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企業股價抗跌性與資訊透明度之關聯：股市崩盤情境之例證

Corporate Transparency as a Defense against a Stock Price Plunge: Evidence from a Market-Crash Context

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摘要：股市崩盤以及崩盤所衍生的金融感染效應為財務領域中之重要議題，但目前的相關研究論述僅侷限於股市崩盤成因之探討及現象之描述，對於崩盤引發的純粹性金融感染及股價抗跌之相關議題未有著墨。本研究是第一篇由股市崩盤情境，探討企業的透明度對其股價抗跌性影響之文章，主要的創新與貢獻性在於確立企業的資訊透明度與其股價抗跌性間的關係；此外，亦以基因演算法做為變數重要性定序技術，針對影響股價抗跌性之攸關變數進行篩選以提升模型有效性。以 2003-2006 年臺灣地區實證資料之研究結果發現，資訊透明度較佳的企業，在股市崩盤時確實有較好的股價抗跌表現；再者，多元迴歸分析結果指出股價抗跌性與 Beta 值呈現顯著負相關，但交易量和本益比兩控制變數均未達顯著水準。

關鍵詞：公司透明度；資訊揭露；股價抗跌性；股市崩盤；變數重要性定序

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Abstract: Stock market crashes and the related financial contagion effects on stock price are important issues in the field of finance. Preventing a sharp plunge in stock prices in reaction to a market crash is an important risk management task. However, there has not been any discussion about how a firm can better protect its stock value in a market crash. This study, being among the first of its kind, sets out to examine the impact of the information transparency of a firm on its ability to defend against a plunge in its stock price in the specific context of a market crash, as well as to perform screening for vital variables affecting stock price defense with a genetic algorithm as the variable importance ranking technique. Utilizing unique pooled firm-event data for listed firms in Taiwan over the sample period 2003-2006, the results of this study substantiate the conjecture that a firm with superior information transparency has greater ability to defend its stock price on the day of a market crash. In addition, multiple regression results show that stock price defense is negatively related to Beta, while trading amount and P/E ratio are not statistically significant in explaining stock price defense.

Keywords: Corporate transparency; Information disclosure; Stock price defense; Market crash; Variable importance ranking

1. Introduction

The stock market remains a common and popular investment vehicle, but investment in common stock is fraught with great uncertainty and risks because there is a wide range of unproven information prevailing in the stock market. Sornette (2003) indicated that if the market is efficient, a stock's price should change with the arrival of new information. Cataclysmic events, such as the 9/11 terrorist attacks in 2001 and the bankruptcy of Lehman Brothers in 2008, caused panic among investors and stock market plunges, which eventually resulted in market crashes. A market crash is a sudden drastic decline of stock prices across a significant cross-section of the market. It is often driven by panic amongst the investors. During a market crash, external economic events combine with crowd

behavior and psychology in a loop where selling by some market participants drives more market participants to sell.

Johansen, Ledoit, and Sornette (2000) and Das and Uppal (2004) concluded that individual stock prices are susceptible to the strong and negative co-movement of a financial contagion effect during a market crash; as a result, many of them become significantly undervalued. Being an unusual financial disaster, a market crash is characterized by a large-scale negative price movement that not only impacts harshly on firms and investors but also seriously threatens the stability of the financial market (Hong and Stein, 2003). There have been few studies examining stock market crashes, and they generally fall into two directions in research: one that focuses on the causes, process, and stock price contagion of a market crash (see, e.g., Johansen and Sornette, 1999; Focardi, Cincotti, and Marchesi, 2002; Barlevy and Veronesi, 2003; Das and Uppal, 2004); while the other one examines the impacts of a market crash and its contagion as a domino effect among different economic bodies (see, e.g., Patel and Sarkar, 1998; Aggarwal, Inclan, and Leal, 1999; Johansen and Sornette, 2010).

This study specifically scrutinizes the scenario of a market crash. When comparing events that shake the stock market or lead to a market crash, the most obvious difference found is the abnormal returns on stocks. In regular conditions, an abnormal return could be either positive or negative, while that in a market crash is negative with almost no exception due to the loss suffered by all firms involved. In other words, the expectations and investment behavior in regular conditions strive for the greatest returns relative to the risk. In contrast, the expectations and investment behavior during a market crash attempt to suppress the potential loss in response to price declines. These two approaches reflect the difference in investment preferences between speculative risks and pure risks.

Among the various events that initiate a market crash, the essential cause is believed to be the investors' pessimistic view toward stock performance as a result of information asymmetry and inadequate information, which leads to panic selling (Sornette, 2003). Literature on corporate disclosure and transparency indicates that superior information transparency helps to lessen information asymmetry (Lang and Lundholm, 1996) and strengthen investors' knowledge of a

business's management and risks (Sheu and Lin, 2006). Gelb and Zarowin (2002) and Chi (2009) discovered that a firm would increase the level of information transparency in order to prevent misguided interpretation of its business performance. Myers and Majluf (1984) assumed that information asymmetry potentially devalues the share price of an individual stock. In these respects, this study proposes that during a market crash firms with superior information transparency are better able to defend themselves against the negative contagion effect and, thus, better able to stabilize their stock prices. As there are no studies which have examined the relationship between corporate transparency and defense against a stock price plunge (hereinafter referred to as "stock price defense") in the context of a market crash, this study aims to fill this gap in the literature.

Kim and Chun (1998) contended that most investment administration and financial risk models focus on the selection of variables, and this view has been widely supported by researchers (see, for example, Thawornwong and Enke, 2004; Chi and Tang, 2007, 2008). Even though there are numerous variables used in research on stock returns, they might not apply effectively to research on stock price defense in the context of a market crash. They could either be redundant or even misleading due to the distinct difference in investment strategies between regular conditions and market crashes. In addition, the factors that would affect stock prices in regular conditions and market crashes respectively could vary. Numerous studies have examined the factors contributing to stock price movements, but there is little or no research that identifies the vital factors affecting stock price defense in market crash settings, hence an empirical investigation is particularly valuable, and this motivates the present study.

The genetic algorithm (the GA) has proved to be particular useful for feature selection (Kudo and Sklansky, 2000; Leardi, 2000; Chi and Tang, 2007), especially concerning nonlinear price movements in the financial markets (Chi, 2009). Therefore, this study attempts to screen for those variables affecting stock price defense with the GA as a variable importance ranking technique. As a result of this, the usefulness and importance of individual variables will be objectively evaluated and the effective ones retained, thereby increasing model validity and

predictability (Chi and Tang, 2007; Chi, 2009).

To conclude, this study, being the first of its kind to examine the impact of corporate transparency on stock price defense as well as to identify the vital factors affecting stock price defense, aims to add to the scant body of literature in the area of a market crash. It utilizes unique pooled firm-event data for listed firms in Taiwan during the period 2003-2006. Results from the variable importance ranking show that all four input variables (corporate transparency, Beta, P/E ratio, and trading amount) underlying this study are useful in explaining the variance of price movements in a crash, but only the first two are considered important. Further, the results of the multiple regression show that only two of the input variables are significantly related to stock price defense. More specifically, corporate transparency and Beta are significant and other variables such as trading amount and P/E ratio are insignificant in explaining the level of stock price defense. Synthesizing the empirical findings, this study substantiates the conjecture that a firm with superior information transparency has a stronger stock price defense on the day of a market crash.

The remainder of this paper is structured as follows. Section 2 provides a review of the extant literature and the derivation of the research hypotheses. Section 3 describes the data and explains the research design. Section 4 then presents the empirical findings. The conclusions are summarized in Section 5.

2. Literature Review and Hypotheses

2.1. Causes of a Stock Market Crash

Stock market crashes usually evolve from business cycles (a series of economic busts and booms), natural disasters, or panic selling induced by political or economical events, sometimes even random events. Lamb (1995) and Focardi *et al.* (2002) concluded that a market crash was a reaction to particular crises, such as financial storms and huge natural disasters. However, a market crash is not dependent upon a crisis, as Madrigal and Scheinkman (1997) and Barlevy and Veronesi (2003) suggested: a market crash can occur despite the absence of any

corresponding change in the economic fundamentals of the underlying assets. Sornette (2003) believed that a market crash was the aftermath of a price bubble which appeared even without uncertainty, speculation, or bounded rationality. He also suggested that a bubble might ultimately be caused by processes of price coordination or emerging social norms. A bubble is most likely to form when intense speculation and investor optimism combine to drive up stock prices considerably, usually within a relatively short span of time. The collapse of bubbles leads to a recession and a stock market crash.

The process of a market crash reflects the psychology of investors (especially noise traders who make their investment decisions partly on irrational factors): to buy high out of greed and sell low out of fear, which causes overvaluing and overshooting in the stock price. Specifically, when investors have no access to an adequate and current analysis of the market, they rely more on experience and instinct. In a normal business cycle, the market is presumed to trend upward over time despite short-term setbacks. During a normal business cycle, investor psychology is mostly optimistic; when stocks are down investors see them as good deals, assuming they will rise in the future, which stimulates popular demand. As a result of cognitive errors and the herding effect, investor overconfidence spurs excessive investment, leading to escalated stock prices. At the point when a certain stock price reaches a level so disjointed from what its true value should be, investors begin to pull back and sell. As soon as investors feel a price bubble is beginning to burst or an unexpected event with potentially negative effects hits, the stock price drops rapidly, which can adversely affect other parts of the economy, and spur a market crash (Statman, 1999; Wermers, 1999).

To conclude, based on missing or misperceived information, investors tend to overreact to the market out of fear and uncertainty, thus indulging themselves in "escape behavior," where individual investors join the crowd of others in a rush to get out of the market. Those investors flood the exchange with sell orders. As a result, more market participants are driven to sell. Sentiments are mirrored in the prices of the stock. As panic sets in, the stock prices go down and this panic selling eventually leads to a market crash (Zeira, 1999).

2.2. Corporate Transparency

Corporate transparency defines the degree of completeness of management and financial information provided to the market. The information includes notes, material information, and future perspectives on business strategy or plans from the management level (Botosan, 2006; Sheu and Lin, 2006). The principle of information disclosure and transparency is to provide reliable, up-to-date, and transparent information. Reliability and promptness refer to information quality, while transparency indicates the quality of information disclosure (Healy and Palepu, 2001).

Previous studies have indicated that greater transparency and better disclosure reduce the information asymmetry between a firm's management and its investors, mitigating the agency problem in corporate governance, and thus creating economical benefits. These benefits include increased business value (Frankel, Mcnichols, and Wilson, 1995; Chi, 2009), increased stock liquidity (Lang and Lundholm, 1996; Botosan, 2006), stabilized volatility of stock prices (Pagano and Roell, 1996; Liu and Ziebart, 1999) as well as reduced costs of equity and debt (Francis, Khurana, and Pereira, 2005; Gietzmann and Ireland, 2005; Mazumdar and Sengupta, 2005; Nikolaev and Van Lent, 2005; Chen, 2008). In addition, superior corporate disclosure and transparency help a firm deliver better performance that promotes stock trades and strengthens market development (Healy and Palepu, 2001; Sheu and Lin, 2006; Ma, Lin, and Chen, 2008).

2.3. Corporate Transparency and Stock Price Defense

The abnormal returns of individual stocks are highly relevant in a market crash triggered by an aggregate crisis, where a contagion effect on individual stock prices is observed (Diebold, Schuermann, and Stroughair, 2000; Johansen, Ledoit, and Sornette, 2000; Das and Uppal, 2004). A market crash is deeply rooted in the irrational panic of its investors. This financial panic can be traced back to incomplete disclosure and information asymmetry that fail to provide investors with sufficient information for decision-making (Sornette, 2003; Smick,

2008).

Stock price movements are closely linked to the reaction of investors to the information provided and their value judgment. In a market crash, even contrarian investors, who bet against irrational investors, who sell after a market rally and buy after a market downturn would restrict their stock operations due to lower risk tolerance. They would prefer buying stocks from firms with superior information transparency to lessen investment risks. Furthermore, for a better-performing firm, superior corporate transparency (less information asymmetry) helps to secure its stock price in a reasonable range (Myers and Majluf, 1984; Sheu and Lin, 2006). Contrarily, a firm with inferior information transparency fails to provide adequate information concerning its business value and management risks: a fact that eventually contributes to excessive selling and price drop in a market crash. To conclude, instead of selling all their stock, investors are more optimistic about holding shares from a firm with superior information transparency, and those shares tend to show a greater price defense.

This study assumes that investors will depend heavily on the function of information transparency for their decision-making during a market crash. A firm with superior information transparency has greater resistance to the strong and negative co-movement of a contagion effect on individual stock prices and, thus, is able to prevent its stock price from being undervalued. The following hypothesis is evaluated:

H1: On the day of a market crash, a firm with superior information transparency has a greater stock price defense.

2.4. Factors That Influence Stock Price Defense

Focardi *et al.* (2002) stated that the short-term behavior of stock prices may be determined by the purely speculative behavior of agents. In a market crash, since investors are likely risk averse, they hurry to throw their holdings into the market to minimize losses, making the price plummet. Specifically, this psychological tendency of loss aversion causes a strong negative demand shock among investors and more declines in stock prices. Therefore, a vicious circle is

formed due to stock downturns and fear of losses, resulting in greater drops in stock prices.

Market crashes are extreme events. Statistical evidence has shown that a stock market crash is an outlier of the distribution of market price variations (Johansen and Sornette, 1999, 2010; Hong and Stein, 2003; Chen, 2008). There are unique and specialized models to analyze stock returns in a market crash, such as the risk-driven model and price-driven model proposed by Sornette (2003). Due to a lack of discussion on the vital factors that contribute to stock returns and stock price defense in earlier research, this study identifies three potential factors: price-to-earnings ratio (P/E), trading volume, as well as Beta (BETA), and examines their correlation with stock price defense. The respective discussions are presented below.

1. P/E ratio and stock price defense

The discrepancy between the value estimated by a stock valuation tool and the actual market value presents an important signal; the market will eventually correct any large price deviations. If a stock price is significantly overvalued prior to a market crash, it will plunge in the crash and lead to lower stock returns. It is traditionally perceived that the P/E ratio of a stock is perhaps the single most important investment benchmark: it mirrors the price investors are willing to pay for each dollar the firm expects to earn (Bradshaw, 2000; Shamsuddin and Hillier, 2004). That is, a P/E ratio acts as an important indicator of stock investment returns (Abarbanell and Bushee, 1997; Aydogan and Gursoy, 2000).

During a market crash, investors face great changes in their investment earnings and risk perception. As a result, an overwhelming majority of pessimistic investors escape from the market by selling their shares to secure their wealth and prevent further losses. The stock price drops even deeper as more investors dump their holdings. Accordingly, a negative-feedback effect occurs and stimulates more selling, which further depresses the market. Campbell and Shiller (2001) stated that investors tend to be over optimistic toward stocks with high P/E while remaining over pessimistic toward ones with low P/E. When they found the stock price unreasonable, they shifted from high P/E stocks to low P/E ones. In addition, Campbell and Shiller (2001) substantiated that low P/E stocks generate higher

returns as compared to high P/E ones.

This study assumes that investors would try to keep their wealth by selling higher-priced stocks in a market crash. Within the same price decline, these stocks fluctuate more in price and are prompted to greater loss compared to lower-priced ones. In general, high P/E stocks suggest that investors are expecting high earnings growth in the future; therefore stocks with high P/E normally come with high price tags, and vice versa. During a down market, high P/E stocks show a greater percentage loss and increased investment risk compared to low P/E stocks. It is believed that the stock with a higher (lower) P/E on the day prior to a market crash shows a weaker (stronger) price defense on the day of a crash (D0).

H2: The P/E of a stock on D-1 and its stock price defense on D0 are negatively correlated.

2. Trading volume and stock price defense

Trading volume represents the amount of securities traded per period. It has long been one of the major variables hypothesized to explain stock price movements in financial research. The market determines a stock's price, and the trading volume represents the amount of interest in that determination. The price of a stock and its volume illustrate a delicate balance between fear and greed. Therefore, it is important to analyze the relationship between price and volume when discussing trading behavior in stock market. There are two important strands of literature on price-volume relationship: the contemporaneous relationship and lead-lag relationship. The former uses data of price and volume change at one point of trading (e.g., Cooper, 1999); while the latter is further divided into three sections: the impact of volume on price (Sheu, Wu, and Ku, 1998), the impact of price on volume (Silvapulle and Choi, 1999), and the mutual effects between price and volume (Hiemstra and Jones, 1994).

According to Harris and Raviv (1993), trading volume and the absolute value in stock price change are positively correlated: the greater the trading volume in the previous quarter, the greater the change in stock prices. In a similar vein, Campbell, Grossman, and Wang (1993) discovered that trading volume had a negative impact on the returns in the subsequent quarter; *i.e.*, the greater the

trading volume, the deeper the drop in future returns. Sheu *et al.* (1998) reported consistent results for the Taiwan context where there was a negative correlation between the trading volume in the previous quarter and future stock returns. Most lines of research agree that trading volume provides information content in estimating future price change in stocks. Therefore, this study predicts a relatively lower future stock return following the overheated trading on the previous day, which implies that the lower the trading volume on D-1, the greater the stock price defense on D0.

H3: The trading volume of a stock on D-1 and its stock price defense on D0 are negatively correlated.

3. Beta and stock price defense

In finance, Beta (BETA) is a measure of a stock's price volatility in relation to the rest of the market. The greater the Beta, the more sensitive are the returns on the stock to changes in the returns on the market, and the greater the relevant risk of that stock. A number of researchers have verified that there is a significant relationship between the Beta and returns on stocks, indicating that Beta is one of the factors affecting stock returns (see, for example, Fama and Macbeth, 1973; Melicher and Rush, 1974). This study postulates that a stock with a lower Beta shows less fluctuation in its market returns, thus having a greater stock price defense on D0.

H4: The stock that has a lower Beta in the previous year earns a higher abnormal return on D0.

3. Research Method

3.1. The Evaluation of Corporate Transparency

Since the evaluation of information transparency is both subjective and abstract, many researchers have found it difficult to quantify. Starting in the early 1980s the content analysis approach was introduced in this line of research to assess corporate disclosure practices, e.g., by Ingram and Frazier (1980) and

Govindarajan (1980). Content analysis is a scoring system that awards points or scores based on the presence or absence of information items, and then uses the rankings based on these scores as the disclosure index.

Currently some professional rating agencies have revealed indices for the assessment of corporate transparency, such as Standard and Poor's (S and P) rankings of Transparency and Information Disclosure Survey which aims at analyzing the transparency of about 1,500 leading companies worldwide. S and P identified 98 disclosure items and grouped them into three subcategories: ownership structure and investor relations, financial transparency and information disclosure, and board and management structure and process. In the US, the annual Report of the Financial Analysts Federation Corporate Information Committee provides the analysts' ratings of firm disclosure practices based on data in three categories: annual published information, quarterly and other published information, and investor relations (Lang and Lundholm, 1996). As a result, most researchers now take advantage of the ranking results from these rating agencies as a benchmark of corporate transparency (Francis *et al.*, 2005; Nikolaev and Van Lent, 2005; Chi, 2009).

In the context of the Taiwanese stock market, this study uses the published rankings of the "Information Transparency and Disclosure Ranking System" (ITDRS) from the Securities and Futures Institute (SFI) as a proxy for the evaluation of corporate transparency in Taiwanese listed companies. By employing a Ranking Committee composed of experts from the accounting profession, industry, and academia, the SFI has produced the ITDRS since 2003. These experts, with consideration for the characteristics of the Taiwanese stock market and government regulations, along with reference to internationally renowned indices, identified 88 disclosure items as evaluation criteria, which fall into five categories: compliance with mandatory disclosures (11 items), timeliness of reporting (16 items), precision of financial forecasts (46 items), information transparency of annual reports (4 items), and the quality of information disclosed on corporate websites (11 items).

In 2003 and 2004, the ITDRS adapted a dichotomous classification method to evaluate corporate transparency; *i.e.*, the "More transparent" rank was given to

companies with superior transparency, while the "Less transparent" rank was given to the ones with poor transparency. Staring from 2005, the ITDRS was updated and used A^+, A, B, C, C^- as five ranks in its information transparency evaluation. This study samples cases in the period from 2003 to 2006, when both the original and updated ranking systems were used. With regard to the original dichotomous ranking system, this study assigns a value of 1 to companies in higher ITDRS rank, otherwise, a value of 0. As for the updated ranking system, rank A^+ or A indicating higher corporate disclosure quality is assigned a value of 1, otherwise (rank B, C, or C^-), a value of 0.

3.2. The Evaluation of Stock Price Defense

This study uses the abnormal return (AR, also referred to as the excess return or the prediction error) as a proxy for the evaluation of stock price defense on D0. Since the market-adjusted return model is employed to calculate the daily returns of the Taiwan Capitalization Weighted Stock Index (TAIEX), sample abnormal returns AR_{D0} are calculated for each stock by subtracting the predicted returns of the market-adjusted return model from its observed returns:

$$AR_{D0}(\%) = \frac{P_{D0} - P_{D-1}}{P_{D-1}} - \frac{R_{D0} - R_{D-1}}{R_{D-1}} \quad (1)$$

where $AR_{D0}(\%)$, $\frac{P_{D0} - P_{D-1}}{P_{D-1}}$, and $\frac{R_{D0} - R_{D-1}}{R_{D-1}}$ are the abnormal returns, daily returns, and daily TAIEX returns on D0, respectively.

3.3. Multiple Regression Model and Variables

This study uses a multiple regression model to examine the impact of the information transparency of a firm on its stock price defense during a market crash. It sets abnormal returns as the dependent variable, corporate transparency as the independent variable, and P/E, trading volume, and Beta as control variables. This study infers that a company whose stock had a lower P/E on D-1 would be better able to defend its price on D0. To measure the P/E, the historical P/E and prospective P/E are widely quoted statistics. The former is computed by

price/earnings per share (EPS); the latter is derived by a price/consensus EPS estimate. Following Anderson and Brooks (2006), who pointed out that the historical P/E is a commonly used valuation measure for equity investment, this study employs this ratio as the baseline measurement. As such, the closing price on D-1 and the EPS from the previous fiscal year are used for the evaluation of P/E underlying this study. Finally an industry average P/E is used to see if the stock price of a share would stay above its fundamental value on D0.

In addition, this study uses trading volume (VOLUME) as the second control variable and predicts that a company whose stock had a higher trading volume on D-1 would be less-able to defend its price on D0. The third control variable underlying this study is the Beta of a stock which is derived from the market model. Specifically, each individual stock's Beta one year before a market crash is calculated using ordinary least squares (OLS) regression on the daily return of an individual stock and its corresponding daily market return. The time of evaluation was set back to 365 days prior to a market crash. This study samples the valid observation cases between 2003 and 2006. The following regression is applied:

$$AR_{D0} = \alpha_0 + \alpha_1 CT_{Y-1} + \alpha_2 P/E_{D-1} + \alpha_3 VOLUME_{D-1} + \alpha_4 BETA_{Y-1} + \varepsilon \quad (2)$$

The expected signs of the coefficients are: $\alpha_1>0$, $\alpha_2<0$, $\alpha_3<0$, and $\alpha_4<0$. α_0 is the intercept; ε is the error term. The description of each variable (CT and BETA are annual data, the rest are derived from daily data) is as follows:

AR_{D0}: The abnormal return of an individual stock on D0 (refer to equation (1)).

CT_{Y-1}: Transparency grade in the previous year (Y-1) for sample firm. The 2003-2006 ITDRS grading by the SFI is used as a proxy, where the higher rank is assigned a value of 1 and the lower rank a value of 0.

P/E_{D-1}: Historical P/E ratio, derived by using the stock price on D-1 to be divided by the EPS from the previous year. If the P/E of a stock is smaller than its industry average P/E, set the value "0," otherwise "1."

$VOLUME_{D-1}$: The amount of trading on D-1, one thousand as a unit.

$BETA_{Y-1}$: The Betas of individual stocks in Y-1; *i.e.*, one-year Beta.

3.4. Variable Importance Ranking - GA

Holland proposed the genetic algorithm (the GA) in 1975 with a view to generating useful solutions to optimization and search problems. This method goes beyond conventional statistical methods in that it provides an effective way to solve both constrained non-linear problems and parameter estimation problems in the finance and accounting field (Chi and Tang, 2007; Chi, 2009). The GA uses a fitness value as a performance index during an evolutionary process, and then applies the genetic operators – selection, crossover, mutation, and replacement – to adjust the search space to find global optimal solutions (see Chatterjee, Laudato, and Lynch, 1996; Leardi, 2000).

This study takes advantage of the feature selection ability of the GA to specifically collect the feature information of the four variables that appear to influence the ability to defend stock price. It identifies association rules for capturing the inherent attributes of each variable, and assigns them importance values between 0 and 1. After adjustment for normalization, the sum of these importance values is 1. Thus, the greater the value of the variable, the more capable it is in predicting results. This variable importance ranking technique systematically weighs the feasibility of individual variables and objectively ranks their importance, thereby sufficing to retain functional modeling variables and discard unfitted ones (Kudo and Sklansky, 2000; Chi and Tang, 2007; Chi, 2009). Table 1, in which each variable is assigned an importance value, shows that BETA (0.498) and CT (0.426) are considered the most important, followed by P/E (0.043), then VOLUME (0.033). The results suggest that all four variables selected in this study are useful in explaining the variance of abnormal returns. Accordingly, they are all kept and applied in the multiple regression model.

Table 1

Results of the GA for Input Feature Selection

Variable	CT	P/E	VOLUME	BETA
Usefulness	Yes	Yes	Yes	Yes
Importance value	0.426	0.043	0.033	0.498

Note: CT represents the transparency rankings of the ITDRS. P/E represents historical P/E ratio. VOLUME represents the amount of trading on D-1. BETA represents the Beta of a stock in Y-1.

3.5. Research Design and Data Collection

To examine the impact of a firm's information transparency on its stock price defense in a market crash, this study uses all of the Taiwan-listed firms as its research sample for the period 2003-2006, wherein each firm in the sample has been assessed by the ITDRS. Given a market crash is regarded as an outlier (Johansen and Sornette, 1999), the criterion of an outlier in this study is considered using the three standard deviation (3 SD) method -- an absolute value of z-score exceeding 3; *i.e.*, ±3 standard deviations away from the mean (Schiffler, 1988). This study first calculates the difference between the mean and standard deviation of daily TAIEX returns in the period of 2003 to 2006. If a daily market return is within three standard deviations of the mean, it is regarded as a market crash day. Panel A of Table 2 illustrates the criteria used in labeling a market crash, with an outlier value of 0.0639%±1.1991% over a four-year horizon, where the difference between the mean and three standard deviations is -3.5334%. Accordingly, the day of a market crash in this study is labeled as one on which a daily market return is less than -3.5334%. As such, as revealed in Panel B of Table 2, eight days of market crash are identified over the research period, respectively two days in 2003, five days in 2004, none in 2005, and one day in 2006.

Due to the fact that no market crash is observed in 2005, the observations derived from data of 2005 are not applied to this study. With reference to Table 3, of the observations in 2003 (n=1,941), 2004 (n=4,828), and 2006 (n=1,240), a total of 149 observations of the finance institutions were first removed due to the unique nature of their regulations and requirements, and their inclusion would probably have biased the results because of their financial characteristics. This study then eliminated 289 observations because they either had been listed for less than one year or were excluded from the ITDRS due to insufficient data.

In the second stage of sample-observation selection, this study further eliminated 182 observations for one of the following reasons: (1) change in transaction mode (e.g., reclassification as a full delivery stock by competent authority), (2) delisting of securities, (3) top executives being prosecuted for

transgressions of personal integrity, (4) going-concern uncertainties in the audit report, or (5) failure to disclose material information cited by the ITDRS Ranking Committee. In addition, 12, 65, and 51 observations that had no AR, EPS, Beta data were also ruled out, respectively. This study further excluded 62 observations that are suspended from trading due to violation of Taiwan Stock Exchange (TSE) regulation No. 142, for instance, any transgression listed in the TSE regulations or refusing a visit from TSE personnel. As a result of the above-mentioned screening process, eight market crashes making 7,199 valid observations are in the final sample.

Table 2

Selection Criteria for the Day of a Stock Market Crash

Panel A: Selection criteria used in labeling a market crash			
Daily TAIEX return (%) (four-year horizon)	Mean (%)	Standard deviation (%)	Mean minus three standard deviations (%)
	0.0639	1.1991	-3.5334
Panel B: Market crash days over the research period (2003-2006)			
Daily TAIEX return (%)		Market crash day	
-3.6206		2003/02/06	
-4.1619		2003/04/24	
-6.6789		2004/03/22	
-4.4422		2004/04/30	
-5.3961		2004/05/05	
-3.5629		2004/05/10	
-5.0951		2004/05/17	
-4.2483		2006/06/08	

Note: There is no market crash event identified in year 2005.

In this study, the ITDRS ranking results are acquired from the SFI. The variable of AR in this study is derived from equation (1), wherein individual stock prices and market indices are based on daily closing prices. The accounting and market information are primarily compiled from the Taiwan Economic Journal (TEJ) database. Where the required information is not available from this data source, it is augmented by information taken from annual reports, the TSE, Gretai Securities Market (OTC), Market Observation Post System, and the InfoWinner Database.

Table 3

Sample Selection and Distribution of Observations Across Sample Years 2003-2006

	2003	2004	2006	Total
Number of observations	1,941	4,828	1,240	8,009
minus: Finance institutions	54	51	44	149
Observations less than one year or excluded from the ITDRS	125	112	52	289
Observations related to the 5 reasons listed above for second stage exclusion	43	34	105	182
Observations without AR data on D0	2	-	10	12
Observations without EPS data for year Y-1	42	23	-	65
Observations without Beta data for year Y-1	-	46	5	51
Observations suspended from trading due to violation against TSE regulation No. 142	22	40	-	62
Valid observations	1,653	4,522	1,024	7,199
Number of market crashes	2	5	1	8

Note: Observations from year 2005 is excluded for no market crash event identified.

4. Empirical Findings

4.1. Descriptive Statistics

Table 4 presents the empirical frequency distribution and descriptive statistics for AR, CT, and the three control variables used in this study. During a market crash, the abnormal returns of 46.60% (n=3,355) observations are higher than the corresponding daily TAIEX return, indicating that although they carried systemic risk, they act as defensive stocks. The proportions of superior and inferior companies ranked in CT are 30.26% and 69.74% of the observations respectively; while the proportions of P/E larger or smaller than the industry average P/E are 33.13% and 66.87%, respectively. In addition, average trading volume is 4,900 shares, with the 25th, 50th, and 75th percentile in 500, 1,450, and 3,990 shares, respectively. As for the value of one-year Beta, the mean of Beta on D0 is 0.78, with a value of 0.79 as the median and the 75th percentile in 1.01.

Table 4

Descriptive Statistics and Frequency Distribution for Variables

Variable	Value of 1	Value of 0	Mean	Standard deviation	Percentile		
					25%	50%	75%
AR	–	–	-4.23	2.86	-6.73	-5.09	-2.40
CT	2,178 (30.26%)	5,021 (69.74%)	0.30	0.46	0	0	1
P/E	2,385 (33.13%)	4,814 (66.87%)	0.14	0.35	0	0	0
VOLUME	–	–	4.90	17.17	0.50	1.45	3.99
BETA	–	–	0.78	0.34	0.54	0.79	1.01

Note: n= 7,199. Numbers in parentheses are percent of total observations. AR= abnormal return on D0. CT= the transparency rankings of the ITDRS; the higher (lower) rank is assigned a value of 1 (0). P/E= historical P/E ratio which takes the value of 1 if a stock's P/E is larger than its industry average P/E and 0 otherwise. VOLUME= trading amount, one thousand as a unit. BETA= one-year Beta.

Table 5

Results of Pearson Product-Moment Correlation

Variable	CT	P/E	VOLUME	BETA
CT	1			
P/E	-0.065**	1		
VOLUME	0.082**	0.051**	1	
BETA	0.070**	0.024*	0.290**	1

Note: n= 7,199. AR= abnormal return. CT= the transparency rankings of the ITDRS. P/E= historical P/E ratio. VOLUME= trading amount. BETA= one-year Beta.
*, ** Significant at the 0.05, and 0.01 levels, respectively.

Before conducting multiple regression analysis, the possibility of multicollinearity was checked using the Pearson product-moment correlation coefficient. As seen in Table 5, correlations are low, ranging from a low of 0.024 to a high of 0.290, which suggests there is little or no evidence of multicollinearity among the variables.

4.2. Multiple Regression Analysis

Table 6 shows the results of the multiple regression analysis for the association between AR, CT, and the control variables, P/E, VOLUME, and BETA. CT is significantly positively related to AR (p=0.032), corroborating the claim that a company with better information transparency is more able to defend its stock price in a market plunge.

The coefficients of most of the control variables are not statistically significant. The exception is the BETA variable, which is negative and highly significant. This study uses Beta to measure the vulnerability of a stock prior to a market crash. The result indicates a negative correlation between individual Betas on D-1 and the AR on D0 (p=0.000), showing that prior to a market crash, the higher Beta value implies a sharper price drop and lower likelihood of defending the stock price, which proves the existence of the contagion effect. In addition, it is interesting to note that Beta has the highest regression coefficient (-0.306) in the four variables and can therefore be considered to have a relatively high association with AR during a market crash.

Table 6

Results of Multiple Regression Analysis

Variable	Expected sign	Coefficient	Standard error	t-statistic	p value
Intercept		-2.263	0.084	-26.824	0.000
CT	+	0.024	0.071	2.147	0.032
P/E	–	-0.010	0.093	-0.849	0.396
VOLUME	–	0.008	0.002	0.701	0.483
BETA	–	-0.306	0.099	-25.982	0.000
F-statistic		181.693**			
R^2		0.304			

Note: n= 7,199. CT= the transparency rankings of the ITDRS. P/E= historical P/E ratio. VOLUME= trading amount. BETA= one-year Beta.

** Significant at the 0.01 level.

5. Conclusions

Stock market crashes and the related financial contagion effects on stock price are important issues in the field of finance. Preventing a sharp plunge in stock prices in reaction to a market crash is an important risk management task. However, there has not previously been any discussion about how companies can react to rapid contagion and defend against plunges in stock prices in a market crash. This study is among the first to identify the vital factors affecting a company's ability to defend its stock price using a variable importance ranking technique, and to explore the relationship between the information transparency

of a company and its effective stock price defense in the context of a market crash.

This study utilizes unique pooled firm-event data for listed firms in Taiwan over the sample period 2003-2006. Results from the variable importance ranking show that all four input variables (corporate transparency, Beta, P/E ratio, and trading amount) underlying this study are useful in explaining the variance of price movements in a crash, but only the first two are considered important. Further, the results of the multiple regression show that only two of the input variables are significantly related to stock price defense. More specifically, corporate transparency and Beta are significant and other variables such as trading amount and P/E ratio are insignificant in explaining the level of stock price defense.

Synthesizing the empirical findings, this study substantiates the conjecture that there is a significant positive correlation between corporate transparency and abnormal returns in a market crash. That is to say, a more transparent company suffers less in a market plunge; tends to be more resistant to the financial contagion effect of market crises, and shows a greater ability to defend its stock price. The empirical results imply that a company may strengthen its transparency to lessen the impact of a stock market crash.

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