

Deciphering The Seemingly Counter Intuitive Impact Of Firm Innovation On Stock Returns In The Electronics Sector

Gun Jea Yu, Hongik University, South Korea
KiHoon Hong, Hongik University, South Korea
Kyoung-Min Kwon, Hongik University, South Korea

ABSTRACT

This paper investigates the impact of firms' innovative activities on stock returns for firms in the electronics sector. The regression analysis provided counter intuitive result that exploitation and exploration are not significant in explaining stock returns. However, further analysis on firm size revealed that innovation have statistically significant explanatory power in the stock returns of relatively large firms, and the effect was negative and positive for exploitation and exploration, respectively. This is consistent with general expectations. The result implies that equity investors may believe that innovation is important for relatively larger firms only.

Keywords: Firm Innovation; Stock Returns; Exploitation; Exploration

INTRODUCTION

Academically and practically, explaining stock returns and finding the determinant factors of stock returns have long been crucial research topics in finance. Stock returns is a very important indicator that reflects how investors evaluate firms over the period for which the return is computed. Therefore, it is not surprising that many significant firm compensation measures such as executive compensation are often influenced by stock returns. Stock returns can be independent of a firm's earnings, as it reflects both firm profitability and market sentiment about the firm's potential. Firm earnings are often determined by accounting information and subsume market perspectives. Therefore, academics often find that stock returns are more volatile and difficult to explain.

The previous literature has heavily investigated many factors that could explain stock returns at various levels such as individual firm, sector, and macro-economic level. Previous studies that have investigated the explanatory variables of stock returns at the individual firm level include Chen and Zhang (2007) and Chen, Da, and Zhao (2013). This stream of literature often employs accounting and financial factors from an individual firm's financial statements to explain stock returns. The accounting and financial factors of individual firms such as earnings, ROE, book value or discount rate obtained from financial statements are empirically shown to have statistically significant explanatory power to explain a firm's stock return.

Fama and French (1993) is one of the most typical studies of reference that investigated stock returns at a macro-economic level. The Fama-French model is a type of asset pricing model that is based on the capital asset pricing model (CAPM). In particular, the Fama and French three factor model underlines three factors: the subtracted value of excess market returns from a portfolio's expected rate of return, the subtracted value of a portfolio's returns for a large firm from a small firm (SMB, small minus big), and the subtracted value of returns for a low book value firm from a high book value firm (HML, high minus low).

Besides the above traditional factors, Hong and Yu (2016) found that firm innovative activities such as exploitation and exploration are also statistically significant when explaining stock returns. Reflecting and specifying their results, this research investigates the impact of firm innovative activities to stock returns in the electronics sector. Firms'

innovation activities are employed as information with which to estimate the potential returns and growth opportunities besides accounting information and the common information in markets, because innovation promotes improvement in products, services, and processes for improved performance (Amabile, 1983).

Exploitation yields lesser but stable profits by improving existing products and services (Lavie, Stettner & Tushman, 2010; March, 1991), whereas exploration yields relatively high profits by generating novel products and services at higher risk than exploitation (Lavie et al. 2010; March, 1991). Thus, firms either pursue short-term performance via exploitation or long-term performance via exploration (Lavie et al. 2010; Raisch & Birkinshaw, 2008) and investors are provided with important information gleaned from these two activities. We suspect that investors respond based on the evaluation of the level of risk and the degree of profit in the two activities hold.

However, fewer studies have been conducted on the impacts of exploitation and exploration on stock returns. As addressed in the literature review, McNamara and Baden-Fuller (2007) first investigated the impacts of exploitation and exploration on stock returns, but the sample was limited to the biotechnology industry. We doubt the generalisability of this study, because exploration had a dramatically larger effect in the biotechnology industry than in other industries (Junni, Sarala, Taras & Tarba, 2013); therefore, we intend to investigate the impacts of the two activities on stock returns using the sample of firms in the electronics industry, where both exploitation and exploration activities are robust, do not have an extreme influence on stock price, and have a critical influence on stock market variations.

We identified the electronics sector as the sector of interest due to unique role of innovation in comparison to other sectors. The length of product lifecycle (PLC) in the electronic industry is often shorter than in other industries such as manufacturing, energy, or utilities. Exploration aims to enhance the long-term firm profitability by developing new products and technologies. However, exploration R&D activities quickly become exploitation activities in the electronics sector once new technology is revealed. Examples include semiconductors and smartphones. This implies that investors recognise exploration as a “must to adapt” factor in fast changing industries such as electronics. In turn, investors must perceive exploration as a positive sign of future profitability. However, investors regard firms that pursue exploitation as having fewer competitive advantages because these firms have rigid core competencies and may be unable to adapt to a new environment.

The main objective of this study is to analyse whether exploitation and exploration can add statistically significant explanatory power to one of the most frequently used existing models that explains stock returns in the electronics sector. There are two aspects to which we wish to attract readers’ attention: 1) We employ accounting information of individual firms and market-wide common factors, and 2) We are specifically interested in the electronics industry.

LITERATURE REVIEW AND HYPOTHESES

Two streams of literature are related to this study. The first stream of studies interprets excess stock returns from a financial perspective and the second stream of studies is concerned with the influence of exploitation and exploration on firms’ returns and potential growth from the perspective of strategy and macro-organisational behaviour. A crucial subject in the financial literature has been explaining the excess stock price returns with the factor model. Numerous efforts have been made to explain excess stock returns from various perspectives including accounting, strategies, management, momentum, and behavioural finance angles.

This study uses accounting information and market information to explain excess stock returns. Accounting information reflects the distinct characteristics of individual firms and market information reflects market-wide shocks, which are commonly applied to firms. This paper uses the Chen and Zhang (2007) model as an excess stock returns model that uses accounting information (Chen & Zhang, 2007). This model has been successfully utilised for interpreting excess stock returns in many other studies, although the recent study of Chen, Da, and Zhao (2013) actively cited this model (Chen, Da & Zhao, 2013; Fama & French, 1993). Meanwhile, the Fama and French (1993) model is universally used to clarify excess stock returns with market-wide factors that are common influences, albeit at different levels. This model is addressed greater depth afterwards (Fama & French, 1993).

Exploitation and exploration have been widely studied in the field of strategies, organisational learning, and organisational structure (Lavie et al., 2010). Extant studies have focused on two aspects: one that covers the drivers of exploration and exploitation such as the characteristics of organisations, managers, and environments, and one that covers the influence of exploitation and exploration on firm performance (Lavie et al. 2010; Raisch & Birkinshaw, 2008). The focus of this study is given to the impacts of exploration and exploitation on firm performance.

Exploration allows firms to adapt to new environments by developing new technologies and products, while exploitation maximises the opportunities in current markets by improving products based on existing skills (Abernathy & Clark, 1985; Burgelman, 2002; Dewar & Dutton, 1986; Tushman & Anderson, 1986). Therefore, the features of outcomes derived from these two activities are dissimilar. First, the outcome of exploration brings high uncertainty whereas the outcome of exploitation has low uncertainty (Levinthal & March, 1993). With these features, exploration positively impacts long-term performance, and exploration leads to short-term performance in the meantime (Junni et al. 2013; Lavie et al. 2010). Second, firms should appropriately allocate their resources and their organisational structure and culture should be appropriately formed to support these two activities (Burgelman, 2002; Smith & Tushman, 2005; Tushman & O'Reilly, 1996).

The influences of exploitation and exploration on firm performance have been widely examined. Previous studies have shown that exploration has a positive impact on organisational growth, and exploitation is most closely associated with organisational profits (Junni et al. 2013). In addition, firms' performance as perceived by managers was also positively associated with both exploitation and exploration. In short, many studies have focused solely on the relationship between accounting performance and internal members' subjective assessments. While we admit that the internal response or results of exploration and exploitation are important, we also point out that the external response to the two is important. Investors, who are external stakeholders, are key financial sources and understanding their behaviour can provide firms with important information. Thus, this study intends to analyse the impacts of exploitation and exploration on stock returns, which can be interpreted as investors' responses.

Explaining stock returns has been of interest to both practitioners and academics. Main analysis primarily investigates information about firm accounting information to access a firm's intrinsic value. The most frequently investigated accounting information includes earnings, dividends, investment opportunities, the cost of capital and R&D expenditure. Ou and Penman (1989) performed financial statement analysis that merged elements of financial statement into a simple measure and showed that the measure could predict stock returns.

Although there is much fundamental information that could influence or explain stock returns, this study intends to investigate innovative activities. Information about firm innovation activities has a well-known influence on firm profitability (Crossan & Apaydin, 2010). R&D expenditure is arguably one of the most important activities that can drive corporations' long-term viability; hence previous period R&D expenditure is often considered to reflect a firm's innovation for explaining stock returns. (Chambers, Jennings, and Thompson, 2002; Chan, Lakonishok, and Sougiannis, 2001).

However, R&D expenditure is an ex-ante indicator of a firm's innovation and is exposed to the uncertainty that investment in innovation could end up with no profitable outcome and therefore result in a loss. Assessing the appropriate result of R&D on firm profitability can be very complicated, as many uncertain factors require consideration. Hence, many existing studies have found it is very difficult and complicated for investors to incorporate the effects of R&D expenditure in previous periods to stock price (Hirshleifer, Lim, and Teoh, 2009).

From this evidence, Hong and Yu (2016) pointed out two disadvantages of R&D expenditure as a proxy for firm innovative activities. First, R&D expenditure only represents an aspect of a firm's innovative activities, in that it reflects the uncertain investments but does not result in its outputs. Second, analysis of final effect of R&D expenditure on firm performance is complicated, and thus it is hard for investors to process such information.

Following their work, we adopted exploration and exploitation to capture innovation activities using patent data. This approach has two advantages: First, intermediate outcomes (exploration and exploitation as measured by patent data) minimises the uncertainty of R&D expenditure, which can succeed or fail. Second, the categorisation of innovation activities in exploration and exploitation can help us understand the distinct impacts of different types of innovation on stock returns due to the difference in the nature of the two.

Investors' response to exploration and exploitation is straightforward. When investors make decisions regarding stock investments, they consider the expected return and the risk for a firm (Fama & French, 1993; Markowitz, 1952). The risk of a firm includes the likelihood of survival (or unlikelihood of default). Investment in a firm is considered less risky if it is less likely to go out of business. Another aspect of risk that an investor should consider when investing in a firm's stock is the financial investment risk. Even if a firm does not go out of business, the price of its stock could decline, which can create significant investment risk.

Investors are interested in the expected return and risk in their investment because a higher expected return increases investors' utility, while a higher variance decreases investors' utility. Investors prefer stocks that have higher expected returns and low variance in returns. The chance of exploration to generate a return is much lower than that of exploitation, although the size of the return in exploration is larger than that of exploitation. In other words, exploration yields a larger expected return with high variance, whereas exploitation generates a relatively small expected return with low variance. In addition, the expected return of exploitation is realised in the short-term, whereas that of exploration is in the long-term.

It is well known that stock market investors prefer short-term earnings, an outcome of exploitation, to long-term ones, an outcome of exploration (Tylecoet & Ramirez, 2006). Therefore, we expect that investors would take exploitation as a positive sign of a firm's expected returns in the short-term; therefore, it would be reflected in positive stock returns. However, we also expect that investors would consider exploration as a negative sign for a firm's expected returns in the short-term; therefore, it would have a negative effect on the stock returns.

However, we believe that such investor response could differ in the electronics industry due to industry-specific characteristics. More specifically, the length of PLC in the electronics industry could be significantly shorter than in other industries such as the manufacturing industry. PLC theory, which has been heavily investigated in previous studies on strategy, suggests that the evolution of a product's market existence is similar to its organic life (Nadeau & Casselman, 2008). PLC consists of four stages: introduction, growth, maturity, and decline. Firms need to create new products through exploration in the early stages such the introduction and growth stages. Meanwhile, firms focus on the improvement of their current products via exploitation in the late stages such as maturity and decline.

This implies that exploration is replaced by exploitation in the maturity and decline stages. However, if the period of transition from exploration to exploitation is shortened by a shortened PLC, the distinction between exploration and exploitation become blurred. Thus, firms need to develop new products or services even though PLC has reached the maturity or decline stages. This implies that investors recognise exploration as a must to adapt to fast changes in the industry. Therefore, they perceive exploration as a positive sign. However, investors regard firms that pursue exploitation as having less of a competitive advantage, because these firms have rigid core competencies and may not be able to quickly adapt to a new environment. Therefore, we suggest the following hypotheses.

Hypothesis 1: Exploitation activities have a negative influence on stock returns.

Hypothesis 2: Exploration activities have a positive influence on stock returns.

RESEARCH DATA AND MODEL

Exploratory Model Of Excess Earning Rate Of Individual Stocks With Accounting Data

As previously discussed, this paper takes advantage of the model of Chen and Zhang (2007) in controlling firm-specific factors. Chen and Zhang (2007)'s model has been frequently employed to explain stock returns in many previous literatures including Hong and Wu (2016) and Chen and Zhang (2007) investigated the underlying operation

process of a companies via relationships between future cash flows and the accounting elements. Chen and Zhang (2007) stated “The advantage of this model is that it embeds the firm’s value-creating capital investment decisions within the set of available opportunities as characterized by options to grow and to downsize or abandon.” A modified version of Chen and Zhang (2007)’s model is employed in this paper.

According to the Chen and Zhang (2007) model, a firm’s returns represented as a return on equity is the most important figure with which to explain the excess earning rate of stocks and estimate the potential values generated by earnings using the firms’ investment. In our model, V_t represents a firm’s capital value at time t , B_t represents the book value of equity, and X_t represents the earnings generated in period t . In Chen and Zhang’s sample, the variable to expand operations g_t that is derived from analysts’ opinions, was also included. We excluded it from our analysis because we could not get the same information for our sample.

The firm’s return on common equity, q_t , is defined as $X_{i,t}/B_{t-1}$, while $P(q_t)$ and $C(q_t)$ represent the put-option to abandon operations and the call-option to develop operations, respectively. In the Chen and Zhan (2007) model, the stock value is as follows in Eq. (1).

$$V_t = B_t \left[\frac{q_t}{r_t} + P(q_t) \right] \equiv B_t v(q_t, r_t) \tag{1}$$

Eq. (1) shows that the stock value is a function of the unit-per-value and discount rates. ΔV_{t+1} is the amount of equity variation from t to $t + 1$, and is defined by $v_1 \equiv \frac{dv}{dq_t}$ and $v_3 \equiv \frac{dv}{dr_t}$ while D_t represents the dividends. Then, we modify the Chen and Zhang (2007) model to apply it to our study, as shown in Eq. (2)

$$R_t = \left[\frac{X_{t+1}}{V_t} \right] + \left[\frac{X_{t+1}}{V_t} \right] + \left[\left(1 - \frac{B_t}{V_t} \right) \frac{\Delta B_t}{B_t} \right] + \left[\frac{(B_t)}{V_t} \Delta r_t \right] \tag{2}$$

Eq. (2) also illustrates how stock return rates can be explained by earnings yield and ROE variation; therefore, Eq. (3) can be estimated using a firm’s accounting data.

$$R_{i,t} = \alpha + \beta x_{i,t} + \gamma \Delta \hat{q}_{i,t} + \delta \Delta \hat{b}_{i,t} + \phi \Delta \hat{r}_{i,t} + \epsilon_{i,t} \tag{3}$$

$R_{i,t}$ is defined by the excess earning rate of stocks, and

$$x_{i,t} = X_{i,t}/V_{i,t} - 1,$$

$$\Delta \hat{q}_{i,t} = \frac{(q_{i,t} - q_{i,t-1})B_{i,t-1}}{V_{i,t-1}},$$

$$\Delta \hat{b}_{i,t} = (B_{i,t} - B_{i,t-1}) \frac{1 - B_{i,t-1}}{V_{i,t-1}},$$

$$\Delta \hat{r}_{i,t} = \frac{(r_{i,t} - r_{i,t-1})B_{i,t-1}}{V_{i,t-1}}$$

In Eq. (3), the regression analysis model x_t represents the earning rate, $\Delta \hat{q}_{i,t}$ represents the return variation, $\Delta \hat{b}_{i,t}$ represents the book value variation, and $\Delta \hat{r}_{i,t}$ represents the discount rate variation. In Eq. (3), the four variables show the individual firm’s data explaining the excess earning rate of individual stocks.

3.2 Fama And French Three Factor Model

Fama and French sought to explain the excess stock return by starting with the stylised fact that two types of stock yielded higher excess return than the market as a whole: 1) small caps and 2) stocks with a low Price-to-Book ratio or value stocks. Fama and French added these two factors to CAPM, which explains the excess stock return with the

market portfolio excess return to reflect a portfolio’s exposure to the two classes. Hence, Fama and French (1993) suggested that excess earnings in a given portfolio can be explained by three factors: the market excess earning rate that is the market portfolio earning minus the risk-free interest rate; the difference between the portfolio earning rates of small vs. large firms; and the difference between the portfolio earning rates of high vs. low book-to-market value firms. This paper follows Fama and French (1993) in modelling the excess earning rate and uses the following model.

$$R_{i,t} = \beta_i \text{MKT} + s_i \text{SMB} + h_i \text{HML} \tag{4}$$

Here, $R_{i,t}$ represents a firm i ’s earning rate in the portfolio, MKT, SMB, HML are the expected risk premiums, and β_i, s_i, h_i is the slope coefficient of the time-series regression. The variable MKT stands for ‘Market’ and is defined as the excess market return over the risk-free rate. The variable SMB is ‘Small (market capitalisation) Minus Big’ and HML is ‘High (book-to-market ratio) Minus Low’. They measure the past excess returns of small cap stocks over big cap stocks and of value stocks over growth stocks. Above factors are computed with combinations of portfolios composed by ranked stocks (BtM ranking, Cap ranking) and include available historical market data. We obtained the historical values for these factors from Kenneth French’s web page.

3.3 Exploitation And Exploration

Therefore, the regression model with which to analyse stock excess earning is as follows.

$$R_{i,t} = \alpha + \beta A_{i,t} + \gamma F_t + \delta E_{i,t} + \varepsilon_{i,t} \tag{5}$$

where

$$\begin{aligned} A_{i,t} &= (x_{i,t} \ \Delta \hat{q}_{i,t} \ \Delta \hat{b}_{i,t} \ \Delta \hat{r}_{i,t})^T, \\ F_t &= (\text{MKT}_t \ \text{SMB}_t \ \text{HML}_t)^T, \\ A_{i,t} &= (E_{i,t} \ \text{ER}_{i,t})^T, \\ \beta &= (\beta_1 \ \beta_2 \ \beta_3 \ \beta_4), \\ \gamma &= (\gamma_1 \ \gamma_2 \ \gamma_3), \\ \delta &= (\delta_1 \ \delta_2) \end{aligned}$$

EMPIRICAL ANALYSIS

Data And Sample

This paper samples all US electronic firms holding exploitation and exploration data based on the Standard Industrial Classification (SIC) for 1997–2006 and uses the stock price, earning, book value and equity value and the risk-free interest rate from the Center for Research in Security Prices (CRSP) for Chen and Zhang (2007)’s accounting and financial model, and data for the Fama and French model from the Data Library of Kenneth French.

Patent data has been widely used to measure exploitation and exploration (Katila & Ahuja, 2002; Quintana-Garca & Benavides-Velasco, 2008). Following previous studies, we measure exploitation and exploration using patent citations. The number category must be specified when applying for a patent. In addition, if other patents are cited, their category must also be stated. While exploitation includes all cases in which the cited patent category is the same as the category that the applying firm already owns, exploration refers to all cases in which the cited patent does not belong to any of them. We measure exploitation as the sum of cases in which the cited patents are owned by the firm, and exploration as the sum of cases in which they are not. To avoid skewness problem, we apply natural log transformation.

The sample in this study consists of 6,707 items of firms’ annual data. There are 80,483 observations, including every US electronics firm over 1997-2006. Table 1 shows sample descriptive statistics, with the average, standard deviation, skewness, and kurtosis in Eq. (5).

This table presents the mean, standard deviation, skewness and kurtosis of the variables in Eq. (5). The sample includes 6,707 items of firm-specific annual panel data of accounting information and innovative activities for 1977–2006.

Table 1. Summary Statistics

	R	X	$\Delta\hat{q}$	$\Delta\hat{b}$	$\Delta\hat{r}$	EI	ER	MKT	SMB	HML
Mean	-0.11	-0.09	0.2	1.508	-0.00	118.12	6.52	0.01	0.33	0.35
S.D.	0.68	7	18.91	129	0.04	9596.9	523.5	0.04	2.91	3.14
Skewness	0.09	-71.1	35.05	81.8	-50.1	81.89	81.88	-0.59	-0.57	-0.57
Kurtosis	6.42	5695	3484	6699	3314	6706	6705	2.26	8.42	1.52

Empirical Result Of Exploitation And Exploration

This section performs an analysis by comparing the regression results from Model 1 to access the earning rate from the accounting data, Model 2 to get Fama and French’s three factors from the accounting data, and Model 3 to consider exploitation and exploration (Fama & French, 1993).

Model 1: $R_{i,t} = \alpha + \beta A_{i,t} + \varepsilon_{i,t}$ (6)

Model 2: $R_{i,t} = \alpha + \beta A_{i,t} + \gamma F_t + \varepsilon_{i,t}$ (7)

Model 3: $R_{i,t} = \alpha + \beta A_{i,t} + \gamma F_t + \delta E_{i,t} + \varepsilon_{i,t}$ (8)

We estimate coefficients from the above three models to test hypotheses 1 and 2, referring to how exploitation and exploration can explain the stock excess earnings of electronics firms. Table 2 shows the coefficients and statistical significance of three model regressions.

This table presents the estimated results of Models 1, 2, and 3 from Eq. (6), (7), and (8). The sample includes 6,707 firm-specific annual panel data of accounting information and innovation activities for 1977–2006.

Table 2. Estimation Results of Models 1, 2 and 3

	Model 1	Model 2	Model 3
X	0.048*** (0.000)	0.05*** (0.000)	0.05*** (0.000)
$\Delta\hat{q}$	-0.001* (0.032)	-0.001* (0.034)	-0.001* (0.033)
$\Delta\hat{b}$	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)
$\Delta\hat{r}$	-0.014 (0.957)	0.08 (0.763)	0.013 (0.959)
MKT	-	1.413*** (0.000)	1.41*** (0.000)
SMB	-	-0.007* (0.034)	-0.006* (0.039)
HML	-	-0.016*** (0.000)	-0.016*** (0.000)
EI	-	-	-0.0001 (0.648)
ER	-	-	0.001 (0.670)
a	-0.11*** (0.000)	-0.11*** (0.000)	-0.11*** (0.000)
R ²	0.026	0.043	0.046

As can be seen from the results in Table 2, the three Fama French factors are statistically significant for determining the stock excess earning of electronics firms, which is influenced by both individual firm's accounting data and the entire market. Our results are consistent with the extant empirical research, so we do not go into further detail (Fama & French, 1993). Comparing the Model 2 and 3 regression results allows examining whether exploitation and exploration have a negative, positive, and statistically significant impact on additional stock returns. The two hypotheses are rejected because they show statistically insignificant coefficient results, and R^2 is slightly increased in Model 3 compared to Model 2.

Why the two hypotheses were rejected should be addressed, while it should be noted that that the positive sign of exploration and negative sign of exploitation were shown. We argue that investors responded to exploration due to the rapid change of PLC. However, we also admit that exploitation contributes to the generation of short-term profits. In the ambidexterity literature, the concurrent pursuit of exploration and exploitation enables firms to gain competitive advantages (Lavie et al., 2010). Therefore, investors evaluate exploration positively but think that exploration is insufficient to realise potential profits.

Size Effect

With the data from all firms in the electronics sector, the result of the empirical analysis is very counterintuitive, in that firm innovative activities do not statistically explain stock returns. It is well known that exploitation and exploration are directly associated with a firm's earnings (Lavie et al., 2010). We notice that stock returns are not only closely associated to a firm's earnings, but also to the judgment of investors regarding a firm's survival. Investors may give a positive evaluation for innovation such as exploration and exploitation when firms are expected to survive. Therefore, the stock price can go down if investors in the stock market believe there are more important negative factors that are hampering a firm's survival, notwithstanding a firm's increased earnings. In short, there are two related but distinct aspects that managers must consider when pursuing exploration or exploitation: earnings enhancement through innovation such as exploration and exploitation and shareholders' response via stock return performance based on a firm's survival. Managers may face a trade-off between earnings maximisation for long-term performance and stock return performance.

Despite the vital nature of management decisions and organisational activities in relatively small firms, market circumstances and liquidity for survival will more likely influence stock returns. This situation, called liquidity risk, has been studied by existing studies including Pastor and Stambaugh (2001), and Acharya and Pedersen (2005) (Acharya & Pedersen, 2005; Pastor & Stambaugh, 2003). At the point of liquidity risk, exploitation and exploration are not deemed statistically significant for explaining the excess earning rate in analysis that examines the entire sample of electronic stocks, considering that large and small enterprises can coexist. Regarding small firms, investors are more concerned about survival. Meanwhile, investors are more concerned about exploration that will lead to long-term viability due to the increased probability of survival. Therefore, we divide the overall sample into two groups according to firm size and verify our assumptions below.

Hypothesis 3: Exploitation has a negative impact on the stock returns of large firms in the electronics industry, while exploration has a positive impact.

Hypothesis 4: Both exploitation and exploration are statistically significant and can explain the stock returns of small firms in the electronics industry.

Table 3 presents the results of Hypotheses 3 and 4 in which Model 3 estimated as a sample that was divided into two based on the size of a firm's capital stock. The results of Table 3 can show that both hypotheses are statistically significant. In the case of firms in the electronics industry with a large capital, exploration is negative for the excess earning rate, whereas exploration has a positive impact, and both are statistically significant. In the case of a small capital, the effects were seen as statistically insignificant.

This table displays the estimated results of Mode 3 from Eq. (8), dividing the total sample into two according to the size of individual corporations. The sample includes 6,707 firm-specific annual panel data of accounting information and innovative activities for 1977-2006.

Table 3. Results of Regression Analysis by Firm Size

	Large Firm	Small Firm
X	-0.073*** (0.000)	0.092*** (0.000)
$\Delta\hat{q}$	0.002 (0.358)	-0.001* (0.033)
$\Delta\hat{b}$	-0.08*** (0.000)	0.005*** (0.000)
$\Delta\hat{r}$	0.875 (0.262)	-2.708*** (0.000)
MKT	1.354*** (0.000)	1.214*** (0.002)
SMB	-0.008* (0.017)	-0.006 (0.217)
HML	-0.024*** (0.000)	-0.011 (0.051)
EI	-1.082*** (0.000)	-0.000 (0.180)
ER	2.073* (0.025)	0.002 (0.499)
a	-0.014 (0.212)	-0.203*** (0.000)
R ²	0.104	0.051 (0.000)

R² Decomposition

It is determined that exploitation and exploration have statistical significance to explain excess returns of firms with large-scale assets. However, the degree to which exploitation and exploration explain stock price volatility compared to other factors included in Model 3 remains unclear. In this section, this study analyses contributions' levels of exploitation and exploration in interpreting excess stock returns of firms with large-scale assets by decomposing R². We use a method to decompose R², which is known as goodness of fit, suggested by Huettner and Sunder (2012), with a contribution level of individual regression factors such as SSR and SST based on Shapley–Owen values. Table 4 estimates Model 3 by using only large-scale firms and shows contributions of R² by each variable.

This table presents the decomposed R² of Mode 3 from Eq. (8). The sample includes 6,707 firm-specific annual panel data of accounting information and innovative activities from 1977 to 2006.

Table 4. R² Decomposition Analysis

	Coeff.	% R² contribution
x	-0.073*** (0.001)	12.60%
$\Delta\hat{q}$	0.002 (0.358)	1.33%
$\Delta\hat{b}$	-0.08*** (0.000)	39.87%
$\Delta\hat{r}$	0.875 (0.262)	8.32%
MKT	1.354*** (0.000)	14.76%
SMB	-0.008* (0.017)	1.14%
HML	-0.024*** (0.000)	18.50%
EI	-1.082*** (0.000)	2.78%
ER	2.073* (0.025)	0.70%
a	-0.0139 (0.212)	0.00%
R ²	0.104	-

Table 4 indicates the results of estimating Model 3 and decomposing R² by using only large-scale firms. As it shows, exploitation accounts for 2.8% of the aggregate R² contribution, and exploration constitutes 0.7%. However, exploration has double the absolute value of the estimated coefficient. This means that although exploitation has greater significance of statistical interpretations, if exploration succeeds, the success has a greater impact on stock returns. This denotes investors’ risk averseness toward an exploration’s lower possibility of success than that of exploitation.

Shareholders believe that exploration impacts on stock prices with a higher probability than exploitation on average. This assumption lies in the fact that while the expected returns of exploitation are greater than exploration's, exploitation has a high variability of results. However, if it succeeds, exploration has greater influences on stock prices. This is based on exploration’s higher expected return if successful.

IMPLICATIONS AND CONCLUSION

This study analysed whether exploitation and exploration are statistically significant, and how exploitation and exploration are correlated with excess stock returns. This approach has a significant meaning in terms of analysing with external perspectives from shareholders, not with an internal perspective of firms.

The outcomes of regressions over every sample prove that excess stock returns of firms in the electronics industry have a positive correlation with exploration and a negative correlation with exploitation. However, it seems that the hypotheses are not supported because those results are not statistically significant. However, additional analysis based on asset scale shows that exploitation and exploration are statistically significant for explaining excess stock returns only for firms with large size assets. This implies that, for small firms, factors such as liquidity have a greater explanatory ability to interpret excess stock returns and, in addition, the bigger firms’ size becomes, the more innovation activities influence investment decisions.

ACKNOWLEDGEMENT

For KiHoon Hong, this research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2016R1D1A1B03930195).

AUTHOR BIOGRAPHIES

Dr Gun Jea Yu has a Ph.D. in Industrial Labor and Relations from Cornell University and is now an Assistant Professor at the College of Business Administration in Hongik University. His current research is focused on innovation and R&D management. Dr Gun Jea Yu is the corresponding author and can be contacted at: gy52@hongik.ac.kr

KiHoon Hong is an assistant professor at the college of business administration in Hongik University. He holds Ph.D. in economics from University of Cambridge. His current research topic includes quantitative finance and crypto currencies.

Kyoung-min Kwon earned his PhD in Finance from Michigan State University in 2012. He is Assistant Professor of Finance at Hongik University College of Business Administration. His research interest includes corporate finance, corporate governance and product markets.

REFERENCES

- Abernathy, W. J., & Clark, K. B. (1985). Innovation – Mapping the winds of creative destruction. *Research Policy*, 14(1), 3-22.
- Acharya V. V., & Pedersen, L. (2005). Asset Pricing with Liquidity Risk. *Journal of Financial Economics*, 77(2), 375-410.
- Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of personality and social psychology*, 45(2), 357.
- Burgelman, R. A. (2002). Strategy as vector and the inertia of coevolutionary lock-in. *Administrative Science Quarterly*, 47(2), 325-357.
- Chambers, D., Jennings, R., & Thompson, R. B. (2002). Excess returns to R&D-intensive firms. *Review of Accounting Studies*, 7(2), 133-158.
- Chan, L. K., Lakonishok, J., & Sougiannis, T. (2001). The stock market valuation of research and development expenditures. *The Journal Of Finance*, 56(6), 2431-2456.
- Chen, L., Da, Z., & Zhao, X. (2013). What Drives Stock Price Movements? *Review of Financial Studies*, 26, 841-876
- Chen, P., & Zhang, G. (2007). How do accounting variables explain stock price movements? Theory and evidence *Journal of Accounting and Economics*, 43(2), 219-244.
- Crossan, M. M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: A systematic review of the literature. *Journal of management studies*, 47(6), 1154-1191.
- Dewar, R. D., & Dutton, J. E. (1986). The Adoption of radical and incremental innovations – An empirical analysis. *Management Science*, 32(11), 1422-1433.
- Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33(1), 1-56
- Hirshleifer, D., Lim, S. S., & Teoh, S. H. (2009). Driven to distraction: Extraneous events and underreaction to earnings news. *The Journal of Finance*, 64(5), 2289-2325.
- Hong, K., & G., Yu, 2016, Patents and R&D Expenditure in Explaining Stock Price Movements. *Finance Research Letters*, 19, 197-203
- Hong, K., & E. Wu (2016). The Roles of Past Returns and Firm Fundamentals in Driving US Stock Price Movements. *International Review of Financial Analysis*, 43, 61-75
- Huettner, F., & Sunder, M. (2012). Axiomatic arguments for decomposing goodness of fit according to Shapley and Owen values, Electronic. *Journal of Statistics*, 6, 1239-1250.
- Junni, P., Sarala, R. M., Taras, V., & Tarba, S. Y. (2013). Organizational ambidexterity and performance: A meta-analysis. *Academy of Management Perspectives*, 27(4), 299-312. doi:10.5465/amp.2012.0015
- Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy Of Management Journal*, 45(6), 1183-1194.
- Lavie, D., Stettner, U., & Tushman, M. L. (2010). Exploration and Exploitation Within and Across Organizations. *Academy of Management Annals*, 4, 109-155. doi:10.1080/19416521003691287
- Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic Management Journal*, 14, 95-112.
- March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2(1), 71-87.
- McNamara, P., & Baden-Fuller, C. (2007). Shareholder returns and the exploration–exploitation dilemma: R&D announcements by biotechnology firms. *Research Policy*, 36(4), 548-565.
- Markowitz, H. (1952). The utility of wealth. *Journal of political Economy*, 60(2), 151-158.
- Nadeau, J., & Casselman, R. M. (2008). Competitive advantage with new product development: implications for life cycle theory. *Journal of Strategic Marketing*, 16(5), 401-411.
- Pastor, L., & Stambaugh, R. F. (2001). Liquidity Risk and Expected Stock Returns. NBER Working Paper No. 8462.

- Ou, J. A., & Penman, S. H. (1989). Financial statement analysis and the prediction of stock returns. *Journal of accounting and economics*, 11(4), 295-329.
- Quintana-Garcia, C., & Benavides-Velasco, C. A. (2008). Innovative competence, exploration and exploitation: The influence of technological diversification. *Research Policy*, 37(3), 492—507.
- Raisch, S., & Birkinshaw, J. (2008). Organizational ambidexterity: Antecedents, outcomes, and moderators. *Journal of Management*, 34(3), 375-409.
- Smith, W. K., & Tushman, M. L. (2005). Managing strategic contradictions: A top management model for managing innovation streams. *Organization Science*, 16(5), 522-536.
- Tushman, M. L., & Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly*, 31(3), 439-465.
- Tushman, M. L., & O'Reilly, C. A. (1996). Ambidextrous organizations: Managing evolutionary and revolutionary change. *California Management Review*, 38(4), 8-23.
- Tylecote, A., & Ramirez, P. (2006). Corporate governance and innovation: The UK compared with the US and 'insider' economies. *Research Policy*, 35(1), 160-180.

GLOSSARY

- B_t: Book value of equity
C(q_t): Call option to increase operations
D_t: Dividends paid at time t+1
E_{lit}: Number of exploitation for firm i at time t
E_{Rit}: Number of exploration for firm i at time t
E_t(X_{t+1}): Expected earnings in the next period
g_t: Firm growth opportunities at time t
HML: ‘High (book-to-market ratio) Minus Low’
K: The earnings capitalisation factor
P(q_t): Put option to close operations
q_t ≡ X_t / B_{t-1}
R_{mt}: Excess market return over the risk free rate
R_{t+1}: Stock return at time t+1
R_{it}: Annual excess stock return over the risk free rate
R&D: Research and Development
SMB: ‘Small (market capitalisation) Minus Big’
V_t: Value of an all equity firm at time t
X_t: Earnings generated at time t
x_{it} = X_{it} / V_{it-1}: Earnings yield
 $\Delta \hat{q}_{it} = (q_{it} - q_{it-1})B_{it-1}/V_{it-1}$: Change in profitability
 $\Delta \hat{b}_{it} = (B_{it} - B_{it-1})(1 - B_{it-1}/V_{it-1})$: Capital investment
 $\Delta \hat{r}_{it} = (r_{it} - r_{it-1})B_{it-1}/V_{it-1}$: Change in the discount rate

NOTES