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EFFECTS OF R&D SPENDING ON TOBIN'S Q OF SELECTED TEN US IT COMPANIES

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ABSTRACT

The purpose of this paper is to empirically re-explore the effects of current and lagged R&D expenditures on Tobin's Q for selected ten US IT companies (Apple, Alphabet, Microsoft, Facebook/ Meta, Dell Technologies, Intel Corp, IBM, HP Inc, Cisco Systems, Oracle). These companies have been selected for their visible and enduring dominance in term of market-capitalization in the US IT sector. They belong to the magnificent 7 as well that approximately constitute 30% of the S&P 500 index value. The empirical methodology involves the implementation of the Ordinary Least Squares (OLS) upon satisfying the statistical requirements for its suitability. Annual data are used with differing sample periods across these companies due to complete availability of data. Unduly wide variabilities are observed in their year-to-year R&D expenditures. The current and lagged explanatory variables negatively correlate with current Tobin's Q with some minor exceptions. Their net effects range from zero to negative in most cases, amid a few exceptions. To conclude, the findings are conditioned on how the spendings for R&D are expensed and the length of the gestation period between R&D spending and the unpredictable outcomes. The findings of this paper are supported by de Andres et al (2017, 2021), Oriani and Sabrero (2008), Coad and Rao (2010), Arad and Weill (2007), and Li and Tallman (2011).

Keywords: Tobin's Q, R&D, Correlation, Regression, Causality, Net Effect
JEL Classifications: G10, G30, G39.

INTRODUCTION

The ten selected US IT Companies include Apple, Alphabet Inc, Microsoft, Facebook/ Meta, Dell Technologies, Intel Corporation, IBM, HP Inc, Cisco Systems and Oracle. These companies have been primarily selected for their high market capitalization and market shares as well as relatively high active engagements in innovations and R&D. They invest heavily in R&D to improve their global competitiveness. R&D is viewed as a source of value creation by breakthrough innovations, development of new products and services and making new profitable ventures through commercialization. R&D activities also lead to inventions and improvement in production processes to reduce uses of resources and production costs (e.g., Bae and Kim, 2003; Shin et al.,2009; Ethie and Olibe, 2010; Kim et al.,2012). They are also included in the magnificent 7 that constitute nearly 30% of the S&P 500 Index value and rank in the top 20 for the best management according to the Wall Street Journal.

In contrast, [(Hartmann et al. 2006) and Kim et al. (2014)] view that R&D spending is risky due to high chance of failures, and additionally, operating costs are high with no guarantee of benefits. Thus, R&D activities are not enough for improving operating performance. Instead, the firms should focus on improving their absorptive capacities.

Both the evolutionary theory approach (Nelson and Winter, 1982) and the path-dependent technological change approach (Ruttan, 1997) recognize the existence of learning processes when firms perform R&D activities in a continual manner. By investing in R&D, firms develop capabilities, which incrementally give the firm a stock of knowledge and experience that can be used to develop new innovations. Therefore, the process of conducting R&D activities is characterized by increasing dynamic returns that materialize in learning and economies of scope in spurring innovations (Cohen and Levinthal, 1989). Persistence in these endeavors is related to higher enhanced productivity growth (Verspagen, 1995), higher profitability (Cefis and Ciccarelli, 2005), and higher levels of innovation (Beneito et al., 2015).

The relationship between aggregate investment and Tobin's Q has become remarkably compacted in recent years, contrasting with earlier times. There is growing empirical dispersion in Tobin's Q, as evidenced both in the cross-section and the time series data. This dispersion in the standard investment model features two distinct mechanisms related to firms' research activities: innovations and learning. Innovations lead to sparking cash inflows and the frequent updating of beliefs about future cash inflows that endogenously amplify volatility in the firm's value function. Counterintuitively, the investment-Q regression works better for research-intensive industries, a growing segment of the economy, despite their greater stock of intangible assets (Andrei et al., 2019). R&D expenditure by nature is a sunk cost, and it is high for large high-tech companies (Stiglitz, 1987). The IT companies are considered important due to ongoing transition of the US economy from industrial economy to knowledge-based economy.

To note, Tobin's Q is a measure of long-term firm value. Usually, Tobin's Q is calculated by dividing market capitalization of a firm with its replacement value (Tobin, 1969). Replacement value is elusive in many cases. So, there are several variants of the formula to calculate Tobin's Q. This paper uses the following formula:

$$Tobin's\ Q = \frac{\text{Equity Market Value} + \text{Liabilities}}{\text{Equity Book Value} + \text{Liabilities}}$$

The calculated Tobin's Q ranging between 0 and 1 indicates that the firm is undervalued, drawing the attention of potential buyers. Tobin's Q exceeding 1 indicates that the firm is earning higher than replacement cost, thereby enticing other competitors to enter the industry to capture some profit (Hayes, 2019). Tobin's Q being equal to 1 implies market efficiency for equality between the recorded value and market value of the firm. The ratio is also an expression of the relationship between market valuation and intrinsic value. Tobin's Q is an integration of metrics of firm-specific and macroeconomic factors, though the latter have relatively very subdued influence. However, they help formulate production and marketing strategies. This metric is used for its widespread acceptance among scholars because it is claimed to be forward-looking and comparable across diverse industries (Anderson et al, 2004).
In information economics literature, evidences indicate that IT improves firm productivity (Brynjolsson and Hitt, 2002), but there is no consensus on whether or how IT increases firm value. Interest in the economics of IT has moved away from macro-level benefits of IT to a debate about firm-level business value (Dos Santos et al., 2012). In one vein of the debate, some have argued that firms no longer benefit from IT investments because common standards for IT infrastructure reduce the potential gains from new IT investments, since competitors can duplicate a new IT application or architecture (Carr, 2004; Bhatt and Grover, 2005). In another vein, proponents have claimed that the value of standardized IT applications are different across firms because firms' processes and resources are not identical. Thus, there are significant organizational and management differences in the way firms implement IT solutions (Clemons and Row, 1991; Brynjolfsson et al., 2002). For example, Brynjolffson et al. (2002) found that the financial markets treat firms' organizational structures as complementary assets with IT in a way that increases long-term output and market value. There exists a large body of research in the information systems literature on the impact of IT on firm productivity (e.g., Barua et al., 1991; Brynjolfsson et al., 2002; Devaraj and Kohli, 2003). A complementary stream of work in economics has separately studied the effect of R&D on firm output and productivity (e.g. Griliches and Mairesse, 1984; Chauvin and Hirschey, 1993; Griliches, 1993; Hall and Mairesse, 1995). Several previous studies have also demonstrated positive impact of IT on firm profitability (Aral and Weill, 2007; Mithas et al., 2012).
Financial market measures, such as Tobin's Q, represent the ex ante market valuation of the level and risk of future firm cash flows (Ben-Horim and Callen, 1989; Smirlock et al., 1984). As noted by a number of scholars, an accurate analysis of the relationship between firm-level investments and market value should examine their impact on the market-to-book ratio rather than market capitalization alone (Foray et al., 2007; Kohli et al., 2012). A financial measure, such as Tobin's Q measures the value of a firm based on its future earnings, relative to current book value, is a better indicator of future growth options associated with R&D and IT spending. Tobin's Q represents a forward-looking measure of firm value that takes into consideration the

impact-lags of investments in R&D on IT firm value. Their payoffs complement the retrospective firm performance captured in financial accounting measures (Kohli et al. 2012).
The primary focus of the paper, in view of the above, is to empirically re-explore the effects of R&D expenditures of the selected ten US IT companies on their individual Tobin's Q. Simple linear regression of each company is estimated by the OLS method. Annual data are used. The lengths of sample periods vary across the selected companies depending on the complete availability of the relevant data. Data are collected from COMPUSTAT Annuals. The remainder of the paper proceeds as follows. Section II provides a brief survey of related literature. Section III delineates a brief outline of the empirical methodology. Section IV reports empirical results and discusses them. Section V offers conclusions.

Brief Review of Related Literature

Bae and Kim (2003) explore the impact of R&D investments on the market value of business enterprises in the U.S., Germany and Japan. They find that R&D investments bring higher market value for firms in the U.S than those in Japan and Germany. Ethie and Olibe (2010) state that R&D investments in the U.S. services sector are connected to lower market value than those in the manufacturing sector during the pre-9/11 period. Using a sample of firms listed on US stock exchanges from 1990 to 2013, Vithessonthi and Racela (2016) find that R&D spending has a negative impact on operating performance (measured by ROA) but is positively associated with firm value (measured as stock returns and Tobin's Q). Min and Smyth (2016) report a positive relationship between R&D and firm value in South Korea, where firm value is proxied as stock returns. The authors also explain that R&D spending can enhance the firm's intangible assets and the firm value.

If the financial markets are myopic, a negative association between R&D spending announcements and firm value is expected (Parcharidis and Varsakelis, 2010). However, the empirical results from the literature have demonstrated that at least the stock exchanges in developed countries react positively to R&D spending. Chan et al. (1990) examine the impacts of R&D spending announcements on stock prices on high and low-technology enterprises from 1979 to 1985. They find that firms announcing plans to increase spending on R&D activities help increase their stock prices.

In inefficient markets, investors can correctly measure the value of future expected returns of R&D expenditures. Therefore, the firm value fully reflects the benefits of past or current R&D expenditures. Several studies have documented positive relationship between R&D spending and firm-value (Bae and Kim, 2003; Connolly and Hirschey, 2005) as well as R&D spending and stock returns (Duqi et al., 2011). Connolly and Hirschey (2005) report positive and statistically significant impact of R&D intensity on the market value of both manufacturing and non-manufacturing business enterprises. Bond et al. (2003) examine the association between R&D and firm's market valuation using data for UK, France, Germany and Belgium. Bosworth and Rogers (2001) employ Australian data to examine the impacts of R&D on firm value. Again, Duqi et al. (2011) evaluate the impacts of R&D on stock returns for a sample of thirteen European countries from 1999 through 2010. The results confirm a positive association between R&D and stock returns.

Employing a sample of Chinese firms, Kim et al (2018) examine the non-linear relationship between R&D investments and the firm value of 563 listed firms in the period of 2005-2013. They find that R&D investments have an inverted U-shaped relationship with Tobin's Q. The results imply that firm value increases following an increase in R&D investments. Subsequently, if R&D investments continue to increase, the firm value diminishes.

Research and Development (R&D) spending improves the future development of companies through two channels. First, the R&D process creates new products and services. Second, the absorptive capacity with external knowledge of firms could be enhanced (Tung and Binh, 2021). As a result, firms can take advantage of new products and services, sales revenues, and profits as well as efficiency.

Research and Development (R&D) is regarded as a primary activity in firms and improves their competitiveness in the era of globalization. Innovation, particularly R&D, is often a source of value creation and competitiveness (Shin et al., 2009). In order to search for growth opportunities in an increasingly global competitive environment, firms should make breakthrough innovations through R&D by developing new services and products in addition to generating ideas to make business ventures commercially feasible and profitable (Ehie and Olibe, 2010). One of the outstanding contributions of R&D activities is to create advanced and superior products in comparison with counterparts, which raises sales revenue and market value (Bae and Kim, 2003). R&D activities also make inventions and improve production processes to reduce uses of resources and hence, production costs. Science and technology are the keys to helping firms improve their competitiveness through a firm's R&D investment.

The role of R&D spending in firms is traced by three approaches: benefit-cost analysis, production functions or cost functions, and market value. The R&D effort of firms with a long-term perspective is evaluated by an increase in the market value of firms when valuing listed firms' stocks (Bae and Kim, 2003). Therefore, R&D activities are one of the effective strategies to promote firms' performance and hence market value (Kim et al., 2012).

R&D spending is also a risky investment for firms since its chance of failure is also high. Hartmann et al. (2006) confirm that R&D activities significantly increase firms' operating costs. Moreover, R&D investment likely makes production costs increase, causing increased marginal costs that need to be compensated by an increase in firm performance. In addition, Kim et al., (2014) emphasized that R&D activities increase risk for firms, because R&D investment is not enough to improve operating performance. So, R&D investment also needs to concentrate on the absorption capacity of enterprises themselves.

The relationship between R&D investments and performance may well be a reciprocal one. Investing in R&D requires resources, including financial capital (e.g., Galunic and Rodan, 1998; Garriga et al., 2013; Monteiro et al., 2017). Empirical evidence suggests that well-performing firms have greater resources to invest in R&D. So, performance may precede and predict R&D investment (e.g., Guldiken and Darendeli, 2016; Patel and Chrisman, 2014). In sum, while investing in R&D may create real options for future firm performance, past and current performance may create a resource base for investing in R&D. However, disentangling these reciprocal relationships is challenging due to their indirect nature, the influence of multiple contingency factors, and the possibility that their direction and strength may vary over time.

Some other authors caution that the performance effects of R&D should not be overestimated. Market and technological uncertainty reduce the value of R&D in the initial years of investment (Oriani and Sobrero, 2008). Investing in R&D as a growth strategy also faces a tradeoff in terms of immediate cash outflows in the pursuit of subsequent performance, which may not materialize (de Andres et al., 2017, 2021). For example, in their analysis of U.S manufacturing firms from 1973 to 2004, Coad and Rao (2010) find that an increase in R&D expenditure is only weakly associated with growth in the subsequent periods. If the intended growth does not occur, firms may not recoup the R&D investments, as expected. Aral and Weill (2007) find R&D investments to be negatively correlated with Tobin's Q. Li and Tallman (2011) reported mixed results in this context.

Brief Outline of Empirical Methodology

For data description, mean, median and standard deviation of each variable involved in this study are computed for each of the selected ten companies. Next, the simple correlation coefficients of current and lagged explanatory variables with the dependent variable are calculated for each company. Finally, the estimating linear regression is specified as follows:

$$TQ_t = \alpha_t + \sum_{i=1}^{n} \beta_i \, RD_{t-i} + u_t$$

Where, TQ = Tobin's Q, RD= R&D expenditure, u = random error-term, α = intercept term, β_i=slope coefficient, t= time subscript, i = 1, 2,….10, and n = number of selected lags. By assumptions, COV (RD_t, u_t) = 0, mean of u_t = 0 with constant variance, and u_t's are i.i.d. In general, the slope-coefficients are expected to be positive. However, they potentially may run to the contrary. TQ_t and u_t are uncorrelated and u_t's are independently distributed with constant variance, as the plots depicted. Thus, they justify the suitability of the application of the OLS for the best linear unbiased estimates of the parameters.

EMPIRICAL RESULTS AND DISCUSSIONS

The earlier stated data descriptors are reported as follows.

Table 1

Descriptive Statistics

Apple (1980-2019)				
Variable	**Mean**	**Median**	**StdDev**	**Mean/Median**
TQ	2.240	2.110	1.176	1.062
XRD	2,295.697	573.675	4,054.332	4.002
LXRD	1,938.741	564.303	3,411.647	3.436
LXRD2	1,615.129	549.152	2,785.545	2.941
LXRD3	1,345.781	534.000	2,267.461	2.520
[redacted]				
Alphabet Inc. (2002-2019)				
Variable	**Mean**	**Median**	**StdDev**	**Mean/Median**
TQ	5.229	3.404	3.774	1.536
XRD	7,446.809	4,462.000	7,778.591	1.669
LXRD	6,354.386	3,762.000	6,439.300	1.689
LXRD2	5,412.848	3,302.514	5,306.014	1.639
LXRD3	4,665.371	2,843.027	4,537.255	1.641
[redacted]				
Microsoft (1985-2020)				
Variable	**Mean**	**Median**	**StdDev**	**Mean/Median**
TQ	5.086	3.932	3.056	1.293
XRD	5,862.690	4,519.000	5,406.287	1.297
LXRD	5,479.653	4,379.000	4,964.917	1.251

LXRD2	5,144.466	4,343.000	4,620.170	1.185
LXRD3	4,854.117	4,307.000	4,365.452	1.127

Facebook/Meta (2010-2019)

Variable	Mean	Median	StdDev	Mean/Median
TQ	5.383	5.279	1.260	1.020
XRD	4,837.400	3,741.000	4,547.054	1.293
LXRD	3,863.778	2,666.000	3,549.062	1.449
LXRD2	3,062.625	2,040.500	2,791.667	1.501
LXRD3	2,392.429	1,415.000	2,213.620	1.691

Dell Technologies (1987-2019)

Variable	Mean	Median	StdDev	Mean/Median
TQ	3.099	1.511	3.798	2.051
XRD	840.571	396.500	1,392.811	2.120
LXRD	697.419	330.000	1,171.524	2.113
LXRD2	557.898	325.500	915.357	1.714
LXRD3	416.190	321.000	534.986	1.297

Intel Corp. (1972-2019)

Variable	Mean	Median	StdDev	Mean/Median
TQ	2.702	2.084	1.425	1.297
XRD	3,735.090	1,552.000	4,419.040	2.407
LXRD	3,530.262	1,296.000	4,230.230	2.724
LXRD2	3,312.594	1,203.500	4,002.023	2.752
LXRD3	3,095.140	1,111.000	3,762.393	2.786

IBM (1972-2019)

Variable	Mean	Median	StdDev	Mean/Median
TQ	1.632	1.609	0.677	1.014
XRD	4,059.096	4,597.500	1,767.370	0.883
LXRD	4,018.034	4,575.000	1,763.182	0.878
LXRD2	3,988.448	4,520.500	1,770.830	0.882
LXRD3	3,948.480	4,466.000	1,769.734	0.884

HP Inc. (1972-2019)

Variable	Mean	Median	StdDev	Mean/Median
TQ	1.592	1.354	0.916	1.176
XRD	1,849.484	1,559.500	1,339.512	1.186
LXRD	1,856.941	1,620.000	1,352.987	1.146
LXRD2	1,866.788	1,690.500	1,366.233	1.104
LXRD3	1,881.827	1,761.000	1,377.815	1.069

Cisco Systems (1989-2020)

Variable	Mean	Median	StdDev	Mean/Median
TQ	4.849	3.426	3.998	1.415
XRD	3,549.322	4,117.500	2,452.051	0.862

LXRD	3,459.075	4,077.000	2,437.962	0.848
LXRD2	3,355.144	3,795.000	2,408.779	0.884
LXRD3	3,252.494	3,513.000	2,383.702	0.926
[redacted]				
Oracle (1984-2019)				
Variable	**Mean**	**Median**	**StdDev**	**Mean/Median**
TQ	4.006	3.191	2.669	1.255
XRD	2,191.879	1,159.296	2,245.678	1.891
LXRD	2,081.162	1,138.591	2,176.491	1.828
LXRD2	1,965.137	1,107.296	2,096.479	1.775
LXRD3	1,840.111	1,076.000	1,996.120	1.710

Mean-to-median ratios of variables within proximity of 1 indicate that the time series data distributions of Tobin's Q (TQ), RD_t (XRD), RD_{t-1} (LXRD), RD_{t-2} (LXRD2) and RD_{t-3} (LXRD3) are near-normal and approximately symmetric primarily depending on relatively large sample sizes. This seems to be the case for IBM, Cisco Systems and HP Inc. In the other 7 cases, the ratios are significantly above unity confirming the extents of non-normality and asymmetry of data distributions. In terms of standard deviations, RD_t (XRD), RD_{t-1} (LXRD), RD_{t-2} (LXRD2) and RD_{t-3} (LXRD3) exhibit excessive fluctuations except TQ_t. This is a confirmation of instability in year-to-year R&D investment.

The computed simple correlation coefficients are reported as follows:

Table 2

Correlation Coefficients

Apple (1980-2019)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	0.211	0.199	0.209	0.215
[redacted]					
Alphabet Inc. (2002-2019)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	-0.520	-0.520	-0.521	-0.479
[redacted]					
Microsoft (1985-2020)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	-0.606	-0.632	-0.696	-0.685
[redacted]					
Facebook/Meta (2010-2019)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	-0.503	-0.450	-0.482	-0.747
[redacted]					
Dell Technologies (1987-2019)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	-0.201	-0.213	-0.235	-0.270
[redacted]					
Intel Corp. (1972-2019)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	-0.213	-0.189	-0.163	-0.186

[redacted]

IBM (1972-2019)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	-0.467	-0.398	-0.338	-0.306

[redacted]

HP Inc. (1972-2019)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	-0.567	-0.544	-0.503	-0.498

[redacted]

Cisco Systems (1989-2020)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	-0.705	-0.784	-0.831	-0.829

[redacted]

Oracle (1984-2019)					
	TQ	XRD	LXRD	LXRD2	LXRD3
TQ	1.000	-0.520	-0.517	-0.491	-0.481

The correlation coefficients of RD_t (XRD), RD_{t-1} (LXRD), RD_{t-2} (LXRD2) and RD_{t-3} (LXRD3) with TQ_t are consistently negative for all selected companies except Apple. Negative correlation between variables seem counterintuitive. However, correlation analyses are no cause and effect analyses.

The OLS estimates of the linear regression for each company are shown as follows:

Table 3

Estimated Regression Results

Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
Apple (1980-2019)	2.000***	0.001	-0.001	-0.001	0.000	0.0884	0.776
	(0.000)	(0.318)	(0.619)	(0.723)	(0.736)		

[redacted]

Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
Alphabet Inc. (2002-2019)	6.926***	-0.001	0.001	-0.002	0.002	0.2832	0.988
	(0.002)	(0.622)	(0.690)	(0.489)	(0.465)		

[redacted]

Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
Microsoft (1985-2020)	7.233***	0.000	0.001	-0.001*	-0.001*	0.6040	8.769
	(0.000)	(0.509)	(0.229)	(0.098)	(0.095)		

[redacted]

Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
Facebook/Meta (2010-2019)	7.211*	-0.001	0.001	-0.000	0.000	0.6211	0.820
	(0.055)	(0.634)	(0.701)	(0.948)	(0.960)		

[redacted]

Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
Dell Technologies (1987-2019)	4.530***	0.009	-0.009	0.004	-0.011	0.1717	0.985

	(0.001)	(0.315)	(0.553)	(0.700)	(0.157)		
[redacted]							
Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
Intel Corp. (1972-2019)	2.680***	0.000	-0.000	0.000	-0.000	0.0542	0.573
	(0.000)	(0.703)	(0.882)	(0.814)	(0.523)		
[redacted]							
Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
IBM (1972-2019)	1.926***	0.000	-0.000	-0.000	0.000	0.1143	1.290
	(0.000)	(0.763)	(0.792)	(0.456)	(0.748)		
[redacted]							
Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
HP Inc. (1972-2019)	1.947***	-0.000	-0.000	0.000	-0.000	0.2854	3.993
	(0.000)	(0.482)	(0.658)	(0.501)	(0.301)		
[redacted]							
Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
Cisco Systems (1989-2020)	9.159***	0.002**	-0.003**	0.001	-0.001	0.7700	20.086
	(0.000)	(0.019)	(0.020)	(0.499)	(0.158)		
[redacted]							
Dependent variable = TQ							
	_cons	XRD	LXRD	LXRD2	LXRD3	R-sq	F
Oracle (1984-2019)	5.470***	-0.000	-0.002	0.002	-0.000	0.2762	2.672
	(0.000)	(0.854)	(0.499)	(0.473)	(0.851)		

Note: P-Values are reported in parentheses. ***, **, and * show statistical significance at 1%, 5%, 10% levels, respectively.

The net effects (sum of the slope-coefficients) of RD_t (XRD), RD_{t-1} (LXRD), RD_{t-2} (LXRD2) and RD_{t-3} (LXRD3) on Tobin's Q is either zero or negative for all the selected companies except Cisco Systems. In several cases, the coefficients of RD_t (XRD) are positive and those for RD_{t-1} (LXRD), RD_{t-2} (LXRD2) and RD_{t-3} (LXRD3) are either zero or marginally negative. R^2 vary from 0.05 to 0.28 except Cisco Systems for which R^2 is 0.77. For Microsoft, (R^2 = 0.60) and for Facebook/ Meta, (R^2= 0.62). In all cases, F-statistics are insignificant except HP Inc., Cisco Systems, and Microsoft. For Facebook/ Meta, R^2 is seemingly overly inflated. Thus, it is inferred that R&D expenditures, in general, have no apparent bearings for improvement in Tobin's Q. This may be due to expensing R&D investment in the current year or overinvesting beyond the optimum level.

CONCLUSIONS

Year-to-year fluctuations in R&D investment by the selected ten US IT companies are unduly varying over sample periods across these companies. Current and lagged R&D investment mostly correlate negatively with current Tobin's Q. Their net effects on Tobin's Q are negative, though quite subdued. Presumably, this may be the case due to much longer gestation periods between R&D expenditures and the final outcomes. Moreover, the resulting final outcomes may likely be shrouded with high uncertainties.

In closing, the findings of this study are largely supported by some of the previous published articles (e.g., Oriani and Sobrero, 2008; de Andres et al. 2017 and 2021, Coad and Rao, 2010, Aral and Weill, 2007; Li and Tallman, 2011).

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