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MANAGERIAL OVERCONFIDENCE, COMPENSATION INDUCED RISK TAKING, AND EARNINGS MANAGEMENT

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ABSTRACT

This study examined Taiwanese listed company and OTC (Over-the-Counter) firms to explore empirically managerial overconfidence and compensation incentives induced risk-taking, and the impact on accrual-based earnings management (AEM) and real earnings management (REM). The study results show that overconfident managers are more likely to adopt REM than AEM. Compensation induced Delta risk-taking is irrelevant to AEM but could lower the propensity for REM, and compensation induced Vega risk-taking could increase the magnitude of AEM but lower the magnitude of REM. These results remain robust after including interaction dummy between overconfidence and Delta risk-taking, and interaction dummy between overconfidence and Vega risk-taking for further analysis and Logistic Regression. In addition, this study also finds that overconfidence could mitigate the positive relationship between Vega risk-taking and AEM.

JEL: G34, G41

KEYWORDS: Risk-Taking, Earnings Management, Overconfidence, Compensation Incentive

INTRODUCTION

Since the twenty-first century, the world has witnessed a series of major accounting fraud scandals, making earnings management a hot issue in the accounting and finance. Schipper (1989) argued earnings management as the purposeful intervention of a firm's management in the financial reporting process to capture private gain, and divided earnings management into two types: accrual-based earnings management (AEM) and real earnings management (REM). Graham et al. (2005), Ewert and Wagenhofer (2005), and Wang and D'Souza (2006) argued that managers adopt REM only on a limited accrual basis, and that REM and AEM have a complementary relationship. Roychowdhury (2006), Burnett et al. (2012) and Chi et al. (2011) argued that a firm's management prefers to use real activities to realize earnings management. A recent study by Chan et al. (2015) found, American listed firms saw a significant decrease in AEM but a significant increase in REM, it means that substitution between REM and AEM after voluntary adoption of compensation Clawback Provisions that the board of directors authorize to recoup compensation paid to executives based on misstated financial reports.

In terms of accounting principles, accruals are usually characterized by reversal. Although AEM distorts statement information, the effect is short term. REM exerts a long-term effect on firms, negatively affecting future cash flows and impairing long-term firm value (Roychowdhury, 2006; Cohen et al., 2008; Ewert and Wagenhofer, 2005). This study focuses on the impact of the personality trait of overconfidence in managers and managerial compensation induced risk-taking on AEM and REM. In terms of managerial overconfidence, most of the prior literature focused on how managerial overconfidence correlated to corporate investment and financing policies, corporate mergers and acquisitions, or earnings management. Few studies considered both managerial overconfidence and compensation incentives. Hsieh, Bedard, and Johnstone (2014) investigated the case in which overconfident CEOs used AEM and REM to meet or beat analysts' predictions. Schrand and Zechman (2012) found that overconfident managers are more likely to manage earnings or engage in excessive risk, and believe it is sufficient to cover the reversal. Li and Hung (2013) investigated Taiwanese listed firms to find that family control could alleviate the positive relationship between managerial overconfidence and AEM. The purpose of compensation incentives is to resolve the agency problem. However, when linked to performance and stock prices, compensation incentives may also drive managers to sacrifice shareholders' profits and attain private gains (Schipper, 1989). Managerial compensation includes cash, stock and stock options; cash includes compensation and cash bonuses. Compensation is associated with performance and promotions, whereas cash bonuses, stock and stock options depend on performance. When performance is linked to stock prices, managerial risk-taking behaviors will be affected. Although most of the prior literature studied compensation and earnings management, few extensively explored the impact of compensation incentives induced risk-taking on earnings management. The design of managerial compensation aims at linking compensation with stock prices to urge managers to take actions that maximize shareholder wealth and create firm value (Guay, 1999; Hanlon et al., 2003; Ittner et al., 2003; Jensen and Meckling, 1976; Mehran, 1995; Nagar et al., 2003). With compensation linked to stock prices, the change and volatility of stock prices have different effects on managerial wealth. The sensitivity of shareholder wealth to stock prices is called *Delta*, while the sensitivity of shareholder wealth to stock volatility is called *Vega*. Lambert et al. (1991), Carpenter (2000), Knopf et al. (2002), and Ross (2004) argued that *Delta* makes managers with a high degree of risk aversion less willing to take risks, whereas *Vega* makes such managers willing to take higher risks; risk-taking behavior affects managers' earnings management behavior.

Because of the nature of accounting information, AEM causes short-term damage to firm value, and some of AEM behaviors may be illegal and may be uncovered in the future. REM causes long-term damage to firm value, with behaviors that are legitimate but unethical, and it is not prone to attracting the attention of accountants or supervisory authorities. Therefore, it is necessary to explore further the impact of overconfidence and compensation incentives induced risk-taking behaviors on earnings management behaviors. The results of the preliminary analysis show that managerial overconfidence is significantly positive in explaining REM but significantly negative in explaining AEM. This result is validated in the logistic regression analysis for robustness, indicating that overconfident managers are more likely to adopt REM than AEM. Considering compensation incentives induced risk-taking, the results of this study show that *Delta* risk-taking had no explanatory power for AEM and REM, whereas *Vega* risk-taking has a negative effect on REM and a positive effect on AEM. This indicates that if compensation incentives induced *Vega* risk-taking is higher, manager is more likely to adopt AEM than REM. Compensation induced *Delta* risk-taking is irrelevant to AEM, but can lower the magnitude of AEM. In addition, this study also further finds that overconfidence could mitigate the positive relationship between *Vega* risk-taking and AEM. This study has three contributions. First, Yu (2014) used an agent model to explain why boards of directors employ overconfident CEOs, and design compensation contract schemes that allow earnings manipulation; however, the study did not provide empirical validation or discuss earnings management resulting from AEM and REM. Our study proposes providing empirical evidence of the impact of managerial overconfidence on earnings management. Second, our study follows recent prior literature associated with earnings management to validate both AEM and REM, and finds that managerial overconfidence is positively associated with REM, but negatively associated with AEM. Third, prior literature associated with earnings management did not explore both the positive and negative impacts of compensation incentives induced risk-taking. Our study analyzes risk-taking from both positive and negative perspectives, filling this gap in the literature.

This paper is organized as follows. Introduction section describes research motivation and objectives. Next section reviews related literature, integrating the prior literature associated with earnings management, and then the relationships between managerial overconfidence and risk-taking and earnings management are explored. Data and methodology section develops the empirical design, identifies the data sources and defines the analytical method and study variables. Empirical analysis results and discussion section describes data characteristics and empirical regression analysis results. Conclusion section gives a comprehensive summary of the empirical analysis, providing conclusions, significance and addresses this paper's limitations and suggestions for future research.

LITERATURE REVIEW

Managers may have different motivations for adopting earnings management, but their objectives all include misleading affiliated parties or external users about the corporate financial status by manipulating, judging or altering financial statements (Healy and Wahlen, 1999). Schipper (1989) divides earnings management into two types: accrual-based earnings management (AEM) and real earnings management (REM). AEM does not involve real, economic activities, but involves actions that take advantage of the flexibility provided by accrual basis accounting, and consequently affect the earnings reported in financial statements. REM involves actions taken by a firm's management to affect its financial statements by manipulating the points or amount of firms' real, operating activities, or making decisions about abnormal operating activities to accomplish earnings management.

Roychowdhury (2006) divided the common methods of REM measure into three individual metrics: abnormal cash flows from operation activities, production costs and discretionary expenses. Common methods of REM include sales manipulation through price discounts, reduction of discretionary expenses (management and sales, advertising, or research and development (R&D) expenses), and inventory adjustments to lower fixed costs per unit and increase gross margin. Roychowdhury (2006) and Cohen et al. (2008) found that in the long term, REM exerts a negative impact on the cash flows of future operations. Graham et al. (2005) stated that 80% of chief financial officers (CFOs) achieve the desired earnings target by reducing discretionary expenses, such as advertising and R&D expenses. Roychowdhury (2006) further stated that managers are very willing to undertake costly REM because REM is less prone to attracting the attention of auditors and supervisory authorities than AEM. Cohen et al. (2008) stated that the occurrence of many accounting frauds urged supervisory authorities to create laws for firm regulation. For example, after the USA passed the Sarbanes Oxley Act (SOX) in 2002, that the number of firms adopting AEM declined significantly, while the number of firms adopting REM increased significantly.

Managerial Overconfidence and Earnings Management

Overconfidence is the tendency for people to overestimate their knowledge and abilities, and the precision of their information, usually making their judgment of the probability of the occurrence of an event much higher than the actual likelihood of the occurrence (Bhandari and Deaves, 2006). March and Shapira (1987), and Goel and Thakor (2008) found that senior managers are more likely to show overconfidence than other managers are. According to prior literature, overconfident managers of a firm have unrealistically high expectations for the firm's future performance (Wong, 2008), and believe that they can make the expectations come true (Malmendier and Tate, 2005a). Yu (2014) explains why boards of directors employ overconfident CEOs and design compensation contract schemes that allow earnings manipulation. Hribar and Yang (2016) empirically stated that overconfident managers are optimistic about earnings predictions, and may conduct earnings management to attain the earnings goal they set. Schrand and Zechman (2012) found that firms with overconfident CEOs are more likely to have misreported financial statements, which are subsequently the subject of enforcement by the Securities and Exchange Commission. Hsieh, Bedard, and Johnstone (2014) found that, after the passage of SOX in 2002, overconfident CEOs were more likely to have discretionary accruals. They remained more likely to engage in real activities management through abnormally high cash flows and have abnormally low discretionary expenses. Managerial overconfidence may cause managers to manipulate earnings, and consequently lead to firms' financial failures.

Compensation Incentives Induced Risk Taking and Earnings Management

From the agency perspective, the design of the compensation mechanism aims at linking managerial wealth with shareholder wealth to urge managers to take actions that maximize shareholder wealth and create firm value (Guay, 1999; Hanlon et al., 2003; Ittner et al., 2003; Jensen and Meckling, 1976; Mehran, 1995; Nagar et al., 2003). However, when compensation is linked to stock prices, stock price will affect managers' future wealth (Nagata and Hachiya, 2007), and may drive managers to sacrifice shareholders' benefits and adopt earnings management to attain private gains (Schipper, 1989). Healy (1985) proposed the bonus plan hypothesis, and argued that bonuses are positively associated with firms' earnings, so managers may increase discretionary accruals to obtain more current or future bonuses. Bergstresser and Philippon (2006) and Meek, Rao, and Skousen (2007) found that managerial compensation is the result of AEM, including earnings inflated by earnings management and stock prices. Kedia and Philippon (2009) argued that the CEO compensation is an incentive for managers to manipulate earnings.

From the agency perspective, the purpose of equity-based compensation design is to encourage risk-averse and non-diversified managers to invest in risk-enhancing positive net present value (NPV) projects, which align with shareholders' benefits (Jensen and Meckling, 1976; Smith and Stulz, 1985). Managerial compensation may contain stock bonuses and stock options, and consequently equity-based compensation may lead to excessive risk-taking by managers (Carpenter, 2000; Ross, 2004; Hanlon et al., 2004). Much theoretical literature stated that the equity-based managerial compensation mechanism can lead to a greater propensity to manipulate financial statements (Goldman and Slezak, 2006; Crocker and Slemrod, 2007; Benmelech et al., 2010). Empirical research also shows that equity-based managerial compensation is positively associated with the magnitude of earnings manipulation (Cheng and Warfield, 2005; Bergstresser and Philippon, 2006; Trompeter et al., 2013). Chen, Lee, and Chou (2015) empirically found that equity-based compensation has a positive effect on AEM and a negative effect on REM. When equity-based compensation is linked to stock prices, the change and volatility of stock prices have different effects on managerial wealth. The sensitivity of shareholder wealth to stock prices is called *Delta*, while the sensitivity of shareholder wealth to the volatility of stock returns is called *Vega*.

Lambert et al. (1991), Carpenter (2000), Knopf et al. (2002), and Ross (2004) argued that the stock option portfolio has two opposite effects on managerial risk-taking incentives: *Delta* makes managers less willing to take risks, while *Vega* makes managers more willing to take risks. Bergstresser and Philippon (2006) and Cornett, Marcus, and Tehranian (2008) found that CEO *Delta* is positively associated with AEM. However, Jiang, Petroni, and Wang (2010) found no correlation between CEO *Delta* and AEM, but do find a positive relationship between CFO *Delta* and AEM. Chava and Purnanandam (2010) assumed that AEM increases stock prices and reduces stock returns, and found that *Delta* is positively associated with AEM, while *Vega* is negatively associated with AEM. In contrast, Armstrong et al. (2013) argued that AEM increases stock prices and stock returns volatility, and empirically found that *Delta* and *Vega* are both positively associated with AEM. Related literature has not explored the impact of compensation induced *Delta* and *Vega* risk-taking on REM. Although AEM has been considered in the literature, the findings are inconsistent. In addition, managerial overconfidence may also encourage risk-taking. Therefore, it is necessary to explore extensively the relationship between overconfidence, compensation induced *Delta*, *Vega* risk-taking, and AEM/REM.

DATA AND METHODOLOGY

Data Source and Sample Descriptions

This study used Taiwanese listed and OTC (Over-the-Counter) firms as the research object, and collected data from the database of the Taiwan Economic Journal (TEJ). There are 729 firms to be studied. We collect information in the form of quarterly data from 2006 to 2015, spanning 10 years and involving 40 quarters in total. The sample is selected according to the following rules: (1) firms demoted as full-cash delivery stocks are excluded; (2) financial and securities companies are excluded because the finance and securities industries are special and subject to special laws and regulations; (3) according to Roychowdhury (2006) and Zang (2012), industries with less than 15 sample firms are excluded, such as the cement, glass ceramics, paper, rubber, and automotive, and oil and electricity industries, to measure the magnitude of earnings management; (4) firms with financial data missing and extreme values are excluded. The industry distribution of the final sample is presented in Table 1. According to Table 1, the industry represented by the largest number of firms is the electronics industry. Therefore, in the regression analysis model, a dummy control variable is added, indicating whether a firm belongs to the electronics industry.

Ordinary Least Squares (OLS) Regression

The preliminary regression analysis is carried out using the ordinary least squares (OLS) method, using accrual-based earnings management (AEM) and real earnings management (REM) as the dependent variables, with managerial overconfidence, and compensation incentives induced *Delta* and *Vega* risk-taking as the explanatory variables, with credit rating, corporate governance, and corporate characteristics as control variables. The regression model is as follows (for the definition of variables, refer to next section):

$$\begin{aligned}\left|Y_{i,t}\right| = {} & \beta_0 + OverC_{i,t} + \beta_2\, Delta_{i,t} + \beta_3 Vega_{i,t} + \beta_4 OverC_{i,t} * Delta_{i,t} \\ & + \beta_5 OverC_{i,t} * Vega_{i,t} + \beta_6 TCRI_{\ i,t} + \beta_7 BoardS_{i,t} + \beta_8 DirEX_{i,t} \\ & + \beta_9 HoldM_{i,t} + \beta_{10} ChairM_{i,t} + \beta_{11} InstF_{\,i,t} + \beta_{12} InstD_{\,i,t} + \beta_{13} CompS_{\ i,t} \\ & + \beta_{14} DebtR_{i,t} + \beta_{15} ROA_{\ i,t} + \beta_{16} EstD_{i,t} + \beta_{17} Electronic_{i,t} + \varepsilon_{i,t} \qquad (1)\end{aligned}$$

In Eq. (1), the dependent variable (Y_i) is a dummy variable, which is substituted into Eq. (1) with *REM*

Table 1: Distribution of Industries and Manufacturers Included in the Samples

Industry Name	Manufacturer Quantity	Sample Quantity	Percentage
M1200 Food	18	720	2.47%
M1300 Plastics	21	840	2.88%
M1400 Textile Fiber	43	1,720	5.90%
M1500 Electric Machinery	46	1,840	6.31%
M1700 Chemistry, Biology, and Medicine	54	2,160	7.41%
M2000 Steel	27	1,080	3.70%
M2300 Electronics	468	18,720	64.18%
M2500 Building Material Construction	52	2,080	7.13%
Total	729	29,160	100.00%

representing REM magnitude or *AEM* representing AEM magnitude. This study intended to explore the magnitude, but not the direction, of earnings management. Hence, absolute values of these two dependent variables are obtained for the analysis. *OverC* is a dummy variable for managerial overconfidence. *Delta* is the sensitivity of a manager's total compensation to stock price changes. *Vega* is the sensitivity of total compensation to stock returns volatility, $TCRI_{t-1}$ is the credit rating. *BoardS* is the size of the board of directors, *DirEX* is the proportion of independent directors in the board of directors. *HoldM* is the proportion of the shares held by the vice general manager and senior managers. *ChairM* indicates whether the chairman of the board serves as the general manager. *InstF* and *InstD* are the proportions of the shares held by foreign and domestic institutional investors, respectively. *CompS* is the size of the firm. *DebtR* is the debt ratio. *ROA* is return on assets. *EstD* is the number of years that a firm has been established, and *Electronic* is a dummy variable indicating whether a firm belongs to the electronics industry.

Logistic Regression

This study used Logistic Regression to analyze the robustness of the results, and divided the sample into high and low groups of REM and AEM magnitudes, using the medians of REM and AEM to separate the firms. The dependent variable (Y_i) is a dummy variable, which sets firms with high REM and low AEM to 1, and firms with low REM and high AEM to 0. The explanatory variables are the same as in the OLS regression analysis. The analytical model is as follows:

$$P_i = E(Y_i) = \mathrm{F}(\beta' X_i) = \frac{1}{(1+e^{-\beta' X_i})} = \frac{e^{\beta' X_i}}{(1+e^{-\beta' X_i})} \qquad (2)$$

In Eq. (2), P_i is the probability of occurrence, Y_i is the dependent variable of the regression equation, β' is the transposed vector of the regression coefficient and X_i is the vector of explanatory variables, which are the same as in Eq. (1). The probability of occurrence, *P*, is a value between 0 and 1. If *P* is closer to 1, there is a higher probability of occurrence of the dependent variable (*Y*). If *P* is closer to 0, there is a lower probability of occurrence of the dependent variable (*Y*).

Variable Definition

Real Earnings Management (REM)

Roychowdhury (2006) divided REM into cash flows from abnormal operation activities, abnormal production costs and abnormal discretionary expenses. Their estimators are as follows. For cash flow from abnormal operation activities,

$$\frac{\mathrm{OCF_{i,t}}}{\mathrm{A_{i,t-1}}} = \alpha_0 + \alpha_1\left(\frac{1}{\mathrm{A_{i,t-1}}}\right) + \alpha_2\left(\frac{\mathrm{S_{i,t}}}{\mathrm{A_{i,t-1}}}\right) + \alpha_3\left(\frac{\Delta \mathrm{S_{i,t}}}{\mathrm{A_{i,t-1}}}\right) + \varepsilon_{\mathrm{i,t}} \qquad (3)$$

$$\frac{\widehat{OCF_{i,t}}}{\mathrm{A_{i,t-1}}} = \hat{\alpha}_0 + \hat{\alpha}_1\left(\frac{1}{\mathrm{A_{i,t-1}}}\right) + \hat{\alpha}_2\left(\frac{\mathrm{S_{i,t}}}{\mathrm{A_{i,t-1}}}\right) + \hat{\alpha}_3\left(\frac{\Delta \mathrm{S_{i,t}}}{\mathrm{A_{i,t-1}}}\right) \qquad (4)$$

$$Abn\_OCF_{i,t} = \frac{OCF_{i,t}}{A_{i,t-1}} - \frac{\widehat{OCF_{i,t}}}{A_{i,t-1}} \qquad (5)$$

Where $OCF_{i,t}$ is cash flows from operation activities, $A_{i,t-1}$ is total assets in the previous period, $S_{i,t}$ is net operation revenue in the current period, $\Delta S_{i,t}$ is the difference between net operation revenue in the current period and that in the previous period, and $\varepsilon_{\mathrm{i,t}}$ is the residual. $Abn\_OCF_{i,t}$ represents cash flows from abnormal operation activities, which is the difference between the actual and estimated values of $OCF_{i,t}$. For abnormal production costs, cost of sales,

$$\frac{\mathrm{COGS_{i,t}}}{\mathrm{A_{i,t-1}}} = \beta_0 + \beta_1\left(\frac{1}{\mathrm{A_{i,t-1}}}\right) + \beta_2\left(\frac{\mathrm{S_{i,t}}}{\mathrm{A_{i,t-1}}}\right) + \varepsilon_{\mathrm{i,t}} \qquad (6)$$

Where $COGS_{i,t}$ is the cost of sales in the current period, $A_{i,t-1}$ is total assets in the previous period, $S_{i,t}$ is the net operation revenue in the current period and $\varepsilon_{\mathrm{i,t}}$ is the residual. Inventory variation variable,

$$\frac{\Delta INV_{i,t}}{A_{i,t-1}} = \beta_0 + \beta_1\left(\frac{1}{A_{i,t-1}}\right) + \beta_2\left(\frac{\Delta S_{i,t}}{A_{i,t-1}}\right) + \beta_3\left(\frac{\Delta S_{i,t-1}}{A_{i,t-1}}\right) + \varepsilon_{i,t} \tag{7}$$

Where $\Delta INV_{i,t}$ is the variation between inventory in the current period and that in the previous period, $A_{i,t-1}$ is total assets in the previous period, $\Delta S_{i,t}$ is the variation between net operation revenue in the current period and that in the previous period, $\Delta S_{i,t-1}$ is the variation between net operation revenue in the previous period and that two periods prior, and $\varepsilon_{i,t}$ is the residual.

Production Costs = Cost of Sales + Inventory Variation Variable,

$$\frac{PROD_{i,t}}{A_{i,t-1}} = \beta_0 + \beta_1\left(\frac{1}{A_{i,t-1}}\right) + \beta_2\left(\frac{S_{i,t}}{A_{i,t-1}}\right) + \beta_3\left(\frac{\Delta S_{i,t}}{A_{i,t-1}}\right) + \beta_4\left(\frac{\Delta S_{i,t-1}}{A_{i,t-1}}\right) + \varepsilon_{i,t} \tag{8}$$

$$\frac{\widehat{PROD}_{i,t}}{A_{i,t-1}} = \hat{\beta}_0 + \hat{\beta}_1\left(\frac{1}{A_{i,t-1}}\right) + \hat{\beta}_2\left(\frac{S_{i,t}}{A_{i,t-1}}\right) + \hat{\beta}_3\left(\frac{\Delta S_{i,t}}{A_{i,t-1}}\right) + \hat{\beta}_4\left(\frac{\Delta S_{i,t-1}}{A_{i,t-1}}\right) \tag{9}$$

$$Abn\_PROD_{i,t} = \frac{PROD_{i,t}}{A_{i,t-1}} - \frac{\widehat{PROD}_{i,t}}{A_{i,t-1}} \tag{10}$$

Where $PROD_{i,t}$ is the sum of the cost of sales and inventory variation variables. $A_{i,t-1}$ is total asset in the previous period. $S_{i,t}$ is net operation revenue in the current period. $\Delta S_{i,t}$ is the variation between net operation revenue in the current period and that in the previous period. $\Delta S_{i,t-1}$ is the variation between net operation revenue in the previous period and those two periods prior, and $\varepsilon_{i,t}$ is the residual. $Abn\_PROD_{i,t}$ is abnormal production cost, which is the variation between the actual and estimated values of $PROD_{i,t}$. For abnormal discretionary expenses,

$$\frac{DIS.EXP_{i,t}}{A_{i,t-1}} = \gamma_0 + \gamma_1\left(\frac{1}{A_{i,t-1}}\right) + \gamma_2\left(\frac{S_{i,t}}{A_{i,t-1}}\right) + \varepsilon_{i,t} \tag{11}$$

$$\frac{\widehat{DIS.EXP}_{i,t}}{A_{i,t-1}} = \hat{\gamma}_0 + \hat{\gamma}_1\left(\frac{1}{A_{i,t-1}}\right) + \hat{\gamma}_2\left(\frac{S_{i,t}}{A_{i,t-1}}\right) \tag{12}$$

$$Abn\_DIS.EXP_{i,t} = \frac{DIS.EXP_{i,t}}{A_{i,t-1}} - \frac{\widehat{DIS.EXP}_{i,t}}{A_{i,t-1}} \tag{13}$$

Where $DIS.EXP_{i,t}$ is discretionary expenses (such as R&D, advertising, management and sales expenses), $A_{i,t-1}$ is total assets in the previous period, $S_{i,t}$ is net operation revenue in the current period, and $\varepsilon_{i,t}$ is the residual. $Abn\_DIS.EXP_{i,t}$ is abnormal discretionary expenses, which is the difference between the actual and estimated values of $DIS.EXP_{i,t}$. Following Roychowdhury (2006) and Cohen et al. (2008), the regression coefficients are calculated to obtain the corresponding abnormal standard values. As cash flows from abnormal operation activities and abnormal discretionary expenses increased, earnings management relatively decreased. Earnings management increased as abnormal production costs increased. REM magnitude can be given by:

$$\left|REM_{i,t}\right| = \left|(-1)Abn\_OCF_{i,t} + Abn\_PROD_{i,t} + (-1)Abn\_DIS.EXP_{i,t}\right| \quad (14)$$

Accrual-Based Earnings Management (AEM)

Common models for measuring AEM include the Healy Model (1985), the DeAngelo Model (1986), the Jones Model (1991), the Industry Model (Dechow and Sloan, 1991), and the Modified Jones Model (Dechow et al., 1995). Kothari, Leone, and Wasley (2005) argued that the previous discretionary accruals (DA) estimation models might produce estimate biases, and then propose returns of asset (ROA) included in the Modified Jones Model to adjust performance. This proposed addition not only can control biases caused by abnormal operation performance, but also can examine the extent to which management implements discretionary accruals. Hence, this study used the model proposed by Kothari et al. (2005) to calculate the magnitude of AEM. The calculation is as follows:

$$\frac{TA_{i,t}}{A_{i,t-1}} = \delta_0 + \delta_1\left(\frac{1}{A_{i,t-1}}\right) + \delta_2\left(\frac{\Delta REV_{i,t} - \Delta REC_{i,t}}{A_{i,t-1}}\right) + \delta_3\left(\frac{PPE_{i,t}}{A_{i,t-1}}\right) + \delta_4 ROA_{i,t-1} + \varepsilon_{i,t} \quad (15)$$

Where TA_t is total accruals, $A_{i,t-1}$ is total assets in the previous period, $\Delta REV_{i,t}$ is the variation in operation revenue, $\Delta REC_{i,t}$ is the variation in receivables, $PPE_{i,t}$ is total depreciable fixed assets, and $ROA_{i,t-1}$ is the ROA in the previous period. The estimated parameters $\hat{\delta}_0, \hat{\delta}_1, \hat{\delta}_2, \hat{\delta}_3,$ and $\hat{\delta}_4$ in Eq. (15) are obtained using OLS estimation, and then are substituted into Eq. (16) to obtain nondiscretionary accruals (*NonDA*), which finally are subtracted from total accruals to obtain *DA*.

$$\frac{NonDA_{i,t}}{A_{i,t-1}} = \hat{\delta}_0 + \hat{\delta}_1\left(\frac{1}{A_{i,t-1}}\right) + \hat{\delta}_2\left(\frac{\Delta REV_{i,t} - \Delta REC_{i,t}}{A_{i,t-1}}\right) + \hat{\delta}_3\left(\frac{PPE_{i,t}}{A_{i,t-1}}\right) + \hat{\delta}_4 ROA_{i,t-1} \quad (16)$$

In Eq. (16), $NonDA_{i,t}$ is nondiscretionary accrual. Discretionary accrual $DA_{i,t}$, namely AEM, is the difference between total actual accruals and nondiscretionary accruals obtained using Eq. (16). This study used the absolute value of AEM as the dependent variable of the regression equation.

Managerial Overconfidence (*OVERC*)

According to the overconfidence measurement concept proposed by Malmendier and Tate (2005b), this study used the agency variable indicating whether there is a continuous increase in the proportions of shares held by the vice general manager and senior managers to measure overconfidence. If the total share ratio increases continuously in the last four quarters, managers in the firm have the tendency to be overconfident, and *OverC* is set to 1; otherwise *OverC* is set to 0.

Delta and *Vega* Risk-Taking

Delta measures the sensitivity of total compensation (including compensation, bonuses, special fees, cash, stock bonuses, dismissal pay, and stock options) of the vice general manager and senior managers to stock prices change. *Vega* measures the sensitivity of total compensation of the vice general manager and senior managers to stock return volatility.

Credit Rating (*TCRI*)

Credit ratings are used to assess a firm's solvency. The lowering of a credit rating has a negative impact on firms; for example, firm value decreases and the firm's stock price declines (Griffin and Sanvicente, 1982; Kliger and Sarig, 2000). Firms with a poor credit rating will be motivated for earnings management (Datta and Dhillon, 1993; Grant, Grant, and Ortega, 2007). The Taiwan Corporate Credit Risks Index (TCRI), originated by the TEJ, considers a firm's operation status, short-term solvency, investment efficiency and asset management. TCRIs are divided into nine degrees from 1 to 9. Degree 1 indicates almost no credit risk, while Degree 9 indicates the highest credit risk. As the credit rating of the current quarter cannot indicate whether a manager has adopted earnings management for that quarter, this study used the credit rating of the next quarter to control for the impact of credit ratings on earnings management.

Control Variables Related to Corporate Governance

The board of directors plays an important role in corporate governance, and a sound board of directors is an important mechanism that prevents managers from gaining private benefits. John and Senbet (1998) stated that the independence of the board of directors is a factor that influences the efficiency of the board. Prencipe et al. (2011) and Kang and Kim (2012) stated that an independent board of directors can effectively monitor managers' manipulation of earnings. Peasnell et al. (2005) has proposed evidence for the negative relationship between the number of outside directors and the magnitude of earnings management, and found that a higher proportion of outside directors indicates lower discretionary accruals, and consequently improves the quality of financial statements. Ahmed and Duellman (2007) have proposed evidence for the positive relationship between the independence of the board of directors and earnings management. The previous literature all supports the active monitoring hypothesis, and states that institutional investors make long-term investments. Shleifer and Vishny (1986) argued that institutional investors holding a certain proportion of shares enable monitoring of corporate operations and protection of their investment profits.

Fama and Jensen (1983) stated that outside directors have a high incentive for monitoring, and a firm where the chairman of the board serves as the general manager will see board function seriously affected. Beasley et al. (2000) stated that the number of directors differs significantly between firms with financial misreporting and other firms in the same industry. Dechow et al. (1996) proved that a larger board size has a higher correlation with earnings management. Eisenberg et al. (1998) stated that the size of the board of directors is negatively associated with earnings management and a smaller board of directors supervises and operates more efficiently. Yermack (1996) argued that a smaller board increases firm value, whereas a larger board endangers firm value and lowers operational efficiency. According to related literature, we define the control variables in this study related to corporate governance, as follows:

Size of the board of directors (*BoardS*): measures the number of members in the board of directors. This is a dummy variable, which is set to 1 if the board size is greater than the median of the sample; otherwise, it is set to 0.

Proportion of independent directors (*DirEX*): the proportion of independent directors in the board of directors.

Proportion of shares held by managers (*HoldM*): indicates whether the vice general manager and senior managers increase their shares consecutively in four quarters during the study period.

Chairman of the board serves as the general manager (*ChairM*): This is a dummy variable set to 1 if the chairman serves as the general manager; otherwise, it is set to 0.

Proportion of shares held by institutional investors (*InstF* and *InstD*): These variables represent the total proportions of shares held by foreign investors (*InstF*) and domestic investors (*InstD*).

Control Variables Related to Corporate Characteristics

Control variables related to corporate characteristics include the debt ratio, firm size, establishment years, and the firm belongs to the electronics industry, which are defined respectively as follows:

Debt ratio (*DebtR*): total assets divide total debts.
Company size (*CompS*): the natural logarithm of the firm's assets.
Establishment years (*EstD*): the number of years from the establishment of the firm to the time of the study.
Electronics industry or not (*Electronic*): a dummy variable that is set to 1 if the firm belongs to the electronics industry; otherwise, it is set to 0.

EMPIRICAL ANALYSIS RESULTS AND DISCUSSION

Data Characteristics

Tables 2 and 3 provide descriptive statistics and correlation analysis data of the sample respectively. Table 2 shows that most variables tend to skew right. Table 3 shows that the correlation coefficients between variables are low and there may be no serious collinearity issue. Table 3 also shows that real earnings management (REM) is significantly negatively correlated with accrual-based earnings management (AEM), indicating that these two earnings management methods can be alternatives of each other. REM is significantly positively associated with managerial overconfidence, whereas AEM is significantly negatively associated with managerial overconfidence, indicating that overconfident managers prefer REM to AEM. REM is significantly negatively correlated with *Delta* and *Vega* risk-taking, whereas AEM is significantly positively correlated with them, indicating that managers with higher *Delta* and *Vega* risk-taking prefer AEM to REM. However, these are preliminary results, and need to be verified in the subsequent regression analysis.

Ordinary Least Squares (OLS) Regression Analysis

Tables 4 and 5 provide the OLS regression analysis results, with AEM and REM as the dependent variables. Table 4 shows that the coefficient of OverC is significantly negative for AEM, whereas Table 5 shows that the coefficient of OverC is significantly positive for REM. It means overconfident managers prefer REM, and will not utilize accrual items for earnings management. Graham et al. (2005), Ewert and Wagenhofer (2005), and Wang and D'Souza (2006) found that REM has a complementary relationship with AEM.

Table 2: Descriptive Statistics of the Sample

Category	Variables	Average	Median	STD Error	Minimum	Maximum
Dependent Variable	|REM|	0.1269	0.0557	0.2193	0.0000	3.6340
	|AEM|	0.1647	0.0442	0.9185	0.0000	62.168
Independent Variable	*OverC*	0.1104	0.0000	0.3134	0.0000	1.0000
	Delta	1.1682	1.0734	0.6964	0.0370	7.0639
	Vega	30.017	25.870	11.853	12.348	170.30
	TCRI	2.1110	2.0000	0.7450	1.0000	4.0000
Corporate Governance	*BoardS*	0.4344	0.0000	0.4957	0.0000	1.0000
	DirEX	0.2139	0.1838	0.1262	0.0000	0.8767
	HoldM	0.0105	0.0033	0.0212	0.0000	0.2594
	ChairM	0.3412	0.0000	0.4741	0.0000	1.0000
	InstF	0.0797	0.0258	0.1290	0.0000	0.7985
	InstD	0.0228	0.0004	0.0496	0.0000	0.7239
Control Variable	*CompS*	21.262	21.142	1.0855	18.722	25.878
	DebtR	0.3815	0.3724	0.1732	0.0101	0.9982
	ROA	0.0490	0.0391	0.0712	-0.8851	0.8053
	EstD	0.9317	1.0000	0.2523	0.0000	1.0000

|REM| is the absolute value of REM of firm i in quarter t; |AEM| is the absolute value of AEM of firm i in Quarter t. OverC is the dummy variable for managerial overconfidence of firm i in quarter t; if the proportion of shares held increase consecutively in four quarters, this variable is set to 1; otherwise, this variable is set to 0. Delta is the sensitivity of total compensation of the vice general manager and senior managers to the stock price change of firm i in quarter t; Vega is the sensitivity of total compensation of the vice general manager and senior managers to stock returns volatility of firm i in quarter t; TCRI(t-1) is the credit rating level of firm i in quarter (t-1); BoardS is the size of the board of firm i in quarter t; DirEX is the proportion of independent directors in the board of directors of firm i in quarter t; HoldM is the proportion of the shares held by the vice general manager and senior managers of firm i in quarter t; ChairM indicates whether the board chairman serves as the general manager in firm i in quarter t; InstF and InstD are the proportions of shares held by foreign investors and domestic investors of firm i in quarter t, respectively; CompS is the size of firm i in quarter t; DebtR is the debt ratio of firm i in quarter t; ROA is the return on assets of firm i in quarter t; EstD is the number of years from the establishment of firm i to the time of the study. This table provides descriptive statistics and correlation analysis data of the sample respectively, and shows that most variables tend to skew right.

Table 3: Analysis of Correlation Coefficients

Variable	|REM|	|AEM|	OverC	Delta	Vega	TCRI	BoardS	DirEX
|REM|	1							
|AEM|	-0.0247 ***	1						
OverC	0.0168 **	-0.0126 *	1					
Delta	-0.0404 ***	0.0136 *	0.0135 *	1				
Vega	-0.115 ***	0.0770 ***	-0.0234 ***	-0.0485 ***	1			
$TCRI_{t-1}$	-0.0395 ***	-0.0336 ***	-0.0317 ***	0.0766 ***	-0.171 ***	1		
BoardS	0.0061	0.0002	0.0125 *	-0.0401 ***	0.0125 *	-0.133 ***	1	
DirEX	-0.0103	-0.0313 ***	-0.0217 ***	-0.0573 ***	0.0858 ***	0.0444 ***	0.0132 *	1
HoldM	0.0546 ***	-0.0247 ***	-0.0159 **	-0.0216 ***	-0.0007	0.0525 ***	-0.0637 ***	-0.0124 *
ChairM	-0.0010	-0.0030	-0.0098	0.0201 ***	-0.0713 ***	0.0835 ***	-0.0985 ***	-0.0756 ***
InstF	0.0632 ***	0.104 ***	-0.0005	-0.0208 ***	0.0383 ***	-0.416 ***	0.0622 ***	-0.0625 ***
InstD	0.0236 ***	0.0826 ***	0.0018	-0.0575 ***	0.0526 ***	-0.311 ***	0.0908 ***	-0.0031
CompS	0.0264 ***	0.138 ***	0.0061	0.128 ***	0.158 ***	-0.409 ***	0.108 ***	-0.220 ***
DebtR	0.0753 ***	0.0796 ***	0.0046	0.0215 ***	0.0099	0.284 ***	-0.0275 ***	-0.0141 *
ROA	0.0015	-0.0160 **	0.0216 ***	-0.0745 ***	0.0992 ***	-0.442 ***	0.0497 ***	0.0244 ***
EstD	-0.142 ***	0.0203 ***	-0.0227 ***	0.0774 ***	0.104 ***	0.0248 ***	-0.0660 ***	0.153

*This table provides descriptive statistics and correlation analysis data of the sample respectively, and shows that the correlation coefficients between variables are low and there may be no serious collinearity issue. It also shows that REM is significantly negatively correlated with AEM, indicating that these two earnings management methods can be alternatives of each other. |REM| is the absolute value of REM of firm i in quarter t; |AEM| is the absolute value of AEM of firm i in Quarter t. OverC is the dummy variable for managerial overconfidence of firm i in quarter t; if the proportion of shares held increase consecutively in four quarters, this variable is set to 1; otherwise, this variable is set to 0. Delta is the sensitivity of total compensation of the vice general manager and senior managers to the stock price change of firm i in quarter t; Vega is the sensitivity of total compensation of the vice general manager and senior managers to stock returns volatility of firm i in quarter t; TCRI(t-1) is the credit rating level of firm i in quarter (t-1); BoardS is the size of the board of firm i in quarter t; DirEX is the proportion of independent directors in the board of directors of firm i in quarter t; HoldM is the proportion of the shares held by the vice general manager and senior managers of firm i in quarter t; ChairM indicates whether the board chairman serves as the general manager in firm i in quarter t; InstF and InstD are the proportions of shares held by foreign investors and domestic investors of firm i in quarter t, respectively; CompS is the size of firm i in quarter t; DebtR is the debt ratio of firm i in quarter t; ROA is the return on assets of firm i in quarter t; EstD is the number of years from the establishment of firm i to the time of the study. * Indicates statistical significance at the 10% level. ** Indicates statistical significance at the 5% level.*** Indicates statistical significance at the 1% level.*

Roychowdhury (2006), Burnett et al. (2012) and Chi et al. (2011) argued that, compared to using accrual items to implement earnings management, managers prefer manipulating actual earnings to realize earnings management. Chan et al. (2015) found that, after adopting a Clawback Provision, US listed firms saw a significant decrease in AEM but a significant increase in REM, suggesting that REM tends to replace AEM. Compared with the previous literature, this study finds that overconfident managers preferred REM to AEM.

Table 3: Analysis of Correlation Coefficients (Continued)

Variable	HoldM	ChairM	InstF	InstD	CompS	DebtR	ROA	EstD
|REM|								
|AEM|								
OverC								
Delta								
Vega								
$TCRI_{t-1}$								
BoardS								
DirEX								
HoldM	1							
ChairM	0.0462 ***	1						
InstF	-0.102 ***	-0.0857 ***	1					
InstD	-0.0579 ***	-0.0636 ***	0.255 ***	1				
CompS	-0.147 ***	-0.138 ***	0.458 ***	0.290 ***	1			
DebtR	0.0255 ***	-0.0237 ***	0.0059	-0.0494 ***	0.0934 ***	1		
ROA	0.0211 ***	-0.0422 ***	0.177 ***	0.150 ***	0.145 ***	-0.148 ***	1	
EstD	-0.0245 ***	0.0215 ***	-0.0298 ***	-0.0479 ***	0.0035	0.0421 ***	-0.0555 ***	1

*This table provides descriptive statistics and correlation analysis data of the sample respectively, and shows that the correlation coefficients between variables are low and there may be no serious collinearity issue. It also shows that REM is significantly negatively correlated with AEM, indicating that these two earnings management methods can be alternatives of each other. |REM| is the absolute value of REM of firm i in quarter t; |AEM| is the absolute value of AEM of firm i in Quarter t. OverC is the dummy variable for managerial overconfidence of firm i in quarter t; if the proportion of shares held increase consecutively in four quarters, this variable is set to 1; otherwise, this variable is set to 0. Delta is the sensitivity of total compensation of the vice general manager and senior managers to the stock price change of firm i in quarter t; Vega is the sensitivity of total compensation of the vice general manager and senior managers to stock returns volatility of firm i in quarter t; TCRI(t-1) is the credit rating level of firm i in quarter (t-1); BoardS is the size of the board of firm i in quarter t; DirEX is the proportion of independent directors in the board of directors of firm i in quarter t; HoldM is the proportion of the shares held by the vice general manager and senior managers of firm i in quarter t; ChairM indicates whether the board chairman serves as the general manager in firm i in quarter t; InstF and InstD are the proportions of shares held by foreign investors and domestic investors of firm i in quarter t, respectively; CompS is the size of firm i in quarter t; DebtR is the debt ratio of firm i in quarter t; ROA is the return on assets of firm i in quarter t; EstD is the number of years from the establishment of firm i to the time of the study. * Indicates statistical significance at the 10% level. ** Indicates statistical significance at the 5% level. *** Indicates statistical significance at the 1% level.*

In the past, researchers have rarely studied the correlation between managerial compensation induced risk-taking incentives and earnings management. The analysis results in Tables 4 and 5 show that *Delta* risk-taking is irrelevant to AEM, and is negatively correlated with REM; that is, *Delta* risk-taking can lower the magnitude of REM. The design of compensation incentive mechanisms aims at solving the agency problem. Agency theory holds that the appropriate compensation incentive based on equities can make managers' interests consistent with those of shareholders (Jensen and Meckling, 1976). The principal-agent model of Holmstrom (1979) and Shavell (1979) explained why shareholders must link managerial compensation to performance to provide managers with incentives to increase firm value. The empirical results of Jensen and Murphy (1990) suggested that the pay-performance sensitivity of managerial compensation contracts is too low to provide a significant incentive for managers to act in the interests of shareholders. Hall and Liebman (1998) showed that, since the 1990s, the pay-performance sensitivity of managerial compensation contracts has seen a significant increase due to the increased frequency of the use of stock options. This study further verified that compensation incentives induced risk-taking is independent of AEM, but helps lower the magnitude of REM. The analysis results in Tables 4 and 5 show that *Vega* risk-taking significantly increases the magnitude of AEM, but significantly reduces the magnitude of REM. The design of the *Vega* risk-taking incentive mechanism aims at linking stock returns volatility to managerial wealth. A higher *Vega* risk-taking incentive indicates that the volatility of stock returns volatility can bring managers more wealth, encourage managers to take risks, and make stock prices more volatile. Both Guay (1999) and Angie (2009) argued that *Vega* risk-taking incentives can encourage managers to take risks, align managers' interests with shareholders, and overcome managers' risk averse attitudes.

Prior literature presents different opinions on the relationship between *Delta* risk-taking and AEM. Some studies support a positive relationship (Bergstresser and Philippon, 2006; Cornett, Marcus and Tehranian, 2008; Chava and Purnanandam, 2010; Armstrong et al., 2013). Some research supports no relationship (Jiang, Petroni, and Wang, 2010). Regarding the relationship between *Vega* risk-taking and AEM, some literature also supports a positive relationship (Armstrong et al., 2013) while other literature supports a negative relationship (Chava and Purnanandam, 2010). This study not only clarifies the relationship between *Delta* risk-taking and AEM, it also finds that *Vega* risk-taking, just like *Delta* risk-taking, could reduce the magnitude of REM and could increase the magnitude of AEM. AEM is different from REM. Graham et al. (2005), Ewert and Wagenhofer (2005), and Wang and D' Souza (2006) argued that the means of manipulation used for REM affect the normal operations of a firm, and even reduce the firm's long-term value (Graham et al., 2005); consequently risk-taking managers tend to use AEM rather than REM. These arguments are in line with the finding of this study.

The analysis results in Tables 4 and 5 show that the credit rating (TCRI) in the previous period has a significantly positive relationship with AEM and REM. According to the variable design of this study, a higher credit rating indicates poor credit. Hence, the analysis results in Tables 4 and 5 indicate that a firm with poor credit tends to use AEM and REM. A firm with poor credit has higher capital cost (Diamond, 1989; Kisgen and Strahan, 2010), and consequently tends to have the incentive to manipulate earnings. Demirtas and Cornaggia (2013) and Jung, Soderstrom, and Yang (2013) found that managers will use earnings management to obtain better credit ratings. Our study further detects that credit ratings are related to the two types of earnings management. For the control variables, Tables 4 and 5 show that return on assets (ROA) is negatively correlated with AEM and REM, whereas the debt ratio (DebtR), firm size (CompS), and whether a firm belongs to the electronics industry (Electronic) are positively correlated with AEM and REM. That is, a firm with higher profitability is less likely to adopt AEM and REM; an electronics firm with larger size and higher debt ratio is more likely to adopt AEM and REM. No consistent results have been achieved on the explanatory direction and significance of other control variables in terms of AEM and REM. Since the control variables are not the focus of this study, the difference between AEM and REM will not be discussed further. Tables 6 and 7 present the results of the analysis in which the interaction dummy of overconfidence and Delta risk-taking, and the interaction dummy of overconfidence and Vega risk-taking are added, respectively. Tables 6 and 7 show that, after the interaction dummy is added. Overconfidence still has a significantly negative relationship with AEM, and has a significantly positive relationship with REM. Delta risk-taking has no explanatory power for AEM, but still has a negative relationship with REM.

Table 4: OLS Analysis Result for AEM

Variables	M1	M2	M3	M4	M5
Constant	-2.226***	-2.230***	-2.239***	-2.155***	-2.385***
	(0.130)	(0.131)	(0.130)	(0.135)	(0.141)
OverC	-0.0435**				-0.0396**
	(0.0169)				(0.0168)
Delta		0.0005			0.0100
		(0.0078)			(0.0078)
Vega			0.0078***		0.0081***
			(0.0005)		(0.0005)
$TCRI_{t-1}$				0.0165**	0.0292***
				(0.0083)	(0.0096)
BoardS	-0.0206*	-0.0208*	-0.0186*	-0.0196*	-0.0151
	(0.0108)	(0.0108)	(0.0108)	(0.0109)	(0.0108)
DirEX	0.0306	0.0328	-0.0283	0.0335	-0.0293
	(0.0437)	(0.0437)	(0.0436)	(0.0437)	(0.0436)
HoldM	-0.158	-0.147	-0.256	-0.138	-0.249
	(0.253)	(0.253)	(0.252)	(0.253)	(0.252)
ChairM	0.0243**	0.0246**	0.0282**	0.0244**	0.0271**
	(0.0114)	(0.0114)	(0.0113)	(0.0114)	(0.0113)
InstF	0.324***	0.326***	0.340***	0.343***	0.380***
	(0.0471)	(0.0472)	(0.0469)	(0.0486)	(0.0485)
InstD	0.940***	0.941***	0.929***	0.965***	0.991***
	(0.114)	(0.114)	(0.113)	(0.115)	(0.115)
CompS	0.0898***	0.0898***	0.0755***	0.0922***	0.0788***
	(0.0059)	(0.0060)	(0.0060)	(0.0061)	(0.0063)
DebtR	0.337***	0.336***	0.328***	0.321***	0.296***
	(0.0312)	(0.0313)	(0.0311)	(0.0330)	(0.0329)
ROA	-0.426***	-0.430***	-0.523***	-0.387***	-0.420***
	(0.0773)	(0.0775)	(0.0772)	(0.0832)	(0.0829)
EstD	0.0943***	0.0951***	0.0713***	0.0958***	0.0695***
	(0.0212)	(0.0213)	(0.0212)	(0.0212)	(0.0212)
Electronic	0.0387***	0.0384***	0.0578***	0.0382***	0.0585***
	(0.0032)	(0.0032)	(0.0034)	(0.0032)	(0.0034)
Adj-R^2	0.035	0.035	0.043	0.035	0.043

This table provides the OLS regression analysis results, with AEM and REM as the dependent variables, and shows that the coefficient of OverC is significantly negative for AEM, The analysis results in table show that Vega risk-taking significantly increases the magnitude of AEM, but significantly reduces the magnitude of REM. The design of the Vega risk-taking incentive mechanism aims at linking stock returns volatility to managerial wealth. A higher Vega risk-taking incentive indicates that the rate of stock returns volatility can bring managers more wealth, encourage managers to take risks, and make stock prices more volatile. |REM| is the absolute value of REM of firm i in quarter t; |AEM| is the absolute value of AEM of firm i in Quarter t. OverC is the dummy variable for managerial overconfidence of firm i in quarter t; if the proportion of shares held increase consecutively in four quarters, this variable is set to 1; otherwise, this variable is set to 0. Delta is the sensitivity of total compensation of the vice general manager and senior managers to the stock price change of firm i in quarter t; Vega is the sensitivity of total compensation of the vice general manager and senior managers to stock returns volatility of firm i in quarter t; TCRI(t-1) is the credit rating level of firm i in quarter (t-1); BoardS is the size of the board of firm i in quarter t; DirEX is the proportion of independent directors in the board of directors of firm i in quarter t; HoldM is the proportion of the shares held by the vice general manager and senior managers of firm i in quarter t; ChairM indicates whether the board chairman serves as the general manager in firm i in quarter t; InstF and InstD are the proportions of shares held by foreign investors and domestic investors of firm i in quarter t, respectively; CompS is the size of firm i in quarter t; DebtR is the debt ratio of firm i in quarter t; ROA is the return on assets of firm i in quarter t; EstD is the number of years from the establishment of firm i to the time of the study.
** Indicates statistical significance at the 10% level. ** Indicates statistical significance at the 5% level. *** Indicates statistical significance at the 1% level.*

Table 5: OLS Analysis Result for REM

Variables	M1	M2	M3	M4	M5
Constant	-0.114***	-0.124***	-0.112***	-0.128***	-0.133***
	(0.0342)	(0.0344)	(0.0342)	(0.0356)	(0.0357)
OverC	0.0091**				0.0092**
	(0.0045)				(0.0044)
Delta		-0.0074***			-0.0089***
		(0.0018)			(0.0021)
Vega			-0.0011***		-0.0011***
			(0.0001)		(0.0001)
$TCRI_{t-1}$				0.0219***	0.0232***
				(0.0022)	(0.0023)
BoardS	0.0007	0.0004	0.0005	0.0010	-0.0020
	(0.0029)	(0.0025)	(0.0029)	(0.0029)	(0.0025)
DirEX	0.0391***	0.0297***	0.0469***	0.0383***	0.0364***
	(0.0115)	(0.0102)	(0.0115)	(0.0115)	(0.0103)
HoldM	0.644***	0.581***	0.656***	0.645***	0.581***
	(0.0666)	(0.0593)	(0.0665)	(0.0666)	(0.0592)
ChairM	-0.0040	-0.0023	-0.0045	-0.0042	-0.0024
	(0.0030)	(0.0027)	(0.0030)	(0.0030)	(0.0027)
InstF	0.0547***	0.0737***	0.0525***	0.0575***	0.0428***
	(0.0124)	(0.0111)	(0.0124)	(0.0126)	(0.0114)
InstD	-0.0157	0.0283	-0.0142	-0.0107	-0.0116
	(0.0299)	(0.0268)	(0.0299)	(0.0301)	(0.0270)
CompS	0.0059***	0.0034**	0.0078***	0.0064***	0.0012
	(0.0016)	(0.0014)	(0.0016)	(0.0016)	(0.0015)
DebtR	0.134***	0.0888***	0.135***	0.132***	0.115***
	(0.0082)	(0.0073)	(0.0082)	(0.0083)	(0.0077)
ROA	-0.0924***	-0.0128	-0.0790***	-0.0826***	-0.0758***
	(0.0203)	(0.0182)	(0.0204)	(0.0212)	(0.0195)
EstD	-0.119***	-0.103***	-0.116***	-0.119***	-0.101***
	(0.0056)	(0.0050)	(0.0056)	(0.0056)	(0.0050)
Electronic	0.0307***	0.0250***	0.0281***	0.0303***	0.0227***
	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.0008)
Adj-R^2	0.069	0.069	0.071	0.072	0.075

This table shows that the coefficient of OverC is significantly positive for REM. It means overconfident managers prefer REM, and will not utilize accrual items for earnings management. The analysis results in table show that Vega risk-taking significantly increases the magnitude of AEM, but significantly reduces the magnitude of REM. The design of the Vega risk-taking incentive mechanism aims at linking stock returns volatility to managerial wealth. A higher Vega risk-taking incentive indicates that the rate of stock returns volatility can bring managers more wealth, encourage managers to take risks, and make stock prices more volatile. |REM| is the absolute value of REM of firm i in quarter t; |AEM| is the absolute value of AEM of firm i in Quarter t. OverC is the dummy variable for managerial overconfidence of firm i in quarter t; if the proportion of shares held increase consecutively in four quarters, this variable is set to 1; otherwise, this variable is set to 0. Delta is the sensitivity of total compensation of the vice general manager and senior managers to the stock price change of firm i in quarter t; Vega is the sensitivity of total compensation of the vice general manager and senior managers to stock returns volatility of firm i in quarter t; TCRI(t-1) is the credit rating level of firm i in quarter (t-1); BoardS is the size of the board of firm i in quarter t; DirEX is the proportion of independent directors in the board of directors of firm i in quarter t; HoldM is the proportion of the shares held by the vice general manager and senior managers of firm i in quarter t; ChairM indicates whether the board chairman serves as the general manager in firm i in quarter t; InstF and InstD are the proportions of shares held by foreign investors and domestic investors of firm i in quarter t, respectively; CompS is the size of firm i in quarter t; DebtR is the debt ratio of firm i in quarter t; ROA is the return on assets of firm i in quarter t; EstD is the number of years from the establishment of firm i to the time of the study.
** Indicates statistical significance at the 10% level. ** Indicates statistical significance at the 5% level. *** Indicates statistical significance at the 1% level.*

Vega risk-taking still has a significantly positive relationship with AEM and has a significantly negative relationship with REM. That is, the explanatory directions of managerial overconfidence, *Delta* risk-taking and *Vega* risk-taking to AEM and REM are similar to Tables 4 and 5, respectively. As shown in Tables 6 and 7, the interaction dummy of overconfidence and *Delta* risk-taking has no significant explanatory power for AEM and REM. This means that, whether REM is adopted or not, the impact of overconfidence on

Table 6: OLS Analysis Result of AEM with the Interaction Dummies of OverC and *Delta/Vega*

Variables	M6	M7	M8	M9
Constant	-2.226***	-2.240***	-2.223***	-2.393***
	(0.131)	(0.130)	(0.130)	(0.141)
OverC	-0.0348**	-0.0442**	-0.0520**	-0.0487**
	(0.0139)	(0.0182)	(0.0231)	(0.0203)
Delta	0.0016		0.0135	0.0113
	(0.0082)		(0.0082)	(0.0082)
Vega		0.0081***	0.0081***	0.0083***
		(0.0005)	(0.0005)	(0.0005)
$TCRI_{t-1}$				0.0293***
				(0.0096)
OverC*Delta	-0.0075		-0.0124	-0.0114
	(0.0247)		(0.0246)	(0.0246)
OverC*Vega		-0.0028*	-0.0029*	-0.0029*
		(0.0016)	(0.0016)	(0.0016)
BoardS	-0.0205*	-0.0184*	-0.0177	-0.0151
	(0.0108)	(0.0108)	(0.0108)	(0.0108)
DirEX	0.0305	-0.0308	-0.0304	-0.0300
	(0.0437)	(0.0436)	(0.0437)	(0.0436)
HoldM	-0.157	-0.262	-0.260	-0.243
	(0.253)	(0.252)	(0.252)	(0.252)
ChairM	0.0243**	0.0280**	0.0276**	0.0273**
	(0.0114)	(0.0113)	(0.0114)	(0.0113)
InstF	0.325***	0.339***	0.344***	0.381***
	(0.0472)	(0.0469)	(0.0470)	(0.0485)
InstD	0.941***	0.926***	0.940***	0.990***
	(0.114)	(0.113)	(0.114)	(0.115)
CompS	0.0897***	0.0754***	0.0737***	0.0787***
	(0.0060)	(0.0060)	(0.0061)	(0.0063)
DebtR	0.337***	0.329***	0.330***	0.297***
	(0.0313)	(0.0311)	(0.0311)	(0.0329)
ROA	-0.425***	-0.519***	-0.511***	-0.420***
	(0.0775)	(0.0772)	(0.0774)	(0.0829)
EstD	0.0942***	0.0706***	0.0686***	0.0698***
	(0.0213)	(0.0212)	(0.0212)	(0.0212)
Electric	0.0387***	0.0580***	0.0583***	0.0583***
	(0.0032)	(0.0034)	(0.0034)	(0.0034)
Adj-R^2	0.035	0.043	0.044	0.044

*This table presents the results of the analysis in which the interaction dummy of overconfidence, Delta risk-taking, the interaction dummy of overconfidence and Vega risk-taking are added, respectively. It also shows that, after the interaction dummy is added. Overconfidence still has a significantly negative relationship with AEM, and has a significantly positive relationship with REM. Delta risk-taking has no explanatory power for AEM, but still has a negative relationship with REM. Vega risk-taking still has a significantly positive relationship with AEM and has a significantly negative relationship with REM. |REM| is the absolute value of REM of firm i in quarter t; OverC is the dummy variable for managerial overconfidence of firm i in quarter t; if the proportion of shares held increase consecutively in four quarters, this variable is set to 1; otherwise, this variable is set to 0. Delta is the sensitivity of total compensation of the vice general manager and senior managers to the stock price change of firm i in quarter t; Vega is the sensitivity of total compensation of the vice general manager and senior managers to stock returns volatility of firm i in quarter t; TCRI(t-1) is the credit rating level of firm i in quarter (t-1). BoardS is the size of the board of firm i in quarter t; DirEX is the proportion of independent directors in the board of directors of firm i in quarter t; HoldM is the proportion of the shares held by the vice general manager and senior managers of firm i in quarter t; ChairM indicates whether the board chairman serves as the general manager in firm i in quarter t; InstF and InstD are the proportions of shares held by foreign investors and domestic investors of firm i in quarter t, respectively; CompS is the size of firm i in quarter t; DebtR is the debt ratio of firm i in quarter t; ROA is the return on assets of firm i in quarter t; EstD is the number of years from the establishment of firm i to the time of the study. * Indicates statistical significance at the 10% level. ** Indicates statistical significance at the 5% level. *** Indicates statistical significance at the 1% level.*

Delta risk-taking does not change significantly. In terms of *Vega* risk-taking, the interaction dummy of overconfidence and *Vega* risk-taking is significantly negatively related with AEM, but its relationship with REM is not significant. It seems overconfidence mitigates the positive relationship between *Vega* risk-taking and AEM, but does not significantly affect the relationship between *Vega* risk-taking and REM.

Robust Test - Logistic Regression Analysis

The result of the OLS regression analysis shows that overconfident managers prefer REM to AEM, to implement earnings management, and this result will not change due to the addition of overconfidence, *Delta* risk-taking, *Vega* risk-taking and interaction dummies between overconfidence and risk-taking. To verify the robustness of this result, AEM and REM variables are divided into high and low groups using the median. A dummy variable is used to set firms with high REM and low AEM to 1, and firms with low REM and high AEM to 0. Logistic Regression Analysis is conducted, with the analysis results presented in Table 8. Table 8 shows that overconfident managers are more likely to adopt high REM and low AEM. That verified some of the results in Tables 4 and 5, indicating that the OLS regression analysis results in this study are robust. In terms of *Delta* risk-taking and *Vega* risk-taking, Table 8 shows that the Logistic Regression Analysis Model (M8) of all variables is significantly negative. *Delta* risk-taking is irrelevant to the probability of a firm adopting high REM and low AEM, but *Vega* risk-taking is significantly negatively. That is, the higher *Vega* risk-taking is, the less likely the firm is to adopt high REM and low AEM. In terms of the variables related to credit ratings, some results in Tables 4 and 5 show that firms with poor credit ratings in the previous period are more likely to adopt AEM and REM. Table 8 further shows that firms with poor credit ratings are more likely to adopt high REM and low AEM.

Table 8 shows that, after the interaction dummies between overconfidence and *Delta* risk-taking and between overconfidence and *Vega* risk-taking are added (M6 to M8), the explanatory powers of overconfidence, *Delta* risk-taking, and *Vega* risk-taking do not change much, and their significant explanatory directions remain unchanged. The interaction dummy between overconfidence and *Delta* risk-taking is irrelevant to the probability of high REM and low AEM, but the interaction dummy between overconfidence and *Vega* risk-taking has a significantly negative effect on the probability. That is, if the *Vega* risk-taking of overconfident managers is increased, the probability of high REM and low AEM will be lowered. In terms of control variables, Table 8 shows that ROA, debt ratio (DebtR), firm size (CompS) and years of establishment (EstD) are negatively correlated with the probability of high REM and low AEM. That is, a firm with higher profit, a higher debt ratio, larger size, and a longer life is less likely to adopt high REM and low AEM. Table 8 also shows that a firm in which the board of directors (BoardS) is large and the proportion of shares held by managers (HoldM) is high is more likely to adopt high REM and low AEM. In addition, Table 8 shows that high REM and low AEM are more likely to be adopted in the electronics industry (Electronic).

Table 7: OLS Analysis Result of REM with the Interaction Dummies of OverC and *Delta/Vega*

Variables	M6	M7	M8	M9
Constant	-0.125***	-0.113***	-0.126***	0.0867***
	(0.0344)	(0.0342)	(0.0343)	(0.0332)
OverC	0.0098**	0.0132**	0.0016**	0.0018**
	(0.0049)	(0.0055)	(0.0066)	(0.0075)
Delta	-0.0073***		-0.0088***	-0.0072***
	(0.0022)		(0.0019)	(0.0019)
Vega		-0.0010***	-0.0009***	-0.0010***
		(0.0001)	(0.0001)	(0.0001)
$TCRI_{t-1}$				-0.0232***
				(0.0023)
OverC*Delta	-0.0004		0.0008	-0.0006
	(0.0065)		(0.0058)	(0.0058)
OverC*Vega		-0.0003	0.0001	0.0002
		(0.0004)	(0.0004)	(0.0004)
BoardS	0.0003	0.0004	-0.0001	-0.0020
	(0.0029)	(0.0029)	(0.0029)	(0.0025)
DirEX	0.0384***	0.0473***	0.0468***	0.0365***
	(0.0115)	(0.0115)	(0.0115)	(0.0103)
HoldM	0.643***	0.658***	0.658***	0.581***
	(0.0666)	(0.0666)	(0.0665)	(0.0592)
ChairM	-0.0037	-0.0045	-0.00410	-0.0024
	(0.0030)	(0.0030)	(0.0030)	(0.0027)
InstF	0.0519***	0.0528***	0.0493***	0.0427***
	(0.0124)	(0.0124)	(0.0124)	(0.0114)
InstD	-0.0237	-0.0142	-0.0238	-0.0115
	(0.0300)	(0.0299)	(0.0300)	(0.0270)
CompS	0.0068***	0.0078***	0.0091***	0.0012
	(0.0016)	(0.0016)	(0.0016)	(0.0015)
DebtR	0.133***	0.135***	0.134***	0.115***
	(0.0082)	(0.0082)	(0.0082)	(0.0077)
ROA	-0.0978***	-0.0800***	-0.0860***	-0.0758***
	(0.0204)	(0.0204)	(0.0204)	(0.0195)
EstD	-0.118***	-0.116***	-0.114***	-0.101***
	(0.0056)	(0.0056)	(0.0056)	(0.0050)
Electronic	0.0306***	0.0281***	0.0278***	0.0227***
	(0.0008)	(0.0009)	(0.0009)	(0.0008)
Adj-R^2	0.070	0.071	0.071	0.075

*|REM| is the absolute value of REM of firm i in quarter t; OverC is the dummy variable for managerial overconfidence of firm i in quarter t; if the proportion of shares held increase consecutively in four quarters, this variable is set to 1; otherwise, this variable is set to 0. Delta is the sensitivity of total compensation of the vice general manager and senior managers to the stock price change of firm i in quarter t; Vega is the sensitivity of total compensation of the vice general manager and senior managers to stock returns volatility of firm i in quarter t; TCRI(t-1) is the credit rating level of firm i in quarter (t-1). BoardS is the size of the board of firm i in quarter t. DirEX is the proportion of independent directors in the board of directors of firm i in quarter t. HoldM is the proportion of the shares held by the vice general manager and senior managers of firm i in quarter t. ChairM indicates whether the board chairman serves as the general manager in firm i in quarter t. InstF and InstD are the proportions of shares held by foreign investors and domestic investors of firm i in quarter t, respectively. CompS is the size of firm i in quarter t. DebtR is the debt ratio of firm i in quarter t; ROA is the return on assets of firm i in quarter t; EstD is the number of years from the establishment of firm i to the time of the study. * Indicates statistical significance at the 10% level. ** Indicates statistical significance at the 5% level. *** Indicates statistical significance at the 1% level.*

Table 8: Logistic Regression Analysis Results

H_REM、L_AEM (High Real Earnings Management and Low Accrual-Based Earnings Management)								
Variables	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Individual Independent Variable						**Interaction Dummy Added**		
Constant	1.252***	1.325***	1.122***	0.274	3.435***	2.855***	2.787***	3.441***
	(0.433)	(0.434)	(0.435)	(0.456)	(0.480)	(0.437)	(0.437)	(0.480)
OverC	0.108*				0.0535*	0.0611*	0.1090*	0.0425*
	(0.0570)				(0.0282)	(0.325)	(0.0559)	(0.0221)
Delta		0.0428			-0.0378	-0.0316		-0.0499*
		(0.0262)			(0.0267)	(0.0278)		(0.0281)
Vega			-0.0337***		-0.0263***		-0.0252***	-0.0262***
			(0.0022)		(0.0020)		(0.0021)	(0.0021)
$TCRI_{t-1}$				0.0760**	0.120***			0.119***
				(0.0322)	(0.0328)			(0.0328)
OverC*Delta						0.121		0.119
						(0.0864)		(0.0866)
OverC*Vega							-0.0018**	-0.0017**
							(0.0077)	(0.0007)
BoardS	0.129***	0.133***	0.122***	0.0986***	0.130***	0.103***	0.0988***	0.0879**
	(0.0368)	(0.0368)	(0.0372)	(0.0369)	(0.0373)	(0.0369)	(0.0371)	(0.0372)
DirEX	-0.0348	-0.0401	0.160	0.0303	0.143	0.0357	0.203	0.213
	(0.152)	(0.152)	(0.154)	(0.151)	(0.154)	(0.151)	(0.153)	(0.153)
HoldM	3.168***	3.180***	3.742***	4.257***	3.964***	4.355***	4.767***	4.606***
	(0.972)	(0.973)	(0.987)	(0.960)	(0.990)	(0.959)	(0.965)	(0.966)
ChairM	0.0070	0.0047	-0.0058	0.0793**	-0.0085	0.0782**	0.0687*	0.0718*
	(0.0385)	(0.0385)	(0.0388)	(0.0386)	(0.0389)	(0.0386)	(0.0388)	(0.0388)
InstF	0.127	0.145	0.0469	0.370**	0.197	0.454***	0.402**	0.246
	(0.156)	(0.157)	(0.158)	(0.161)	(0.161)	(0.157)	(0.157)	(0.162)
InstD	-0.579	-0.550	-0.642*	-0.0087	-0.391	0.119	0.151	-0.120
	(0.361)	(0.361)	(0.370)	(0.377)	(0.373)	(0.372)	(0.380)	(0.385)
CompS	-0.0806***	-0.0863***	-0.0175	-0.162***	0.0049	-0.146***	-0.101***	-0.116***
	(0.0197)	(0.0199)	(0.0201)	(0.0206)	(0.0210)	(0.0201)	(0.0202)	(0.0213)
DebtR	-2.106***	-2.101***	-2.011***	-2.584***	-2.122***	-2.666***	-2.589***	-2.460***
	(0.110)	(0.110)	(0.111)	(0.116)	(0.113)	(0.111)	(0.112)	(0.117)
ROA	-1.783***	-1.748***	-1.398***	-0.478	-1.026***	-0.246	0.0862	-0.338
	(0.279)	(0.279)	(0.280)	(0.302)	(0.290)	(0.282)	(0.283)	(0.303)
EstD	-0.926***	-0.935***	-0.835***	-0.822***	-0.830***	-0.813***	-0.745***	-0.744***
	(0.0771)	(0.0772)	(0.0773)	(0.0761)	(0.0775)	(0.0762)	(0.0762)	(0.0764)
Electronic	0.330***	0.332***	0.268***	0.300***	0.252***	0.298***	0.246***	0.245***
	(0.0135)	(0.0135)	(0.0141)	(0.0131)	(0.0144)	(0.0131)	(0.0137)	(0.0137)
Adj-R^2	0.0755	0.0755	0.0904	0.0780	0.0920	0.0784	0.0921	0.0921

*|REM| is the absolute value of REM of firm i in quarter t; |AEM| is the absolute value of AEM of firm i in Quarter t; OverC is the dummy variable for managerial overconfidence of firm i in quarter t; if the proportion of shares held increase consecutively in four quarters, this variable is set to 1; otherwise, this variable is set to 0. Delta is the sensitivity of total compensation of the vice general manager and senior managers to the stock price change of firm i in quarter t; Vega is the sensitivity of total compensation of the vice general manager and senior managers to stock returns volatility of firm i in quarter t; TCRI(t-1) is the credit rating level of firm i in quarter (t-1); BoardS is the size of the board of firm i in quarter t; DirEX is the proportion of independent directors in the board of directors of firm i in quarter t; HoldM is the proportion of the shares held by the vice general manager and senior managers of firm i in quarter t; ChairM indicates whether the board chairman serves as the general manager in firm i in quarter t; InstF and InstD are the proportions of shares held by foreign investors and domestic investors of firm i in quarter t, respectively; CompS is the size of firm i in quarter t; DebtR is the debt ratio of firm i in quarter t; ROA is the return on assets of firm i in quarter t; EstD is the number of years from the establishment of firm i to the time of the study. * Indicates statistical significance at the 10% level. ** Indicates statistical significance at the 5% level. *** Indicates statistical significance at the 1% level.*

CONCLUSIONS

In this study, data from Taiwanese listed and OTC (Over-the-Counter) companies from 2006 to 2015 are investigated to explore empirically managerial overconfidence, compensation induced risk-taking, and the impacts on accrual-based earnings management (AEM) and real earnings management (REM). Although previous literature investigated the relationship between managerial overconfidence with AEM and REM, as well as the relationship between compensation with AEM and REM, few studies completely investigated managerial overconfidence and compensation incentives induced risk-taking, and the impact on AEM and REM.

The results of both the preliminary analysis and robustness analysis show that overconfident managers prefer REM to AEM. Compensation induced *Delta* risk-taking is irrelevant to AEM, and is negatively associated with REM, indicating that *Delta* risk-taking can lower the magnitude of REM. Compensation induced *Vega* risk-taking can increase the magnitude of AEM and reduce the magnitude of REM. The analysis including the interaction dummies between overconfidence and *Delta* risk-taking and between overconfidence and *Vega* risk-taking shows that the same direction of the relationships of overconfidence, *Delta* risk-taking, and *Vega* risk-taking to AEM and REM remain unchanged, indicating that the results of this study are robust. In addition, the study further finds that the interaction dummy between overconfidence and *Delta* risk-taking has no explanatory power for AEM and REM, but the interaction dummy between overconfidence and *Vega* risk-taking has a negative effect on AEM and REM. That is, overconfidence will mitigate the positive relationship between *Vega* risk-taking and AEM, but has no impact on the negative relationship between *Vega* risk-taking and REM.

The economic costs incurred by AEM are short-term and easily subsequently recognized, whereas the impact of REM is long-term and harder to detect, which is more of an ethical issue. Prior literature found that, in recent years, saw a significant decrease in AEM but a significant increase in REM, it means that substitution between REM and AEM after voluntary adoption of compensation Clawback Provisions that the board of directors authorize to recoup compensation paid to executives based on misstated financial reports.

The results of this study show that overconfident managers tend to use REM rather than AEM. This means that overconfident managers, despite overestimating their information and knowledge and underestimating risks, are less likely to take the risk of being detected but instead adopt an earnings management pattern that may cause long-term loss to their firms. Securities regulatory authorities should pay more attention to this problem. In addition, the design of compensation incentives mainly aims at linking managerial compensation and stock price changes or volatility to make managers' interests consistent with those of shareholders. According to the results of the analysis in this study, stock price changes and volatility will reduce the probability of REM, but stock price changes will increase the probability of earnings management. This result shows that the existing design of compensation incentives cannot eliminate the phenomenon of earnings management. Therefore, boards of directors should call for additional research to propose a more effective monitoring mechanism and design of managerial compensation. The paper is limited in the selection of Taiwanese listed and OTC firms as the research object, and collected data from the database of the Taiwan Economic Journal (TEJ). Some are not included in the sample. Firms demoted as full-cash delivery stocks, financial and securities companies, and industries with less than 15 sample firms are notably absent from the sample. In a future study, another interesting extension of this paper would be a more detailed examination of correlation between risk-taking induced managerial overconfidence and earnings management induced risk-taking. In a further study, we could put managerial experience and working years into the model to examine how earning management induced managerial overconfidence affects stock price volatility.

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SEASONAL VARIATIONS IN TWO-YEAR TREASURY NOTE YIELDS

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ABSTRACT

We study seasonality in the two-year Treasury Note yields. We find that most anecdotally observed seasonal variations of yields do not pass the more rigorous statistical significance test. In addition, the seasonality findings depend on how me measure yields and what kind of seasonal patterns we test. No statistical significance is found with tests using nominal yields, most likely due to the fact that yields have been dropping substantially since the 1980s which distorted the mean values of yields. When we instead use the rank of monthly yields in a year to test the seasonality, however, we find strong statistical significance to support the variation of high yields from March to August and low yields from September to February.

JEL: G10, G12, G14

KEYWORDS: Seasonality, Treasury Yields, Asset Pricing

INTRODUCTION

Persistent seasonal asset pricing anomalies have important implications for market efficiency, thus it is important to understand seasonality and where it might have come from. Treasury yields play a central role in determining and influencing interest rates and interest rates movements, which both directly and indirectly affect the seasonality in all asset prices. To the best of our knowledge, academic research on yields seasonality is very limited to almost nonexistent. Most research on seasonality has focused on the risky assets while the few available ones on the risk free assets have focused on returns instead of yields. Even then, their findings are mixed. For example, while Schneeweis and Woolridge (1979), Chang and Pinegar (1986), Sharp (1988) and Krehbiel (1993) find no seasonalities in Treasury bond's monthly returns, others like Flannery and Protopapadakis (1988), Clayton, Delozier and Ehrhardt (1989), and Athanassakos and Tian (1998) find Treasury returns' seasonality in days-of-the-week, month-of-the-year, and quarter-of-the-year.

In this paper, we study the seasonality in Treasury yields with a focus on the two-year Treasury Note. The two-year Note is one of the five intermediate term Treasury securities issued by the US government, which includes Notes with fix maturities of two, three, five, seven and ten years. It is auctioned on a monthly basis, typically on the last day of the month. If the last day of the month is a Saturday, Sunday, or federal holiday, the securities are issued on the first business day of the following month ("General Auction Timing", www.TreasuryDirect.Gov). The two-year Note yields fluctuate over time, perhaps more significantly than any other intermediate term Treasuries given its shortest maturity. While the ten-year Note is the most popular Note and followed closely by many investors, the two-year Note is also very important and perhaps deserves more attention than it receives currently. With a much shorter maturity compared to the ten-year Note (but not too much longer than the deeply discounted one-year Bill) and offering coupons, the two-year Note offers a lot of flexibility and value especially in an uncertain market.

We find that although anecdotally the two-year Note yields seem to have a clear pattern of seasonality, with some months having higher yields than the others, statistically these seasonal patterns do not hold in terms of the nominal yields. However, if we look at the rank of monthly yields in its calendar year, we find strong statistical evidence to support a half-year variation of high and low yields, where months from March until August have higher yield than months from September until February. The rest of the paper is organized in the following ways. Section 2 presents the literature review. Section 3 explains the data and methodology. Section 4 reports and discusses the test results and their implications. Section 5 concludes the findings.

LITERATURE REVIEW

Persistent asset pricing anomalies have important implications for market efficiency as discovered anomalies typically disappear quickly through arbitrage in efficient markets. Finance literature has over the years documented a variety of seasonal anomalies across different markets and asset classes. The most well-known anomalies include the turn-of-the-year effect, the turn-of-the-month effect and the day-of-the-week effect. Explanations offered for such anomalies include macroeconomic seasonalities (Kramer, 1994), standardization of payments which results in concentrations of cash flows at certain times (Ogden, 1987, 1990), portfolio rebalancing (Ritter and Chopra, 1989), and behavioral perspective such as seasonal mood swings (Kamstra, Kramer and Levi, 2015).

The focus of the seasonality studies has been on the risky assets such as stocks and corporate bonds. Only a few have studied risk free assets such as the U.S. Treasury securities, and their findings have been mostly inconclusive with some supporting seasonalities while others not. In addition, all of these studies have been on the returns rather than the yields of the Treasuries. For example, Athanassakos and Tian (1998) investigate the seasonality in quarterly returns in the Canadian government bond market and find that government bond returns in the last quarter of the year are significantly higher than any other quarter of the year. Chen and Chan (1997) examine the January effect in returns of a number of asset classes including stocks, U.S. government bonds and Treasury-bills with additional tests for auto-correlated and heteroskedastic residuals in the data series, on top of the standard dummy regression analysis. They find that the January effect is robust in the returns of risky assets such as small stocks and low grade bonds, but does not exit in the government bonds and T-bills. Kamstra, Kramer and Levi (2015) examine the U.S. Treasury securities returns and find an annual cycle with variation in mean monthly returns of over 80 basis points from peak to trough. Our earlier study Liu, Lin and Varshney (2018) is probably the first academic research paper that looks at the seasonalities in the Treasury yields. We studied the ten-year Treasury Note yields and find that most anecdotally observed seasonalities are not statistically significant.

The focus of this paper is on the seasonality in the two-year Treasury Note yields. The two-year Note has the shortest fixed maturity among all Treasury Notes, thus offers the most flexibility and extra value that comes with it, especially when the market is uncertain. Given its shorter terms, the two-year Note yields would also fluctuate over time more significantly than any other intermediate term Treasury Notes. The research on the two-year Treasury Note yields is almost nonexistent, not even much from the practitioners. We intend to fill in this gap in the literature.

DATA AND METHODOLOGY

Our monthly two-year Treasury Note yields data is obtained from FRED (Federal Research Economic Database) Federal Reserve Bank of St. Louis. The earliest available data is from 1976.06 and the latest is on 2018.06. The total time series observations consist of 505 months (42 years and 1 month). Our study of the yields seasonality follows the standard dummy variable regression analysis methods used in the seasonality studies of the Treasury returns in Athanassakos and Tian (1998), Chen and Chan (1997) and Kamstra, Kramer and Levi (2015). Specifically, we test the seasonality in monthly yields and month-over-month changes of yields using, respectively

$$Y_t = \alpha_0 + \sum_{j \neq 5}^{12} \beta_j M_t^j + \varepsilon_t \quad (1)$$

$$\Delta Y_t = \alpha_0 + \sum_{j \neq 5}^{12} \beta_j M_t^j + \varepsilon_t \quad (2)$$

where Y_t is the monthly two-year Note yields and ΔY_t represents the month-over-month changes of yields $\Delta Y_t = Y_t - Y_{t-1}$. M_t^j is a dummy variable that is equal to 1 if the month is j and 0 otherwise. j varies from 1 to 12 except 5, i.e., there are 11 dummy variables for every month except May. Many practitioners have found that May has on average the largest ten-year Treasury Note yields. Since we do not find past seasonality research on the two-year Treasury Note yields, we use May as the reference month in our study. The choice of this reference month should not affect the seasonality results. β_j measures the average difference in yields between the month j and May in Equation (1); and the average difference of the month-over-month changes of yields between those of month j and May in Equation (2). α_0 measures the average yield in May in Equation (1); and average month-over-month changes of yields in May in Equation (2). A statistically significant and negative β_j indicates that the associated month j has lower yields (month-over-month changes of yields) than May, and vice versa.

The null hypothesis is that yields and month-over-month changes of yields do not vary across different months of the year, i.e., all βs are simultaneously equal to 0, or $\beta_1 = \beta_2 = \cdots = \beta_j = 0$. If the null hypothesis is rejected, then there is a seasonality because some month(s) always have higher (or lower) yield or changes of yields than those in May. *F*-test is used to test the joint null hypothesis and the overall fitness of the regression. To make conclusions more reliable, we also check the serial correlation and heteroscedasticity of the regression residuals using the Durbin-Watson d statistics and the White's χ^2 test. The presence of serial correlation and heteroscedasticity in the regression residuals invalidates the normality assumptions of the *F*-test and OLS, therefore inferences of seasonalities based on their results may become less reliable. Given that we do not know the probability distribution of the two-year Note yields; we also conduct a non-parametric test. Kruskal-Wallis test is used because it is similar to the *F*-test regarding the joint null hypothesis but compares medians instead of means, and does not make specific assumptions regarding the probability distribution of the variables.

RESULTS

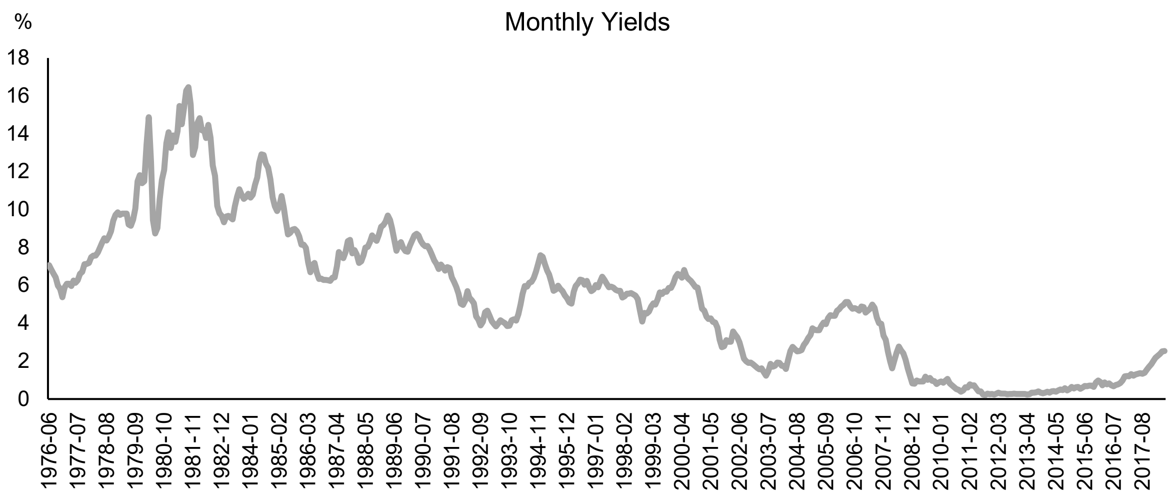
Anecdotal Observations

Table 1 reports the key summary statistics of the nominal monthly two-year Treasury Note yields from 1976.06 to 2018.06. The most noticeable number is the wide range of yields over the period: the minimum is only 0.21% while the maximum is 16.46%. Figure 1 plots the monthly two-year yields over the sample period and confirms that yields have been coming down substantially since the 1980s.

Table 1: Summary Statistics of Two-Year Treasury Note Yields (1976.06-2018.06)

	Yield (%)
Mean	5.39
Median	5.38
Standard Deviation	3.78
Kurtosis	-0.27
Skewness	0.52
Range	16.25
Minimum	0.21
Maximum	16.46
Count	505

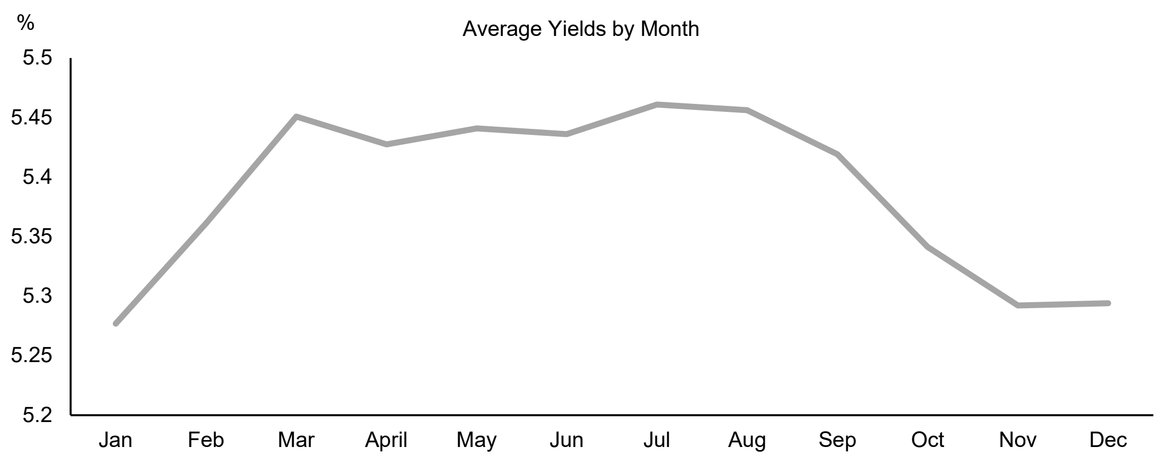
Figure 1: Two-Year Treasury Note Yields (1976.06-2018.06)



This figure shows the monthly yields of the two-year Treasury Note since it first started in 1976.06. until 2018.06.

Figure 2 plots the average two-year yields by months for the period under study. The yields exhibit a noticeable pattern of being higher from March until August before heading down for the rest of the year.

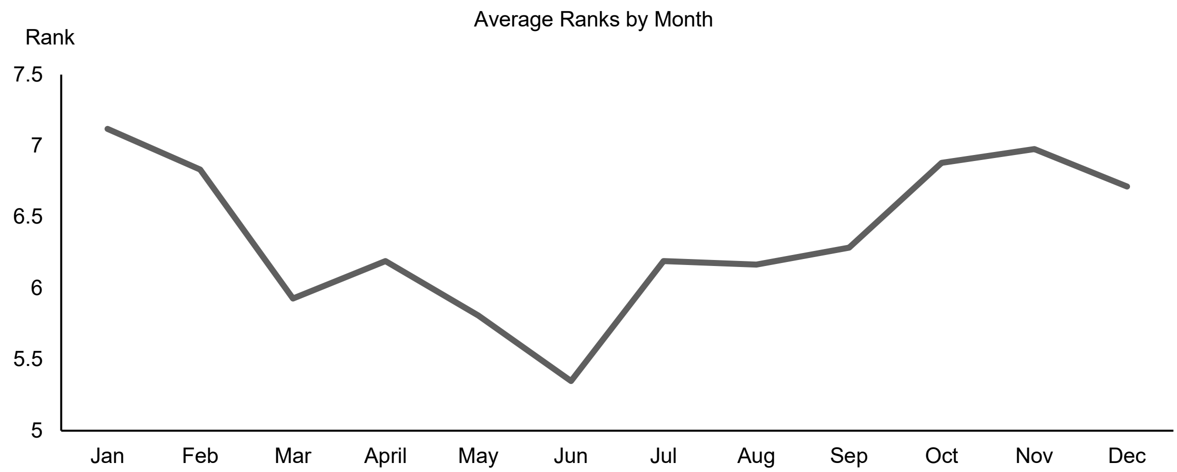
Figure 2: Average Two-Year Treasury Note Yields by Month (1976.06 - 2018.06)



This figure shows the average two-year Treasury Note yields by month for the period from 1976.06. to 2018.06.

Since yields have dropped a lot over the years which may have distorted the average yields shown in Figure 2, we also take a look at the average ranks of monthly yields in a year. The ranks will be independent of the levels of yields at different periods of time. Figure 3 plots the average ranks of yields by months over the period under study, with the highest ranks noted as 1 and lowest as 12. We can see that on average June has the highest yields (with the lowest rank) of the year. In addition, the months from March to August have higher yields (lower ranks) than other months of the year, which is consistent with the findings of Figure 2.

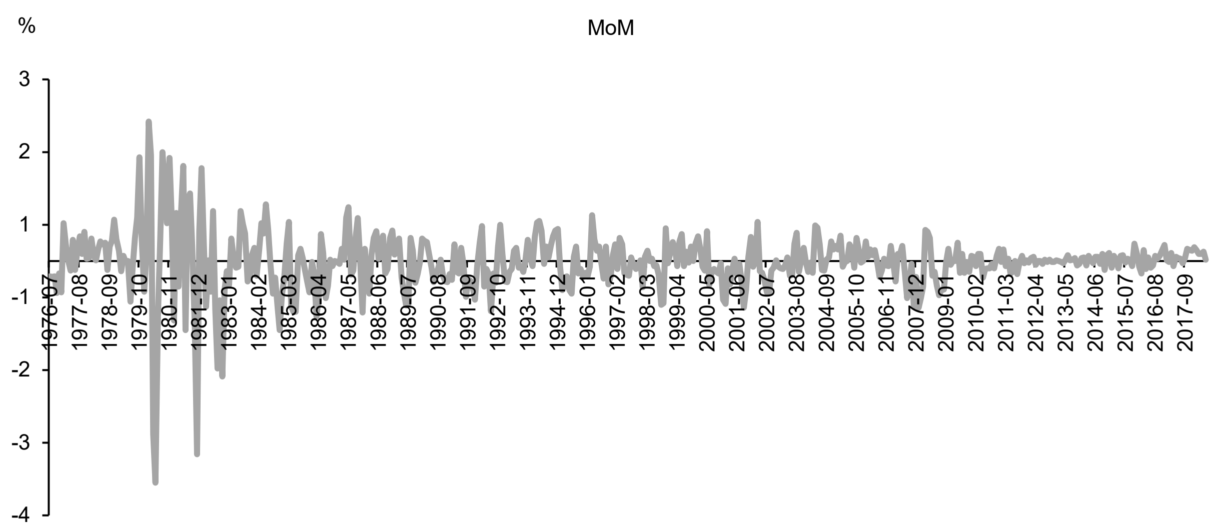
Figure 3: Average Ranks of Two-Year Treasury Note Yields by Month (Highest As 1 and Lowest As 12)



This figure shows the average ranks of the monthly yields in the calendar year for the period of study from 1976.06. to 2018.06.

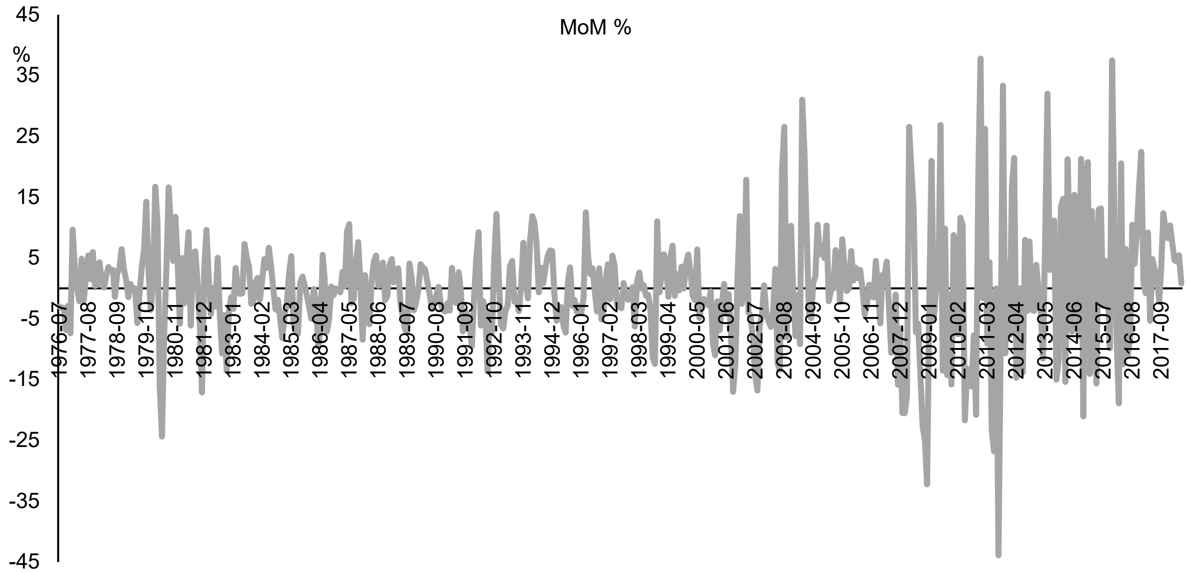
Figures 4 and 5 plot the month-over-month changes of yields over the period under study, both in absolute values and in percentages respectively. We see that although the month-over-month changes of yields vary in larger absolute values in the 1980s, they vary a lot more in terms of the percentage changes in more recent years especially after 2008. This means that although the yields in recent years are at lower levels compared to those in the past, their variations in percentage terms nevertheless are much bigger. In addition, plots in both figures show mean reversion, that is, the differences in yields tend to fluctuate but towards a central value. This indicates that the monthly yields probably have a unit root and are difference stationary. The Augmented Dickey-Fuller tests (results not reported here) confirm that yields are indeed difference stationary.

Figure 4: Month-Over-Month Changes of Two-Year Treasury Note Yields (Absolute Values)



This figure shows the absolute amount of the month-over-month changes of yields from 1976.06 to 2018.06.

Figure 5: Month-Over-Month Changes of Two-Year Treasury Note Yields (Percentages)



This figure shows the percentage amount of the month-over-month changes of yields from 1976.06 to 2018.06.

Statistical Analysis

The anecdotal seasonal variations observed in the previous section are tested here using more rigorous statistical methods. Tables 3 and 4 report the results of seasonality tests conducted using monthly yields and the month-over-month changes of yields in the sample period. Table 5 reports the results of tests on the half year variation pattern observed in Figures 2 and 3, where the months from March until August have higher yields than the rest months of the year. Table 3 shows that months with negative β coefficients in general belong to the half of the year with lower yields, which is from September to February. April and June are also found to have negative betas or smaller yields than May but their difference with May is much smaller than the other months.

The differences in yields compared to May from the months in the lower yields half of the year are at least 2 basis points (September) and can be as large as over 16 basis points (January). The differences for April and June are only 1 and 0.5 basis points respectively. However, none of the above differences are statistically significant. In addition, R-squared value is very low and the Adjusted R-squared value is negative, which indicate a poor model overall. The null hypothesis of no monthly differences in yields cannot be rejected by the F-test with p-value almost equal to 1. In other words, there is no seasonalities in the nominal monthly yields in the period under study. While the Durbin-Watson d statistics finds positive first order serial correlation in yields, the White's χ^2 test finds no heteroscedasticity. The nonparametric Kruskal-Wallis test also shows that there is no seasonality in the monthly yields. Therefore, the findings from both the parametric and nonparametric tests do not support the existence of a statistically significant seasonality in monthly yields in the period under study.

Table 4 reports the seasonality test results on the month-over-month changes of yields. We see that other than February and March, the month-over-month changes of yields in all other months are smaller than those in May. This indicates that while May has on average higher yields, it also has more changes of yields from the previous month. Durbin-Watson statistic indicates that there is still some but much weaker serial correlation among the month-over-month changes of yields.

Table 3: Seasonality in Monthly Two-Year Treasury Note Yields

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	5.4410	0.5896	9.2289	0.0000
Jan	-0.1640	0.8338	-0.1968	0.8441
Feb	-0.0798	0.8338	-0.0957	0.9238
Mar	0.0098	0.8338	0.0117	0.9907
Apr	-0.0136	0.8338	-0.0163	0.9870
Jun	-0.0049	0.8289	-0.0059	0.9953
Jul	0.0200	0.8338	0.0240	0.9809
Aug	0.0152	0.8338	0.0183	0.9854
Sep	-0.0219	0.8338	-0.0263	0.9791
Oct	-0.0998	0.8338	-0.1197	0.9048
Nov	-0.1488	0.8338	-0.1785	0.8584
Dec	-0.1469	0.8338	-0.1762	0.8602
R-Squared			0.0003	
Adjusted R-Squared			-0.0220	
F-Statistic (P-Value)			0.0143	1
White's Chi-Square (P-Value)			0.5081	1
Durbin-Watson Stat			0.0115	
Kruskal-Wallis (P-Value)			0.1845	1

Regression results are based on Equation (1) $Y_t = \alpha_0 + \sum_{j\neq 5}^{12} \beta_j M_t^j + \varepsilon_t$. M_t^j *is a dummy variable that varies from 1 to 12 except 5.* β_j *is reported as "Coefficient". *, **, and *** indicate significance at the 10, 5 and 1 percent levels respectively. None of the* β_j *coefficients are significant at 10% level of significance.*

Again, none of the reported results are statistically significant. Therefore, there is no evidence to support a statistically significant seasonality in the month-over-month changes of yields. Since we have observed a seasonal pattern of higher yields in months from March to August in the previous section, we also test if there is a half year pattern of high versus low yields. Table 5 reports the results. We use similar regression methods employed earlier. We find that while the half-year high versus low yields pattern seems pretty convincing in Figures 2 and 3, results presented in Table 5 confirm that it does not pass the statistical significance test.

Table 4: Seasonality in the Month-Over-Month Changes of Yields

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	0.0136	0.0633	0.2146	0.8302
Jan	-0.0307	0.0895	-0.3434	0.7315
Feb	0.0707	0.0895	0.7905	0.4296
Mar	0.0760	0.0895	0.8491	0.3962
Apr	-0.0369	0.0895	-0.4126	0.6801
Jun	-0.0571	0.0895	-0.6388	0.5232
Jul	-0.0579	0.0895	-0.6468	0.5181
Aug	-0.0183	0.0895	-0.2050	0.8377
Sep	-0.0507	0.0895	-0.5670	0.5710
Oct	-0.0914	0.0895	-1.0221	0.3072
Nov	-0.0626	0.0895	-0.7000	0.4842
Dec	-0.0117	0.0895	-0.1304	0.8963
R-squared			0.0145	
Adjusted R-squared			-0.0076	
F-statistic (p-value)			0.6568	0.7795
White's Chi-square (p-value)			8.7753	0.6426
Durbin-Watson stat			1.2858	
Kruskal-Wallis (p-value)			0.4924	1

*Regression results are based on Equation (2) $\Delta Y_t = \alpha_0 + \sum_{j\neq5}^{12} \beta_j M_t^j + \varepsilon_t$, where ΔY_t is the month-over-month change of yields $\Delta Y_t = Y_t - Y_{t-1}$. M_t^j is a dummy variable with j varies from 1 to 12 except 5. β_j is reported as "Coefficient". *, **, and *** indicate significance at the 10, 5 and 1 percent levels respectively. None of the β_j coefficients are significant at 10% level of significance.*

Since yields have dropped significantly during the period under study, we also test the ranks of monthly yields in a year that removes the effect of the differences in the levels of yields. Tables 6 and 7 report the results on the monthly seasonality and the half-year seasonality of the ranks respectively. As we can see that the results using ranks are much stronger compared to those using nominal yields. In Table 6, although the p-value of the F-test statistics is much closer to 0 than any previously reported results, it is still not statistically significant at the 10% level. However, January is found to have lower yields (higher ranks) than May at the 10% significance level.

The most interesting results are in Table 7, which tests the half-year high versus low yields seasonality using the ranks of the monthly yields in its calendar year. Once we compare yields using only relative performances in a year instead of their absolute values, we find a strong statistical significance to support the high versus low half-year yields pattern. Table 7 shows that the parametric F-test statistics is significant at the 1% level. The months from the lower yields half of the year are found to have ranks almost double those of the months from the higher yields half of the year, and significantly so at the 5% level. The only issue is that the White's χ^2 test finds heteroscedasticity in the regression residuals that cast some doubts on the normality assumptions of the parametric regression. However, we can reasonably assume that it is not affecting much of the seasonality findings, because the non-parametric Kruskal-Wallis test statistic is also significant at the 5% level.

Table 5: Seasonality in Half-Year High Versus Low Yields

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	5.4453	0.2378	22.8970	0.0000
LOW	-0.1146	0.3367	-0.3403	0.7337
R-squared			0.0002	
Adjusted R-squared			-0.0018	
F-statistic (p-value)			0.1158	0.7337
White's Chi-square (p-value)			0.0112	0.9157
Durbin-Watson stat			0.0116	
Kruskal-Wallis (p-value)			0.0003	0.9860

*Results are based on a regression similar to Equation (1) as $Y_t = \alpha_0 + \beta_{low} M_t + \varepsilon_t$. M_t is a dummy variable that is equal to 1 for the low yields months (September to February) and 0 otherwise (March to August). β_{low} is reported as "Coefficient". *, **, and *** indicate significance at the 10, 5 and 1 percent levels respectively.*

Table 6: Seasonality in Ranks of Monthly Yields

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	5.8095	0.5321	10.9180	0.0000
Jan	1.3095	0.7525	1.7402	0.0824*
Feb	1.0238	0.7525	1.3605	0.1743
Mar	0.1190	0.7525	0.1582	0.8744
Apr	0.3810	0.7525	0.5062	0.6129
Jun	-0.4607	0.7481	-0.6158	0.5383
Jul	0.3810	0.7525	0.5062	0.6129
Aug	0.3571	0.7525	0.4746	0.6353
Sep	0.4762	0.7525	0.6328	0.5272
Oct	1.0714	0.7525	1.4238	0.1551
Nov	1.1667	0.7525	1.5504	0.1217
Dec	0.9048	0.7525	1.2023	0.2298
R-squared			0.0225	
Adjusted R-squared			0.0007	
F-statistic (p-value)			1.0314	0.4170
White's Chi-square (p-value)			83.5458	0.0000***
Durbin-Watson stat			0.8116	
Kruskal-Wallis (p-value)			10.7418	0.4651

*Results are based on a regression similar to Equation (1) as $Rank_t = \alpha_0 + \beta M_t^k + \varepsilon_t$, where $Rank_t$ measures the rank of the monthly yield in its calendar year, highest as 1 and lowest as 12. M_t^k is a dummy variable with k varies from 1 to 12 except 5. β is reported as "Coefficient". *, **, and *** indicate significance at the 10, 5 and 1 percent levels respectively.*

Table 7: Seasonality in Half-Year High Versus Low Ranks of Monthly Yields

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	5.9368	0.2154	27.5648	0.0000
LOW	0.8648	0.3049	2.8365	0.0047**
R-squared			0.0157	
Adjusted R-squared			0.0138	
F-statistic (p-value)			8.0460	0.0047**
White's Chi-square (p-value)			30.5551	0.0000***
Durbin-Watson stat			0.8210	
Kruskal-Wallis (p-value)			4.5880	0.0322**

*Results are based on a regression similar to Equation (1) as $\overline{Rank_t} = \alpha_0 + \beta M_t + \varepsilon_t$, where $\overline{Rank_t}$ measures the average rank of yields in the high versus low half-year months, i.e. average yield of March to August and average yield of September to February (highest yields rank 1 and lowest rank 12). M_t is a dummy variable that is equal to 1 for the low yields months (September to February) and 0 otherwise (March to August). β is reported as "Coefficient". *, **, and *** indicate significance at the 10, 5 and 1 percent levels respectively.*

CONCLUSION

In this paper, we study the seasonality in the two-year Treasury Note yields. Our goal is to find out if there is any seasonality in the yields and what does it look like. Using the dummy variable regression method, we test a number of seasonal patterns in yields over the longest available period since the two-year Note's inception in 1976.06 until most recently in 2018.06. We find that the statistical significance of the seasonality depends on how we measure yields in the seasonality test and whether the focus is on months or in other patterns. We find that most anecdotally observed seasonalities do not pass the rigorous statistical tests for significance. This is perhaps due to the substantial drops of yields since the 1980s, which affect the mean of the nominal yields and make it no longer suitable for the seasonality tests. All our tests using nominal yields do not find any statistically significant seasonal variations. However, when we switch to the ranks of monthly nominal yields in a year, which is a different measure of the relative performance of monthly yields that removes the effect of differences in yields levels, we find statistically significant evidence that yields are higher in the half year from March to August than the other half year from September to February.

We note two areas that are beyond the scope of this paper but are worth further study. First, we need better methods to test seasonality. The standard dummy variable regression analysis method commonly used in the seasonality literature ignores the factors other than the monthly dummies as well as any interactions among other factors. Second, we need to better understand the contributing factors to the Treasury yields seasonalities. The monthly dummies may review where the seasonalities would show up but certainly do not explain why or how. We would like to have a theoretical model with sound variables that can be tested in order to better understand what contribute to the seasonality in the Treasury Note yields.

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FLEXIBLE OPTIMAL MODELS FOR PREDICTING STOCK MARKET RETURNS

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ABSTRACT

This study assesses the usefulness of flexible optimal models of business cycle variables for predicting stock market returns. We find that variable estimation periods identify structural breaks in months with large absolute returns and the optimal models recognize regime switches. Flexible optimal models have much greater predictive power for stock market returns than fixed univariate or multivariate models. The dividend yield has consistent predictive power for stock market returns, but different variables make significant contributions to predicting stock market returns in different periods. These findings highlight the importance of employing flexible optimal models to consistently predict stock market returns.

JEL: G11, G12

KEYWORDS: Predicting Stock Returns, Optimal Models, Business Cycles, Dividend Yield

INTRODUCTION

Researchers presented empirical evidence that future excess stock market returns are significantly related to readily observable market variables more than three decades ago. Several models have been developed to predict stock market returns but their reliability and practical utility remain unclear. Some researchers have questioned the evidence of predictability of stock market returns while others have supported it. Mukherji, Jeong and Kundagrami (2017) recently developed a methodology for identifying time-varying optimal models and parameters of commonly used business cycle variables to predict stock market returns. They showed that an investment strategy of holding T-bills in months with negative excess returns forecasted by the optimal models and investing in the stock market in other months produced a Sharpe ratio of 0.1243, which was much higher than the Sharpe ratio of 0.0980 for a buy-and-hold strategy. A stable investment strategy of holding T-bills in months with two consecutive negative excess returns forecasted by the optimal models and investing in the stock market in other months delivered an even higher Sharpe ratio of 0.1349. The stable investment strategy provided a Sharpe ratio that was 38% higher than that of the buy-and-hold strategy by increasing the mean return from 0.43% to 0.49% and reducing the standard deviation from 4.37% to 3.65% compared to the buy-and-hold strategy.

While Mukherji, Jeong and Kundagrami (2017) focused on the results of investment strategies based on their optimal model forecasts, this study conducts a detailed investigation of the economic foundations and rationales for the superior investment results produced by their forecasting methodology. We examine the characteristics of the flexible optimal models, based on variable estimation periods, which enable them to provide predictions of stock market returns that have practical utility. Our results show the relative contributions of different business cycle variables for predicting stock market returns in different periods and demonstrate the importance of employing time-varying models and parameters for consistently predicting stock market returns. The rest of the paper is organized as follows. The next section reviews the existing literature. The following section describes the data and methodology. Next, we present the empirical results. The final section provides concluding remarks.

LITERATURE REVIEW

Fama and Schwert (1977) documented a negative relationship between stock risk premiums and Treasury bill rates. Subsequent studies found that stock risk premiums can be predicted by a yield variable comprising the default and term spreads (Keim and Stambaugh, 1986), term spread (Campbell, 1987), and dividend yield, default spread, and term spread (Fama and French, 1989). Chen, Roll and Ross (1986) suggested that the default premium reflects business conditions; it is likely to be high when conditions are poor and low when they are strong. Fama (1990) viewed stock return predictability as rational variation in expected returns in response to business conditions. He observed that expected returns are inversely related to business conditions: they are high when conditions have been weak, characterized by high dividend yields and default spreads, and when conditions are weak but expected to improve, indicated by a low term spread. Fama (1991) pointed out that predictability of excess returns does not imply stock market inefficiency and theoretical interpretations cannot be conclusive because they are dependent on the models used. Avramov (2002) suggested that the term premium captures variations in stock returns related to shifts in interest rates and economic conditions that impact the probability of default. Cooper and Priestley (2009) observed that stock return predictability reflects time-varying investment opportunities or risk aversion.

Several studies (Fama, 1990, Ferson and Harvey, 1991, Cooper and Priestley, 2009) have included changes in the primary explanatory variables in their models. These additional variables may enhance the explanatory power of regression models, particularly in periods when the primary variables are not significantly related to stock returns. Some studies (Bossaerts and Hillion, 1999, Ferson and Harvey, 1991) included lagged excess return, to determine the marginal contribution of the other variables. Lagged excess return also has weak business cycle characteristics; although the autocorrelation of excess returns is generally very low, it is positive overall but negative around the turning points of business cycles. Some studies have questioned the evidence of stock return predictability. Bossaerts and Hillion (1999) showed that even the best prediction model chosen by formal model selection criteria does not work out-of-sample (OOS) because its parameters change over time, indicating model nonstationarity. Sullivan, Timmermann and White (1999) found that stock returns are substantially predictable in-sample (IS) but not predictable OOS. Welch and Goyal (2008) demonstrated that models predicting the equity premium appear unstable and have performed poorly, both IS and OOS, for 30 years, indicating that they could not have been used to profit from market timing. Lettau and Nieuwerburgh (2008) indicated that researchers have not convincingly identified the source of parameter instability or showed why the OOS evidence is much weaker than the IS evidence, and even the IS evidence has disappeared in the late 1990s. They found that price ratios adjusted for nonstationarity provide better IS and OOS stock return forecasts than unadjusted price ratios, but they do not outperform the random walk model.

Recent studies employing a variety of methods have found evidence of stock return predictability. Campbell and Thompson (2008) demonstrated that applying two rational restrictions – the regression coefficient has the theoretically expected sign, and the fitted value of the equity premium is positive – substantially enhances OOS stock return predictability, which can be improved even more by restricting the coefficients to values implied by a steady-state model. Rapach, Strauss and Zhou (2010) showed that combination forecasts from 15 individual predictive regression models are linked to the real economy and reduce forecast volatility, consistently providing OOS gains over the historical average. Dangl and Halling (2012) used a Bayesian model averaging approach with 13 predictive variables and found evidence of OOS predictability with strong support for models with moderately time-varying coefficients. They also documented a strong link between OOS predictability and business cycles, suggesting that predictability persists because it reflects business cycle risk rather than market inefficiency.

DATA AND METHODOLOGY

Since this paper extends the findings of Mukherji, Jeong and Kundagrami (2017), it is based on the same data and methodology. Their optimal models were estimated with future stock market excess returns (ER) and market variables from 1953 through 2009. Although the data ended several years ago, the results are expected to be valid because the study period covers nine complete business cycles. It may also be noted that the sharp drop of 37.00% in the stock market in 2008 was mostly recouped in 2009 when the stock market rose 26.46%. We examine the roles of nine market variables in predicting stock market excess returns (ER). The four primary variables are treasury bill yield (TY), dividend yield (DY), default premium (DP), and term premium (TP). The other five variables are changes in TY, DY, DP and TP over the previous month, denoted by TYC, DYC, DPC, and TPC, respectively, and the ER in the previous month (PER). Total returns on the S&P 500 Composite Index (R), returns on T-bills (TB), the inflation rate (IN), and the yield on long-term government bonds (LY) were obtained from Ibbotson Associates (2010). The TB yield (TY) and yields on seasoned issues of domestic corporate bonds rated by Moody's as Baa (BY) and Aaa (AY) were available from the Federal Reserve Economic Data website (http://research.stlouisfed.org/fred2/categories/22/downloaddata). Dividends (D) and index levels (P) of the S&P 500 Composite Index were available from Professor Robert Shiller's website (http://ww.econ.yale.edu/~shiller/data.htm**)**. We deflated R and TB by IN to compute real R and TB. ER was calculated by subtracting real TB from real R. DY is the ratio of D to P, DP is the difference between BY and AY, and TP is the difference between LY and TY. The estimation periods varied between 60 and 120 months. For each month t in the 49-year study period from 1961 through 2009, we identify the optimal model based on the combination of explanatory variables and estimation period that provides the highest explanatory power for the ER, from the following regressions:

$$ER_t = \sum_{\tau=t-120+n}^{t-1} \beta_i' X_{\tau,i} + \varepsilon_{t,i} \qquad \text{for } i = 1,2,\dots\ 2^k - 1 \text{ and } n = 0,1,2,\dots.,60 \qquad (1)$$

where $X_{\tau,i}$ represents models containing k regressors estimated over estimation periods beginning in month t-120+n and ending in month t-1, β_i' are the parameters of the regressors, and $\varepsilon_{\tau,i}$ are the error terms of the regressions. In our context, $X_{\tau,i}$ are 511 combinations (2^9-1) of 9 regressors. Since n ranges from 0 to 60, there are 61 estimation periods of 120 to 60 months, beginning in months t-120 to t-60 and ending in month t-1. From these regression models, we select the optimal model that provides the maximum adjusted R^2 in each month. As Foster, Smith and Whaley (1997) noted, the goodness-of-fit is the simplest method of choosing among potential regressors based on past information.

RESULTS AND DISCUSSION

Table 1 provides descriptive statistics of ER and the explanatory variables for the estimation periods of the optimal models used to predict ER. The data indicate major differences between the dependent and independent variables. Panel A shows that ERs have a much higher standard deviation relative to the mean, resulting in a coefficient of variation (CV) that is 9 to 23 times the CVs of the primary explanatory variables. Further, all the primary explanatory variables have autocorrelations close to 1 whereas ERs have an autocorrelation close to 0. Persistent and relatively stable independent variables cannot be expected to individually provide much explanatory power for a volatile and unstable dependent variable. Panel B indicates that the changes in the primary explanatory variables have much larger CVs than ERs and their autocorrelations are about two to six times that of ERs. The means and medians of the changes in the primary explanatory variables are all close to 0, suggesting that these variables are unlikely to have much predictive power for ERs. Since PER is the lagged ER, its descriptive statistics are similar to those of ER.

Table 1: Descriptive Statistics

A: Stock Market Excess Returns and Primary Explanatory Variables					
	ER	**TY**	**DY**	**DP**	**TP**
Maximum	0.1606	0.1630	0.0624	0.0338	0.0455
Mean	0.0054	0.0500	0.0323	0.0098	0.0160
Median	0.0087	0.0484	0.0317	0.0084	0.0152
Minimum	-0.2212	0.0003	0.0111	0.0032	-0.0365
Standard deviation	0.0427	0.0285	0.0114	0.0046	0.0142
Coefficient of variation	7.97	0.57	0.35	0.47	0.89
Autocorrelation	0.06	0.99	0.99	0.97	0.95
B: Previous Stock Market Excess Returns and Changes in Primary Explanatory Variables					
	PER	**TYC**	**DYC**	**DPC**	**TPC**
Maximum	0.1606	0.0261	0.0059	0.0094	0.0423
Mean	0.0053	-0.0000	-0.0001	0.0000	0.0000
Median	0.0086	0.0001	-0.0001	0.0000	-0.0001
Minimum	-0.2212	-0.0462	-0.0064	-0.0063	-0.0328
Standard deviation	0.0426	0.0044	0.0013	0.0011	0.0043
Coefficient of variation	8.09	-152.10	-23.72	142.30	93.32
Autocorrelation	0.06	0.34	0.27	0.29	0.11

Descriptive statistics of monthly real excess returns on the S&P 500 index (ER), and the market variables used to explain the future ER. TY is the Treasury bill yield, DY is the dividend yield, DP is the default premium, and TP is the term premium. PER is the ER in the previous month. TYC, DYC, DPC, and TPC are the changes in the TY, DY, DP, and TP, respectively, compared to the previous months.

Table 2: Correlations between Explanatory Variables for Stock Market Excess Returns

	TY	**DY**	**DP**	**TP**	**TYC**	**DYC**	**DPC**	**TPC**
DY	0.48**							
DP	0.36**	0.35**						
TP	-0.41**	-0.16**	0.27**					
TYC	0.09*	-0.04	-0.19**	-0.16**				
DYC	0.13**	0.03	-0.08*	-0.14**	0.13**			
DPC	0.07	0.06	0.12**	-0.15**	-0.25**	0.14**		
TPC	-0.06	0.04	0.14**	0.16**	-0.78**	-0.06	0.07	
PER	-0.09*	0.02	0.01	0.07	-0.13**	-0.64**	-0.04	0.01

*Correlations between explanatory variables used to estimate the optimal regression models. TY is the Treasury bill yield, DY is the dividend yield, DP is the default premium, and TP is the term premium. TYC, DYC, DPC, and TPC are the changes in the TY, DY, DP, and TP, respectively, compared to the previous months. PER is the stock market excess return in the previous month. Correlations significant at the 1% and 5% levels are denoted by ** and *, respectively.*

Table 2 reports the correlations between the business cycle variables used for identifying the optimal models to predict ER. The correlations are generally weak or moderate, although several of them are significant at 1% level. There are only two correlations exceeding 0.5: between TPC and TYC, and between PER and DYC. These strong negative correlations are consistent with expectations since an increase in TY reduces TP, and an increase in DY generally implies a fall in stock prices, which results in a lower contemporaneous stock return. Overall, the data indicate that multicollinearity should not be a severe problem in the estimated regressions. In any case, since our selection of optimal models is based on the maximum adjusted R^2, variables will be included in the optimal models only if they enhance explanatory power, and interpretation of the coefficients is not our goal. Table 3 shows the results of fixed univariate and multivariate regressions of monthly ERs against the independent variables from the previous months over the entire study period. Only two variables have significant coefficients in the univariate regressions in panel A: TYC and DY, which provide very low R^2s of 1.1% and 0.7%, respectively. In the full-model regression in panel B, three variables have significant coefficients: DY has the largest t-statistic and is significant at 1% level, along with TYC, while TY is significant at 5% level. Consistent with earlier studies, DY has a positive coefficient whereas TY and TYC have negative coefficients. The explanatory power of the full model, although more than twice that of the best individual model, is quite low, at 2.8%. The multivariate regression in panel C, using only those three variables that had significant coefficients in the full-model regression, shows that DY and TY are significant at 1% level, while TYC is significant at 5% level, and the adjusted R^2 increases marginally to 3.0%. These findings indicate that DY, TY, and TYC have significant, but low, explanatory power for future monthly ERs. The weak results are consistent with the sharp differences between the volatilities of ERs and the explanatory variables shown in Table 1.

Table 3: Regressions of Stock Market Excess Returns against Explanatory Variables

A: Univariate Regressions										
		TY	**DY**	**DP**	**TP**	**TYC**	**DYC**	**DPC**	**TPC**	**PER**
Intercept		0.01**	-0.01	0.00	0.00	0.01**	0.01**	0.01**	0.01**	0.01**
(T-statistic)		(3.27)	(-1.10)	(0.85)	(0.72)	(3.26)	(3.20)	(3.25)	(3.24)	(3.05)
Coefficient		-0.11	0.33*	0.21	0.22	-1.09**	-1.54	0.48	0.48	0.06
(T-statistic)		(-1.90)	(2.33)	(0.59)	(1.94)	(-2.96)	(-1.20)	(0.33)	(1.26)	(1.54)
Adjusted R^2		0.4%	0.7%	-0.1%	0.4%	1.1%	0.1%	-0.1%	0.1%	0.2%
B: Full-model Regression										
	INT	**TY**	**DY**	**DP**	**TP**	**TYC**	**DYC**	**DPC**	**TPC**	**PER**
Coefficient	-0.01	-0.16*	0.58**	-0.23	0.14	-1.77**	-0.08	-0.67	-1.10	0.02
(T-statistic)	(-0.93)	(-2.02)	(3.47)	(-0.49)	(0.95)	(-2.76)	(-0.04)	(-0.40)	(-1.76)	(0.35)
Adjusted R^2	2.8%									
C: Regression with Significant Variables in Full-model Regression										
	INT	**TY**	**DY**			**TYC**				
Coefficient	-0.00	-0.21**	0.57**			-0.92*				
(T-statistic)	(-0.54)	(-3.16)	(3.49)			(-2.50)				
Adjusted R^2	3.0%									

*Results of univariate and multivariate regressions of monthly stock market excess returns for 674 months, from 10/1953 through 11/2009, on explanatory variables from the previous months. TY is the Treasury bill yield, DY is the dividend yield, DP is the default premium, and TP is the term premium. TYC, DYC, DPC, and TPC are the changes in the TY, DY, DP, and TP, respectively, compared to the previous months. PER is the lagged stock market excess return. INT is the regression intercept. Intercepts and coefficients significant at the 1% and 5% levels are denoted by ** and *, respectively.*

We find that, in contrast to these fixed univariate and multivariate regression results, the flexible optimal models provide much stronger explanatory power for future excess stock market returns. The adjusted R^2s of the 588 optimal models, identified for forecasting monthly returns from January 1961 through December 2009, generally range between 10% and 30%, around the mean of 20%, with a few spikes above 30%. The lowest R^2s of 9% to 10% occurred in the last 8 months of the 106-month expansion that ended in 12/1969, while the highest R^2s of 43% to 48% were produced during 1/1991 to 5/1991, the turning point between an 8-month recession and the 92-month expansion that began in 3/1991. The estimation period of the optimal models ranges from 60 to 120 months, but it averages 76 months and generally varies between 60 and 84 months; this range accounts for 73% of the estimation periods. Our data indicate that the optimal models are estimated from the same beginning month as the previous month's optimal model in 77% of estimation months, and the estimation periods increase until the regressions switch to a new beginning month. The optimal models for the 588 months in the study period are estimated from 96 different beginning months. The most common beginning months are 11/1962, 12/1991, and 10/1987, which have unusually large ERs of 10.7%, 11.0%, and –22.1%, respectively, and serve as the estimation beginning months for optimal models in 61, 40, and 36 months, respectively. The 11 most common beginning months account for 51% of the estimation beginning months, which have a mean absolute ER of 10.6%. The mean absolute ER of 7.9% for all the estimation beginning months is more than twice the mean of 3.3% for all the potential estimation beginning months. These results suggest that the variable rolling estimation periods of the optimal models identify structural breaks in months with large absolute returns and, for several consecutive months, the parameters of the optimal models are estimated starting from the structural break months.

Of the 511 possible models we consider in each of the 588 months in the study period, 94 (18%) provide the highest adjusted R^2 in at least one month. The distribution of optimal models is uneven and concentrated in a few models. The most frequently optimal model is optimal in 65 months while 25 different models are optimal in just one month each. Only 14 (15%) of the optimal models produce the highest adjusted R^2 in more than half of the months, and 33 (35%) provide the greatest explanatory power in more than three-quarters of the months. These findings indicate that, while optimal models vary over the estimation period, a fairly small proportion of models is optimal in most of the months, suggesting that the optimal models are quite stable from month to month. Our data show that the optimal models remain unchanged from the previous month in 70% of the months.

The number of variables in the optimal models generally ranges between 4 and 6. It changes infrequently across the study period; the optimal models are estimated with the same number of variables as in the previous month for 77% of months. The distribution of the number of explanatory variables in the optimal models is quite symmetric, centered at the average of 5, and 79% of the optimal models use 4 to 6 variables. Only one optimal model uses one variable, and the full model of nine variables is optimal in two estimation months. The largest numbers of 8 to 9 explanatory variables contributing to the optimal models occurred during the 6/1979 to 4/1980 estimation months, which included the change in the Federal Reserve's operating procedures starting in 9/1979 as well as the waning months of a 58-month expansion ending in 12/1979 and the onset of the subsequent recession. The smallest numbers of 1 to 2 explanatory variables participating in the optimal models occurred in the 11/2001 to 6/2002 estimation months, which marked the beginning of an expansion following an 8-month recession.

The overall characteristics of the optimal models indicate why the forecasts generated by them have practical utility. The flexibility of varying optimal models and estimation periods generates average explanatory power that is much higher than those of the fixed univariate and multivariate models. In addition, the optimal model remains the same, and is estimated from the same beginning month as the previous month's model, in 63% of the months. Thus, the models that generate the forecasts are also optimal, and their parameter estimates change only slightly, in most of the months. Models that are generally stable and have reasonably good explanatory power can be expected to provide useful forecasts.

Table 4 shows the number of months for which each independent variable participates in the optimal models, and has a significant coefficient at 5% level, in each year of the study period. TY contributes to optimal models quite regularly and has significant coefficients in most months. DY also participates fairly consistently with significant coefficients. DP generally participates in optimal models, but it is often not significant. The contribution of TP appears to deteriorate after 1995; while it often participates in the last few years, it is not significant in these years. By contrast, the participation of TYC increases after 1995, although it is generally not significant after 1999. DYC participates in some periods but rarely after 1995. The contribution of DPC is largely concentrated after 1994, when it is often significant. TPC enters optimal models in some of the early years and a few of the later years, but it is rarely significant. PER participates quite frequently until 2001 and regularly has significant coefficients from 1996 through 2000.

Our data show that both TBY and DVY have significant coefficients in about two-thirds of the optimal models, while DFP and TMP are significant in more than one-third of the models. The significant coefficients are almost always positive for DVY and generally negative for TBY. TMP has more than twice as many negative as positive significant coefficients, whereas DFP has slightly more positive than negative significant coefficients. These findings indicate that, consistent with expectations, DVY has a reliable positive relationship, and TBY, has a fairly reliable negative relationship, with ER. DFP and TMP are also significantly related to ER quite frequently although the directions of these relationships are not consistent.

It is worth noting that the four primary explanatory variables play the most significant roles in the optimal regressions. Changes in these variables, and the lagged dependent variable, generally enhance explanatory power without being significant when they participate in the optimal models. However, all the nine explanatory variables contribute to some optimal models. The weakest contributor is TMPC, which participates in 31%, and is significant in only 7%, of optimal models.

Table 4: Contributions to Optimal Models by Explanatory variables in Each Year

Year	TY	DY	DP	TP	TYC	DYC	DPC	TPC	PER
1961	12 (10)			2 (0)		12 (12)			
1962	11 (11)	7 (4)	4 (0)	7 (7)	1 (0)	8 (6)		6 (4)	1 (0)
1963	4 (4)	12 (12)	2 (0)	12 (12)		8 (8)		4 (1)	8 (6)
1964		12 (12)	12 (10)	12 (8)				12 (0)	
1965	5 (0)	12 (12)	12 (12)	12 (6)		1 (0)		6 (0)	2 (0)
1966	1 (1)	12 (12)	12 (12)	11 (11)		9 (2)		1 (0)	12 (4)
1967	11 (10)	9 (9)	7 (3)	9 (9)	6 (3)	9 (6)	12 (7)	5 (3)	4 (1)
1968	11 (11)	4 (4)	8 (8)	9 (5)	4 (2)	11 (11)	7 (1)	4 (2)	1 (0)
1969	12 (12)	9 (1)	11 (3)	8 (3)	4 (0)	12 (4)	12 (6)	3 (0)	
1970	12 (12)	9 (3)	9 (4)	6 (4)	6 (3)	5 (3)	8 (2)	4 (3)	7 (0)
1971	12 (12)	12 (7)	12 (0)	10 (0)	12 (7)			12 (2)	12 (0)
1972	12 (12)	12 (12)	12 (0)	12 (0)	12 (1)			12 (0)	12 (0)
1973	12 (9)	12 (6)	2 (0)	8 (4)	6 (2)	4 (0)	1 (0)	6 (4)	6 (0)
1974	8 (5)	8 (0)	4 (1)	4 (3)	12 (2)	5 (0)	8 (2)	12 (11)	7 (2)
1975	12 (7)	1 (0)	11 (10)	6 (5)	6 (2)	11 (9)	1 (0)	10 (2)	2 (1)
1976	12 (12)		12 (12)	12 (7)	10 (0)	12 (12)		1 (0)	
1977	12 (12)	6 (0)	12 (12)	12 (12)		12 (12)			
1978	9 (8)	12 (8)	12 (12)	8 (8)	4 (3)	8 (8)	4 (0)	3 (0)	4 (2)
1979	6 (0)	12 (12)	12 (12)	7 (2)	12 (12)	1 (0)	12 (11)	11 (6)	12 (11)
1980	7 (4)	12 (12)	12 (12)	9 (6)	6 (6)	12 (6)	6 (0)	2 (0)	6 (1)
1981	4 (4)	12 (12)	12 (12)	8 (8)		12 (12)			
1982	12 (12)	12 (12)	12 (12)	10 (0)		9 (7)			3 (0)
1983	12 (12)	11 (11)	12 (11)	10 (0)			1 (1)		12 (0)
1984	12 (12)	11 (1)	11 (1)	10 (0)			11 (1)		12 (0)
1985	12 (12)	12 (12)		12 (0)			12 (0)		12 (0)
1986	12 (12)	12 (12)	7 (0)	12 (3)		7 (3)	8 (0)		12 (5)
1987	12 (12)	12 (12)	4 (1)	2 (0)		12 (4)			12 (11)
1988	12 (12)	12 (12)	2 (2)	12 (0)		2 (0)		10 (0)	2 (0)
1989	12 (12)	12 (12)	11 (1)	12 (10)	3 (0)	6 (0)		6 (0)	6 (0)
1990	12 (12)	12 (12)	12 (4)	12 (12)		12 (3)			12 (0)
1991	12 (12)	12 (12)	12 (6)	12 (12)		12 (3)			9 (0)
1992	12 (12)	12 (12)	11 (2)	12 (10)		4 (0)			4 (0)
1993	12 (12)	12 (12)	12 (12)	12 (12)		12 (0)			12 (0)
1994	12 (12)	12 (12)	12 (12)	12 (12)		12 (0)			12 (0)
1995	12 (11)	10 (10)	10 (10)	10 (9)	2 (2)	11 (5)	10 (1)	2 (0)	12 (2)
1996	9 (9)	3 (1)	1 (0)	3 (3)	12 (11)	1 (0)	12 (3)	9 (0)	12 (12)
1997	12 (12)	1 (0)		1 (0)	12 (12)		12 (8)	8 (0)	12 (12)
1998	12 (12)	1 (0)		3 (1)	12 (12)	3 (3)	9 (1)		9 (9)
1999	12 (1)	1 (0)			12 (12)		12 (12)		12 (12)
2000	12 (3)	1 (1)	2 (0)		11 (2)		12 (11)		12 (11)
2001	8 (4)	12 (12)			7 (0)	4 (0)	12 (0)	3 (0)	7 (1)
2002	4 (2)	12 (12)	1 (1)	1 (0)		4 (0)	6 (1)		
2003	7 (7)	12 (12)	3 (3)	2 (2)	5 (0)		12 (12)	5 (0)	
2004	8 (0)	12 (12)	12 (7)		7 (0)		12 (12)	7 (0)	
2005	7 (1)	12 (12)	9 (0)		3 (0)		12 (1)		
2006	10 (0)	12 (12)	12 (0)		12 (0)		12 (10)		
2007	12 (7)	12 (12)	12 (0)	7 (0)	5 (1)		12 (5)	6 (0)	
2008	9 (2)	12 (12)	6 (3)	3 (0)	5 (1)	3 (2)	10 (3)	3 (0)	4 (2)
2009		10 (9)	9 (7)	11 (0)	5 (0)	5 (5)	5 (3)	8 (4)	12 (12)

Number of months in which each explanatory variable participated in the optimal regression model each year, with the number of months in which the coefficient of the variable was significant at 5% level in parentheses. TY is the Treasury bill yield, DY is the dividend yield, DP is the default premium, and TP is the term premium. TYC, DYC, DPC, and TPC are the changes in the TY, DY, DP, and TP, respectively, compared to the previous months. PER is the lagged stock market excess return.

Overall, these results indicate how the contributions of the explanatory variables to optimal models vary over time. DY has the most consistent significant relationship with ER in the entire study period. TY also has significant explanatory power for ER until 1998, but its role diminishes in the last few years, when DPC has more frequent significant coefficients. DP and TP have significant relationships with ER until 1995 but appear to have lost their significance after that. These trends depict the varying roles of different variables in explaining future ERs in different periods, highlighting the importance of using flexible models, and they show that DY has maintained a significant role long after its discovery. There were only two multi-year periods when DY did not have significant explanatory power: 1974 to 1977, when DY averaged a high level of 4.28%, and 1996 to 2000, when it averaged a low level of 1.57%, compared to the overall average of 3.23% during the study period. This suggests that in some periods, when DY is at an unusually high or low level, it may not contain much information about future ERs.

Table 4 highlights the importance of including the changes in the primary variables and the lagged endogenous variable among the set of potential predictors for consistent explanatory power in periods when most of the primary variables do not have significant coefficients. For example, DYC contributed to optimal models most frequently, and significantly, during 1975-77, when DY did not participate significantly. The results for 1996-2000 are particularly illustrative. During this period, which marked the second half of the longest expansion of 120 months in our study period, the average ER of 1.10% was 2.6 times the average ER of 0.43% in the full study period. While TY was the only primary variable that contributed significantly to optimal models, TYC, DPC, and PER all played significant roles during this period. DPC also made significant contributions during 2003-07, when DY was the only primary variable that was consistently significant.

CONCLUDING COMMENTS

This study analyzes the roles of business cycle variables commonly used to predict stock market returns, based on a flexible methodology employing time-varying models and parameters. We find that the optimal model search procedure accommodates regime switches, but a small proportion of models is optimal in most of the months in the study period. The variable estimation periods identify structural breaks in months with large absolute returns, and the parameters of the optimal models are estimated from the structural break months for several consecutive months. The flexible optimal models with variable estimation periods generate much greater predictive power than the fixed univariate or multivariate models. The optimal models are quite stable in consecutive months, indicating that the models that generate the forecasts are also optimal in most of the following months, and their parameter estimates are only slightly different. These characteristics indicate that the optimal models have practical utility.

Our results show that the dividend yield has a consistent significant positive relationship with future stock market excess returns. The Treasury bill yield has a fairly reliable negative relationship with returns. The default premium and term premium are also significantly related to returns quite frequently, but the directions of these relationships are not consistent. Changes in the primary business cycle variables and lagged excess stock returns help provide consistent predictive power in some periods when the primary variables do not have significant power. These findings indicate the varying roles of different variables in predicting excess stock market returns in different periods, highlighting the importance of using flexible optimal models. It is worth noting some limitations of our study. We evaluate a specific forecasting methodology based on the explanatory power of a limited set of market variables for future U.S. stock market returns. These limitations suggest multiple avenues for future research. Researchers may study how this methodology works in other stock markets with a similar set of market variables or different variables that may be more appropriate for those markets. They may also develop different forecasting methodologies based on similar market variables or a different set of variables for predicting stock market returns in the U.S. and other countries.

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BANKING CRISIS AND CYCLIC SHOCKS: A PERSPECTIVE ON VOLATILITY CLUSTERING

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ABSTRACT

Typical systemic risk measurement barely captures the dynamic risk characteristics of the entire banking system. Experience from past financial crises shows, major indicators in financial markets have clustered volatility during periods of economic downturns. This study focuses on the overall profile of the commercial banking sector. The Ratio of Adjusted Weighted Estimated Loss is introduced as an indicator of banking crisis to analyze volatility clustering in a system-wide perspective. The results show that crises indicator volatility tends to cluster together when distress signals begin to appear in the market. A leverage effect is also presented in the results when applying the EGARCH model. Analysis of the effect of cyclic shocks discusses the process of risk transfer from exogenous shocks to endogenous contagion. The results have implications for a better understanding of the relationship between business cycle and banking crises.

JEL: C32, E32, G01, G21

KEYWORDS: EGARCH, Volatility Clustering, Cyclic Shocks, Leverage Effect

INTRODUCTION

Business models of the entire banking industry have undergone development for decades. But banking failures happened occasionally, and innovation with securitized products was a major driving force in the recent financial crisis. These innovations also have tremendous impact on systemic credit risk and reveals the potential for instability. Similarly, regulatory actions are slow and not strong enough to identify and manage the risk on the eve of a system-wide crisis. Historical experience shows that shocks from macroeconomic factors can cause the collapse of the financial system. Under typical circumstances, systemic risk results from two major sources: exogenous shocks due to the fluctuations of macroeconomic variables and internal contagion processes within the system. It is intuitive to hypothesize the mechanism of the occurrence of banking crisis as follows:

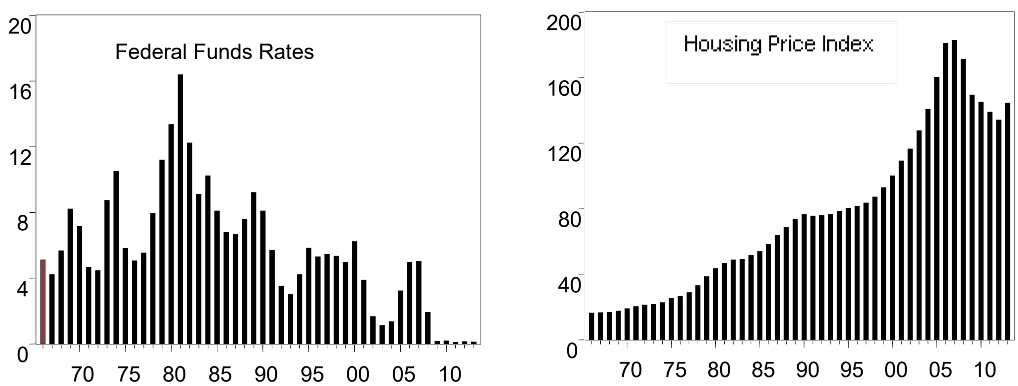
The first stage: Exogenous shocks cyclically give rise to volatility of both commodity prices and capital costs including interest rate uncertainty and the impact on the solvency of financial institutions. This early phase is referred to as out-of-system shocks.

The second stage: A system-wide crisis is caused by endogenous contagion within the financial sector which exacerbates the recession.

Shocks including interest rate fluctuations and deregulation are typically considered major determinants of the savings and loans crisis during the 1980s. As deregulation measures progressed in the 1990s, securitization, a profitable businesses, brought the real estate market to the bubble that ultimately burst. As the banking crisis spread, the system as a whole did not recover promptly from the downward trend. A subsequent in-system contagion process among counterparty institutions occurred which resulted in recession in other sectors. Figure 1 shows the Federal Funds Rate and Housing Price Index from 1966 through 2013.

This study seeks to deepen understanding of the characteristics of systemic risk in banking. This study focuses on system-wide dynamic features of how systemic risk, driven by macroeconomic shocks, is created and transferred through the mechanism of commercial banking. The first objective of this paper is to investigate volatility clustering of banking crises by using a GARCH model. The second mission is to describe how exogenous sources of triggers have affected the banking system and eventually caused a crisis. The rest of this paper is structured as follows: The next section presents the literature review. Then I discuss the methodology and data and report the results of clustering estimation and robustness tests. The next section presents the empirical results of estimation with cyclic shocks. The last section concludes this study.

Figure 1: Federal Funds Rate and U.S. Housing Price Index 1966-2013



This figure shows the Federal Funds Rate and the housing price index from 1966 to 2013; the data source is from Federal Reserve Bank of St. Louis and S&P/Case-Shiller Home Price Indices respectively

LITERATURE REVIEW

Interactions among institutions can cause risk transfer and default contagion through the system. These interactions can also result in contagions from both asset prices and business counterparties (Staum, 2011). Theoretical frameworks of modeling counterparty risk are developed to detect the correlations when a firm's default could lead to another firm's distress (Davis and Lo, 2001; Jarrow and Yu, 2001). Under certain circumstances, banks respond homogeneously to macroeconomic volatilities (Calmès and Théoret, 2014). Nontraditional businesses of banks are more sensitive to the volatility of macroeconomic variables (Lukas and Stokey, 2011). Exogenous shocks may distort the information transfer and thus force financial institutions to reallocate their portfolios of assets (Bernanke and Gertler, 1989). Evidence shows that system-wide uncertainty will cause dispersion in loan-to-asset ratios among affected institutions (Baum et al, 2009). Moreover, exogenous sources of shocks could be created by monetary policy and banks with less liquid assets will be affected more severely (Kashyap and Stein, 2000). Internal dispersion will further aggregate damage to the system. Another finding shows that non-systemic features represent the major component of a firm's risk (Campbell et al., 2001).

Methods for measuring systemic risk in the banking industry are developed from diversified angles. Value at risk (VaR) is widely applied as a measure of systemic risk. The measurement CoVaR, as an extension, is applied to assess the marginal risk of each individual institution (Adrian and Brunnermeier, 2016). Expected shortfall is another frequently used framework in estimating risk and has been developed and derived into various forms such as systemic expected shortfall and marginal expected shortfall (Tarashev et al, 2009; Acharya et al., 2017). Expected shortfall, shows that interconnectedness among banks plays a significant role in systemic risk aggregation (Drehmann and Tarashev, 2013). An exogenous framework, through the application of Default Intensity Model (DIM), is employed in the analysis. In this case, the properties of credit risk are formulated as the insurance price against the risk faced by financial institutions (Huang et al., 2009). Other research shows that systemic risk can be measured by defining an event that individual banks fail simultaneously. In this case, there is no clear boundary when the combined failures of individual banks become a systemic disaster (Lehar, 2005). Systemic risk is also defined as a failure-based measure by calculating the conditional probability of bank failures in a large portion of the whole financial intermediaries (Giesecke and Kim, 2011). Some researchers investigate early warning system based on different theoretical foundations to predict financial crises (Gramlich et al, 2010 and Illing and Liu, 2006).

DATA AND METHODOLOGY

A dataset of commercial bank failures is constructed from FDIC Historical Statistics on Banking Failures and Assistance Transactions. Data covers the period from 1986 to 2013. All 1722 bank observations are incorporated into the dataset. The variable Total Assets and Estimated Loss of each failed institution is collected for the calculation of a yearly indicator of banking crisis. The data of total assets of all commercial banks is collected from the Federal Reserve Board (FRB) Assets and Liabilities of Commercial Banks in the United States - H.8. The indicator of banking crisis is measured by defining the ratio of adjusted weighted estimated-loss (termed *rawel*). The *rawel* is devised to measure the level of overall loss in the banking system. The form of *rawel* is as follows:

$$rawel_t = \frac{safb_t}{tacb_t} \times \left(\sum_{i=1}^{k}(ar_{it} \times \frac{el_{it}}{aib_{it}})\right) \quad (1)$$

Where *k* indicates the number of failed banks in one observation year t; *safb* denotes the aggregate assets of failed banks in year t and *tacb* is the total assets of all commercial banks in the same year. The whole term in the parenthesis represents the ratio of weighted estimated-loss before adjustment for each year, *el* is the amount of estimated loss for each failed bank, and *aib* indicates the total assets of the individual bank *i*. The term *ar* represents the weight of bank *i*'s assets in aggregate assets of all failed banks. The regression imputation method is applied in solving the zero observations. Descriptive statistics are presented in Table 1.

The volatility of *rawel* is assumed as the proxy of the volatility of banking crisis. It can be tested for time-varying volatility clustering under the framework of Generalized Autoregressive Conditional Heteroskedasticity (Bollerslev, 1986). A typical form of GARCH is presented in the following equations:

$$r_t = \varphi x' + \varepsilon_t \quad (2)$$

$$\sigma_t^2 = \beta_0 v + \beta_1 \varepsilon_t^2 + \beta_2 \sigma_{t-1}^2 \quad (3)$$

Where the conditional heteroskedasticity is the function of three components including long-term mean, square of stochastic error and lagged term variance. Eifferent weights have been allocated for each term as coefficients. The limitation on the coefficients in GARCH can be relieved in an Exponential GARCH model (Nelson, 1991), which is specified as follows:

$$log(\sigma_t^2) = \beta_0 + \beta_1 \left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \beta_2 \log(\sigma_{t-1}^2) + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \quad (4)$$

The leverage effect becomes exponential after taking logarithmic volatility into consideration. The coefficient γ follows the null hypothesis that the impact of informational shocks will be symmetric if it's equal to zero, otherwise, asymmetric information effect exists with a positive coefficient indicating more powerful upward information. I construct the mean equation with one term lagged, where equation (5) is introduced with only lagged terms, and equation (6) includes exogenous variables.

$$0rawel_t^{lag} = \beta_0 + \beta_1 rawel_{t-1} + \varepsilon_t \quad (5)$$

$$rawel_t^{ex} = \beta_0 + \beta_1 ffr_t + \beta_2 niir_t + \beta_3 ncf_t + \beta_4 sglr_t + \beta_5 rawel_{t-1} e^{1+hpr_t} + \varepsilon_t \quad (6)$$

Table 1: Descriptive Statistics

Year	No. of Bank Failures	Mean of TA	Mean of EL	S.D. of EL	TA of Commercial Banking
1986	144	56.80	12.28	24.92	2928.85
1987	201	38.30	9.75	17.05	2986.59
1988	280	192.49	24.71	132.80	3116.30
1989	206	136.19	28.69	130.17	3283.83
1990	159	67.00	12.07	27.81	3369.56
1991	108	407.49	26.63	76.42	3413.49
1992	99	156.60	14.94	31.16	3486.13
1993	42	73.13	12.88	15.63	3684.87
1994	11	83.61	14.76	15.15	3984.65
1995	6	133.69	14.08	9.07	4285.28
1996	5	40.01	7.74	5.03	4551.34
1997	1	27.92	5.03	-	4983.85
1998	3	96.75	74.23	124.71	5400.19
1999	7	217.60	98.14	212.80	5687.97
2000	6	63.11	5.20	6.23	6192.25
2001	3	18.77	1.93	1.97	6491.79
2002	10	282.11	46.29	56.63	7008.63
2003	2	469.42	30.98	25.73	7521.94
2004	3	52.23	1.96	1.47	8319.42
2005	0	-	-	-	8936.00
2006	0	-	-	-	9991.52
2007	1	125.36	29.38	-	11073.97
2008	23	56477.39	250.23	295.68	12208.27
2009	126	14915.72	185.36	455.62	11728.64
2010	129	454.31	99.04	126.36	11986.13
2011	84	323.97	78.72	72.69	12573.88
2012	40	229.90	54.11	63.28	13318.70
2013	23	258.74	50.59	129.75	13600.76
Total	1722	2008.41	43.73	159.74	

This table shows descriptive statistics of the sampled data set of failed banks from 1986 to 2013. The third column reports the mean total assets in millions of all failed banks in one sample year. The fourth column reports the mean estimated loss in millions of all failed banks during the same year. The fifth column reports the standard deviation of estimated loss in each year. The sixth column presents total assets in billions of all commercial banks in the corresponding year.

In equation (6), variable *ffr* represents the federal funds rate; *sglr* denotes the proportion of gains and losses of securities in the total value of investment securities in commercial banks, and *niir* is the proportion of net interest income in total interest income; *ncf* represents logarithmic ratio of net charge-offs to net loans and leases; the lagged term is adjusted by multiplying the exponential growth rate of housing price to detect the combined impact from the emphasis on the housing market, where *hpr* is the growth rate of a nationwide housing price index. This term will be substituted by *multi* in the empirical section. Housing price data is selected from the S&P/Case-Shiller U.S. National Home Price Index. The variable *ffr* is employed as the exogenous control variable in this initial setting. The housing price is considered another control variable as well as federal funds rate. The effects these variables brings to the banking crisis measurement will be discussed as a comparison in the robustness test. For the tests of exogenous shocks, I define the ratio of failed assets (termed as *rfa*) as the proxy for banking crisis in a longer time span because the data of the estimated loss of each bank is only available since 1986. The *rfa* is expressed as follows:

$$rfa = \frac{Total\ Assets\ of\ Failed\ Banks}{Total\ Assets\ of\ the\ Banking\ System} \quad (7)$$

Total assets of failed banks are not the exact representative of the magnitude of the systemic failure but could be considered as "contaminated" assets which would experience rapid depreciation. Federal funds rate and housing price index are assumed driving factors of the exogenous shocks and selected as proxy measures. To detect the relationship between out-of-system shocks and system-wide indicators, Vector Autoregression is employed to investigate the effects. A restricted form of VAR is also applied in the analysis and could provide an error correction term to express the long-term relationship.

Clustering Estimation

Table 2 shows the best fitted characterization comes from GARCH (1, 1). The ratio series after revision shows more robustness and goodness of fit in both GARCH and EGARCH tests. By comparing general conditional variance with exponential conditional variance, explanatory power is not presented explicitly with the limited hypothesis of GARCH model despite the significance of the coefficients. The results imply the GARCH model is not convergent. In contrast, the EGARCH model provides a better interpretation of the behavior of volatility. The EGARCH results are essentially unchanged and no asymmetric information effect has been detected in this setting. It implies that positive shocks and negative shocks are not behaving in an unbalanced fashion implying that one source of volatility cannot dominate the other.

Table 2: Tests of Volatility Clustering

	$rawel_t^{lag}$		$re\_rawel_t^{lag}$		$rawel_t^{ex}$		$re\_rawel_t^{ex}$	
	(a)	**(b)**	**(a)**	**(b)**	**(a)**	**(b)**	**(a)**	**(b)**
Constant	0.0519	0.0011	0.0335	-0.0006	4.8104***	1.9194***	4.7956***	1.3608***
	(1.6652)	(0.1571)	(0.5565)	(-0.0145)	(3.5522)	(4.4131)	(6.6957)	(3.7056)
$rawel_{t-1}$	0.6014***	0.5908***	0.6056***	0.6512***				
	(6.1787)	(6.9872)	(5.2243)	(4.3179)				
ffr					-	-	-0.3632***	-
					0.3659***	0.1383***	(-6.8023)	0.1007***
					(-3.7121)	(-4.1525)		(-3.7339)
niir					-	-	-5.3561***	-
					5.3012***	2.1960***	(-6.0465)	1.5478***
					(-3.1159)	(-4.5411)		(-3.6963)
ncf					0.5501***	0.1261	0.5284***	0.1139**
					(4.8700)	(1.5136)	(5.3508)	(2.3857)
sglr					-	-	-	-
					119.26***	42.995***	107.775***	29.496***
					(-7.6116)	(-3.6746)	(-5.7105)	(-3.6029)
multi					0.0872	0.0468	0.0607	0.0400*
					(1.2896)	(1.2038)	(1.3139)	(1.8956)
β_0	-0.0021	0.6780***	-0.0029**	0.4523***	0.0088	-	0.0029	-
	(-1.5064)	(4.5646)	(-2.3433)	(3.5064)	(0.7469)	5.6924***	(0.5487)	6.2956***
						(-3.8775)		(-6.4005)
β_1	-	-	-	-	1.6605**	3.3896***	2.3440**	3.5470***
	0.1183***	0.9963***	0.1533***	0.6195***	(2.2217)	(4.4024)	(2.1959)	(6.3476)
	(-5.3575)	(-5.3302)	(-4.5782)	(-5.2525)				
β_2	1.3896***	1.0269***	1.4744***	1.0231***	-0.0157	0.3926	-0.0097	0.3916*
	(12.792)	(26.196)	(11.659)	(34.240)	(-0.1031)	(0.9479)	(-0.4113)	(1.6463)

This table shows GARCH tests of volatility clustering. The model of mean equation is specified as follows: $rawel_t^{lag} = \beta_0 + \beta_1 rawel_{t-1} + \varepsilon_t$ *and* $rawel_t^{ex} = \beta_0 + \beta_1 ffr_t + \beta_2 niir_t + \beta_3 ncf_t + \beta_4 sglr_t + \beta_5 rawel_{t-1} e^{1+hpr_t} + \varepsilon_t$ *Column (a) and (b) show the results of GARCH test and EGARCH test respectively. Coefficient* γ *representing the effect of asymmetric information is zero in EGARCH model so it is not presented in this table. The figures in the parenthesis are z-statistics. The term multi represents the interaction effect between the lag term of rawel and the exponential form of housing price index. ***, **, * are significant at the 1%, 5%, and 10% level respectively;*

Robustness Test

To test the robustness of the model, reconsideration of correlations between variables has been conducted on a hypothesized basis that shocks from interest rate and real estate markets are major contributors to the volatility clustering of banking failures. The federal funds rate *ffr*, therefore, is put into the model with the same role as exponential growth rate of housing price index. By switching different control variables, the fit of goodness and compatibility is specified in the following Table 3.

Table 3: Robustness Test (1)

	$rawel_t^{ex}$		$re\_rawel_t^{ex}$	
	(a)	**(b)**	**(a)**	**(b)**
Constant	2.3536***	2.3270***	2.3302*	2.0194**
	(3.1458)	(15.4783)	(2.1330)	(4.6280)
exp_hpi	-1.0762***	-0.9727***	-1.0786**	-0.7911**
	(-3.9608)	(-15.0410)	(-2.7514)	(-4.7317)
niir	1.6412***	0.9130***	1.7223**	0.5274*
	(3.4790)	(6.6983)	(4.2427)	(2.2224)
ncf	0.4708***	0.2502***	0.5886**	0.1928**
	(4.6178)	(7.1481)	(5.8040)	(3.4361)
sglr	-	-16.9642***	-72.5026**	-18.8044**
	61.8636***	(-3.7693)	(-3.3327)	(-3.2016)
	(-2.8754)			
*Rewel_lag**	0.07017	0.0717*	0.0483	0.0141
ffr_ lag	(0.8367)	(1.6617)	(0.3527)	(0.3429)
β_0	0.0191	-5.9214***	0.0342	-4.6864***
	(0.9141)	(-4.6733)	(0.7765)	(-3.2410)
β_1	1.9865	3.7706*	1.3227	4.4822***
	(1.6170)	(4.5625)	(1.3325)	(3.9159)
β_2	-0.3198	0.3102	-0.4265	0.8283**
	(-1.0017)	(1.3824)	(-0.6679)	(2.4284)

This table shows the robustness test of volatility clustering with exogenous variables. The model of mean equation is specified as follows: $rawel_t^{ex} = \beta_0 + \beta_1 e^{1+hpr_t}{}_t + \beta_2 niir_t + \beta_3 ncf_t + \beta_4 sglr_t + \beta_5 rawel_{t-1} ffr + \varepsilon_t$. *Column (a) and (b) shows the results of GARCH test and EGARCH test respectively. Coefficient* γ *representing the effect of asymmetric information is zero in this model so it is not presented in this table. The figures in the parenthesis are z-statistics. The lag term of ffr instead of hpi is included in the interaction term. ***, **, * are significant at the 1%, 5%, and 10% level respectively;*

The result is basically unchanged and the exponential GARCH test is much better performing than the original GARCH as shown in Table 4. Similar to the result of *rawel* previously discussed, the revised version of variable has shown marginally more power of explanation but not a dominant one. The uncertainty of housing prices will results in a negative effect to the banking system as well as the federal funds rate. But the effect magnitude of housing price is greater than *ffr* and forms a more straightforward facilitator to the crisis. The standard deviation *devr* of all ratios of estimated losses in each sampled year is another estimator that can interpret the extent of dispersion among failed commercial banks. The calculation takes *ar* as weights. However, it is clearly shown that the standard deviation overestimates the systemic importance during some periods with less banking failure events, such as from 1998 to 1999, and thus a multiplier which indicates the relative systemic importance for each cross section is added to the measure:

$$devr_t = \frac{k}{\bar{k}}\sqrt{\sum_{i=1}^{k} ar_{it} \times (el_{it} - \bar{el}_t)^2} \tag{8}$$

Where $\bar{k}$ indicates the mean of the failure counts of the sampled period. This measure gives rise to a general assessment of the institution-wide dispersion effect. The result implies that exponential the GARCH model can also capture volatility clustering. On the other hand, the lag equation shows less explanatory capacity in both GARCH and EGARCH tests. In the setting of exponential equation, all coefficients are significant at least at the confidence level of 90%.

Table 4: Robustness Test (2)

	$devr_t^{lag}$		$devr_t^{ex}$		
	(a)	**(b)**	**(a)**	**(b)**	**(c)**
Constant	1.2007	-0.0000	0.0661	0.1891***	-0.1195***
	(0.2680)	(-0.0001)	(0.4493)	(4.2982)	(-6.4608)
ffr/dhpi			-0.0093	-0.0127***	-0.0025***
			(-0.8244)	(-4.3807)	(-7.2359)
niir			-0.0564	-0.2444***	0.2238***
			(-0.3161)	(-4.4162)	(7.5895)
ncf			0.1369***	0.0230***	0.0210*
			(3.6190)	(5.1938)	(1.7735)
sglr			1.5089	0.3570	5.4871***
			(0.6161)	(0.9136)	(6.5183)
devr_lag/	0.7516**	0.7767***	0.2779***	0.2771***	0.1013***
multi	(2.2349)	(16.1403)	(7.5956)	(82.8583)	(57.2894)
β_0	15.1146	-0.1232	0.0010	-5.7881***	-5.6948***
	(0.3735)	(-0.3732)	(1.3134)	(-4.7758)	(-4.2701)
β_1	-0.0840***	-0.8464***	0.5515**	6.5645***	5.3781***
	(-5.8027)	(-6.5162)	(2.1650)	(5.3868)	(5.1643)
β_2	0.5802	0.8865***	-0.0312	0.8420***	0.7656**
	(0.5600)	(21.7636)	(-0.2390)	(3.2382)	(2.3290)
γ					-1.7144*
					(-1.9043)

*This table shows the second robustness test with dispersion. Column (a) and (b) shows the results of GARCH test and EGARCH test respectively. This test contains exogenous equations and one additional test for asymmetric information effect presented in column (c). The denotation ffr applies to column (a) and (b) in the exogenous equations; the term dhpi regarded as the difference of hpi applies to column (c); The denotation devr_lag applies to the two lag equations and the multi term indicates exp_hpi*devr_lag for columns (a) and (b) and ffr_lag*devr_ lag for the column (c) correspondingly; ***, **, * are significant at the 1%, 5%, and 10% level respectively;*

More evidently, asymmetric impacts of information are detected in (c) column where β2+ γ=3.6637 when ε>0 and β2+ γ=7.0925 when ε<0. This finding implies that volatility is more sensitive to negative information, and the magnitude of the negative information effect is about twice of the positive information effect.

TESTS OF CYCLIC SHOCKS

Impacts from Exogenous Fluctuations

Long-term correlations between different time series can be investigated by the co-integration test. The three chosen financial ratios *ncfr*, *niir* and *sglr* are modeled as in-system variables in the VAR analysis with *ffr* and hpi as shock variables out of system. By testing the unit root of each variable under Augmented Dickey-Fuller criteria, the result, shown in Table 5, illustrates variables *rfa*, *ncfr*, *sglr*, *ffr* and hpi are stationary under at least 95% confidence level. The only variable not stationary is *niir* so that it is substituted by *niirc* after being processed by the Hodrick-Prescott filter.

Table 5: Unit Root Test

	rfa	*ncfr*	*niirc*	*sglr*	*ffr*	*hpi*
t-statistic	-4.7170	-5.5159	-7.2761	-3.9964	-3.9146	-4.1118
Prob	0.0004	0.0002	0.0000	0.0031	0.0192	0.0117

This table reports the results of unit root test. The variables rfa, ncfr, niirc, sglr, ffr and hpi represent the ratio of failed assets, ratio of net charge-offs, proportion of net interest income in total interest income, proportion of gains and losses of securities in the total value of investment securities, federal funds rate and housing price index respectively. Every variable is stationary at the significance of 5%

Table 6 presents the results of the co-integration test. As it is specified in Section 2, I have conducted co-integration test for every pair of variables in the hypothesized contagion systems. Both the Trace statistic and Max-Eigen statistic indicate at least one co-integration equation exists in each pair of variables. The same implication applies to the corresponding pairs with one term lagged *rfa*. Exceptions are shown in the correlation with *ncfr* in the hypothesis of none co-integration equations, where trace and max-eigen statistics present different results.

Table 6: Co-integration Test

Panel A				**Panel B**			
rfa	**No. of CE(s)**	**Trace (Max-Eigen)**	**Prob**	rfa_{t-1}	**No. of CE(s)**	**Trace (Max-Eigen)**	**Prob**
$ncfr$	None	21.9833 (12.7277)	0.0046(0.0862)	$ncfr$	None	16.3688(10.4074)	0.0369(0.1865)
	At most 1	9.2556 (9.2556)	0.0023(0.0023)		At most 1	5.9614(5.9614)	0.0146(0.0146)
$sglr$	None	25.5999(16.5549)	0.0011(0.0213)	$sglr$	None	36.1638(21.7703)	0.0000(0.0027)
	At most 1	9.0450(9.0450)	0.0026(0.0026)		At most 1	14.3935(14.3935)	0.0001(0.0001)
$niirc$	None	43.3106(33.5822)	0.0000(0.0000)	$niirc$	None	47.0994(37.1161)	0.0000(0.0000)
	At most 1	9.7284(9.7284)	0.0018(0.0018)		At most 1	9.9833(9.9833)	0.0016(0.0016)

This table reports co-integration tests to investigate long-term relationships between rfa and the three financial indicators. Johansen methodology is employed in this test for multiple variables. For the purpose of comparison, Panel B presents the co-integration results with the lagged ratio of failed assets. The figures in the parenthesis in the second column of each panel are Max-Eigen statistics.

By identifying the long-term relationship with co-integration test, a restricted Vector Autoregression model, that is, Vector Error Correction Model could be applicable to the analysis. However, it is more reasonable to make a comparison with the unrestricted VAR model so that it is conducted in the exemplified contagion process. The VAR system is specified as follows:

$$\begin{bmatrix} Y \\ X \end{bmatrix} = \begin{bmatrix} C_1 \\ C_2 \end{bmatrix} + \boldsymbol{A_1} \begin{bmatrix} Y_{t-1} \\ ffr_{t-1} \end{bmatrix} + \boldsymbol{A_2} \begin{bmatrix} Y_{t-2} \\ ffr_{t-2} \end{bmatrix} + \boldsymbol{A_3} \begin{bmatrix} Y_{t-3} \\ ffr_{t-3} \end{bmatrix} + \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \quad (9)$$

Where Y = $[ncfr \quad sglr \quad niirc]^T$ and X = $[ffr \quad hpi]^T$; A_j with j=1,2,3 represents the matrix of parameters; The term u_i is the stochastic error. The results in Table 7 exhibit the explanatory performance of the coefficients against in-system variables. In terms of the ratio of net charge-offs, housing price produces more explicit impact to the measure. It could be related to traditional exposure to the real estate market and the write-downs of assets proportionally came from fluctuations of housing price. Shocks from interest rate are less significant. The ratio of securities gains and losses reacts evidently to the federal funds rate in recent periods rather than in further lagged periods. The response to the housing market appears to be slow and cannot indicate a direct co-movement in between.

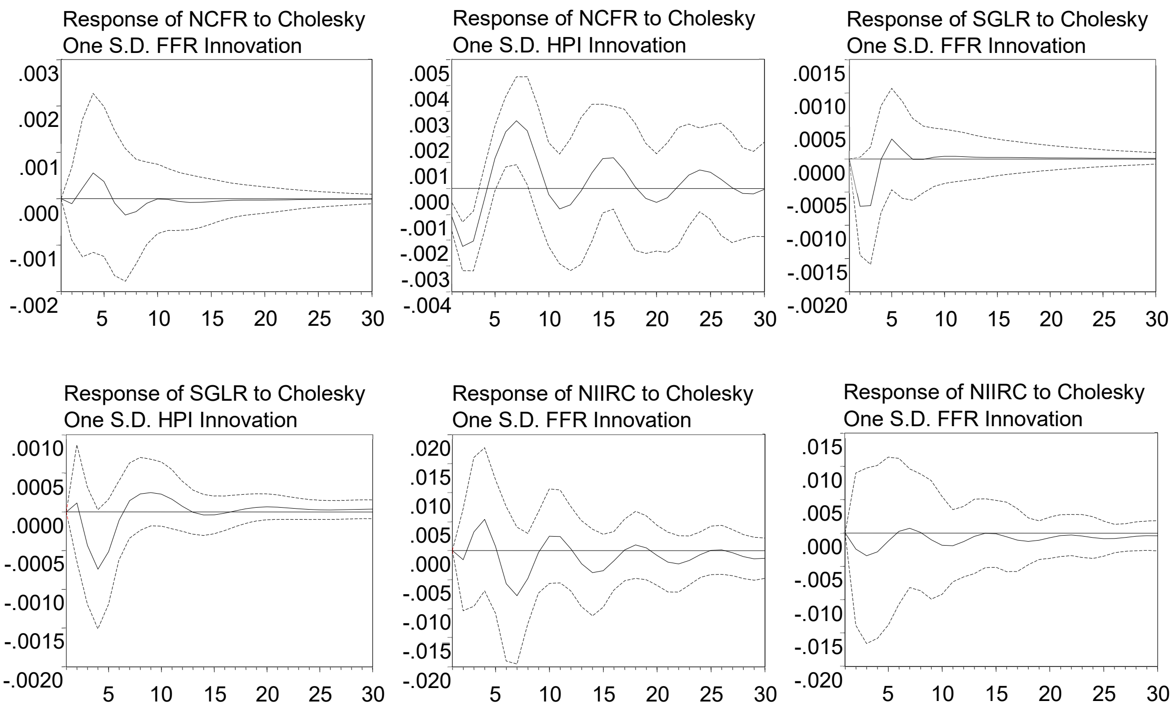
Table 7: Vector Autoregression Results

	$ncfr$	$ncfr_{t-1}$	$sglr$	$sglr_{t-1}$	$niirc$	$niirc_{t-1}$
$constant1$	0.0017	0.0016	0.0005	0.0017**	0.0061	0.0057
	(1.0941)	(1.0989)	(0.6251)	(2.3023)	(0.5664)	(0.6609)
ffr_{t-1}	-0.0001	-0.0004**	-0.0004*	-0.0002**	-0.0014	-0.0123***
	(-0.2721)	(-2.0834)	(-1.9773)	(-2.0284)	(-0.3621)	(-5.1696)
ffr_{t-2}	0.0003	0.0004	0.0003	—	0.0061	0.0156***
	(0.9373)	(1.4935)	(1.0366)	—	(1.0356)	(3.7884)
ffr_{t-3}	-0.0002	-0.0001	0.0001	—	-0.0057	-0.0045
	(-1.1061)	(-0.3759)	(0.3884)	—	(-1.4947)	(-1.4525)
$constant2$	0.0001*	0.0001*	0.0006	0.0004	0.0055	0.0068
	(1.9582)	(1.9818)	(0.8000)	(0.5089)	(0.6209)	(0.7527)
hpi_{t-1}	-0.0003***	-0.0003***	0.0000	0.0001	-0.0007	-0.0008
	(-3.0427)	(-4.4490)	(0.3037)	(1.0148)	(-0.7642)	(-0.9003)
hpi_{t-2}	0.0005**	0.0004***	-0.0002	-0.0002	0.0006	-0.0007
	(2.4515)	(2.9194)	(-1.0214)	(-1.4559)	(0.7004)	(0.8200)
hpi_{t-3}	-0.0000	-0.0001	0.0001	0.0002*	—	—
	(-0.0378)	(-1.0581)	(1.6006)	(1.6956)	—	—
hpi_{t-4}	-0.0002	—	—	—	—	—
	(-1.5887)	—	—	—	—	—

*This table shows the Vector Autoregression results between exogenous shocks and internal financial indicators. The variables ncfr, sglr, niirc, ffr and hpi represent ratio of net charge-offs, proportion of gains and losses of securities in the total value of investment securities, proportion of net interest income in total interest income, federal funds rate and housing price index respectively. ***, **, * are significant at the 1%, 5%, and 10% level respectively.; Each pair under estimation complies with optimal lags criterion*

Impulse responses are presented in Figure 2. Cholesky decomposition method is introduced as the transformation matrix to structure irrelevant error terms. Given an exogenous shock to the system, responses of *ncfr* to *ffr* are approximately positive and then turns to be negative after six periods. However, its response to *hpi* shows a slower process of stabilization. The variable *sglr* responds to *ffr* negatively and the response turns to be positive before stabilizing and the response to *hpi* shows a similar pattern. The net interest income measure *niirc* responds to the shocks from *ffr* in a more volatile way than the response to *hpi*. All the three responses tend to be stable after several fluctuations despite of different horizon of absorbing the impact, which indicates that the impact from exogenous shocks is not permanent to the system.

Figure 2: Impulse Response of NIIRC to Cholesky One S.D. HPI Innovation

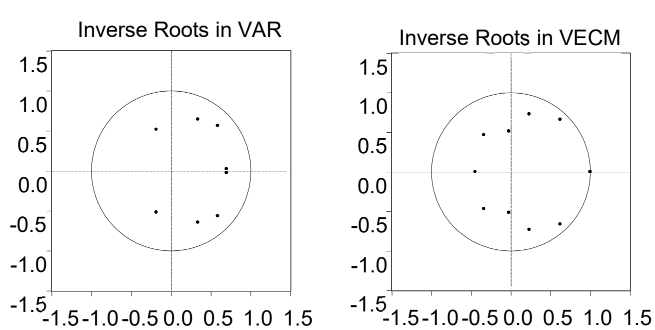


This figure shows the impulse response of each pair of relationship. The variables ncfr, sglr, niirc, ffr and hpi represent ratio of net charge-offs, proportion of gains and losses of securities in the total value of investment securities, proportion of net interest income in total interest income, federal funds rate and housing price index respectively.

<u>Internal Contagion Process</u>

The error correction term is introduced into the system to conduct the comparison between VECM and unrestricted VAR. It can be observed that the VAR system is more stable than the VECM system by testing the inverse roots of AR characteristic polynomial. Figure 3 shows no roots locate outside the unit circle implying that the unrestricted VAR model satisfies the stability condition in each system.

Figure 3: Inverse Roots of AR Characteristic Polynomial



This figure shows the inverse roots of the system of VAR and VECM. The roots in both VAR and VECM locate inside the unit circle.

In Table 8, depicts a comparison between VAR and VECM. The term of the co-integration equation represents the speed of adjustment to equilibrium. The positive coefficients in both columns of VECM show no long-term causality. The results indicate that shocks from the three independent variables to *rfa* will be stabilized due to short-term causality. VECM shows a slightly better explanatory power than unrestricted VAR model in the relationship between *ncfr* and *rfa*.

Table 8: Comparison between VAR and VECM

	Unrestricted VAR		**VECM**	
	rfa	rfa_{t-1}	$d(rfa)$	$d(rfa_{t-1})$
Co-integration eq.	—	—	0.3162*	0.4263***
	—	—	(1.9787)	(2.7991)
$constant$	0.0107	0.0091	0.0041	0.0024
	(1.0513)	(1.1220)	(1.3108)	((0.7654))
$ncfr_{t-1}$	0.8087	—	-0.3439	—
	(0.2510)	—	(-0.1169)	—
$ncfr_{t-2}$	-5.0982	-1.9585	-4.1400	2.0488
	(-1.1378)	(-0.7287)	(-1.3408)	(0.7311)
$ncfr_{t-3}$	2.8438	1.0648	-4.0255	-6.0628***
	(1.3575)	(0.5997)	(-1.5939)	(-2.6578)
$sglr_{t-1}$	-2.6955	—	-4.7340***	—
	(-1.4229)	—	(-2.7409)	—
$sglr_{t-2}$	7.2869***	-2.9422	2.5319	-5.5855***
	(3.6811)	(-1.6383)	(1.2642)	(-3.2870)
$sglr_{t-3}$	-1.4749	5.5285***	0.2891	2.6551
	(-0.7363)	(3.4191)	(0.1575)	(1.4955)
$niirc_{t-1}$	-0.1027	—	0.3047*	—
	(-0.8935)	—	(1.9763)	—
$niirc_{t-2}$	-0.2305	-0.0930	0.0691	0.2859**
	(-1.4789)	(-1.1472)	(0.4459)	(2.3216)
$niirc_{t-3}$	-0.0290	-0.2674***	-0.0748	0.0070
	(-0.2243)	(-2.8944)	(-0.5639)	(0.0544)

*This table shows a comparison between Vector Autoregression and Vector Error Correction Model. The variables rfa, ncfr, sglr, niirc represent ratio of failed assets, ratio of net charge-offs, proportion of gains and losses of securities in the total value of investment securities, proportion of net interest income in total interest income respectively. ***, **, * are significant at the 1%, 5%, and 10% level respectively; In the VECM system, each independent variable (ncfr,sglr and niir) in the left column represents the difference of the original value.*

The differences of variables *ncfr* and *sglr* show a pattern of consistency in affecting the independent variable *rfa* while this effect does not exist in unrestricted VAR system. It indicates that a longer impact will be created to the ratio of failed assets. Further, these two indicators will not digest the shocks in a short period. Through this process, the volatility from shocks out of the system will be transferred through the mechanism, creating a potential of financial crisis.

CONCLUSION

The goal of this study is to propose a measure of banking crisis to capture dynamic features of systemic risk. Generalized Autoregressive Conditional Heteroskedasticity is employed to portray volatility clustering of the banking crisis measure with the data of bank failures selected from Federal Deposit Insurance Corporation. The Ratio of Adjusted Weighted Estimated Loss is calculated as the indicator of banking crisis, providing a straightforward and proxy-free perspective on the risk factor of systemic risk. The Exponential

GARCH model shows the existence of volatility clustering, which indicates a possibility that in general large losses in the banking sector would be followed by large losses. On the other hand, the GARCH model has weaker explanatory capacity in capturing and characterizing the behavior of volatility. Asymmetric information effect of dispersion degree indicates the banking system will respond more drastically to negative information than positive information. The banking system is more sensitive to weak market confidence than positive information signals.

The Vector Autoregression shows that cyclic shocks diffuse into the system and result in contagion in a time-delaying manner. This risk transmission process leads to fluctuations of the system-wide financial indicator represented by ratio of failed assets. The limitation of this research is that the relatively low frequency of time series may compromise the explanatory power of the GARCH model. However, if the yearly observations are transformed into quarterly or monthly observations, missing data points will be increased and the results could be biased. Future research could be conducted in the direction of integrating the dynamic features of banking crisis, in particular, volatility clustering and leverage effect, into the systemic risk measurement.

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DO STYLE MOMENTUM STRATEGIES PRODUCE ABNORMAL RETURNS: EVIDENCE FROM INDEX INVESTING

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ABSTRACT

In this study, we investigate the return enhancement ability of style momentum strategy: a strategy that switches between value and growth styles based on previous performance. We explore the variation in abnormal returns of long-only and long-short momentum strategies using various style based indexes (Russell value/growth indexes, Fama-French value/growth indexes, and MSCI value/growth indexes) where value and growth stocks are classified using different criteria. Our results show that the performance of style momentum does vary across different index families. We first find that in general the long-only strategies create significant positive abnormal returns whereas the long-short strategies do not. Second, for a fixed formation period, abnormal returns of the strategies tend to decrease when the length of holding periods increase. Third, abnormal returns are stronger and more significant when rotating within large cap value and growth indexes while abnormal returns are weaker and inconsistent when rotating within small cap value and growth indexes. Fourth, strategies based on rotating across all market cap levels do not generate consistently significant positive abnormal returns for Russell indexes or Fama-French indexes but they do for MSCI indexes. Fifth, individual stock momentum only explains a very small portion of the returns of style moment strategies.

JEL: G11

KEYWORDS: Style Momentum, Value, Growth, Large Cap, Small Cap

INTRODUCTION

Investment styles refer to the categories that stocks are grouped into based on their book to market ratio, dividend yield, market capitalization and other attributes. Labels such as value/growth, and small cap/large cap are widely used investment styles by money managers. Given the tremendous growth of value/growth funds, style based investment strategies have obtained increasing attention from both academics and practitioners. Early studies focus on the different risk and return characteristics of various styles. Recently, strategies involving more active trading such as style momentum have started to draw more attentions. Stock return momentum, which was originally documented by Jegadeesh and Titman (1993), refers to the phenomena that past winner stocks tend to continue to have higher returns in the next period than past loser stocks. As a result, investors can achieve abnormal returns by buying stocks that are in favor and selling stocks that are out of favor, commonly known as momentum strategy. So do styles exhibit return momentum? Can investors earn abnormal returns by chasing the winning styles and selling the losing styles based on past performance? Those questions have received consideration attention recently (Lewellen (2002), Chen and Bondt (2004), Arshanapalli et al. (2007), Froot and Teo (2008)). Those studies find evidence for style momentum. However, the trading costs for the strategies illustrated in those studies are expensive since they involve creating style portfolios using individual stocks. With the increasing growth of style indexes, a natural question to ask is whether style indexes exhibit return momentum. Index based style momentum strategies are much easier to implement and considerably less expensive compared style momentum based on individual stocks. In addition, which one is better: long-only strategy or long-short strategy? Is there variation in return momentum when different formation and holding periods are used? Should we rotate between large value and large growth or small value and small growth or at all market cap levels (all four combined)? Do the results differ if we use style indexes from different fund families where value and growth stocks are classified using different criteria?

Those are the questions we seek to answer. We utilize value/growth indexes from three fund families: Russell indexes, Fama-French Indexes and MSCI indexes and test the performance of two style momentum strategies "long-only" vs. "long-short" using various combinations of formation period and holding period. The reason we use the three fund families is that each family has their own classification rule for value and growth styles. For example, the Russell value and growth indexes are constructed based on the book to market (BM) ratio and I/B/E/S forecasted long-term growth mean; the Fama-French value and growth indexes are defined solely based on the BM ratio; and the MSCI value and growth indexes are constructed using a number of variables including, the BM ratio, 12-month forward earnings to price ratio, dividend yield, long term earnings per share growth rate, etc. Do the results differ across all three index families? We find that although the performance of the return momentum strategy does vary across those three fund families, they exhibit considerable commonality. First, we find that in general the long-only strategies provide significant positive abnormal returns whereas the long-short strategies do not. Second, for a fixed formation period, the abnormal returns tend to decrease when the length of holding periods increase. Third, abnormal returns are stronger and more significant when rotating within large cap value and growth indexes while abnormal returns are less significant and inconsistent when rotating within small cap value and growth indexes. Fourth, strategies based on rotating across all market cap levels do not generate consistently significant positive abnormal returns for Russell indexes and Fama-French indexes but they do for MSCI indexes. Fifth, individual stock momentum only explains a very small portion of the returns of the style moment strategies. In other words, chasing winning styles does provide additional benefits to chasing winning stocks. The reminder of the article is organized as follows. The next section reviews related literature. Section 3 describes data and methodology. Section 4 presents empirical results and discussion. The fifth section concludes.

LITERATURE REVIEW

The seminal paper by Jegadeesh and Titman (1993) documented that past winning stocks tend to outperform past losing stocks in the next period, which is also known as momentum phenomena. Since then, tremendous attention has been given to momentum strategy. Conrad and Kaul (1998) test about 120 strategies and find evidence that supports momentum strategy. Daniel, Hirshleifer and Subrahmanyam (1998) explore the relationship between investor psychology (over/under reaction) to profits of momentum strategy. Cooper, Gutierrez and Hameed (2004) find performance of momentum strategy depend on the state of market. From 1929 to 1995, the mean monthly momentum profit following positive market returns is 0.93%, whereas the mean profit following negative market returns is− 0.37%. Antoniou, Lam and Paudyal (2007) explores profitability of momentum strategy in international markets; Asem and Tian (2010), Cheng and Wu (2010) find evidence supporting momentum strategy using data from the Hong Kong market. Another line of research focuses on style momentum rather than momentum of individual stocks. Lewellen (2002) showed that portfolios constructed based on size and book-to-market ratio exhibited momentum as strong as in individual stocks and industries. Chen and Bondt (2004) reported that style momentum existed within the S&P 500 stocks and was distinct from the price momentum and the industry momentum. Arshanapalli et al. (2007) utilized a timing model based on macroeconomic and fundamental public information to conduct style rotation using Russell style index data. Froot and Teo (2008) demonstrated that institutional investors reallocate across stock groupings based on styles more intensively than across randomly generated stock groupings. The authors also showed that at the firm level, the weekly returns exhibited strong style momentum. Liu and Wang (2010) investigates the impact of time horizon on style momentum. Those studies involve creating style portfolio from individual stocks and thus incur high trading expenses. With the dramatic growth of style indexes, exchange traded funds, there is a need to explore the performance of style momentum using style indexes, that is the contribution of this paper.

DATA AND METHODOLOGY

In our analysis, we use the monthly returns of style indexes from three index families: Russell, Fama-French and MSCI for the period from June 1995 to December 2010 during which data are available for all three index families. This fifteen years are very rich in significant financial market events: 1997 Asian Financial Market Crisis, 1998 Russian Default, 2000 Tech Bubble Bust and 2008 Subprime market crisis, thus provide an interesting window to study the performance of a trading strategy. We used four Russell indexes: Russell 1000 value/growth and Russell 2000 value/growth; six Fama-French indexes: Fama-French large cap value/blend/growth and Fama-French small cap value/blend/growth; and four MSCI indexes: MSCI U.S. prime market value/growth and MSCI U.S. small cap value/growth. In the next three paragraphs, we briefly describe how the three families of indexes are constructed, respectively.

The Russell U.S. index family covers all stocks listed on NYSE, AMEX, and NASDAQ. The stocks are first ranked based on their market capitalization. The Russell 1000 index contains the largest 1000 stocks and is generally considered as a large cap index; and the Russell 2000 index includes the next 2000 stocks and is generally considered as a small cap index. Within each cap-based index, the stocks are classified into value index and growth index based on the BM ratio and the I/B/E/S forecast long-term growth mean using a non-linear probability function. The details regarding the classification function can be found on the website of Russell Investments. Four Russell style indexes used in this study are known as Russell 1000 growth, Russell 1000 value, Russell 2000 growth, and Russell 2000 value, which correspond to large cap growth, large cap value, small cap growth, and small cap value styles, respectively.

The Fama-French style indexes are formed based on size and the BM ratio as follows. All the stocks traded on NYSE, NASDAQ, and AMEX are first divided into large and small cap portfolios where the size breakpoint is equal to the median market capitalization for stocks listed on NYSE. Note that the numbers of stocks in the portfolios vary over time. The average numbers of firms in the large cap and small cap portfolios are 968 and 3868, respectively. The stocks are then divided into three value-growth portfolios based on the BM ratio where breakpoints are the 30^{th} and 70^{th} NYSE BM ratio percentiles. The six Fama-French indexes used in this study are the intersections of the size and the BM ratio portfolios and namely, they are large growth, large blend, large value, small growth, small blend, and small value indexes. The MSCI style indexes are constructed as follows. All the stocks traded on NYSE, AMEX, and NASDAQ are first sorted based on market capitalization where the top 750 stocks are used to form the U.S. prime market index (MSCI750) and the next 1750 stocks are used to form the small cap index (MSCI1750). Within each cap-based index the stocks are divided into value and growth segments using a two-dimensional framework. The MSCI indexes define the value and growth investment style characteristics using the following variables:1) book value to price ratio, 2) 12-month forward earnings to price ratio, 3) dividend yield, 4) long-term forward earnings per share growth rate, 5) short-term forward EPS growth rate, 6) current Internal Growth Rate, 7) long-term historical EPS growth trend, 8) long-term historical sales per share growth trend.

The details of the classification method can be found on the MSCI index website. The four MSCI style indexes used in this study are: MSCI U.S. prime market growth, prime market value, small cap growth and small cap value indexes. We implement long-only and long-short style momentum strategies. We use F and H to denote the formation and holding periods, respectively. We use formation periods of three, six, and twelve months (F= 3, 6, 12). For each formation period, we consider the holding periods that are less than or equal to the length of the formation period. For example, if the formation period F=6 months, the holding periods are one, three, and six months (H=1, 3, and 6). Following Jegadeesh and Titman (1993), we use overlapping holding periods to increase the power of the test and rebalance the portfolio on a monthly basis. Our strategy is constructed according to the following rule. At the beginning of each month t, we rank the style indexes based on their returns in the past F months where the single best performing style is the winner and the single worst performing style is the loser. The long-only strategy will only purchase the winner style while the long-short strategy will buy the winner style and go short the loser style. At the same time, we close out the position initiated in month t-F. The new positions will be held for H months. Portfolio returns are equally weighted monthly returns for each position.

For each index family we test our strategies using three groups: the large cap indexes, the small cap indexes, and across market cap indexes. Take the Russell indexes as an example. First, we implement the strategy based on the two large cap indexes: Russell 1000 growth vs. Russell 1000 value; Second, we implement our strategy using two small cap indexes: Russell 2000 growth vs. Russell 2000 value; Finally, we test the strategy by rotating among all of the four Russell indexes: Russell 1000 growth, Russell 1000 value, Russell 2000 growth, and Russell 2000 value. To estimate abnormal returns, we use Carhart four-factor model (Fama-French three factors plus momentum) as our benchmark, which is specified as follows:

$$r_t - r_f = \alpha + \beta_1(r_m - r_f) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 WML_t + \varepsilon_t \quad (1)$$

where: r_t is the return of the style momentum strategy in period t; r_f is the risk free rate in period t; r_m is the market return in period t; SMB_t: the Fama-French large minus small factor in period t; HML_t is the Fama-French high minus low factor in period t; HML_t is the winner minus loser factor in period t; ε_t is the disturbance in period t; α is the abnormal return; β_1 is the market beta; β_2 is the coefficient for *SMB*; β_3 is the coefficient for *HML*; β_4 is the coefficient for *WML*. The risk-free rate and the Fama-French factors were obtained from Kenneth French's data library.

RESULTS AND DISCUSSION

Table 1 presents the descriptive statistics for the monthly returns of the selected indexes. Panel 1 of Table 1 focuses on the Russell indexes. We can see that for each market cap level the average return of the growth index is less than that of the value index: 0.0069 and 0.0078 at the large cap level; 0.0075 vs.0.0097 at the small cap level. At each market cap level, the return standard deviation of the growth index is higher than that of the value index: 0.0543 vs. 0.0458 at the large cap level; 0.0721 vs. 0.0530 at the small cap level. As a consequence, at each market cap level, the Sharpe ratio of the value index is higher than that of the growth index. Moreover, for both value and growth indexes, the small cap indexes have higher returns and higher standard deviations than the large cap indexes. Panel 2 of Table 1 focuses on the Fama-French indexes. The average returns of the large cap growth, blend, and value indexes are 0.0078, 0.0084, and 0.0078, respectively while the average returns of the small cap growth, blend, and value indexes are 0.0076, 0.0123, and 0.0133, respectively. The mean returns indicate that large cap growth is more profitable than small cap growth, but large cap blend and large cap value are less profitable than their small cap counterparts for the Fama French indexes. Panel 3 of Table 1 focuses on the MSCI indexes. We can see that at each market cap level, the value index has higher mean returns, lower standard deviations, and higher Sharpe ratios. Moreover, similar to the Russell indexes, small cap growth and small cap value have higher returns and higher standard deviations than large cap growth and large cap value, respectively.

Table 1: Descriptive Statistics

Panel 1: Russell Indexes				
	Russell 1000 Growth	**Russell 1000 Value**	**Russell 2000 Growth**	**Russell 2000 Value**
Mean	0.0069	0.0078	0.0075	0.0097
S.D.	0.0543	0.0458	0.0721	0.0530
Sharpe Ratio	0.0739	0.1084	0.0637	0.1289

Panel 2: Fama-French Indexes						
	Large Growth	**Large Blend**	**Large Value**	**Small Growth**	**Small Blend**	**Small Value**
Mean	0.0078	0.0084	0.0078	0.0076	0.0123	0.0133
S.D.	0.0478	0.0478	0.0524	0.0760	0.0561	0.0595
Sharpe Ratio	0.1025	0.1151	0.0945	0.0622	0.1684	0.1749

Panel 3: MSCI Indexes				
	Prime Market Growth	**Prime Market Value**	**Small Cap Growth**	**Small Cap Value**
Mean	0.0073	0.0078	0.0101	0.0103
S.D.	0.0573	0.0444	0.0718	0.0519
Sharpe Ratio	0.0780	0.1109	0.1008	0.1440

Notes: Table 1 shows the descriptive statistics of the monthly returns for the style indexes for June 1995 – Dec 2010.

Empirical results on the performance of style momentum strategies are presented in Tables 2 to 10. Throughout the paper, we use FiHj to denote the strategy that forms the portfolio based on the return of the past i months and holds the portfolio for j months. Tables 2, 3, and 4 present results based on the Russell indexes at the large cap, small cap and cross market caps levels respectively. For long only strategies at the large cap level (Panel 1 of Table 2), average returns range from 0.0052 to 0.0074; standard deviations are between 0.0490 and 0.0523; and Sharpe ratios vary between 0.0464 and 0.0919. All strategies except F3H3 generate significant positive abnormal returns. Interestingly, for a fixed formation window, abnormal returns tend to decline when the holding period increases. For example, with a 3 months formation period, abnormal returns are 0.0026 and 0.0014 for holding periods of 1 month and 3 months, respectively. With a 6 months formation period, abnormal returns change from 0.0037 to 0.0023 when holding periods change from 1 month to 6 months.

With a 12 months formation period, abnormal returns change from 0.0031 to 0.0026 when holding periods change from 1 month to 12 months. The market betas across all strategies are around 1. For all strategies the coefficient of the SMB factor is negative and is close to zero since the style indexes are within large cap stocks. The coefficient of HML is negative. The coefficients of the momentum factor, WML, range from 0.0349 to 0.1432, which implies that the individual stock momentum factor only explains a small portion of the returns of the style momentum strategies. For long-short strategies at the large cap level (Panel 2 of Table 2), average returns range from 0.0037 to 0.0080 and tend to be lower compared to the long-only strategy; and none of abnormal returns are significant, which indicates that the long-only strategy outperforms the long-short strategy at the large cap level for Russell indexes. Results for the small cap Russell indexes are presented in Table 3. Interestingly, all abnormal returns are insignificant except for the F3H1 strategy. The long-only F3H1 provides a monthly abnormal return of 0.0031 and the long-short F3H1 provides a monthly abnormal return of 0.0056, both are significant only at the 10% level.

Table 2: Style Momentum with Russell 1000 Value / Growth Indexes

Panel 1: Long-Only									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0061	0.0052	0.0074	0.0064	0.0058	0.0070	0.0064	0.0058	0.0053
S.D.	0.0502	0.0507	0.0491	0.0493	0.0490	0.0515	0.0516	0.0518	0.0523
Sharpe	0.0642	0.0465	0.0919	0.0709	0.0599	0.0800	0.0678	0.0566	0.0464
Alpha	0.0026*	0.0014	0.0037***	0.0025**	0.0023**	0.0031***	0.0026**	0.0027***	0.0026***
Rm-Rf	1.0072	1.0406	0.9948	1.0159	1.0092	1.0495	1.0452	1.0286	1.0183
SMB	-0.1192	-0.0724	-0.0779	-0.0778	-0.0990	-0.0626	-0.0569	-0.0698	-0.0738
HML	-0.8818	-0.8935	-0.8934	-0.8701	-0.9168	-0.9562	-0.9668	-1.0644	-1.1226
WML	0.0889	0.1105	0.1201	0.1229	0.0995	0.1432	0.1238	0.0769	0.0349
Panel 2: Long-Short									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0054	0.0037	0.0080	0.0060	0.0049	0.0072	0.0060	0.0048	0.0038
S.D.	0.0538	0.0477	0.0519	0.0505	0.0461	0.0468	0.0453	0.0376	0.0332
Sharpe	0.0476	0.0173	0.0989	0.0615	0.0430	0.0930	0.0686	0.0526	0.0292
Alpha	0.0002	-0.0022	0.0024	0.0000	-0.0004	0.0013	0.0003	0.0004	0.0002
Rm-Rf	0.0491	0.1158	0.0242	0.0664	0.0529	0.1337	0.1250	0.0917	0.0712
SMB	0.0846	0.1782	0.1671	0.1673	0.1249	0.1978	0.2092	0.1832	0.1754
HML	0.1860	0.1625	0.1628	0.2094	0.1160	0.0371	0.0160	-0.1793	-0.2956
WML	0.2272	0.2703	0.2894	0.2951	0.2483	0.3358	0.2969	0.2032	0.1192

*Notes: Table 2 shows the performance measures of the monthly returns for the momentum strategies based on Russell 1000 indexes (large cap indexes). The long-only strategy invests in the style with greater previous returns out of the two indexes: Russell 1000 Value and Russell 1000 Growth. The long-short strategy invests in the winner style and takes a short position in the loser style. F denotes formation periods. H denotes holding periods. For example, F3H1 denote the strategies with a 3 months formation period and a 1 one month holding period. Alpha is estimated based on the Carhart four factor model. The coefficients for the four factors are reported: Rm-Rf represents the market beta; SMB represents the beta for small minus big factor; HML represents beta for high minus low factor; WML represents winner minus loser factor. *,**,*** indicate statistical significance at 0.1, 0.05 and 0.01 level.*

Table 3: Style Momentum with Russell 2000 Value / Growth Indexes

Panel 1: Long-Only									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0108	0.0083	0.0096	0.0094	0.0094	0.0092	0.0076	0.0067	0.0064
S.D.	0.0632	0.0642	0.0637	0.0643	0.0629	0.0653	0.0657	0.0658	0.0661
Sharpe Ratio	0.1250	0.0853	0.1064	0.1010	0.1033	0.0966	0.0727	0.0577	0.0542
Alpha	0.0031*	0.0003	0.0015	0.0010	0.0012	0.0008	-0.0006	-0.0011	-0.0008
Rm-Rf	0.9391	0.9785	0.9756	0.9783	0.9577	0.9982	1.0187	1.0067	0.9992
SMB	0.8257	0.8621	0.8278	0.8780	0.8770	0.8757	0.8599	0.8606	0.8503
HML	-0.6310	-0.6306	-0.5782	-0.5870	-0.5988	-0.6386	-0.6856	-0.7633	-0.8402
WML	0.0950	0.1122	0.1315	0.1291	0.1285	0.1625	0.1656	0.1279	0.0818
Panel 2: Long-Short									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0106	0.0058	0.0084	0.0078	0.0078	0.0074	0.0044	0.0024	0.0020
S.D.	0.0580	0.0519	0.0597	0.0556	0.0532	0.0552	0.0505	0.0448	0.0395
Sharpe Ratio	0.1338	0.0562	0.0925	0.0888	0.0930	0.0828	0.0301	-0.0101	-0.0224
Alpha	0.0056*	0.0001	0.0024	0.0015	0.0018	0.0011	-0.0017	-0.0028	-0.0022
Rm-Rf	-0.1196	-0.0408	-0.0465	-0.0411	-0.0824	-0.0015	0.0396	0.0157	0.0006
SMB	0.2220	0.2948	0.2263	0.3267	0.3246	0.3220	0.2905	0.2918	0.2713
HML	0.1756	0.1765	0.2813	0.2636	0.2401	0.1605	0.0664	-0.0888	-0.2428
WML	0.2020	0.2365	0.2751	0.2703	0.2691	0.3371	0.3433	0.2679	0.1757

*Notes: Table 3 shows the performance measures of the monthly returns for the momentum strategies based on Russell 2000 indexes (small cap indexes). The long-only strategy invests in the style with greater previous returns out of the two indexes: Russell 2000 Value and Russell 2000 Growth. The long-short strategy invests in the winner style and takes a short position in the loser style. F denotes formation periods. H denotes holding periods. For example, F3H1 denote the strategies with a 3 months formation period and a 1 one month holding period. Alpha is estimated based on the Carhart four factor model. The coefficients for the four factors are reported: Rm-Rf represents the market beta; SMB represents the beta for small minus big factor; HML represents beta for high minus low factor; WML represents winner minus loser factor. *,**,*** indicate statistical significance at 0.1,0.05 and 0.01 level.*

Table 4 presents the results based on the strategies that rotate among all four Russell indexes based on past performances. Similar to the results using the small cap indexes, neither long-only strategy nor the long-short strategy provides any significant abnormal returns, which indicates that style momentum cannot generate abnormal returns when implemented across market cap levels using Russell indexes.

Table 4: Style Momentum: Russell 1000 Value / Growth and Russell 2000 Value / Growth Indexes

Panel 1: Long-Only									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0080	0.0059	0.0094	0.0089	0.0092	0.0089	0.0075	0.0069	0.0068
S.D.	0.0588	0.0590	0.0599	0.0593	0.0577	0.0613	0.0619	0.0593	0.0578
Sharpe Ratio	0.0878	0.0512	0.1090	0.1019	0.1097	0.0977	0.0754	0.0674	0.0673
Alpha	0.0021	-0.0006	0.0022	0.0018	0.0024	0.0019	0.0006	0.0008	0.0017
Rm-Rf	0.9358	0.9945	0.9630	0.9930	1.0008	1.0164	1.0516	1.0523	1.0449
SMB	0.4721	0.5225	0.6199	0.5886	0.5342	0.5494	0.5485	0.4387	0.3318
HML	-0.8022	-0.8047	-0.6979	-0.7140	-0.7326	-0.8156	-0.8421	-0.8911	-0.9538
WML	0.1286	0.1566	0.1784	0.1813	0.1633	0.2298	0.2284	0.1548	0.0813
Panel 2: Long-Short									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0086	0.0044	0.0064	0.0066	0.0074	0.0072	0.0057	0.0044	0.0045
S.D.	0.0660	0.0563	0.0621	0.0580	0.0521	0.0556	0.0520	0.0455	0.0416
Sharpe Ratio	0.0867	0.0273	0.0575	0.0648	0.0872	0.0771	0.0537	0.0335	0.0388
Alpha	0.0028	-0.0020	-0.0008	-0.0004	0.0009	0.0005	-0.0010	-0.0009	0.0008
Rm-Rf	-0.1299	-0.0235	-0.0549	0.0071	0.0277	0.0751	0.1430	0.1295	0.1008
SMB	0.3876	0.3860	0.4897	0.3965	0.3288	0.3546	0.3147	0.1813	0.0429
HML	0.1670	0.1960	0.2667	0.2863	0.2089	0.0078	0.0134	-0.0911	-0.2044
WML	0.2467	0.2766	0.3463	0.3259	0.3148	0.4163	0.3988	0.2910	0.1726

*Notes: Table 4 shows the performance measures of the monthly returns for the momentum strategies based on all four Russell indexes. The long-only strategy invests in the style with greater previous returns out of the four indexes: Russell 1000 Value/Growth, Russell 2000 Value/Growth. The long-short strategy invests in the winner style and takes a short position in the loser style. For example, F3H1 denote the strategies with a 3 months formation period and a 1 one month holding period. Alpha is estimated based on the Carhart four factor model. The coefficients for the four factors are reported: Rm-Rf represents the market beta; SMB represents the beta for small minus big factor; HML represents beta for high minus low factor; WML represents winner minus loser factor. *,**,*** indicate statistical significance at 0.1,0.05 and 0.01 level.*

In summary, for Russell indexes, the long-only strategies using the large cap value and the large cap growth indexes provide the highest and significant abnormal returns while the long-short strategies do not. Second, strategies using Russell small cap value/growth indexes or all four Russell indexes (large cap value/growth and small cap value/growth) do not create significant abnormal returns. Third, abnormal returns tend to decline when holding periods increase. Fourth, the individual stock momentum factor only explains a small portion of the returns of style momentum strategies. The results based on the Fama-French indexes are shown in Tables 5, 6, and 7 and are consistent with those from the Russell indexes. At the large cap level, we choose winning/losing styles out of three indexes: large cap value, large cap blend, and large cap growth. The results are presented in Table 5. For the long-only strategy (Panel 1 of Table 5), average returns range from 0.0051 to 0.0082; standard deviations vary between 0.0485 and 0.0502; and Sharpe ratios range from 0.0461 to 0.1054. Abnormal returns vary from 0.0009 per month to 0.0039 per month and all of them are significant except for F12H6. Similarly to Russell 1000 indexes, for a fixed formation window, abnormal returns tend to decline as holding periods increase. For example, abnormal returns are 0.0035, 0.0034 and 0.0019 for strategies F6H1, F6H3 and F6H6 respectively. Abnormal returns are 0.0035, 0.0021, 0.0009 and 0.0018 for strategies F12H1, F12H3, F12H6 and F12H12 respectively. It is worth-noting that the coefficients of the momentum factor, WML, range from 0.0391 to 0.1424, which indicates that the individual stock momentum only explains a very small portion of the returns of the long-only strategy. For the long-short strategies (Panel 2 of Table 5), again, they underperform the long-only strategy. None of the alphas are significant. In addition, the market betas across all strategies are close to zero since buying winner and shorting loser cancels out the market risk.

Table 6 presents the results based on the three Fama-French small cap indexes: small cap value/blend/growth. The long-only strategies provide greater average returns and greater abnormal returns than the long-short strategies. Five out of nine abnormal returns for the long-only strategies are significant with the F3H1 being the highest (alpha=0.0036) while none of the long-short strategies provide a significant alpha. If we compare Panel 1 of Table 6 with Panel 1 of Table 5, it shows abnormal returns of the long-only strategies based on large cap indexes are more significant, and tend to be greater than those based on the small cap indexes, which is consistent with the Russell indexes. In addition, those significant abnormal returns tend to decline when holding periods increase. For example, long-only strategies provide abnormal returns of 0.0036, 0.0028 and 0.0022 for strategies F6H1, F6H3, and F6H6, respectively. Similarly, the coefficients for WML are low and ranges from 0.0636 to 0.1429, which indicates that individual momentum cannot explain profitability of style momentum. Table 7 presents the results based on the six Fama-French style indexes: large cap value/blend/growth and small cap value/blend/growth. For the long-only strategies, five out of nine alphas are significant. However, four out of the five are only significant at 10% level. None of the long-short strategies generate significant alphas. Those results indicate that style momentum strategies do not provide consistently significant abnormal returns when implemented across various market cap levels for Fama-French indexes.

Table 5: Style Momentum with Fama-French Large- Cap Value / Blend / Growth Indexes

Panel 1: Long-Only									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0077	0.0082	0.0076	0.0078	0.0065	0.0079	0.0066	0.0051	0.0053
S.D.	0.0494	0.0502	0.0491	0.0488	0.0487	0.0485	0.0492	0.0494	0.0494
Sharpe Ratio	0.0983	0.1054	0.0967	0.1008	0.0754	0.1041	0.0764	0.0461	0.0502
Alpha	0.0039***	0.0039***	0.0035**	0.0034***	0.0019*	0.0035**	0.0021*	0.0009	0.0018**
Rm-Rf	0.9784	1.0136	0.9786	0.9869	1.0078	0.9799	1.0129	1.0208	1.0032
SMB	-0.1241	-0.0853	-0.0903	-0.0564	-0.0613	-0.0425	-0.0499	-0.0449	-0.0595
HML	-0.7209	-0.6860	-0.6893	-0.6704	-0.6437	-0.7163	-0.7305	-0.7615	-0.8586
WML	0.0687	0.0931	0.0946	0.1067	0.1176	0.1424	0.1435	0.1040	0.0391
Panel 2: Long-Short									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0067	0.0077	0.0081	0.0083	0.0063	0.0076	0.0052	0.0029	0.0027
S.D.	0.0511	0.0473	0.0498	0.0487	0.0458	0.0465	0.0442	0.0386	0.0326
Sharpe Ratio	0.0750	0.1024	0.1048	0.1112	0.0742	0.1014	0.0536	-0.0003	-0.0052
Alpha	0.0029	0.0030	0.0033	0.0031	0.0011	0.0025	0.0002	-0.0017	-0.0008
Rm-Rf	-0.0625	0.0325	-0.0045	0.0137	0.0223	0.0154	0.0500	0.0607	0.0586
SMB	-0.0031	0.0712	0.0876	0.1242	0.1238	0.1348	0.1425	0.1499	0.1223
HML	0.0427	0.0804	0.0917	0.1144	0.1102	-0.0098	-0.0269	-0.1054	-0.2388
WML	0.1630	0.2125	0.2448	0.2617	0.2600	0.3149	0.2968	0.2172	0.1115

*Notes: Table 5 shows the performance measures of the monthly returns for the momentum strategies based on three Fama-French large cap indexes. The long-only strategy invests in the style with greater previous returns out of the three indexes: Fama-French Large Cap Value/Blend/Growth. The long-short strategy invests in the winner style and takes a short position in the loser style. For example, F3H1 denote the strategies with a 3 months formation period and a 1 one month holding period. Alpha is estimated based on the Carhart four factor model. The coefficients for the four factors are reported: Rm-Rf represents the market beta; SMB represents the beta for small minus big factor; HML represents beta for high minus low factor; WML represents winner minus loser factor. *,**,*** indicate statistical significance at 0.1,0.05 and 0.01 level.*

Table 6: Style Momentum with Fama-French Small Cap Value / Blend / Growth Indexes

Panel 1: Long-Only									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0120	0.0102	0.0128	0.0121	0.0114	0.0114	0.0102	0.0093	0.0096
S.D.	0.0698	0.0697	0.0697	0.0698	0.0691	0.0687	0.0694	0.0697	0.0694
Sharpe Ratio	0.1312	0.1054	0.1422	0.1325	0.1233	0.1246	0.1054	0.0927	0.0964
Alpha	0.0036**	0.0014	0.0036**	0.0028**	0.0022*	0.0026*	0.0012	0.0007	0.0016
Rm-Rf	0.9810	1.0025	0.9995	0.9921	0.9787	0.9645	0.9912	0.9887	0.9660
SMB	1.0186	1.0493	1.0509	1.0888	1.0902	1.0628	1.0630	1.0588	1.0463
HML	-0.6415	-0.6170	-0.5214	-0.5329	-0.5466	-0.6259	-0.6345	-0.6900	-0.7950
WML	0.0664	0.0930	0.1169	0.1283	0.1222	0.1315	0.1429	0.1174	0.0636
Panel 2: Long-Short									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0094	0.0059	0.0109	0.0093	0.0081	0.0078	0.0048	0.0033	0.0037
S.D.	0.0567	0.0524	0.0617	0.0587	0.0575	0.0564	0.0538	0.0498	0.0433
Sharpe Ratio	0.1153	0.0581	0.1306	0.1097	0.0910	0.0874	0.0365	0.0077	0.0190
Alpha	0.0043	-0.0002	0.0043	0.0023	0.0012	0.0014	-0.0017	-0.0025	-0.0007
Rm-Rf	-0.0691	-0.0052	-0.0414	-0.0362	-0.0490	-0.0667	-0.0076	-0.0216	-0.0680
SMB	0.2283	0.2899	0.2814	0.3540	0.3486	0.3114	0.3032	0.2982	0.2744
HML	0.1827	0.2599	0.4210	0.4102	0.3942	0.2331	0.1942	0.0651	-0.1233
WML	0.1734	0.2395	0.2803	0.3075	0.3004	0.3457	0.3610	0.2924	0.1801

Notes: Table 6 shows the performance measures of the monthly returns for the momentum strategies based on three Fama-French small cap indexes. The long-only strategy invests in the style with greater previous returns out of the three indexes: Fama-French Small Cap Value/Blend/Growth. The long-short strategy invests in the winner style and takes a short position in the loser style. F denotes formation periods. H denotes holding periods. For example, F3H1 denote the strategies with a 3 months formation period and a 1 one month holding period. Alpha is estimated based on the Carhart four factor model. The coefficients for the four factors are reported: Rm-Rf represents the market beta; SMB represents the beta for small minus big factor; HML represents beta for high minus low factor; WML represents winner minus loser factor.

Table 7: Style Momentum with Fama-French Large -Cap Value / Blend / Growth and Small Cap Value / Blend/ Growth Indexes

Panel 1: Long-Only									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0096	0.0091	0.0121	0.0122	0.0109	0.0109	0.0094	0.0079	0.0079
S.D.	0.0637	0.0630	0.0660	0.0650	0.0624	0.0637	0.0646	0.0612	0.0569
Sharpe Ratio	0.1052	0.0994	0.1395	0.1437	0.1282	0.1258	0.1015	0.0822	0.0891
Alpha	0.0029	0.0019	0.0034*	0.0039**	0.0027*	0.0033*	0.0016	0.0008	0.0022*
Rm-Rf	0.9313	0.9907	1.0170	0.9817	1.0089	0.9561	1.0048	1.0052	0.9836
SMB	0.6110	0.6520	0.7995	0.8356	0.7427	0.7584	0.7493	0.6482	0.4767
HML	-0.7310	-0.7372	-0.5814	-0.6519	-0.6079	-0.7957	-0.7891	-0.7815	-0.8340
WML	0.1296	0.1754	0.2355	0.2057	0.1989	0.2269	0.2331	0.1582	0.0564
Panel 2: Long-Short									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0094	0.0064	0.0111	0.0112	0.0095	0.0082	0.0057	0.0046	0.0043
S.D.	0.0717	0.0619	0.0670	0.0635	0.0592	0.0594	0.0570	0.0507	0.0425
Sharpe Ratio	0.0909	0.0569	0.1235	0.1306	0.1119	0.0891	0.0503	0.0338	0.0347
Alpha	0.0036	-0.0007	0.0026	0.0028	0.0014	0.0007	-0.0018	-0.0018	0.0003
Rm-Rf	-0.1494	-0.0282	-0.0154	-0.0397	0.0125	0.0074	0.0449	0.0369	0.0043
SMB	0.3946	0.5248	0.7081	0.7609	0.6282	0.6425	0.6519	0.5265	0.1917
HML	0.1378	0.1754	0.2181	0.1629	0.1836	-0.1061	-0.1049	-0.1396	-0.2018
WML	0.2592	0.3391	0.4602	0.4226	0.4332	0.4849	0.4538	0.3448	0.1734

Notes: Table 7 shows the performance measures of the monthly returns for the momentum strategies based on all six Fama-French indexes. The long-only strategy invests in the style with greater previous returns out of the six indexes: Fama-French Large Cap Value/Blend/Growth and Small Cap Value/Blend/Growth. The long-short strategy invests in the winner style and takes a short position in the loser style. F denotes formation periods. H denotes holding periods. For example, F3H1 denote the strategies with a 3 months formation period and a 1 one month holding period. Alpha is estimated based on the Carhart four factor model. The coefficients for the four factors are reported: Rm-Rf represents the market beta; SMB represents the beta for small minus big factor; HML represents beta for high minus low factor; WML represents winner minus loser factor.

Overall, the results using Fama-French indexes are consistent with those using Russell indexes, long-only strategies can generate significant abnormal returns while long-short strategies cannot. Abnormal returns tend to decline when holding period increases. Strategies implemented at the large cap level generate greater and more significant abnormal returns compare to those implemented at the small cap level or across all market cap levels. The results based on the MSCI indexes are provided in Tables 8, 9, and 10. Table 8 presents the results using two large cap indexes: MSCI U.S. prime market value index, MSCI U.S. prime market growth index. The long-only strategies provide average returns that range from 0.0056 to 0.0082 and abnormal returns that range from 0.0018 per month to 0.0040 per month. All of the alphas except for F3H3 are significant. Abnormal returns tend to decline when holding periods increase. The coefficients of the momentum factor, WML, range from 0.1031 to 0.1954 which indicates that the individual stock momentum only explains a very small portion of the returns of the buy winner strategy. Panel 2 of Table 8 presents the results for the long-short strategies. Similar to other indexes, long-short strategies underperform long-only strategies and none of the alphas are significant. Table 9 presents the results based on the two small cap indexes: MSCI U.S. small cap value and MSCI U.S. small cap growth. Again, in general, average returns and abnormal returns from the long-only strategies are higher than those from the long-short strategies. Six out of nine alphas are significant for the long-only strategies with three significant only at 10% level. None of the long-short strategies provide significant alphas. Table 10 presents the results based on the strategy rotating among all the four MSCI indexes: MSCI U.S. prime market value, MSCI U.S. prime market growth, MSCI U.S. small cap value, and MSCI U.S. small cap growth. Long-only strategies invest in the best performing index out of the four based on past returns. Similarly, the long-only strategies outperform the long-short strategies and generate positive alphas that range from 0.0024 to 0.0047. All of them are significant except for the F3H1 strategy. None of the alphas from the long-short strategies are significant. It is worth noting that MSCI is the only index family that can provide consistently significant abnormal returns when the long-only strategies are implemented across different market cap levels. This may be partially explained by the description in the data section, that is, the stocks covered by the MSCI small cap indexes are relatively larger than those included in the Russell 2000 indexes and Fama-French small cap indexes.

Table 8: Style Momentum with MSCI U.S. Prime Market Value / Growth Indexes

Panel 1: Long-Only	F3H1	F3H3	F6H1	F6H3	F6H6	F12H1	F12H3	F12H6	F12H12
Mean	0.0071	0.0056	0.0076	0.0079	0.0074	0.0082	0.0074	0.0070	0.0062
S.D.	0.0505	0.0505	0.0520	0.0521	0.0512	0.0525	0.0532	0.0535	0.0546
Sharpe Ratio	0.0845	0.0546	0.0912	0.0965	0.0889	0.1020	0.0855	0.0766	0.0618
Alpha	0.0038**	0.0018	0.0034**	0.0036***	0.0034***	0.0040***	0.0033***	0.0034***	0.0032***
Rm-Rf	0.9835	1.0194	1.0358	1.0486	1.0316	1.0476	1.0647	1.0474	1.0471
SMB	-0.1004	-0.0511	-0.0311	-0.0233	-0.0234	-0.0153	-0.0211	-0.0289	-0.0404
HML	-0.9545	-0.9230	-0.9439	-0.9345	-0.9933	-0.9857	-1.0257	-1.1162	-1.1995
WML	0.1031	0.1223	0.1828	0.1847	0.1672	0.1954	0.1910	0.1459	0.1040
Panel 2: Long-Short	**F3H1**	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0071	0.0040	0.0080	0.0086	0.0076	0.0092	0.0076	0.0067	0.0053
S.D.	0.0568	0.0508	0.0540	0.0525	0.0467	0.0509	0.0468	0.0407	0.0346
Sharpe Ratio	0.0740	0.0231	0.0955	0.1089	0.1019	0.1251	0.1016	0.0946	0.0697
Alpha	0.0024	-0.0016	0.0017	0.0020	0.0017	0.0028	0.0014	0.0017	0.0012
Rm-Rf	-0.0068	0.0651	0.0979	0.1234	0.0895	0.1214	0.1558	0.1211	0.1205
SMB	0.0521	0.1507	0.1906	0.2062	0.2060	0.2223	0.2107	0.1950	0.1721
HML	0.1370	0.2000	0.1583	0.1771	0.0595	0.0746	-0.0054	-0.1863	-0.3530
WML	0.2147	0.2529	0.3740	0.3779	0.3427	0.3992	0.3904	0.3003	0.2164

Notes: Table 8 shows the performance measures of the monthly returns for the momentum strategies based on MSCI US prime market indexes (large cap indexes). The long-only strategy invests in the style with greater previous returns out of the two indexes: MSCI US Prime Market Value and US Prime Market Growth. The long-short strategy invests in the winner style and takes a short position in the loser style. F denotes formation periods. H denotes holding periods. For example, F3H1 denote the strategies with a 3 months formation period and a 1 one month holding period. Alpha is estimated based on the Carhart four factor model. The coefficients for the four factors are reported: Rm-Rf represents the market beta; SMB represents the beta for small minus big factor; HML represents beta for high minus low factor; WML represents winner minus loser factor.

Table 9: Style Momentum with MSCI U.S. Small Cap Value / Growth Indexes

Panel 1: Long-Only									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0119	0.0101	0.0110	0.0111	0.0114	0.0104	0.0095	0.0085	0.0085
S.D.	0.0625	0.0635	0.0648	0.0647	0.0636	0.0658	0.0655	0.0658	0.0657
Sharpe Ratio	0.1443	0.1131	0.1248	0.1280	0.1339	0.1146	0.1017	0.0853	0.0860
Alpha	0.0046**	0.0024*	0.0030*	0.0032**	0.0036***	0.0026*	0.0018	0.0012	0.0017
Rm-Rf	0.9918	1.0367	1.0512	1.0417	1.0317	1.0815	1.0717	1.0657	1.0496
SMB	0.6959	0.7436	0.7410	0.7594	0.7525	0.7204	0.7305	0.7267	0.7193
HML	-0.6556	-0.6810	-0.6662	-0.6504	-0.6884	-0.7503	-0.7463	-0.8173	-0.8773
WML	0.0889	0.1210	0.1646	0.1386	0.1396	0.1842	0.1636	0.1204	0.0794
Panel 2: Long-Short									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0095	0.0058	0.0076	0.0080	0.0085	0.0065	0.0047	0.0027	0.0027
S.D.	0.0588	0.0483	0.0557	0.0545	0.0498	0.0510	0.0501	0.0442	0.0402
Sharpe Ratio	0.1124	0.0606	0.0849	0.0936	0.1122	0.0712	0.0373	-0.0049	-0.0038
Alpha	0.0042	-0.0003	0.0009	0.0014	0.0022	0.0001	-0.0015	-0.0027	-0.0017
Rm-Rf	-0.1059	-0.0163	0.0129	-0.0061	-0.0261	0.0735	0.0539	0.0418	0.0096
SMB	0.2987	0.3940	0.3888	0.4257	0.4119	0.3477	0.3679	0.3602	0.3456
HML	0.1124	0.0615	0.0912	0.1227	0.0467	-0.0771	-0.0691	-0.2111	-0.3311
WML	0.2333	0.2976	0.3848	0.3328	0.3349	0.4240	0.3828	0.2964	0.2145

Notes: Table 9 shows the performance measures of the monthly returns for the momentum strategies based on MSCI US small cap indexes. The long-only strategy invests in the style with greater previous returns out of the two indexes: MSCI US Small Cap Value and US Small Cap Growth. The long-short strategy invests in the winner style and takes a short position in the loser style. F denotes formation periods. H denotes holding periods. For example, F3H1 denote the strategies with a 3 months formation period and a 1 one month holding period. Alpha is estimated based on the Carhart four factor model. The coefficients for the four factors are reported: Rm-Rf represents the market beta; SMB represents the beta for small minus big factor; HML represents beta for high minus low factor; WML represents winner minus loser factor.

Table 10: Style Momentum with MSCI U.S. Prime Market Value / Growth and Small Cap Value / Growth Indexes

Panel 1: Long-Only									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0103	0.0086	0.0112	0.0114	0.0112	0.0113	0.0101	0.0093	0.0087
S.D.	0.0569	0.0579	0.0624	0.0615	0.0614	0.0639	0.0631	0.0615	0.0600
Sharpe Ratio	0.1314	0.0996	0.1333	0.1393	0.1350	0.1311	0.1150	0.1039	0.0981
Alpha	0.0047**	0.0024	0.0040**	0.0043***	0.0042***	0.0042**	0.0032**	0.0032**	0.0034***
Rm-Rf	0.9615	1.0139	1.0721	1.0597	1.0637	1.1161	1.1024	1.0967	1.0785
SMB	0.3674	0.4605	0.5230	0.5252	0.5293	0.4881	0.4985	0.4200	0.3533
HML	-0.8552	-0.8406	-0.7970	-0.8024	-0.8436	-0.8835	-0.8893	-0.9518	-1.0048
WML	0.1532	0.1751	0.2465	0.2470	0.2257	0.2804	0.2597	0.1740	0.1250
Panel 2: Long-Short									
	F3H1	**F3H3**	**F6H1**	**F6H3**	**F6H6**	**F12H1**	**F12H3**	**F12H6**	**F12H12**
Mean	0.0103	0.0064	0.0093	0.0104	0.0104	0.0115	0.0097	0.0078	0.0068
S.D.	0.0636	0.0547	0.0597	0.0587	0.0535	0.0575	0.0548	0.0466	0.0407
Sharpe Ratio	0.1166	0.0651	0.1073	0.1281	0.1415	0.1497	0.1249	0.1067	0.0970
Alpha	0.0046	-0.0003	0.0013	0.0023	0.0028	0.0035	0.0018	0.0014	0.0018
Rm-Rf	-0.1000	-0.0035	0.0983	0.0869	0.0735	0.1490	0.1610	0.1388	0.0957
SMB	0.3133	0.4362	0.4792	0.5024	0.5013	0.4578	0.4792	0.3759	0.2878
HML	0.1314	0.1653	0.1703	0.2107	0.1156	0.0976	0.0855	-0.0698	-0.2213
WML	0.2919	0.3235	0.4855	0.4607	0.4391	0.5116	0.4839	0.3655	0.2556

Notes: Table 10 shows the performance measures of the monthly returns for the momentum strategies based on all four MSCI indexes. The long-only strategy invests in the style with greater previous returns out of the four indexes: MSCI US Prime Mraket Value/Growth, MSCI Small Cap Value/ Growth. The long-short strategy invests in the winner style and takes a short position in the loser style. F denotes formation periods. H denotes holding periods. For example, F3H1 denote the strategies with a 3 months formation period and a 1 one month holding period. Alpha is estimated based on the Carhart four factor model. The coefficients for the four factors are reported: Rm-Rf represents the market beta; SMB represents the beta for small minus big factor; HML represents beta for high minus low factor; WML represents winner minus loser factor.

CONCLUDING COMMENTS

In this study, we investigate the return enhancement ability of style momentum strategy. We explore the variation in abnormal returns estimated based on the Carhart four-factor model (Fama-French three factors plus momentum) of long-only and long-short momentum strategies using various style based indexes (Russell value/growth indexes, Fama-French value/growth indexes, and MSCI value/growth indexes) where the value and growth stocks are classified using different criteria. Such strategies are much easier to implement and considerably less expensive compared to the style momentum strategies based on individual stocks. We did cross-style analysis by comparing the performance of the strategy using large cap value/growth vs. small cap value/growth indexes. Although results from three index families do vary, the primary results are robust. We first find that in general the long-only strategies create significant positive abnormal returns whereas the long-short strategies do not. This result is consistent with the literature on stock momentum (see, Griffin et al. (2005), Ammann et al. (2011)). Second, for a fixed formation period, abnormal returns of style momentum tend to decrease when the length of holding periods increases. Third, rotating value/growth styles at the large cap level tend to generate more consistent and more significant abnormal returns than rotating at the small cap level or across all market cap levels. Fourth, our strategies based on rotating across all market cap levels do not generate consistently significant abnormal returns for Russell indexes or Fama-French indexes, but they do for MSCI indexes. Fifth, individual stock momentum only explains a very small portion of the returns of the style moment strategies. In other words, chasing winning styles does provide additional benefits to chasing winning stocks. Those findings are of great interest to individual investors and portfolio managers and will help them enhance their investment performance. Our findings also bring up questions for future research. For example, why style momentum exists? Under what market it may be the strongest? And so on. We plan to explore those questions in future.

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DO CORPORATE GOVERNANCE MEASURES IMPACT AUDIT PRICING OF SMALLER FIRMS? EVIDENCE FROM THE UNITED STATES AND NEW ZEALAND

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ABSTRACT

Motivated primarily by the claims that audit committee independence and accounting expertise and CEO compensation influence audit fees, this study examines the effect of such factors, on audit fees in two different institutional settings in the post-Sarbanes Oxley Act (SOX) era. The institutional settings are those of the U.S. and New Zealand audit markets, where the U.S. market is more regulated and litigious than the New Zealand market. The study sample comprises firms of similar size from each country. Firms in the U.S. with higher audit committee accounting expertise charge higher audit fees than New Zealand firms. The results also suggest that short-term incentives and total compensation in both the countries are considered as audit risk and priced accordingly even though N.Z. firms operate in a different regulatory environment. Study findings suggest that firms with better corporate governance arrangements in the post-SOX era in the U.S. demand a better audit effort from audit firms and pay higher audit fees.

JEL: M42, M48, M49

KEYWORDS: New Zealand, Audit Fees, SOX, IFRS

INTRODUCTION

The role of audit committee independence and expertise, and executive compensation on audit fees are extensively examined in the audit fee literature (e.g., Carcello et al. 2002; Abbott et al. 2003; Krishnan and Visvanathan 2006). Major accounting scandals highlighted the importance of managerial incentives to manipulate earnings for personal gain of the Chief Executive Officer (hereinafter CEO) in the U.S. Public Company Accounting Oversight Board (hereinafter PCAOB) had advised auditors to carefully evaluate CEO compensation practices in their audit consideration and processes. The International Federation of Accountants (IFAC), with ultimate jurisdiction over the international accounting and auditing standards employed in N.Z., has specifically noted the need for greater oversight of executive compensation as it relates to firm risk management.

Hay et al. (2006) revisit the audit fee literature and identify numerous inconsistencies and gaps in the results of the studies conducted since 1980. Their results reveal that the path adopted in the extant studies have been less than systematic. Ananthanarayanan et al. (2017) observe that several U.S. studies have emerged to empirically examine the relation between the sensitivity of stock options in executive compensation to stock returns (vega) and stock prices (delta), and audit fees. This small body of research generally suggests that auditors evaluate higher risks when there is greater sensitivity of executive stock option compensation to market-based performance measures (Chen et al. 2015; Kim et al. 2014; Billings et al. 2013; Yezen et al. 2014), albeit with some mixed evidence. They also emphasize that results of the U.S. studies cannot be generalized to N.Z. or many other countries primarily because of differences in the size and nature of CEO compensation. Nuno et al. (2013) find that salaries (base) account for 28% of total pay for CEOs in the U.S., compared to 46% in other countries. Similarly, equity-based pay (consisting of restricted stock, stock options, and performance shares) account, on average, for 39% of total pay for U.S. CEOs, with non-U.S. countries averaging only 22%.

Several studies have investigated determinants of audit fees using single country samples in different settings. Most of the studies provided mixed evidence on the determinants of audit fees (Hay et al. 2006). Choi et al. (2008) conducted a cross-country study to shed light on such mixed results. Their study (pre-sox period) finds that a country's legal liability regime is an important audit fee increasing factor due to the risks associated with auditing firms in that country mainly in small and medium-sized firms. This study considers the effects across institutional contexts and conducts the study across two countries to examine if institutional contexts affect the determination of audit fees. The two institutional contexts this study consider are those of the U.S. and New Zealand after the implementation of SOX in the U.S. and corporate governance reform in New Zealand. The main differences between the two contexts for this study are that SOX has brought in stringent regulations for audit and corporate governance, but the New Zealand reform brought in a set of codes of better corporate governance, which is not mandatory. Further, the U.S. audit environment is litigious, whereas the New Zealand audit environment is moderately litigious. These conditions can affect the extent of influence in the audit markets raising concerns for higher audit prices.

The study uses a combined sample of 1170 firm-years from both the U.S. and New Zealand settings for pooled regression analyses. Since the U.S. firms are in a stronger regulatory oversight environment, this study expects that the audit risk signals/variables would lead to higher/lower audit fees in the U.S. as compared to N.Z. Overall, the findings of this study suggest that better corporate governance arrangements in the post-SOX era in the U.S. lead to higher audit fee as audit committee experts demand a better effort from the audit firm. This effect is higher in firms that report strong corporate governance measures. Audit firms in both the countries consider short-term incentive of CEO as a risk factor and charge higher audit fees for firms offering such incentives even though the audit firms in N.Z. face lesser risk due to lower litigation rate. The total compensation of CEO is also considered as a risk factor in both countries. This study is the first to expand the current U.S. CEO compensation and audit fee research to the N.Z. environment specifically, and to non-U.S. settings generally, with evidence suggesting that auditors are pricing client CEO compensation incentives even in a smaller non-U.S. market. Second, this study also finds that mandatory corporate governance is more effective in the U.S. and policymakers in N.Z should consider implementing such measures. The remainder of this paper is organized as follows. The next section provides a review of the prior literature and empirically testable hypotheses. The research method and results discussion follow, and the final section conclude the paper.

LITERATURE REVIEW

The background settings of both the U.S. and New Zealand identify certain significant factors that are unique to each country. The differences in the institutional settings of the U.S. and New Zealand can have different impacts on the audit price settings in the two markets. With the introduction of SOX, auditing services are under further strain. For example, with the introduction of Regulation 404, smaller audit firms are less likely to be in the market for large audits because of its arduous regulatory requirements, which adds to their audit risks. Therefore, in the U.S. auditors are likely to reduce their audit fees if the auditee has better audit committee independence and expertise (two measures of corporate governance emphasized by SOX), higher, and executive compensation. In contrast, these governance factors would have less effect on audit services and audit fees in New Zealand. Firstly, in New Zealand, these factors are regarded as suggested codes rather than requirements. Secondly, the level of audit risk in New Zealand, relative to the audit risk in the U.S. is low. Thirdly, the penalties of audit failure are far less evident in New Zealand than in the U.S. Fourthly, the New Zealand audit profession is self-regulatory in nature, and is not under any supervisory body like the PCAOB in the U.S. Finally, unlike the U.S. Securities Exchange Commission (hereinafter SEC), the N.Z. stock exchange has no statutory authority to establish financial accounting and reporting standards for publicly held companies but has Financial Markets Authority (FMA) board to regulate capital market and financial services and audit profession.

First, the U.S. is a highly litigious country, whereas New Zealand is less litigious. In the U.S., the corporate governance codes are mandatory, but in New Zealand, it is optional The SEC in the U.S. has the statutory authority to establish and enforce accounting and reporting standards while NZSC has no such statutory or enforcement authority. The U.S. follows USGAAP as its accounting standards, but New Zealand follows IFRS. The executive compensation arrangements in the U.S. may have a mixed effect on the audit risk unlike New Zealand, which does not have broader incentive schemes.

Auditors evaluate their audit risk by looking at various factors like board independence, audit committee independence, audit committee expertise, and duality. An active audit committee (more independent directors and directors with financial expertise) may reduce the auditor's workload and result in reduced audit fees (Bedard et al. 2004). Abbott et al. (2003) report that audit committee independence and financial expertise are significant, positively associated with audit fees, which supports the findings of Carcello et al. (2002) to a certain extent. More recent studies direct their attention to the types of financial experts on the audit committee (e.g., Krishnan and Visvanathan 2008; Hoitash et al. 2009). observe that accounting experts (those holding a CPA or with CFO experience) are better monitors of the financial reporting process that are audit committee members with nonaccounting expertise. Vafeas and Waegelein (2007) suggest that audit committee characteristics (size, member expertise, and member independence) are positively associated with audit fees because it complements the external audit in monitoring management. Rainsbury, Bradbury, and Cahan (2009) observe no significant association between the quality of audit committees and the level of fees paid to external auditors in New Zealand firms. The above findings suggest that the board (through its various committees) may influence audit quality through formal and informal means. At the same time, outside and independent directors are more concerned with audit quality, and they may encourage the firms to purchase higher quality audit services at higher prices.

Studies conducted in the U.S. show both positive and negative association between audit fees and executive compensation schemes. Healy (1985) and Holthausen et al. (1995) along with other researchers have documented that bonuses have an influence on managerial accounting and reporting practices. Vafeas and Waegelein (2007) find that CEO long-term pay has a negative association with audit fee levels. They opine that certain types of management incentives can lead to reduced corporate audit fees and argue that boards of directors choose external auditors of higher quality that charge higher fees to restrain management from excessive earnings manipulation to increase their compensation. Engel, Hayes, & Wang (2010) find that there is a positive correlation between total compensation and cash retainers paid to audit committees with audit fees. Wysocki (2010) finds a positive and significant association between total compensation and audit fees. A recent study (ex., Billings et al. 2013; Yezen et al. 2014) investigate the role of managerial incentives to executives (CEO and CFO) and its association with audit fees and find the CFO equity incentives are positively associated with audit fees. Ananthanarayanan et al. (2017) find that short-term incentives and total compensation is positive and significantly associated with audit fees in firms that have weaker corporate governance measures or audited by big four firms. The results of the study show that short-term incentive and total compensation have a positive and significant association with audit fees only when the firm's corporate governance measures are weaker.

In the U.S., BIG4 firms have become more conservative in their audit client-retention decisions in the post-SOX period, which is construed as a measure taken by auditors to avoid risk and enhance their reputation (e.g., Rama and Read 2006; Huang, Raghunandan, and Rama 2009). Plitch and Wei (2004) observe that the BIG4 audit firms are dropping smaller, low marginal revenue audits due to new auditing requirements imposed by SOX. Asthana, Balsam, and Kim (2009) find that many small tier-auditing firms exit the market to avoid the costs of registering with the PCAOB, possibly decreasing competition for small audits, and raising their prices. Beckstead (2006) contends that the PCAOB's one-size-fits-all rules create a barrier to entry for small tier auditors. Cosgrove and Niederjohn (2008) find evidence of higher audit fees across all firms in the U.S. (both BIG4 and non-BIG4) resulting from compliance with SOX. This could be due to reduced competition in the audit market. Small-sized audit firms that have few SEC audit clients are leaving the market for SEC-required audits (Read, Raghunandan, and Rama 2004). Taylor and Simon (1999) observe that increased litigation pressures, institutional traditions of increased disclosure, and increased regulation put upward pressures on audit fees in the U.S. Griffin et al. (2008) find that better governance enhances the quality of financial statements and internal controls, which enables auditors to decrease the price of audit risk and reduce fees.

Prior studies in New Zealand have noted the effects of institutional changes on audit and non-audit fees. Hay and Lee (1999) investigate the determinants of audit fees in New Zealand in the pre-and post-regulatory change period and find that audit fees increased between 1985 and 1990 but decreased between 1990 and 1995 due to regulatory changes. Hay and Knechel (2010) observe that changes in regulation in 1986 and 1992 regarding advertising and solicitation by audit firms in New Zealand led to fee increases in the case of advertising and fee reductions in the case of solicitation, especially for the Big8. Griffin, Lont, and Sun (2009) examine the association between overseas and New Zealand governance regulatory reforms, its companies' audit and non-audit fees, and report that audit fees have increased due to the adoption of the International Financial Reporting Standards (IFRS) in New Zealand. Boo and Sharma (2008) find both positive and negative institutional influences on internal control and audit fees. They opine that regulation can either mitigate or enhance the effectiveness of the internal governance arrangements. Additionally, Haskins and Williams (1988) provide evidence of mimetic behavior across countries. They examine audit fee differences in a sample from the UK, Australia, New Zealand, Ireland, and the U.S. They observe that there is a great deal of uniformity in major audit firms' audit fees across countries (UK, Australia, New Zealand, and the U.S.) which have similar accounting and auditing environments. Ananthanarayanan et al. (2017) find both short-term incentive and stock option compensation to have a significantly positive impact on audit fees in N.Z.

Hypotheses Development

Prior research has shown that key audit committee characteristics, rather than the mere presence of an audit committee, critically affect the audit committee's ability to effectively execute its duties (e.g., Abbott and Parker 2000; Beasley et al. 2000; Carcello and Neal 2000; Raghunandan, Read, and Rama 2001). An audit committee with independent directors with financial expertise should be able to conduct investigations when appropriate, assess risks and exposures, and comment on internal audit practices. The presence of an effective audit committee could substitute for some of the work of external auditors. Krishnan and Visvanathan (2006) observe that auditors price the effectiveness of the audit committee as it relates to the control risk and thus, the overall audit risk. They find that after controlling for several board and audit committee and firm characteristics, audit pricing is negatively related to accounting and financial expertise. In the post-SOX environment, and because of the attention corporate governance has received in recent years, indicators such as an independent audit committee with at least one financial expert is an important signal of audit risk and audit fees reduction in the U.S. Therefore, in the stricter regulatory environment of the post-SOX era, where auditors are more concerned about their risks and have to provide more governance-oriented assurances to the capital markets, this study hypothesizes for all the firms:

> *H1: There is a positive/negative association between audit fees and the percentage of an audit committee independence.*
> *H2: There is a positive/negative association between audit fees and the percentage of an audit committee financial expert.*

Yezen et al. (2014) observe that auditors, boards of directors, compensation committees, shareholders, managers, academics, and regulators may be interested in whether audit pricing reflects risks impounded in CEO pay and equity incentives. Vafeas and Waegelein (2007) opine that certain types of management incentives can lead to reduced audit fees and can restrain management from excessive earnings manipulation. Yezen (2014) finds that auditors price CEO incentive pay in the post-SOX period and Wysocki (2010) finds that there is a positive and significant association between CEO total compensation and audit fees. However, Wysocki (2010) did not consider effects of short and long-term incentive plans (STIP/LTIP) and restricted stock plans in his study. A recent study by Billings et al. 2013 and Yezen at al. 2014 investigated the role of managerial incentives (stock options) to executives (CEO and CFO) and its association with audit fees. The audit firms consider executive incentives (long-term incentive plans and stock options) as a risk factor (Yezen et al. 2014). Roberts (2005) finds that New Zealand CEOs are not overpaid, while Andjelkovic et al. (2002) find that CEO cash incentives depend primarily on firm size. Gunasekaragea and Wilkinson (2002) draw similar conclusions but show that if compensation includes the change in the value of CEO shareholdings and cash, then short-term, long-term, and future firm performances become significant determinants of the total compensation for CEOs. Similarly, Elayan et al. (2003) conclude that executive compensation depends primarily on company size and business risk.

The executive compensation packages offered by most firms listed on the NZX are simpler with basic compensation and limited incentives. Since executive compensation is a risk factor for the audit firms, audit firms view them as significant signals of audit risk and a reason for charging audit fee premiums in a high-risk setting like the U.S. However, New Zealand auditors operate in a low-risk environment and executive compensation incentive schemes are not comparable to those of the U.S. In such an environment, it is unlikely that the audit firms would view executive compensation as a potential audit risk in the determination of audit fees but may consider it as a risk when corporate governance measures are weaker. Accordingly, this study proposes the following hypotheses for all the firms:

H3: There is no association between audit fees and the level of CEO's base compensation.
H4: There is a positive association between audit fees and the level of CEO's incentives
H5: There is a positive association between audit fees and the level of CEO's stock options.
H6: There is a positive association between audit fees and the level of CEO's total compensation

DATA AND METHODOLOGY

The study examines the association between executive compensation and audit fees in the post-SOX period data from 2004 to 2012 selecting companies both from the U.S. and New Zealand. This study obtains the financial data for the firms under study from Compustat, and obtain audit fees and executive compensation data from the Audit analytics and ExecuComp &GMI rating database for the U.S. For the New Zealand sample, this study obtains the financial data from Global Vantage database, whereas audit fees and executive compensation were collected from respective company's annual reports. Overall, this study obtains an initial sample of 2276 (1257 and 1019 U.S., and New Zealand) firm-year observations for the period 2004 to 2012. From this sample, this study excludes all the foreign firms, dual listing firms, firms that do not have all years' data and pool the two samples based on total assets. This study selects firms of both the U.S. and New Zealand that have less than $ 400 million total assets for all the years as most of the New Zealand firms are small and medium-sized. The overall sample consists of 1170 firms (576 U.S. firm-years and 594 New Zealand firm-years) for the period 2004 to 2012. The overall sample consists of a balanced panel of 1170 firms (576 U.S. firm-years and 594 New Zealand firm-years) for the years 2004-2012. All the financial data reported in this study is in U.S. dollars. New Zealand firm's financials have been translated to U. S. dollars using appropriate exchange rates for all the years 2004 to 2012. Table 1 summarizes sample selection procedure, and Table 2 provides the sample distribution by the two digits Standard Industrial Classification (SIC) code.

Table 1: Sample Construction

Firms listed in S&P 600 and NZX from 2004 to 2012 (less than $400 million)	2,276
Less: Foreign firms	-121
Less: Dual listing	-257
Less: Firms with incomplete data	-353
Less: Firms with less than five observations in the industry	-375
Total Observations dropped	-1,106
Total Sample Size	1,170

This table shows sample selection of firms from the United States and New Zealand stock exchanges for the years 2004 to 2012

Table 2: Sample Distribution by Industry

Industry Description	Frequency	Percentage
Food	108	9.23%
Textiles, Printing/Publishing	108	9.23%
Chemicals	99	8.46%
Pharmaceuticals	117	10.00%
Durablemanufacturers	126	10.77%
Transportation	189	16.15%
Retail	198	16.92%
Services	108	9.23%
Computers	117	10.00%
Total	1170	100.00

This table shows sample distribution by Industry and all industry categories are based on two-digit industry SIC code.

Empirical Model

This study specifies and estimates OLS regression fee models based on prior audit fee research (e.g., Yezen et al. 2014; Hay and Knechel 2010; Venkataraman et al. 2008; Vermeer et al. 2008; Hay et al. 2006). All regressions are based on firm-level clustered robust (heteroscedasticity-consistent) standard errors since analysis includes repeated firm measures over time.

$$AUDFEE = \beta_0 + \beta_1 ACINDEP + \beta_2 ACEXP + \beta_3 Control + \varepsilon \quad \text{Model 1}$$

and

$$AUDFEE = \beta_0 + \beta_1 lnBASE + \beta_2 lnSTIC + \beta_3 STOCK \; \boldsymbol{or} + \beta_1 lnTOTCOMP + \beta_4 Control + \varepsilon \quad \text{Model 2}$$

Dependent Variable: Audit Fees

Following the prior audit fee literature (e.g., Yezen et al. 2014; Hay and Knechel 2010; Venkataraman et al. 2008; Vermeer et al. 2008; Hay et al. 2006), dependent variable of this study is measured as the natural logarithm of audit fees paid to the external auditor ($AUDFEE$).

Test Variables: Audit Committee Independence and Expertise, and CEO Compensation

This study uses the proportion of independent directors on the audit committee to the total audit committee members (ACINDEP), the proportion of accounting experts on the audit committee to total audit committee members(ACEXP) in Model 1. The BASE compensation (BASE) is defined as compensation that includes base cash elements and compensation taken as deferred compensation. This study uses lnBASE as BASE compensation measure. This study uses lnSTIC, as measures of total incentives offered to executives. Since most of the firms in New Zealand do not offer much of long-term incentives to chief executives, this study used only short-term incentives as a variable. However, since some of the U.S. firms offer long-term incentives, this study tests long-term incentives as a variable in sensitivity tests. Most of the New Zealand annual reports do not have detailed reports on the dollar value of different stock options available to the CEO's, and this study measured stock variable as a dichotomous variable. Stock option is a dichotomous variable 1 if the CEO of the company is offered stock options and 0 otherwise. Total compensation (TOTCOMP) is the sum of BASE compensation, and total incentive plans excluding stock option values. This study uses lnTOTCOMP as a measure of total compensation. These are tested in Model 2.

Corporate Governance and Other Control Variables

Carcello et al. (2002) report that corporate governance significantly influences audit fees. Consequently, this study draws on the prior literature (e.g., Vafeas and Waegelein, 2007; Abbott et al. 2003; Carcello et al. 2002; Wysocki. 2010) and include several corporate governance control variables in empirical models, unlike most prior research on executive compensation and audit fees. This study includes board size (BDSIZE = number of directors on the board), audit committee size (ACSIZE = number of directors on the audit committee), and compensation committee size (CCSIZE = number of directors on the compensation committee). This study also includes the proportion of independent directors on the board (BDINDEP), the proportion of independent directors on the compensation committee (CCINDEP). In Model 2, this study also includes audit committee variables (the proportion of independent directors on the audit committee (ACINDEP), and the proportion of accounting experts on the audit committee (ACEXP). Since earlier literature (Vafeas & Waegelein, 2007; Abbott et al. 2003; Carcello et al. 2002; Krishnan and Visvanathan, 2008) provide mixed evidence and most of the firms are medium and small sized, no sign is expected on the above variables.

This study also calculates the corporate governance index using board, audit, and compensation committee independence, audit committee meeting, accounting experts in audit committee, board and audit committee size, and duality (e.g., Bebchuk et al. 2009, Bhagat et al.2008). Based on the prior literature, this study measures these variables individually as 1 if they are above median and 0 otherwise. This study sums up all these measures and creates the CGINDEX which is measured as 1 if it is below the median of the sum of all corporate governance measures (stronger governance), and 0 (poor) otherwise.

This study control for firm size (SIZE = natural log of total assets), number of business and geographical segments (BUSSEG, GEOSEG), and the sum of accounts receivable and inventory scaled by total assets (ARINV). This study predicts a positive association for these variables with audit fees since client size, complexity, and other specific risk factors increases audit effort (Yezen et al. 2014; Hay et al. 2006). This study also includes the proportion of total long-term debt to total assets (LEVERAGE), the presence of an acquisition or merger in the year (MERGER), and the firm's market-to-book value (MB), anticipating a positive association with audit fees due to the effect of such market risks on audit risk (Hay et al. 2006). This study also controls for non-audit service fees (NONAUDFEE) as they have been shown to be positively associated with audit fees (Hay et al. 2006). This study includes audit firm size (BIGFOUR) to capture any associated fee premium and expect it to have a positive association with audit fees (Hay and Knechel, 2010). This study also includes industry (IND_FE), and year (YEAR_FE) indicator variables to control for industry and year fixed effects. This study defines all of these variables in Appendix A.

RESULTS

Table 3 provides the descriptive statistics for dependent and independent variables used in this study. The average audit fees of the firm (AUDFEE) is 587.64 thousand dollars (median 301.00) suggesting that the audit firms on an average (median) earn five hundred eight seven thousand dollars (301.00) as audit fee. The percentage of independent directors on the audit committee (ACINDEP) of the firm on an average is 0.84 (median 1.0), and the percentage of accounting expertise directors in the audit committee is 0.52

(median 1.0). The base compensation (BASE) earned by the CEO of the firm is 764.36 thousand dollars (median 428.00). Total short-term incentives (STIC) earned by the CEO of a firm on an average is 103.11 thousand dollars (median 52.18) The stock options (STOCK) awarded to the CEO of a firm on an average is 0.47 percentage (median 0.25). The total compensation (TOTCOMP) of the CEO of a firm on an average is 867.47 thousand dollars (median 480.18). Summary statistics on all other control variables are provided in Table 3.

Table 3: Descriptive Statistics (N=1170)

Variable Name	Mean	Median	Std Dev	Q1	Q3
AUDFEE ($000)	587.64	301.00	562.61	75.67	879.00
AUDFEE	8.99	5.67	4.41	4.83	13.94
ACINDEP	0.77	1.00	0.21	0.42	1.00
ACEXP	0.52	1.00	0.28	0.00	0.61
BASE ($000))	764.36	428.00	548.25	212.00	646.21
lnBASE	12.62	13.51	3.11	12.68	13.91
STIC ($000))	103.11	52.18	62.28	23.21	89.74
lnSTIC	3.69	0.00	4.97	0.00	9.56
STOCK	0.47	0.25	0.50	0.00	1.00
TOTCOMP ($000)	867.49	480.18	610.53	235.21	735.95
lnTOTCOMP	16.31	13.51	8.08	12.68	23.47
TA ($mil)	181.85	168.66	142.61	42.34	299.16
SIZE	4.67	5.48	1.52	3.87	5.90
ARINVTA	1.68	0.23	0.22	0.11	0.75
BUSSEG	1.33	1.00	0.43	1.00	1.73
GEOSEG	1.42	1.41	0.59	1.00	2.00
BDINDEP	0.65	0.67	0.19	0.50	0.80
CCINDEP	0.58	1.00	0.41	0.33	1.00
BDSIZE	2.46	2.00	2.48	2.00	4.00
ACSIZE	1.50	2.00	1.97	2.00	3.00
CCSIZE	1.50	2.00	1.88	1.00	2.00
NONAUDFEE ($000)	74.97	26.00	128.03	3.00	90.00
NONAUDFEE	4.34	0.13	5.48	0.01	10.85
MB	0.60	0.42	0.58	0.21	0.86
LEVERAGE	0.28	0.23	0.29	0.00	0.46
MERGER	0.21	0.15	0.34	0.00	0.42
BIGFOUR	0.82	1.00	0.68	1.00	1.00

This table shows sample mean. Median. Standard deviation, first quartile and third quartile for main test variables. All variable definitions are provided in Appendix A.

Correlation Analysis

Table 4 provides the Pearson and Spearman correlations between the independent variables. The Pearson correlations are reported above the diagonal and Spearman correlations below the diagonal. There are several high and significant Pearson and Spearman correlations, where the correlations are greater than 0.80 and significant at the 5percent level. The lnSTIC and lnTOTCOMP has a high correlation (0.92). Since these variables are of the same construct, they are not used in the same regression model. Variance inflation factors (VIF) (not disclosed) are in the range of 2 to 3 and these values rule out the presence of multicollinearity bias in hypothesis testing. Since the data involve similar companies over a period of nine years, this study also run the time series test for auto serial correlation and find that the Durbin-Watson coefficient is 1.914. Therefore, this study rejects the notion that the data are autocorrelated.

Table 4: Correlations: Pearson (Spearman) Correlation Coefficients in the Upper (Lower) Diagonal

Variable	1	2	3	4	5	6	7	8	9	10	11
AUDFEE (1)	1.00	**0.49**	-0.05	**0.43**	**0.58**	**-0.31**	**-0.29**	**0.26**	**0.51**	**0.54**	**0.33**
lnBASE (2)	**0.51**	1.00	-0.03	**-0.30**	**-0.26**	**0.28**	**0.36**	**-0.08**	**-0.22**	**-0.40**	**-0.30**
lnSTIC (3)	-0.03	-0.03	1.00	0.06	**0.09**	0.07	0.04	0.00	-0.04	-0.04	-0.02
STOCK (4)	**0.44**	**-0.37**	0.06	1.00	**0.55**	**-0.58**	**-0.61**	**0.23**	**0.36**	**0.42**	**0.46**
lnTOTCOMP (5)	**0.61**	**-0.40**	**0.09**	**0.59**	1.00	**-0.43**	**-0.48**	**0.24**	**0.30**	**0.36**	**0.43**
BDSIZE (6)	**-0.31**	**0.35**	0.07	**-0.57**	**-0.45**	1.00	**0.49**	**-0.15**	**-0.45**	**-0.44**	**-0.55**
ACSIZE (7)	**-0.33**	**0.42**	0.04	**-0.59**	**-0.52**	**0.33**	1.00	**-0.14**	**-0.48**	**-0.47**	**-0.56**
CCSIZE (8)	**0.22**	**-0.12**	0.00	**0.19**	**0.19**	**-0.13**	**-0.10**	1.00	**0.12**	**0.23**	**0.54**
BDINDEP (9)	**0.48**	**-0.31**	-0.04	**0.37**	**0.36**	**-0.45**	**-0.50**	**0.12**	1.00	**0.27**	**0.35**
ACINDEP (10)	**0.53**	**-0.39**	-0.06	**0.45**	**0.43**	**-0.48**	**-0.53**	**0.15**	**0.28**	1.00	**0.44**
CCINDEP (11)	**0.35**	**-0.37**	-0.04	**0.49**	**0.48**	**-0.59**	**-0.65**	**0.26**	**0.43**	**0.43**	1.00
ACEXP (12)	**-0.12**	**0.12**	0.06	**-0.11**	**-0.12**	**0.21**	**0.22**	0.03	**-0.21**	-0.01	-0.01
SIZE (13)	**0.52**	**-0.54**	-0.02	**0.48**	**0.58**	**-0.41**	**-0.49**	**0.14**	**0.36**	**0.39**	**0.42**
BUSSEG (14)	**0.29**	**-0.20**	0.03	**0.15**	**0.19**	**-0.11**	**-0.11**	**0.10**	**0.10**	**0.13**	**0.09**
GEOSEG (15)	**0.47**	**-0.21**	0.00	**0.32**	**0.40**	**-0.42**	**-0.40**	**0.19**	**0.25**	**0.32**	**0.41**
ARINV (16)	**-0.24**	**0.46**	-0.08	**-0.23**	**-0.23**	**0.11**	**0.16**	**-0.10**	**-0.10**	**-0.28**	**-0.14**
MB (17)	**0.32**	**-0.11**	-0.02	**0.32**	**0.30**	**-0.43**	**-0.46**	**0.23**	**0.21**	**0.27**	**0.38**
LEVERAGE (18)	**-0.40**	**0.37**	0.06	**-0.48**	**-0.37**	**0.61**	**0.65**	-0.07	**-0.43**	**-0.39**	**-0.48**
MERGER (19)	**-0.14**	**0.35**	-0.03	-0.02	**-0.14**	-0.02	0.00	-0.04	0.01	-0.06	-0.06
NONAUDFEE (20)	**0.57**	**-0.37**	-0.01	**0.34**	**0.35**	**-0.49**	**-0.49**	**0.16**	**0.33**	**0.32**	**0.46**
BIGFOUR (21)	**0.38**	**-0.21**	0.02	**0.35**	**0.39**	**-0.20**	**-0.27**	**0.13**	**0.18**	**0.19**	**0.20**
Variable	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
AUDFEE (1)	**-0.22**	**0.51**	**0.26**	**0.31**	**-0.36**	**0.43**	**-0.39**	-0.07	**0.51**	**0.35**	**-0.22**
lnBASE (2)	0.07	**-0.52**	**-0.21**	**-0.12**	**0.51**	**-0.09**	**0.31**	**0.45**	**-0.38**	**-0.20**	0.07
lnSTIC (3)	0.06	0.01	0.01	0.00	-0.02	-0.03	0.05	-0.03	-0.04	0.02	0.06
STOCK (4)	**-0.11**	**0.43**	**0.17**	**0.21**	**-0.30**	**0.30**	**-0.41**	-0.02	**0.52**	**0.35**	**-0.11**
lnTOTCOMP (5)	**-0.15**	**0.40**	**0.18**	**0.28**	**-0.21**	**0.25**	**-0.27**	-0.08	**0.44**	**0.28**	**-0.15**
BDSIZE (6)	**0.22**	**-0.37**	**-0.16**	**-0.28**	**0.23**	**-0.43**	**0.50**	-0.02	**-0.73**	**-0.20**	**0.22**
ACSIZE (7)	**0.23**	**-0.48**	**-0.18**	**-0.27**	**0.28**	**-0.46**	**0.56**	0.01	**-0.75**	**-0.29**	**0.23**
CCSIZE (8)	**0.10**	**0.15**	**0.09**	**0.16**	**-0.16**	**0.20**	-0.08	-0.01	**0.23**	**0.14**	**0.10**
BDINDEP (9)	**-0.20**	**0.28**	**0.12**	**0.15**	**-0.14**	**0.20**	**-0.39**	0.01	**0.44**	**0.16**	**-0.20**
ACINDEP (10)	0.01	**0.41**	**0.14**	**0.21**	**-0.35**	**0.25**	**-0.32**	**-0.11**	**0.41**	**0.16**	0.01
CCINDEP (11)	0.06	**0.37**	**0.13**	**0.29**	**-0.35**	**0.32**	**-0.30**	-0.05	**0.55**	**0.18**	0.06
ACEXP (12)	1.00	**-0.10**	-0.06	-0.02	-0.02	**-0.19**	**0.24**	-0.04	**-0.19**	**-0.12**	1.00
SIZE (13)	**-0.12**	1.00	**0.29**	**0.17**	**-0.52**	**0.13**	**-0.39**	**-0.45**	**0.50**	**0.39**	**-0.12**
BUSSEG (14)	-0.03	**0.31**	1.00	0.02	**-0.10**	0.01	-0.06	**-0.15**	**0.24**	**0.12**	-0.03
GEOSEG (15)	-0.04	**0.27**	0.04	1.00	**-0.11**	0.04	**-0.12**	0.03	**0.29**	**0.13**	-0.04
ARINV (16)	-0.01	**-0.40**	-0.05	**-0.15**	1.00	-0.06	**0.15**	**0.18**	**-0.28**	**-0.18**	-0.01
MB (17)	**-0.20**	**0.16**	-0.05	**0.20**	0.01	1.00	**-0.36**	-0.05	**0.30**	**0.20**	**-0.20**
LEVERAGE (18)	**0.24**	**-0.36**	0.00	**-0.28**	**0.10**	**-0.45**	1.00	0.07	**-0.48**	**-0.26**	**0.24**
MERGER (19)	-0.04	**-0.34**	**-0.16**	0.02	**0.20**	0.00	0.02	1.00	-0.07	-0.05	-0.04
BUSY (20)	**-0.10**	**0.46**	**0.21**	**0.34**	**-0.19**	**0.17**	**-0.34**	**-0.11**	1.00	**0.26**	**-0.10**
NONAUDFEE (21)	**-0.12**	**0.35**	**0.11**	**0.19**	-0.05	**0.24**	**-0.28**	-0.05	-0.08	1.00	**-0.12**
BIGFOUR (22)	**-0.22**	**0.51**	**0.26**	**0.31**	**-0.36**	**0.43**	**-0.39**	-0.07	**0.51**	**0.35**	**-0.22**

This table shows Pearson (upper) and Spearman (lower) correlations diagonally. All variables are defined in Appendix A. Bold coefficients are significant at p<0.05.

Test of Hypotheses

In this section, this study report and review the results of OLS regressions followed by sensitivity tests. The first sets of tests are based on hypothesis model. This study test different measures of the chief executive officers' compensation components. Table 5 tests association between natural logs of audit fees and audit committee independence and expertise. The adjusted R2 across all models are similar to prior research (e.g., Choi et al. 2008; Engel et al. 2010; Wysocki, P. 2010) and the all the models are significant (p<0.01).

Hypotheses 1 and 2 -Audit Fees and Audit Committee Independence and Expertise

The coefficient on all audit committee independent percentage (ACINDEP) is not significant suggesting that audit committee independent percentage is not associated with audit fees. The coefficient on audit committee expert percentage (ACEXP) is positive and significant (β=0.154, t=3.425, p<0.01/) in the full sample test indicating that audit committee expert percentage is positively associated with audit fees as reported in earlier studies (e.g., Vafeas and Waegelein (2007). The coefficient on audit committee expert percentage (ACEXP) is positive and significant in the subsample tests. (β=0.112, t=2.605, p<0.01, and β=0.143, t=2.012, p<0.05,) This indicates that even in firms that have strong or poor governance measures the audit committee expert percentage is positively and significantly associated with audit fees. The audit committee experts demand a higher audit effort from the audit firms for the audit fee premium. The coefficients on interaction variable (REGION* ACIND) is not significant in any of the tests suggesting that audit committee independence is not a determinant of audit fees either in the U.S. or New Zealand. The results do not support hypothesis H1. However, the coefficients on (REGION*ACEXP) is positive and significant (β=0.048, t=2.587, p<0.01) in the main sample suggesting that in the U.S. audit committee experts demand a higher effort from the audit firm than their counterparts in New Zealand supporting hypothesis H2. The results are consistent with earlier studies results (Vafeas and Waegelein 2007; Abbott 2003).

Table 5: Regressions of Audit Fees on Audit Committee Independence and Expertise ($AUDFEE = \beta_0 + \beta_1 ACINDEP + \beta_2 ACEXP + \beta_3 Control + \varepsilon$)

	Coeff	t Value	Coeff	t Value	Coeff	t Value
INTERCEPT	3.715	21.423***	3.767	19.810***	3.075	14.517***
ACINDEP (+/-)	0.122	0.968	0.049	0.336	0.037	0.150
ACEXP (+/-)	0.151	3.425***	0.112	2.605***	0.143	2.012**
REGION × ACIND (?)	-0.017	-0.608	-0.031	-0.961	0.062	1.117
REGION × ACEXP (?)	0.048	2.587***	0.041	1.965**	0.059	1.431
SIZE (+)	0.310	3.511***	0.271	3.401***	0.714	3.124***
ARINV (+)	0.002	0.375	0.001	0.094	-0.005	-0.435
BUSSEG (+)	0.178	3.583***	0.201	4.734***	0.102	1.199
GEOSEG (+)	0.120	1.987**	0.127	2.168**	0.028	0.618
BDSIZE (?)	0.069	3.587***	0.071	3.657***	0.004	0.131
ACSIZE (?)	0.001	0.034	0.027	0.783	0.074	1.412
BDINDEP (?)	0.061	0.515	0.087	0.897	0.051	0.268
NONAUDFEE (+)	0.017	2.321**	0.015	2.179**	0.039	2.812***
MB (+)	-0.148	-3.610***	-0.115	-2.687***	-0.049	-0.486
LEVERAGE (+)	0.391	4.341***	0.349	3.689***	0.287	1.611
BIG4 (+)	0.164	2.329**	0.241	3.189***	-0.013	-0.105
REGION	0.461	5.188***	0.318	4.180***	0.267	3.056***
CGIND (?)	0.171	2.817***	-	-	-	-
REG*CGIND ((?)	0.068	3.873***	-	-	-	-
YEAR_FE	YES		YES		YES	
IND_FE	YES		YES		YES	
N	1170		761		409	
F value	48.611***		25.941***		13.701***	
R Squared	0.815		0.798		0.774	
Adj. R-Square	0.801		0.781		0.766	

*This table shows regression results of audit fees on audit committee independence and accounting expertise for the full sample (1170) and partitioned sample for strong (798) and weak (409) governance. *, **, *** denote significance at the 0.10, 0.05, and 0.01 levels, respectively. Directional tests are one-tailed, otherwise two-tailed. This study estimates the OLS regression models with firm-level clustered robust (heteroscedasticity-consistent) standard errors. All variables are defined in Appendix A.*

In Table 6 this study reports the results of base, incentive and stock option of CEO and audit fees on the main sample and subsamples. The coefficient on BASE payments to executives (lnBASE) is not significant suggesting that base compensation of the chief executive officer is not associated with audit fees. The coefficient on BASE payments to executives in both the countries (REGIONS*lnBASE) is not significant suggesting that base compensation of the chief executive officer is not associated with audit fees in both the countries. Thus, the null hypothesis of H3 cannot be rejected. The coefficient on short-term incentives (lnSTIC) is positive and significant (β=0.012, t=2.018, p<0.05) is positive and significant indicating that audit firms consider incentives received by the chief executive officer of such firms as an audit risk and charge higher audit fees. Study results are consistent with earlier studies results (e.g., Kim et al. 2014; Yezen et al. 2014). The coefficient on stock payments to executives in both the countries (REGIONS*STOCK) is not significant suggesting that stock options of the chief executive officer are not associated with audit fees in both the countries. Since most of the sample firms are small and medium-sized firms and do not offer much stock options to the executives, the stock option is not a significant determinant of audit fees in this study. The coefficients on the total executive compensation (*TOTCOMP*) is positive and significant (β=0.01, t=2.254, p<0.05). Results for *STIC* is positive and significant in both regions (the U.S., and N.Z) suggesting that this study result may be driven by the short-term incentives and support hypotheses H4, and H6 but reject H5.

Table 6: Regressions of Audit Fees on Base Salary, Short-Term Incentive, and Stock Option Compensation ($AUDFEE = \beta_0 + \beta_1 lnBASE + \beta_2 lnSTIC + \beta_3 STOCK + \beta_5 Control + \varepsilon$)

Variable (Predicted Sign)	lnBASE, lnSTIC & STOCK Full Sample		lnBASE, lnSTIC & STOCK CGI =1 (Strong)		lnBASE, lnSTIC & STOCK CGI = 0 (Weak)	
	Coeff	T Value	Coeff	t Value	Coeff	t Value
INTERCEPT	3.507	17.213***	3.505	13.953***	3.873	10.440***
lnBASE (?)	0.008	1.101	0.006	0.637	-0.019	-0.784
lnSTIC (?)	0.012	2.018**	0.011	1.981**	0.013	1.254
STOCK (?)	0.012	1.234	0.011	1.011	0.009	0.513
REGION*lnBASE (?)	-0.005	-0.991	-0.004	-0.698	-0.005	-0.439
REGION * lnSTIC (?)	0.003	0.424	0.007	0.745	-0.013	-0.845
REGION * STOCK (?)	-0.006	-0.748	-0.005	-0.530	-0.006	-0.278
SIZE (+)	0.021	4.129***	0.020	3.663***	0.039	3.457***
ARINV (+)	0.000	0.097	0.001	0.157	0.000	0.038
BUSSEG (+)	0.019	4.079***	0.021	4.161***	0.009	0.940
GEOSEG (+)	0.008	2.014**	0.009	1.978**	0.006	0.640
BDSIZE (?)	0.038	3.512***	0.043	3.350***	-0.001	-0.059
ACSIZE (?)	0.009	0.649	-0.009	-0.555	0.055	2.297
BDINDEP (?)	0.003	0.493	0.004	0.650	0.001	0.113
ACINDEP (?)	0.006	1.127	0.002	0.414	-0.008	-0.680
ACEXP (?)	0.015	3.164***	0.011	2.126**	0.016	1.565
CCINDEP (?)	0.021	3.020***	0.017	2.250**	0.023	1.539
NONAUDFEE (+)	0.020	2.549***	0.022	2.634***	0.054	2.956***
MB (+)	-0.020	-3.752***	-0.015	-2.644***	-0.003	-0.277
LEVERAGE (+)	0.023	3.911***	0.021	3.232***	0.020	1.691*
BIG4 (+)	0.010	2.115**	0.015	2.798***	0.001	0.078
REGION (?)	0.610	8.303***	0.049	5.450***	0.481	5.098***
CGIND (?)	0.244	4.376***	-	-	-	-
REG*CGIND (?)	0.066	3.371***	-	-	-	-
YEAR_FE	YES		YES		YES	
IND_FE	YES		YES		YES	
N	1170		761		409	
F value	79.236***		48.911***		35.248***	
R Square	0.836		0.829		0.820	
Adj. R-Square	0.820		0.812		0.809	

*This table shows regression results of audit fees on base salary, short-term incentives and stock options for the full sample (1170) and partitioned sample for strong (798) and weak (409) governance. *, **, *** denote significance at the 0.10, 0.05, and 0.01 levels, respectively. Directional tests are one-tailed, otherwise two-tailed. This study estimates the OLS regression models with firm-level clustered robust (heteroscedasticity-consistent) standard errors. All variables are defined in Appendix A.*

Table 7: Regressions of Audit Fees on Total Compensation ($AUDFEE = \beta_0 + + \beta_1 lnTOTCOMP + \beta_2 Control + \varepsilon$)

Variable (Predicted Sign)	lnTOTCOMP Full Sample		lnTOTCOMP CGI =1 (Strong)		lnTOTCOMP CGI = 0 (Weak)	
	Coeff	t Value	Coeff	t Value	Coeff	t Value
INTERCEPT	3.638	24.810***	3.721	16.287***	4.236	14.001***
lnTOTCOMP (?)	0.008	1.757*	0.007	1.811*	0.017	1.259
REGION*lnTOTCOMP (?)	-0.005	-0.991	-0.004	-0.698	-0.005	-0.439
SIZE (+)	0.020	3.999***	0.019	3.521***	0.037	3.364***
ARINV (+)	0.000	0.000	0.001	0.145	0.000	-0.010
BUSSEG (+)	0.019	4.117***	0.022	4.273***	0.010	1.082
GEOSEG (+)	0.007	2.191**	0.008	2.033**	0.004	0.430
BDSIZE (?)	0.038	3.470***	0.043	3.339***	0.005	0.245
ACSIZE (?)	0.008	0.636	-0.009	-0.566	0.050	2.125
BDINDEP (?)	0.002	0.369	0.003	0.482	0.001	0.110
ACINDEP (?)	0.007	1.253	0.004	0.641	-0.008	-0.662
ACEXP (?)	0.016	3.372***	0.012	2.327**	0.017	1.685*
CCINDEP (?)	0.021	3.009***	0.018	2.371**	0.021	1.421
NONAUDFEE (+)	0.019	2.429***	0.020	2.404***	0.053	2.905***
MB (+)	-0.021	-3.986***	-0.018	-3.079***	-0.004	-0.358
LEVERAGE (+)	0.021	3.732***	0.019	3.000***	0.019	1.645**
BIG4 (+)	0.012	2.615***	0.017	3.150***	0.005	0.508
REGION (?)	0.045	8.506***	0.51	6.325***	0.059	7.215***
CGIND (?)	0.235	5.126***				
REG*CGIND (?)	0.068	3.214***				
YEAR_FE	YES		YES		YES	
IND_FE	YES		YES		YES	
N	1170		761		409	
F value	82.112***		49.632***		37.987***	
R Square	0.840		0.831		0.822	
Adj. R-Square	0.827		0.816		0.810	

*This table shows regression results of audit fees on total compensation for the full sample (1170) and partitioned sample for strong (798) and weak (409) governance. *, **, *** denote significance at the 0.10, 0.05, and 0.01 levels, respectively. Directional tests are one-tailed, otherwise two-tailed. This study estimates the OLS regression models with firm-level clustered robust (heteroscedasticity-consistent) standard errors. All variables are defined in Appendix A.*

<u>Audit Fees and Audit Committee Independence and Expertise, and CEO Compensation in Stronger and Weaker Corporate Governance Environments</u>

Based on earlier discussions that corporate governance codes vary between the U.S. and N.Z, this study considers if the association is conditional on firms' corporate governance. This study calculates the median values for BDSIZE, ACSIZE, CCSIZE, BDINDEP, ACINDEP, CCINDEP, and ACEXP and subtracts them from the actual values for each of these variables. An indicator variable is created with a value of 1 if this difference falls above the median, and 0 otherwise. These indicator variables are aggregated to compute the total corporate governance score for each firm. Similarly, compute the median for this aggregated variable and subtract it from the actual aggregated values to establish Corporate Governance Index (CGI). CGI as 1 is measured as 1 (stronger governance) if the firm's score falls above the median, and 0 otherwise (weaker governance) (e.g., Bebchuk et al. 2009, Bhagat et al. 2008).

This study re-estimates regressions on partitions of sample into stronger and weaker governance clients and present the results side by side in Tables 5 to 7. In Table 5 results indicate that the coefficients on (REGION*ACEXP) are positive and significant (β=0.041, t=1.965, p<0.01) for firms that have stronger corporate governance measures. Study results suggest that in the U.S. due to stricter regulations in the post-SOX period and risk associated with SOX regulations audit committee experts demand a higher effort from the audit firms by paying a premium for their increased effort. Results for components of CEO compensation base (BASE), short-term incentive (STIC), and stock option (*STOCK*) show mixed results. The coefficients on all base salary measures (*lnBASE, and STOCK*) remain insignificant in both stronger and weaker governance. However, in Table 6, short-term incentives (*lnSTIC)* in the main sample showed positive and significant results suggesting that incentive payments to executives in both the countries as the coefficients on *REGIONS*lnSTIC* are not significant. This result is evident only in firms that report stronger governance measures (β=0.011, t=1.981, p<0.05). The short-term incentive is considered as audit risk invariably in both the countries.

The coefficient on *TOTCOMP* is positive and significant (β=0.019, t=2.141 p<0.05) for firms that report stronger governance measures suggesting that the audit firms consider total compensation of a firm as a risk factor and charge a premium. This result is contrary to the expectation that poor governance measures of a firm pose a risk to audit firms thereby they charge higher audit fees. In this study, incentives are considered as a risk factor as reported in Table 6. The coefficient on total compensation (*REGION*lnTOTCOMP*) is positive and significant (β=0.008, t=1.757, p<0.10) in the main sample suggesting that in the U.S. audit firms consider total compensation of a firm as a risk factor and charge a premium. For firms that report stronger governance measures (β=0.007, t=1.811, p<0.10) in the U.S. audit firms consider total compensation as an audit risk and charge higher fees. Since the total compensation along with incentives is higher in firms that reported stronger governance measures than the firms that reported weaker governance measures, total compensation shows a positive and significant association with audit fees.

Sensitivity Tests

For greater confidence in results, this study conducts several sensitivity analyses. First, given auditors may learn more about CEO compensation risks over the course of the current year audit that could impact the following year's audit pricing, this study re-performs all of the regressions using audit committee independence and accounting expertise and current year compensation measures and next year audit fees. The results are not tabulated. This study partitions the sample into Big4 and non-Big4 auditors and the results (not reported) are inconsistent with results reported in Table 5 to 7 and are as expected with earlier studies results (Choi et al. 2008). The Big4 audit firms in both the countries charge audit premium when the audit firm's expertise percentage is higher in the post-SOX period. Post Sox Big4 firms in both the countries have increased the audit effort at a premium. Similarly, the incentives show a positive and significant association with audit fees for firms that are audited by Big4 firms. The firms of this study are mostly small firms and audit firms consider incentives offered as a greater audit risk and thereby charge higher audit fees. This study does not find any evidence for Big4 firms charging premium mainly in the U.S. as evidenced in Choi et al. (2008).

This study conducts further tests to test the association audit fees with chief executive officers' compensation components by replacing the log measure with *ABASE, ASTIC, ATOTCOMP* (average industry measures) *MBASE, MSTIC, MTOTCOMP* (median measures). The results (not reported) are inconsistent with results reported earlier in Tables 5 to 7, but the significance level varies (p<0.10). Similarly, this study tested long-term incentives (*LNLTINC*) as a test variable along with other incentives and results are insignificant due to low incidence. Such results are on the expected lines as many smaller firms do not offer long-term incentives to their CEO's. The results of this study are consistent across current audit fees and next year audit fees for all the audit committee independence and expertise, base, incentive, stock options, and total compensation measures. The results of endogeneity tests are also largely consistent with the main results. The consistency in the results strengthens the validity of the results and inferences drawn thereupon.

To sum up, the results of audit committee expertise suggest that in the U.S. the audit committee experts demand a better audit to cover the enhanced risk on the board of directors and pay a premium. Moreover, as expected the corporate governance measures are more effective in for the U.S. firms as this study find the *REGION*CGI* is positive and significant in most of the Tables (5 to 7). This study provides evidence to the findings of Vafeas and Waegelein, 2007 and host of other researchers (e.g., Choi et al. 2008; Engel at al. 2010; Kim et al. 2014; Anthony et al.2014; Yezen et al.2014).

CONCLUSION

Corporate governance measures in the U.S. vary from other countries due to its mandatory nature. In such setting, audit firms exercise care as any mistake may affect their reputation. Moreover, audit committees also play an important role in the determination of audit and non-audit work. The increasing focus on executive compensation in the U.S. and N.Z has highlighted the risk attached to the various CEO compensation. The audit firms are also advised by PCAOB and IFAC to carefully evaluate client executive compensation arrangements in the context of the financial statement audit. A stream of research studies also provide evidence to support the views expressed by the regulators (Chen et al. 2015; Kim et al. 2014; Billings et al. 2013; Yezen et al. 2014; Ananthanarayanan et al. 2017).

This study investigates the audit fee determinants in countries that have a similar background in accounting and auditing standards but vary in regulations. Observing 1170 small and medium-sized firms in both U.S., and New Zealand this study empirically tests the model used by Choi et al. (2008). Results suggest that in the U.S. firms the corporate governance measures are stronger than similar firms of New Zealand. Moreover, firms with stronger governance audit committee experts demand a better-quality audit from audit firms by paying a premium. Short-term incentives are construed as an audit risk factor in both the countries probably due to the size of the firms. This study does not find any evidence for Big4 segmentation premium as Big4 firms in both countries charge a higher audit fee when incentives are offered to the CEO in the post-SOX period, and the results are consistent with earlier studies (Choi et al. 2008: Winsocki 2010; Ananthanarayanan et al. 2017).

This study extends both the U.S. and New Zealand literature on audit fee determinants. This study is the first to expand the current U.S. CEO compensation and audit fee research to the N.Z. environment specifically, and to non-U.S. settings generally, with evidence suggesting that auditors are pricing client CEO compensation incentives even in a smaller non-U.S. market. Second, this study also finds that mandatory corporate governance is more effective in the U.S. and policymakers in N.Z should implement such measures. Third, this study informs N.Z. stakeholders of the relative importance of corporate governance measures in mitigating their concerns surrounding CEO compensation, with results supporting arguments for greater corporate governance reform. A point of interest of this study is to see how the enhanced audit and governance regulations under SOX affect audit fees through their effects on audit risk in two different settings for small and medium-sized companies.

The scope of this study is mainly limited to three issues. First, the study focuses on the effects of audit committee independence and expertise, and executive compensation on audit fees. These are related corporate governance measures and are perceived to have direct effects on audit fees, rather than indirect effects as perceived in earlier studies (e.g., Bedard, Chtourou, and Courteau 2004; Griffin et al. 2008; Choi.et al 2008). Second, the study examines the effects of these corporate governance measures on audit fees in the post-SOX era. Finally, the sample of this study consists of small firms based on a relative measure namely value of total assets. In sum, results suggest that future studies should pay more attention to country level specifics and include such variables in their audit fee settings. Studying firms of countries which have similar auditing and accounting backgrounds over a longer period would be productive.

APPENDIX

Appendix A: Operational Definition of Variables

Dependent Variables		
AUDFEE	=	natural logarithm of total audit fees paid by the client to the external auditor
Test Compensation Variables		
lnTOTCOMP	=	natural logarithm of total CEO compensation
lnBASE	=	natural logarithm of CEO base salary compensation
lnSTIC	=	natural logarithm of CEO short-term incentive compensation, including annual bonus, spot rewards, and retention bonus
STOCK	=	1 if the firm provides CEO stock option compensation, 0 otherwise
ACINDEP	=	the proportion of independent directors on the firm's Audit Committee
ACEXP	=	the proportion of accounting experts on the firm's Audit Committee
Governance Variables		
BDSIZE	=	number of directors on the firm's Board of Directors
ACSIZE	=	number of directors on the firm's Audit Committee
CCSIZE	=	number of directors on the firm's Compensation Committee
BDINDEP	=	the proportion of independent directors on the firm's Board of Directors
CCINDEP	=	the proportion of independent directors on the firm's Compensation Committee
Additional Control Variables		
SIZE	=	natural logarithm of firm's total assets
GEOSEG	=	number of firm's geographic segments
BUSSEG	=	number of firm's business segments
ARINV	=	the sum of accounts receivable and inventory scaled by total assets
MB	=	firm's market price per share to book value per share ratio
LEVERAGE	=	total long-term debt scaled by total assets
MERGER	=	1 if the firm had a merger or an acquisition during the year, 0 otherwise
NONAUDFEE	=	natural logarithm of total non-audit fees paid by the firm to the auditor
BIGFOUR	=	1 if the client's external auditor is a Big 4 auditor, 0 otherwise
YEAR_FE	=	year fixed-effects indicator variable
IND_FE	=	industry fixed-effects indicator variable
REGION	=	1 if the firm is from the U.S. and 0 otherwise

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DATA AVAILABILITY

All data are publicly available from sources identified in the text.

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TAIWAN AND U.S. EQUITY MARKET INTERDEPENDENCE AND CONTAGION: EVIDENCE FROM FOUR-FACTOR MODEL

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ABSTRACT

A four-factor model is used to measure the interdependence's co-movement and crisis' contagion effect on portfolio returns of 23 Taiwanese industries during tranquil and the U.S. subprime mortgage crisis periods. By incorporating the control variables of economic and financial fundamentals, we deconstruct the relevance of returns on industrial assets' channels. The empirical results show that the co-movement effect on Taiwan's industrial portfolios returns are affected by "global," "regional," and "domestic" factors. Additionally, in the subprime mortgage crisis period, the contagion effect of Taiwan's industrial portfolios returns was affected by the domestic and crisis factor. Based on our empirical study, the transmission of Taiwan's industrial portfolio returns channel is significantly impacted by the instrument variables of interest rate, trade integration, political stability, and government budgets of the economy fundamentals.

JEL: G12, G15

KEYWORDS: Co-Movement, Contagion, Financial Crisis, Factor Model

INTRODUCTION

Increasing globalization and networkization raises the importance of mutual relationship among various countries. Most countries intend to establish regional economic cooperation to improve relationships and guarantee their interests. For example, countries attempt to improve regional economic integration through alliances such as the EU, CPTPP (Comprehensive and Progressive Agreement for Trans-Pacific Partnership, formerly known as the Trans-Pacific Partnership (TPP)), RCEP, and B&R (Belt and Road known as the Silk Road Economic Belt and the 21st-Century Maritime Silk Road). Such alliances have affected the relationship between countries in recent years. However, some countries have adopted anti-alliance propositions, such as the Grexit of Greece, Brexit of the United Kingdom (the U.K.), and President Trump's decision to withdraw the United States of America (U.S.) from the Trans-Pacific Partnership (CPTPP) Agreement. Overall, strengthening alliances among countries influences financial and trade markets and impacts mutual economies. Several studies in finance examine the transmission effect. Taiwan enjoys significant specialization, as it is located at the center of the Asia-Pacific region, special geopolitical ties, high volume trade, high inflows, and outflows of capital, and high degree of trade dependence. Therefore, Taiwan is a more efficient capital market with an open financial policy. However, in comparison to other countries, Taiwan, the RCEP, and CPTPP members do not have the advantages of regional economic integration, such as preferential tariffs, and the elimination of financial and trade barriers.

The U.S. has been an important trade and strategic partner of Taiwan. The trade volume between Taiwan and the U.S. was 62.1 billion USD in 2016, which was 12.34% of Taiwan's total trade volume. Taiwan has very close relations with the U.S. in terms of high frequent trading. As the U.S. has long been a leader in the international financial market, it also has significant influence on Taiwan and is one of most important partners of Taiwan. Therefore, the motivation of this study is to explore whether Taiwan's industrial returns are affected by including partner-U.S. factors other than global, regional, and domestic factors.

Based on Bekaert, Ehrmann, Fratzscher, and Mehl (2014), this study examines the transmission phenomena in Taiwan. The first contribution of this study is different from the analysis of Bekaert et al. (2014) of a global co-movement and contagion based on global cross-country/regional industry portfolio returns. However, this study focuses on the transmission effect of only Taiwan's individual industry returns. The second feature of this study is the continuation of the three-factor model of Bekaert et al. (2014), with the addition of transmission factors from special partner countries as a four-factor model by exploring global, regional, partner countries, and domestic factors for their own national transmission effectiveness. Overall, this study, through a four-factor model coupled with the U.S. subprime mortgage crisis, understands that the industry return in Taiwan continues to have the co-movement and contagion effect during all sample and crises periods. Therefore, this study is contributes to the examination of the transmission effect of a single country.

The introduction section explores the study's background and motivation, followed by the literature review. The third section presents the data and methodology and the fourth section details the results and discussion. The final section concludes the paper.

LITERATURE REVIEW

The transmission argument begins with King and Wadhwani (1990) discussing the effect of co-movement of financial assets, which analyzes the correlation of returns between the U.S., the U.K., and Japan in the 1987 stock market crash period. Although in different economic environments, they find a market transmission phenomenon among these countries with their stock markets falling simultaneously, where one country's domestic market turmoil is the result of market fluctuations in the other countries. Additionally, they find that the markets fluctuated violently after October 1987. Since, the transmission phenomenon has been widely explored, particularly during crises periods.

Forbes and Rigobon (2002) compare the correlation of cross-sector assets return between full and crisis periods. They define "co-movement" as the transmission in full periods, including tranquility and crisis periods. Alternatively, "contagion" is the significant increase in transmission after the shock attack period. In other words, "contagion" is a significant increase in "co-movement" during a crisis period. They adopt a correlation coefficient heterogeneity bias model and conclude that there is a highly interdependent co-movement effect among all markets in all periods.

In addition to Forbes and Rigobon's (2002) correlation coefficient heterogeneity bias model, Bekaert, Harvey, and Ng (2005) propose a factor assets pricing model and define transmission as the correlation between residuals. They used global and regional stock price indices to establish a factorial model and converted these factors into a relationship through a mechanism. The relationship is called the exceed correlation factor and is beyond economic fundamentals. Furthermore, it increases correlation and factor volatility. The magnitude of increasing the correlation is determined by the factor loading. For example, if the international transmission channel collapses, resulting in weakened international transmission and increased domestic transmission, the international correlation will reduce and the domestic correlation will increase. Therefore, observing factor loadings by controlling time-variant economic or financial variables helps understand the transmission phenomenon through factors and channels.

Several studies discuss the transmission of financial crisis. For example, Rigobon (2003) explored the Mexico Tequila crisis. In addition, Baig and Goldfajn (1999), Kaminsky and Reinhart (2000), Dungey, Fry, González-Hermosillo, and Martin (2006), Dooley and Hutchison (2009), and Longstaff (2010) discuss the transmission of financial crisis.

Governments adopt an aggressive monetary policy for financial bailouts in the aftermath of crisis. For example, the U.S. QE (Quantitative easing) is an unconventional monetary policy operated by a country's monetary authority (generally the central bank) through open market operations to increase the money supply in the real economy. Additionally, Japan's Abenomics are aggressive monetary policies that devaluate the domestic currency in order to enhance international competitiveness and boost the economy, but also indirectly affect the economies of their partner countries, forming the so-called "Beggar-Thy-Neighbor concept." Forbes and Rigobon (2002) empirically examine the "contagion" effect. In addition to exploring the crisis impact during the crisis period, they also explore various channels of shock transmission. Such channels include the strength of foreign trade, similarity among the countries' economic constitutions, financial weaknesses, and investor behaviors. Various channels affect the transmission effect differently. Bekaert, Harvey, and Ng (2005) define that the transmission among markets is more relevant than the economic fundamentals. In addition, they find that some mechanisms link the correlation between economic fundamentals and asset returns, particularly during crisis periods. However, there is considerable disagreement on the definition of economic fundamentals through which the transmission between countries is linked to the return on assets. Bekaert et al. (2014) use a number of control variables based on different hypotheses to explore the transmission channels. In addition, we use some of those relevant proxy control variables to explore the transmission channel as follows:

1. Financial institutions exposure hypothesis: Currencies circulate through monetary lending of financial institutions. Multinational financial institutions are important channels for the securities markets. Bekaert et al. (2014) state that financial institutions can impose financial constraints and adjust interest rates to affect the exposure of industrial transmission factors. They consider that financial liberalization will lead to changes in the quality of financial institutions, such as the stock market and banking industry. Therefore, liberalization will increase investment efficiency and affect the degree of transmission risk. Caramazza, Ricci, and Salgado (2004) explore financial linkage and the crises contagion, and find that financial correlation played an important role in the contagion in the Mexican, Asian, and Russian crises. Moreover, emerging markets with strong links to countries that bear the crisis will significantly increase the possibility of transmission. Kaminsky and Reinhart (2000) study the transmission mechanism of spillover effects and establish a crisis contagion model, which is analyzed by the cross-market influence of the linkage between the financial sector and the effect of international bank loans. Broner, Gelos, and Reinhart (2006) and Boyer, Kumagai, and Yuan (2006) examine that certain international funds with bilateral investments in the U.S. and outside the U.S. are forced to reduce international investments in overseas markets during crises. As a result, such international funds generate negative returns on global investment portfolios and create serious spillover effects.

2. Globalization hypothesis: Through the flow of assets, integration of financial and trade, and exchange rate variation form a linkage, which leads to the transmission phenomenon. First, Boyer, Kumagai, and Yuan (2006) empirically find evidence that crisis spreads globally through the flow of assets. It leads to a high degree of equity returns co-movement in emerging markets. Further, the globalization of economic integration has increased the exposure of transmission factors. On the other hand, there is significant decoupling between the financial industry and the exposure of transmission factors under anti-globalization. Several studies examine the integration of finance and trade, such as Forbes and Chinn (2004), which investigates the bilateral relations between the five largest economies and other markets to study their market relations. They find that the change of capital or trade among the global big powers often have a significant impact on other financial markets. Therefore, bilateral direct trade continues to be the most important factor in the co-movement of stock market returns. Baele (2005) and Bekaert and Harvey (1997) find that higher the integration level of a country's global or regional trade, the more transmission exposure there is with one's global or regional stock market return. Frankel and Rose (1998) also find a closer trade

link among countries, which will also lead to higher cross-border stock markets return under a similar economic cycle. Glick and Rose (1999) study transmission in the currency crisis and find that the alliance of the relevant countries could be tied by international trade to produce a mutually transmission effect. In addition, Bekaert and Harvey (1995) find that an open economy establishes broad links with global financial markets; Mendoza and Quadrini (2010) empirically study that more than half of the non-financial sector's net borrowing in the U.S. comes from foreign loans. When a market collapses, the impact of bank capital leads to the financial assets price spillover. The mark-to-market mechanism results in greater impact and a vicious circle. Consequently, opening up to trade and finance will speed up transmission and weaken the industry with higher financial and economic integration under the impact of the crisis. Consequently, they observe that globalization plays an important role in financial crisis. In addition, Bekaert and Harvey (1995) demonstrate that financial openness has some relation with transmission. They consider international financial assets and liabilities to be an index of financial integration, and use the size and market value of securities markets as financial depth indicators. Using purchasing power parity, Dumas and Solnik (1995) argue that stochastic fluctuations in exchange rates have linkage with changes in product prices, which is an additional time-varying exchange rate risk source of international asset pricing markets. Therefore, the four major global stock markets supported the co-movement of stock and currency foreign exchange risk premiums. Finally, Claessens and Forbes (2001) deal with the transmission channels and mechanisms resulting from soaring speculation by lowering the exports of high-technology products and higher USD. Bekaert, Harvey, Lundblad, and Siegel (2011) propose that a country's regulation of foreign capital flows and certain non-regulatory factors are important.

3. Wake-up hypothesis: The hypothesis states that investors may only experience some risk, for a particular market or crisis, and be prompted to re-examine the assessment of whether other markets experience the same crisis. Under this hypothesis, countries that do not have trade or banking links with the countries where the crisis originated, may also be exposed to the risks. However, the degree to which the factor is exposed depends on the steady state of the regulatory authorities and the economic fundamentals. Ahnert and Bertsch (2013) argue that the wake-up theory refers to speculators who increase the likelihood that speculative currencies have been attacked in the process of obtaining foreign information. They argue that the transmission mechanism of the wake-up theory provides a powerful explanation for the Asian currency crisis of 1997 and the Russian crisis of 1998. The transmissions of these two crises appear to have limited correlation with the fundamentals and connection among countries. Such transmission mechanisms may be changed by economic fundamentals to reflect in the political system, implementation of policies, coordination of external arrangements, internal employment policies, and the government budget.

4. Herding hypothesis: The herding behavior of investors or the risk appetite of investors results in unconscious transmission, which is beyond the fundamentals. The transmission phenomenon can be detected by the global risk indicators such as VIX. The volatility index (VIX) utilizes S&P 100 index option prices to generate and imply volatility from the Chicago Board Options Exchange (CBOE) established in 1997. This reflects the market's expectations of future market volatility to provide option traders with more information to plan their trading and hedging strategies, and offer a more practical and balanced perspective on the market's outlook. The VIX service reflects the change in investor sentiment, and the index is known as the "investor fear gauge." Baker, Wurgler, and Yuan (2012) constructed the VIX index as an indicator of investor sentiment. Empirical evidence shows that sentiment indicators have correlation with the relative prices of dual-listed companies. Similarly, global sentiment indicators are inverse predictors to predict the reverse of the market return. In other words, because of higher sentiment and lower yields in the future, arbitrage is relatively challenging to operate and the stocks' value is difficult to assess. Adrian and Shin (2010) argue that by the processing of investors' continually evaluation stocks, a change in equity immediately generates the reflection of asset prices changes. Besides, the trigger responses from financial intermediaries and the leverage with the characteristics of pro-cyclical can predict financial market risk based on the Chicago Board Options Volatility Index VIX index. Therefore, we can use the VIX as a proxy variable of investor risk awareness of transmission by the herding effect.

Based on the above hypothesis, we establish the proxy variables of related economic and financial control variables. As shown in Table 1, we examine the factor loading changes in instrumental variables by testing the industrial return channel in Taiwan and establish a full model to understand the implication of these economic fundamentals. There are time-varying degrees of transmission effect with different economic fundamentals. In other words, considering the shock contagion effect of different economic fundamentals, we investigate the channels of Taiwan's industrial portfolio returns.

Table 1: Control Instrument Variable (Z)

Category	Variables	Description	Unit
Banking Exposure (Banking Sector Hypothesis)	Interest rate exposure	Taiwan, Policy Rates, Discount Rate	%
External Exposure / Segmentation (Globalization Hypothesis)	Capital flows	Taiwan, Expenditure Approach, Gross Capital Formation	TWD
	Financial integration	Stock Position of Liabilities, % of Gross Domestic Product	% of GDP
	Financial depth	Taiwan, Doing Business, Getting Credit, Depth of Credit Information Index (0-8), Index	0-8
	Trade integration	United States, Exports to Taiwan, USD	USD
	Exchange rate exposure	Taiwan, Spot Exchange Rate	TWD
Domestic Macroeconomic Fundamental (Wake-up Hypothesis)	Political stability	Taiwan, Risk Rating, Political Stability	
	Sovereign rating	Taiwan, Risk Rating, Trade Credit (7 = Lowest Risk	1-7
	FX reserves	Taiwan, Reserves, Foreign Exchange, USD	US$
	Current account	Taiwan, Current Account Balance	% of GDP
	Unemployment rate	Taiwan, Unemployed Rate	% of Total Labor
	Government budget	Taiwan, General Government Structural Balance	% of GDP
Global / Common risk aversion (Herding Hypothesis)	Risk: VIX	CBOE SPX Volatility VIX (New)	ln %

The control instrument variables of four hypothesis - banking sector, globalization, wake-up and herding Data Source: DataStream

DATA AND METHODOLOGY

This study extends the three-factor model of Bekaert et al. (2014) to a four-factor model adding the partner-country factor for regression analysis. The four factors include the index of FTSE ALL WORLD, FTSE ASIA PACIFIC, FTSE UNITED STATES, and FTSE W TAIWAN. The extended the Capital Asset Pricing Model adopted as the main model for examining whether the systematic fundamental factors or the financial crisis contagion effects can explain the variations in Taiwan's industrial portfolio returns. Specifically, we implement four different hypotheses of 13 instrument variables to inspect the interdependence and financial crisis impacts in the empirical models, which can discern the main channels of Taiwan's industrial portfolio returns. The empirical sample period covers 1,119 weekly data points during the period 1996/1/1 to 2017/7/26. The 1,119 data points include variables of four market index returns: global, Asia-Pacific, U.S. and Taiwan, and 23 Taiwanese industry portfolio returns. In addition, we consider the U.S. subprime mortgage financial crisis during 2007/8 to 2009/3, and retrieve the empirical data from DataStream.

We use the factor model to define the change in factor loading (β, γ, η) as a factor transmission. First, we define the method of factor transmission, that is, the global impact on the region, the regional impact on the United States, and then the United States' impact on Taiwan by setting the impact factors of ($R_{w,t}$, $e_{reg,t}$, $e_{o,t}$, $e_{T,t}$). Dungey et al. (2005) propose that the fluctuation of returns during the crisis is attributed to three effects: common effect, idiosyncratic effect, and the contagion effect. By decomposing the three effects model, we orthogonalize country-level returns to obtain the residual as an indicator of the transmission contagion effect, after excluding the common effect and the idiosyncratic effect. The four factors are orthogonalized as follows:

$$R_{reg,t} = \alpha_{reg,0} + \beta^{w}_{reg,t} R_{w,t} + e_{reg,t} \quad (1)$$

$$R_{O,t} = \alpha_{O,0} + \beta^{w}_{O,t} R_{w,t} + \beta^{reg}_{O,t} e_{reg,t} + e_{O,t} \quad (2)$$

$$R_{T,t} = \alpha_{T,0} + \beta^{w}_{T,t} R_{w,t} + \beta^{reg}_{T,t} e_{reg,t} + \beta^{O}_{T,t} e_{O,t} + e_{T,t} \quad (3)$$

$R_{w,t}$, $R_{reg,t}$, $R_{O,t}$, $R_{T,t}$. Representing the world index excess return, regional index excess return, partner-U.S. index excess return, and the Taiwan index excess return for the FTSE country-level stock price index return minus risk-free interest rates. Besides, $e_{reg,t}$, $e_{O,t}$, and $e_{T,t}$ can be defined as the transmission factor representing the residual term obtained by orthogonalizing the excess return of $R_{w,t}$, $R_{reg,t}$, $R_{O,t}$,$R_{T,t}$. The $R_{w,t}$ represents the impact factor of "global," The $e_{reg,t}$ represents the impact factor of "regional." The $e_{T,t}$ represents the impact factor of Taiwan, and $e_{O,t}$ represents the impact factor of the United States. The impact factor is expressed as follows:

$F_t = [F^{w}_t, F^{reg}_t, F^{O}_t, F^{T}_t,] = [R_{w,t}, e_{reg,t}, e_{O,t}, e_{T,t}]$
F^{w}_t: Global factor, denoted by $R_{w,t}$
F^{reg}_t: Regional factor, denoted by $e_{reg,t}$
F^{O}_t: Partner-U.S. factor, denoted by $e_{O,t}$
F^{T}_t : Domestic factor, denoted by $e_{T,t}$

According to the direction of the spread, the global factor (F^{w}_t) is expressed by the world index ($R_{w,t}$). The regional factor (F^{reg}_t) is represented by the residual term ($e_{reg,t}$) derived from the regional index ($R_{reg,t}$), which regresses on the world factor (F^{w}_t). The partner-U.S. factor (F^{O}_t) is represented by the residual term ($e_{o,t}$) derived from the regression of the partner-U.S. index ($R_{o,t}$) on the world factor (F^{w}_t) and the regional factor (F^{reg}_t). Taiwan's domestic factor (F^{T}_t) is the residual term ($e_{T,t}$) derived from the regression of the Taiwan domestic index ($R_{T,t}$) on the world factor (F^{w}_t), regional factor (F^{reg}_t), and the partner-U.S. factor (F^{o}_t). $\beta^{w}_{i,t}, \beta^{reg}_{i,t}, \beta^{o}_{i,t}, \beta^{T}_{i,t}$ are coefficients of $F^{w}_t, F^{reg}_t, F^{o}_t, F^{T}_t$, representing the global, regional, partner-U.S., and Taiwan's domestic factor loading, respectively.

The full model is as follows:

$$R_{i,t} = \alpha_{i,0} + \alpha_{i,0} R_{i,t-1} + \alpha_{i,2} dy_{i,t-1} + \beta'_{i,t} F_t + \eta_{i,t} CR_t + e_{i,t} \quad (4)$$

$$\beta_{i,t} = \beta_{i,o} + \beta'_1 Z_{i,t-k} + \gamma_{i,t} CR_t \quad (5)$$

$$\gamma_{i,t} = \gamma_{i,0} + \gamma'_1 Z_{i,t-k} \quad (6)$$

$$\eta_{i,t} = \eta_{i,0} + \eta'_1 Z_{i,t-k} \quad (7)$$

For equations (4) to (7),

$R_{i,t}$: The excess returns of i-industry portfolio during week t
$R_{i,t-1}$: The excess returns of i-industry portfolio lagged by one week
dy: The dividend yield of the portfolios
F_t: Vector of the four observable factors $F_t = [F^{w}_t, F^{reg}_t, F^{O}_t, F^{T}_t]$
CR_t: The financial crisis proxy variable

$Z_{i,t}$: Vector of control variables lagged by 26 weeks to capture time and cross-industrial variables in factor exposures

We analyze Taiwan's industrial portfolios for both, the co-movement effect of interdependence and the contagion effect of crisis using a pooled Ordinary Least Squares (OLS) standard errors heteroskedasticity model. Further, Bekaert et al. (2014) define the United States subprime crisis period from August 2007 to March 2009. We also consider the United States subprime mortgage crisis (2007/8 to 2009/3) to be the crisis period. We then test the co-movement effect using the corresponding interdependence parameter, β_1', the contagion effect by contagion parameter γ_1', and the crisis effect by $\eta_{i,t}$. The variables $Z_{i,t}$, is lagged by 26 weeks to prevent unobservable factors from affecting same period of returns and $Z_{i,t}$ value simultaneously, resulting in a spurious regression.

To understand the well-specified factor model, we perform a correlation test on the residuals as a measure of excess co-movement indicators after performing regression on the portfolio returns. When the factor model outperforms or underperforms, there will be an excess co-movement phenomenon in residuals as follows:

$$EXCOV_t = \frac{2}{N(N-1)} \sum_{i=1}^{N} \sum_{j>i}^{N} (e_{i,t} \times e_{j,t}) \tag{8}$$

N: Represents the number of industry portfolios in Taiwan

We create a statistic that divides EXCOV by the number of sample variations to check for excess co-movement as follows:

$$ECTEST = \frac{\left[\left(\frac{1}{T}\right) \sum_{t=1}^{T} EXCOV_t\right]^2}{VAR(EXCOV_t)} \tag{9}$$

This test statistic conforms to $\mathcal{X}^2(1)$ null hypothesis.

We also establish EXCOR as another test statistic to perform cross-model and cross-period (crisis and non-crisis) analyses. First, $\rho_{i,j}$ is the correlation between the weighted average residuals of industrial portfolios i and j. The equation is as follows:

$$EXCOR = \frac{2}{N(N-1)} \sum_{i=1}^{N} \sum_{j>i}^{N} \rho_{i,j} \tag{10}$$

The empirical procedures include three steps:
First step: co-movement model (interdependence)

$$R_{i,t} = E_{t-1}[R_{i,t}] + \beta_{i,0}' F_t + e_{i,t} \tag{11}$$

The interdependent co-movement model represents the regression of the portfolios' excess returns $R_{i,t}$ on the four factors (F_t), global, regional, partner-U.S., and domestic-Taiwan. The coefficients ($\beta_{i,0}'$) are factor loadings of the co-movement effect. Besides, the model has an option of $\mathrm{CR}_t$to understand the same effect with crisis parameter.

2. Second step: contagion model

Besides the co-movement model, we add the crisis dummy variable, CR_t, as a contagion model to understand the transmission during the financial crisis. Equations (12) and (13) represent the contagion effect of the portfolios' excess returns ($R_{i,t}$) in the crisis period. The equation is as follows:

$$R_{i,t} = E_{t-1}[R_{i,t}] + \beta'_{i,t}F_t + \eta_{i,0}CR_t + e_{i,t} \quad (12)$$

$$\beta_{i,t} = \beta_{i,0} + \gamma_{i,0}CR_t \quad (13)$$

$\beta_{i,0}$ represents the co-movement effect factor loading; $\gamma_{i,0,A}$ represents the contagion effect factor loading; $\eta_{i,0,A}$ represents the crisis effect factor loading. If there is a transmission, the factor loading value should change.

3. Third step: influential sources (channel) model

In addition, we include some financial and economic variables Z as control variables to understand the transmission channel. The equation is as follows:

$$R_{i,t} = E_{t-1}[R_{i,t}] + \beta'_{i,t}F_t + \eta_{i,t}CR_t + e_{i,t} \quad (14)$$

$$\beta_{i,t} = \beta_{i,o} + \beta'_1 Z_{i,t-k} + \gamma_{i,t}CR_t \quad (15)$$

$$\gamma_{i,t} = \gamma_{i,0} + \gamma'_1 Z_{i,t-k} \quad (16)$$

$$\eta_{i,t} = \eta_{i,0} + \eta'_1 Z_{i,t-k} \quad (17)$$

In equations (14) to (15), variables $Z_{i,t-k}$ represent the control variables by lagged two seasons, $\gamma_{i,0}$ represents the factor loading of the contagion effect, γ_1 is the factor loading of the contagion channel, $\eta_{i,0}$ represents the crisis factor loading of the interdependence effect, and η_1 represents the crisis factor loading of the interdependent effect's channel.

RESULTS AND DISCUSSION

Table 2 shows the descriptive statistics related to Taiwan's industrial portfolio returns. The statistics show zero means, right skewness, rejecting of unit root hypothesis, and no spurious regression. Table 3 shows the correlation matrix for returns of global, regional, United States, and Taiwanese industries. Panel A represents the correlation coefficients before orthogonalization. The correlation coefficient of Taiwan with global, Asia Pacific, and the United States factors is 0.474, 0.570, and 0.453, respectively. Panel B represents the correlation after orthogonalization. Apparently, all correlation coefficients fall sharply to 0 because orthogonalization removes common factors to be as well-specified as the contagion factors.

Table 2: Descriptive Statistics of Taiwan's Industrial Portfolio Returns

Panel A						
Industry	**BASIC MATS**	**CONSUMER GDS**	**CONSUMER SVS**	**FINANCIALS**	**TECHNOLOGY**	**AN HEALTH CARE**
Mean	0.0011	0.0007	0.0002	-0.0002	0.0011	-0.0008
Median	0.0007	0.0017	0.0000	-0.0003	0.0023	0.0000
Maximum	0.1926	0.2497	0.2007	0.2005	0.1880	0.2002
Minimum	-0.1599	-0.2528	-0.2260	-0.2358	-0.2490	-0.1940
Std. Dev.	0.0354	0.0437	0.0384	0.0410	0.0454	0.0366
Skewness	0.19	-0.25	-0.19	0.23	-0.25	0.12
Kurtosis	5.92	7.28	7.06	6.78	5.51	10.05
Jarque-Bera	411.2	878.6	786.1	684.6	310.3	2358.4
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Observations	1119	1119	1119	1119	1119	1119
Panel B						
Industry	**INDUSTRIALS**	**OIL & GAS**	**AUTO & PARTS**	**BANKS**	**CHEMICALS**	**ELTRO/ELEC EQ**
Mean	0.0009	0.0006	0.0005	-0.0002	0.0016	0.0007
Median	0.0013	0.0000	0.0000	0.0001	0.0000	0.0008
Maximum	0.1762	0.1890	0.7159	0.2126	0.2100	0.1762
Minimum	-0.2512	-0.1772	-0.9999	-0.2605	-0.1678	-0.2512
Std. Dev.	0.0428	0.0277	0.0522	0.0419	0.0404	0.0440
Skewness	-0.31	0.05	-3.83	0.14	0.34	-0.32
Kurtosis	6.37	11.82	152.49	6.94	5.47	6.15
Jarque-Bera	556.2	3678.5	1060473.0	737.8	309.1	488.1
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Observations	1119	1119	1119	1119	1119	1119
Panel C						
Industry	**FD PRODUCERS**	**FIN SVS L**	**INDS ENG**	**INDS TRANSPT**	**INDUSTRIAL MET**	**LIFE INSURANCE**
Mean	0.00177	-0.00046	0.00155	-0.00035	0.00060	0.00001
Median	0.00060	0.00000	0.00000	0.00000	0.00000	0.00000
Maximum	0.20025	0.18885	0.22314	0.26982	0.18043	0.77245
Minimum	-0.19403	-0.22593	-0.24717	-0.22310	-0.24800	-0.25448
Std. Dev.	0.04325	0.04308	0.05339	0.04466	0.03643	0.04895
Skewness	0.06	0.13	-0.65	0.09	-0.27	3.82
Kurtosis	5.38	6.24	6.95	6.75	8.22	60.73
Jarque-Bera	269.1	500.2	818.9	668.8	1302.1	160532.2
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Observations	1119	1119	1119	1119	1119	1119
Panel D						
Industry	**LEISURE GDS**	**OIL & GAS PROD**	**REAL EST**	**CON & MAT**	**TCH H/W & EQ**	
Mean	0.00171	0.00055	-0.00015	0.00012	0.00110	
Median	0.00072	0.00000	0.00000	0.00000	0.00234	
Maximum	0.24939	0.18897	0.24358	0.23006	0.18804	
Minimum	-0.25280	-0.17719	-0.20002	-0.20154	-0.24896	
Std. Dev.	0.05188	0.02773	0.04693	0.04724	0.04539	
Skewness	-0.15	0.05	0.71	0.01	-0.25	
Kurtosis	5.65	11.82	9.31	6.33	5.51	
Jarque-Bera	335.7	3678.5	1980.4	526.1	310.3	
Probability	0.00	0.00	0.00	0.00	0.00	
Observations	1119	1119	1119	1119	1119	

The descriptive statistics include the portfolio returns of 23 industries in Taiwan. Data Source: DataStream

Table 3: Correlation Matrix of Four Factors

Panel A: Raw Data				
	Global	**Regional**	**Partner-U.S.**	**Domestic-Taiwan**
Global	1.000	0.696	0.942	0.474
Regional	0.696	1.000	0.626	0.570
Partner-U.S.	0.942	0.626	1.000	0.453
Domestic-Taiwan	0.474	0.570	0.453	1.000
Panel B: Orthogonalized Data				
	Global	**Regional**	**Partner-U.S.**	**Domestic-Taiwan**
Global	1.000	0.000	0.000	0.000
Regional	0.000	1.000	0.000	0.000
Partner-U.S.	0.000	0.000	1.000	0.000
Domestic-Taiwan	0.000	0.000	0.000	1.000

In Panel A, "Global" represents FTSE ALL WORLD index return, "Regional" represents FTSE ASIA PACIFIC index return, "Partner-U.S." represents FTSE UNITED STATES index return, and "Domestic-Taiwan" represents FTSE W TAIWAN index return. In Panel B, the orthogonalized data follows the rule of equation from (1) to (3).

Based on the different hypotheses, we set up the instrument variables in the model to understand the channels of transmission effect. The descriptive statistics are shown in Table 4.

Table 4: Descriptive Statistics of Control Instrument Variables

	Interest Rate Exposure	Capital Flow	Financial Integration	Trade Integration	Exchange Rate Exposure	Political Stability	Current Account Balance	Unem-ployed Rate	Governme nt Budget	COBE VIX
Mean	0.62	184,792	708	4.59	25.01	1,820	-0.08	0.93	226	20.65
Median	0.47	182,543	699	4.46	25.41	1,708	-0.08	0.96	230	19.19
Maximum	1.41	249,359	1,071	27.76	30.99	2,193	-0.03	1.46	311	80.06
Minimum	0.24	91,955	429	-14.47	18.98	1,501	-0.15	0.36	131	9.77
Std. Dev.	0.33	29,166	110	8.95	3.12	216	0.03	0.22	54	8.37
Skewness	0.88	-0.10	0.13	0.20	-0.09	0.50	-0.52	0.05	0.00	1.96
Kurtosis	2.38	2.26	2.60	4.12	1.83	1.63	2.44	2.51	1.67	9.57
Jarque-Bera	163.59	27.25	10.74	66.84	65.20	135.38	65.65	11.70	83.02	2,740
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	1119	1119	1119	1119	1119	1119	1119	1119	1119	1119

Data Source: DataStream

We analyze the transmission effect by performing regression on Taiwan's 23 industries' portfolio returns on global, regional, partner-U.S., and domestic Taiwan factors. We explore the co-movement or contagion effect owing to changes in the factor loading of β, γ, and η during the non-crisis period and the subprime mortgage crisis period. Finally, we combine the control variables to understand the transmission channel. According to the interdependence model represented by equation (11), Table 5 shows the co-movement effect of Taiwan's industrial portfolio returns on the four factors in the entire sampling period. To conclude, the four factors' exposures are 0.58 for the global factor, 0.55 for the regional factor, and 0.83 for the domestic factor, all of which are significant at the 1% level. The global, regional, and domestic factors have a significant co-movement effect on Taiwan's industrial portfolio returns, while the partner-U.S. factor has an insignificant co-movement effect on the returns.

Table 5: Interdependence Effect in Full Sample or Subprime Period

$R_{i,t} = E_{t-1}[R_{i,t}] + \beta'_{i,0}F_t(+\eta_{i,t}CR_t) + e_{i,t}$				
	Coef. (with CR)		**Coef. (without CR)**	
Interdependence				
β^w	0.66824	***	0.57883	***
β^{reg}	0.60408	***	0.55364	***
β^o	0.11596		0.20586	
β^d	1.06979	***	0.83216	***
Test Statistics				
ECTEST	0.00246		0.49033	
EXCOR	0.34379		0.46726	
Observation	45977		45977	
R^2	0.5460		0.3415	
Adjusted R^2	0.6188		0.3391	

*The interdependence model represented by equation (11), shows the co-movement effect of Taiwan's industrial portfolio returns on the four factors in the entire sampling period with or without CR. ***, **, and * indicate statistical significance at the 1%, 5%, and 10* levels, respectively.*

Confirming Bekaert et al. (2014)'s study, the exposure of emerging markets–except for that of the Americas–to the United States and the world is relatively small. In the test of individual residual co-movement in Taiwan's 23 industry portfolio, ECTEST and EXCOR for all periods indicated a chi-square statistic of 0.49 and 0.46, respectively, which is well below the 5% (1%) significance level; the critical value of $\chi^2(1)$-distributed variable was 3.86 (6.63). In other words, the correlation between excess co-movement residuals shows that the covariance between the industrial residuals is small.

Comparing the tests conducted in Bekaert et al. (2014) and our study, the former is a cross-border test, whereas the latter is only relevant to the domestic industry. Therefore, our conclusion is reasonable and acceptable. In addition, the results show that the domestic-Taiwan factor coefficient is 0.83 and has a stronger co-movement effect compared to the global and regional factors. The adjusted determination coefficient, R^2 is 0.34 without the parameter CR_t and 0.62 with the parameter CR_t, and the model has explanatory power.

For the contagion model represented by equations (14) and (15), Table 6 shows the contagion and interdependence effects of Taiwan's industrial portfolio returns on the four factors in the full sample. In the interdependence effect, the strongest effect is of the domestic factor with a coefficient value of 0.82, followed by coefficient values of 0.57 for the global factor and 0.53 for the regional factor, all of which are significant at the 1% significance level. The partner-U.S. co-movement factor is insignificant. On the contrary, the crisis factor η, although not economically significant, is still statistically significant at the 5% level. The adjusted determination coefficient, R^2, is 0.34 with explanatory power. Although the crisis contagion effect on the global factor, regional factor, and partner-U.S. factor are insignificant for the U.S. subprime crisis period, the domestic factor with a coefficient value of 0.27 is significant at the 10% significant level. Further, the crisis factor η in the U.S. subprime crisis spread is statistically significant at the 10% significant level, although the economy is insignificant at 0.008. For the contagion model during the U.S. subprime crisis, the adjusted determination coefficient, R^2, is 0.35 and has explanatory power.

For the crisis contagion model, we find that (1) the η coefficient of 10% is significant; however, the economy is insignificant, which indicates that Taiwan's industrial returns can be captured by the crisis factor. (2) The co-movement effect is captured by the β value; all factors other than the partner-U.S. are significant, especially the domestic factor, which shows that the transmission effect of Taiwan's industrial portfolio returns comes from global, regional, and domestic factors. In particular, the domestic factor has a strong economic significance. Therefore, most of the co-movement in Taiwan's portfolio mainly comes from itself. Specifically, the U.S.A. factor in our study is different from that in Bekaert et al. (2014). It can be said because the sequence of orthogonalization of the partner-U.S. factor between the two studies is different; the U.S.A. factor in our study has been explained by global and regional factors, resulting in an insignificant U.S.A. factor. (3) All γ values for the crisis contagion are insignificant, indicating that during the crisis, Taiwan's industrial returns are less affected by external influences and are mainly affected by domestic factors. Comparing our study with Bekaert et al. (2014), the values of γ are significant in our study, and the result is different.

Table 6: Contagion Effect

$$R_{i,t} = E_{t-1}[R_{i,t}] + \beta'_{i,0}F_t + \eta_{i,0}CR_t + e_{i,t}$$
$$\beta_{i,t} = \beta_{i,0} + \gamma_{i,0}CR_t$$

	Coef.		Std Err.
Interdependence			
β^w	0.56857	***	0.0643
β^{reg}	0.53105	***	0.0831
β^o	0.22240		0.2113
β^d	0.81111	***	0.0672
Contagion			
γ^w	0.09172		0.1373
γ^{reg}	0.07536		0.1816
γ^o	-0.08457		0.4196
γ^d	0.27163	*	0.1686
Other			
η	0.00790	*	0.0060
Test Statistics			
ECTEST	0.51938		
EXCOR	0.46777		
Observation	2001		
R^2	0.3512		
Adjusted R^2	0.3459		

*The contagion model represented by equation (12) to (13) shows the contagion effect of Taiwan's industrial portfolio returns on the four factors and the U.S. subprime crisis. ***, **, and * indicate statistical significance at the 1%, 5%, and 10* levels, respectively.*

In the following section, the goodness-of-fit of the models are compared in four different settings: the interdependence model with and without the Taiwan market factor, and the contagion model with and without the Taiwan market factor. To make the model well-specified and for the factor exposure to fully predict the vulnerability, we use the interdependence model with and without the Taiwan factor to estimate Taiwan's industrial accumulated returns during the crisis. To test the goodness-of-fit, we regress the actual value, $R_{i,t}$ on the estimate $\hat{R}_{i,t}$. The slope parameters of Xs are 1 and statistically significant at the 0.01% level, suggesting that $\hat{R}_{i,t}$ is a good fitted value of $R_{i,t}$. In addition, we find that because the adjusted R-squared values with the Taiwan factor (0.79) and without the Taiwan factor (0.46) are significantly different, the model with the Taiwan factor is better fitted than that without the Taiwan factor. The details are as follows:

As shown in the normal probability plot in Figures 1 and Figure 2, the horizontal axis is the residual value and the vertical axis is the sample probability value. The data points generally fall near the virtual normal straight line, indicating that the data distribution is similar to the normal distribution. The residuals' range in Figure 1 is more concentrated than that in Figure 2, suggesting that the goodness-of-fit with the Taiwan factor of estimate is better than that without the Taiwan factor of estimate.

Figure 1: Normal Probability Plot of Residuals with Taiwan Factor

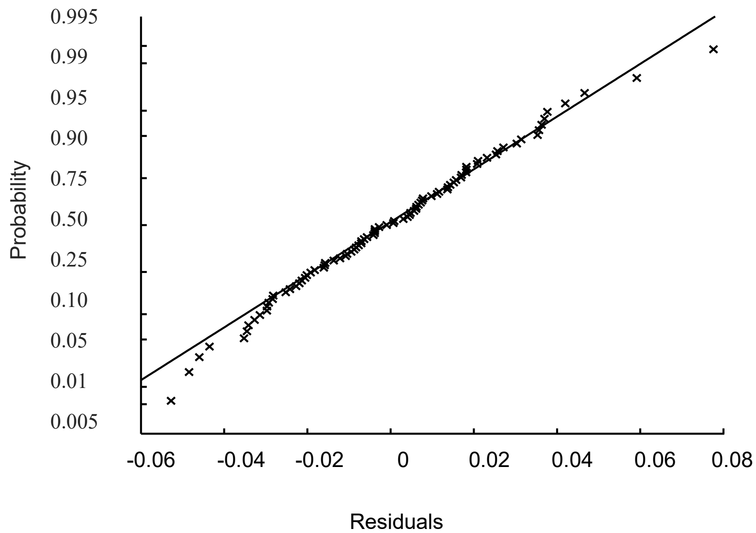


Figure 2: Normal Probability Plot of Residuals without Taiwan Factor

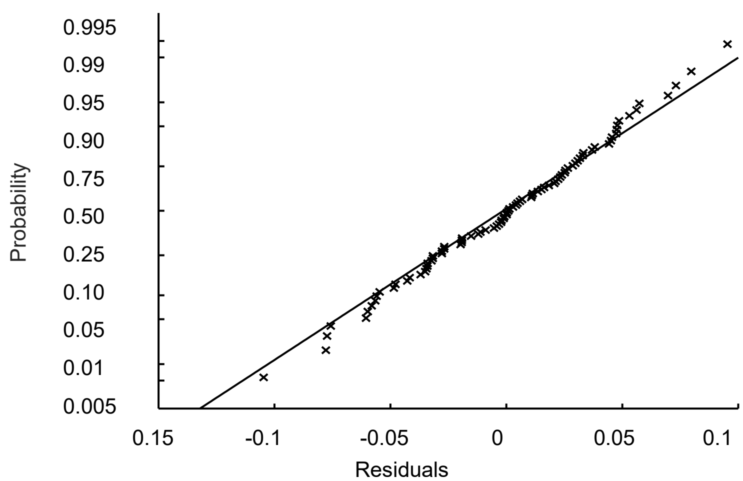


Figure 3 and Figure 4 show the bitmap of the interdependence model (Equation 11) of Taiwan industrial portfolio returns' fitted value and the actual returns and their allocation. From the graphs in Figure 3 (with the Taiwan factor) and Figure 4 (without the Taiwan Factor), it can be seen that the estimate is a goodness-of-fit, is concentrated on the mean value, and has a nonlinear relationship between fitted value and returns. The interdependence model with the Taiwan factor is better fitted than it is without the Taiwan factor. Comparing the graphs in Figure 3 (with the Taiwan factor) and Figure 4 (without the Taiwan Factor), the graph in Figure 4 (without the Taiwan Factor) is more curved than that in Figure 3 (with the Taiwan factor). This implies that the contagion model with the Taiwan factor is better fitted than that without the Taiwan factor.

Figure 3: Goodness-of-fit of Interdependence Model with Taiwan

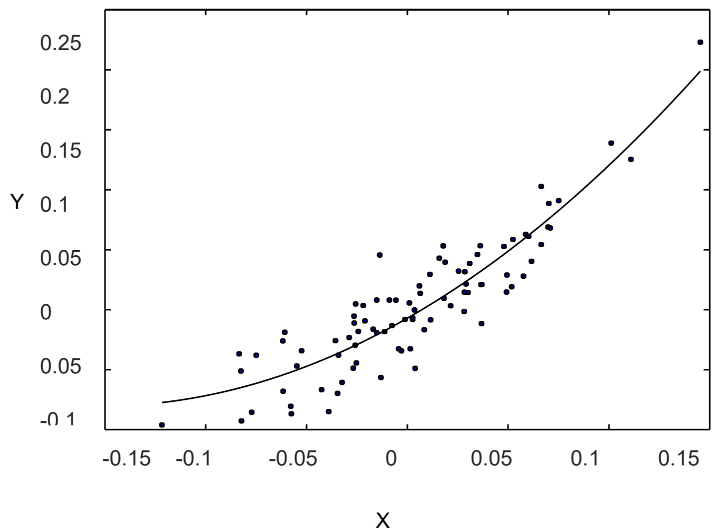
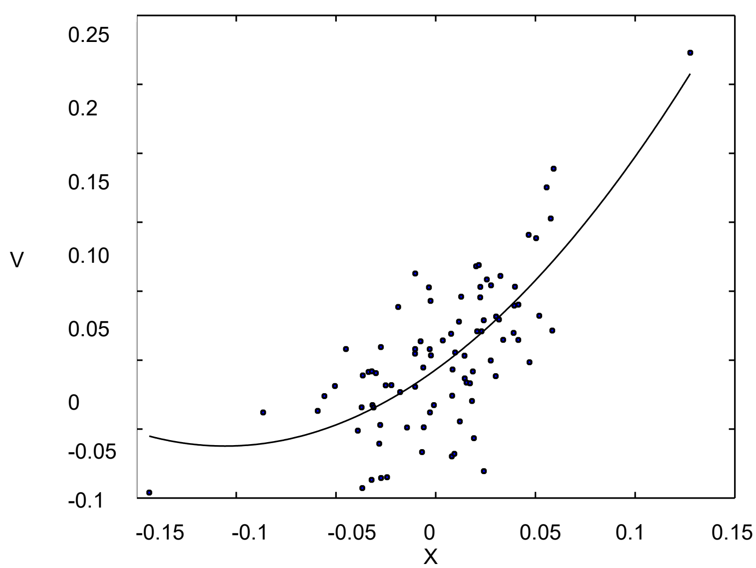


Figure 4: Goodness-of-Fit of Interdependence Model without Taiwan



Similarly, we consider the contagion model, represented by equations (14) and (15), with and without the Taiwan factor to estimate Taiwan's industrial accumulated returns during the crisis. Besides, we regress the actual value, $R_{i,t}$., on the fitted value $\widehat{R}_{i,t}$, to test the goodness-of-fit. Both slope parameters of X are 1 and statistically significant at the 0.01% level, showing evidence that $\widehat{R}_{i,t}$is a good fit value of $R_{i,t}$. Further, because the adjusted R-squared with the Taiwan factor (0.78) and without the Taiwan factor (0.44) have significant difference, the model with the Taiwan factor will have a better fit than that without the Taiwan factor. The details are as follows:

Figure 5 (with the Taiwan factor) and Figure 6 (without the Taiwan Factor) show a normal probability plot in which the horizontal axis is the residual value, the vertical axis is the sample probability value, and the data point falls roughly in the virtual space of the normal straight line; thus, the data distribution is similar to a normal distribution. The residuals range in Figure 5 is more concentrated than in Figure 6; therefore, the goodness-of-fit with Taiwan factor of estimate are better than without Taiwan.

Figure 5: Normal Probability Plot of Residuals with Taiwan Factor

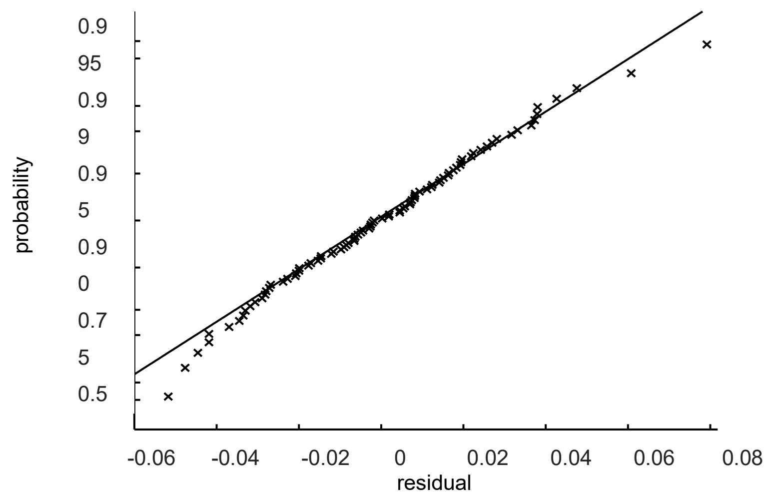
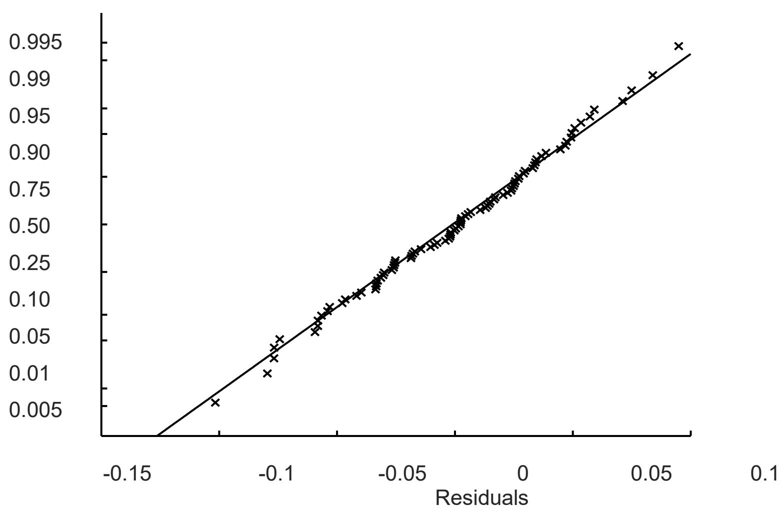


Figure 6: Normal Probability Plot of Residuals without Taiwan Factor



Comparing the graphs in Figure 7 (with the Taiwan factor) and Figure 8 (without the Taiwan Factor), the graph in Figure 8 (without the Taiwan Factor) is more curved than that in Figure 7 (with the Taiwan factor). This implies that the contagion model with the Taiwan factor is better fitted than that without the Taiwan factor.

Figure 7: Goodness-of-Fit of Contagion Model with Taiwan

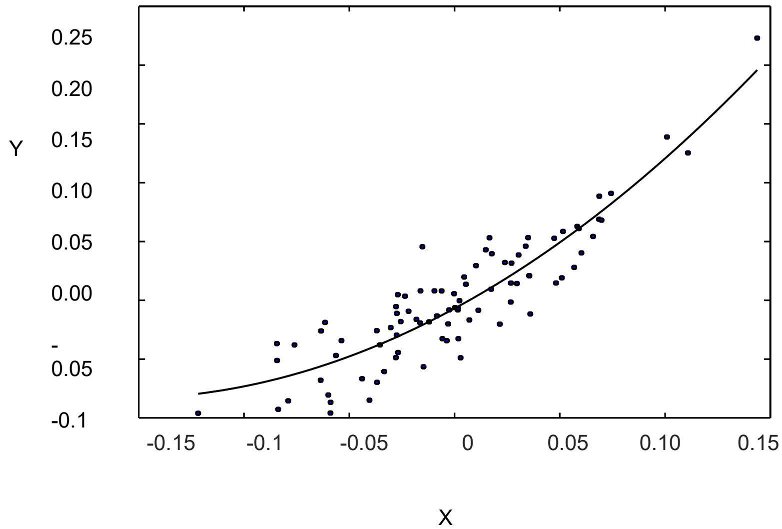
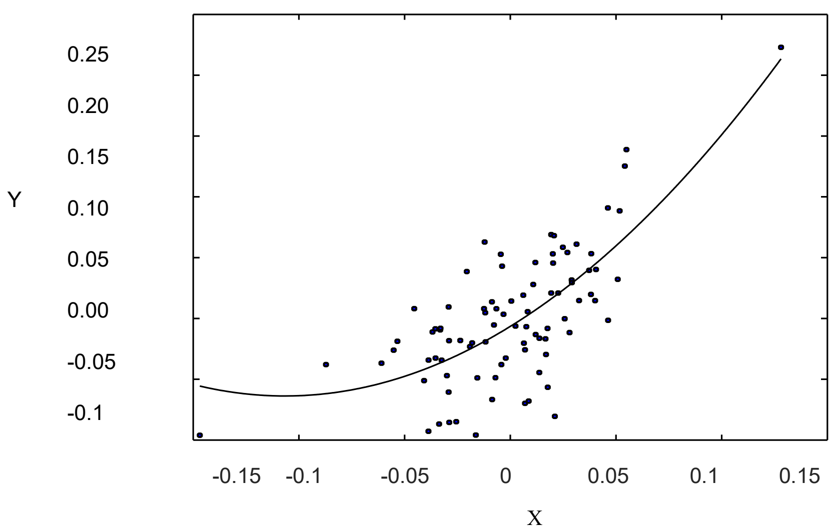


Figure 8: Goodness-of-Fit of the Contagion Model without Taiwan



The overall results strongly indicate that the interdependence models display extremely good fitness to interpret Taiwan's industrial portfolio return variations, whereas the contagion models add little additional information to understand Taiwan's industrial returns. Moreover, the domestic market factor plays an important role in determining the industrial sectors' returns, regardless of whether the full sample or financial crisis periods are considered.

In particular, based on equations (14) to (17), we combine the full model with the instrument control variables by examining factor loading - β, γ, and η changes to explore the channels of transmission of Taiwan's industrial portfolio returns. In addition, to study the co-movement and contagion effects, we first add instrument variables individually to the model (individual model), as shown in Table 7. Next, we add instrument variables simultaneously to the model (encompassing model), as shown in Table 8.

Table 7: The Interdependence and Contagion Effect (Individual Model)

	Contagion					Interdependence						
	γ^w	γ^{reg}	γ^o	γ^d	η	β^w	β^{reg}	β^o	β^d	η	R^2	Adjusted R^2
Interest rate exposure	-0.978	-0.093	-1.245	-0.071	0.086 ***	-0.383 **	-0.053	-0.478	-0.131	-0.058 **	0.370	0.360
Capital flows	-1.295	0.441	-1.420	-0.701	-0.059 *	0.528 *	-0.282	0.025	0.091	0.724 *	0.365	0.354
Financial integration	-0.001	0.000	-0.001	0.000	0.000	0.001 *	-0.001	0.000	0.000	0.026	0.364	0.353
Trade integration	0.031	-0.036	0.131	-0.017	-0.004 ***	0.001	0.004	-0.024	0.003	0.006 *	0.368	0.357
Exchange rate exposure	0.002	0.007	-0.080	-0.018	-0.001	-0.024	-0.023	-0.020	-0.007	0.036	0.363	0.353
Political stability	-0.002	-0.001	-0.005	0.000	0.000 ***	0.001 ***	0.000	0.001 *	0.000	-0.614 ***	0.378	0.368
Current account	-11.070	6.976	-120.524 *	-17.516	1.835 *	2.424	-2.616	7.649	0.963	0.102 *	0.367	0.356
Unemployment rate	-0.641	-0.375	-2.193	-0.414	0.029	0.319	-0.140	0.374	0.005	-0.020	0.366	0.355
Government budget	-0.034	0.011	-0.098	0.025	0.005 ***	0.003 ***	0.001	0.004	0.002 *	-1.138 ***	0.381	0.370
Risk: VIX	0.004	0.037	-0.020	-0.010	0.001	0.006	-0.009	-0.008	0.003	-0.010	0.362	0.351

*The individual full model represented by equation (14) to (15), shows the channels of the interdependence and contagion effect of Taiwan's industrial portfolio returns on the four factors, and the U.S. subprime crisis with instrument control variables individually. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

Table 8: The Interdependence and Contagion Effect (Encompassing Model)

	Contagion					Interdependence				
	γ^w	γ^{reg}	γ^o	γ^d	η	β^w	β^{reg}	β^o	β^d	η
Interest rate exposure	-15.430 *	2.860	-31.129	26.798 **	2.067 **	0.019	-0.883	-0.006	0.352	0.208
Capital flows	13.995	10.182	-26.026	-42.760 ***	0.140.0	-0.014	0.644	-2.113	0.097	0.208
Financial integration	0.011	-0.010	0.009	0.000	-0.491	0.001	-0.001	0.001	-0.001	0.208
Trade integration	-0.271	0.043	-1.791	-0.132	-1.391 *	0.005	-0.013	-0.009	0.003	0.208
Exchange rate exposure	-0.084	-0.029	1.654 *	1.337 **	1.893 **	-0.018	0.046	0.026	0.013	0.208
Political stability	0.113	0.078	-0.576	-0.295 *	0.158	0.000	0.000	0.002	-0.001*	0.208
Current account	314.100	251	-2,294 *	-1,034 *	-0.925	-0.977	-10.239 **	5.516	-0.938	0.208
Unemployment rate	-9.677	-3.070	-0.810	-12.480	-2.877 ***	0.047	-1.543	0.266	-0.149	0.208
Government budget	-1.075	-1.035	6.775 *	2.903 *	-0.253	0.003	0.005	-0.003	0.009**	0.208
Risk: VIX	-0.013	0.086 **	-0.167 **	0.059 *	1.274	0.011 *	-0.003	-0.025	0.006	.208

R^2=0.45, Adjusted R^2=0.40

*The Encompassing full model represented by equation (14) to (15) shows the channels of the interdependence and contagion effect of Taiwan's industrial portfolio returns on the four factors and the U.S. subprime crisis with instrument control variables simultaneously. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

The co-movement in global factor β^w is statistically significant at the 1% level with respect to interest rate exposure, political stability, and government budget. Besides, it is statistically significant at the 10% level with respect to capital flow and financial integration. In addition, the crisis factor, η, is statistically significant in both the full sample and crisis periods for interest rate exposure, trade integration, political stability, and government budget, at the 1% significance level, and both capital flow and current account at the 10% significance level.

To regress the same control variable simultaneously, Table 8 reveals the statistical significance of the domestic factor in contagion effects through interest rate exposure, capital flow, exchange rate exposure, political stability, current account, government budget, and VIX channels. The crisis factor is of statistical significance in contagion effects through different channels, such as interest rate, trade integration, exchange rate, and unemployment rate. The effects of co-movement, as previously studied, are influenced by global, regional, and domestic factors. In particular, the VIX index is significant in the encompassing model. This implies that the crisis effect can be transmitted through the VIX channel.

Tables 5 and 6 reveal that Taiwan's industrial portfolio returns experience interdependent effects owing to global, regional, and domestic factors. In particular, domestic factors play a significant role in both economic and statistical influences. However, the partner-U.S. factor is insignificant, which can be explained by the fact that the global financial and economic impact on the United States is equivalent to that of the global and regional economies. By orthogonalizing global and regional factors on the U.S. factor, the global and regional factors explain most of the U.S. factors across many phenomena. In Table 6, for the contagion effect during a crisis period, domestic and crisis factor are significant, whereas the global, regional, and partner-U.S. factors are insignificant. Evidently, domestic and crisis factor have a significant impact on Taiwan's industrial portfolio returns. The returns on Taiwan's industrial portfolios were more affected by domestic and crisis factors when compared to other countries' portfolio returns during the sub-prime crisis.

We further explore the channels through which these phenomena occur and clarify them through different hypotheses. First, financial institutions' exposure shows that the co-movement and contagion effects are affected by crisis factor of financial institutions' channels. Second, through the globalization test, the globalization instrument variables influence Taiwan's industrial portfolio returns. They mainly come from the crisis factor of the co-movement and contagion effect via capital flows and trade integration channels. In particular, capital flows and trade integration in the co-movement effect have a negative impact on the contagion effect, as shown in Table 7. Essentially, the effects increased due to capital flows and good trade relations during tranquil periods, and worsened during the U.S. subprime mortgage crisis period. Third, the wake-up theory hypothesis for global and crisis factors of Taiwan's industrial portfolio returns co-movement or contagion effect through political stability, current account, and government budget channels. We find that political stability is a key factor affecting Taiwan's industrial portfolio returns. In particular, the political stability and government budget channels have the opposite sign of the value of η for co-movement and contagion. Generally, Taiwan's industrial portfolio returns will have an adverse contagion effect during crises through the impact of economic indicator channels.

CONCLUSION

In conclusion, Taiwan has a special geographical position and complicated political status. Although Taiwan is not a member of international organizations such as CPTPP or RCEP, it is still an economic entity considerably dependent on foreign trade. Therefore, its economy is easily affected by other countries, especially its relationship with the U.S., one of Taiwan's most important trading partners. Our study uses the four-factor model to investigate the co-movement effect during the full sample period and the contagion effect during the U.S. subprime crisis period. First, we regress Taiwan's industrial portfolio returns on four-factors in three progressive steps. We find that Taiwan's industrial portfolio returns are significant in global, regional, and domestic factors in both the interdependent and contagion models. It shows that the co-movement effect of Taiwan's industrial portfolio returns comes from global, regional, and domestic factors by β value. In particular, the domestic factor has strong economic significance. Therefore, most of the co-movement is domestic, whereas, it is insignificantly effective in partner-U.S. Owing to the sequence of orthogonalization of the partner-U.S. factor, global and regional factors explain the U.S.A. factor in our study, resulting in an insignificant U.S.A. factor. Additionally, it is significant in the crisis factor by η value but insignificant in the contagion effect by γ value. We then test the factor of goodness-of-fit of the interdependence/contagion model, which suggests that the goodness-of-fit with the Taiwan factor of estimate is better than without the Taiwan factor of estimate. Finally, we study the channels of transmission in the full model. Based on the empirical study, we find that the transmission of Taiwan's industrial portfolio returns' channel is significantly impacted by the variables of interest rate, political stability, and government budgets of the economic fundamentals in the crisis factor exposure η and the co-movement global factor β^{w}. Further, trading with other countries as well as injected capital flow can influence Taiwan's industry to some degree. Taiwan cannot remain isolated from the world, resulting in the transmission effect of industrial portfolio returns. The limitation of these financial contagion investigations is that we only focus on U.S. subprime mortgage crisis period. Nevertheless, we also perform a test for robustness during the Asian Financial Crisis of July 1997 to December 1998, but which is not included owing to space limitations. In addition, for completeness of the test, we need to adopt more factors to confirm our finding in future research.

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AUDIT FIRM INDUSTRY SECTOR LEADER GEOGRAPHIC LOCATION AND ITS ASSOCIATION WITH AUDIT FEES

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ABSTRACT

This study tests whether an association exists between the geographic location of industry sector leaders in an auditing firm and differences in audit pricing for that same auditing firm's industry clients. Using organizational learning theory and human capital theory, we predict that the industry-specific human capital of the audit partner in charge of an industry practice serves as a silo for this knowledge and provides an opportunity to charge a fee premium to their local clients. Using a hand collected dataset of partners overseeing industry-specific audit practices on audit firm websites, we provide evidence that a positive association exists between industry sector leaders' office locations and audit fees for same-industry clients in that city. Building on prior research on the effect of individual audit partners and general human capital on audit quality, this study provides additional insight into the human capital of audit firm industry sector leaders and the dynamics of audit market competition.

JEL: J24, M12, M42

KEYWORDS: Audit Firm Structure; Audit Pricing; Human Capital

INTRODUCTION

Academic research in auditing has tried to identify how, and why, auditing firms can charge a higher price to clients. Since auditing services are arguably a "credence good" for which the consumer is unable to identify service quality or auditor effort (Causholli and Knechel 2012), there is a high degree of variation in audit pricing. Behavioral accounting research supports this notion and identifies elements of business risk associated with audit fee increases, including litigation risk and non-litigation risk such as potential reputational damage (Houston et al. 2005). Prior archival accounting research provides evidence of numerous factors associated with the price of audit services: an auditor's industry specialization (e.g. Francis et al. 2005), office size (e.g. Francis and Yu 2009), and numerous factors tied to the client itself (e.g. Hay et al. 2006). From the archival research cited above, it is notable that many determinants of audit pricing may serve as a proxy for human capital. Organizational learning research suggests that companies potentially use their available knowledge to provide a "better" audit (e.g. Huber 1991). In this study, we presume that human capital of the audit partner in charge of an industry practice serves as a silo for this knowledge and provides an opportunity to charge a fee premium to their local clients. This study builds upon recent research that analyzes the role of geographic proximity to audit clients (e.g. Jensen et al. 2015) and the role of individual partners in enhancing audit quality (e.g. Goodwin et al. 2014; Zimmerman et al. 2018). Using a unique hand collected data set of audit firm industry sector leaders from Public Company Accounting Oversight Board ("PCAOB") annually inspected public accounting firms, this study analyzes the following research question: *is there an association between the geographic location of an* *auditing firm's industry sector leader and the audit fee charged to that same auditing firm's industry clients in that city?* Based upon both fiscal year 2016 audit fee and financial data for U.S. public companies, this study provides evidence consistent with a positive association between the location of this industry sector leader and the audit clients in that city. This result is robust to analyzing the data according to the level of geographic concentration in an industry, the degree of auditor dominance in an industry, the overall size of the auditor's office, and the stability of the industry sector leadership over time.

This study contributes to the extant auditing literature by analyzing the role of industry leadership in publicly accounting firms and evaluating whether the geographic concentration of human capital is associated with changes in audit pricing. The rest of the paper is organized as follows. First, we describe the literature review of prior related and relevant studies and provide in-depth background of our study. Second, we describe the data selection process and the empirical research model. Third, we analyze the results of the empirical model as well as considering potential alternative explanations for our findings. Finally, we present the conclusion of the research, which includes the summary and originality value of the study along with the implication of the study.

LITERATURE REVIEW

Audit Pricing Literature

Prior research in audit pricing provides evidence that numerous factors are associated with increased levels of audit pricing. Hay et al. (2006) evaluate and summarize the determinants of audit fees by performing a meta-analysis of studies from 1977-2003. The paper finds that fee drivers have consistent results across different studies, samples and countries. Audit fees also serve different purposes, such as evaluating the competitiveness of audit markets and examining issues of contracting and independence related to audit process. The study depicts that in numerous major academic journals, noting several key client-specific variables, such as total assets, the number of subsidiaries or segments, the level of inventories and receivables relative to total assets, profitability, their debt ratio, and several industry indicator variables have a significant positive association with audit fees. Regarding auditor-specific variables, Hay et al. (2006) note that the auditor's brand name (i.e. "Big 4") and the type of audit opinion have a significant positive association with audit fees.

More recently, there has been an increased focus on auditor-specific determinants of audit pricing. For example, auditor industry specialization has been a topic of intense research. While there is no formal consensus on how to measure industry specialization (e.g. Neal and Riley 2004), a commonly used definition is that of Francis et al. (2005), which conceptually defines industry specialization as having the leading market share of client audit fees relative to other public accounting firms. Research normally evaluates audit markets geographically using either the full national market or a localized area such as a city. Generally, industry specialization is positively associated with greater audit fees ("fee premium") when the auditor is both the market leader nationally and locally (Francis et al. 2005). The study indicates that national and city-specific industry leadership both affect auditor reputation and pricing. Inferred from the previous study result is that human capital may both have a local effect (especially given findings that audit pricing varies by the size of the office – e.g. Francis et al. 2009; Choi et al. 2010) and a national effect. Francis et al. (2009) study and validate the predication that larger offices of Big 4 auditors have higher quality audits. Furthermore, larger offices are more likely to issue going-concern audit reports and clients in larger offices show less aggressive earnings management behaviors. Additionally, Choi et al. (2010) use a large sample of U.S. audit client firms from 2000 to 2005 and provide evidence that the size of a local practice office within an audit firm has significantly positive relationship with both audit quality and audit fees even when national-level audit firm size and office-level industry expertise variables are controlled.

Finally, Fung et al. (2012) examine the effect of industry specialization and scale economies on auditing prices in U.S. at the city-level rather than national-level since the Big N firms have large and comparable national operations. The studies used a sample of Big N clients from 2000 to 2007. The study finds that there is a significant city-industry specialization premium and scale discounts throughout the sample period. Taken together, these studies support the perspective that large offices provide higher-quality audits compared to small local offices, which leads to differences in pricing for the audit services that consider quality as a base.

Geographic Organization of Audit Firms

More recent research has focused on the relative differences in the size of the local office and its' effect on audit pricing. One inference from these studies is that there is greater human capital in these larger offices (e.g. Danos et al. 1989) and audit personnel likely access that information to a greater degree in these offices. Industry-specific knowledge is the primary input factor in producing an audit, as specialized knowledge is more valuable in regulated industries than nonregulated industries. Local office personnel are far more likely to provide consultation than other practice office or national office personnel. Further evaluating industry-specific knowledge, Numan and Willekens (2012) examine the effects of competition through differentiation on audit pricing. Using U.S. data on Big 4 audit fees and client characteristics of relatively larger public companies for 2005 and 2006, the authors provide evidence that clients are willing to pay a premium for auditors that are more specialized towards their characteristics (e.g. auditor-client industry alignment; auditor industry market share dominance). Two recent studies explain in more detail the relationship of geographic location along with information communication and the performance of financial institutions. On the one hand, Petersen and Rajan (2002) provide evidence that electronic communication between small businesses and their lenders has not resulted in a degradation in loan defaults due to higher quality credit modeling made possible through the increased usage of information technology tools. On the other hand, Coval and Moskowitz (2001) provide evidence that there is a strong geographic link between mutual fund investment and performance as fund managers exploit informational advantages in their selections of nearby stocks. This finding suggests that human capital may play a significant role in service quality.

Organizational Learning and Firm-Specific Human Capital

In the psychology and strategic management research literature, resource-based theory suggests that human capital contains knowledge, skills, and abilities held in people and groups (e.g. Crook et al. 2011). Human capital can be either general in nature (e.g. industry experience) or specific to the company itself. Using a meta-analysis of studies of resource-based theory, Crook et al. (2011) provide evidence that specific-human capital (but not general human capital) is associated with improved corporate performance. The study took a further step towards better understanding how human capital shapes performance. It is important to realize that human capital appears essential to firm's viability and success. Similarly, organizational learning focuses on a more holistic understanding of human capital by analyzing how companies acquire, retain, and use knowledge. Huber (1991) conceptually defines organizational learning with several constructs: knowledge acquisition, information distribution, information interpretation, and organizational memory. Knowledge acquisition can be gained via experience, vicariously from others, or by hiring experienced personnel. However, while knowledge is important, it has relatively little usefulness without active implementation within the organization. Knowledge transfer refers to the situation in which knowledge developed for one task will assist an individual's judgment performance in another task

Additionally, some studies consider the effect of knowledge sharing in audit firms. In particular, audit firms can share information either through conversations between individuals (e.g. Starbuck 1992) or through a knowledge repository (e.g. internal database) per Vera-Muñoz et al. (2006). Starbuck (1992) emphasizes the importance of knowledge sharing at Knowledge-Intensive Firms ("KIFs"). The study finds that KIFs learn by hiring, training and dismissing personnel and convert ideas into physical capital, routines, organizational culture and social capital. To further study knowledge sharing in public accounting firms, Vera-Muñoz et al. (2006) examine the role of three factors: information technology ("IT"), formal and informal interactions among auditors and reward systems in encouraging knowledge sharing. The paper points out the difficulty in documenting the time and extra effort individual auditors need to sort through appropriate databases and collect relevant information since IT-based expert knowledge systems are not universally embraced within public accounting firms. Therefore, since knowledge sharing is performed at the organizational level, it is an organizational concept and not just a technological process. Indeed, it requires public accounting firms to be more willing to share knowledge through informational interpersonal interactions (Vera-Muñoz et al. 2006).

Analyzing the knowledge repository mode of dissemination, Banker et al. (2002) provide evidence that large public accounting firms are more efficient with greater IT capabilities. IT implementation has a positive impact on public accounting firms' productivity. This finding proves the importance of the value of audit automation and knowledge-sharing applications in public accounting firms. Regarding interpersonal interactions, Chow et al. (2008) provide survey evidence that tight audit time budgets and the possibility of professionals losing future promotions by helping their colleagues hamper interpersonal interactions. Nevertheless, we suspect that knowledge sharing by an industry sector leader (or through their leadership team) is more likely than under alternative knowledge sharing mechanisms. Since they are senior managing partners in the public accounting firms, these individuals likely have the greatest industry knowledge and a vested interest in enhancing the audit firm's reputation and market share in that industry. Further, PCAOB Auditing Standard No. 1110 and Quality Control Standard No. 20 mandate that audit teams refer to these personnel when complex accounting and auditing issues arise. As a result, audit firm partners will likely follow the guidance of their industry sector leader and involve them as appropriate

Prior Research on Individual Audit Partner Human Capital and Audit Pricing Hypothesis

Building upon the previous studies reporting audit fee premium for auditor industry expertise measured at the office level, Goodwin et al. (2014) extend the research measured at the partner level. The study used Australian Big 4 audit clients' data from 2003 to 2010 and provide evidence that neither firm-level nor office-level industry leadership are necessary or sufficient for auditors to earn a fee premium. Rather, individual partner-level specialization is a sufficient condition for a fee premium. This suggests that it is more important that firms develop audit partners with strong industry knowledge in order to increase the profitability of their services. Similarly, Zimmerman et al. (2018) provides evidence that human capital of audit partners is associated with audit fee premiums. Using LinkedIn data of self-reported auditor experience at the partner level among non-Big 4 firms, the study provides evidence that partners with prior Big 4 experience charge higher audit fees. Therefore, non-Big 4 offices with a greater number of partners with Big 4 experience arguably have a higher reputation level that eventually leads to higher audit fees. A potential inference from this study is that these partners with greater reputation may also have greater industry-specific capital. Beck et al. (2018) more directly capture human capital by examining two city-specific labor characteristics as proxies for a city's human capital: average educational attainment and the number of accountants in a city. The research provides evidence that human capital also appears to affect the supply and quality of public company audits. The study finds that there is a positive association between audit quality and average education level in the city where the lead engagement office is located. Additionally, a public company is more likely to choose a non-Big 4 auditor when the education level of human capital in the audit office is high.

Finally, Argote and Ingram (2000) theorize that organizations that develop knowledge internally gain a significant comparative advantage when this knowledge is difficult for competitors to replicate. In other words, audit firm leaders have an incentive to share their knowledge with audit teams since it may help enhance audit pricing. Therefore, hypothesis one predicts that firms with greater human capital in their local offices will be able to transfer this knowledge to their client engagements.

H1: *There will be a positive association between the geographic location of the audit sector leader and audit fees for clients located in the same geographic location.*

DATA AND METHODOLOGY

Research Model

From the conceptual level, this study considers the following research question: *is there an association between the geographic location of an auditing firm's industry sector leader and the audit fee charged to that same auditing firm's industry clients in that city?* We can think of the dependent variable as the economic value of a service and the independent variable as human capital. At an operational level, this study tests whether the location of an industry sector leader (proxy for local concentration of human capital) is associated with audit fees. As described in detail in the next paragraph, the dependent variable is audit fees and the independent variables are auditor industry, leading partner and geographic location. Control variables are auditor industry specialization, auditor city size, client accounting quality and client organizational complexity. Appendix A provides a visual depiction of the conceptual and operational summary of hypotheses in this study. In this study, ordinary least squares regression is used following prior audit pricing research and controls for key determinants of audit fees in non-financial industries (e.g. Hay et al. 2006). Our dependent variable is the log transformation of audit fees following prior literature (e.g. Francis et al. 2005). Our variable of interest in this study is *LeaderMSA*, which captures whether the auditor-client observation is geographically located in the same city as the audit firm's industry sector leader for the company's industry. For example, Deloitte's industry sector leader for the energy industry (Fama-French industry code 4) is located in Houston, Texas. Auditor-client observations in the energy industry for Deloitte in Houston are coded as one and any Deloitte audit clients in the energy industry located in other cities are coded as zero. Similar to previous audit pricing studies, all financial industry observations (Fama-French industry code 11) are dropped from the study. Equation 1 provides the OLS regression model for this study:

$$Log(Audit\ Fee) = \beta_0 + \beta_1 LeaderMSA + \beta_2 Big4 + \beta_3 JOINTLEADER + \beta_4 NATIONALONLY + \beta_5 CITYONLY + \beta_6 OfficeSize + \beta_7 Influence + \beta_8 Log(Assets) + \beta_9 DebtRatio + \beta_{10} ROI + \beta_{11} Opinion + \beta_{12} IC\_Opinion + \beta_{13} InvRec + \beta_{14} Log(Business\_Segments) + \beta_{15} HighLitigation + \epsilon \quad (1)$$

Control variables in this study capture both auditor-specific and company-specific determinants of audit fees. As shown in prior literature, an auditor's brand name (*Big4)* and auditor industry specialization (*JOINTLEADER; NATIONALONLY; CITYONLY)* have a positive association with audit fees. Additionally, characteristics of the audit firm office including its size (*OfficeSize)* measured by the number of clients and the relative influence of a large client in that office have been shown to be associated with audit fees. Regarding company-specific variables, firm size (*Log(Assets)),* financial health (*DebtRatio; ROI),* the outcome of the audit (*Opinion; IC_Opinion),* the company's liquid resources (*InvRec)* and its operational complexity (Log (Business_Segments) have a significant association with audit fees in prior literature. Table 1 provides a more detailed description of each of these variables.

Table 1: Variable Definitions

Variable	Definition
LAF	natural log of audit fees in millions of dollars
LeaderMSA	1= auditors who share the same city as their firm's partner in charge of the relevant Fama-French 12 industry sector, 0 = otherwise
Same_LeaderMSA	1 = LeaderMSA (defined above) is in the same location in both 2014 and 2017, 0 = otherwise
Big4	1 = auditor is a Big 4 firm, 0 = otherwise
JOINTLEADER	1 = auditors that are both national industry leaders and city-specific industry leaders where clients are headquartered, 0 = otherwise
NATIONALONLY	1 = auditors that are national industry leaders but not the city-specific industry leaders where clients are headquartered, 0 = otherwise
CITYONLY	1 = auditors that are not national industry leaders but are the city-specific industry leaders where clients are headquartered, 0 = otherwise
OfficeSize	log transformation of the number of public clients the audit firm has in the same city as the audit-client observation
Influence	Ratio of the audit fee for the audit-client observation relative to the total audit fees in the same city as the audit-client observation
Log(Assets)	log transformation of total assets in millions of dollars
DebtRatio	ratio of long-term debt to total assets
ROI	ratio of earnings before interest and tax to total assets
Opinion	indicator variable derived from Compustat, 1 = an unqualified audit report with additional language (e.g. explanatory paragraph) or a non-clean audit opinion, 0 = otherwise
IC_Opinion	indicator variable derived from Compustat, 1 = not unqualified internal controls audit report, 0=otherwise
InvRec	ratio of inventory and receivables divided by total assets
Log(Business_Segments)	log transformation of the number of business segments of the company
HighLitigation	1 = company primarily operates in a high litigation industry SIC per Francis et al. (1994), 0 = otherwise

Empirical Data

The sample of this study covers fiscal year 2016 external audit engagements for all public accounting firms that the PCAOB inspects on an annual basis. These include public company audits performed by the Big 4 public accounting firms as well several other public accounting firms with large public company audit practices (BDO; Cohen & Company; Crowe Horwath; Grant Thornton; MaloneBailey; Marcum; RSM). Due to the frequency of PCAOB inspections and the fact that all of these firms have at least 100 publicly traded clients, each of these firms likely have similar capability to organize its human capital by industry. Audit firm leader demographic data was hand collected during November 2017 from audit firm websites and matched to the closest Fama-French industry group. For instances where no audit leader was listed on an audit firm website (more common outside of the Big 4), it was assumed that the audit firm did not have an audit firm leader and *LeaderMSA* was coded as zero for these industry's observations. Additionally, all observations in Fama-French industry group 12 (i.e. the "other" group) were coded as zero for *LeaderMSA*.

All auditor-specific control variables, as well as the audit fees for the auditor-client observation, are extracted from Audit Analytics. We then match this data with company specific data from Compustat. As a result of this matching protocol, there were 2334 available observations in the population from fiscal year 2016. As a result, there is only one observation per company in the dataset. Of these available observations, 1450 observations were performed by Big 4 public accounting firms and the remaining 834 observations were audits performed by other annually inspected public accounting firms with large public company audit practices named in the previous paragraph.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 2 provides descriptive statistics for each of the variables included in the study. Most notably, roughly eight percent of the observations in the study are for auditor-client observations located in the same city as that firm's industry sector leader. This percentage is somewhat lower than the percentages for the industry specialization categories for two reasons: (1) some industries are more geographically concentrated (e.g. energy) than others (e.g. manufacturing) and (2) not every public accounting firm has an industry sector leader in every industry. At the median, an observation in the study has a Big 4 auditor, charges just below $1 million in audit fees, and comprises roughly 60 percent of the audit fees earned by public company audits from that office across all industry sectors. Generally, these companies are also relatively large with assets of roughly $400 million, operate three business segments, and receive clean financial statement and internal control audit opinions.

Table 2: Univariate Statistics

Variable	N	Min	Mean	Median	Max	Std Dev
LAF	2334	8.92	13.59	13.69	18.22	1.44
LeaderMSA	2334	0	0.08	0	1	0.27
Big4	2334	0	0.62	1	1	0.49
JOINTLEADER	2334	0	0.15	0	1.00	0.36
NATIONALONLY	2334	0	0.07	0.00	1.00	0.25
CITYONLY	2334	0	0.21	0.00	1.00	0.41
OfficeSize	2334	1.79	3.91	4.19	4.50	0.61
Influence	2334	0	0.60	0.63	1	0.40
Log(Assets)	2334	0	5.91	5.96	12.81	2.48
DebtRatio	2334	0	0.25	0.17	31.99	0.75
ROI	2334	-6.94	-0.15	0.03	43.45	1.07
Opinion	2334	0	0.20	0	1.00	0.40
IC_Opinion	2334	0	0.04	0	1.00	0.20
InvRec	2334	0	0.20	0.14	1.00	0.19
Log(Business_Segments)	2334	0	1.02	1.10	3.50	0.92
HighLitigation	2334	0	0.42	0	1.00	0.49

Variables are defined previously in Table 1.

Table 3 provides a univariate correlation table to display the relationships among different variables for the main variables and the auditor-specific control variables in this study. Pearson correlation statistics are included above the diagonal line and Spearman correlation statistics are included below the diagonal line. Coefficients with three stars are statistically significant at the 1% level. Reviewing the dependent variable (Log(Audit Fees)), there is a positive association with the variable of interest (*LeaderMSA)* providing initial univariate support for the study's hypothesis. Most notably, there is no evidence of heteroscedasticity between *LeaderMSA* and any of the other control variables as the largest correlation is -0.28. Among the remaining control variables, there are several strong positive associations with Log(Audit Fees) consistent with prior literature.

Table 3: Univariate Correlations

No.	Variable	1	2	3	4	5	6	7	8
1	LAF		0.12 ***	0.66 ***	0.31 ***	0.10 ***	0.24 ***	-0.05 ***	-0.15 ***
2	LeaderMSA	0.12 ***		0.12 ***	0.01	-0.05	-0.07 ***	0.00	-0.27 ***
3	Big4	0.68 ***	0.12		0.33 ***	0.21 ***	0.23 ***	-0.01	-0.37 ***
4	JOINTLEADER	0.31 ***	0.01	0.33 ***		-0.11 ***	-0.22 ***	-0.08 ***	-0.17 ***
5	NATIONALONLY	0.11 ***	-0.05	0.21 ***	-0.11 ***		-0.14 ***	0.02	-0.03
6	CITYONLY	0.24 ***	-0.07 ***	0.23 ***	-0.22 ***	-0.14 ***		-0.07 ***	-0.05 ***
7	OfficeSize	-0.08 ***	-0.01	0.02	-0.04	0.01	-0.08 ***		-0.24 ***
8	Influence	-0.15 ***	-0.28 ***	-0.38 ***	-0.18 ***	-0.03	-0.06 ***	-0.29	

Variables are defined previously in Table 1.

Empirical Results

In this study, there is a hypothesized positive association between the location of the audit firm's industry sector leader and audit fees. This is due to the fact that the individual serving as the industry sector leader is likely to be among the most experienced audit partners in the firm in that industry and these individuals likely proxy for strong human capital in that industry for which companies are willing to pay a fee premium to access. While most significance tests in the tables are two-tailed, the hypothesized relationship is tested as a one-tailed test given the structure of hypothesis one predicting a positive association between human capital and audit fees.

Table 4: Multivariate OLS Regression of Auditor and Company characteristics on Audit Fees

	Dep. Var. = Log (Audit Fee)				
Parameter	**Pred.**	**Est.**	**Std. Err.**	**t Value**	**Pr > |t|**
Intercept		10.155	0.135	75.030	<.0001 ***
Variable of Interest					
LeaderMSA	?	0.182	0.046	3.940	<.0001 ***
Audit Firm Control Variables					
Big4		0.511	0.044	11.720	<.0001 ***
JOINTLEADER		0.145	0.045	3.250	0.001 ***
NATIONALONLY		0.030	0.054	0.550	0.582
CITYONLY		0.171	0.035	4.950	<.0001 ***
OfficeSize		0.004	0.031	0.130	0.893
Influence		0.061	0.043	1.420	0.155
Company Control Variables					
Log(Assets)		0.454	0.011	42.530	<.0001 ***
DebtRatio		0.032	0.019	1.720	0.086 *
ROI		-0.023	0.041	-0.570	0.571
Opinion		0.112	0.037	3.000	0.003 ***
IC_Opinion		0.244	0.083	2.940	0.003 ***
InvRec		0.499	0.096	5.180	<.0001 ***
Log(Business_Segments)		0.065	0.018	3.650	0.000 ***
HighLitigation		-0.006	0.040	-0.140	0.887
Fama-French 12 Group Dummies		Yes			
White Heteroscedasticity Correction		Yes			
Number of Observations		2,334			
R-squared		0.811			
Adjusted R-squared		0.809			
Root Mean Square Error		0.629			

LeaderMSA is 1= auditors who share the same city as their firm's partner in charge of the relevant Fama-French 12 industry sector, 0 = otherwise.
Big4 is 1 = auditor is a Big 4 firm, 0 = otherwise.
JOINTLEADER is 1 = auditors that are both national industry leaders and city-specific industry leaders where clients are headquartered, 0 = otherwise.
NATIONALONLY is 1 = auditors that are national industry leaders but not the city-specific industry leaders where clients are headquartered, 0 = otherwise
CITYONLY is 1 = auditors that are not national industry leaders but are the city-specific industry leaders where clients are headquartered, 0 = otherwise.
OfficeSize is the log transformation of the number of public clients the audit firm has in the same city as the audit-client observation.
Influence is the ratio of the audit fee for the audit-client observation relative to the total audit fees in the same city as the audit-client observation.
Log(Assets) is the log transformation of total assets in millions of dollars.
DebtRatio is the ratio of long-term debt to total assets.
ROI is the ratio of earnings before interest and tax to total assets.
Opinion is 1 = an unqualified audit report with additional language (e.g. explanatory paragraph) or a non-clean audit opinion, 0 = otherwise.
IC_Opinion is 1 = not unqualified internal controls audit report, 0=otherwise
InvRec is the ratio of inventory and receivables divided by total assets.
Log(Business_Segments) is the log transformation of the number of business segments of the company.
HighLitigation is 1 = company primarily operates in a high litigation industry SIC per Francis et al. (1994), 0 = otherwise.

Table 4 provides the results of the OLS regression shown in equation 1. Consistent with prior audit pricing research, this regression has a relatively high R^2 value ($R^2 = 0.81$) and corrects for heteroscedasticity since audit fee models typically have more predictive power for larger companies. As shown in Table 4, there is a positive association between *LeaderMSA* and the dependent variable (*coefficient = 0.18, t<.0001*) providing support for hypothesis one. In other words, companies are more willing to pay a fee premium when the audit firm's industry sector leader works in the same city. This result holds while controlling for factors shown to have significant associations with audit fees: auditor brand name (*Big4),* auditor industry specialization (*JOINTLEADER; CITYONLY)*, company size (*Log(Assets)),* less than optimal audit opinion outcomes (*Opinion; IC_Opinion)*, more liquid company resources (*InvRec),* and greater operational complexity (*Log(Business_Segments))*. In an untabulated regression, we split the full sample into two subsamples based upon auditor brand name (Big 4 – 1450 observations; non-Big4 – 834 observations) to verify whether this positive association is consistent across the full sample. Repeating the same empirical model, while there is a positive association between *LeaderMSA* and audit fees in both subsamples, it is only statistically significant in the Big 4 subsample *(coefficient = 0.21, t<.0001).* Overall, these results suggest that human capital is an important factor when considering the pricing of audit services. More specifically, it is likely that knowledge sharing is more likely to occur in local offices (e.g. Vera-Muñoz et al. (2006)) as its barriers are relatively lower despite the interconnected nature of the modern business environment.

Sensitivity Analysis - Variation in Industry Geographic Concentration

One potential confounding factor for the main result is that certain industries are naturally more concentrated geographically (e.g. energy industry). Within these industries, it is feasible that the geographic location of the audit industry sector leader is not primarily tied to human capital but rather selected based upon economic or competitive necessity. Among the ten Fama-French 12 industry groups used in the study, the energy industry has a geographic center in Houston (MSA 26420). Additionally, three other industries have at least three public accounting firms with their industry sector leader in the same city: consumer nondurable goods (Fama-French code 1) in New York City (MSA 35620), manufacturing (Fama-French code 3) in Chicago (MSA 16980), and wholesale retail (Fama-French code 9) in New York City (MSA 35620). To address this potential concern, the main test is repeated in an untabulated regression by splitting the main data into highly concentrated (n=1167) and low concentration (n=1167) subsamples. In both groups, while the result is stronger in the highly concentrated subsample, there is a positive and statistically significant association between *LeaderMSA* and the audit fee charged to clients in both subsamples. This result provides evidence that the degree of industry geographic concentration does not appear to be the primary driver of the main result.

Sensitivity Analysis - Variation in Auditor Market Leadership Dominance and Office Size

Within the main regression in Table 3, two of the three variables corresponding to auditor industry specialization (*JOINTLEADER; CITYONLY)* were positively associated with audit fees. Neither of these coefficients were significantly correlated with our test variable *LeaderMSA* and, in an untabulated regression, there was no statistically significant interaction effect associated with audit fees between any of the industry specialist variables and *LeaderMSA.* Nevertheless, prior literature on auditor industry specialization notes that audit firms with a dominant market leadership position may have incentives to lower audit fees to maintain their leadership (e.g. Cahan et al. 2008; Bills et al. 2015). To address this potential concern, we split the full sample into two subsamples based upon whether there is a dominant market leader in the Fama-French industry grouping used for identifying the audit firm industry sector leader (i.e. greater than 10%). Six industries had such a leader: consumer nondurables (code 1), consumer durables (code 2), energy (code 4), chemicals (code 5), telecommunications (code 7), and utilities (code 8). Repeating the main table regression for these two subsamples, the main result of a positive association between *LeaderMSA* and audit fees holds in both subgroups.

Additionally, as noted in the literature review section, recent prior literature on auditor industry specialization has paid particular attention to the role of auditor office size in moderating the effect between auditor industry specialization and audit fees. While there was no association between auditor office size and audit fees in the main regression, it is feasible that larger audit offices may be more likely to have an audit firm industry sector leader and the joint effects could confound the main result. Running a regression splitting the main sample into subsamples based upon auditor office size using both the mean and median office size, in each case the main result holds in both the large office size subsample and the small office subsample.

Sensitivity Analysis - Consistency of Auditor Industry Market Leader Geographic Location over Time

As noted in the empirical data section, auditor industry sector leader data is hand collected from the websites of the annually inspected auditing firms. While this data should have high construct validity since clients may make financial decisions using this information, individuals serve as a sector leader for various lengths of time and frequent turnover in this role may be associated with a corresponding diminishment of human capital.

Table 5: Multivariate OLS Regression of Auditor and Company characteristics on Big 4 Firm Audit Fees

	Dep. Var. = Log (Audit Fee) Big 4 Subsample				
Parameter	**Pred.**	**Est.**	**Std. Err.**	**t Value**	**Pr > |t|**
Intercept		10.435	0.177	59.070	<.0001 ***
Variable of Interest					
Same_LeaderMSA	?	0.206	0.057	3.580	0.000 ***
Audit Firm Control Variables					
JOINTLEADER		0.177	0.046	3.880	0.000 ***
NATIONALONLY		0.011	0.054	0.200	0.842
CITYONLY		0.158	0.039	4.090	<.0001 ***
OfficeSize		0.078	0.040	1.970	0.049 **
Influence		0.176	0.051	3.420	0.001 ***
Company Control Variables					
Log(Assets)		0.434	0.012	36.040	<.0001 ***
DebtRatio		0.172	0.054	3.200	0.001 ***
ROI		0.008	0.018	0.460	0.647
Opinion		0.077	0.047	1.620	0.105
IC_Opinion		0.232	0.106	2.180	0.030 **
InvRec		0.698	0.161	4.330	<.0001 ***
Log(Business_Segments)		0.060	0.021	2.800	0.005 ***
HighLitigation		-0.071	0.052	-1.350	0.176
Fama-French 12 Group Dummies		Yes			
White Heteroscedasticity Correction		Yes			
Number of Observations		1,450			
R-squared		0.697			
Adjusted R-squared		0.691			
Root Mean Squared Error		0.591			

Same_LeaderMSA is 1=LeaderMSA (auditors who share the same city as the their firm's partner in charge of the relevant Fama-French 12 industry sector) is in the same location in both 2014 and 2017, 0 = otherwise
JOINTLEADER is 1 = auditors that are both national industry leaders and city-specific industry leaders where clients are headquartered, 0 = otherwise.
NATIONALONLY is 1 = auditors that are national industry leaders but not the city-specific industry leaders where clients are headquartered, 0 = otherwise
CITYONLY is 1 = auditors that are not national industry leaders but are the city-specific industry leaders where clients are headquartered, 0 = otherwise.
OfficeSize is the log transformation of the number of public clients the audit firm has in the same city as the audit-client observation.
Influence is the ratio of the audit fee for the audit-client observation relative to the total audit fees in the same city as the audit-client observation.
Log(Assets) is the log transformation of total assets in millions of dollars.
DebtRatio is the ratio of long-term debt to total assets.
ROI is the ratio of earnings before interest and tax to total assets.
Opinion is 1 = an unqualified audit report with additional language (e.g. explanatory paragraph) or a non-clean audit opinion, 0 = otherwise.
IC_Opinion is 1 = not unqualified internal controls audit report, 0=otherwise
InvRec is the ratio of inventory and receivables divided by total assets.
Log(Business_Segments) is the log transformation of the number of business segments of the company.
HighLitigation is 1 = company primarily operates in a high litigation industry SIC per Francis et al. (1994), 0 = otherwise.

While this study cannot eliminate the risk that human capital may be lost, we attempt to address this concern by developing a longer time series of hand collected data dating back to 2014 using data hand collected Big 4 firm websites during a preliminary phase of data collection. For these Big 4 firms, we can identify whether the industry sector leader is consistently located in the same city and restrict our human capital proxy to those industries where the sector leader is in the same city both in 2014 and in 2017 (*Same_LeaderMSA)*. Table 5 provides a regression similar to equation one with the exception that we replace *LeaderMSA* with the previously described variable where the industry sector leader location is the same in both periods (*Same_LeaderMSA)*. This data restriction allows for a cleaner test of human capital in the Big 4 subsample where the primary results were strongest. Reviewing Table 5, there is a positive association between our updated human capital proxy (*Same_LeaderMSA)* and audit fees (coefficient = 0.21, t<.01). This result provides additional support for hypothesis 1 that human capital is positively associated with audit fees.

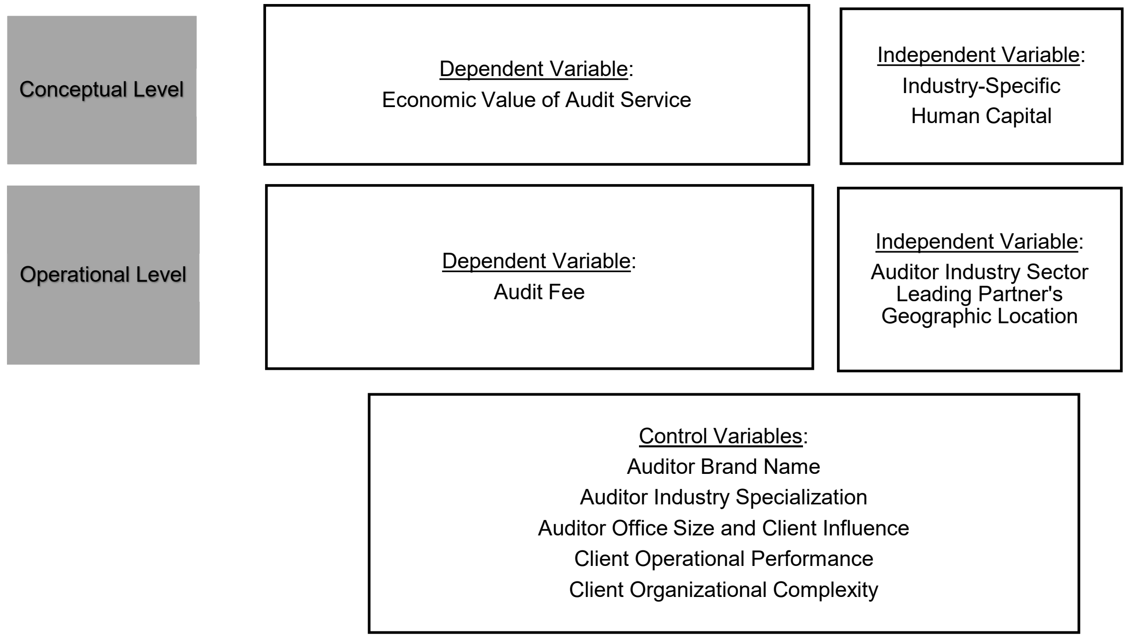
CONCLUDING COMMENTS

The purpose of the study is to examine whether there is an association between the geographic location of industry sector leaders in an auditing firm and audit fees for that same auditing firm's industry clients. Building upon prior research that examines the role of individual partner expertise on audit quality (e.g. Goodwin et al. 2014; Zimmerman et al. 2018) and on human capital and audit quality (e.g. Beck et al. 2018), this study provides evidence that a positive association exists between the geographic location of industry sector leaders (proxy for industry-specific human capital) and audit pricing. This result is robust to alternative explanations, including differences in the geographic concentration of industries, in market dominance and office size of audit firms, and the stability of audit firm industry sector leaders over time.

This study is subject to several limitations. First, there is a limitation for our data collection process. Beyond the Big 4, some annually inspected public accounting firms do not identify industry sector leader information published on the companies' websites for every Fama-French 12 industry subgroup. While this may suggest that these firms wish to focus in specific industries, this nonetheless eliminates a number of auditor-client pairings from empirical analysis. Second, due to the timing of this study, we cannot identify the audit partner signing the audit opinion (and thus responsible for the specific audit engagement – including negotiating audit fees). Given the new requirement under PCAOB Auditing Standard 3101 to disclose the audit partner name on Form AP, future research can disentangle the effect of knowledge transfer by controlling for partner-specific reputation.

Finally, this finding has implications for practicing accountants. Since knowledge sharing and transfer are very important in the auditing industry, interactions among skilled auditors can help the public accounting firms to leverage the skills of the workers and enhance overall audit quality. Nevertheless, we recognize that despite publicized efforts of public accounting firms, knowledge and expertise is likely greater in particular. Human capital is a valuable asset for companies and it is critical that knowledge is utilized in audit practice not only to receive financial benefits in the form of higher audit fees but also in producing high quality audits that protect investors from financial misstatements.

APPENDIX A: Conceptual and Operational Summary of Study



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