Resident Bird in Growth Stock; Evidence from Innovation Ability

Abstract

I investigate whether firm characteristics influence the mean reversion in profitability. I assume that when a firm has more innovation abilities, a firm can keep (or increase) its profitability level over time. This characteristic attenuates a mean reversion in profitability when a firm has higher level of profitability. In addition, if a firm has lower profitability level currently, this innovation ability will stimulate the mean reverting in profitability. In order to measure the likelihood of firm innovation ability, I employ the number of patents and citations scaled by a firm size. I expect that the firm innovation is negatively associated with a firm profitability mean reversion. My evidence suggests that the firm innovation ability plays an important role in the firm mean reversion in profitability. Therefore, we have to consider a new evidence to develop a forecasting model for profitability.

Section 1: Introduction

I study whether firm innovation abilities and their outcomes can influence its mean reversion strength in profitability[1]. I conjecture that a firm having ability to innovate its core competency has a higher probability of keeping higher profitability relative to peer group when it has higher profitability currently. If a firm has a higher level of innovation ability, it has weak mean reversions in profitability. On the contrary, if a firm has less profitability than median of competitors, this innovative ability will make a firm quickly mean reverting to long-run equilibrium profitability level. In order to measure a likelihood of a firm's innovative ability, I use a standardized number of patents and citations by a firm size. These are proxies of the firm innovativeness. Thus, the higher a standardized number of patents (or citations) represent the more innovativeness; if a firm has a higher number of patents (or citations), a firm's mean reversion strength will be attenuated under my hypothesis.

This is important in terms of stock market mispricing and investors' investment strategies because a specific firm characteristic can influence its natural mean reversion, in other words "standard economic argument" (Fama and French, 2000). This evidence shows that when firms keep their innovation ability and its outputs, their higher profitability last long. Therefore, if an ordinary investment strategy follows a general belief which is a mean reversion in profitability (or a firm migration), it might lose many specifications. This misunderstanding may lead mispricing and improper investors' reactions. My research highlights that one of these missing specifications is a firm innovativeness.

[1] This research proposal was started at the College of Business in University of North Texas. I developed my idea and constructed a broad sample with the University of North Texas system.

Section 2: Literature review

2.1. Mean Reversion in Profitability

We have a traditional belief; it is generally assumed that profitability would be mean reverting and competitions will force a conversion of firm profitability over time. Strong competition and new entrants will decrease a high profitability at the industry level and the firm level. Similarly, firms with low profitability may spend their resources to improve their profitability.

According to Fama and French (2000), predictability in earnings can be explained by the predictability and the profitability mean-reversion. They report that annul mean reverting in profitability is 38% with simple partial adjustment model during 1964 ~ 1996 when highly regulated industries are excluded. Mean reversion in profitability may explain why it is hard for firms to sustain their higher profitability over time. They employ a change in profitability as a function of the previous year's change in profitability from a firm expected return, $ROA_t - E(ROA_t)$. This deviation of profitability from expected value (DFE hereafter) is the important measure can explain their mean reversion in profitability. Especially, mean reversion in profitability is stronger when profitability is below (or far below) average mean level in either direction.

This argument is also explained by the stock migration (Fama and French, 2007, Migration). They examine that the migration of firms having different size and values, such as big and growth, big and value, big and neutral, small and growth, small and value, and small and neutral. Then they report that a small firm migrates to a big firm and a value firm migrates to a growth firm, or vice versa, respectively. They insist that migration of stock contributes to the size

and value premium in average stock returns. The size premium is entirely generated by the small-capitalization stocks which show higher returns and change their portfolio to big-capitalization stocks. The value premium is generated by value stocks having higher earnings, growth stocks having lower earnings relative to expectations, and value stocks having slightly higher returns than growth stocks that do not migrate. They also suggest that a migration mechanism from growth firms to value firms with required rate of returns and actual returns (Fama and French, 2007, "The Anatomy of Value and Growth Stock Returns"). Fama and French break stock returns into dividends and three other sources of capital gain which are growth in book equity, price to book ratio, and upward drift in P/B ratio. The growth firms have higher expected profitability and higher expected growth rate but when they underperform in their profit and growth rate, these growth firms will start to migrate from the category of growth firm to the value firm. This is because disappointed investors realize their lower expectations on the market price. On the other hands, the capital gains of value stocks make its returns more profitable and this value stock move to growth stock group. Therefore, different required rates of return in value stocks and growth stocks may change their stock price and their category, growth and value.

Chan et al. (2003) find that only few firms maintain their growth rate consistently above median growth in sales. This finding is generally consistent with Fama and French (2000) mean reversion in profitability, but partially, they suggest that the possibility of specific firm characteristics can make mean reversion in profitability less influential. In this sense, this finding is very important. Authors analyze historical long-term growth rates with several operating performance variables, such as the growth in sales over five years, book to market value ratio, dividend yield, R&D expenditures, and technology sector dummy. They report that only few

firms have grown at high rates in sales, but the consistent higher growth in sales does not translate into the consistent in earning growth. They use a stock price, net sales, operating income, and income before extraordinary items for common equity as performance measures from 1951 to 1997.

Recently, Knapp et al. (2006) report the significant mean reversion in profitability after banking merger. The significant mean reversion is not surprising because of the competitive environments in banking industry. Serban (2010) find that there is mean reversion in return in the foreign exchange market as well as equity market. The investment strategy using mean reversion and momentum can generate abnormal returns. They argue that this portfolio strategy originated from equity market is working better in foreign exchange market. Chen and Zhao (2005) find theoretical and empirical evidence that leverage ratios can revert on mean level. Even if firm follows pecking order theory to raise funds, authors insist that we can observe mean reverting in leverage ratio.

Another important previous finding is seasonal mean reversion effect in stock price (Jegadeesh, 1991). He finds that the evidence of mean-reverting in stock prices but this effect is concentrated in January, in other words January effect. Therefore he points out "The evidence of slowly mean-reverting components in stock prices has been controversial." The author tests a set of regression models with one month equally weighted index of stocks as dependent variable and aggregated lagged multiyear returns (4 years, 5 years, 6 years, 7 years, 8 years, 9 years and 20 years) as independent variables. He also obtains similar results with London stock exchange data.

2.2. Mean Reversion with Time Series model

Recently many researchers try to find mean reversion with time series methods because most of profitability measures are time varying. Chen and Lin (2010) find the evidence that there is an asymmetric mean reversion in return on equity with AR models. They also show that the speed of mean reversion in ROE to the long-term equilibrium level is slower in ROE increasing than in ROE decreasing. If ROE is an accounting return measure, Becker et al. (2010) report the mean reversion using the financial return measure, stock returns. They employ S&P 500s' P/E ratios from 19871 to 2003 and time series models.

Canarella et al. (2012) examine the mean reversion in profitability with ROA, ROE, and ROI measures using a unit root time series method. The dataset covers 11,360 U.S. public firms belong to all sectors from 2001 to 2010. However, they find the profitability persistence in some sectors. Their test results do not specify the sector do not show the mean reversion in profitability, but results report that some industries do not have the mean reversion after a controlling for a cross sectional dependence.

2.3. Innovation and Firm Performance

In terms of competition, one of main sources of the mean reversion, a business must continuously innovate and upgrade its competitive advantage to compete effectively in markets, as Porter (1992) stated. In this sense, the innovation is one of the most important driver of a firm growth but the innovation takes long time to realize its outcomes, it is risky, unpredictable, and

its economic impacts are vary[2]. Many researchers have examined that the relationship between firm innovations and performances, and they employ various methodologies. Most of basic researches into the firm performance and the innovation have been executed by the Management field. However, recently, researchers in Finance also start their academic investigations for firm innovations with the financial perspectives. The topics in financial perspectives could be the associations between CEO characteristics, firm capital structures, innovation motives, or directors' influences and firm innovation. Most papers dealing with the firm innovations report a positive impact on the firm performance.

First of all, in a sense of a firm innovation and a firm performance, Bowen et al. (2010) stress the innovations are positively related to the future performances. They insist that there is a stronger relationship between innovation and future performance relative to the past performance. Also, they report that the positive relationship is stronger with a small firm. Their contribution is that they provide strong and consistent evidences that innovation is positively associated with future performance, and it is robust across the firm specifications and the stages of innovations. They employ the meta-analyses to test their hypotheses. Moreover, one other recent research shows that firm innovative efforts positively related with firm financial performances (Santos et al., 2010). Their factorial analysis and structural equation modeling techniques reveal that the relationships between the latent variables, such as operating income,

[2] Bolton (1993) shows the evidence benefits from innovation can be different because of innovation adoption timings and competitions. He report that the positive relationship between firm performance and innovation emerged only when the effects of the initial adoption decision (adopt/not adopt) were separated from the effects of adoption timing (early/late). This result is consistent with the general idea which is the competition make firm performances revert on long-term equilibrium level. He uses the data from 74 U.S. high technology firms with adoption of an innovation, and the decision to join an R&D consortium.

net income, R&D forces, or R&D expenditure per capita, and human capital, innovative efforts, and performance.

On the contrary, there are several evidences indicating a negative relationship between firm innovations and firm performances. Greve (2003b) reports the evidence that the firm innovation and performances have negative relation. The author employs R&D intensity measured as R&D expenditures divided by sales as a proxy of a firm innovation and ROA is a proxy of firm performance. He argues that the R&D expenditures are increased when low performed projects, "problematic search", or over invested projects, "slack search", are executed. This is consistent with our intuitions which is the outcomes of R&D is more important than the amount of R&D spending. With author's data, shipbuilding industry, he insists that higher performance reduce a R&D intensity and innovative project launchings.

There is positively related between CEO compensations and firm innovations (Balkin et al., 2000). They insist that CEO short-term compensation is associated with the number of patents and the amount of R&D expenditures (a proxy of firm innovations) rather than financial outcomes, ROA. This result shows that CEO can take higher risks not only because they are paid to do so, but also because they do not bear the financial risk resulting from risky projects. However the relation of long-term CEO compensation is less consistent. They employ the resource based view to examine the hypotheses with CEO compensation in 90 high-tech firms and 74 low-tech firms as a control group.

Rosenbusch et al. (2009) also suggest the controversial evidence. They stress that there are innovation risks for small and medium firms because small and medium size firms are more likely invest and devote more resources for firm innovation. Therefore, innovation benefit will

be substantial, but it is also very dangerous when a firm fail to obtain innovation outputs. Their empirical results show that a venture has more benefits from innovation relative to matured small and medium size firms. A new firm having flexible resources can enjoy more benefit than a firm having specialized resources. This is because the flexibility of new firms can make them to adapt new environments rules and change their competitive advantages.

2.4. Innovation Motives

If the firm innovation can lead higher firm performance, the motives of innovation must be a very important issue. So far we know individual motive is an important factor can lead innovation outputs (Sauermann and Cohen, 2008[3]). More specifically, CEO characteristics can make differences in terms of firm innovations (Hirshleifer et al., 2010; Bereskin and Hsu, 2011; Galasso and Simcoe, 2011). Also, firm financing structure and firm ability to adapt new environments and changes can make differences (Kostopoulos et al., 2010; Ayyagari et al., 2011).

Some of recent findings in finance focus on the impact of CEO in firm innovations as the most important factor to lead firm innovations. Hirshleifer et al. (2010) insist that overconfident CEOs are more likely launch innovation projects and tolerate higher risk level. They find that overconfident CEOs have greater return volatility, invest more in innovation, obtain more patents and patent citations, and achieve greater innovative success for given research and development (R&D) expenditure. However, overconfident CEOs are not related

[3] Sauermann and Cohen (2008) report that individual level of motives on innovation efforts and performances are important on innovation output. They find that individual incentives, both intellectual challenge and payment, are significant variables for scientists and engineers.

with lower sales, ROA, or Tobin's Q. Also, Galasso and Simcoe (2011) examine the relationship between CEO attitudes to the future performance and firm innovation with a different measure. They assume that the CEO exercises her stock option when the stock price is overvalued. Therefore, if CEO does not exercise her options, in other words, if CEO is confident about future performances, she is more likely launch firm innovation projects. This CEO's confidence also can be understood as she underestimates the probability of failure. Their measurement is based on CEO career concern models used in other literatures. They suggest the evidences that the positive association between the overconfident CEO and firm innovations, captured by the number of citations per patents. This effect is stronger in more competitive industries.

Ayyagari et al. (2011) examine that the association between firm characteristics and innovations with 47 developing countries and 19,000 small and medium size, public and private firms. They define the innovation as introducing new products, developing new technologies, or adapting new processes and knowledge. They find that external financing sources, mostly bank financing, are strongly related with firm innovation because firms have not enough internal funding to invest innovations due to the sample focusing only small and medium size firms. They report that the firm having highly educated managers, ownership by families, individuals, or managers, and exposure to foreign competitions is associated with firm innovations. This result is on the same line of Kickul and Gundry' finding (2002). They investigate that the relationship between an entrepreneur's personality and the firm innovation outputs with 107 small firms. In this study, CEO characteristics are also main testable variables on firm innovations.

Section 3: Hypothesis Development

In the traditional economic point of view, the competition forces firm earnings back to its long-run equilibrium over time. This mean reversion in profitability is well proved in previous researches (Fama and French, 2000; Nissim and Penman, 1999). However, only few papers deal with the earnings (or stock price) persistency. We still do not have very good understandings about what kind of firm characteristics make a firm maintains its higher profitability for a long period. How some firms can keep their higher profitability for many years?

We may easily expect that firms in the regulated industries, firms have heavy market share, and firms having unique technologies have different profitability mechanism than firms in highly competitive industry. Therefore, I assume that a main reason of mean reversion in profitability is the competition. If a firm can obtain a comparative advantage in the industry, the firm has different mean reversion magnitudes than other competitors in the same industry. In order to measure a comparative advantage, I employ a firm innovation output, the number of patents and citations, as a proxy of a source for the comparative advantage for firm. If a firm has more patents (or citations), this higher innovation level has a positive influence on its future profitability. However, I may consider two different cases; if a firm currently has a higher profitability level and it has a higher level of innovation outputs, a firm is more likely can maintain its higher future profitability. This means a firm has less mean reversion over time. On the contrary, if a firm has a lower level of profitability currently but its innovation level is high, this firm will have higher mean reversion magnitude. This is the case of a high mean reversion in future profitability. Base on this idea, first, I hypothesize that the likelihood of a mean reversion magnitude is less when the firm currently has a higher level of profitability and innovation.

Second, the likelihood of a mean reversion magnitude is stronger when the firm has a lower level of profitability and a higher level of innovation currently. Therefore, my hypothesis is,

- *H1: firm innovation is negatively associated with mean reversion in profitability when firm current profitability is high.*
- *H2: firm innovation is positively associated with mean reversion in profitability when firm current profitability is low.*

The other argument is the industry issue; there must be a huge difference among industries in a sense of an impact of innovations. In the high-tech industry, it is easy to understand that firms have more innovation outputs will have higher future profitability. However, food processing industry has relatively lower incentive to the firm innovations. Also, if firms play in the highly regulated business fields, banking and utility, they have different innovation influences. Therefore, I will test whether each industry has different mean reversion magnitude of firm innovation.

- *H3: firm innovation is strongly associated with mean reversion in profitability when industry is more competitive.*

The mean reversion in profitability will be tested with earnings before interest and extraordinary items but after taxes and industry specification will be distinguished by two digit of SIC code in these hypotheses.

Section 4: Data and Variables

4.1. Sample

The main sample examined in this paper consists of patents and citations data from the National Bureau of Economic Research (NBER hereafter) Patent Citation database. The latest version of NBER Patent Citation database includes more than three million U.S. patents granted and citations information from 1976 to 2006 (for more details, see Hall, Jaffe, and Trajtenberg, 2001). Even though this database serves 31years patents and citations data but as Hall et al. stated, latest few years' data might record fewer numbers of patents and citations. This is because it takes little long time for some patents' applications to be granted. This evaluation time is different from each application, so some applications are already granted and included in the latest patents and citations database but some of them are still under evaluation process. Thus, I discard last two years in my sample.

Accounting and financial data are drawn from the Center for Research in Security Prices database (CRSP hereafter) and the COMPUSTAT through THE Wharton Research Data Services. I include all firms except some firms having negative financial accounting numbers for book assets, capital, and stock price following previous literatures. I obtain more than 214,000 firm years as my sample. In order to reduce misleading from extreme outliers, I winsorize my sample at the 99^{th} and 1^{st} percentile. I also consider fixed effects for year and industry with the two digits SIC code to all regression models.

4.2. Variables

My dependent variable is the Change Profitability (CP) measured by a sum of Deviation of Profitability from its Expected value (DFE) and the change in profitability from previous year and to current year (see equation 1).

$$CP_{t+1} = a + b \cdot DFE_t + c \cdot CP_t + d \cdot INV_t + \varepsilon_{t+1} \quad (1)$$

$$Y_{t+1}/A_{t+1} - Y_t/A_t = a + b \cdot \left(Y_t/A_t - E(Y_t/A_t)\right) + c \cdot (Y_t/A_t - Y_{t-1}/A_{t-1}) + \varepsilon_{t+1} \quad (2)$$

Following Fama and French (2000), Y_t is earnings before interest and extra ordinary items but after taxes at year *t*, and A_t is a firm total book asset. Thus, Y_t/A_t is the measure of profitability and $E(Y_t/A_t)$ is its expected value.

In order to obtain expected value of current profitability, I use OLS regression with following model (Fama and French 2000).

$$Y_t/A_t = \alpha + \beta \cdot D_t/BE_t + \gamma \cdot DD_t + \delta \cdot V_t/A_t + \varepsilon_t \quad (3)$$

In this model, three variables explain expected profitability. First of all, dividend can explain the future cash flow and it is good proxy for profitability, so the dollar value of annual dividend payments divided by book value of common equity. Second, I use dummy variable to capture non-linear relationship between dividend and expected profitability. Last, the market to book value ratio explains other expected profitability cannot be captured by dividend variables.

The main independent variable, INV_t, is the number of patents provided from NBER Patent Citation database, provides annual information on patent assignee name, the number of

patents, the number of citations received by each patent, application years, and granted years, etc. As the existing literature pointed out, NBER Patent Citation database has truncation bias because the database shows the patent only after a patent is granted and it takes some time to receive citations. This is because they are under the reviewing process, but some of them will be granted eventually and firm innovative outputs are already realized when the firm submits its application (Hall, Jaffe, and Trajtenberg, 2001). The number of patents (*N_patent*) might need to be transformed as a natural logarithm because raw data is skewed right. The number of patents data has very many zero observations, so I need to transform the data values to make that the error term follow normal distribution. Technically, in order to transform the data, I need to add one to each observation not to lose observations; *Log(1+N_patent).*

Also I employ the number of citations scaled by the number of patents as an alternative innovation variable because, a possibility that the number of citations make better contribution to the firm profitability than the number patents. In some senses, citations might show the real value of a patent. Therefore, I test both innovation variables and report their results.

The other measure of main independent variable is the time frame issue. The innovation outputs can have large enough impact on the firm profitability, so they might influence (or change) firm profitability in a short time, in the same year. However, in many cases, it takes some time until patents (and citations) change firm profitability. Therefore, I construct lagged innovation variables up to three years lag after taking logarithm; $Log(INV)_t$, $Log(INV)_{t-1}$, and $Log(INV)_{t-2}$.

In order to control other effects, such as firm size, growth opportunity, leverages, I use total asset, Tobins'Q, total debt to asset ratio, free cash flow, R&D expenditures scaled by asset, sales growth, and firm age.

Last, two other regressors are used in my regression analyses to understand firm characteristics, Herfindahl-Hirschman Index (*HHI*) and anti-takeover index (*G-index*). The *HHI* is a measure of the size of firms in relation to the industry and an indicator of the amount of competition among them. It is defined as the sum of the squares of the market shares of the 50 largest firms (or summed over all the firms if there are fewer than 50) within the industry, where the market shares are expressed as fractions. The higher *HHI* means higher market influences and lower competitions. The *G-index* is an anti-takeover index that is constructed by identifying 24 distinct anti-takeover provisions (ATPs) and counting the number of the ATPs a firm has adopted.

Section 5: Methodology

Based on these ideas, I examine that basic associations between the change in future profitability (CP_{t+1}) and the change in current profitability (CP_t) and the current deviation of profitability from its expected value (*DFE*) with OLS regression.

$$CP_{t+1} = \alpha_1 + \alpha_2 \cdot DFE_t + \alpha_3 \cdot CP_t + \varepsilon_{t+1} \quad (4)$$

According to Fama and French (2000), these relations are negatively associated each other. Then I will test my first and second hypothesis[4] with innovation variable (equation 1). This innovation variable will be tested with two different measures and three different time frames; $INV_{patent,t}$ and $INV_{citation,t}$, and *t+1*, *t+2*, and *t+3* respectively.

Moreover, as I state before, innovation variables' influence on future profitability will be different because of current firm profitability level. If a firm currently has higher profitability level, the innovation effect will negatively associated with the mean reversion in profitability. On the contrary, if a firm has lower level of profitability, the innovation effect positively influences mean reverting. Therefore, I will construct structural change model with profitability dummy variables. If a firm is currently more profitable than median (or mean), profitability dummy is one, otherwise zero.

$$CP_{t+1} = \alpha_1 + \alpha_2 \cdot DFE_t + \alpha_3 \cdot PD_t + \alpha_4 \cdot (PD_t \times DFE_t) + \alpha_5 \cdot CP_t + \varepsilon_{t+1} \qquad (5)$$

where PD_t is an innovation dummy, $E(\varepsilon_i)=0$.

In this model, if a firm is more profitable, the practical regression model will be

$$CP_{t+1} = \alpha_1 + (\alpha_2 + \alpha_4) \cdot DFE_t + \alpha_3 + \alpha_5 \cdot CP_t + \varepsilon_{t+1} \qquad (6)$$

However, if a firm less profitable than median (or mean), the regression model is same as equation 4, because all PD_ts are zero. With this model, I can capture both cases in a same model and I am free from the criticism which is the sample is not the random sample when I use sub-samples, divided into firms having higher profitability and lower profitability.

[4] H1: firm innovation is negatively associated with mean reversion in profitability when firm current profitability is high.

H2: firm innovation is positively associated with mean reversion in profitability when firm current profitability is high.

The other approach is the time series estimation methodology. This is because main variable, profitability (Y_t/A_t), has time-varying characteristic. If my dataset is stationary, I would better employ time series estimation methods. This is because significances from simple linear regressions or non-linear regressions are spurious, statistically when data has time varying characteristic. The first step will be the testing stationarity of dataset with augmented Dickey-Fuller (ADF) test,

$$\Delta Y_t = \alpha_1 Y_{t-1} + \delta_1 \Delta Y_{t-1} + \delta_2 \Delta Y_{t-2} + \cdots + \delta_p \Delta Y_{t-p} + \varepsilon_t \quad (7)$$

where Y_t denote the profitability and $\varepsilon_t \sim N(0, \sigma^2)$.

The test statistics is the same as previous tests $\begin{cases} H_0: \alpha_1 = 0 \\ H_1: \alpha_1 < 0 \end{cases}$

If I reject null hypothesis, the data series are stationary and I can develop forecasting models using time series models. Following previous several literatures, I employ a univariate Auto Regressive (AR) as follow,

$$Y_t = \beta_1 Y_{t-1} + \varepsilon_t \quad (8)$$

where Y_t denote the profitability and the error term follows a white noise process.

Base on this AR(1) model, I develop time series model to test my first two hypotheses as follow,

$$CP_{t+1} = \beta_1 CP_t + \beta_2 INV_t + \varepsilon_t \quad (9)$$

where the error term follows a white noise process.

Under time series models using OLS, we must get biased estimates because the error term is correlated with the lagged regressors. In the OLS, we assume the correlation between the error term and the regressors is equal to zero. However, in the time series model, we regress the

dependent variable on lagged values of the dependent variable. And there must be a correlation between the independent variable and the error term at future periods. Therefore, we employ Maximum Likelihood Estimation (MLE) to estimate models that are intrinsically nonlinear, non-linear restrictions, non-normal error, very large sample size, and lagged dependent variable. The MLE parameters estimates are asymptotically unbiased, asymptotically efficient, asymptotically normal, and consistent. However, we may have biased MLE estimators under the distribution of the variable is unknown, or the small sample size.

Last, in order to make sub-samples for testing my third hypothesis[5], I will use several dummy variables following Fama and French's twelve industry classifications. I use same methods as previous my hypothesis testing, the OLS with structural change model and univariate time series model.

Section 6: Preliminary Results

The results are consistent with Fama and French (2000) results; DFE and change of profit have negative signs in panel A. Also, in panel B, the profitability, Y_t/A_t, is negatively, the expected value of Y_t/A_t is positively associated with change in future profitability. In the model (2), which uses the number of patents as innovation variable, report generally similar results, but innovation variable, is not significant. In the model (3), the number of citation per patent, innovation variable is highly significant and it has negative impact on change in future profitability. The coefficients of Y_t/A_t and $E(Y_t/A_t)$ are attenuated after adding an innovation

[5] H3: firm innovation is associated with mean reversion in profitability with different magnitude in different industry

variable. This can be interpreted as a magnitude of mean reversion in profitability is weaker because of innovation although its influence will be examined more accurately with all other reasonable control variables.

Table1: Mean Reversion in Profitability

Dependent variable: Change in future Profit

panel A.	***Model (1)***	***Model (2)***	***Model (3)***
DFE	-0.267***	-0.266***	-0.292***
$\Delta Y_t/A_t$	-0.028***	-0.028***	-0.129***
panel B	***Model (1)***	***Model (2)***	***Model (3)***
Y_t/A_t	-0.265***	-0.263***	-0.289***
$E(Y_t/A_t)$	2.051***	2.073***	0.398***
$\Delta Y_t/A_t$	-0.028***	-0.028***	-0.129***
PAT_t	-	0.564	-
$CITE_t$	-	-	-0.053***

Asterisk, ***, **, *, represents statistical significance at 1%, 5%, and 10% level of significance respectively. The model (1) is the same as Fama and French (2000) model and the model (2) and (3) include innovation variable with the number of patents and the number of citations per patent, respectively.

Section 7: Further discussions

My next research topic will be the test whether these mispricing and improper behaviors make inferior investment returns. If investors misunderstand the fair asset value because of firm specific characteristics, there must be better chance to earn additional returns. Therefore, I will compare the buy and hold abnormal return (BHAR) and the long term portfolio return to match groups.

Second, I might develop more accurate model to test my first two hypotheses, which are *H1: firm innovation is negatively associated with mean reversion in profitability when firm current profitability is high. H2: firm innovation is positively associated with mean reversion in profitability when firm current profitability is high.* Even though many literatures use AR(1) model but I might the improve testing methodology. This is because I employ an innovation variable, so AR(1) may not be the best model to understand the relationship between the mean reversion in profitability and the firm innovations.

Last, there may be the survivorship bias because in my data set does not consider firms choose the exit option. Therefore, the mean reversion magnitude can be higher than what it should be. If I can estimate proper bankruptcy or market exit function, I might fix this survivorship bias.

Appendix A: Definitions of Variables

Variable Names	Definitions of variables
CP_t	Change Profitability measured by earnings before interest and extraordinary items but taxes divided by total asset, Y_t/A_t.
DFE_t	Deviation of profitability from its expected value, Y_t/A_t-$E(Y_t/A_t)$.
Y_t	Earnings before interest and extraordinary items but taxes.
A_t	Total asset.
INV_t	Innovation variable.
Patents (PAT) $_t$	A number of applications for patents
Citations (CITE)$_t$	A number of citations for patents weighted by time divided by a number of patents
D_t	The dollar value of annual dividend.
BE_t	Book value of common stock equity.
DD_t	Dummy variable of dividend payment.
V_t	Firm market value.
Tobin's Q_t	Market value of assets divided by book value of assets [(PRCC_F×CSHO + at - EQ)/at)].
Leverage$_t$	A debt in current liabilities plus long-term debt divided by assets .
Free cash$_t$	Free cash flow normalized by asset.
$R\&D_t/Assets_t$	R&D expense divided by assets.
Firm age$_t$	Firm age is counted from the year appeared a firm in the Compustat.
HHI_SALES_t	Herfindahl-Hirschman Index, an industry concentration ratio measured by sales.
G-index$_t$	An anti-takeover index, which is constructed by identifying 24 distinct anti-takeover provisions (ATPs) and counting the number of the ATPs a firm has adopted (Gompers et al. (2003)).

References

Ayyagari, M., Demirg¨uc-Kunt, A., and Maksimovic, M., (2011), "Firm Innovation in Emerging Markets: The Role of Finance, Governance, and Competition," *JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS*, Vol. 46, No. 6, pp. 1545–1580.

Balkin, D. B., Markman, G. D., and Gomez-Mejia, L. R., (2000), "Is CEO pay in high-technology firms related to innovation?," *The Academy of Management Journal*, Vol. 43, No. 6, pp. 1118-1129

Becker, R., Lee, J., and Gup, B. E., (2012), "An empirical analysis of mean reversion of the S&P 500's P/E ratios," *Journal of Economics and Finance*, 36:675–690.

Bereskin, F. L., and Hsu, P. H., (2012), "New Dogs New Tricks: CEO Turnover, CEO-related Factors, and Innovation Performance," *SSRN Library*.

Bolton, M. K., (1993), "ORGANIZATIONAL INNOVATION AND SUBSTANDARD PERFORMANCE: WHEN IS NECESSITY THE MOTHER OF INNOVATION?," *Organization Science*, Vol. 4, No. 1

Bowen, F. E., Rostami, M., and Steel, P., (2010), "Timing is everything: A meta-analysis of the relationships between organizational performance and innovation," *Journal of Business Research*, 63, 1179–1185.

Canarella, G., Miller, S. M., and Nourayi, M. M., (2012), "Firm Profitability: Mean-Reverting or Random-Walk Behavior?," *SSRN Library*.

Chan, L. K. C., J. Karceski, and J. Lakonishok, (2003), "The level and persistence of growth Rates," *The Journal* of Finance, 58 (2), 643-684.

Chen, A. S., Lin, S. C., (2010), "Asymmetrical return on equity mean reversion and catering," *Journal of Banking & Finance*, 35, 471–477.

Chen, L. and Zhao, X., (2005), "Profitability, Mean Reversion of Leverage Ratios, and Capital Structure Choices," *SSRN Library*.

Fama, E. F. and French, K. R., (2000), "Forecasting profitability and earnings," *Journal of Business*, 73 (2), 161-175.

Fama, E. F. and French, K. R., (2007), "Migration," *Financial Analysts Journal*, Vol. 63, No. 3, 48-58.

Fama, E. F. and French, K. R., (2007), "The Anatomy of Value and Growth Stock Returns," *Financial Analysts Journal*, 63, 44-54.

Galasso, A. and Simcoe, T. S., (2011), "CEO Overconfidence and Innovation," *MANAGEMENT SCIENCE*, Vol. 57, No. 8, pp. 1469–1484.

Greve, H. R., (2003b), "A behavioral theory of Rand D expenditures and innovations: evidence from shipbuilding," *The Academy of Management Journal*, Vol. 46, No. 6, pp. 685-702

Henderson, B. J. and Pearson, N. D., (2011), "The dark side of financial innovation: A case study of the pricing of a retail financial product," *Journal of Financial Economics*, 100, 227–247.

Hirshleifer, D. A., Low, A., and Teoh, S. H., (2010), "Are Overconfident CEOs Better Innovators?", *The Journal of Finance*, Volume 67, Issue 4, 1457–1498

Jegadeesh, N., (1991), "Seasonality in Stock Price Mean Reversion: Evidence from the U.S. and the U.K.," *The Journal of Finance*, VOL. XLVI, NO. 4.

Kickul, J. and Gundry, L. K., (2002), "Prospecting for Strategic Advantage: The Proactive Entrepreneurial Personality and Small Firm Innovation," *Journal of Small Business Management*, 40(2), pp. 85–97.

Knapp, M., Gart, A., and Chaudhry, M., (2006), "The impact of mean reversion of bank profitability on post-merger performance in the banking industry," *Journal of Banking & Finance*, 30, 3503–3517

Koijen, R. S., Rodriguez, J. C., and Sbuelz, A., (2009), "Momentum and Mean Reversion in Strategic Asset Allocation," *MANAGEMENT SCIENCE*, Vol. 55, No. 7, July, pp. 1199–1213.

Kostopoulos, K., Papalexandris, A., Papachroni, M., and Ioannou, G., (2011), "Absorptive capacity, innovation, and financial performance," *Journal of Business Research*, 64, 1335–1343.

Matsuo, M., (2006), "Customer orientation, conflict, and innovativeness in Japanese sales departments," *Journal of Business Research*, 59, 242 – 250

Poretr, M. E., (1992), "Capital disadvantage: America's failing capital investment system," *Harvard Business Review*, 70(5):65-82.

Rosenbusch, N., Brinckmann, J, and Bausch, A., (2011) "Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs," *Journal of Business Venturing*, 26, 441–457.

Serban, A. F., (2010), "Combining mean reversion and momentum trading strategies in foreign exchange markets," *Journal of Banking & Finance*, 34, 2720–2727.

Santos, D. F., Basso, L. F., and Kimura, H., (2010), "THE INFLUENCE OF INNOVATION ON FIRM PERFORMANCE IN BRAZIL," *SSRN Library*.

Sauermann, H. and Cohen, W. M., (2008)," WHAT MAKES THEM TICK? EMPLOYEE MOTIVES AND FIRM INNOVATION," *NBER Working Paper Series*.