Econometric Analysis and Data Analysis Optimization Strategies for Accounting Measurement Errors in Financial Derivatives

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Abstract: This article mainly studies and analyzes the accounting measurement errors of financial derivatives. Firstly, this article elaborates on the core concepts, types, and accounting measurement requirements of financial derivatives, and explains the connotation, universality, volatility, and measurability characteristics of measurement errors; Next, this article introduces the measurement indicators of accounting measurement errors and the application logic of econometric models, and explores and analyzes the existing problems in data collection, processing, modeling, and verification; Finally, this article proposes targeted data analysis optimization strategies. Research has shown that the core cause of measurement errors is defects in the data analysis process; By expanding data sources, scientifically processing data, matching models and data features, and constructing a closed-loop verification system, errors can be significantly reduced and measurement accuracy can be improved. This provides a reference for the accounting measurement practice of financial derivatives.

1. Overview of Accounting Measurement Fundamentals for Financial Derivatives

1.1. Core Concepts and Main Types of Financial Derivatives

In the financial market, financial derivatives are an important risk management tool whose value is derived from other underlying assets such as stocks, bonds, foreign exchange, or interest rates. Investors can diversify, transfer, or hedge specific financial risks through these derivatives. The main financial derivatives include futures contracts, options contracts, forward contracts, and swap contracts, as shown in Figure 1.

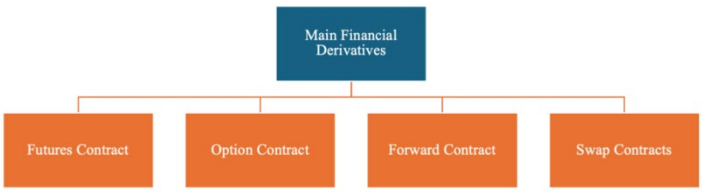

Figure 1: Main financial derivatives.

Futures contract refers to an agreement between two parties to trade a specific quantity of assets at a predetermined price on a specific future date; Option contract is a contract that grants the buyer the right to buy or sell the underlying asset at an agreed price on or before a specific date; Forward contracts are similar to futures, but are usually traded over-the-counter and have higher flexibility; Swap refers to a financial contract in which both parties agree to exchange cash flows within a certain period of time. Derivatives have a wide range of applications, not only in speculation, but also to avoid price or exchange rate volatility risks [1].

1.2. Core Requirements for Accounting Measurement of Financial Derivatives

Accurately reflecting the fair value of financial instruments is the most important aspect in the accounting measurement of financial derivatives. International Accounting Standards (IFRS), particularly IFRS 9 and US Accounting Standards (GAAP), emphasize that financial derivatives should be measured at fair value and presented in the financial statements as a change in value.

Fair value measurement requires companies to regularly evaluate the current market value of financial instruments and calculate them based on active market quotes or using valuation techniques such as discounted cash flow models. In addition, companies must disclose risk management objectives, policies, and financial instrument classification information. At the same time, due to the risk nature and complexity of derivatives, companies are required to have mature internal control and risk management systems to ensure the accuracy and transparency of accounting measurements [2].

1.3. The Connotation and Basic Characteristics of Accounting Measurement Errors in Financial Derivatives

In general, accounting measurement mistakes in financial derivatives happen when businesses can't figure out the fair value of derivatives correctly, which is quite likely to change the way financial reports seem. There are several reasons why mistakes happen, such as collecting data incorrectly, choosing the wrong model, market data changing quickly, and making mistakes [3].

The complexity of derivatives makes measurement errors mostly characterized by the following features, as seen in Figure 2: The first is the concealment of errors, which are difficult to detect in the short term; The second is the cumulative nature of errors, which may gradually affect the overall situation over time; The third is the widespread impact of errors, which can greatly affect the entire financial system of a company and even investor decisions. Accurately identifying and handling these errors can improve the quality of financial reports and ensure the foundation of market trust.

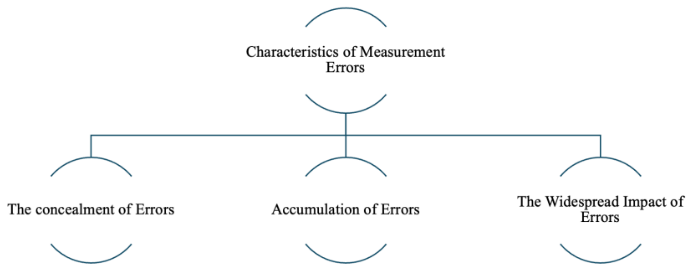

Figure 2: Characteristics of measurement errors.

2. Econometric Analysis Method for Accounting Measurement Error of Financial Derivatives

2.1. Design of Measurement Indicators for Accounting Measurement Errors

When evaluating accounting measurement errors in financial derivatives, it is essential to design accurate measurement indicators, which is a crucial step. The absolute and relative values of error should also be considered, as they are the fundamental criteria for measuring error. This may involve consistency indexing, which can promote the stability of evaluation errors over different periods. In addition, it is necessary to design risk indicators such as VAR (Value at Risk) to quantitatively evaluate the contribution of errors to enterprise risk.

For the fair value measurement of derivatives, the error can also be measured and reflected by the deviation index of market prices. Frequency and duration indicators can effectively evaluate the frequency and persistence of errors, thereby helping to identify potential structural problems. The measurement indicators of innovation help to comprehensively evaluate the characteristics of errors, thereby ensuring the effectiveness of research and improvement measures [4].

2.2. Selection and Application of Econometric Models

To look into accounting measurement errors in financial derivatives, it's important to choose the right econometric models. Some of the most common models, as shown in Figure 1, are time series models, stochastic volatility models, and linear regression models. The functional link that linear regression can make between mistakes and variables that might affect them makes it possible to predict errors and do factor analysis, as shown in Figure 3:

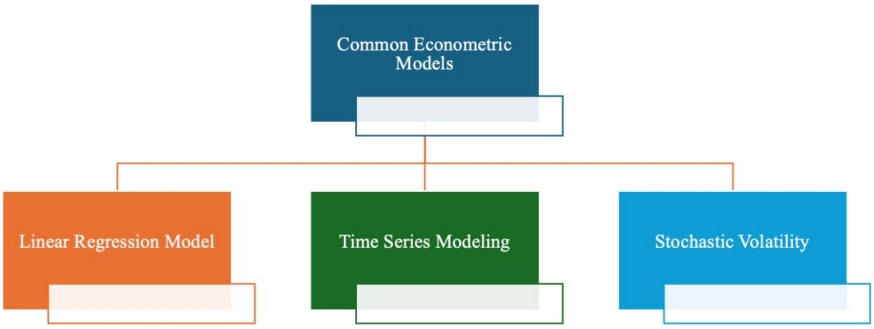

Figure 3: Common econometric models.

The ARIMA model is a common way to deal with the stationarity and seasonal patterns of errors. The time series model works well for data with errors that depend on time.

Due to the uncertainty of the financial market environment, stochastic volatility models can obtain the dynamic characteristics of errors through the random changes of latent variables, such as ARCH or GARCH models. The application of this model also needs to ensure that it is consistent with the actual financial market and enterprise characteristics, which requires the combination of professional knowledge and experience [5].

2.3. The Logic of Metrological Analysis of Factors Affecting Measurement Errors

The examination of determinants influencing measurement mistakes must adhere to explicit econometric principles. The first step is to find possible elements that might have an effect, such as signs of market volatility, the quality of information disclosure, the level of corporate financial management, and the state of the economy outside the company. Next, use correlation analysis and causal analysis techniques to clarify the relationship between these factors and measurement errors.

The control variables and experimental design are mainly used to exclude the influence of other confounding factors to ensure the effectiveness of the analysis. After setting up the model, the impact of each factor on the error is evaluated through parameter estimation. At the same time, hypothesis testing is needed to evaluate the applicability of the model and the significance of variables. The logic of analysis needs to be based on the mechanism of error generation and combined with industry background to ensure the accuracy of conclusions and guidance for application [6] .

3. The Existing Problems of Data Analysis in Accounting Measurement of Financial Derivatives

3.1. Problems in the Data Collection Process

Data collection, essentially, is the fundamental step in accounting measurement of financial derivatives. Currently, there are three obvious problems in this process, as seen in Figure 4. One reason is that the data source is single. Many companies overly rely on a single channel to obtain data, for example, they only choose basic tool price data from a certain exchange, or they rely solely on parameters provided by a third-party data service provider, which leads to a lack of cross validation mechanisms between multi-channel data. Once there are deviations, delays, or anomalies in the data of the selected channel, it will directly affect the distortion of the basic data for subsequent measurement, thereby directly affecting the final measurement results.

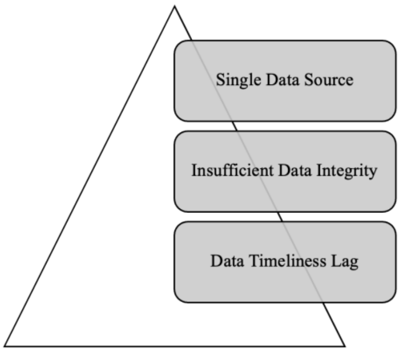

Figure 4: The basic steps of accounting measurement for financial derivatives.

The second issue is insufficient data integrity. Common situations include missing core parameters, such as the historical volatility and expected dividend rate of the underlying asset, which are often overlooked when measuring the fair value of options; The data related to the future cash flow forecast of some forward contracts is incomplete, and can only be estimated and supplemented based on the subjective experience of the staff, which will further amplify the uncertainty of the measurement results.

The third issue is the lag in data timeliness. Some enterprises still adopt the mode of collecting data in batches at fixed times every day, which makes it difficult for them to obtain various dynamic information in real time, such as basic tool prices, market interest rates, etc. Especially during periods of intense market fluctuations, the lagging data is difficult to effectively reflect the real value of derivative products at present, which may directly lead to the widening deviation between measurement results and actual value [7].

3.2. Problems in the Data Processing Stage

The quality of data processing can directly have a decisive impact on the accuracy of subsequent measurements. Currently, the main problem with this stage is the rough handling method and lack of scientific rigor. Firstly, simplify the handling of missing values. When faced with missing data, most companies either directly delete samples containing missing values or use global mean or median filling without considering the distribution characteristics of the data itself. For example, if the underlying asset price data shows a skewed distribution, using mean filling will distort the original fluctuation pattern of the data, thereby affecting the estimation accuracy of core parameters such as volatility and discount rate in the future.

Secondly, there is insufficient recognition of outliers. It is difficult to effectively identify abnormal trading prices or data entry errors in extreme market conditions solely based on subjective judgment without establishing a sound outlier screening mechanism. These outlier values that have not been removed will directly interfere with the calculation of core parameters, such as causing the volatility of the underlying asset to be overestimated or underestimated, thereby further amplifying measurement errors.

Finally, there is a lack of data standardization. The data obtained from different channels may have inconsistent formats and units, for example, some price data may be rounded to one decimal place, while others may be rounded to four decimal places; Some interest rate data is presented in percentage form, while others are presented in decimal form. If these different formats and units of data are directly combined and used without standardization, it will result in inconsistent calculation standards and measurement deviations [8].

3.3. Issues in the Data Modeling Process

Data modeling is a crucial step in transforming basic data into measurement results. Currently, there are issues with model data mismatch, rough parameter estimation, and unrealistic assumptions in this process. One is that the model does not match the characteristics of the data. Many companies ignore the inherent quantitative relationship of the data and blindly choose simple models. For example, when measuring the fair value of options, linear regression models are used to fit the nonlinear relationship between the underlying asset price and the option price, which cannot reflect the convex characteristics of the option price changing with the underlying asset price, resulting in a significant deviation between the measurement results and the true value.

Secondly, the parameter estimation method is rudimentary, and the calculation of core parameters lacks rationality. For example, when estimating the volatility of the underlying asset, only the simple arithmetic mean of the past year's data is used, without considering the dynamic changes in recent market volatility or using estimation methods such as rolling windows that are more in line with market reality. This makes the calculated volatility unable to reflect the current market risk level, directly affecting measurement accuracy [9].

The third is that the model assumptions are detached from reality. Most econometric models continue to use various ideal assumptions, such as no transaction costs, no market friction, and complete information symmetry. However, in reality, factors such as transaction fees, taxes, and liquidity premiums are commonly present. These factors that are not included in the model will further lead to inherent deviations between the econometric results and the actual value of derivatives.

3.4. Problems in the Data Verification Process

Data validation is an important guarantee for verifying the reliability of measurement results. Currently, there are issues with a single verification dimension, limited scope, and lack of feedback loop in this process. Firstly, verify that the indicators are single. Most companies only use the goodness of fit (R^2) as the sole criterion for judging the effectiveness of a model, while ignoring the actual scale of the error itself. For example, a certain econometric model has a high R^2, but the root mean square error (RMSE) far exceeds the acceptable range in the industry. Relying solely on R^2 makes it difficult to detect actual deviations in econometric results in a timely manner, which may lead to the continued use of invalid models. Secondly, the scope of validation is limited, and the validation work mostly stays at the level of historical data fitting, that is, testing the fitting effect of the model based on past data. This verification method does not conduct predictive validation, nor does it require testing the model's ability to measure future market data. If the market environment changes, the model is likely to produce significant errors due to a lack of adaptability.

Finally, there is a lack of feedback mechanism. During the verification process, the problems discovered cannot be reversed to the previous steps. For example, after verification, it was found that the measurement error of a certain derivative product continued to be high, but the reasons were not traced and analyzed. Whether it was incomplete data collection, improper data processing methods, or unreasonable model parameters, the previous steps were not adjusted accordingly, resulting in the recurrence of similar problems and difficulty in forming an effective optimization loop.

4. Data Analysis Optimization Strategy for Accounting Measurement of Financial Derivatives

4.1. Optimizing the Data Collection Process

To solve the problems of single source, insufficient integrity, and lagging timeliness in the data collection process, we need to start from three aspects. Expand data sources and establish a cross validation mechanism, no longer relying on a single channel, but integrating exchange public data, authoritative third-party data service provider data, and industry database resources to further determine the priority of core data. For example, for measurement options, priority should be given to obtaining necessary data such as real-time prices and historical volatility of underlying assets, and at least two independent channels should be used to collect and verify differential data for a second time to ensure the fairness and reliability of basic data.

Establish a sound data integrity assurance system, develop a data collection list for various types of derivatives in advance, and label mandatory and optional items. At the same time, in the case of missing mandatory items, priority should be given to obtaining them through supplementary research. If it is not possible to supplement, authoritative alternative indicators should be used. For example, in the case of missing dividend rates for the underlying assets, it is recommended to estimate the dividend levels of similar assets in the same industry and record in detail the reasons for the missing and alternative basis, in order to effectively avoid subjective and arbitrary supplementation.

Improve data timeliness, establish differentiated collection frequencies based on the volatility characteristics of derivatives, and connect data interfaces to achieve real-time collection for intraday volatile varieties such as futures and options. The time interval between each collection should not exceed 15 minutes; For varieties with slow fluctuations such as forwards and swaps, data should be collected at regular intervals every hour to ensure timely reflection of the latest market changes. Especially during periods of intense market volatility, it is necessary to shorten the collection interval in a timely manner to avoid significant deviations in timeliness.

4.2. Optimizing the Data Processing Process

In order to solve the problems of simple handling of missing values, insufficient identification of outliers, and lack of standardization in data processing, it is necessary to continuously strengthen the scientific nature of the processing flow. To scientifically handle missing values, it is necessary to abandon the single filling or deletion mode, and first analyze the distribution characteristics of the data: if the target asset price and other data are normally distributed, they can be filled with the mean; If there is a skewed distribution, such as price data under extreme market conditions, fill in the median; For time-series data, such as historical volatility sequences, the linear interpolation method of adjacent data should be used to preserve the trend of the data, avoid affecting the original pattern, and record the handling method of missing values to ensure traceability in the later stage.

Establish a systematic mechanism for identifying and handling outliers, which can effectively combine statistical methods and market logic to screen outliers. Use the 3 σ principle or quartile range method to preliminarily identify data that exceeds a reasonable range, and then make judgments based on market background. For example, if price fluctuations under extreme market conditions conform to market logic, they are marked as reasonable anomalies and retained; If the abnormality is caused by data entry errors or platform failures, replace it with the mean of adjacent data in that period, and record the cause and processing results of the abnormality in detail to avoid interference with core parameter calculations caused by outliers.

Establish unified data standardization standards, develop standardized data formats for financial derivatives, and clarify the units, accuracy, and format of various types of data. For example, price data should be kept to 2 decimal places, interest rate data should be kept in decimal form instead of percentages, and exchange rate data should be kept to 4 decimal places. At the same time, develop data cleaning templates to automatically identify and convert data in different formats, ensuring consistency in multi-channel data caliber and effectively eliminating calculation bias.

4.3. Optimizing the Data Modeling Process

The main problems in data modeling include model mismatch with data, rough parameter estimation, and unrealistic assumptions. These can be addressed from three aspects: model selection, parameter calculation, and hypothesis correction. To achieve precise matching between the model and data features, it is necessary to use basic analysis to determine the data relationship before modeling, and use scatter plots to observe the correlation between the underlying asset price and the derivative price; If there is a linear relationship, such as the price of a forward contract and the price of the underlying asset, a simple linear model should be used; If there is a non-linear relationship, such as between option prices and underlying asset prices, an adapted simplified model is used. For option measurement, the basic version of the Blackshot Coles model is used, which does not require complex correction terms and can fit data characteristics effectively, while also reducing operational difficulty.

Improve parameter estimation methods. Firstly, it is necessary to improve the accuracy of core parameters. When estimating the volatility of the underlying asset, the simple arithmetic mean method should be abandoned and the rolling window method should be used instead. High frequency data from the past 30 days should be selected for calculation, and higher weights should be given to recent data. For example, the weight of data from the past 10 days accounts for 60%, which can reflect the dynamic changes in market volatility. When determining the discount rate, it is necessary to add a liquidity premium adjustment term based on the risk-free interest rate of the same period in the market. For example, the premium should be set according to the activity of derivative trading, that is, a premium of 0.1% to 0.3% should be set, so that the parameters can better fit the actual market risk level [10].

If the model assumptions are revised to be closer to reality, there is no need to continue using the traditional ideal assumptions of no trading costs and no market friction. Instead, reasonable adjustment terms need to be added to the model, such as deducting trading fees and delivery related fees when calculating the value of futures contracts; When measuring option prices, it is necessary to fully consider the tax and fee costs in the exercise process, and make small adjustments to make the model more in line with practical scenarios, further reducing inherent biases.

4.4. Optimizing the Data Validation Process

To solve the problems of single indicators, limited scope, and missing feedback in the data verification process, it is necessary to construct an optimization system that combines multidimensional verification, full coverage, and closed-loop feedback. Continuously enriching the validation indicator system requires not only relying on goodness of fit (R^2), but also incorporating error scale indicators such as root mean square error (RMSE), mean absolute error (MAE), etc. At the same time, it is necessary to carefully analyze the distribution characteristics of errors. If the error shows a normal distribution, it indicates that the error is a random deviation and the overall reliability of the model is high; If the error is concentrated in a specific time period or specific derivative type, it is necessary to further carefully investigate the problems in the preceding steps and comprehensively and systematically judge the reliability of the measurement results through Togolese indicators.

Expanding the scope of validation requires dividing it into two categories: historical data fitting validation and future data prediction validation. The historical verification method requires selecting multiple sets of historical data from different market environments, such as stationary and volatile periods, to test the model and ensure its applicability in different scenarios; The future validation method will adopt a rolling prediction model, regularly testing the model's measurement effectiveness with the latest market data. For example, the derivative value for the next 20 days will be predicted using data from the first 10 days of the month each month. The actual measurement results will be compared and analyzed with the predicted values to evaluate the model's adaptability.

Establish a complete feedback optimization mechanism, and address issues identified during classification and annotation validation, such as errors caused by missing data that need to be fed back to the data collection stage, and errors caused by unreasonable model parameters that need to be fed back to the data modeling stage. At the same time, it is necessary to develop a list of problem rectification, further clarify the responsibility links, rectification measures, and completion deadlines, hold monthly optimization review meetings to review the rectification effects, truly ensure closed-loop problem resolution, and form a continuous improvement cycle of verification feedback optimization and re verification.

5. Research Conclusion and Future Prospects

5.1. Research Findings

This study starts with the accounting measurement errors of financial derivatives and conducts a systematic analysis to draw three core conclusions. The three major characteristics of accounting measurement errors in financial derivatives are universality, volatility, and measurability. Therefore, effective measurement can be achieved through simple indicators such as absolute error, relative error, root mean square error, etc., and basic econometric methods such as linear regression and time series can also be used to analyze and study influencing factors.

The core reason for the occurrence of data analysis is measurement error. Data collection has singularity and lag, roughness in data processing, mismatch in data modeling, and limitations in data validation, all of which increase errors from different dimensions.

The optimization strategies for each stage of data analysis have clear effectiveness. By expanding data sources, scientifically processing data, matching models and data features, and constructing a multidimensional verification system, measurement errors can be significantly reduced, and the accuracy and reliability of financial derivatives accounting measurement can be improved.

5.2. Future Prospects

In the future, efforts can be made to promote accounting measurement of financial derivatives from three aspects. One is at the technical application level, exploring and analyzing the simple application of big data technology in the processing of massive derivative data, such as using distributed computing to comprehensively improve the efficiency of multi-channel data integration, thereby further reducing the time required for data collection and processing, and effectively reducing manual operation errors.

The second aspect is the improvement of methods, which organically combines basic machine learning algorithms with traditional econometric models, such as using decision tree algorithms to assist in screening key parameters of derivative econometrics, further improving the accuracy of parameter estimation without increasing complexity.

The third is at the practical implementation level, continuously promoting the optimization strategies obtained from research, and then transforming these strategies into standardized operating procedures, thus forming a simple guide that can be directly referenced by enterprises. This can help more enterprises use convenient optimization methods to achieve results and achieve comprehensive improvement in the accounting measurement quality of financial derivatives.

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