

# ***Research on the Application of Monte Carlo Simulation in Level 3 Fair Value Measurement—A Case Study of Huatai Securities***

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**Abstract.** Following the 2008 financial crisis, the International Accounting Standards Board (IASB) issued IFRS 13 Fair Value Measurement in 2011, which established a comprehensive disclosure framework for Level 3 fair value measurements. Level 3 applies to financial instruments that lack active market quotes and whose valuation relies on unobservable inputs; consequently, their measurement is highly dependent on management judgment. This paper employs Huatai Securities Co., Ltd. (hereinafter referred to as "Huatai Securities") as a case study to examine the application of the Monte Carlo simulation in the valuation of Level 3 financial instruments. Using a combination of case analysis and literature review, and drawing data from Huatai Securities' 2025 annual and semi-annual financial statements and audit reports, the study finds that both the Monte Carlo simulation and the Black-Scholes option pricing model (B-S model) are identified as alternative valuation techniques for over-the-counter (OTC) derivative contracts and income certificates. The two models serve distinct use cases and are complementary in practice.

**Keywords:** Fair Value Hierarchy, Level 3, Monte Carlo Simulation, Valuation of Financial Instruments

## **1. Introduction**

The 2008 financial crisis exposed the limitations of fair value measurement when market liquidity dried up. In particular, Level 3 fair value measurements apply to financial instruments that lack active market quotes and whose valuation relies on unobservable inputs. Consequently, Level 3 measurements are highly dependent on management judgment, rendering this category the area with the greatest subjectivity and the highest audit risk within fair value measurement.

Prior literature has extensively discussed the application of Monte Carlo simulation in enterprise-wide valuation; however, studies focusing on Level 3 fair value measurement remain scarce, and there is a notable lack of case-based evidence drawing on the annual reports of Chinese securities firms. Taking Huatai Securities as a case study, this paper analyzes the application logic of the Monte Carlo simulation in valuing Level 3 financial instruments and compares its performance with the B-S model. The study employs a case analysis approach and a literature review, with Huatai Securities' 2025 annual and semi-annual financial statements and audit reports serving as the

primary data sources. This paper provides a reference for valuation specialists and auditors in assessing the valuation methodologies applied to complex financial instruments within securities firms.

## **2. Fair value level and the accounting system framework of Level 3 measurement**

### **2.1. Overview of fair value hierarchy system**

Both IFRS 13 and Accounting Standards for Business Enterprises No. 39 (ASBE 39) define fair value as the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date. IFRS 13 establishes a three-level fair value hierarchy, which is based on the observability of inputs. Level 1 input is the unadjusted quoted price for an identical asset or liability in an active market that the entity can access at the measurement date. Level 2 input is an input other than a Level 1 input that is directly or indirectly observable for the asset or liability. Level 3 input is an unobservable input for the asset or liability. The fair value hierarchy prioritizes the inputs used in valuation techniques over the valuation techniques themselves.

### **2.2. Particularity of Level 3 measurement**

Level 3 fair value measurements are applicable to financial instruments that don't have active market quotes, and their valuations are entirely based on model-based estimation. This category has a distinguishing feature, that the selection of valuation techniques and the determination of unobservable inputs are mainly based on management judgment. Different valuation methods and parameter assumptions might result in measurement outcomes that are materially different, thus making Level 3 the category with the highest estimation uncertainty in the fair value hierarchy. So, auditors usually identify Level 3 measurements as key audit matters (KAMs).

### **2.3. Literature review**

Previous literature has generated a body of research regarding the application of Monte Carlo simulation in the accounting and valuation processes. However, the primary emphasis has been placed on the enterprise-wide valuation.

In international literature, Ernst pointed out that risk analysis crucial in simulating the company valuation and suggested adding Monte Carlo simulation to reduce valuation risk [1]; Silva et al. included highly uncertain risk factors like cost of capital and market conditions into discounted cash flow (DCF) model, using Monte Carlo simulation for valuation purposes [2].

In Chinese literature, a number of scholars have also employed Monte Carlo simulation to evaluate enterprise valuations. Liu Xinyi took Monte Carlo simulation and scenario analysis to assess enterprise value [3]; Wei Yeshe used Monte Carlo simulation to refine the cash flow model and expand the valuation from point estimation to interval estimation via sensitivity analysis [4]; Recognizing the limitation that static growth rate assumptions in high-risk enterprise valuation fail to accurately capture complex dynamics, Wang Shaohao proposed integrating Monte Carlo simulation into the traditional DCF model to enhance reliability [5]; Duan Yixuan applied the Schwartz–Moon pricing model and Monte Carlo simulation to value a listed apparel company under the new retail model, effectively mitigating the influence of subjective factors and improving the objectivity and accuracy of the valuation [6].

To sum up, prior literature mostly looked at Monte Carlo simulation in the context of enterprise-wide valuation, but there are still some research that focuses on its application to the specific accounting context of Level 3 fair value measurement.

### **3. Principle and application logic of Monte Carlo simulation in Level 3 fair value measurement**

#### **3.1. Basic principles of Monte Carlo simulation**

Monte Carlo simulation, also called random sampling or statistical testing method, is a numerical computational technique based on probability theory. It uses computer-generated random variables with known probability distributions to do statistical simulations and get approximate solutions.

This method can be used to value financial instruments in four steps. First, figure out the key variables that affect the value, such as the underlying asset price and volatility. Second, each variable must have a probability distribution that is reasonable. Third, produce a huge number of random samples, each sample contains a set of valuation results. Finally, combine all simulation results into a probability distribution, and then compute summary statistics to give risk assessment and decision-making.

#### **3.2. Applicability analysis of Monte Carlo simulation**

The need for Monte Carlo simulation to be used for Level 3 fair value measurement can be analyzed from two interconnected aspects: one is the institutional requirements, and the other is the asset characteristics.

From the standpoint of institutional requirements, IFRS 13 mandates that fair value measurement should include credit risk adjustments and risk premiums. These features are typically path-dependent and challenging to accurately capture using point-estimation models. Monte Carlo simulation can produce multiple interest rate paths, and compute expected exposures on a path-by-path basis, thus enabling more accurate credit risk adjustments.

From the aspect of asset characteristics, Level 3 financial instruments usually have complex contractual terms, and their fair value is determined by a multitude of interrelated variables. Monte Carlo simulation has the flexibility to handle these complex features, so it has a distinct advantage in Level 3 valuation.

#### **3.3. Comparison with other valuation techniques**

Valuation techniques commonly employed in Level 3 fair value measurement include the Monte Carlo simulation, the B-S model, and the DCF model. The B-S model is computationally efficient but cannot accommodate path-dependent features. The DCF model is suitable for non-financial assets; however, its treatment of path dependence is limited. Although Monte Carlo simulation entails higher computational complexity, it excels at handling path dependence and multivariate interactions, making it well suited for the valuation of complex Level 3 financial instruments. A detailed comparison of these three valuation techniques is presented in Table 1.

Table 1. Comparison of three valuation techniques

| Dimension of comparison       | Monte Carlo simulation                        | B-S Model                            | DCF Method                                |
|-------------------------------|-----------------------------------------------|--------------------------------------|-------------------------------------------|
| Application scenarios         | Path dependent options, complex derivatives   | European option (no path dependence) | Cash-Generating Unit non-financial assets |
| Path-Dependency handling      | able                                          | unable                               | Partially able to handle                  |
| Multivariate processing power | strong                                        | Weak                                 | medium                                    |
| Computational complexity      | high                                          | low                                  | medium                                    |
| Output information            | Probability distribution(interval estimation) | point estimation                     | point estimation                          |

## 4. Case study of Huatai securities

### 4.1. Basic information of Level 3 financial instruments

Huatai Securities Co., Ltd. is a listed joint-stock securities firm principally engaged in brokerage, proprietary trading, investment banking, and asset management. Its business scope encompasses securities brokerage, securities investment advisory, public securities investment fund distribution, securities custody, and intermediary services for futures companies, among others. Given the substantial share of derivative financial instruments, particularly OTC derivative contracts, equity-linked notes, and income certificates—in its business mix, Huatai Securities holds a significant portfolio of Level 3 financial assets and financial liabilities.

As of December 31, 2025, the basic situation of Level 3 financial instruments of Huatai Securities is shown in Table 2.

Table 2. Overview of Level 3 financial instruments of Huatai Securities [7]

| Item                          | Book Value(m) | Main Types                                                        |
|-------------------------------|---------------|-------------------------------------------------------------------|
| Level 3 financial assets      | 81.66         | Bonds, unlisted equity investments, OTC Derivative Contracts, etc |
| Level 3 financial liabilities | 126.91        | OTC Derivative Contracts, Income Certificate                      |

Data source: Huatai Securities: Annual Report 2025

Among the aforementioned asset and liability categories, OTC derivative contracts and income certificates are the primary financial instruments valued using both the Monte Carlo simulation and the B-S model, and thus constitute the principal focus of the case analysis in this paper.

## 4.2. Valuation techniques and unobservable inputs values

Based on the quantitative disclosures on Level 3 fair value measurement in Huatai Securities' 2025 annual report, the valuation techniques and unobservable inputs applied to these two categories of financial instruments—OTC derivative contracts and income certificates—are summarized in Table 3.

Table 3. Valuation technology and input values of Level 3 financial instruments of Huatai Securities [7]

| Types of financial instruments | Valuation techniques              | unobservable inputs Values                   | Impact on fair value                                                   |
|--------------------------------|-----------------------------------|----------------------------------------------|------------------------------------------------------------------------|
| OTC Derivative Contracts       | B-S Model, Monte Carlo simulation | The price volatility of the underlying asset | The greater the price volatility, the greater the impact on fair value |
| Income Certificate             | B-S Model, Monte Carlo simulation | The price volatility of the underlying asset | The greater the price volatility, the greater the impact on fair value |

Data source: Huatai Securities: Annual Report 2025

The price volatility of the underlying asset is the key unobservable input affecting the fair value of both types of financial instruments. As shown in Table 3, there is a positive correlation between the level of volatility and the magnitude of fair value impact: the higher the volatility, the greater the effect on fair value, although the specific direction of the impact depends on the position direction (long or short).

## 4.3. Analysis of the valuation application of Monte Carlo simulation in specific financial instruments

### 4.3.1. Over-the-counter(OTC) derivative contracts

OTC derivative contracts are privately negotiated, non-exchange-traded derivative agreements between two counterparties. Common types include forwards, swaps, and exotic options. Due to the absence of active market quotes, their fair values must be determined using valuation models.

For path-dependent options—where the payoff at maturity depends on the entire price path of the underlying asset over the contract term—the B-S model cannot provide a direct closed-form solution. Monte Carlo simulation obtains the current fair value by generating multiple price paths, computing the terminal payoff for each path, and discounting the average back to the valuation date. For contracts featuring early-exercise rights, the Least Squares Monte Carlo (LSM) method can be incorporated to evaluate the optimal exercise decision at each time step and determine the contract value under the optimal stopping strategy.

### 4.3.2. Income Certificate

Income Certificate is a debt financing instrument issued by securities companies with their own credit, and their income is usually linked to the performance of specific underlying assets. Since the income structure of income certificates may contain embedded derivative characteristics, their fair value valuation needs to be broken down into fixed income part and derivative part respectively.

Huatai Securities takes the price volatility of the underlying asset as the key unobservable inputs value and uses Monte Carlo simulation or B-S Model to evaluate the embedded derivatives.

#### 4.4. Auditors' evaluation of valuation methods

The auditor's response to Level 3 fair value measurement at Huatai Securities mainly involves three procedures: (i) assessing the appropriateness of selected valuation techniques, (ii) evaluating the reasonableness of significant unobservable inputs, and (iii) reviewing the valuation results with the help of internal valuation specialists. This demands that auditors have the professional competence to challenge the reasonableness of Monte Carlo simulation assumptions and calculations, and it also shows the inherent dependence of Level 3 valuation on specialized expertise.

These audit procedures suggest that Monte Carlo simulation has been recognized in audit practice as a valid Level 3 valuation approach; however, auditors must be aware that they must exercise professional skepticism in their own independent evaluation of the reasonableness of model selection and parameter assumptions.

#### 5. Conclusion

Based on the Level 3 disclosure framework of IFRS 13, this paper analyzes the application of Monte Carlo simulation in the fair value measurement of Level 3 under IFRS 13.

The study concludes as follows. First, Monte Carlo simulation changes the fair value measurement from point estimation to interval estimation, so that we can effectively value path-dependent derivatives. Second, Huatai Securities finds both Monte Carlo simulation and B-S model as alternative valuation techniques for OTC derivative contracts and income certificates; these two models have different use cases, so they are complementary in practice. Third, the auditor performs an independent evaluation of the model appropriateness and the input reasonableness. This is a crucial mechanism to ensure the reliability of Level 3 measurements.

This study has a main limitation: it uses publicly disclosed annual report information, so it can't access internal simulation parameters for independent verification. Future research might get proprietary internal data to do empirical comparisons of alternative valuation methods, and could expand the sample scope to include multiple securities firms for cross-sectional comparative analysis of Level 3 valuation practices.

#### References

- [1] Dietmar, E. (2023). Risk measures in simulation-based business valuation: Classification of risk measures in risk axiom systems and application in valuation practice. *Risks*, 11(1), 13-13.
- [2] Silva, C. V., de Souza, A. B., Sales, H. L., et al. (2019). Aplicação do modelo Monte Carlo na avaliação da empresa Ambev com custo de capital impreciso. *Revista Eniac Pesquisa*, 8(1), 153-175.
- [3] Liu, X. (2024). *New retail enterprise valuation based on scenario analysis: A case study of Chongqing Department Store* [Doctoral dissertation, Zhejiang University of Finance & Economics]. DOI:10.27766/d.cnki.gzjcj.2024.000937.
- [4] Wei, Y. (2023). *Study on value evaluation of BH Hospital based on improved free cash flow method* [Doctoral dissertation, Shenyang Jianzhu University]. DOI:10.27809/d.cnki.gsjgc.2023.000097.
- [5] Wang, S. (2003). Monte Carlo simulations of the valuation of high-risk firms. *Appraisal Journal of China*(6), 19-21+5-6.
- [6] Duan, Y. (2022). Research on enterprise value evaluation of clothing listed companies under new retail mode. *Undertaking & Investment*, 33(9), 51-53.
- [7] Huatai Securities Co., Ltd. (2025). Huatai Securities: Annual report 2025. [https://crm.htsc.com.cn/pdf\\_finchina/CNSESH\\_STOCK/2026/2026-3/2026-03-31/12036131.pdf](https://crm.htsc.com.cn/pdf_finchina/CNSESH_STOCK/2026/2026-3/2026-03-31/12036131.pdf)