text{Annual Dummies} + \varepsilon \quad (3)$$

We are interested in the sign and magnitude of α_4 – the coefficient on RD. As indicated special care needs to be taken to ensure α_4 is not biased. We estimate equation (3) with two separate specifications of RD. We estimate forecast values of R&D intensity, proxied by R&D Expenditure to Sales (RD-Sales) and, we estimate

[1] It is important to note that Wooldridge (2000) indicates that the dummy variable estimation gives identical estimates of the coefficients and their standard errors.

whether a firm is an R&D firm or not using a latent variable approach. For comparative purposes we also estimate versions of equation (3) with actual RD-Sales data and a dummy variable equal to one if the firm reports any research and development expenditure in a given year and zero otherwise (DRD). These latter estimates are likely to be biased.

We estimate the determinants of RD using the following model:

$$RD_t = \alpha_0 + \alpha_1 TQ_{t-1} + \alpha_2 RoA_{t-1} + \alpha_3 RD_{t-1} + \alpha_4 Log(Assets_{t-1}) + \alpha_5 Log(Assets_{t-1})^2 + \text{Industry Dummies} + \text{Annual Dummies} + \varepsilon \quad (4)$$

RD is taken as RD-Sales and also DRD. In the DRD specification we have estimated a Logit model.

There are some econometric considerations that need discussion before we present our results. First, the use of a lagged dependant variable in equation (4) raises potential problems in testing for autocorrelation. As the Durbin-Watson test has different critical values to the standard tables in the presence of a lagged dependent variable (see Inder (1986)), we test for auto-correlation using the Breusch-Godfrey test. Second, outliers and influence points are identified by Cook's Distance. Cook's Distance follows the F-distribution with k + 1 and n – (k + 1) degrees of freedom. In the actual empirical analysis, the Cook's Distance measure identified very few significant influence points. All standardised residuals greater that 2.5 are removed from the reported equations as a further precaution against outliers and leverage points. All significant Cook's Distance observations, also had a standardised residual greater than 2.5.[2] We report for each equation how many outliers have been removed. Third, the estimated models do not appear to exhibit multicollinearity. Variance-inflation-factors are calculated for all regressions. With the exception of the quadratic term in equation (4) none of the variance inflation factors indicate any potential for multicollinearity. The quadratic term, however, is not a linear function of Log(Assets) and the standard no-multicollinearity assumption is not violated by non-linear relationships between independent variables (Gujarati 2003: 343). Finally, heteroskedasticity robust standard errors (see White (1980)) are calculated and the corresponding p-values reported for all equations.

(iii) Data.

Most research into R&D activity is undertaken using US or UK data. The data for these economies are easily available and, in particular, R&D activity is reported in the annual financial statements. R&D coverage for other economies, including Australia, is less comprehensive with voluntary disclosure being the norm. Hall and Oriani (2003), however, report that many (and even most) European firms voluntarily report their R&D activity. Australian firms are required to report 'material' R&D activity (AASB 1011), however, we have no means of establishing whether this actually occurs or not. The data on research and development activities of firms was sourced from the Intellectual Property Research Institute of Australia.[3] This database contains data on the amount of R&D expenditure, the numbers of patents, designs and trademarks, and the amount of revenue of firms over several years, 1996/97 to 2001/02. This source is the most comprehensive in Australia for R&D data and while some omissions may occur we are confident that little can be done to expand our R&D data. We assume that all firms that report R&D are the same set of firms that undertake R&D in Australia.

Firm specific, non–R&D data are collected from the Osiris (April 2004 release) database. Osiris is one of a suite of databases owned by Bureau van Dijk. We collect data for all Listed Australian firms (excluding financial firms) from 1996/97 – 2001/02. We were careful to include those firms that have been delisted over that period. We potentially have a maximum of 1376 firms per year and seven years worth of data. Missing data, and firms becoming delisted, however, reduces this sample size in any given year. Conversely, however, new firms add to our sample size. Summary statistics for the data we collect is shown in table 1.

TABLE ONE ABOUT HERE

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[2] Of course, this is true by construction. The Cook's Distance is calculated based on both the residuals and the leverage of each observation.

[3] This data are a continuation of the Melbourne Institute R&D and Intellectual Property Scorecard.

We separate our data into those firms that report R&D expenditure (R&D-firms) and those that do not (Non R&D-firms). The final two rows of table one show p-values from an F-test for equality of variances and p-values from a two-sided t-test (with unequal variances) for equality of means. We report that R&D-firms are more valuable, as measured by Tobin's Q, are larger and more profitable than Non R&D-firms. There is no statistical difference between the Debt-ratios of R&D-firms and Non R&D-firms.[4] Bah and Dumontier (2001) present evidence from Europe, Japan, the UK and US indicating that R&D-firms generally have lower debt levels than Non R&D-firms. This is consistent with the theoretical capital structure literature (Jensen and Meckling 1976, Myers 1977) that indicates that firms with more growth options and high monitoring costs would, ceteris paribus, have less debt. Consequently, the finding of equal debt levels is inconsistent with the international theoretical and empirical literature. We explore this finding in section 3.

3. Empirical Results

(i) Determinants and Valuation of R&D

We first estimate equation (4). Results are shown in table 2. The first column reports results from a Logit estimation while the second column reports results from a standard OLS estimation where the dependent variable is R&D to Sales (RD-Sales). Heteroskedasticity consistent p-values are reported. Despite the potential for serial correlation, the Breusch-Godfrey test fails to reject the null hypothesis of no serial correlation. Two significant leverage points were identified using Cook's Distance in the second equation, while many potential outliers with a standardised residual greater than 2.5 (absolute value) were deleted from the final analysis.

TABLE TWO ABOUT HERE

Overall the two models have reasonable explanatory power with R-squares in the order of seventy percent. A major determinant of R&D activity in any given year is R&D activity in the previous year. The coefficients on lagged R&D activity in both

[4] When looking at the median values of the debt-ratios it appears that R&D firms have a high debt level

model specifications are very large. To some extent this finding begs the question, we have found that those firms likely to undertake R&D are those firms that have undertaken R&D in the past. The other major determinant of R&D activity is size. Both size terms in each of the two equations are significant – indicating quadratic size effects. The turning points in each instance were calculated and reported in the final row of table 2. Each turning point is statistically plausible, falling within the data range. In terms of the logit specification larger firms are more likely to undertake R&D activity than smaller firms. The turning point, while statistically plausible, is not likely to be economically significant. Only seven firms are larger than the turning point size and of these seven, two undertake R&D activity. The second specification also shows a quadratic size effect that is both statistically and economically important. There are 124 firms larger than the size turning point with forty-three of them undertaking R&D expenditure. The results relating to value and profitability are mixed. The logit estimation indicates that more valuable firms (lagged Q) are likely to undertake R&D activity while indicating no relationship between R&D activity and profitability (lagged RoA). The second equation indicates no relationship between value and the amount of R&D undertaken. It does, however, indicate a negative relationship between profitability and the amount of R&D activity undertaken. This negative coefficient, however, is only on the cusp of significance (p = 0.0966).

The models estimated in table 2 are used to create forecast series of R&D activity (either a dummy variable DRD, or an estimate of RD-Sales). These series are subsequently employed to estimate equation (3) – reported in table 3 below.

TABLE THREE ABOUT HERE

The first and third columns in table 3 show our selectivity corrected estimations, while columns two and four show uncorrected versions of the model. Consistent with our initial expectations, the selectivity correction has a large impact on the results. When we define R&D activity as a dummy variable the selectivity corrected estimation gives a lower return to R&D activity than the uncorrected model. R&D firms are 16.74 percent more valuable than non-R&D firms. The uncorrected model

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than non-R&D firms.

estimates that R&D firms would be more than 30 percent more valuable than non-R&D firms. Results such as this may form part of the 'firms underinvest in R&D' view. If the 30 percent R&D premia is generally accepted as being correct the potential private returns to R&D are very high. If, however, the 16 percent figure is correct it is less surprising that not as many firms undertake R&D as might otherwise be expected.

Turning our attention to the third and fourth columns, we see the returns to firms actually undertaking R&D are quite high. Indeed they are nearly three times higher than the uncorrected model indicates. At sample means the selectivity model estimates a Q of 1.37, while the uncorrected model only predicts a Q of 0.47. The selectivity model provides a far more accurate estimate (average Q = 1.68) than the uncorrected model. We evaluate the economic significance of the RD-Sales term by substituting sample means into the equation and then adding (subtracting) one standard deviation for the RD-Sales. A one standard deviation increase in RD-Sales would increase the value of R&D firms by about twenty percent. Similarly, reducing RD-Sales to zero reduces the value of R&D firms by twenty-one percent.

Overall table 3 supports the use of a selectivity corrected model. The RD coefficients are very different when the selectivity correction is made. The difference between R&D firms and non-R&D firms is about seventeen percent, not thirty percent. When looking at those firms that undertake R&D activity the returns are higher than the uncorrected model would suggest.

How do our results compare from those of Bosworth and Rogers (2001)? They report that private returns to R&D activity are small. Our approach differs from theirs in some important ways. First we have a different specification of the underlying model. Their approach is based on Griliches (1981) and Hall (1993). We have relied on more recent valuation models developed in the finance literature. Second, we have a larger and longer sample of data. Importantly, we have employed a selectivity corrected model. In order to shed some light on this point we estimate a variation of the Bosworth and Rogers (2001).

$$\text{Log(MV)} = \alpha_0 + \alpha_1 \text{log(Total Assets)} + \alpha_2 \text{RD-Total Assets} + \varepsilon \qquad (5)$$

Where MV = sum of equity market capitalisation plus book value of debt, RD-Total Assets is the ratio of R&D expenditure to total Assets. Due to data constraints this specification is not identical to any of the models estimated in Bosworth and Rogers (2001), but is similar in spirit. Results are shown in table 4.

TABLE FOUR ABOUT HERE

The α_2-coefficient appears large. The equivalent coefficients from the Bosworth and Rogers (2001) paper range from 0.772 – 3.279. These coefficients are low when compared to the international literature.[5] When we undertake sensitivity analyses, however, it appears that the returns to R&D activity are small. For example, if we set RD-Total Assets equal to zero, the estimated value of the firm falls by only 3.6 percent. When we increase the average value of RD-Total Assets by one standard deviation the value of the firm increase by only 7.4 percent. While the Bosworth and Rogers (2001) coefficients are low compared to that estimated in table 4, our own version of the Bosworth and Rogers model also provides a low estimate of the value of R&D. In short, estimates of R&D valuation are sensitive to model specification.

(ii) R&D and non-debt tax shields.

The R&D tax concession creates a (non-debt) tax shield. The capital structure literature indicates that debt financing is valuable to firms due to the tax deductibility of interest payments. Firms, however, can shield income from tax liability via non-debt tax shields such as investment credits and tax concessions. Within the literature there is some disagreement about whether NDTS are a substitute (De Angelo and Masulis 1980) or a complement (Scott 1977) for debt in a firms capital structure. Do firms borrow and employ NDTS simultaneously? The consensus in the literature seems to be that debt and NDTS are substitutes (Titman and Wessels 1988). We investigate this issue for Australian firms undertaking R&D. The summary statistics indicated similar mean levels of debt for both types of firm, while the median values indicated higher debt levels for R&D firms. In principle, R&D firms have lower debt capacity, and consequently the NDTS may be very valuable as both a tax shield and a

[5] For comparison, see Bosworth and Rogers (2001: Table A1).

source of internal finance. We investigate this possibility by investigating the impact NDTS have on debt ratios.

In the literature NDTS are often proxied by R&D expenditure (to Assets or Sales). In our instance, we are trying to model the NDTS in relation to R&D expenditure, consequently we have to use another proxy. Following Titman and Wessels (1988) the non-debt tax shield can be estimated as:

$$\text{NDTS} = \text{OI} - \text{i} - \frac{\text{T}}{\tau}$$

where OI = profit before interest and taxation, i = interest expense , T = tax actually paid and τ = corporate tax rate. The average value of the NDTS (as a proportion of Total Assets) is –21.97 percent, with a standard deviation of 0.8926. A negative NDTS seems to indicate that Australian firms are paying too much in corporate tax. The discrepancy, however, is due to the difference between corporate financial accounting and tax accounting. Australian tax rules do not require congruence between financial accounting and tax accounting. A negative NDTS indicates that the firm has already exhausted any tax shields. Consistent with this view is the NDTS for R&D firms – it is –2.6 percent with a standard deviation of 0.175. Some readers, however, may be uncomfortable with the notion of a negative NDTS – consequently, we estimate two specifications of the models below. First, we estimate the models with all the data including positive and negative NDTS. Second, we re-estimate all the models with only positive values for the NDTS. We investigate the relationship between the Debt-Assets Ratio and the NDTSTA (NDTS as a proportion of total assets) by estimating the following regression:

$$\text{Debt Ratio}_i = \alpha_0 + \alpha_1\log(\text{Total Assets}_i) + \alpha_2\text{NDTSTA}_i + \alpha_3\text{NDTSTA}_i{*}\text{RD}_i + \varepsilon \quad (6)$$

Results are shown in table 5. The first two columns (Panel A) show results for the entire dataset, while the last two columns (Panel B) show results when NDTS are positive.

TABLE FIVE

Turning our attention first to Panel A, we observe the α_2-coefficient is negative in both versions of equation (6). This is consistent with the international literature that reports an inverse relationship between the use of debt in the firm's capital structure and NDTS. While the coefficient is statistically significant, economically it is small. We evaluate the economic significance of the NDTSTA term by substituting sample means into the equation and then adding (subtracting) one standard deviation for the NDTSTA term. Adding one standard deviation to the average value of the NDTSTA has a small impact on the estimate Debt Ratio (about two percent). In the first column of table 5 the α_3-coefficient is not statistically significant, while in the second column it is significant. Merely undertaking R&D activity does not seem to modify the relationship between Debt and NDTS. When we interact NDTS and RD expenditure, however, it appears that R&D activity creates a tax shield that operates as a substitute for debt in the firm's capital structure. This observation would be consistent with the notion that tax concessions associated with R&D activity are valuable to the firm for their tax impact. To the extent that firms undertaking R&D activity are constrained to having lower Debt-ratios, the tax concession would then appear to offer a substitute allowing firms to shield their income from tax and so generate larger internal cashflows. If R&D-firms do have difficulty raising finance on capital markets, the tax concession could go some way to alleviating that problem. This result is consistent with the notion that tax concessions create (some) financial flexibility for firms. This argument, however, is undermined by the relatively small economic impact of the α_3-coefficient. Adding and subtracting one standard deviation of the interaction term increases (decreases) the estimated Debt Ratio by four percent.

Looking at Panel B of Table 5 we see a slightly different outcome. The α_2-coefficient Remains negative, however, it is significant in only one instance. In that instance, column 3, it appears to be large. Sensitivity analysis, however, indicates that a one standard deviation increase in the NDTS will decrease the debt-ratio by seven percent (or by 1.5 percentage points). While the impact is larger than in Panel A, nonetheless it is not hugely different. The α_3-coefficient is more problematic. First, it is significant in only one instance, and the same instance as in Panel A and second, the sign is reversed. The negative α_3-coefficient in Panel B, indicates, for those firms with unexploited tax shields, an even greater substitution for debt. These firms would appear to be underleveraged. The economic significance of the α_3-coefficient, however, is miniscule. An increased of one standard deviation only changes the debt-ratio by 2.7 percent (or less than one percentage point overall). Overall, the results in table 5 indicate that NDTS are a substitute for debt in Australian firms capital structure. R&D plays a very small part in modifying that relationship.

Finally, we re-estimate equation (3) including the NDTS proxy and also the NDTS interaction term with R&D activity. Results are shown table 6 below. Again we estimate two versions of each model. First we include the entire dataset, including both positive and negative NDTS shown in Panel A. Second, we only include positive NDTS, shown in Panel B. Again we first discuss Panel A, and the we discuss Panel B.

TABLE SIX

Of particular interest is the positive coefficient on the NDTS-Asset*RD interaction term. It is statistically significant in both specifications of the model in Panel A. We evaluate the economic significance of the interaction term by substituting sample means into the equation and then adding (subtracting) one standard deviation of the interaction term. We evaluate the predicted Q ratios under the various values for the interaction term. In the first column of table 6, the interaction term, while highly statistically significant, is not economically significant. Adding or subtracting one standard deviation to the interaction term modifies the expected Q by only two percent. That result, however, is quite different in column two. Adding (subtracting) one standard deviation has a twenty percent impact on the expected Q. While the R&D tax shield has a relatively small impact on the firm's capital structure, it appears to have a relatively large impact on firm value. Contrast this to the results in Panel B. Neither of the interaction term coefficients is statistically significant. This, is consistent with the result in table 5, the interaction term had little impact on the firms capital structure, and here has no impact on firm value.

4. Conclusion

This paper has investigated the market value of R&D activity in Australia. It is commonly argued that Australian firms should undertake more R&D. R&D activity is associated with generous tax concessions. The generosity of those concessions has varied in recent years and the level of R&D in the Australian economy did fall in the late 1990s. Bosworth and Rogers (2001) present evidence indicating that R&D is not highly valued in Australia. This could explain the low levels of R&D activity.

We have reinvestigated the issue using a different empirical specification of their model and a longer time period. Our results are consistent with R&D being highly valued by capital markets. This, of course, does not mean correctly valued. We also report that the tax concessions create some, but not much, financial flexibility for firms undertaking R&D activity.

This all seems to create something of a puzzle. If R&D is valued and tax concessions are generous why then do firms not undertake more R&D? The answer to this question is likely to be very complex and we can only speculate as to some of the aspects of a comprehensive solution. As Brooks and Davidson (2004) indicate, Australia probably undertakes as much R&D as can be expected given the structure of the economy. It may well be that all private gains from R&D, within Australia, are already fully exploited. There may well be unexploited social gains. As intellectual property rights are strengthened, however, the scope for positive externalities may decline placing further pressures on R&D activity. No doubt other potential issues and explanations are equally important. In short, however, explaining the gap between how much R&D is undertaken and how much should be undertaken is an exciting research challenge.

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Table 1: Summary Statistics.

RD-Firms	TQ	Log(Assets)	RoA	RD-Sales	Debt-Ratio
Mean	1.6754	6.3969	3.8361	3.1055	24.6270
Median	1.2699	6.4224	6.1350	0.5324	25.2776
Std. Dev.	1.7733	1.7178	19.6549	8.7880	15.1360
N	317	384	384	384	382
Non-RD	TQ	Log(Assets)	RoA	RD-Sales	Debt-Ratio
Mean	2.0116	3.8752	-21.3328		23.3971
Median	1.1648	3.6376	0.0750		18.1818
Std. Dev.	3.9086	2.1231	77.8509		36.4612
N	1783	4256	4230		3241
F	0.0000	0.0000	0.0000		0.0000
t	0.0136	0.0000	0.0000		0.2213

Table 2: Determinants of R&D Expenditure. Robust p-values in parentheses.

	Dependent Variable = RD_t	
	RD = DRD	RD = RD-Sales
C	-12.3586	10.4169
	(0.0000)	(0.0154)
TQ_{t-1}	0.0966	0.2225
	(0.0001)	(0.2787)
RoA_{t-1}	0.0144	-0.0869
	(0.2029)	(0.0966)
RD_{t-1}	5.7151	0.8120
	(0.0000)	(0.0000)
$Log(Assets)_{t-1}$	1.5229	-2.2002
	(0.0018)	(0.0292)
$Log(Assets)^2_{t-1}$	-0.0712	0.1290
	(0.0319)	(0.0461)
Annual Dummies	Yes	Yes
Industry Dummies	Yes	Yes
McFadden-R^2/Adj-R^2	0.7286	0.6994
Significant Cook's Dist.	0	2
Deleted Std.Resid > 2.5	46	4
N	1720	199
Turning Point ($m)	44250.2916	5053.0114

Table 3: Valuation of R&D Results. White adjusted p-values in parentheses.

	Dependent Variable = Tobin Q			
	RD = DRD		RD = RD-Sales	
	Estimated	Actual	Estimated	Actual
C	1.9159	1.4589	0.9946	0.8384
	(0.0000)	(0.0000)	(0.0004)	(0.1434)
Log(Total Assets)	-0.1503	-0.1571	0.0031	-0.0828
	(0.0000)	(0.0000)	(0.9200)	(0.0131)
RoA	-0.0058	-0.0056	0.0247	0.0147
	(0.0576)	(0.0000)	(0.0000)	(0.0001)
Debt Ratio	0.0071	0.0066	-0.0014	0.0001
	(0.0004)	(0.0000)	(0.6079)	(0.9767)
RD	0.1674	0.3026	0.0939	0.0337
	(0.0751)	(0.0003)	(0.0000)	(0.0000)
Annual Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Adj-R^2	0.1301	0.1382	0.3275	0.2679
Significant Cook's Dist.	0	0	0	1
Deleted Std.Resid > 2.5	33	32	8	10
N	1774	1766	263	305

Table 4: Comparison to Bosworth and Rogers (2001). White adjusted p-values in parentheses.

	Dependent Variable = Market Capitalisation	
C	0.0757	-0.5164
	(0.6002)	(0.0052)
Log(Total Assets)	0.9851	0.9744
	(0.0000)	(0.0000)
RD-Total Assets	6.3218	5.7763
	(0.0000)	(0.0000)
Annual Dummies	No	Yes
Industry Dummies	No	Yes
Adj-R^2	0.9068	0.9203
Significant Cook's Dist.	1	0
Deleted Std.Resid > 2.5	9	9
N	278	287

Table 5: Impact of NDTS and R&D on Capital Structure. White adjusted p-values in parentheses.

	Dependant Variable = Debt Ratio			
	Panel A: NDTS = All		Panel B: NDTS > 0	
	RD = DRD	RD = RD-Sales	RD = DRD	RD = RD-Sales
C	5.8330	21.5299	9.5505	28.2990
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log(Total Assets)	2.9322	2.0732	2.2722	1.3342
	(0.0000)	(0.0000)	(0.0000)	(0.0931)
NDTS-Asset	-0.0196	-0.2662	-0.1255	-0.1467
	(0.0002)	(0.0016)	(0.0067)	(0.1885)
NDTS-Asset*RD	-0.0128	0.0137	-0.5540	-0.0222
	(0.8885)	(0.0058)	(0.0172)	(0.4419)
Annual Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Adj-R^2	0.1130	0.1197	0.1228	0.0408
Significant Cook's Dist.	1	0	0	0
Deleted Std.Resid > 2.5	59	6	23	4
N	3367	262	1276	136

Table 6: Value of R&D Tax Shields. White adjusted p-values in parentheses.

	Dependent Variable = Tobin Q			
	Panel A: NDTS = All		Panel B: NDTS > 0	
	RD = DRD	RD = RD-Sales	RD = DRD	RD = RD-Sales
C	2.0297	0.1262	0.8970	0.2148
	(0.0000)	(0.7593)	(0.0000)	(0.6928)
Log(Total Assets)	-0.1597	0.0399	-0.0313	0.0667
	(0.0000)	(0.2335)	(0.1084)	(0.1104)
RoA	0.0210	0.0562	0.0416	0.0451
	(0.0006)	(0.0001)	(0.0000)	(0.0059)
Debt Ratio	0.0090	-0.0023	0.0037	-0.0074
	(0.0000)	(0.4093)	(0.1192)	(0.0312)
RD	0.1548	0.1038	0.0038	0.0984
	(0.0955)	(0.0000)	(0.9725)	(0.0024)
NDTS-Asset	-2.4239	-5.3999	-0.0190	-0.0398
	(0.0001)	(0.0002)	(0.0746)	(0.0122)
NDTS-Asset*RD	0.7610	0.0701	-0.0167	0.0084
	(0.0000)	(0.0632)	(0.3548)	(0.2297)
Annual Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Adj-R^2	0.1152	0.3799	0.1365	0.4475
Significant Cook's Dist.	0	0	0	1
Deleted Std.Resid > 2.5	23	5	16	6
N	1696	263	805	134