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Stock Market Valuation of R&D Expenditures in R&D-intensive Economy: Evidence from Finland

ABSTRACT

This paper investigates the stock market response to firms' research and development (R&D) expenditures in Finland, where a substantial increase in the economy-wide investments in R&D activities occurred during the 1990's. Consequently, the use of Finnish data provides an interesting environment to test the hypothesis that the stock market valuates R&D expenditures as an asset rather than a cost (see, for instance, Lev 1999). The results reveal a significantly positive market response to R&D expenditures even after controlling for the valuation impact of negative earnings, industry differences and annual variation in returns. The results also indicate that the positive market response to the R&D expenditures becomes stronger as the economy-wide investments in R&D activities increase.

JEL classification: G15, M4
Keywords: *R&D expenditures, stock market*

1. INTRODUCTION

As noted by Lev (1999), empirical research on the research and development (R&D) activities and capital markets indicates that markets consider firms' investments in R&D as a significant

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value-increasing activity. Bublitz and Ettredge (1989), for instance, find that the slope coefficient of regressing stock returns on R&D expenditures is positive, suggesting that stock market values R&D expenditures as an asset rather than a cost. Similar results are reported by Chaucin and Hirschey (1993) and Green, Stark and Thomas (1996), among others.

The present paper investigates the stock market response to R&D expenditures in Finland, where both public and private investments in R&D increased dramatically after the middle of the 1990's. To illustrate, the Finnish firms' expenditures on R&D increased about 42 per cent from 1993 to 1997, while the corresponding figures for US, Germany, and the average OECD firms were 8 per cent, 4 per cent and 4 per cent, respectively. The Finnish data from the abovementioned time period provides an interesting environment to test the market valuation of R&D expenditures. If stock market values the R&D activities as an asset rather than a cost, the association between stock returns and R&D expenditures should become stronger as the economy-wide investments in R&D activities increase over time. To investigate these issues, the response coefficients of the R&D expenditures (RDRCs) are first estimated by regressing contemporaneous stock returns on the R&D expenditures. Next, the variation in the estimated RDRCs is explained by the development of economy-wide R&D expenditures.

The study contributes to the literature in three respects. First, the stock market valuation of R&D expenditures is investigated in Finland, where exceptional economy-wide R&D investments were made during the 1990's. For example, the R&D expenditures as a fraction of GDP were 1.77 per cent during the sample period in Finland while the OECD average was 1.47 per cent. Therefore, a strong positive stock market response to R&D expenditures should be observed in Finland, if the market valuation of R&D expenditures is an international rather than a country-specific phenomenon. Second, the variation of the estimated RDRC as a result of the remarkable increase in economy-wide R&D investments over the sample period is investigated. The positive market response to R&D expenditures should become stronger as the R&D investments increase. Again, the Finnish data from the sample period provides and excellent arena for this type of research, since the economy-wide R&D investments increased significantly during the 1990's. Third, the method of analyzing the value relevance R&D expenditures is improved by controlling for several factors affecting the valuation process. Based on Hayn (1995) value irrelevance of accounting losses is taken into account when investigating the market valuation of R&D expenditures. Hayn (1995) reports that the valuation impact of accounting losses in returns-earnings regressions is different from that of profits and should be controlled for in research investigating the returns-earnings relationship. In addition, the impact of annual variation in stock returns and the industry differences are controlled for when investigating the market valuation of R&D expenditures.

2. MARKET VALUATION OF RESEARCH & DEVELOPMENT EXPENDITURES

A common result of studies investigating the stock market response to R&D expenditures is that the stock market regards R&D expenditure as investment rather than a cost. Consequently, R&D expenditures are positively related to stock returns and other market valuation measures, such as book-to-market ratio. However, there is little empirical evidence on the issue from other than the US markets. This is most probably due to the absence, in several countries, of comprehensive disclosure requirements concerning research and development activities. Regarding the US stock market, Hirschey (1982, 1985), Hirschey and Weygandt (1985) and Chaucin and Hirschey (1993) regress different market valuation measures on annual R&D expenditures together with a number of control variables. Despite the different model specifications, the coefficients of R&D expenditures are significantly positive in these studies. Moreover, Bublitz and Ettredge (1989) document that that the annual R&D expenditures can be used to explain abnormal stock returns. Similar results are reported by Green, Stark and Thomas (1996) in the UK.

The above-mentioned studies use only the current R&D expenditures in the valuation models while it can be expected that past R&D expenditures are also value relevant. The use of current R&D expenditures is based on the assumption that current R&D expenditures measure the stock of R&D capital of a firm. Hirschey (1982) shows that if R&D expenditures grow at a constant rate and their value depreciates exponentially, the market value of all past R&D expenditures is equal to current R&D expenditures multiplied by a coefficient which depends on growth rate and depreciation rate of R&D expenditures. Supporting this theory, Sougiannis (1994) finds that lagged values of R&D expenditures are not value relevant while current values are, suggesting that the current R&D expenditures capture both their own valuation-relevance and that of the past values.

Despite the evidence by Sougiannis (1994), in more recent studies the assumption that the current R&D expenditures also measure the stock of R&D capital is relaxed. In this approach, the intangible R&D capital of a firm is estimated from the financial statements and used in the valuation model. Using this approach, Lev and Sougiannis (1996, 1999) find that the R&D capital is significantly associated with stock returns. This indicates that the stock market regards R&D capital as a valuable asset rather than a cost.

In addition to valuation studies Chan, Martin and Kensinger (1990) investigates stock market reaction to information releases regarding the R&D expenditures. They use an event study methodology to investigate markets response to announcements of increased R&D spending. They find positive responses for high technology firms with increased R&D expenditures and conversely negative responses for low technology firms.

Stock market valuation of the R&D expenditures is especially interesting in countries where substantial investments are made in R&D. However, empirical evidence from other than the US and the UK markets is lacking. The development of new products that can compete in the global markets is crucial for many other countries that are dependent on their exports. Thus, the whole economy may be dependent on the success of R&D activities in these countries. See, for instance, Martinez-Zarzoso and Suarez-Burguet (2000) for the effect of technical activities on international trade flows.

Table 1 compares the aggregate business enterprises' expenditures on R&D as a fraction of the gross domestic product of Finnish firms to the corresponding figures in Germany, France, UK, US and to the average OECD figures. The data is obtained from the OECD Main Science and Technology Indicators Statistics (see www.oecd.org). As can be seen, the economy-wide R&D expenditures increase considerably during the sample period in Finland, whereas the corresponding figures remain the same or even decrease in Germany, France, UK and US. The average OECD figures slightly increase during the sample period.

TABLE 1. R&D activities in Finland and in major OECD countries: business enterprises' expenditures on R&D as a fraction of gross domestic product.

	Finland	Germany	France	UK	USA	OECD
1993	1.27	1.58	1.48	1.36	1.78	1.43
1994	1.42	1.51	1.45	1.30	1.71	1.40
1995	1.45	1.50	1.41	1.27	1.80	1.41
1996	1.68	1.49	1.41	1.22	1.87	1.45
1997	1.79	1.54	1.39	1.18	1.91	1.48
1998	1.94	1.57	1.35	1.18	1.94	1.49
1999	2.19	1.70	1.38	1.25	1.98	1.52
2000	2.39	1.75	1.37	1.21	2.04	1.56

Source: OECD Main Science and Technology Indicators statistics (see www.oecd.org)

3. THE DATA

3.1. Helsinki Stock Exchange

The Helsinki Stock Exchange (HSE), which is the only stock market in Finland, underwent rapid changes in the 1990's.The liberalization of money markets in the late 1980's and the abolition of foreign ownership restrictions in the stock market in 1993 paved the way for the increase in stock prices and the trading volume of stocks. The success of Nokia generated a remarkable increase in the Finnish high-tech industry as the firms providing goods and servic-

es to Nokia expanded with their client. This development significantly increased the market values of these firms since the middle of 1990's. As a consequence, high-tech industry is in a dominating role in the HSE and in the Finnish economy as a whole. To illustrate, the telecommunication and electronics industries represented 42.3 per cent and 31.1 per cent of the annual turnover and the year-end market value of HSE in 1997 respectively. The proportion of the electromechanic industry of the total foreign export of Finland was about 42.7 per cent in 1997. These figures illustrate the high-tech intensity of the HSE and that of the Finnish economy as a whole.

Despite the development of the Finnish stock market, the HSE has remained a small market comprising, for the most part, infrequently traded stocks. As an example, Table 2 compares the key statistics of the HSE in 1995 to those of the leading European stock markets, the London Stock Exchange and the Deutche Börse. As can be seen, the number of listed firms in London was about 30 times higher than the corresponding figure for Helsinki. However, when interpreting these figures, it should also be noted that the stock markets in the UK and Germany are the major stock markets in Europe and that many of the European stock markets are close to the HSE in size.

TABLE 2. Summary statistics for Helsinki Stock Exchange, Deutsche Börse and London Stock Exchange in 1995.

	Number of listed firms	Average annual trading volume per firm	Average market value per firm
Helsinki	**73**	**201**	**467**
Deutsche Börse	**1622**	**287**	**270**
London	**2265**	**386**	**458**

Note: All monetary amounts are in millions of Euros.

3.2. Sampe selection

The sample consists of all listed Finnish industrial firms reporting their annual R&D expenses in the publicly available Worldscope database during the 1993–2000 period for which at least two consecutive years of stock market data is available. The Worldscope database contains financial and general information, fundamental analysis and stock performance data on public and private corporations from over 50 countries. The R&D expense variable represents all direct and indirect expenditures related to the creation and development of new processes, techniques, applications and products. It includes basic research, applied research, as well as de-

velopment costs of new products. The expenses reported exclude all customer and government sponsored research. Stock returns and market values of equity are retrieved from the database provided by the HSE. Stock returns are adjusted for issues, splits and dividends.

Since many firms are not listed continuously due to mergers or initial public offerings, the sample consists of 154 firm-year observations. We concede that the sample size is relatively small because of data availability limitations and because the number of firms listed in the HSE is relatively small (see Table 2). However, we are confident in that the sample size is large enough to perform the tests used in the study. Stock returns calculated from April_t to March_{t+1} are matched with the R&D expense variable from year t to ensure that the financial reports are available for investors when the stock market response to the R&D activities is investigated.[1]

4. RESEARCH DESIGN AND THE PRELIMINARY DATA ANALYSIS

The so-called returns based approach is taken to investigate the market valuation of R&D expenditures. The following pooled regression of stock returns on earnings and R&D expenditures is first estimated:

$$(1) \qquad R_{it} = \alpha_0 + \alpha_1 EARN_{it}/P_{it-1} + \alpha_2 (LOSS_{it} \times EARN_{it})/P_{it-1} + \alpha_3 RDC_{it}/P_{it-1} + e_{it},$$

where R_{it} is the stock return of the ith firm in year t calculated from April_t to March_{t+1}, $EARN_{it}$ is the annual reported earnings plus R&D expenditures of the ith firm in year t, P_{it-1} is the market value of equity at the end of year $t-1$ (stock price multiplied by the number of shares outstanding), $LOSS_{it}$ is a dummy variable that has a value of one if the earnings of the ith firm in year t are negative, otherwise zero, and RDC_{it} is the amount of R&D expenditures of the ith firm in year t. Earnings are included as an independent variable in the model (1), because it is well documented in the literature that earnings are significantly related to stock returns. R&D expenditures are added to the earnings to make sure that the earnings figures do not reflect the information involved in the separate R&D variable. The variable $LOSS_{it}$ is included in the model (1), because Hayn (1995), among others, suggests that accounting losses are not siginificantly associated with stock returns. As a robustness check, the analyses are repeated without loss observations (the number of loss observations is eight). In addition, all the models are re-estimated by adding the variable $LOSS_{it}$ as an additional independent variable. The results are virtually unchanged and are therefore not reported. Finally, α_0 is an intercept term, α_1 is the

1 This return calculation period is frequently used in previous studies (see. e.g. Collins and Kothari 1989).

estimated earnings response coefficient (ERC), α_2 is the estimated slope coefficient of accounting losses, α_3 is the estimated response coefficient of the R&D expenditures (RDRC), and e_{it} is an error term. Based on previous literature, such as Lev and Sougiannis (1996, 1999), unadjusted returns are used. However, Equation 1 and the other estimations are also made with the market-adjusted returns but since the interpretation of the results is the same these results are not reported.

To control for possible time-variation in stock returns and the impact of high-tech industries on the estimated RDRCs, we extend the basic model by estimating the following models:

$$(2)\quad R_{it} = \beta_0 + \beta_1 EARN_{it}/P_{it-1} + \beta_2 (LOSS_{it} \times EARN_{it})/P_{it-1} + \beta_3 RDC_{it}/P_{it-1} + \beta_4 D_{93} + \beta_5 D_{94} + \beta_6 D_{95} + \beta_7 D_{96} + \beta_8 D_{97} + \beta_9 D_{98} + \beta_{10} D_{99} + e_{it},$$

$$(3)\quad R_{it} = \delta_0 + \delta_1 EARN_{it}/P_{it-1} + \delta_2 (LOSS_{it} \times EARN_{it})/P_{it-1} + \delta_3 RDC_{it}/P_{it-1} + \delta_4 D_{93} + \delta_5 D_{94} + \delta_6 D_{95} + \delta_7 D_{96} + \delta_8 D_{97} + \delta_9 D_{98} + \delta_{10} D_{99} + \delta_{11} INDUSTRY + e_{it},$$

where D_{93} to D_{96} are annual dummy variables that have the value of one for data from year t, otherwise zero, and *INDUSTRY* is a dummy variable that has a value of one if firm i belongs to non-high-tech industries[2] and zero if it belongs to high-tech industries. All other variables are as defined earlier. This specification also takes into account the possibility that the economic boom simultaneously accelerated stock returns and R&D orientation. This issue is also investigated by including a return of the HEX portfolio index as a control variable instead of the yearly dummy variables. However, the results remain virtually the same and are therefore not reported.

The variation in the estimated RDRCs as the economy-wide R&D expenditures increase over time is investigated by including an intersection term of the R&D expenditures of the ith firm in year t and the economy-wide R&D expenditures in year t in models (1) and (2). Thus, the following models are estimated:

$$(4)\quad R_{it} = \phi_0 + \phi_1 EARN_{it}/P_{it-1} + \phi_2 (LOSS_{it} \times EARN_{it})/P_{it-1} + \phi_3 (RDC_{it} \times BERD_t)/P_{it-1} + \phi_4 D_{93} + \phi_5 D_{94} + \phi_6 D_{95} + \phi_7 D_{96} + \phi_8 D_{97} + \phi_9 D_{98} + \phi_{10} D_{99} + e_{it},$$

$$(5)\quad R_{it} = \lambda_0 + \lambda_1 EARN_{it}/P_{it-1} + \lambda_2 (LOSS_{it} \times EARN_{it})/P_{it-1} + \lambda_3 (RDC_{it} \times BERD_t)/P_{it-1} + \lambda_4 D_{93} + \lambda_5 D_{94} + \lambda_6 D_{95} + \lambda_7 D_{96} + \lambda_8 D_{97} + \lambda_9 D_{98} + \lambda_{10} D_{99} + \lambda_{11} INDUSTRY + e_{it},$$

2 Firms are classified as high-tech and non high-tech industries based on the industry classification of the HSE.

where $BERD_t$ is the economy-wide expenditures on R&D activities in Finland in year t as a fraction of the gross domestic product, and all other variables are as defined earlier. RDC_{it} is not included as an independent variable, because RDC_{it} and the intersection term $RDC_{it} \times BERD_t$ are almost perfectly correlated. Alternative variable and model specifications including annual intersection terms and a trend variable are applied to handle the problem of the high correlation between the RDC_{it} variable and the intersection term, but the correlation remains high.

The descriptive statistics of the variables used in the regressions are reported in Panel 1 of Table 3. The results indicate that the R&D expenses are on average about 4.4 per cent of the market value of equity. This is somewhat higher than 2.2 per cent in the UK in 1992 as reported by Green, Stark and Thomas (1996). The Pearson correlation matrix of the variables report-

TABLE 3. Summary statistics of the variables (N = 154).

Panel 1: Descriptive statistics

Variable	Mean	Median	Std.dev.	Minimum	Maximum
R_{it}	0.131	0.097	0.426	–0.976	1.532
$EARN_{it}/P_{it-1}$	0.133	0.122	0.085	–0.244	0.385
$LOSS_{it}EARN_{it}/P_{it-1}$	–0.001	0.000	0.029	–0.244	0.253
RDC_{it}/P_{it-1}	0.040	0.034	0.036	0.001	0.303
$RDC_{it}BERD_t/P_{it-1}$	0.067	0.057	0.053	0.002	0.386

Panel 2: Pearson correlation coefficients.

Variable	$EARN_{it}/P_{it-1}$	$LOSS_{it}EARN_{it}/P_{it-1}$	RDC_{it}/P_{it-1}	$RDC_{it}BERD_t/P_{it-1}$
R_{it}	0.315	0.057	0.299	0.249
	(0.000)	(0.475)	(0.000)	(0.002)
$EARN_{it}/P_{it-1}$		0.375	0.319	0.307
		(0.000)	(0.000)	(0.000)
$LOSS_{it}EARN_{it}/P_{it-1}$			0.301	0.256
			(0.000)	(0.001)
RDC_{it}/P_{it-1}				0.949
				(0.000)

Notes:
R_{it} is the stock return of the *i*th firm in year *t* calculated from April*t* to March*t*+1,
$EARN_{it}$ is the annual reported earnings plus R&D expenditures of the *i*th firm in year *t*,
P_{it-1} is the market value of equity at the end of year *t–1* (stock price multiplied by the number of shares outstanding),
RDC_{it} is the amount of R&D expenditures of the *i*th firm in year *t*,
$LOSS_{it}$ is a dummy variable that has a value of one if the earnings of the *i*th firm in year *t* are negative, otherwise zero, and
$BERD_t$ is the economy-wide expenditures on R&D activities in Finland in year *t* as a fraction of the gross-domestic product.

Probability values are reported in parentheses.

ed in Panel 2 of Table 3 indicates that earnings, R&D expenses and R&D intensity are positively correlated with stock returns. It also appears that there is a significant correlation between the independent variables, but the values of the Pearson correlation coefficients are low. The exception is the Pearson correlation between RDC_{it} and the intersection term $RDC_{it} \times BERD_t$, which is close to unity ($p < 0.000$). Furthermore, the analysis of variance inflation factors indicate that the multicollinearity problem is not present in the regression analysis (see, for example, Judge et al. 1988, pp. 868–871).

5. RESULTS

5.1. Market valuation of R&D expenditures

The results of investigating the market valuation of the R&D expenditures are reported in Table 4. The numbers in the table are the estimation results of models (1–3). As hypothesized, the ERCs, i.e. the estimated slope coefficients of earnings ($EARN_{it}/P_{it-1}$) are significantly positive in all models. The coefficient of the intersection term including a dummy variable for accounting losses is significantly negative in model (3) and negative, though insignificant, in models (1–2). This supports Hayn's (1995) notion that value-irrelevance of accounting losses should be taken into account when regressing stock returns on accounting earnings[3].

Our main interest, however, is in the estimated RDRC, i.e. in the slope coefficent of the R&D expenditures. The results indicate that the estimated RDRCs are positive and highly significant in all models. This indicates that the Finnish stock market regards R&D expenditures as a value-increasing investment rather than as a cost. The results are consistent with those reported by Hirschey (1982), Hall (1993), among others. The magnitude of the estimated RDRCs is also relatively large as compared to the estimated ERCs.

The results of including annual dummies (models 2 and 3) in Table 4 indicate a considerable increase in the explanatory power of the models. The adjusted R^2 for model (3) equals 0.495, while the adjusted R^2 for model (1) is only 0.139**.** It therefore seems that annual variation in the returns is high and should be controlled for in this type of research. The significantly negative slope coefficient of the industry dummy (*INDUSTRY*) in model (3) indicates that non high-tech firms have lower returns compared to high-tech firms. The coefficient of *RDC*, however, also remains significant in model (3).

3 We also estimate all the models without the dummy variable for losses. The results (available from the authors on request) are similar to those reported in the paper.

TABLE 4. Results of regressing stock returns on R&D expenditure and the control variables (N = 154).

Model	(1)	(2)	(3)
Constant	–0.173	–0.347	–0.365
	(0.011)	(0.000)	(0.000)
$EARN_{it}/P_{it-1}$	1.411	0.767	1.002
	(0.001)	(0.025)	(0.004)
$LOSS_{it}EARN_{it}/P_{it-1}$	–1.775	–0.803	–2.544
	(0.139)	(0.406)	(0.022)
RDC_{it}/P_{it-1}	2.891	2.280	4.287
	(0.003)	(0.006)	(0.000)
D_{93}		0.449	0.454
		(0.001)	(0.000)
D_{94}		–0.140	–0.116
		(0.215)	(0.292)
D_{95}		0.351	0.368
		(0.002)	(0.001)
D_{96}		0.556	0.569
		(0.000)	(0.000)
D_{97}		0.468	0.481
		(0.000)	(0.000)
D_{98}		–0.048	–0.034
		(0.658)	(0.745)
D_{99}		0.467	0.479
		(0.000)	(0.000)
INDUSTRY			–3.530
			(0.003)
Adj. R^2	0.139	0.466	0.495

Notes:

The estimated models are as follows:

(1) $R_{it} = \alpha_0 + \alpha_1 EARN_{it}/P_{it-1} + \alpha_2 (LOSS_{it} \times EARN_{it})/P_{it-1} + \alpha_3 RDC_{it}/P_{it-1} + e_{it}$,

(2) $R_{it} = \beta_0 + \beta_1 EARN_{it}/P_{it-1} + \beta_2 (LOSS_{it} \times EARN_{it})/P_{it-1} + \beta_3 RDC_{it}/P_{it-1} + \beta_4 D_{93} + \beta_5 D_{94} + \beta_6 D_{95} + \beta_7 D_{96} + \beta_8 D_{97} + \beta_9 D_{98} + \beta_{10} D_{99} + e_{it}$,

(3) $R_{it} = \delta_0 + \delta_1 EARN_{it}/P_{it-1} + \delta_2 (LOSS_{it} \times EARN_{it})/P_{it-1} + \delta_3 RDC_{it}/P_{it-1} + \delta_4 D_{93} + \delta_5 D_{94} + \delta_6 D_{95} + \delta_7 D_{96} + \delta_8 D_{97} + \delta_9 D_{98} + \delta_{10} D_{99} + \delta_{11} INDUSTRY + e_{it}$,

where R_{it} **is the stock return of the** *i***th firm in year** *t* **calculated from April$_t$ to March$_{t+1}$,**
$EARN_{it}$ **is the annual reported earnings plus R&D expenditures of the** *i***th firm in year** *t*,
P_{it-1} **is the market value of equity at the end of year** *t–1* **(stock price multiplied by the number of shares outstanding),**
RDC_{it} **is the amount of R&D expenditures of the** *i***th firm in year** *t*,
$LOSS_{it}$ **is a dummy variable that has a value of one if the earnings of the** *i***th firm in year** *t* **are negative, zero otherwise,**
D_{93} **to** D_{99} **are annual dummy variables that have the value of one for data from year** *t*, **zero otherwise, and**
INDUSTRY **is a dummy variable that has a value of one is the firm** *i* **belongs to non-high-tech industries and zero if it belongs to high-tech industries.**

Probability values are in parantheses.

According to White's (1980) test, heteroskedasticity is not a problem in any case.

5.2. Variation in estimated RDRCs as economy-wide R&D investments change

The variation in the estimated RDRCs as a function of the economy-wide R&D investments is investigated next. Since the R&D expenditures by the Finnish firms significantly increased during the 1990's, it can be assumed that the market response to the R&D expenditures, i.e. the estimated RDRCs, should also have increased during this period. The variation in the estimated RDRCs is investigated by estimating the models (4–5), in which an interaction term of the firms' R&D'expenditures and the economy-wide R&D expenditures is included. Note that the economy-wide R&D investment variable is a constant in any given year, because the variable measures the overall R&D expenditures of the Finnish firms in a given year.

The results of estimating models (4–5) are reported in Table 5. The slope of the interaction term ($RDC_{it} \times BERD_t / P_{it-1}$) reflecting the change in the estimated RDRC as economy-wide R&D investments increase is significantly positive in both of the models. This suggests that the positive stock market response to the R&D expenditures has increased as the investment in R&D activities have increased over time. The slope of the industry dummy (*INDUSTRY*) in model (5) is significantly negative as expected.

Finally, we test the robustness of the results by investigating the impact of outliers on the results. Outliers are detected by using Weisberg's (1985) test[4]. The test detects no outliers at the 5 per cent level of significance. However, at the 10 per cent level of significance six outliers are detected. We re-estimated all the regressions by excluding the six outlier observations. The results (available on request) are consistent with the results of the whole sample.

6. CONCLUSIONS

This paper investigates the stock market response to firms' research and development (R&D) expenditures. Previous US studies report a significantly positive market response to the R&D expenditures of the firm (see, for instance, Lev 1999). Finnish data is used, because substantial economy-wide investments in R&D activities were made in Finland during the 1990's. In addition, Nokia and the other Finnish high-technology firms are in a key role in the Finnish economy. Therefore, the use of Finnish data provides an interesting environment to test the hypothesis that the stock market valuates R&D expenditures as an asset rather than a cost.

4 Weisberg's test is calculated as follows (see Weisberg 1985):

$$t_i = r_i \sqrt{\frac{n-k-1}{n-k-r_1^2}},$$

where r_i is the standardized residual, n is the sample size, k is the number of parameters, and df = $n - k - 1$. Critical values of the test statistic are reported in Weisberg 1985).

TABLE 5. Stock market response of the R&D expenditures as a function of R&D investment intensity (N = 154).

Model	(4)	(5)
Constant	–0.359	0.395
	(0.000)	(0.000)
$EARN_{it}/P_{it-1}$	0.751	0.906
	(0.031)	(0.009)
$LOSS_{it}EARN_{it}/P_{it-1}$	–0.477	–1.720
	(0.618)	(0.109)
$RDC_{it} \times BERD_t / P_{it-1}$	1.143	2.154
	(0.029)	(0.001)
D_{93}	0.533	0.593
	(0.000)	(0.000)
D_{94}	–0.099	–0.046
	(0.386)	(0.685)
D_{95}	0.389	0.436
	(0.001)	(0.000)
D_{96}	0.588	0.622
	(0.000)	(0.000)
D_{97}	0.489	0.520
	(0.000)	(0.000)
D_{98}	–0.031	–0.006
	(0.768)	(0.954)
D_{99}	0.475	0.492
	(0.000)	(0.000)
INDUSTRY		–2.847
		(0.015)
Adj. R^2	0.455	0.512

Notes:

The estimated models are as follows:

(4) $R_{it} = \phi_0 + \phi_1(EARN_{it})/P_{it-1} + \phi_2(LOSS_{it} \times EARN_{it})/P_{it-1} + \phi_3(RDC_{it} \times BERD_t)/P_{it-1} + \phi_4 D_{93} + \phi_5 D_{94} + \phi_6 D_{95} + \phi_7 D_{96} + \phi_8 D_{97} + \phi_9 D_{98} + \phi_{10} D_{99} + e_{it}$,

(5) $R_{it} = \lambda_0 + \lambda_1(EARN_{it})/P_{it-1} + \lambda_2(LOSS_{it} \times EARN_{it})/P_{it-1} + \lambda_3(RDC_{it} \times BERD_t)/P_{it-1} + \lambda_4 D_{93} + \lambda_5 D_{94} + \lambda_6 D_{95} + \lambda_7 D_{96} + \lambda_8 D_{97} + \lambda_9 D_{98} + \lambda_{10} D_{99} + \lambda_{11} INDUSTRY + e_{it}$,

where R_{it} **is the stock return of the** *i***th firm in year** *t* **calculated from April$_t$ to March$_{t+1}$,**
$EARN_{it}$ **is the annual reported earnings plus R&D expenditures of the** *i***th firm in year** *t*,
P_{it-1} **is the market value of equity at the end of year** *t–1* **(stock price multiplied by the number of shares outstanding),**
RDC_{it} **is the amount of R&D expenditures of the** *i***th firm in year** *t*,
$LOSS_{it}$ **is a dummy variable that has a value of one if the earnings of the** *i***th firm in year** *t* **are negative, otherwise zero,**
$BERD_t$ **is the economy-wide expenditures on R&D activities in Finland in year** *t* **as a fraction of gross-domestic product,**
D_{93} **to** D_{99} **are annual dummy variables that have the value of one for data from year** *t*, **zero otherwise, and**
INDUSTRY **is a dummy variable that has a value of one is the firm** *i* **belongs to non-high-tech industries and zero if it belongs to high-tech industries.**

Probability values are in parantheses.

According to White's (1980) test, heteroskedasticity is not a problem in any cases.

The results reveal a significantly positive market response to the R&D'expenditures in Finland, indicating that the R&D expenditures are regarded as a value increasing activity of the firm rather than a cost. This supports the idea that investments in the R&D generate a valuable asset to the firm despite decreasing earnings in the short run. The positive stock market response to the R&D expenditures is highly significant, even after controlling for the impact of negative earnings, industry differences or annual variation in returns. The results also indicate that the positive market response to the R&D expenditures becomes stronger as the economy-wide investments in R&D activities increase over time. These findings suggest that the positive market response to R&D expenditures found in previous studies is an international phenomenon and is related to a reasonable extent to the R&D intensity of the economy. ■

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