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Jeffrey E. Jarrett
University of Rhode Island, jejarrett133@gmail.com

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Estimation Theory in Financial Accounting as It Applies to Valuing Intellectual Property Assets

Jeffrey E. Jarrett, PhD
Professor Emeritus
University of Rhode Island (COB)

ABSTRACT

The abandonment option under various capital budgeting models are discussed in this study to illustrate the notion that present value of cash flows is often improperly estimated in financial models utilizing decision analytics in estimation theory as it applies in financial accounting. In this study, intellectual property rights and other intangible assets which are often not considered in the accounting estimation processes utilized in financial accounting. An investor/analyst often misestimates cash flow resulting in less-than-optimum capital budgeting decisions. This is especially a problem when actions to abandon for salvage and other similar decisions improve when the present value of intangibles and property rights are included in the decision process. This last statement is the goal of this study as well as to present well-founded processes to improve abandonment and similar decisions in capital budgeting decisions. The estimation problem in financial accounting is included in the analysis to accomplish this goal.

Keywords: abandonment, estimation theory, present value of cash flow, distribution of earnings, normal fiducial deviate, opportunity loss

INTRODUCTION

Financial researchers such as Deschow (1994; Deschow and Strand, 2004) indicated that employing accrual-based accounting methods creates the capability of accounting-based earnings projections to control and continuously improve the measures of firm performance reflected in analysts' earnings forecasts. The argument was that cash flow accuracy is expected to suffer from matching, realization, and other timing problems concerning the timing of the recognition of costs and revenues. Accuracy of financial earnings predictions was studied by Brandon and Jarrett (1974), Jarrett (1983, 1992), Jarrett and Khumawala (1987), and Lambert, Matolcsy, and Wyatt (2015). They compared methods of predicting earnings seeking to learn how forecast models can be compared and possibly improved to produce more accurate results as to cash flow. Questions posed included sources of accuracy, but accrual accounting alone was not considered the most important source of inaccurate results. However, no one established a theoretical link between sources of inaccuracy and the matching principle and the accuracy of financial analysts' forecasts although many studied the problem (Jarrett, 1989, 1990; Clement, 1999; Gu and Wu, 2003; Ramnath, Rock, and Shane, 2008; Grosyberg, Healy, Nohria, and Serafeim, 2011). Accounting reports containing these forecasts of cash flow and rates of return are, in addition, subject to fluctuations in the interpretation of timing principles utilized by accountants. However, Gu and Wang (2005) brought up the possibility of another source of inaccuracy in the forecast of rates of return, cash flow, and earnings. Beneish, Lee, and Nichols

(2013) created a model that calculates with accounting data of a specific company to check if it is likely that the reported earnings for a firm were manipulated—the goal being to estimate earnings better in financial reports. Last, Lev and GU (2016) in their study produced evidence from large-sample empirical analysis that financial documents continuously deteriorate in relevance to investors' decisions. Further, they detail why accounting reporting is losing relevance in today's decisions related to capital budgeting and the abandonment option.

Note that decisions about abandonment and salvage utilize normal capital budgeting methods to determine whether there is a relation among the various capital budgeting options, financial leverage, and financial estimation by analysts. Illustrating capital budgeting with the abandonment option; allows us to implement and illustrate how corporations utilizing capital. In turn, one learns and understands that budgeting process are dynamic and flexible, involving the information flow throughout an organization that determines the investment and abandonment decisions at individual stages. With this in mind, one may examine how an abandonment option influences the optimal timing of information. In particular, one may compare timely information, where the manager acquires perfect precontract project information. We examine how the future revenues from intangible and intellectual assets may affect the level of financial leverage of a firm when not all is known about the economic value of assets which have not tangible definitions.

In the absence of the real option, the following trade-off arises: If information is timely, the investment decision can be based on perfect information. Alternatively, if information about intangible assets is not considered in the abandonment option, the timing and decision concerning the abandon option may very well be estimated incorrectly. The incorrect information is the product of the misreporting of factual events associated with intangible assets, and the error associated with incorrect analysts' forecasts turn to the estimation problem in financial accounting and in turn apply it to the relation of analysts' forecasts and the bias in estimating earnings and cash flow present in evaluating capital decisions.

CAPITAL BUDGETING METHODOLOGY

Berger (1996) established the link among analysts' forecasts, cash flow, the expected capital asset pricing model (CAPM) return, and the present value of cash flow, which includes forecasts of earning rather than the distributable cash flow. In addition, Wong (2009) examined the relation between the abandonment option's potential effect on a firm's decision analysis and the eventual analytics employed to determine the optimal decision and operating leverage. Furthermore, others analyzed abandonment options, divestment options, expansion options, and growth options previously examined in a survey by another. These and many more studies revealed that they use real options to the general problems associated with capital budgeting.

Analysts' earnings forecasts enable analysts to estimate the present value of cash flow (PVCF). According to Berger, Ofek, and Swary (1996), the advantage is that analysts' forecasts of earnings do not incorporate the value of the abandonment option. If forecasts of distributable cash flows, cash flows from non-ongoing concern events would be included in the forecasts. Thus, earnings may not be the same as cash flows. Hence, we adjust because capital expenditures are not equivalent to depreciation and the growth in working capital is not subtracted from earnings. No longer is it required to adjust for capital structure changes in the environment that such changes cannot be foreseen. Borrowing again from Berger, Ofek, and

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Swary (1996), their equation constructs the present value of capital formation (PVCF) that evolves from the analyst's discounted forecasts. Included in the equation is the sum of the present value of analysts' predicted going-concern cash flows discounted by analyst forecast of year *t* after-interest earnings and expected CAPM (capital asset pricing model return), consensus forecast of five-year earnings growth, the terminal growth rate of earnings, the number of years for which earnings are forecast, and a year index. The CAPM adjustment includes the reduction to the present value of analysts' earnings. The second adjustment to PVCF is the working capital adjustment, which is a reduction to the present value of analysts' earnings forecasts to adjust for growth in working capital. Finally, the expected CAPM return is defined as

$$r = rf + \beta e * [r_m - rf], \quad (1)$$

where rf is the risk-free rate, βe is the firm's beta or systematic risk (from the CRSP beta file), and $(r_m - rf)$ is the risk premium of the stock market minus the risk-free rate.

In implementing Equation (1), we assume that the relevant investment horizon is short term. Therefore, a useful solution is to use the one-month Treasury rate as a proxy for the risk-free rate and a risk premium (the arithmetic mean from a long period of time from between the return on the S&P 500 and the return on Treasury bills).

The problem with the above approach is the variable the analysts' forecasts of earnings. In part, this is a solution to the problems noted by Pappas (1977) in response to the work by Brief and Owen (1968, 1969, 1970, 1977; Barnea and Sadan, 1974; Jarrett, 1983, 1992), who used their work in developing models to adjust analysts' earnings forecasts in evaluating the abandonment option. Studies concerning analysts' forecasts are well known and include a huge number. In general, as stated by many in the field of financial accounting, earnings forecasts are dependent on the principles of financial accounting that produce the data for modeling trends and seasonality (or modeling components). The accuracy of analysts' forecasts has a long history and includes works by Clement (1999), GU and Wu (2003), Ramnath, Rock, and Shane (2008), Groysberg, Healy, Nohria, and Serafeim (2011), and Makridakis, Spiliotis, and Assimakopoulos (2017). The last paper suggested that machine learning models may have better results than self-prepared models for forecasting. The aforementioned studies focused on a relation between analysts' forecasts and the magnitude and value of intangible assets. Intangible assets were not considered in the forecasting method discussed by the researchers in their many and detailed studies. The value of intangible assets produces a great source of error if they are not considered in the forecasting methods utilized by analysts in the production of cash flow, rates of return and earning per share (EPS and/or rates of return) forecasts. When adjustments for intangible assets are included in the analysts' forecasts, GU and Wang (2005, p. 673) stated that "the rise of intangible assets in size and contribution to corporate growth over the last two decades poses an interesting dilemma for analysts. Most intangible assets are not recognized in financial statement, and current accounting rules do not require firms to report separate measures for intangibles." Intangibles include trademarks, brand names, patents, and similar properties that have value but are generally not listed in the financial reports of firms. Many of these items are technology based and are very important in financial decisions such as in mergers and acquisitions (M&A). They are an intricate part of the growth of firms and therefore are shown to be related in the statistical sense to the overall estimates made by accounting and analysts.

In another study concerning analysts' forecasts, Matolcsy and Wyatt (2006) found that an association between EPS forecast, growth rates forecast error, and measures of technological conditions in the firm's industry. They found that as the forecast horizon increases, the technological conditions and current EPS are statistically associated with analysts' forecasts. Long horizon creates the conditions for within one to conclude that interactions between technological conditions and current EPS are associated with analysts' EPS and growth forecasts. This conclusion aligns itself with Jung, Shane, and Yang (2012), who suggested that analysts' growth forecasts effect efforts to evaluate analysts' forecasts may produce optimistically biased long-term forecasts. Because intangible assets that are often technology based take up more of the balance sheet of many firms, it is likely that analysts' forecasts may produce less accurate predictions of earnings, cash flow, and rate of return. The conclusions of other become less important. Balance sheets usually have little or no involvement with the value of intangibles, although there are some practices by accounting that are still used. Thus, in the remaining portions of this analysis, we propose a method by which one can estimate earnings such that the value of intangible assets is valued and earnings estimate are not biased by serious errors of omission such that the capital budgeting model expressed earlier in equations by Berger, Ofek, and Swary (1996, p. 264) are not unduly biased.

As noted by Brief and Owen (1969, 1970, 1977), Jarrett (1971, 1974, 1983), Roberts and Roberts (1970), and Barnea and Sadan (1974), the timing of recognition of revenue for intellectual property rights (IPR) in financial statements of ten are not featured in merger-and-acquisition activity. The Financial Accounting Standards Board (FASB) provides for such activities; however, they are often ignored due to their evasiveness or are not fully informational in their normally structured rules. Recognizing future performance is a goal of matching and timing but are unrelated to recognizing cash flow and similar items in the historical performance of a firm. Nonprofit entities often do not use accrual rules at all because the goal of these are related to achieving high rates of return. Often IPR for nonprofits would differ from the same item for profit-maximizing entities because the goal of seeking high rates of return does not enter the strategic planning process for nonprofits (World Trade Organization, 2016). The purpose here is to consider intellectual property (IP) as intangible assets, as a product of intellect that law protects from unauthorized use by those not responsible for the IPR. Hence, IPR are characterized as the protection of distinguished signs such as trademarks for goods and services, patents, and other similar items that are under protection from unauthorized use. This includes art, music, creations by authors including the authorship of computer software, and similar items such as discoveries, inventions, phrases, symbols, and design. Obviously, a writer and conductor of music such as Leonard Bernstein and Daniel Barenboim would have created IP that differ greatly from physicists such as Lise Meitner, Niels Bohr, or Albert Einstein.

Presently, accounting suggests two methods to determine the value of IPR to produce better estimates of from accounting analysts' forecasts. The convention of the "lower of cost or market" is based on the rule of conservatism in valuing assets to anticipate future losses instead of future gains. The policy tends to understate rather than overstate the value of net assets and could therefore lead to an understatement of income, cash flow, earnings, and rates of return. The purpose of this study and its conclusive result is to neither understate nor overstate cash flow so as to produce a rate of return on cash flow that is commensurate with the goal of producing accurate prediction of cash flow and its rate of return for financial and decision-

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making purposes. Stated differently, the purpose is not to violate accounting policy but to ensure the M&A that cash flow is estimated properly. Traditionally, when accounting writes policy about intangible assets as a residual, by "residual" they mean a buyer is ready to value a firm in excess of the value of the tangible assets. This value is often referred as "goodwill" (White, 1994), which is an imperfect method. This notion of goodwill is estimated as a residual value. If the valuation of intangible property is imperfect because it considers part of the solution of a bargaining process, in this case, the buyer and seller may have different market power, which greatly affects the residual of the bargaining process and produces an imperfect or biased estimate of the value of the intangible assets. One may examine the case of the sale of Superman by struggling comic book artists to a much larger corporate power who could market the character to comic books, television, and the film industry. The near-destitute conditions of the original artists who created the intangible product could never cope with the business and marketing (power) of those who purchased the name Superman. Thus, goodwill becomes a vague valuation system that justifies the bringing of data analysis and science into the valuation process.

Accountants often suggest during the M&A process is to simply list the patents, trademarks, brands, and similar items of IP in the financial reporting of the firm. Following this initiative and suggestion of the accounting principles board provide little aid concerning the economic value of IPR and products for a firm during the M&A events. In the final step of the problem, the evaluation may biases of the reading of the financial reports. Accountants forecast the overall rate of return for a firm but do not ignore the convention of "conservatism." Accounting practice values the IPR for a firm each year for each and every IPR under consideration. The principle of goodwill is not to be used during M&A activity to account for the value of IPR. IP may induce greater asset values but it also affects the rate of return on cash flow because the denominator of the rate of return will change. (To understand the gravity of ignoring or improperly valuing IPR, see Jarrett, 2016, 2017a, 2017b.) This result, debated previously (Brief and Owen, 1969; Brief, 1977; Pappas, 1977), indicated that including earnings risks may not fully reflect all risks in estimating earnings, but at least reflects that part of risk from the variation in earnings.

Furthermore, Helliar, Lonie, Power, and Sinclair (2001) summarized attitudes of managers toward risk in the following way. The abandonment option may be extremely important when considering the survival of a firm or nonprofit entity. Survival is often the goal of the abandonment option, indicating that risks that are taken in special situations such as catastrophes when the survival of whole areas of an industry may be under threat (Shleifer and Vishny, 1992; Liu and Liu, 2011) may be different from those taken in more usual environments. An entity in decline may avoid innovative options and concentrate on immediate short-term options rather than riskier longer-term projects with more difficult goals to be accomplished. In addition, the choice may rapidly increase the rate of the process decline and result in managers becoming more risk averse and not employing greater use of intangible assets and IP.

INTANGIBLE AND SIMILAR ASSETS

One illustrates the size of the bias in estimating earnings when the monetary equivalent of values of intangible assets is not considered by analysts in estimating future earnings. Note that failure to estimate future earnings affects PVCF, resulting in errors in assessing the abandonment option. Intangible assets including patents, trademarks, copyrights, and similar

items are usually overlooked and/or not estimated properly in many financial statements. These statements are considered fundamental information in determining PVCF in abandonment decisions, M&A, and similar financial decisions analysis and analytics.

To illustrate the case of monetarizing property rights and other intangibles often referred to by the acronym IPR, let us consider the specific problem of a firm abandoning or selling IPR through a direct acquisition and the effect on debt as part of its holdings. Obviously, the ratio of common equity to total capital stock will be changed during the financial operation. In turn, the effects of financial leverage on total financial risk will also be part of the problem. The rate of return to common shareholders is related to the measure of financial risk utilized in any decision of this type. We assume that the firm is motivated to finance the acquisition by leverage instead of issuing new common share nor a strict loan from a financial institution or similar institution is the result of an economic optimization policy. Define T as the sum of debt and common stock. To illustrate simply, preferred share and other financial instruments are valued at zero to avoid complications that may hinder the explanation. S is the monetary value of common stock, and D is the amount of debt. X is the amount of earning in a future time period. X is a random variable, and E(X) is the mean of the random variable. V(X) is the variance, and S(X) is the square root or standard deviation. The cost of the debt per dollar is I; the interest rate. The mean earning per dollar of S is

E(Y) = E(X)/S = E(X)/(T–D) (1)

Note that Y is also a random variable with mean E(Y). Mean (or expected) earning is defined as follows:

E (X') = E(X) – iD for D >0; (2)

Hence, E (X') = E(X), for D = 0 (2')

The variance of total earnings is

V (X') = V(X) for D ≥0 (iD)

and is a constant) (2'')

The financial decision-optimum to fund the purchase is an example of decision analytics where the decisions are to substitute debt for common stock or not to substitute debt. Using data analytical language, for this decision problem the states of nature are defined by

E(X) >ID or E(X) ≤ID (3)

We define the opportunity loss function as an integral approximation the firm's view toward choosing a nonoptimal decision. No loss occurs when earnings are greater than the cost of debt because management will benefit from the strategy of leverage financing.

As an example, consider cash flow to be greater than the cost of debt management, and in turn, the loss function would change, reflecting the goal of optimum decision analytics. The basic structure of the acquisition strategy would not change except for the substitution of cash flow for earnings. To calculate the opportunity loss function associated with this strategy, we estimate some probability density function (PDF) that approximates the PDF for future earnings. Before we consider all PDFs, let the firm focus on the normal distribution or T-

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distribution having a very large number of degrees of freedom, which approximates the standard normal distribution. The opportunity loss at breakeven (X_b) becomes

$X_b = E(X') - Z((S(X'))$ (4)

Z refers to the normal fiducial deviate. S (X') is the standard deviation. By rearrangement, we find E(X) = E(X') – iD. The next step is to determine the size and distribution of the loss function for the distribution of future earnings, which is all in line with objectives of the timing of the realization revenues discussed before (Jarrett, 1971, 1992and 2018). In Table 1, we preview one of three methods to estimate the monetary value of IPR. The E(X) is $4,200, and the S(X) increases by given amounts ($100). Column 3 contains the cost of debt of $3,200. The Z (the normal deviate) calculation is accomplished column 4 with column 5 containing the cumulative normal probability. In turn, the IPR monetary value is simply the normal probability multiplied by E(X) and is contained in column 6. The $IPR is thus calculated for a variety of circumstances.

Table 1: The Estimation of Monetary Value

E(X)	S(X)	Cost of debt	*Z*-Score	Cum. Prob.	$IPR
4,200	**400**	**3,200**	**2.50000**	**0.993790**	**4,174**
4,200	**500**	**3,200**	**2.00000**	**0.977250**	**4,104**
4,200	**600**	**3,200**	**1.66667**	**0.952210**	**3,999**
4,200	**700**	**3,200**	**1.42857**	**0.923436**	**3,878**
4,200	**800**	**3,200**	**1.25000**	**0.894350**	**3,756**
4,200	**900**	**3,200**	**1.11111**	**0.866740**	**3,640**
4200	**1000**	**3200**	**1.00000**	**0.841345**	**3534**

A second example of estimating the monetary value of IPR (Table 2), E(X), column 1 is constant from row to row; column 2, S(X), remains the same ($600) from row to row; and column 3, the cost of debt changes from row to row due to the change in the interest rate and other costs associated with debt. In column 4, the standard normal deviate, *Z*, decreases in value from row to row, and in column 5, the cumulative probability from the normal curve decreases from row to row. The dollar value of the IPR will continually decrease from the top row to the bottom row in Table 2.

Table 2: The Dollar Value of IPR Changes in Interest Rates and the Cost of Debt

E(X)	S(X)	Debt cost	*Z Score*	Normal probability	$IPR
2,100	**600**	**500**	**2.66667**	**0.996170**	**2,091.96**
2,100	**600**	**1,200**	**1.50000**	**0.933193**	**1,959.70**
2,100	**600**	**1,400**	**1.16667**	**0.878327**	**1,844.49**
2,100	**600**	**1,600**	**0.83333**	**0.797672**	**1,675.11**
2,100	**600**	**1,800**	**0.50000**	**0.691462**	**1,452.07**
2,100	**600**	**2,000**	**0.16667**	**0.566184**	**1,188.99**

One last example, Table 3: we alter the example by comparing the monetary value of IPR when the cost of debt and **debt: equity ratio** in columns 1 and 2 of Table 3. In turn, both columns 3 and 4 (cost of debt and net cash, respectively) change from row to row. The *Z*-statistics and normal probabilities change, and the monetary value of IPR changes from row to row with the highest in row 1 and descending thereafter.

Table 3: Comparison of the Debt to Equity Ratio) (Equity = $200,000)

Debt	D:E ratio	Debt cost	Cash inflow	S(X)	*Z Score*	Normal prob.	$IPR
50,000	0.25	2,000	2,300	230	1.304	0.903942	180,788
60,000	0.30	2,400	1,900	190	–2.632	0.004249	850
70,000	0.35	2,800	1,500	150	–8.667	0.000000	0
80,000	0.40	3,200	1,100	110	–19.091	0.000000	0
90,000	0.45	3,600	700	70	–41.429	0.000000	0
100,000	0.50	4,000	300	30	123.333	0.000000	0

Note: $IPR is the Dollar value of IPR

These examples show that estimation theory in financial accounting is a fundamental ingredient in correcting financial reporting data. Now, financial analysts now have a complete set of data to work with when making earnings forecasts and other decisions. Our finding does not dispute that of others.

Additional Evidence Concerning Estimation Theory and Methods

Estimation and timing of the recognition and matching of costs and revenues is dependent on the underlying analysis of data that corroborates its use. Although one cannot examine all data but only samples of data previously analyzed by Berger, Ofek, and Swary (1996). In this study, one obtains data from the International Brokers Estimate System (IBES) that have forecasts of earnings and growth in earnings. In Table 4, we provide their descriptive information on the sample information obtained. The information obtained describes the distribution of PVCF for three separate forecasting methods. In analyzing these data, one may calculate the skewness coefficient and present the results in the expanded table. The analytics indicates the symmetry in the distributions of the PVCF data.

Table 4	**Distributions of PVCF from Berger, et**			**al. (1996) p. 269**				
	Data from IBES	Sample	Studies By Berger et al.					
		Minimum	**Median**	**Mean**	**Maximum**	**Std. Dev.**	**Skewness**	
PVCF from	**Forecast/ETF**	-0.645	0.128	0.144	0.622	0.08	0.200	
PVCF from	**Growth**	0.037	0.42	0.413	1.161	0.086	-0.081	
PVCF from	**Terminal Growth**	0.084	0.437	0.443	1.521	0.12	0.050	
If skewness is positive, the data are positively skewed or skewed right, meaning that the right tail of the distribution								
is longer than the left. If skewness is negative, the data are negatively skewed or skewed left, meaning that the left								
tail is longer. If skewness = 0, the data are perfectly symmetrical								
Any threshold or rule of thumb is arbitrary, but here is one: If the skewness								
is greater than 1.0 (or less than -1.0), the skewness is substantial and the								
distribution is far from symmetrical.								

As we see from Table 4, the distribution of the sample data is probably close to symmetrical and, in turn, likely to be distributed similar to a normal distribution process. If not exactly

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normally distributed, there are many ways one can estimate the distribution of the PVCF data, bringing more credibility to the process. One last point concerning the distribution of PVCF in Table 4 concerns the kurtosis in the sample data summarized above. Westfall (2014, notes, "it's only unambiguous interpretation in terms of the tail extremity; i.e., either existing outliers (for the sample kurtosis) or propensity to produce outliers (for the kurtosis of a probability distribution).' The logic is simple: Kurtosis is the average (or expected value) of the standardized data raised to the fourth power. Any standardized values that are less than 1 (i.e., data within one standard deviation of the mean, where the "peak" would be) contribute virtually nothing to kurtosis, because raising a number that is less than one to the fourth power makes it closer to zero. The only data values (observed or observable) that contribute to kurtosis in any meaningful way are those outside the region of the peak, stated differently, the outliers. Therefore, kurtosis measures outliers only; it measures nothing about the "peak." Without the original data, one cannot measure the exact kurtoses for the data. However, one can observe that the mean of data and minimum and maximum values do not differ by huge amounts. Hence, the exact likelihood of long tails in the distribution of data about the mean does not exist. The likelihood is therefore, if such an observation indicates that at all, the measures of kurtoses would be relatively small and approach a normal distribution when examining the population from which the sample was chosen. Hence, the normal approximation when the sample size is large as in the cases observed indicates the validity of the normal approximation. This also the case if one has evidence that the data are distributed according to another probability distribution function and that one could be used in evaluating the value of IPR.

SUMMARY AND CONCLUSIONS

Firms entering into decisions in times of financial distress are often confronted with failure and survival. These decisions concern the abandonment of assets. The problems associated with valuing intangible assets and IPR are similar to those involved in decisions about M&A. The firm's environment may be different in each case, but the problems associated with predicting cash flow and earnings by analysts still prevail. This study suggests ways of estimating earnings and PVCF when considering the effects of IPR and other intangible assets in the process. The proposal studied meets the requirements of the estimation theory in financial account, which is consistent with accounting conservatism and the goals of financial accounting. Additional methods exist for estimating the value of intangibles, which include using the distribution of financial earnings when the normal distribution does not apply. This will be the focus of new and additional research. Future studies will examine results when the assumption of the normal distribution is valid, that other probability distributions will be utilized to calculate IPR.

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