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Does Fixed Asset Revaluation Build Trust between Management and Investors?

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Abstract: In this paper, we examine whether fixed asset revaluation has an impact on the timeliness and relevance of information disclosed in financial reporting. Using firms listed in the Korea Stock Exchange market during 2007–2017, this study investigates the change in transparency of the information disclosure environment as proxied by stock price crash risk. We find that, on average, fixed asset revaluation has a positive effect on sustainability by improving timeliness and relevance of disclosed information, thereby decreasing stock price crash risk. In contrast, firms with unhealthy financial conditions and a high degree of information asymmetry show an increase in crash likelihood after fixed asset revaluation. These findings suggest that the relationship between fixed asset revaluation and stock price cash risk is dependent upon management's motivation for honesty during the revaluation process.

Keywords: fixed asset revaluation; transparent financial reporting; sustainability in information disclosure environment; stock price crash risk

1. Introduction

Research suggests that corporate actions have an effect on the economic environment outside of companies themselves, which leads many to claim that companies should, therefore, be held accountable by more than just their own shareholders. Consequently, many firms now focus on the issue of corporate sustainability, which refers to the longevity and long-term value of a company, including not only the success of that individual company but also the success of the economy as a whole [1]. An important factor in the sustainability of a firm is its proclivity for transparent communication regarding its operational and financial information. As many investors believe, the transparent disclosure of information allows for a more accurate evaluation of a firm's long-term financial condition. An honest corporate information disclosure environment strengthens communication between managers and investors by building both knowledge and trust, therefore promoting the sustainability of the company [2].

This paper examines the effect fixed asset revaluation has on stock price crash risk by determining whether the fair value estimates therein increase the transparency and relevancy of financial statements, thus improving transparency in the corporate information disclosure environment. Questions as to whether fixed asset revaluation actually increases the relevance and transparency of disclosed information still remain more than a decade since the implementation of the Statement of Korean Accounting Standard No. 5 and K-IFRS 1016 (effective December 2008). Those who promote fixed asset revaluation contend that its fair value estimates reflect current market conditions while also accounting for any recently available information, both positive and negative, thereby forming a sustainable flow of communication [3]. Critics, however, argue that the fair values in a revaluation are irrelevant, as prices are capable of being distorted by market inefficiencies, investor irrationality, liquidity problems,

and unreliable assumptions of management, which leads to an opaque and unsustainable corporate information disclosure environment [4].

Due to this controversy, accounting rules for fixed assets were revised in compliance with International Accounting Standards 16 by the Korean Accounting Standards Board (KASB) on 30 December 2008. During the United States' (US) subprime crisis of 2008, as capital markets contracted and froze worldwide, the Korean government tried to moderate its effects by allowing firms to revalue their fixed assets. In order to ensure the security of their finances, Korean firms, whose financial health was desperately failing as economic tribulations hindered financing, were required to guarantee that they would lessen their debt ratios by the end of the year. Hence, the Korean government was compelled to intervene and help firms reduce debt ratios while avoiding bankruptcy. The revised version of the Statement of Korean Accounting Standard No. 5 effectively supported the financial health of the firms by stabilizing their finances and cutting down debt ratios.

In 2011, the International Financial Reporting Standards (IFRS) were mandatorily adopted by Korean-listed companies, officially enabling them to account for fair value on fixed assets, such as property, plants, and equipment. With the implementation of the asset revaluation policy, Korean firms were free to choose between the historical cost model and the revaluation model in their accounting of fixed assets. The fair value of fixed assets is determined at the date of revaluation, according to the revaluation model, otherwise known as asset revaluation. Gains from asset revaluation are recorded as revaluation surplus under other comprehensive income.

The recent volatility of the stock market has made stock price crashes a primary concern of investors, and according to Sunder [5], investors cannot mitigate crash risk simply by diversifying their portfolios. It is therefore important to identify the causes of stock price crash in order to maximize the sustainable management of a firm and maintain a healthy financial environment. Harvey and Siddique [6] show that conditional skewness is priced in to the value of a stock, and investors expect higher returns for negatively skewed stocks to compensate for the risk. Because of the degree of asymmetry in the disclosure of information factors in stock price crash risk, we will build on previous research by examining factors that affect the transparency of the information disclosure environment within a company.

Currently, there is a high degree of informational asymmetry in the stock market, because investors only receive the information that managers choose to disclose about a firm. Due to concerns about job security and performance evaluations, managers may withhold or obscure negative information about the performance of their firm [7]. For the manager, the release of positive information may lead to a pay raise and greater job security, but the release of negative information may result in a lower salary, a bad reputation, or outright termination [8]. Managers are therefore incentivized to hide negative information regarding the performance of their firms in the hope that conditions will improve with time [9]. However, this strategy backfires when a large amount of negative information about a firm is suddenly released, which may result in a stock price crash [10,11]. When investors acquire negative information about a firm, they may quickly sell their shares in order to salvage money, thus causing the stock price to drop rapidly. The solution to this problem may be a more symmetrical, transparent information disclosure environment in which both positive and negative information is shared freely and frequently [8].

Fixed asset revaluation is capable of preventing a stock price crash by hindering management's ability to obscure or withhold negative information from stakeholders. The fair value estimates of fixed asset revaluation report a firm's economic situation more clearly and honestly than the estimations generated in the historical cost model [12]. A report from the European Central Bank states that, because fair value is based on the concept of expected cash flow, it reflects all affordable information, both positive and negative, and is therefore essentially progressive. Despite this, numerous researchers question whether fair value estimates faithfully report economic realities [13–16] Fair value gain and loss represent unrealized gain and loss, and real economic change is not always reflected. For example, although current measurements may reflect accurate fair value, the transparency of information in

accrual accounting can be deteriorated by the external shocks reflected in fair value estimates; this usually happens when influenced by exogenous volatility. In this study, we focus on corporate information disclosure behavior to examine whether fixed asset revaluation lowers stock price crash risk and improves sustainability by improving the timeliness and relevance of information or heightens stock price crash risk by motivating management to withhold negative information. Hence, the exact overall effect of fixed asset revaluation on stock price crash risk remains an empirical question.

We examined the effects fixed asset revaluation has on stock price crash risk using a sample of 6277 firm-year observations from South Korean firms between 2007 and 2017. Our findings indicate that fixed asset revaluation is more likely to increase the timely disclosure of corporate information and therefore reduce, on average, stock price crash risk. These results suggest that changes in accounting policy can improve transparency in the information disclosure environment for investors. Additional tests revealed that the increased timeliness and relevance resulting from a fixed asset revaluation is an overall improvement on the information disclosure environment, even after considering its long-term effects. We do, however, find that the aforementioned reduction of stock price crash risk does not apply to firms with high leverage and a high degree of information asymmetry. Further analysis shows that these results can vary depending on a number of influencing factors. Given that fixed asset revaluation is an informational adjustment to the disclosure environment that influences users of revalued financial statements, our findings illustrate the importance of understanding the interdependence between accounting policies and managerial incentives to implement them. The implicit suggestion in these findings is that the effectiveness of fixed asset revaluation depends on the honest desire of management to improve and actively sustain the transparency of its information disclosure environment.

This paper contributes to the prior studies in some aspects. First, it provides further evidence to the literature on selection of accounting methods to improve the timeliness and relevance of information. Prior studies report that accounting methods, such as deferred tax accounting and financial asset reclassification option, alleviate negative impacts from economic crises [17,18]. Regarding this, this study shows that, under the honest desire of managements, fixed asset revaluation supports the communication of corporate information between managers and investors by increasing transparency in the information environment. Second, this study adds the incremental contributions to the literature on fixed asset revaluation. Most prior literature focuses on either the determinants of fixed asset revaluation or the short-term market reaction to the revaluation [12,19]. However, this study investigates the effect of fixed asset revaluation on the third moment approach focusing on extreme tail risk, i.e., stock price crash. Third, this study should be intriguing to stakeholders that use revalued financial statements. For instance, financial analysts from outside South Korea may employ the reported fixed asset values of firms in South Korea more efficiently, as the adoption of fixed asset revaluation improves the timeliness and relevance of information. Investors who wish to invest in the South Korean stock market could benefit from the outcomes of this study as it shows that fixed asset revaluation has improved the transparency of the information disclosure environment among firms in South Korea. Because the primary purpose of adopting fixed asset revaluation is to increase transparency in the information environment, the findings of this study offer relevant evidence on this issue.

The rest of this paper is organized as follows: Section 2 reviews previous literature and builds upon hypotheses. Section 3 explains our data sample and research design. Section 4 displays the empirical results, and finally, Section 5 presents our conclusions.

2. Backgrounds and Hypotheses

2.1. Prior Research on Fixed Asset Revaluation

During the financial crisis of 2008, in an effort to help firms recover from financial collapse, the Korean government allowed them to voluntarily revaluate before revaluation would become mandatory with the forthcoming adoption of IFRS. Consequently, 21.2% and 14.0% of listed firms

implemented asset revaluation in 2008 and 2009, respectively. This reduced their leverage by an average of 41.0% and 24.7%, respectively.

South Korea's asset revaluation policy allows companies to choose between the historical cost model and the revaluation model for their accounting policy. In the revaluation model, the fair value of fixed assets is determined on the date of revaluation, and gain from asset revaluation is recorded as revaluation surplus. Thus, earnings management through asset revaluation is not viable under the applied regulations. Furthermore, if revaluation is applied to depreciable assets, the increase of asset value is recorded along with other comprehensive income. On the other hand, an increase in depreciation leads to a deduction of future earnings. If the reduction of asset value exceeds the revaluation surplus of the asset, it is inevitably recorded as a loss.

There are two main groups of literature on the subject of fixed asset revaluation. The first group investigates the types of firms that choose to revaluate and their motivation to do so. Aboody at al. [12] found a causal relationship between revaluations and an increase in future performance, which was influenced by leverage ratios. Barlev et al. [20], assessing a sample of 35 countries, found that though firms in countries similar to Australia and the United Kingdom (UK) are comparably motivated to conduct asset revaluations, their motivations are not shared uniformly around the world. Similarly, the effects of revaluations vary by country. Missonier-Piera [21] focused on the motivating factors of Swiss-listed companies, where he found a positive correlation between asset revaluations and both leverage and proportion of foreign sales and, at the same time, a negative correlation between asset revaluation and investment opportunities, suggesting that these firms are motivated to conduct asset revaluations in order to increase their borrowing capacity. Missonier-Piera [21] reached a similar conclusion using another dataset of Swiss firms. Using a sample from December 2008 to March 2009, near the beginning of the financial crisis, Choi et al. [19] found that Korean-listed companies similarly utilized fixed asset revaluation to increase their borrowing capacity and improve their financial positions.

The second group of fixed asset revaluation literature focuses on the value relevance of revaluation and subsequent stock market reactions. Previous studies have shown that investors view fixed asset revaluation favorably, specifically when examining various time horizons during and immediately following the financial crisis of 2008. In their short-horizon studies, Song et al. [22] and Yoo et al. [23] found that the Korean stock market responds favorably to firms who conduct fixed asset revaluations, while Choe and Son [24] found that the disclosure of revaluation results is also seen as positive. In long-horizon studies, Kim et al. [25] showed the positive correlation between revaluation surplus and annual stock returns, and Yoo et al. [23] found a positive reaction to abnormal buy-and-hold returns that occurred more than one year from the announcement of fixed asset revaluation. This market reaction to fixed asset revaluation is not limited to Korea; when examining firms in the UK and Australia, Barth and Clinch [26] and Aboody et al. [12] also found that revaluations produce positive reactions in the market. Some studies, however, have found negative market responses to fixed asset revaluations. Lopes and Walker [27], studying Brazilian firms, showed a negative correlation between fixed asset revaluation and stock price, perhaps a result of inconsistent management motivations and capital structures across countries. Though a number of these studies examined the effect fixed asset revaluation has on stock price, few have explored its effect on corporate risk.

Fixed asset revaluation allows investors to immediately identify and respond to critical changes in a firm's financial situation via the timely disclosure of corporate information. Because gains and losses are promptly reported in the financial report following a fixed asset revaluation, rather than diffused over the entire lifespan of the asset or liability, investors are given a more accurate and transparent account of the firm's financial health. Plantin et al. [28] showed that fixed asset revaluation benefits investors, because the established fair value estimates clarify and update the information disclosure environment more effectively than prices used in the historical cost model. Krumwiede [29] and Barth et al. [30] agreed, finding that, in normal economic conditions, the transparency provided by fair value estimates that honestly reflect market conditions provide the opportunity for investors and

management to take swift action. Boyer [31] further shows that while the timeliness and transparency of fixed asset revaluations makes markets more efficient, the historical cost model obscures or conceals information, which leads to market inefficiency. According to the findings of Plantin et al. [32], fixed asset revaluation can curtail the deceitful strategies of managers who use the historical cost model as a tool to conceal and manipulate potentially damning information.

At the same time, the positive effects of fixed asset revaluation can be diminished by a lack of quoted market prices, which are necessary for accurate and reliable fair value estimates. When market prices are unavailable for assets, whether due to market turbulence or the illiquid nature of some assets, companies must formulate their own fair value estimations. In this situation, those estimates, divorced from actual economic conditions, are intrinsically less reliable and result in inevitably less dependable valuations. As Power [33] showed, because fair values are estimates rather than real market values, they are dependent upon a certain degree of assumption. In the absence of a market on which to base these assumptions, the discretion granted to management provides another opportunity to influence the valuation, whether the effect is intentional or not. Furthermore, the inconsistency of information resulting from these types of fixed asset revaluations has the potential to negatively affect investors' ability to construct realistic expectations and assess corporate risk. As Penman [34] explained, fixed asset revaluation can create price bubbles in ensuing financial statements, and those bubbles, according to Foster and Shastri [35], drive financial institutions to irregularly and inappropriately respond to market changes, thereby threatening the sustainability of the information disclosure environment.

2.2. Prior Research on the Stock Price Crash Risk

The risk created by the unwillingness of management to disclose negative information about a company is generally reflected in its stock price crash risk. In order to achieve sustainability, it is important to identify the factors that lead to a corporate environment of asymmetrical or disingenuous information disclosure and irrational decision-making.

There is an abundance of literature on the subject of stock price crash risk, but the study by Jin and Myers [10] was one of the earliest to focus on the relationship between the deceitful or opportunistic disclosure of information and crash risk. They found that management is incentivized to withhold negative information regarding the financial health and efficiency of the firm in order to protect its own interests, such as bonuses and job security. This approach often backfires, however, as negative information is compounded and eventually reaches a point where it can no longer be contained, at which time it floods the market, leading to a stock price crash. Haggard et al. [36], exploring the relationship between disclosure and stock price movement, found that the firms with a higher degree of information disclosure and, therefore, a higher degree of corporate transparency experience fewer sharp declines in stock prices. Hutton et al. [11], focusing on the agency theory and the relationship between corporate opacity and stock returns, also found that the timely disclosure of negative information is negatively correlated with stock price crash risk. Kim and Zhang [37] further specified that conditional conservatism, or a policy of disclosing bad news more readily than good news, establishes a trustworthy communication flow, which significantly decreases stock price crash risk. DeFond et al. [38] found that IFRS adoption and the consequent increase in timeliness and relevance in the information disclosure environment by non-financial firms widely lowered stock price crash risk, and in examining a sample of publicly traded banks with headquarters in the US, Cohen et al. [39] also found a negative correlation between a transparent information disclosure environment and risk.

The study by Jin and Myers [10], mentioned above, not only showed that the dishonest disclosure of information promotes stock price crash risk but also suggested that managerial deceit is a result of information asymmetry. Fundamentally, information asymmetry is a consequence of the lack of agency given to investors, who are not involved in the management of a firm but are rather provided with information by the managers of the firm [40]. This asymmetry of information and agency between outside investors and management creates a demand for the timely disclosure of relevant information and financial reporting [40]. By correcting this disparity, the transparent disclosure of information

increases market liquidity [41], reduces the cost of capital, and stabilizes the price of shares [42,43]. Management, however, is unlikely to disclose this information if it is considered negative and assumed to be detrimental to the firm. As Dumay [44] showed, managers generally share positive information relatively quickly while withholding negative information until its release is vital or it is uncovered by an outside party. Kothari et al. [8] agreed, finding that information asymmetry between management and investors creates the space in which management can hide bad news. As Bleck and Liu [45] showed, the historical cost model provides managers with the opportunity to obscure a firm's performance, which inherently results in a lack of disclosing timely and relevant information and ultimately leads to more frequent and extreme drops in stock prices.

Other studies that focused on stock price crash risk examined the effect of regional religious factors [46] and differences in management level [47–50].

2.3. Fixed Asset Revaluation and the Transparency of Information Disclosure Environments

Most of the literature assumes the symmetrical and honest disclosure of information by the management of a firm [8]. This ignores the fact that managers determine which information is shared and the speed with which it is reported. If a dishonest manager would benefit personally from the nondisclosure of certain information, he or she may choose to withhold that information to the detriment of shareholders. By manipulating the release of information, managers can obscure the information disclosure environment and reduce sustainability throughout the system. Furthermore, the abrupt release of accumulated negative information can lead to a stock price crash [11]. The theory that managerial dishonesty increases the likelihood of a stock price crash is supported by previous studies, which find that crash risk is positively correlated with opaque financial reporting, corporate tax avoidance, and executive equity incentives [11,48,51]. This study focuses primarily on the degree of transparency in financial reporting and its specific effect on crash risk.

Fixed asset revaluation increases equity by recognizing the fair value of tangible assets, such as property, land, and equipment, which leads to better financial health and an expansion of capital stock without compensation through tax exemption of revaluation surplus. This also helps to bolster the firm's credit rating and reduce cost of capital from a financial institution. However, it is unclear as to whether these improvements reflect an increase in intrinsic value. It is also difficult to accurately predict future outcomes, because indicators such as price-to-book ratio and return on equity (ROE), which compare book value and stock price, are hard to use when comparing different periods of the financial ratio, as well as different firms.

According to prior research, if the revaluation model is applied on the financial statement through fixed asset revaluation, the degree to which revenues match with costs, a qualitative characteristic of accounting, will improve. This is because if a fixed asset is evaluated with its most recent value, that value can still be recorded before it is disposed of or depreciates. In accrual basis accounting, a successful matching of revenues and costs leads to an improvement in the timeliness of information disclosure—a characteristic of the relevance of accounting earnings. This is reported to be a more effective technique than cash-based accounting, because it produces a more informative disclosure of earnings [52]. Additionally, Su [53] showed that up-to-date revenue and cost matchings lead to more sustainable earnings, as well as an easier and more accurate forecast of future earnings. When relating this to stock price crash risk, if the manager of a firm increases the relevance and timeliness of accounting information along with IFRS and implements fixed asset revaluation in order to send a positive signal regarding future firm performance via the open communication of information, the potential of that manager to hoard bad news and create an unsustainable disclosure information environment would decrease. As a result, the risk of stock prices crashing due to the distortion of discretionary and unsustainable disclosure behavior, resulting in the abrupt release of negative news into the capital market, would relatively diminish.

However, when observing the main contents of accounting treatment regarding fixed asset revaluation, there is a possibility that information disclosure environments are not symmetric and

sustainable when asset revaluation allows the manager to have high discretionary power over information management. Specifically, the manager can (1) choose whether to determine value based on the historical cost model or the revaluation model, (2) choose the period of asset revaluation after they have chosen a revaluation model, and (3) select which sort of fixed asset to apply for the revaluation model. Hence, the manager can choose to either revaluate its land or buildings but not both. Due to this, the manager has discretion in adjusting the firm's financial situation on the revaluation. Additionally, firms that are a part of this study's sample period seem to have given managers an even greater opportunistic motivation by also letting them choose the revaluation model after adopting IFRS in 2011. In this way, managers can use the revaluation system as a tool for self-interest, such as short-term promotion, salary increase, and reputation improvement, which greatly challenges sustainability in the information disclosure environment. Nevertheless, there is a limit to the amount and degree of bad news a manager can hide, and when that limit is reached, the bad news floods the market, which can lead to the extreme decline of stock prices. Overall, the information disclosure environment can be manipulated by untrustworthy managerial behavior when deciding which fixed asset revaluation system to implement. The stock price crash risk will increase if revaluation is used to initiate a misleading flow of information, but if revaluation is applied according to its intended purpose, stock price crash risk will instead decrease. Because it is an empirical problem, this study makes a null hypothesis without predicting a certain direction, as follows:

Hypothesis 1 (H1). *Applying a fixed asset revaluation has no relation to stock price crash risk.*

According to prior studies, managers select the fixed asset revaluation model in order to improve financial health and to accurately reflect the intrinsic value of the asset. Specifically, the increase of assets from revaluation is reported as revaluation surplus or deferred corporate taxes on financial statements. Liability and equity increase together; however, because the increase of equity is large, it can lower the debt ratio. Moreover, the gain from revaluation is considered unrealized gain, so it is not counted as dividend resources. According to the Financial Supervisory Service's Data Analysis, Retrieval and Transfer System (DART), some listed firms applied revaluation in order to improve the firm's financial structure and boost the stock price; however, the effects generally only lasted for a short period. Stock prices shot up immediately after the application of revaluation, but all of the firms have since pared back their gains and are now in decline. This shows that although the firms may have been able to accomplish temporary financial health, there is a question as to whether they could achieve sustainable financial health and profitability.

Additionally, 22% of firms listed on the Korea Exchange (KRX) in 2008 voluntarily revalued their assets that year, and the debt ratio of those firms declined by an average of approximately 41% [54]. However, ROE from the revaluation mostly showed a negative (-) value. This indicates the possibility of a lost opportunity to raise profitability and ROE by borrowing funds. It therefore suggests that long-term or actual liquidity improvement is difficult through the opportunistic use of the revaluation model, which cannot even facilitate the compensation of interests. Considering this phenomenon, this study presumes a difference in the relationship between stock price crash risk and the implementation of fixed asset revaluation depending on the actual effect of a revaluation system that is applied with the goal of improving financial health. Firms that apply the revaluation model for the purpose of improving fundamental financial health may be able to clarify the information disclosure environment through the effects of health improvement, or they may experience the opposite effect due to short-sighted and opportunistic behavior. Therefore, this study states the following hypothesis, using the debt ratio and the existence of net loss to measure financial health:

Hypothesis 2 (H2). *Whether or not a revaluation system is implemented for the purpose of improving financial health affects the relationship between fixed asset revaluation and stock price crash risk.*

Whether or not a certain firm is able to have sustainable future growth is primarily decided by the information of sales and earnings on financial statements. However, in situations where the external investors and internal managers have no line of communication and a high degree of information asymmetry exists, there is a greater chance of distorted outcomes on the financial statement, which not only obscures intrinsic value but also reduces the relevance of predictions about growth possibilities of sales and earnings. Especially as financial statements are formulated by upwardly adjusting the income through fair value revaluation of the fixed asset and disclosed in a less timely manner, outside investors who do not know this fact may have overly optimistic expectations about the firm's growth opportunities. Additionally, in cases where information is highly uncertain, investors react hesitantly to signals such as periodical announcements about information on earnings. This leads them to place less weight value on them than their intrinsic value. When uncertainty is high, investors can be slow to decide whether or not to invest in a firm or fail to respond appropriately to a particular signal. This inaction is only resolved when uncertainty is mitigated. The greater degree of opacity in a firm's information environment, the harder it is for insiders, as well as those outside the firm, to predict the future expected cash flow. It is easier for self-interested managers privy to inside information to take advantage of unclear information environments in order to hide bad news. In this case, the stock price crash risk will actually increase after the application of a fixed asset revaluation. Therefore, this study posits the following hypothesis:

Hypothesis 3 (H3). *The degree of information asymmetry affects the relationship between fixed asset revaluation and stock price crash risk.*

3. Research Design and Sample Description

3.1. Estimation Model of Opacity by Discretionary Accruals

The reporting of opaque earnings is an inaccurate representation of a firm's operation and financial standing. This opacity encourages misjudgment by those who seek to assess the value of the firm. For that reason, in this study, discretionary accruals serve as a proxy for opaque earnings. To differentiate between discretionary and normal accruals, the modified Jones model [55] is used. The variable of return on assets (ROA) is included in the modified Jones model, because firm performance affects discretionary accruals [56]. The estimation model is shown in Equation (1) below:

$$\frac{TA_t}{A_{t-1}} = \alpha_0 + \beta_1 \frac{1}{A_{t-1}} + \beta_2 \frac{\Delta S_t - \Delta AR_t}{A_{t-1}} + \beta_3 \frac{PPE_t}{A_{t-1}} + \beta_3 ROA_t + \varepsilon_t, \quad (1)$$

where TA_t = net income—cash flow from operations; S_t = sales revenue; AR_t = accounts receivables; PPE_t = plant, property, and equipment; ROA_t = net income/total assets; and A_t = total assets.

We used a cross-sectional model of discretionary accrual, with a sample of firms from each industry, designated by the appropriate two-digit industry code. We only included firms for which we have at least 15 firm-year observations, which we considered to be a sufficient amount of data upon which to formulate parameter estimations. Discretionary accruals were estimated using any residuals from the estimation model of Equation (2). As Dechow et al. [56] presented in their study of firms known to have intentionally misrepresented earnings, earnings are generally falsified for between one and three years before being detected by enforcement agencies. Considering this, Hutton et al. [11] used a three-year sum of the absolute value of annual discretionary accruals to determine earnings opacity, as shown in the model below:

$$OPACITY_t = |DA_{t-1}| + |DA_{t-2}| + |DA_{t-3}|. \quad (2)$$

The underpinning logic of Equation (2) is that the firms most likely to be managing earnings and hence most likely to conceal information are those that regularly report large discretionary accruals in

either direction. To ensure that one-time outliers are not mistaken for a fundamental firm policy of earnings management, Equation (2) uses a moving three-year sum. Finally, to control for movements of the economic environment as a whole, overall market performance is accounted for in the analysis.

3.2. Proxy of Sustainable Information Disclosure: Stock Price Crash

Using only firm years containing data of at least 26 weekly stock returns, we estimated firm-specific regression using the same equation as Hutton et al. [11]:

$$R_{i,w} = \beta_0 + \beta_1 R_{mkt,w-1} + \beta_2 R_{mkt,w} + \beta_3 R_{mkt,w+1} + \beta_4 R_{ind,w-1} + \beta_5 R_{ind,w} + \beta_6 R_{imd,w+1} + \varepsilon_{i,w}. \quad (3)$$

In this equation, $R_{i,w}$ represents the current weekly return of a given firm i; $R_{mkt,w}$ represents the weekly market return for the current week, with $R_{mkt,w-1}$ and $R_{mkt,w}$ representing returns for the previous and following weeks, respectively; and $R_{ind,w}$ represents the weekly industry return for the current week, with $R_{ind,w-1}$ and $R_{ind,w+1}$ again representing returns for the previous and following weeks, respectively. Nonsynchronous trading is allowed by the inclusion of lead and lag terms for market and industry indexes [57]. Because the residuals of Equation (3) were highly skewed, we used an estimation of Equation (3) to calculate $W_{i,w}$, the natural logarithm of the residual return plus 1 ($W_{i,w} = 1n(\varepsilon i,w+1)$), after which $W_{i,w}$ was assumed to follow a normal distribution. This allowed *CRASH* to be defined symmetrically, as residual returns corresponding to a threshold number of standard deviations below the mean.

CRASH, an indicator variable, equals 1 if there is at least one extremely low $W_{i,w}$ in year t and 0 otherwise. We considered a $W_{i,w}$ to be extremely low if it was smaller than [Mean ($W_{i,w}$) − 3.09 × standard deviation ($W_{i,w}$)]. *CRASH* was formulated to estimate the likelihood of a stock price crash in a given week, based on the number of extremely negative events throughout the year.

3.3. Empirical Models

To test Hypothesis 1, we analyzed the correlation between fixed asset revaluation and stock price crash risk while employing firm-level controls in the following model. We attempted to cluster analyses by incorporating year and firm, which served as a control for the potential either that residuals were not identically distributed or that there was a correlation within the group of residuals [58]. This kind of clustering results in more conservative t-statistics, which is achieved by calculating standard deviations that reflect the time series and cross-sectional correlations of samples [58].

$$\begin{aligned} CRASH_{t+1} = \quad & \beta_0 + \beta_1 REVAL_t + \beta_2 RET_t + \beta_3 SIGMA_t + \beta_4 SIZE_t + \beta_5 LEV_t + \\ & \beta_6 MTB_t + \beta_7 ROA_t + \beta_8 OPACITY_t + \beta_9 OPACITY^2{}_t + \beta_{10} IFRS_t + \varepsilon \end{aligned}, \quad (4)$$

where *CRASH* = an indicator variable equal to 1 if, within its fiscal year, a firm experiences one or more firm-specific weekly returns falling 3.09 or more standard deviations below the mean firm-specific weekly return for its fiscal year and 0 otherwise; *REVAL* = a dummy variable, which equals 1 if the firm had revalued its asset and 0 otherwise; *RET* = the mean return of the firm-specific weekly return over the fiscal year; *SIGMA* = the standard deviation of the firm-specific weekly return over the fiscal year; *SIZE* = Ln(total assets); *LEV* = total liability/total assets; *MTB* = market value or book value of equity; *ROA* = net income/total assets; *OPACITY* = the moving sum of the absolute value of discretionary accruals for the previous three years; *OPACITY2* = the squared value of *OPACITY*; *IFRS* = an indicator variable that equals 1 if firms mandatorily adopt the IFRS and 0 otherwise.

Chen et al. [59] suggested that past returns over the previous three years can be used to predict the likelihood of a future crash, specifically finding a correlation between high returns and high crash risk. With this in mind, we introduced several control variables that are known to influence the likelihood of a crash, including the main controls used in their study, in order to isolate opacity from other variables that affect crash risk. *RET* is the mean firm-specific weekly return over the previous fiscal year, and *SIZE* is the mean firm size, calculated as the natural log of total assets. *SIGMA* represents the standard

deviation of firm-specific weekly returns over the fiscal year. This controls for the volatility of weekly returns, because stocks that experience significant volatility in a given year are more likely to crash the following year. We also included the additional control variables *MTB*, which stand for market-to-book ratio or the market value of equity, and *LEV*, representing financial leverage, which is calculated as total liability divided by total assets. Borrowing from Hutton et al. [11], we introduced *ROA*, calculated as net income divided by total assets, as a control for any synchronous correlation between profitability and crash risk, and we calculated *OPACITY* as the moving three-year sum of discretionary accrual absolute values, estimated by the modified Jones model. $OPACITY^2$ is simply the squared value of *OPACITY*, which we used to control for the reverse effect of discretionary accruals. Finally, we included the *IFRS* dummy variable to control for accounting standards.

We examined Hypotheses 2 and 3 to determine if the effect of fixed asset revaluation is dependent upon the underlying motivation of the revaluation. To conduct the clustering analyses [58], we used the regression models below:

$$\begin{aligned} CRASH_{t+1} = \; & \beta_0 + \beta_1 REVAL_t + \beta_2 RISKY_t + \beta_3 REVAL \times RISKY_t + \\ & \beta_4 RET_t + \beta_5 SIGMA_t + \beta_6 SIZE_t + \beta_7 LEV_t + \\ & \beta_8 MTB_t + \beta_9 ROA_t + \beta_{10} OPACITY_t + \beta_{11} OPACITY^2{}_t + \beta_{12} IFRS_t + \varepsilon \end{aligned}, \quad (5)$$

$$\begin{aligned} CRASH_{t+1} = \; & \beta_0 + \beta_1 REVAL_t + \beta_2 IA_t + \beta_3 REVAL \times IA_t + \\ & \beta_4 RET_t + \beta_5 SIGMA_t + \beta_6 SIZE_t + \beta_7 LEV_t + \\ & \beta_8 MTB_t + \beta_9 ROA_t + \beta_{10} OPACITY_t + \beta_{11} OPACITY^2{}_t + \beta_{12} IFRS_t + \varepsilon \end{aligned}, \quad (6)$$

where *RISKY* = *SOUNDNESS* or *NET LOSS*; *SOUNDNESS* = an indicator variable that equals 1 if (total debt/total equity) is above the median and 0 otherwise; *NET LOSS* = an indicator variable that equals 1 if the firm reports net loss; *IA* = *TURNOVER* or *VOLATILITY*; *TURNOVER* = the average daily turnover (percentage) over the past six months, where the daily turnover is the ratio of the number of shares traded each day to the number of shares outstanding at the end of the day; *VOLATILITY* = stock return volatility, which is measured using the standard deviation of weekly market excess returns over the course of a year.

In Equation (5), β_3 was negatively correlated with the stock price crash risk resulting from fixed asset revaluation by high-leveraged firms, as predicted in Hypothesis 2. Net loss factors were also considered in the model. In Equation (6), β_3 was negatively correlated with the stock price crash risk resulting from fixed asset revaluation by firms with high information asymmetry, as predicted in Hypothesis 3.

3.4. Sample Selection

The sample included companies listed on the Korea Stock Exchange (KSE) market as of 31 December 2017 that satisfied the following criteria: (1) companies (except financial companies) listed on the KSE market with accounts closing in December and (2) companies with financial statements, stock prices, and share trading information in the FnGuide database. The list of firms that conduct fixed asset revaluations was obtained from the Korea Investors Network for Disclosure (KIND), operated by the KRX. Each industry was denoted by its two-digit industry code, and we only included industries with at least 20 observations in each industry year group, so as to reduce bias. The top and bottom 1% of dependent and independent variable outcomes were winsorized, in an attempt to minimize the effect of outliers. Complete firm-year observation values are described in Table 1. Via this process, only companies whose values increased through the revaluation model remained in the final sample.

Table 1. The sample.

Initial observations from 2007 to 2017	7680	
	Increase after revaluation 7660	Decrease after revaluation 20
Less		
Closing fiscal year in months other than December	733	5
Financial companies	157	5
Industries with less than 20 observations in each industry-year group	29	2
Companies with no financial statements, stock prices, and share trading information	514	6
Final observation	6227	0

4. Empirical Results

4.1. Descriptive Statistics

Table 2 presents the summary statistics for the variables used in this paper. The mean value of *CRASH* was 0.159, which shows that approximately 16% of firms in our sample, on average, experienced stock price crashes. *REVAL* had a mean (median) of 0.372 (0.000), with a standard deviation of 0.483. The average *LEVERAGE* measured by the debt ratio in the sample firm was 0.280. Values for *NET LOSS*—the other measure of low financial soundness were similar to those for *LEVERAGE*. The firms in our sample had an average volatility of 2.847 with a standard deviation of 1.086. The mean value and standard deviation of stock return turnover in our sample were 2.418 and 1.192, respectively.

Table 2. Descriptive Statistics.

Variables	Mean	STD	Q1	Median	Q3
CRASH	0.159	0.365	0.000	0.000	0.000
REVAL	0.372	0.483	0.000	0.000	1.000
SOUNDNESS	0.280	0.449	0.000	0.000	1.000
NET LOSS	0.204	0.403	0.000	0.000	0.000
VOLATILITY	0.028	0.011	0.021	0.026	0.035
TURNOVER	2.418	3.804	0.546	1.192	2.619
RET	−0.148	0.790	−0.578	−0.140	0.300
SIGMA	0.055	0.029	0.039	0.049	0.063
SIZE	19.138	1.707	17.890	18.798	20.120
LEV	0.421	0.199	0.263	0.424	0.569
MTB	1.273	1.223	0.574	0.905	1.466
ROA	0.025	0.077	0.005	0.030	0.062
OPACITY	0.168	0.130	0.081	0.131	0.216
$OPACITY^2$	0.045	0.082	0.007	0.017	0.047
IFRS	0.675	0.468	0.000	1.000	1.000

Notes: Variable definition: *CRASH* = an indicator variable equal to 1 if, within its fiscal year, a firm experiences one or more firm-specific weekly returns falling 3.09 or more standard deviations below the mean firm-specific weekly return for its fiscal year and 0 otherwise; *REVAL* = a dummy variable, which takes the value of 1 if the firm revalued its asset and 0 otherwise; *SOUNDNESS* = an indicator variable that takes the value of 1 if the total debt/total equity is above the median and 0 otherwise; *NET LOSS* = an indicator variable that takes the value of 1 if the firm reports net loss; *VOLATILITY* = stock return volatility, which is measured using the standard deviation of weekly market excess returns over the course of a year; *TURNOVER* = the average daily turnover (percentage) over the past six months, where daily turnover is the ratio of the number of shares traded each day to the number of shares outstanding at the end of the day; *RET* = the mean return of the firm-specific weekly return over the fiscal year; *SIGMA* = the standard deviation of the firm-specific weekly return over the fiscal year; *SIZE* = Ln(total assets); *LEV* = total liability/total assets; *MTB* = market value of equity/book value of equity; *ROA* = net income/total assets; *OPACITY* = the moving sum of the absolute value of discretionary accruals for the previous three years; $OPACITY^2$ = the squared value of opacity; *IFRS* = an indicator variable that equals 1 if firms mandatorily adopt the IFRS and 0 otherwise.

Table 3 displays the Pearson correlation matrix for the main variables used in this research. The crash risk measure, *CRASH*, was negatively correlated with *REVAL* and positively correlated with *SOUNDNESS* and *NET LOSS*, and all the values were significant at the 1% level. The correlation coefficients of both *VOLATILITY* and *TURNOVER*—two measures of information asymmetry were insignificant at positive 0.008 and 0.007, respectively. Even though these two measures were quite different in their construction, they seemed to present essentially identical information. Overall, our univariate results largely supported the notion that fixed asset revaluation is associated with stock price crash risk.

Table 3. A Correlation Matrix.

	(3)	**(2)**	**(4)**	**(5)**	**(6)**	**(6)**
CRASH (1)	1.000	−0.050 (<0.0001)	0.039 (0.002)	0.044 (0.000)	0.008 (0.548)	0.007 (0.590)
REVAL (2)		1.000	0.199 (<0.0001)	0.119 (<0.0001)	0.018 (0.164)	0.069 (<0.0001)
SOUNDNESS (3)			1.000	0.254 (<0.0001)	0.179 (<0.0001)	0.076 (<0.0001)
NET LOSS (4)				1.000	0.232 (<0.0001)	0.160 (<0.0001)
VOLATILITY (5)					1.000	0.619 (<0.0001)
TURNOVER (6)						1.000

(1) See Table 2 for definitions of the variables.

4.2. Main Results

Table 4 presents the results of the multivariate test of Hypothesis 1 based on the estimation in Equation (4). Hypothesis 1 explores whether fixed asset revaluation affects stock price crash risk by reducing management's ability to report misleading information or withhold negative firm-specific information from investors. Table 4 presents the coefficient estimates for testing Hypothesis 1 resulting from the logistic regressions, with the firms' stock price crash risk (*CRASH*) as the dependent variable. As predicted in Hypothesis 1, the results show that the coefficients on *REVAL* were negative (−0.202) and statistically significant at the 0.05 level (χ^2 = 5.31), after controlling for the effect of firm-specific mean return, standard deviation of mean return, size, leverage, market-to-book, firm profitability, and firm opacity. This significantly negative result supports Hypothesis 1, indicating that investors regard asset revaluation as an effective tool for reflecting the intrinsic value of a financial statement and improving the sustainability of a firm's information disclosure environment, resulting in a lower stock price crash risk. This finding is consistent with the results of the study by Hsu et al. [60], suggesting that there is less room for management to hide negative news or manipulate it when reporting by revaluation.

The control variables utilized in this study were the combined sets of stock price crash determinants examined by Hutton et al. [11], Kim et al. [48,51], DeFond et al. [38], and Callen and Fang [46]. *SIZE* was negatively correlated with crash risk, suggesting that small firms are prone to future crash risk. Not surprisingly, *LEV* was significant, with a positive coefficient, meaning that firms with higher debt ratios tend to have more crashes in their stock prices. The remaining control variables were also consistent with the research in Hutton et al. [11]. Positive relations were found between the stock price crash dummy and firm-specific mean return (*RET*) and market-to-book (*MTB*) and *OPACITY*, and negative relations were shown with *SIGMA*, *ROA*, and $OPACITY^2$ [11,48,51].

Table 4. The impact of fixed asset revaluation on stock price crash.

$$CRASH_t = \alpha_0 + \beta_1 REVAL_{t-1} + \beta_2 RET_{t-1} + \beta_3 SIGMA_{t-1} + \beta_4 SIZE_{t-1} + \beta_5 LEV_{t-1} + \beta_6 MTB_{t-1} + \beta_7 ROA_{t-1} + \beta_8 OPA_{t-1} + \beta_9 OPA^2{}_{t-1} + \beta_{10} IFRS_{t-1} + \sum IND + \sum YR + \varepsilon_t$$

Variables	Coeff.	Wald Chi-square
Intercept	0.319	4.05 ***
REVAL	−0.026	−2.35 **
RET	0.014	2.19 **
SIGMA	−0.114	−0.66
SIZE	−0.005	−1.50
LEV	0.051	1.86 *
MTB	0.010	2.12 **
ROA	−0.169	−2.41 **
OPACITY	−0.057	−0.56
$OPACITY^2$	0.218	1.39
IFRS	0.008	0.35
Industry Dummy	Included	
Year Dummy	Included	
R^2	0.02	
F-stat.	5.32 ***	
N	6277	

Notes: (1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 2 for definitions of the variables.

Overall, the results for Hypothesis 1 support the notion that firms with fixed asset revaluation are less likely to experience a stock price crash, because an asset revaluation, by reducing leverage, signals a firm's borrowing capacity and clarifies its information disclosure environment via the timely incorporation of relevant information [21].

Hypothesis 2 tests the effect of the opportunistic use of asset revaluation on stock price crash risk. Table 5 presents the results of testing Hypothesis 2. The coefficient of β_3 in panel A was positive and significant at the 1% level. This is consistent with the prediction in Hypothesis 2 that the asset revaluation of a high-leveraged firm is more likely to increase stock price crash risk. The coefficient of interaction term in panel B was significantly positive, with the amount of 0.015 at the 1% level. The findings suggest that stock price crash risk is more pronounced for firms experiencing loss and using asset revaluation. Overall, capital market participants assume that firms in financial distress (with high leverage and net loss) are opportunistically using fixed asset revaluation to mask their poor financial condition. This finding is consistent with the prediction of Penman [34], suggesting that if fixed asset revaluation is opportunistically used to camouflage the financial soundness of firms with low financial soundness, fair value reporting provides more room for management to hide information, thereby polluting the information disclosure environment and threatening sustainability.

Hypothesis 3 examines whether fixed asset revaluation's impact on the likelihood of a stock price crash is more pronounced for firms with high information asymmetry than for firms with low information asymmetry, and vice versa. Following Lim [61], we utilized two proxies (*TURNOVER* and *VOLATILITY*) for measuring information asymmetry between managers and outside investors. Table 5 displays the regression results of the testing of Hypothesis 3, where *CRASH* is the dependent variable and the two proxies for information asymmetry (*IA*) are applied. *TURNOVER* is the average daily turnover (percentage) over the past six months, whereas daily turnover is the ratio of the number of shares traded each day to the number of shares outstanding at the end of the day. *VOLATILITY* is stock return volatility, which is measured using the standard deviation of weekly market excess returns over the course of a year. For all information asymmetry measures, higher values indicate a higher degree of information asymmetry.

Table 5. The impact of fixed asset revaluation on stock price crash for firms with low financial soundness.

$$CRASH_t = \alpha_0 + \beta_1 REVAL_{t-1} + \beta_2 RISKY_{t-1} + \beta_3 REVAL \times RISKY_{t-1} + \beta_4 RET_{t-1} + \beta_5 SIGMA_{t-1} + \beta_6 SIZE_{t-1} + \beta_7 LEV_{t-1} + \beta_8 MTB_{t-1} + \beta_9 ROA_{t-1} + \beta_{10} OPA_{t-1} + \beta_{11} OPA^2_{t-1} + \beta_{12} IFRS_{t-1} + \sum IND + \sum YR + \varepsilon_t$$

Panel A. Leverage

Variables	Coeff.	Wald Chi-square
Intercept	0.325	4.12 ***
REVAL	−0.043	−3.34 ***
SOUNDNESS	−0.009	−0.47
REVAL × *SOUNDNESS*	0.056	2.66 ***
RET	0.014	2.21 **
SIGMA	−0.124	−0.72
SIZE	−0.005	−1.46
LEV	0.025	0.62
MTB	0.010	2.24 **
ROA	−0.167	−2.37 **
OPACITY	−0.064	−0.63
$OPACITY^2$	0.227	1.45
IFRS	0.008	0.37
IND Dummy	Included	
YEAR Dummy	Included	
R^2	0.02	
F-stat.	5.26 ***	
N	6277	

Panel B. Net Loss

Variables	Coeff.	Wald Chi-square
Intercept	0.311	3.93 ***
REVAL	−0.041	−3.33 ***
NET LOSS	−0.004	−0.20
REVAL × *NET LOSS*	0.065	2.80 ***
RET	0.015	2.38 **
SIGMA	−0.112	−0.65
SIZE	-0.005	−1.42
LEV	0.042	1.53
MTB	0.010	2.10 **
ROA	−0.107	−1.18
OPACITY	−0.081	−0.80
$OPACITY^2$	0.253	1.62
IFRS	0.008	0.36
IND Dummy	Included	
YEAR Dummy	Included	
R^2	0.02	
F-stat.	5.35 ***	
N	6277	

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 2 for definitions of the variables.

Table 6 reports that the coefficient of *REVAL* × *TURNOVER* was significantly positive at the 5% level, and the coefficient of *REVAL* × *VOLATILITY* was also positive with a 10% level significance.

These findings are consistent with Hypothesis 3, suggesting that the impact of fixed asset revaluation on the likelihood of stock price crashes is evident in environments with higher information asymmetry. In other words, fixed asset revaluation provides a space for opportunistic management in firms with high information asymmetry to use the revaluation model to hide corporate financial condition, thereby damaging the information disclosure environment. Consistent with the prior studies, this finding suggests that greater information asymmetry leads to a reduction in the monitoring role of fixed asset revaluation in reducing stock price crashes [62].

Table 6. The impact of fixed asset revaluation on stock price crash for firms with high information asymmetry.

$$CRASH_t = \alpha_0 + \beta_1 REVAL_{t-1} + \beta_2 IA_{t-1} + \beta_3 REVAL \times IA_{t-1} + \beta_4 RET_{t-1} + \beta_5 SIGMA_{t-1} + \beta_6 SIZE_{t-1} + \beta_7 LEV_{t-1} + \beta_8 MTB_{t-1} + \beta_9 ROA_{t-1} + \beta_{10} OPA_{t-1} + \beta_{11} OPA^2_{t-1} + \beta_{12} IFRS_{t-1} + \sum IND + \sum YR + \varepsilon_t$$

Panel A. Turnover

Variables	Coeff.	Wald Chi-square
Intercept	0.328	4.16 ***
REVAL	−0.037	−2.89 ***
TURNOVER	0.004	2.23 **
REVAL × *TURNOVER*	0.004	1.81 *
RET	0.016	2.46 **
SIGMA	0.002	0.01
SIZE	−0.005	−1.65
LEV	0.050	1.81 *
MTB	0.010	2.24 **
ROA	−0.189	−2.67 ***
OPACITY	−0.053	−0.53
$OPACITY^2$	0.224	1.43
IFRS	0.009	0.41
IND Dummy	Included	
YEAR Dummy	Included	
R^2	0.02	
F-stat.	5.14 ***	
N	6277	

Panel B. Volatility

Variables	Coeff.	Wald Chi-square
Intercept	0.309	3.74 ***
REVAL	−0.076	−2.78 ***
VOLATILITY	2.386	3.60 ***
REVAL × *VOLATILITY*	1.956	2.22 **
RET	0.012	2.78 ***
SIGMA	−0.054	−0.60
SIZE	−0.003	−1.01
LEV	0.020	0.71
MTB	0.007	1.59
ROA	−0.343	−4.83 ***
OPACITY	0.000	0.00
$OPACITY^2$	0.154	0.99
IFRS	0.002	0.10
IND Dummy	Included	
YEAR Dummy	Included	
R^2	0.02	
F-stat.	5.86 ***	
N	6277	

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 2 for definitions of the variables.

4.3. Long-term Stock Price Crash Risk

The regressions in this paper examined the relationship between fixed asset revaluation and stock price crash risk using an identical forecasting window. However, we also believed it would be intriguing to investigate the duration of fixed asset revaluation's effect on future stock price crash risk. To do so, we expanded the measurement windows of stock price crash risk to one year, two years, and three years in the future. By using the long-term crash risk measures as the dependent variable, we re-estimated the baseline prediction model of Table 4 and report the related results in Table 7.

As shown in Table 7, all of the coefficients of *REVAL* were significantly negative. These results indicate that fixed asset revaluation is effective at achieving a long-term reduction of stock price crash risk.

Table 7. The impact of fixed asset revaluation on stock price crash for longer forecasting window.

Variables	$CRASH_{t+1}$		$CRASH_{t+2}$		$CRASH_{t+3}$	
	Coeff.	Wald Chi-square.	Coeff.	Wald Chi-square.	Coeff.	Wald Chi-square.
Intercept	0.301	3.66 ***	0.298	3.50 ***	0.182	1.99 **
REVAL	−0.034	−2.83 ***	−0.035	−2.80 ***	−0.026	−1.86 *
Controls	Included		Included		Included	
IND Dummy	Included		Included		Included	
YEAR Dummy	Included		Included		Included	
R^2	0.02		0.02		0.01	
F-stat.	5.06 ***		3.41 ***		2.28 ***	
N	5627		4992		4380	

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 2 for definitions of the variables.

4.4. Alternative Proxies of Stock Price Crash Risk

The first alternative crash measure we used was *NCSKEW*—the negative skewness of weekly returns over a fiscal year [48,49,51,59,63]. We calculated *NCSKEW* as the negative third moment of weekly returns for each firm-year observation, and it is reduced by the standard deviation of weekly returns cubed. The equation for *NCSKEW* of stock j in year t is as follows:

$$\mathrm{NCSKEW_{j,t}} = -\left[\mathrm{n}(\mathrm{n}-1)^{3/2}\sum W_{j,t}^{3}\right]/\left[(n-1)(n-2)\left(\sum W_{j,t}^{2}\right)^{3/2}\right]. \quad (7)$$

Here, Wj,τ is the weekly return of a given firm as calculated in Equation (1), and n is the number of weekly returns during the fiscal year t.

We allowed for a cross-variant comparison of stocks by scaling the raw third moment by the standard deviation cubed, the standard normalization technique for statistical skewness [64]. Bates [65] and Chen et al. [59] agreed on the precise definition of stock price crash as the conditional skewness of stock returns, which is most accurately represented by our variable *NCSKEW*. High crash risk in a stock is signaled by an increase in *NCSKEW*, which is determined by multiplying the third moment of stock returns by −1 [48,49,51,59,63].

The second alternative crash measure we used was *DUVOL*, the down-to-up volatility of stock returns. Weekly returns for a given firm j are divided by a fiscal year t, and weeks are designated as being "up" if returns are above the average annual return and "below" if returns fall below the average. The standard deviation of weekly returns was calculated separately for "up" and "down" weeks. *DUVOL* was then found using the natural logarithm of the ratio of the standard deviation in "down" weeks to the standard deviation in "up" weeks.

$$\mathrm{DUVOL_{j,t}} = \log[(n_u-1)\sum_{Down} W_{j,t}^{2}/(n_d-1)\sum_{Up} W_{j,t}^{2}]. \quad (8)$$

Here, Wj,τ is the weekly return of a given firm as calculated in Equation (1), and n is the number of weekly returns during the fiscal year t.

Table 8 shows the additional regression results of testing the effectiveness of fixed asset revaluation in reducing stock price crash using *NCSKEW* and *DUVOL* as the dependent variables. As shown in columns 1 and 2 of Table 8, the coefficients of *REVAL* were significantly negative, indicating that fixed asset revaluation effectively reduces stock price crash risk. Overall, the results in Table 8 are in line with the main outcome of Hypothesis 1, namely that fixed asset revaluation decreases stock price crash risk regardless of various crash measures.

Table 8. Alternative proxies for stock price crash: *NCSKEW* and *DUVOL*.

Variables	$NCSKEW_t$		$DUVOL_t$	
	Coeff.	**t-stat.**	**Coeff.**	**t-stat.**
Intercept	−2.767	−11.94 ***	−2.296	−13.39 ***
REVAL	−0.081	−2.47 **	−0.049	−2.06 **
Controls	Included		Included	
IND Dummy	Included		Included	
YEAR Dummy	Included		Included	
R^2	0.06		0.07	
F-stat.	15.73 ***		17.76 ***	
N	6277		6277	

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 2 for definitions of the variables.

4.5. Endogeneity Test for Choice of Revaluation Model

Our results indicate that fixed asset revaluation has a measurable effect on the likelihood of stock price crash risk when compared with the historical cost model. By initiating a timelier disclosure of corporate information, fixed asset revaluation may ultimately lower stock price crash risk. Conversely, fixed asset revaluation may encourage management to withhold negative information, which would heighten stock price crash risk. However, the likelihood that management would manipulate the results of fixed asset revaluation depends on the firm's motivation for conducting the revaluation. A financially healthy firm, for example, may choose to conduct fixed asset revaluation in order to openly communicate its sustainably low stock price crash risk to investors.

We therefore controlled for the choices made during the revaluation process through propensity score matching (PSM). We predicted these choices and estimated propensity scores by employing a logit model, as follows:

$$REVAL_t = \alpha_0 + \beta_1 Debtratio_{t-1} + \beta_2 Netloss_{t-1} + \beta_3 Tangible_{t-1} + \beta_4 Land_{t-1} + \varepsilon, \quad (9)$$

where *Debtratio* = an indicator variable that equals 1 if firms have an above-median debt ratio in year *t* and 0 otherwise; *Netloss* = an indicator variable that equals 1 if the firm reports net loss; *Tangible* = fixed asset/total asset; *Land* = land/total asset.

In Equation (7), variables for the incentive to engage in revaluation model are included [66]. Then, firms with revaluation models were matched with firms with historical models with the closest predicted value from Equation (7) within a maximum distance of 3% [67]. Firms that adopted revaluation models that could not be matched with any firms with historical models were excluded from the analysis, because predicted values for the latter firms were not within the specified distance of 3%. Consequently, there was a decrease in the number of firm-year observations in comparison to that in the main analysis. Panel A of Table 9 presents the empirical results for the propensity score-matched samples.

In panel B of Table 9, which shows similar results for H1, the coefficient *REVAL* has a strong negative correlation to stock price crash risk, implying that a significant decrease in stock price crash risk may be seen in firms that employ the revaluation model compared with firms that use the historical cost model. In addition, the coefficients for *Reval*Risky* and *Reval*IA* were significantly positive, indicating that the financial health and information asymmetry of the firms affect the relationship between fixed asset revaluation and stock price crash risk. Even when controlling for the variable of incentives, Table 9 supports our main finding, that the revaluation model results in a relative decline in stock price crash risk when compared with the historical model.

Table 9. The additional test: using a propensity score-matched sample.

Panel A. Univariate mean differences of matched sample			
Variable	**Revaluation**	**Non-revaluation**	**Differences**
Debtratio	0.3985	0.1948	0.2037
Netloss	0.2619	0.1629	0.0990
Tangible	0.3399	0.2630	0.0769
Land	0.1604	0.0824	0.0780

Panel B. H1		
Variables	**Coeff.**	**t-stat.**
Intercept	0.060	0.64
Reval	−0.021	−1.85 *
Controls	Included	
R^2	0.02	
F-stat.	4.64 ***	
N	5218	

Panel C. H2-1				
Variables	**(1) *Risky* = *SOUNDNESS***		**(2) *Risky* = *NET LOSS***	
	Coeff.	**t-stat.**	**Coeff.**	**t-stat.**
Intercept	0.417	4.37 ***	0.342	3.68 ***
Reval	−0.035	−2.46 **	−0.022	−1.65 *
Risky	−0.025	−1.18	0.021	1.04
*Reval*Risky*	0.064	2.98 ***	0.048	2.07 **
Controls	Included		Included	
R^2	0.03		0.03	
F-stat.	5.73 ***		5.04 ***	
N	5218		5218	

Panel D. H2-2				
Variables	**(1) *IA* = *TURNOVER***		**(2) *IA* = *VOLATILITY***	
	Coeff.	**t-stat.**	**Coeff.**	**t-stat.**
Intercept	0.456	4.88 ***	0.625	6.30 ***
Reval	−0.025	−1.83 *	−0.103	−3.47 ***
IA	0.005	2.04 **	4.121	5.35 ***
*Reval*IA*	0.007	2.56 **	3.492	3.68 ***
Controls	Included		Included	
R^2	0.03		0.04	
F-stat.	6.22 ***		7.02 ***	
N	5218		5218	

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 2 for definitions of the variables.

4.6. Firm-Year Fixed Regression without Financial Crisis Period

As a sensitivity test, we also controlled for the financial crisis period. Including revaluation firms for the financial crisis period may have had an important confounding effect on the results of the analyses. Thus, we conducted a sensitivity analysis that excluded the crisis period from the sample.

Table 10 presents the results of the firm-year fixed regression without the financial crisis period, and it shows the results excluding the years 2007, 2008, and 2009. Overall, the results are consistent with the main results suggesting that the relationship between fixed asset revaluation and stock price crash risk was still significant after controlling for the financial crisis period.

Table 10. Firm-year fixed regression without financial crisis period.

Panel A. H1		
Variables	**Coeff.**	**t-stat.**
Intercept	0.248	2.75 ***
Reval	−0.031	−2.68 ***
Controls	Included	
R^2	0.02	
F-stat.	4.67 ***	
N	4769	

Panel B. H2-1				
Variables	**(1) *Risky* = *SOUNDNESS***		**(2) *Risky* = *NET LOSS***	
	Coeff.	**t-stat.**	**Coeff.**	**t-stat.**
Intercept	0.254	2.82 ***	0.262	2.92 ***
Reval	−0.041	−3.10 ***	−0.038	−3.04 ***
Risky	0.007	0.30	0.007	0.29
*Reval*Risky*	0.042	1.70 *	0.043	1.65 *
Controls	Included		Included	
R^2	0.02		0.03	
F-stat.	4.59 ***		4.71 ***	
N	4769		4769	

Panel C. H2-2				
Variables	**(1) *IA* = *TURNOVER***		**(2) *IA* = *VOLATILITY***	
	Coeff.	**t-stat.**	**Coeff.**	**t-stat.**
Intercept	0.247	2.74 ***	0.223	2.46 **
Reval	−0.041	−3.15 ***	−0.062	−2.13 **
IA	0.002	1.13	2.320	2.26 **
*Reval*IA*	0.004	1.67 *	1.636	1.66 *
Controls	Included		Included	
R^2	0.02		0.02	
F-stat.	4.42 ***		4.45 ***	
N	4769		4769	

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 2 for definitions of the variables.

5. Conclusions

In this study, we examined the relationship between fixed asset revaluation and stock price crash risk. Fixed asset revaluation was introduced into the capital market before the official adoption of IFRS by the Korean government in an attempt to strengthen firms' statement of financial position during the financial crisis of 2008. Using stock price crash risk as a tool for evaluating the effectiveness of revaluation in terms of sustainability and clarity of an information disclosure environment, we found that fixed asset revaluation generally decreases the likelihood of stock price crashes through a timely reflection of intrinsic value in a firm's financial reporting. These results are similar to those of several prior Korean studies that showed positive stock market reactions to fixed asset revaluation [22,23,25]. The results were robust, even after controlling for different testing windows and various crashes measures. These findings indicated that fixed asset revaluation in South Korea has the potential to be an effective policy tool for increasing financial conditions in a sustainable way. However, additional findings suggest caution when interpreting and employing fixed asset revaluation. The evidence of additional analysis shows that the effectiveness of revaluation in mitigating crashes is

less pronounced for firms with low financial soundness and high information asymmetry. These findings have important implications for regulators, standard-setters, and capital market investors, as fixed asset revaluation appears to benefit firms that are sound and sustainable and honestly present financial information, though it is unlikely that this is the effect regulators intended to produce. In order to promote sustainability and transparency in information disclosure, explicit guidelines for using the revaluation model in fixed asset revaluation is necessary. Our analysis also shows that the stock market may be overly optimistic in its response to firms that conduct fixed asset revaluations—an effect investors may want to consider when evaluating such firms.

Caution should be taken in the adoption of these conclusions. First of all, the correlation between fixed asset valuation and stock price crash risk may be affected by financial conditions besides leverage. Further studies should be conducted to explore the relevant conditions and the degree to which they have an effect. Secondly, the unique conditions and nature of the Korean economic environment should be considered when interpreting the results of fixed asset revaluation in South Korea. Policymakers in other countries should evaluate their own economic environments when implementing fixed asset revaluation in order for it to achieve the desired effect.

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