THE JAPANESE ACCOUNTING REVIEW

VOLUME 15
2025

Expected Default Frequency-Adjusted Implied Cost of Equity: How and When Does the Probability of Default Affect the Implied Cost of Equity?

HITOSHI TAKEHARA†

Graduate School of Business and Finance,
WASEDA UNIVERSITY

ABSTRACT

Researchers have proposed some estimation methods for implied cost of equity (ICE) based on equity valuation models, but they have generally failed to consider the probability of default, assuming that firms will never go out of business. To overcome this problem, I propose a new method for estimating the ICE that explicitly considers the probability of default. Contrary to the fact that the conventional ICE increased rapidly during the stock market crash in 2008, the expected default frequency-adjusted ICE decreased during this same period. An examination of the relationship between ICE and future stock returns reveals that the probability of default is strongly associated with future stock returns, whereas the relationship between expected default frequency-adjusted ICE and future stock returns is ambiguous.

JEL Classifications: M41, C58, G31
Keywords: Implied Cost of Equity; Expected Default Frequency; Dividend Discount Model

† Hitoshi Takehara, Graduate School of Business and Finance, Waseda University.
Address: 1-6-1 Nishiwaseda, Shinjyuku-ku, Tokyo 169-8050, Japan. *Phone:* +81-3-5286-8419; *Email:* takehara@waseda.jp

Received August 24, 2022; accepted October 6, 2025, available online December 24, 2025
DOI: 10.11640/tjar.15.2025.01

1. Implied Cost of Equity and the Probability of Default

The concept of cost of equity can be estimated through two representative approaches. One approach comprises a series of implied methods based on equity valuation models, implicitly assuming that the existing stock price is fair[1] (Gebhardt et al. 2001; Claus and Thomas 2001; Easton 2004; Ohlson and Juettner-Nauroth 2005). The other approach comprises an asset-pricing model that estimates the cost of equity as an equilibrium stock return (Fama and French 1993,1997, 2015; Carhart 1997). While each mentioned methodological approach presents distinct advantages and limitations, a comparative evaluation or an assessment of their distinctions falls beyond the scope of this study. Instead, this paper hopes to revisit the cost of equity's foundational definition as the expected return demanded by equity investors, proposing the degree of correlation between estimated cost of equity and future stock returns as a key metric for assessing the reliability and quality of cost of equity estimations.

This metric has been major for evaluating cost of equity estimation methods. Lee et al. (2021), for instance, reported that the forecasting power of future stock returns of the implied cost of equity (ICE) is higher than that of the capital asset pricing model and/or Fama and French's (1993) three-factor model. Importantly, previous studies on ICE have neglected that these estimation methods do not consider corporate failure (hereinafter, the probability of default): In estimating the ICE, researchers have implicitly assumed that the equity valuation model they are using is the true one. However, the dividend discount model (DDM) and/or the residual income model cannot be true equity valuation models because they do not consider the probability of default. This is important in situations where such probability is not negligible, as the non-consideration of the probability of default would likely lead to inaccurate ICE estimations.

It is important to emphasize at this point that the available evidence describes a robust association between ICE and future equity performance. Specifically, Vassalou and Xing (2004) empirically confirmed that the probability of default is positively associated with stock returns through asset pricing tests. For one, the ICE tends to increase rapidly during stock market downturns. For another, as a rapid decline in stock prices is generally accompanied by an increase in the probability of default, there may be a positive correlation between ICE and future stock returns, which in turn can be explained by a change in the probability of default rather than a change in business risk. Worthy of mention is that while the evidence on the ICE–future equity performance association is robust, that on the underlying mechanisms driving this link remains under discussion. Accordingly, this study has the primary goal of determining whether ICE's predictive power is merely a reflection of heightened credit risk or if it captures broader market expectations about firm performance. This is actualized through a rigorous empirical analysis and model-based estimation focused on isolating the influence of the probability of default, hoping to clarify whether this probability amplifies, distorts, or independently contributes to the explanatory strength of ICE in forecasting future returns. This distinction is critical for investors, analysts, and policymakers reliant on ICE as a forward-looking metric in valuation, risk assessment, and strategic decision-making.

In order to unveil the mechanisms behind the ICE–future stock returns positive correlation, it is key to first clarify whether it is default risk premium (DRP) changes or business risk premium (BRP) changes that explain more of such correlation. For this examination, I propose a new ICE

---

[1] For a detailed analysis of the ICE using long-term data for the Japanese market, see Kitagawa and Gotoh (2011).

estimation method that explicitly considers expected default frequency (EDF), wherein the ICEPD[2]—estimated from the proposed method—does not include the impact of the probability of default on the cost of equity. Therefore, the difference between ICE and ICEPD can also be considered as a measure of DRP, and the ICE can be decomposed into ICEPD and DRP. By examining the relationship of ICEPD and DRP with future stock returns, the reason for ICE being positively associated with future stock returns can be unveiled.

Additionally, by applying the portfolio formation method, I constructed ICE, ICEPD, probability of default, and DRP-ranked decile portfolios and examined the returns from these portfolios. The empirical results show that the ICE is positively associated with future stock returns, similar to what is shown in numerous previous studies. However, there is no clear tendency for the association between ICEPD and future stock returns, while both the probability of default and DRP are positively associated with future stock returns. Thus, the positive correlation between ICE and future stock returns should be explained by the probability of default change rather than business risk change. To examine the relationship between ICE, probability of default, and future stock returns more closely, I also employed a two-way sequential portfolio formation method and constructed probability of default- and ICEPD-ranked 25 portfolios. The patterns that appear in the stock returns of these portfolios show that the ICEPD is positively correlated with stock returns only when the probability of default is relatively low.

The remainder of the paper is organized as follows. Section 2 proposes a new framework for estimating ICE that explicitly considers the probability of default. Section 3 describes the employed data and presents the EDF estimation results. Section 4 examines the ICEPD's characteristics. Section 5 investigates the relationship between ICEPD and future stock returns via the portfolio formation method. Finally, Section 6 concludes the study and presents its limitations.

2. EDF-Adjusted ICE

As discussed, the existing ICE estimation methods do not consider the situation in which a firm goes bankrupt. Therefore, the conventional ICE includes a DRP. Meanwhile, this study developed a new method for estimating the ICE that explicitly considers the probability of default of a corporation and decomposes it into risk-free interest rate, BRP, and DRP.

I employed Shaffer's (2006) constant growth DDM, which explicitly considers the probability of default. In the standard constant-growth DDM (i.e., the Gordon model), which does not consider the default, the intrinsic value of the stock, V_0, is expressed as follows:

$$V_0 = \frac{c_0(1+r)}{r-g}. \tag{1}$$

Here, C_0, r, and g denote the dividend in year 0, cost of equity, and constant dividend growth rate (DGR), respectively.

Notably, the cost of equity, r, in Equation (1) is constant and determined by considering only dividend risk. The risk premium corresponding only to the risk of cash flows received by shareholders (i.e., dividends) is the BRP. Let r_f denote the risk-free interest rate; then, $BRP = r - r_f$ when the firm is default-free. The ICE is obtained, as in Equation (2), by solving Equation (1):

[2] The ICEPD denotes the implied cost of equity (ICE) after adjusting for the probability of default (PD).

$$r = \frac{c_0}{V_0 - c_0} + \frac{V_0}{V_0 - c_0} g. \tag{2}$$

Although the denominators ($V_0 - c_0$) of the first and second terms on the right-hand side represent the ex-dividend stock price, r is approximately equal to the sum of the dividend yield (DY) and DGR.

As noted above, when we estimate the cost of equity (r) by using Equation (2), ICE is assumed to be the sum of the risk-free rate (r_f) and BRP because we do not consider the probability of default in Equation (1). However, in the estimates of ICE defined by Equation (2), the premiums for all equity risk factors are explicitly included because the stock price (V_0) is included on the right-hand side. There are various potential risks associated with stock prices, among which there is the probability of default—considered to have a significant effect on stock prices. In other words, ICE is calculated using an equity valuation model that does not account for the probability of default. This results in an inconsistency, as the actual estimates clearly include a DRP. As aforementioned, I focus specifically on the probability of default.

I employed the Black-Scholes-Merton probability of bankruptcy (i.e., EDF, hereafter just p)[3] to estimate the probability of default (Black and Scholes 1973; Merton 1974). Based on the assumption that EDF is constant over time, Shaffer (2006) derived a formula to compute the intrinsic value of stock price (Equation (3)), where r^* is the cost of equity when the probability of default is explicitly considered:

$$V_0 = \frac{c_0(1+r^*)(1-p)}{r^* + p - g(1-p)}. \tag{3}$$

In an analogous method to derive Equation (2) from DDM in Equation (1), Equation (4) is derived from DDM in Equation (3), which considers corporate default to express the EDF-adjusted ICE, ICEPD.[4]

$$r^* = \frac{c_0(1-p)}{V_0 - c_0(1-p)} + \frac{(V_0(1-p) - p)}{V_0 - c_0(1-p)} g. \tag{4}$$

---

[3] Altman's (1968) Z-score and Ohlson's (1980) O-score are more commonly used in accounting studies. However, the *probability* of default must be estimated to compute the EDF-adjusted ICE. The Z-score and/or O-score cannot be used because they are measures of the *propensity* to default. For example, if the Z-score of a particular firm is 3.0 or higher, it is considered to be in the "safe" zone, and if it is 1.8 or lower, it is considered to be in the "distressed" zone. Therefore, the Z-score (or O-score) is simply a measure of the degree of financial distress, that is, the *propensity* to default. Conversely, to estimate the EDF-adjusted ICE, the *probability* p ($0 \leqq p \leqq 1$) that a firm will default in the next year is required. The relationship between the Z-score, O-score, and default probability in Japan has been examined by Suda and Takehara (2013). The Pearson correlation between p and Z-score is 0.228, and that between p and O-score is 0.285 in the study by Suda and Takehara (2013). While the probability of default (p), Z-score, and O-score are all ways to measure default risk, they appear to be different from each other to some degree.

[4] In this study, I derived the EDF-adjusted ICE based on the DDM proposed by Shaffer (2006). However, it can be derived using the general stock valuation model. This is done by solving the nonlinear equations using an iterative method; the estimation formula can be derived in the same way as in Equation (4) for Frankel and Lee's (1998) valuation model without solving the nonlinear equations. A discussion of these issues is provided in the Appendix.

When the firm is default-free (i.e., $p = 0$), Equation (4) reduces to Equation (2). A comparison of Equations (2) and (4) indicates that the first and second terms on the right-hand side of Equation (4) can be interpreted as the EDF-adjusted DY (*DYPD*) and EDF-adjusted DGR (*DGRPD*), respectively.[5]

The ICE, denoted by r and defined in Equation (2), does not consider the probability of default, whereas the ICEPD, represented by r^* in Equation (4), explicitly considers it. This distinction is important because the difference between r and r^* reflects the extent to which the anticipated probability of default influences the cost of equity. For this study, I define this difference as the DRP.

I described above that when the probability of default is zero, r comprises two components: the risk-free rate and a general BRP. However, when the probability of default is non-zero, the cost of equity must be decomposed further. Accordingly, as shown in Equation (5), r can be expressed as the sum of three elements: the risk-free rate, the BRP, and the DRP. This decomposition into three components provides a more nuanced understanding of how the probability of default influences equity valuation and the cost of equity.

$$r = r_f + (\text{business risk premium}) + (\text{default risk premium}). \tag{5}$$

To compute the ICEPD from Equation (4), DGR (g) and the probability of default (p) must be estimated. In this study, I employed the following sustainable growth rate first:

$$g = (\text{Return on Equity}) \times (1 - \text{Payout Ratio}). \tag{6}$$

I assumed that investors do not have a direct estimate of the expected value of future earnings and dividends, but that they consistently update the company's return on equity (ROE) and payout ratio for the next period based on the most recent earnings forecast data. Let FNI_{jt} and $FDIV_{jt}$ denote the latest earnings forecast and dividend farecast, respectively, estimated by the Nikkei.[6] Subsequently, the ROE forecast and payout ratio for firm j at the end of month t is given by Equation (7), where BV_{jt}, FNI_{jt}, and $FDIV_{jt}$ denote the book value of equity, earnings forecast, and dividend forecast of firm j in month t, respectively.[7]

$$ROE_{jt} = \frac{FNI_{jt}}{BV_{j,t-1}},\ PayoutRatio_{jt} = \frac{FDIV_{jt}}{NI_{jt}}. \tag{7}$$

If the earnings forecast, FNI_{jt}, is negative, I set $g = 0$. In this case, I implicitly assumed that I could value the stock using the no-growth model, as well as excluded samples with $BV_{j,t-1} \leq 0$ and estimated $r \leq 0$. These treatments may introduce bias into the intrinsic value of stocks and ICE, which is a limitation of the proposed method and of existing methods for calculating the ICE.

---

[5] Strictly speaking, all premiums for potential risk factors other than the business risk factor are also included in the ICEPD, as only the default risk is adjusted in Equation (4).

[6] The Nikkei Forecast data used for this research was downloaded via the QUICK Workstation Astra Manager.

[7] Here, the book value in month t (BV_{jt}) is the book value at the end of the fiscal year in the most recent available financial statement.

The Black-Scholes-Merton model (Black and Scholes 1973; Merton 1974) was employed to estimate the second parameter p; the three parameters in the model and the EDF were estimated via Vassalou and Xing's (2004) framework.

First, let V_A denote the market value of the firm's total assets, and let μ_A and σ_A denote the drift term and volatility of the total assets, respectively. As there is no market to trade the total assets of public firms, all three parameters, V_A, μ_A, and σ_A, are unobservable and must be estimated via an iteration method. Let X and T denote the total debt and time to maturity (one year in this study), respectively.[8] Thereafter, the EDF is expressed by Equation (8), where r_f denotes the risk-free interest rate and $N(\cdot)$ denotes the cumulative distribution function of the standard normal distribution.

$$EDF = N\left(-\frac{\ln(V_A / X) + (\mu_A - (\sigma_A^2 / 2)T)}{\sigma_A \sqrt{T}} \right). \tag{8}$$

The value in parentheses in Equation (8) is called the distance to default (DD). It is an inverse measure of the firm's probability of default, and is expressed as:

$$DD = \frac{\ln(V_A / X) + (\mu_A - (\sigma_A^2 / 2)T)}{\sigma_A \sqrt{T}}. \tag{9}$$

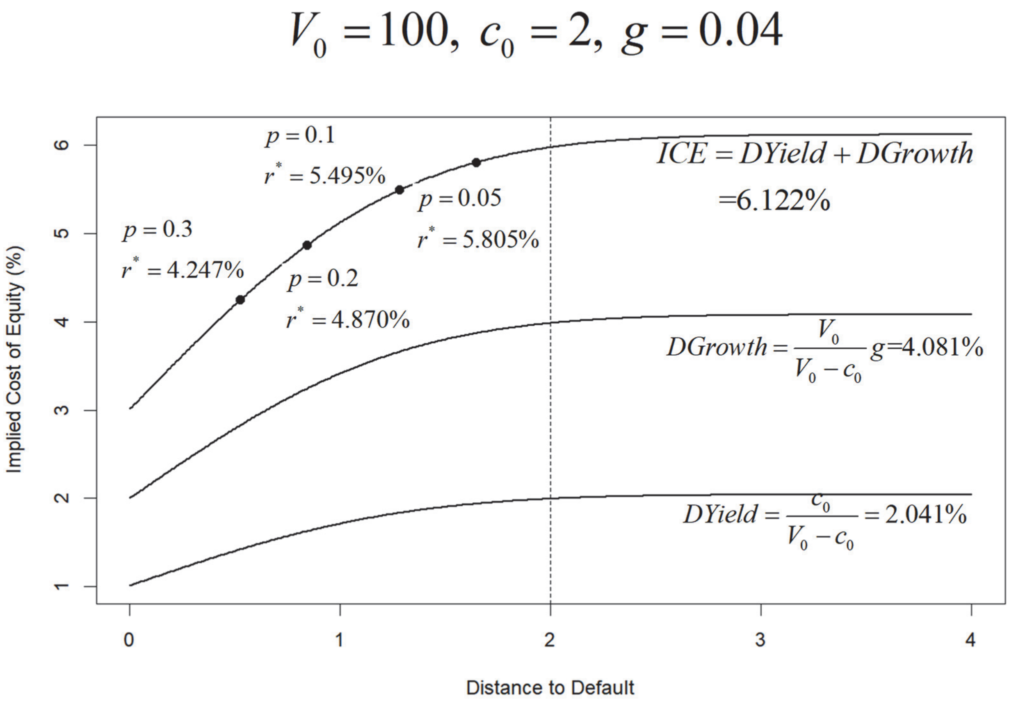
Vassalou and Xing (2004) estimated the V_A of the firm on each trading day by solving the call option Equation (10), where V_E is the market value of equity. In solving Equation (10), σ_E, referring to a realized volatility of the stock returns, is used as an initial guess for the volatility of total assets (σ_A).

$$\begin{gathered} V_E = V_A N(d_1) - X e^{-r_f T} N(d_2), \\ d_1 = \frac{\ln(V_A / X) + (\mu_A + (\sigma_A^2 / 2)T)}{\sigma_A \sqrt{T}}, \; d_2 = d_1 - \sigma_A \sqrt{T}. \end{gathered} \tag{10}$$

Second, the other two parameters, μ_A and σ_A, are estimated based on the daily time series of the V_A of the previous year. Before estimating the ICEPD with the long-term Japanese data, the nonlinearity in the relationship between EDF and ICEPD is discussed based on the following numerical example. Suppose that the current stock price V_0 = 100, C_0 = 2, ROE = 8%, and the payout ratio = 50%; then, the sustainable DGR is g = 0.04 (0.08 × 0.5). Figure 1 illustrates the relationship between DD and the ICEPD. Therein, as p approaches 0 (i.e., DD becomes sufficiently large), the ICEPD r^*, in Equation (4), reduces to r = 6.122%. Figure 1 also shows that the gap between r^* and r is marginal when DD is > 2. However, in the region where DD is < 2, r^* reduces rapidly as DD decreases. When p is 5%, 10%, 20%, and 30%, r^* is 5.805%, 5.495%, 4.870%, and 4.247%, respectively. Figure 1 shows that a nonlinear relationship exists between r^* and DD. Therefore, the linear regression model is not employed to investigate the interrelationship between r^*, DD, and stock returns.

[8] According to Vassalou and Xing (2004), X = (current liabilities + [fixed liabilities / 2]). I conducted the same analyses by setting X = (current liabilities + [fixed liabilities / 2]). The results of these additional analyses show that our main conclusion is not sensitive to this change.

FIGURE 1. RELATIONSHIP BETWEEN THE DD AND EDF-ADJUSTED ICE



3. Data and Estimated Results of EDF

Among the types of data necessary for estimating sustainable DGR, EDF, and ICEPD, there are financial statement data, which were obtained from the Nikkei NEEDS database. The primary data source for the market value of equity and monthly stock returns was the Nikkei NEEDS Daily Stock Return Database. The monthly EDF and ICEPD values of Japanese non-financial listed firms are estimated from January 2005 to December 2023 (total number of firm-month observations: 521,392). Table 1 presents the number of firms at the end of June of each year (t = 2005, …, 2023). As of December 2023, approximately 98% of these firms were listed on the Tokyo Stock Exchange (approximately 52% and 44% were listed in the Prime Section and Standard Section, respectively).

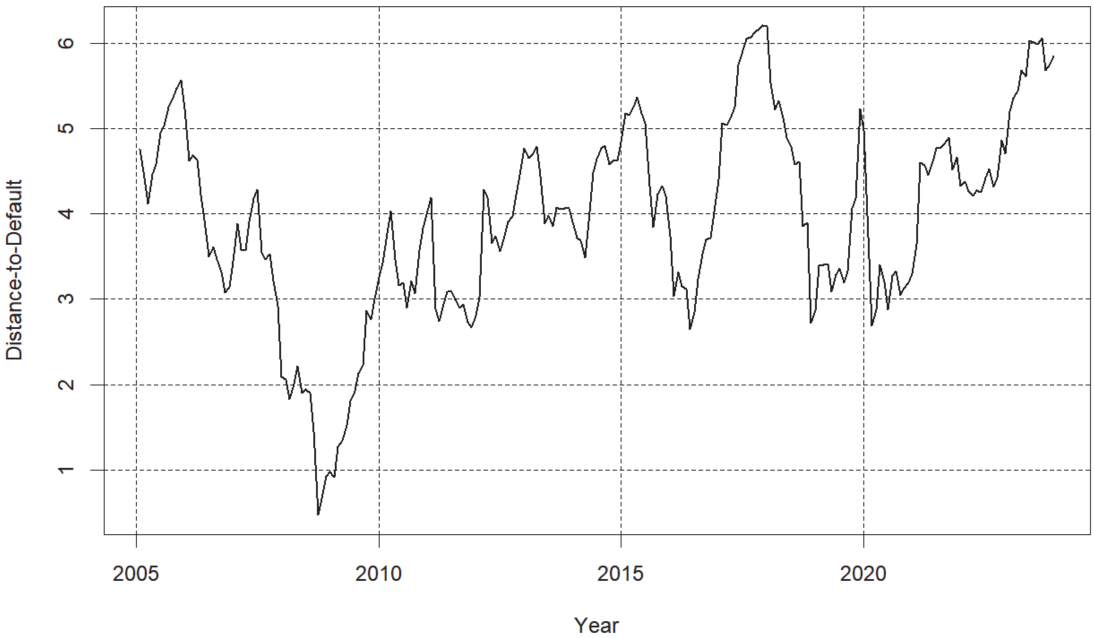
To construct a market-wide measure of the probability of default, the monthly average of the DD of each firm was computed. Figure 2 illustrates the time series of average DD over the period of interest. The market average DD has been greater than 2.651 since 2010, and the average effect of the probability of default on ICE is limited because p is not far from 0. Conversely, the average DD is less than 2.0 during the 2008 global financial crisis (and until July 2009) and approximately 3.0 at the beginning of the COVID-19 pandemic in 2020. During these downturns in the stock market, the gap between the existing ICE and ICEPD expands rapidly and continues for a considerable period, as is shown in Section 4.

TABLE 1. NUMBER OF SAMPLED FIRMS

Fiscal Year	#Sampled Firms	#Listed on TSE	TSE First Section	TSE Second Section	Others
2005	1789	1237	993	219	577
2006	1945	1353	1069	244	632
2007	2042	1406	1109	244	689
2008	2029	1388	1081	243	705
2009	1883	1262	969	225	689
2010	2164	1475	1140	262	762
2011	2219	1502	1183	254	782
2012	2237	1520	1195	254	788
2013	2329	1739	1292	372	665
2014	2403	1831	1391	354	658
2015	2478	1929	1484	369	625
2016	2527	1981	1526	368	633
2017	2620	2067	1608	369	643
2018	2628	2082	1658	341	629
2019	2612	2083	1667	338	607
2020	2274	1822	1474	281	519
2021	2588	2071	1672	326	590
Fiscal Year	**#Sampled Firms**	**#Listed on TSE**	**TSE Prime**	**TSE Standard**	**TSE Growth and Others**
2022	2613	2553	1443	1013	157
2023	2523	2467	1289	1093	141

Notes: Number of sample firms at the end of year t = 2005, …, 2023.

FIGURE 2. TIME-SERIES BEHAVIOR OF THE MARKET AVERAGE DD



4. Property of ICEPD

As expressed in Equation (2), the computed ICE is a sum of DY and DGR, while the ICEPD—derived from Equation (4)—is a sum of the DYPD and DGRPD. The ICEPD decreases with the increase in p. However, when p is significantly small, the effect of the EDF adjustment on ICE is marginal, and the ICEPD and ICE almost correspond. Therefore, the extent of the gap between the ICE before and after the EDF adjustment depends on the market environment at the time of estimating the ICE or, more precisely, the probability of default. The summary statistics of these key variables (*ICE*, *ICEPD*, *DY*, *DYPD*, *DGR*, *DGRPD*, *DD*, and *DRP* = [*ICE* – *ICEPD*]) are presented in Table 2.

The sample mean of DD is 3.983, and its first quantile is 2.226, indicating that p at the average and first quantile are 0.0034% and 1.310%, respectively. Even under this condition, a non-negligible difference exists between ICE and ICEPD. The difference between the sample means of DRP (= *ICE* – *ICEPD*) is 0.386% (8.105 – 7.720), which may affect equity valuation.

Table 3 presents the correlation matrix. The Pearson and Spearman correlations between ICE and ICEPD are 0.962 and 0.960, respectively. The Pearson correlation between ICEPD and DD is 0.051, and that between ICE and DD is negative at –0.051.

Figure 3 compares the time-series averages of the ICE and ICEPD during the sampled period. Therein, the long-term trends of the ICE and ICEPD are consistent, particularly after 2010, and usually do not significantly deviate. Their trends during the global financial crisis are particularly interesting; when the ICE increases sharply to 9% in 2008, the ICEPD decreases to 5%.[9] The

[9] The sharp decline in the ICEPD is explained by the large decrease in the DD. Figure 2 shows that the average DD of

TABLE 2. SUMMARY STATISTICS

	Mean	S.D.	1st Qu.	Median	3rd Qu.
ICE	8.105	4.851	4.578	7.229	10.574
ICEPD	7.720	4.681	4.284	6.917	10.189
DY	2.021	1.236	1.128	1.930	2.863
DYPD	1.924	1.183	1.062	1.838	2.738
DGR	6.065	4.884	2.396	4.966	8.421
DGRPD	5.783	4.682	2.216	4.738	8.097
DD	3.983	2.705	2.226	3.556	5.229
DRP	0.386	1.333	0.000	0.002	0.128

Notes: ICE: implied cost of equity without EDF adjustment, ICEPD: EDF-adjusted ICE, DY: dividend yield, DYPD: EDF-adjusted DY, DGR: growth rate of dividends, DGRPD: EDF-adjusted GDR, DD: distance to default, DRP: default risk premium (= ICE – ICEPD). Units other than DD are given in percent.

TABLE 3. CORRELATION MATRIX

	ICE	ICEPD	DY	DYPD	DGR	DGRPD	DD	DRP
ICE	1.000	0.960	0.054	0.043	0.947	0.923	-0.006	0.200
ICEPD	0.962	1.000	0.036	0.090	0.918	0.950	0.110	0.080
DY	0.004	-0.012	1.000	0.959	-0.216	-0.221	0.013	-0.029
DYPD	-0.011	0.035	0.955	1.000	-0.212	-0.175	0.125	-0.138
DGR	0.963	0.933	-0.242	-0.243	1.000	0.978	-0.001	0.186
DGRPD	0.938	0.965	-0.246	-0.210	0.977	1.000	0.080	0.103
DD	-0.051	0.051	-0.009	0.097	-0.044	0.027	1.000	-0.931
DRP	0.262	-0.013	0.059	-0.163	0.228	0.026	-0.367	1.000

Notes: The definitions of the variables are the same as in Table 2. The lower-left triangular matrix shows the Pearson moment correlations, and the upper-right matrix shows the Spearman rank correlations.

increase in the DRP explains the rapid increase in the ICE observed in 2008, when the stock market crashed.

---

listed firms dropped sharply below 1.0 during the 2008 global financial crisis (i.e., average DD is 0.474 in November 2008). Suppose that the DD decreases from 3 to 1; in this case, the probability of default (p) would increase from 0.135% to 15.866%. Now, suppose the stock price (V) falls from 100 to 80, representing a 20% decrease. As in Figure 1, assume the dividend per share C_0 = 2 and the dividend growth rate g = 4%. In this scenario, the ICEPD decreases from 6.113% to 5.578%, while the ICE increases from 6.122% to 6.667%. An increase in the probability of default has a more significant impact on ICEPD when the DD is less than two. In this case, the downward effect of ICEPD due to the sharp increase in the probability of default outweighs the upward effect of the decline in stock price, resulting in a lower ICEPD.

FIGURE 3. ICE WITH AND WITHOUT EDF ADJUSTMENT

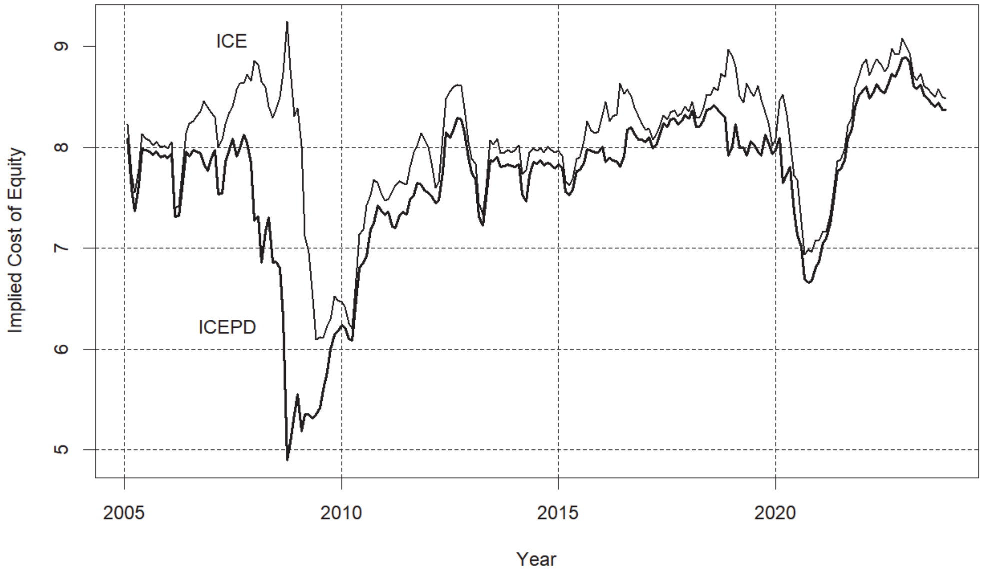
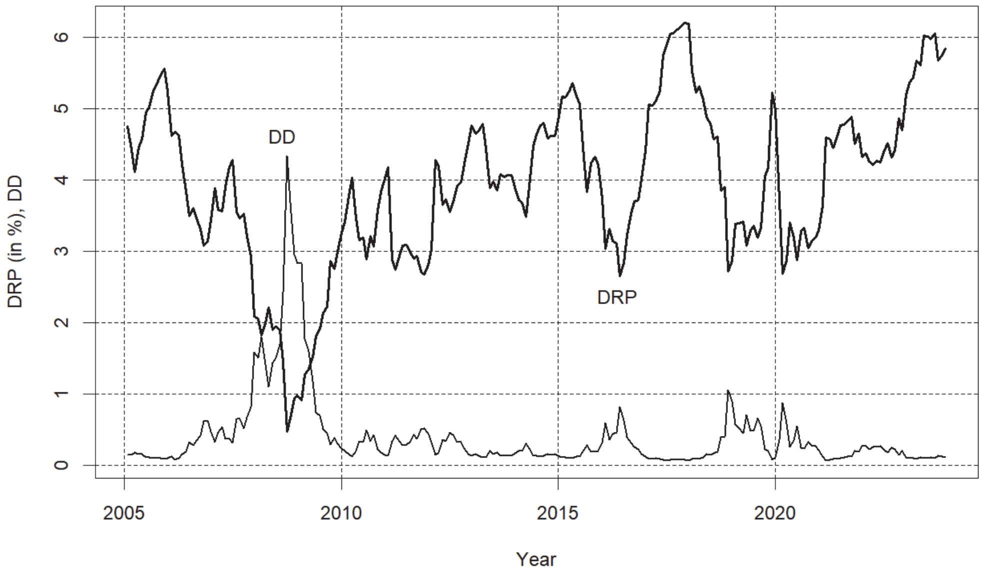


FIGURE 4. TIME-SERIES BEHAVIOR OF THE MARKET AVERAGE DD AND DRP



I now closely examine the impact of the probability of default on the cost of equity. As aforementioned, the measure of the DRP is defined as the difference between ICE and ICEPD. Accordingly, when and to what extent the probability of default affects the cost of equity can be confirmed by examining the relationship between the DD and DRP. The time variation of DD and DRP over the sample period is illustrated in Figure 4.

During the 17 months from January 2008 to May 2009, the DRP is well above 1%. However, there is also an increase in market average DRP in other periods, such as June 2016, the end of 2018, and at the time of the COVID-19 pandemic shock (March 2020). In Table 2, the standard deviation of the DRP is 1.333%, and the distribution has a thick tail on the right. Note that there is no guarantee that the DRP will be close to 0, even if the market average DD is sufficiently large.

5. ICE and Future Stock Returns

The findings confirm that the ICEPD exhibits significantly different trends and levels at an increased p from the ICE. Under these conditions, the relationship between ICE and future stock returns must be elucidated. Thus, this section analyzes the relationship between ICE and future stock returns employing the portfolio formation method.

Chava and Purnanandam (2010) demonstrated a positive correlation between the probability of default and ICE in the U.S. stock market. Additionally, Vassalou and Xing (2004) established a positive correlation between the probability of default and stock returns. Therefore, it is not surprising that the ICE is positively correlated with stock returns as long as it includes the probability of default. However, the conventional ICE is the sum of the BRP and DRP when risk premiums for other potential risk factors are marginal. At this point, the relationship between business risk and stock returns and between the probability of default and stock returns must be examined.

To determine the effect of the ICE, ICEPD, and the probability of default on stock returns, decile portfolios are constructed based on the four variables of *ICE*, *ICEPD*, *DD*, and *DRP*. After each month, from February 2005 through December 2023, the sampled firms are ranked based on these variables, after which equal-weighted decile portfolios are constructed. Table 4 presents the total asset volatility (σ_A), the drift term (μ_A), and the DD, ICE, ICEPD, and DRP (= *ICE* – *ICEPD*) of these four decile portfolios. Regarding the ICE-ranked decile portfolio (Panel A), DD tends to be relatively small (indicating a high probability of default) in low ICE portfolios (ICE9 and ICE10). As the volatility of the total assets in ICE9 and ICE10 is lower than that in ICE1 and ICE2, and the drift term is low in ICE9 and ICE10, both portfolios have low risk and return characteristics. The low growth rate of the total assets explains the relatively low DD (i.e., high EDF). A similar trend is observed for ICEPD9 and ICEPD10 in Panel B. Conversely, in the DD-ranked decile portfolios (Panel C), the total assets volatility in DD9 and DD10 is higher than that in others, and the drift term decreases monotonically from DD1 (the lowest probability of default) to DD10 (the highest probability of default). This indicates that the increasing volatility of total assets and declining growth of total assets reduce DD (denoting an increased measure of the probability of default). Finally, regarding the DRP-ranked decile portfolios (Panel D), the DD increases monotonically as the total asset volatility decreases and the drift term increases monotonically from DPR1 to DRP10. However, DD is greater than 3 in DRP5 to DRP10, and therefore the DRP in DRP5 to DRP10 is less than 0.1%.

TABLE 4. CHARACTERISTICS OF THE ICE-, ICEPD-, DD-, AND DRP-RANKED DECILE PORTFOLIOS

Panel A. ICE-Ranked Decile Portfolios

	σ_A	μ_A	DD	ICE	ICEPD	DRP
ICE1(High)	36.670	16.039	3.300	18.536	17.164	1.372
ICE2	27.570	9.182	3.793	13.124	12.480	0.644
ICE3	24.645	7.158	4.022	10.523	10.070	0.453
ICE4	23.204	6.075	4.037	8.946	8.597	0.350
ICE5	22.121	4.875	4.065	7.713	7.408	0.304
ICE6	21.533	3.795	4.079	6.629	6.372	0.258
ICE7	21.116	2.793	4.156	5.611	5.393	0.218
ICE8	21.093	1.953	4.115	4.579	4.393	0.185
ICE9	21.405	1.133	3.981	3.393	3.241	0.152
ICE10(Low)	25.624	0.200	3.748	1.593	1.504	0.089

Panel B. ICEPD-Ranked Decile Portfolios

	σ_A	μ_A	DD	ICE	ICEPD	DRP
ICEPD1(High)	36.522	19.593	3.600	18.272	17.593	0.679
ICEPD2	27.226	10.926	3.980	12.920	12.572	0.348
ICEPD3	24.458	8.241	4.142	10.397	10.096	0.301
ICEPD4	23.051	6.753	4.129	8.868	8.573	0.295
ICEPD5	21.876	5.117	4.112	7.670	7.368	0.302
ICEPD6	21.527	3.977	4.104	6.624	6.306	0.318
ICEPD7	20.868	2.433	4.146	5.642	5.306	0.337
ICEPD8	21.159	1.080	4.002	4.675	4.290	0.385
ICEPD9	21.732	-0.458	3.772	3.586	3.117	0.469
ICEPD10(Low)	26.560	-4.464	3.308	1.994	1.401	0.594

TABLE 4. (continued)

Panel C. DD-Ranked Decile Portfolios

	σ_A	μ_A	DD	ICE	ICEPD	DRP
DD1(High)	21.395	13.733	8.968	7.391	7.357	0.034
DD2	23.704	13.699	6.039	7.851	7.813	0.038
DD3	23.659	12.607	5.012	7.968	7.922	0.047
DD4	23.153	10.358	4.326	7.955	7.891	0.064
DD5	22.987	8.266	3.782	8.065	7.968	0.097
DD6	22.924	6.132	3.306	8.146	7.988	0.159
DD7	23.538	3.688	2.851	8.209	7.959	0.250
DD8	24.756	1.423	2.370	8.276	7.852	0.424
DD9	27.075	-2.138	1.802	8.318	7.540	0.778
DD10(Low)	31.816	-14.531	0.831	8.483	6.348	2.135

Panel D. DRP-Ranked Decile Portfolios

	σ_A	μ_A	DD	ICE	ICEPD	DRP
DRP1(High)	34.239	-3.923	1.675	13.749	11.186	2.563
DRP2	29.065	-0.899	1.841	9.429	8.670	0.759
DRP3	24.776	0.030	2.224	7.613	7.264	0.349
DRP4	23.324	2.569	2.717	7.409	7.230	0.179
DRP5	22.420	4.334	3.182	7.210	7.116	0.094
DRP6	22.382	6.645	3.672	7.200	7.153	0.047
DRP7	22.429	8.737	4.286	7.109	7.087	0.022
DRP8	22.592	10.736	5.163	7.072	7.064	0.008
DRP9	22.492	12.148	6.453	6.982	6.981	0.002
DRP10(Low)	21.275	12.856	8.080	6.878	6.878	0.000

Notes: σ_A is the volatility of the total assets; μ_A is the drift of the total assets; DD is the distance to default; ICE is the implied cost of equity without EDF adjustment; ICEPD is the EDF-adjusted ICE; DRP is the default risk premium (= ICE−ICEPD).

TABLE 5. REALIZED RETURNS FROM THE DECILE PORTFOLIOS

	ICE Ranked Decile Portfolios	ICEPD Ranked Decile Portfolios	DD Ranked Decile Portfolios	DRP Ranked Decile Portfolios
P1 (High)	0.987	0.930	0.627	1.168
P2	1.001	0.949	0.744	1.040
P3	1.006	0.983	0.706	1.029
P4	0.996	0.933	0.813	1.035
P5	0.946	0.947	0.832	0.970
P6	0.909	0.882	0.893	0.878
P7	0.908	0.873	1.028	0.797
P8	0.746	0.814	1.029	0.661
P9	0.733	0.762	1.018	0.730
P10 (Low)	0.716	0.877	1.261	0.641
Spr. (P1-P10)	0.271	0.053	-0.634	0.526
p-value	0.115	0.756	0.079	0.119

Table 5 presents the average monthly returns of the four decile portfolios (i.e., constructed in Table 4). First, regarding the ICE-ranked decile portfolios, the realized stock returns tends to decrease from P3 to P10, and the return spread between P1 (the highest ICE) and P10 (the lowest ICE) is 0.271% per month, which is not statistically significant at the 10% level (p-value = 0.115). This reconfirms a positive correlation between ICE and stock returns, corresponding to the results of previous studies. Conversely, regarding the ICEPD-ranked decile portfolios, no clear tendency is observed between ICEPD and realized stock returns. The return spread is low (0.053% per month) and not statistically significant (probability value = 0.756). After controlling for the effect of EDF on ICE, no positive correlation is observed between the ICE and future stock returns. However, the magnitude of the spread (P10–P1) for the DD-ranked decile portfolios is high (0.634% per month) and significant at the 10% level. These results indicate that the observed positive correlation between ICE and future stock returns may be explained by EDF. The implication that the positive correlation between ICE and stock returns is explained by EDF is supported by the trend in the returns of the DRP-ranked decile portfolios. These returns decrease almost monotonically from DRP1 to DRP10, and the return spread (DRP1–DRP10) is as high as 0.526%, although statistically insignificant at the 10% level (p-value = 0.119). As the ICE is the sum of the ICEPD and DRP, and the ICEPD and stock returns are almost uncorrelated, the positive relationship between the ICE and stock returns should be mainly explained by the DRP.

Finally, to examine the relationship between DRP and ICEPD, 25 two-way ranked portfolios were constructed, ranked first by DRP and ICEPD and then by ICEPD and DRP. Panel A of Table 6 reveals that, when controlling for DRP in the first step, the magnitude of the return spread

TABLE 6. REALIZED RETURNS FROM THE SEQUENTIAL TWO-WAY-RANKED 25 PORTFOLIOS

Panel A. DRP–ICEPD Ranked 25 Portfolios

	ICEPD1 (High)	ICEPD2	ICEPD3	ICEPD4	ICEPD5 (Low)	Spr. (P1-P5)	*p*-value
DRP1(High)	0.972	0.994	1.015	1.234	1.304	-0.332	0.179
DRP2	0.936	1.076	1.070	1.064	1.014	-0.078	0.683
DRP3	1.001	0.898	0.927	0.915	0.885	0.116	0.465
DRP4	0.912	0.835	0.738	0.650	0.508	0.403	0.005
DRP5(Low)	1.000	0.854	0.722	0.543	0.308	0.691	0.000

Panel B. ICEPD–DRP Ranked 25 Portfolios

	DRP1 (High)	DRP2	DRP3	DRP4	DRP5 (Low)	Spr. (P1-P5)	*p*-value
ICEPD1(High)	0.959	0.866	0.909	0.944	1.014	-0.055	0.841
ICEPD2	1.058	1.183	0.836	0.866	0.847	0.210	0.402
ICEPD3	1.072	1.067	0.913	0.763	0.759	0.314	0.272
ICEPD4	1.161	0.984	0.915	0.617	0.538	0.622	0.033
ICEPD5(Low)	1.268	1.069	0.934	0.516	0.311	0.957	0.010

is large and significant at the 5% level only for DRP4 and DRP5. The ICEPD is applied in the second step, and if the DRP is relatively low or close to 0, the ICEPD has a positive correlation with stock returns. However, for portfolios with a higher DRP, the relationship between ICEPD and stock returns is not clearly observed. Conversely, in Panel B, in which the firms are ranked based on the ICEPD in the first stage and the DRP in the second stage, the return spreads between DRP1 and DRP5 are positive and significant in ICEPD4 and ICEPD5. Therefore, controlling for the effect of the EDF does not eliminate the effect of the ICEPD on stock returns, although the effect of the probability of default on future stock returns is much larger. From the observations in Tables 5 and 6, the BRP (ICEPD – r_f) and DRP are positively related to future stock returns and they are in a complementary relationship. When the ICEPD or DRP is low, the positive correlation of one with the other and of each with stock returns will be stronger.

6. Conclusions

In this study, I propose a new framework for estimating the ICE that explicitly considers the possibility of corporate failure, as assessed through the probability of default. The empirical results demonstrated that the conventional ICE increased rapidly during the global financial crisis in 2008, but the ICEPD declined. Moreover, no clear relationship existed between ICEPD and future stock returns. This suggests that the relationship between the probability of default and stock return is the primary explanation for the positive correlation between ICE and future stock returns, as reported in previous studies. In contrast, the positive correlation between ICEPD and future stock returns becomes stronger only when the probability of default is sufficiently low.

Regarding limitations, the sustainable growth rate was calculated by inputting Nikkei's earnings and dividend forecast data in the ICE estimation model. The EDF was also estimated using the method given by Vassalou and Xing (2004), and hence the empirical results may be somewhat affected by the way the model inputs are estimated. To verify the robustness of these results, the construction of a pro forma model for forecasting earnings and dividends and/or analyses using other methods for estimating the probability of default are needed. This would be a subject for further research.

Appendix: ICEPD and Residual Income Valuation

This section describes how the ICEPD is defined under the general equity valuation model. It also shows that Equation (4) in the main text includes the ICEPD under the residual income model introduced by Frankel and Lee (1998) as a special case. Let $IV_{t:\infty}$ be the intrinsic value at the end of year t of the firm that never defaults (p = 0). Similar to the work of Shaffer (2006), the fundamental value of a firm that is likely to default is given by Equation (A1):

$$FV_t = IV_{t:\infty} - \sum_{i=1}^{\infty} (1-p)^{i-1} p \cdot \left(\frac{IV_{(t+i):\infty}}{(1+r_E)^i} \right). \tag{A1}$$

The second term on the right-hand side of Equation (A1) is the sum of the present value of the cash flows that would be lost if the firm survives until year (t + i – 1) and goes bankrupt at the end of year (t + 1). If a model exists that can be used to estimate the intrinsic value of a company without default, it is possible to compute the ICEPD by replacing the left-hand side of Equation (A1) with the market capitalization of the company and applying the iterative method.

However, in some cases, it is not necessary to use iterative methods to compute the ICE and/or ICEPD. For example, according to Frankel and Lee (1998), residual income after year t is constant over time and treated as a perpetual annuity. Suto and Takehara (2018) showed that the ICE is equal to the earnings-to-price ratio under the perpetual annuity assumption. Since Frankel and Lee's (1998) model corresponds to a no-growth model (b = 0, g = 0), the ICEPD is given by Equation (A2).

$$r^* = \frac{E_0(1-p)}{V_0 - E_0(1-p)}. \tag{A2}$$

In Equation (A2), E_0 is the net income in year t, which is assumed to be paid out as dividends to shareholders.

As already mentioned in Footnote 2, for firms that do not pay a dividend (i.e., the plowback ratio b = 1), the ICEPD given in Equation (4) is reduced to the following Equation (A3):

$$r^* = \frac{(V_0(1-p)-p)}{V_0} ROE. \tag{A3}$$

Thus, the ICEPD in Equation (5) includes the no-growth and non-dividend models as special cases.

REFERENCES

Altman, E. 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance* 23: 589–609.

Black, F. and M. Scholes. 1973. The pricing of options and corporate liabilities. *Journal of Political Economy* 81 (3): 637–654.

Carhart, M. 1997. On persistence in mutual fund performance. *The Journal of Finance* 52 (1): 57–82.

Chava, S. and A. Purnanandam. 2010. Is default risk negatively related to stock returns? *Review of Financial Studies* 23 (6): 2523–2559.

Claus, J. and J. Thomas. 2001. Equity premia as low as three percent? Evidence from analysts' earnings forecasts for domestic and international stock markets. *The Journal of Finance* 56 (5): 1629–1666.

Easton, P. D. 2004. PE ratios, PEG ratios, and estimating the implied expected rate of return on equity capital. *The Accounting Review* 79 (1): 73–95.

Fama, E. F. and K. R. French. 1993. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics* 33 (1): 3–56.

Fama, E. F. and K. R. French. 1997. Industry costs of equity. *Journal of Financial Economics* 43 (2): 153–193.

Fama, E. F. and K. R. French. 2015. A five-factor asset pricing model. *Journal of Financial Economics* 116 (1): 1–22.

Frankel, R. and C. M. C. Lee. 1998. Accounting valuation, market expectation, and cross-sectional stock returns. *Journal of Accounting and Economics* 25 (3): 283–319.

Gebhardt, W. R., C. M. C. Lee, and B. Swaminathan. 2001. Toward an implied cost of capital. *Journal of Accounting Research* 39 (1): 135–176.

Kitagawa, N. and M. Gotoh. 2011. Implied cost of capital over the last 20 years. *The Japanese Accounting Review* 1: 71–104.

Lee, C. M. C., E. C. So, and C. C. Y. Wang. 2021. Evaluating firm-level expected-return proxies: Implications for estimating treatment effects. *Review of Financial Studies* 34 (4): 1907–1951.

Miller, M. H. and F. Modigliani. 1961. Dividend policy, growth, and the valuation of shares. *Journal of Business* 34 (4): 411–433.

Merton, R. 1974. On the pricing of corporate debt: the risk structure of interest rates. *The Journal of Finance*, 29 (2): 449–470.

Ohlson, J. 1980. Financial ratios and the probabilistic prediction of bankruptcy. *Journal of Accounting Research* 18: 109–131.

Ohlson, J. A. and B. E. Juettner-Nauroth. 2005. Expected EPS and EPS growth as determinants of value. *Review of Accounting Studies* 10 (2–3): 349–365.

Shaffer, S. 2006. Corporate failure and equity valuation. *Financial Analysts Journal* 62 (1): 71–80.

Suda, K. and H. Takehara. 2013. On the relationship between accruals anomaly and default risk. *Contemporary Disclosure Research* 13: 15–30. (in Japanese)

Suto, S. and H. Takehara. 2018. *Corporate Social Responsibility and Corporate Finance in Japan*, Singapore: Springer. Vassalou, M and Y. Xing. 2004. Default risk in equity returns. *Journal of Finance* 59 (2): 831–868.