The Study of Equity Valuation Based on Modified Ohlson Model: Case of BYD

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Abstract. New energy vehicle companies are at an early stage of development and have large differences in terms of technological development, market maturity and R&D costs. In this context, traditional valuation methods do not meet the requirements for valuing new energy vehicle companies. This study modified the traditional Ohlson model according to the characteristics of new energy vehicle companies, adopts DuPont's analysis system to decompose and measure several financial indicators, addresses the problem that residual returns are difficult to predict directly, and provides a reasonable and accurate valuation of new energy vehicle companies to provide investors with basis. The actual valuation will also be demonstrated with the example of BYD.

Keywords: Ohlson model, new energy vehicle, equity valuation.

1. Introduction

With escalating energy scarcity, environmental issues, and a growing focus on eco-consciousness, society is increasingly investing in new energy vehicle companies. However, these firms are in the early development stages with varying levels of technological advancement, market maturity, and R&D costs. Traditional evaluation methods are inadequate for their needs. As competition intensifies within the industry and activities like listings, acquisitions, and financing rise, accurate valuation of these assets becomes vital for both academia and industry.

Against this backdrop, this paper propose the Ohlson model as an innovative alternative. It introduces a linear dynamic assumption based on residual income, analyzing impacts from factors like profit, book value, and dividends. This approach bypasses future profit forecasting, providing a fresh method for valuing new energy vehicle companies.

As an example, BYD, a leading new energy vehicle firm, implemented improvements to the Ohlson valuation model using empirical evidence, achieving a more accurate and reasonable valuation. This offers a significant benchmark for determining company and capital market values. This study dissects the definitions, value characteristics, and key valuation points of new energy vehicle companies attempting to upgrade the Ohlson model and apply it to actual company valuations.

The modified Ohlson model delivers a more reasonable and reliable equity valuation basis for investors when selecting investment targets. Moreover, viewing overall enterprise value in terms of residual returns provides a lucid value reference for business decisions and future company expansion.

2. Literature Review

2.1. Definition of the Concept

2.1.1. New energy vehicle industry

(1) Definition of new energy vehicles

According to the definition in the 'Administrative rules for the market access of manufacturers and products of new energy vehicles', new energy vehicles refer to vehicles with advanced power train and propulsion technologies and new system structures, using fuels other than conventional fuels. There are different types of new energy vehicles and the three main types of new energy vehicles are fuel cell vehicles, hybrid vehicles and pure electric vehicles.

(2) New energy vehicle industry

The new energy vehicle industry chain includes upstream raw materials, intermediate core components, downstream vehicle sales and support facilities. The upstream raw material industry refers to the mining industry of lithium metal, nickel metal and rare earth metals; the intermediate core component industry covers the research and development and production of batteries, motors and electronic control units; the downstream vehicle sales industry covers the production and sales of new energy vehicles; and the support facilities mainly cover after-sales services and the construction of charging stations.

2.1.2. Ohlson model

The remaining income is defined as the difference between its operating profit and its costs. It consists of two aspects: first, the revenue of the company and second, the capital costs of the company. Alfred Marshall, the founder of the residual profit, put forward the theory of economic profit, he believed that the residual value is the difference between the operating profit of the company and the return to investors. From this perspective, residual value and economic profit are similar. Preinreich, as the originator of the concept of residual profit, has first introduced it in 1938, based on an examination of the concept of excess profits.

The basic idea of Ohlson residual profit model is that the net assets to be opened up and the present value of the potential residual profit constitute the intrinsic value of the firm. Edward and Bell (1961) have formally proposed the residual income model to illustrate the role of accounting data in the value of a stock, and Peasnell (1982) has refined the residual income model on the basis of existing research. Peasnell believed that accounting data had a significant impact on the value of a company, but Peasnell has not solve the problem of the unestimated error term in the residual earnings model. Ohlson (1995) has formally proposed the residual profit model, which is recognized as the beginning of the modern residual profit model and also as the symbol of the residual profit model from theory to implementation.

2.2. Review of Related Literature

2.2.1. Studies related to the Ohlson model

Feltham and Ohlson (1995) have proposed the famous Ohlson's model and introduced the residual earnings stock price theory, and they have believed that the application of this model breaks the previous neglect of residual value in valuation and can improve the accuracy of firm valuation [1]. Based on their research, Beaver's (1996) study shows, that Ohlson's model has a strong generality and at the same time its calculation is relatively simple, and he has believed that Ohlson's model's method of predicting the value of a company is more scientific in predicting the value of a company [2]. Bao and Mindy (1999) have believed that forecasting the value of a company by using Ohlson model is in which the directly measurable indicators and data cannot be converted into accounting data in the company's financial report, which can reduce the difficulty of estimating the value of a company [3].

2.2.2. Studies related to the modified Ohlson model

Mani (2016) and Rocio et al. (2016) have argued that when forecasting the value of a company by using Ohlson model, it is necessary to improve Ohlson model according to the actual situation of the company to improve the accuracy of the forecast [4,5]. Fairuz et al. (2017) and Chen (2017) have applied dynamic array model to Ohlson model for stock price forecasting, and the results has shown that this method can improve the accuracy of stock price forecasting because using dynamic array can better simulate the process of dynamic changes in stock price [6,7]. Similarly, many researchers have predicted the value of Chinese listed companies, Júlio et al. (2018) predicted the value of Chinese A-share listed companies, the results showed that Ohlson's model should be combined with DuPont financial system to predict the value of listed companies, and that this combination can improve the accuracy of company value prediction. His study has shown that the application of the DuPont system of financial ratios can decouple the residual value of a firm, which reduces the

difficulty of forecasting and also improves the accuracy of forecasting [8]. The study by Chatterjee (2018) and Samuel et al. (2018) has confirmed the applicability of Ohlson's model in estimating the value of listed companies and they have believed that Ohlson's model has an important significance in estimating the value of a company, he has pointed out that the residual returns of a company represent the direction in which the company may evolve in the future and also influences the capital market's valuation of the company [9,10]. adil Khassanov (2021) et al. has studied the modification of Ohlson's model to estimate the stock price dynamics of listed companies. Described the main points of Ohlson's model, has presented empirical work proving that corporate governance is a factor in firm value estimation, and assessed the relevance of the modified Ohlson's model for the market [11]. M. Noor Salim (2021) et al. has built on the Altman, Springate, Zmijewski, Ohlson and Grover models to assess the accuracy of these five forecasting models for Indonesian listed coal mining companies for the period 2015-2019. The results have shown that the improved Altman and Ohlson models have the highest prediction accuracy [12].

2.2.3. Research overview

Due to the late start of the domestic market, which is not perfect compared to the foreign market, many researchers are still stuck in the use of discounted cash flows and other methods to value companies. Domestic researchers combined with the latest foreign research theories to improve their studies in an attempt to create a valuation model suitable for the Chinese market. At present, Ohlson's model is still only used in a small number of industries, researchers for listed companies systematically analyze and make improvements, such as the introduction of a three-stage forecasting model, a price-earnings ratio and a market net ratio, including the use of BP neural networks and random forests, and other models of operating profit, cash flow and other reasonable forecasts, while domestic researchers have also noticed the influence of other information in the valuation of enterprise value and try to quantify it, so that Ohlson's model is suitable for China's market valuation. and are trying to quantify it so that the Ohlson model can be applied to segmented industries.

In this study, this article intends to introduce DuPont's analytical system to decompose the residual income formula, decompose the residual income measure, create an improved Ohlson model, and provide ideas for valuing a new energy vehicle company.

3. BYD Company Profile and Choice of Equity Valuation Methods

3.1. Introduction to BYD

3.1.1. Background history of the company

BYD was founded in February 1995 and later listed on both the Shenzhen Stock Exchange and the Hong Kong Stock Exchange. Over two decades of rapid development, the company has established more than 30 industrial parks throughout the world, including strategic placements on six continents. BYD's business solutions cover electronics, automotive, new energy, and railway transportation industries and have a significant impact from energy sourcing, storage, to deployment, as well as a comprehensive construction of new energy solutions. The total market capitalization and turnover exceed 100 billion yuan. In 2022, the Group announced its decision to cease production of fuel-powered vehicles and concentrate on developing its new energy vehicles business. This move makes the Group the first automotive company worldwide to stop producing fuel-powered vehicles and shift focus to the development of new energy vehicles.

3.1.2. Overview of the company's key financial data

(1) BYD's Revenue

BYD achieved revenue of RMB 424.061 billion in 2022, an increase of 96.20%. Net profit reached 16.622 billion RMB, year-over-year increased 445.86%, automotive gross profit reached 20.39%; in 2023Q1, the company achieved total revenue of 120.174 billion RMB, year-over-year increased 79.83%. In the past ten years, BYD's total revenue basically showed an upward trend, based on the

growth rate analysis, in the past five years, except for 2019, which was severely affected by the epidemic, the company's total revenue growth rate showed an upward trend, and the company's total revenue growth rate in 2022 reached a maximum of 96.2%, which is generally still at a higher level. The revenue data of BYD over the past decade is shown in table 1.

Table 1. BYD revenue data 2012-2022

Year	Revenue (RMB'000)	Growth Rate
2022	424,060,635	96.20%
2021	216,142,395	38.02%
2020	156,597,691	22.59%
2019	127,738,523	-1.78%
2018	130,054,707	26.70%
2017	102,650,614	2.44%
2016	100,207,703	29.11%
2015	77,611,985	40.18%
2014	55,366,384	11.25%
2013	49,767,887	12.14%
2012	44,380,858	-4.17%

Data source: data collection from BYD's published financial report.

(2) BYD revenue structure

BYD Limited is primarily involved in the automotive industry, which consists mainly of new energy vehicles, mobile phone parts and assembly, battery and photovoltaic equipment. In addition, due to its technological advantages, the Group is actively developing businesses such as light rail transportation. In 2022, the revenue generated from automobiles and related products is estimated to be around RMB324,691 million, indicating an impressive year-on-year increase of 151.78%. Additionally, revenue from mobile phone parts and assembly services is expected to reach RMB98,815 million, reflecting a year-on-year increase of 14.30%. These business segments contributed to 76.57% and 23.30% of the organization's overall revenue, respectively. The proportions are shown in Figure 1.

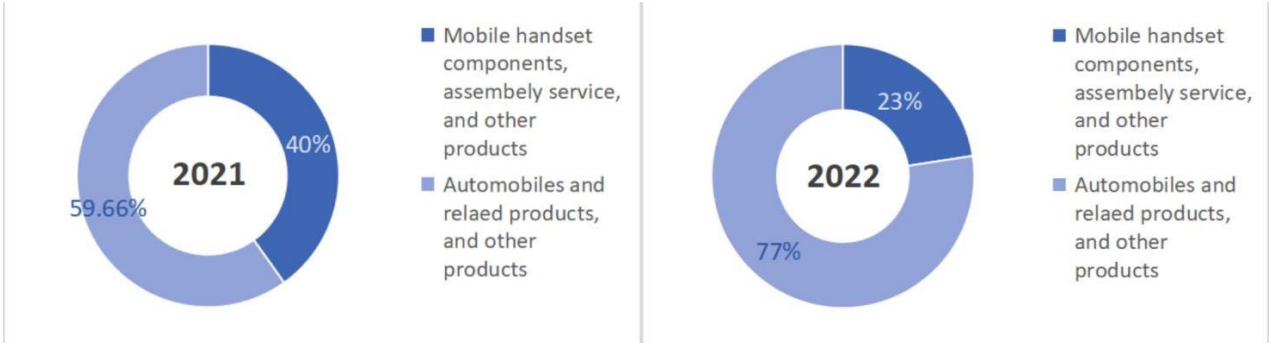

Figure 1. Breakdown of BYD's revenue by product category

According to BYD's annual report, the domestic market accounted for more than 70% of BYD's total revenue in 2022. The overseas market is expanding rapidly, and the share of overseas market revenue in total revenue increased by 8% compared to 2021. In the first half of 2023, BYD's cumulative overseas sales have reached 74,300 units, surpassing the previous year's total revenue of 53,600 units. In the first five months of 2023, BYD's market share in the pure electric vehicle market in Singapore reached 20.7%. In addition, in Thailand, BYD ATTO 3 license volume in the first five months of this year was 9,310 units, accounting for 38.6% of the local pure electric vehicle market, and BYD is the top seller of electric vehicles in Thailand for the first half of 2023 as of the end of June. The proportions are shown in Figure 2.

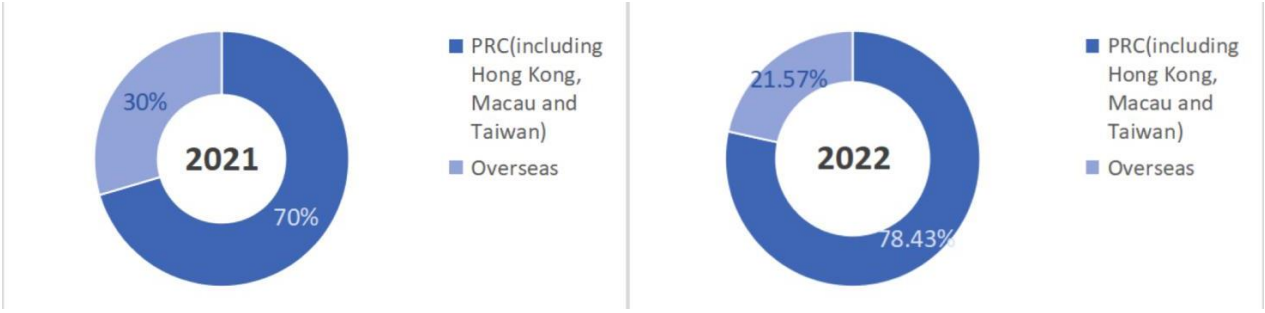

Figure 2. BYD revenue segmentation table by customer location

3.2. Choice of BYD's Equity Valuation Methods

Traditional valuation methods include the cost method, market method, and income method. While each has its place, they also have limitations when applied to new energy vehicle companies. The cost method tends to undervalue companies as it doesn't fully capture their future growth potential. The market method focuses on relative value rather than intrinsic value by comparing other similar companies, which isn't always useful due to the difficulty in finding comparable firms. Further, this approach doesn't give room for parameter adjustments translating into low accuracy of valuation results. The income method assumes that a company's future revenue and related risks can be accurately predicted, which is a challenge given the lack of historical data and the unpredictability of emerging markets like the new energy vehicles in China.

Newer valuation techniques such as the option pricing method and the BP neural network have been introduced but come with their challenges too. Due to the underdeveloped nature of Chinese capital markets, the practical application of the option pricing method is limited. It involves complex calculations and high technical requirements, contributing to inaccuracies and limiting its usage. On the other hand, the BP neural network requires not only substantial historical data but also rigorous assumptions. Especially in industries like new energy, where the relationship between a company's value and influencing factors is complex, creating an accurate mathematical model becomes difficult.

This paper advocates for the use of the residual income model, which calculates a company's value by combining the net present value of opening net assets and residual income. This way, it captures the intrinsic value of the company more accurately. An analysis of the Ohlson residual income model reveals several benefits for new energy vehicle companies. Firstly, it recognizes the effect of equity book value on equity, consistent with the asset-heavy nature of these companies. Secondly, the modified model aligns better with actual market conditions and financial reporting, reducing subjectivity.

Moreover, the focus of the residual income model is on value creation, offering a more realistic reflection of a company's intrinsic value compared to wealth distribution-focused models like the discounted dividend model. It allows for emphasis on value creation rather than subjective activities such as value distribution. As such, the residual income model is superior for valuation purposes.

In conclusion, the Ohlson residual income model is an effective tool for valuing new energy vehicle companies. It compensates for the limitations of traditional methods like the discounted return valuation method by considering the unique characteristics and market environment of these companies. Thus, it provides a more scientific and accurate approach to assess their value which is crucial for their growth and development in the emerging marketplace.

4. Improving the Construction of Ohlson Residual Income Model

4.1. Principles and Basic Form of Ohlson Residual Income Model

The Ohlson Residual Income Model is a financial analysis tool for valuation, which was first proposed by American scholar James Ohlson in 1995. The model aims to predict a company's future residual income through financial statement information, thus providing investors with a more

accurate basis for valuing the market value of a company. Briefly, its core idea is that the market value of a company depends on its future profitability, which is specifically interpreted as its expected future residual earnings, i.e., the portion of earnings over the required rate of return. By discounting future surplus back to the current point in time, the model attempts to quantify this portion of future value to provide investors with a more accurate basis for valuation.

From the above concepts, the Ohlson residual income model considers that netbook assets and residual income together constitute the firm's value, and its basic expression is shown in equation (1)

$$P_t = BV_t + \sum_{t=1}^{\infty} \frac{E\left(X_t - R_f \times BV_{t-1}\right)}{(1+r)^t} \tag{1}$$

Where: Pt denotes the value of the firm at time t; BV_t denotes the book value (net asset value) of the firm at time t;$Xt - R_f * BV_{t-1}$ denotes residual income; r denotes the discount rate.

In the expression of the Ohlson model, two components make up the market capitalization of a company: one is the book value, i.e., the net asset value, which reflects the existing financial position of the company, and the other is the expected future residual income, i.e. the portion of the earnings that exceeds the rate of return required by investors. Residual earnings can be defined as the company's future surplus, minus the return required by investors. In the stock market, investors are willing to take a certain amount of risk to earn a return that exceeds that of a risk-free investment, such as a Treasury bond. Therefore, the residual return reflects the difference between the investor's required return on risk and the company's actual surplus, which is calculated as shown in equation (2).

$$RI_t = X_t - R_f \times BV_{t-1} \tag{2}$$

Where RIt denotes the residual income in period t; Xt denotes the net profit in period t; Rf denotes the necessary rate of return demanded by the shareholders; and BVt-1 denotes the firm's book net worth at time t-1.

Based on the elaboration of the Ohlson model in the previous section, the expression for residual returns, i.e. expression (2), is introduced into expression (1), and the expression as a whole can be simplified as shown in equation (3)

$$P_t = BV_0 + \sum_{t=1}^{\infty} \frac{RI_t}{(1+r)^t} \tag{3}$$

Where: Pt denotes the enterprise value in the current period; BV0 denotes the netbook assets of the enterprise at the time of t0; RIt denotes the residual income of the enterprise in period t; r denotes the discount rate.

From the basic form of the model, it is understood that the value of the firm is determined by the netbook assets, the residual income for each period, and the required rate of return, r.

4.2. Ohlson Model-related Improvements and Construction

The traditional residual income model establishes a direct link between the value of a company's equity and its accounting information, which has a good rating in terms of operability and practicality, but at the application level, the traditional residual income model faces a major shortcoming in terms of predicting residual income and its duration.

To address this problem, based on reading and summarizing previous studies, this paper adopts the method of introducing DuPont's analysis system into Ohlson model, explores the improvement measures of the residual income model at the application level, and tries to apply it to the study of BYD's enterprise valuation.

The DuPont Analytical System is a comprehensive approach to financial analysis designed to assess the performance and financial health of a business. The method breaks down a firm's financial data into several key metrics to reveal information on profitability, asset management and financial leverage. In the improvement study of the Ohlson model, the DuPont analysis system, out of the precise use of the enterprise's historical financial data, improves the objectivity compared to the traditional assessment method, which can make the prediction of residual income simple and easy, and make the final assessment result more objective and accurate.

The DuPont system of analysis is based on the DuPont equation, which multiplies a firm's net profit margin, total asset turnover and equity multiplier to arrive at a firm's return on equity (ROE), the basic expression of which is shown in equation (4)

$$\begin{aligned} ROE &= ROA \times EM \\ &= MOS \times ATO \times EM \end{aligned} \tag{4}$$

Where: ROE stands for net equity margin; ROA stands for net asset margin; EM stands for equity multiplier; MOS stands for net sales margin; ATO stands for asset turnover ratio

Based on this, the residual income is dis-aggregated and measured

$$RI_t = V_t - R_f \times BV_{t-1} = BV_{t-1} \times (\frac{V_t}{BV_{t-1}} - R_f) \tag{5}$$

$$\frac{V_t}{BV_{t-1}} = ROE = ROA \times EM_{t-1} \tag{6}$$

$$ROA = MOS_t \times ATO \tag{7}$$

From this

$$RI_t = BV_{t-1} \times (MOS_t \times ATO_t \times EM_{t-1} - R_f) \tag{8}$$

$$= \frac{V_t}{MOS_t \times ATO \times EM_{t-1}} \times (MOS_t \times ATO_t \times EM_{t-1} - R_f) \tag{9}$$

$$= S_t \times \frac{1}{ATO_t} \times \frac{1}{EM_{t-1}} \times (MOS_t \times ATO_t \times EM_{t-1} - R_f) \tag{10}$$

Substituting formula (15) into formula (3) gives the improved residual income model as

$$P_t = BV_0 + \sum_{t=1}^{\infty} \frac{S_t \times (MOS_t \times ATO_t \times EM_{t-1} - R_f)}{ATO_t \times EM_{t-1}(1+r)^t} \tag{11}$$

Where: St represents sales revenue in period t; MOS_t represents net sales margin in period t; EM_{t-1} represents equity multiplier in period t-1; ATO_t represents the asset turnover ratio in period t.

Thus, with the introduction of the DuPont analysis system, the process of predicting a firm's residual income is decomposed into the operation of the following five accounting indicators: sales revenue (S), asset turnover (ATO), equity multiplier (EM), margin on sales (MOS), and cost of equity capital (r).

5. Valuation of BYD's Equity Based on Improved Ohlson Model and Analysis of Results

5.1. Determination of Parameters of Ohlson Residual Income Model

5.1.1. Sales revenue (S)

Sales revenue is the monetary income earned by an enterprise through the sale of products or the provision of services and is one of the most important financial indicators in the operation of an enterprise. BYD's source of sales revenue is dominated by the sales of new energy vehicles. As the main business of the enterprise, the sales revenue of new energy vehicle sales for BYD accounts for more than 50% of the total sales revenue of the enterprise, and the proportion shows a rising trend year by year. Therefore, this paper adopts the main business income index to replace BYD's sales revenue. BYD Company's sales revenue and growth rate from Q3 2020 to Q2 2023 is shown in table 2.

Table 2. BYD Company Sales Revenue and Growth Rate from Q3 2020 to Q2 2023

season (sports)	Sales revenue (￥billion)	Growth rate (% over the previous year)
2020Q3	445.2	-
2020Q4	515.8	15.86
2021Q1	409.9	-20.53
2021Q2	498.9	21.71
2021Q3	543.1	8.86
2021Q4	709.5	30.64
2022Q1	668.3	-5.81
2022Q2	837.8	25.36
2022Q3	1171	39.77
2022Q4	1564	33.56
2023Q1	1202	-23.15
2023Q2	1400	16.47

Source: Based on data from BYD's 2020-2023 annual report.

The 12 groups of data in the table were brought into the spss software, set time as the independent variable, and sales revenue as the dependent variable, and used the exponential function, the second-order linear function and the logarithmic function to fit the sales revenue data of a total of 12 quarters selected for analytical research, so that Q3 of 2020 takes the value of 1, and the R2 of each function is 0.887, 0.826, 0.618, respectively.

In this way, this paper predicts the sales revenue of BYD in 2024-2028 according to the fitting results, in which relatively speaking, the use of exponential function mode to fit the data is highly operable and the degree of fit is better. The Spss software can get the relevant equation after fitting: y=337.3806404230473*exp^ (0.1227176358748407 * x), which the image is shown in figure 3.

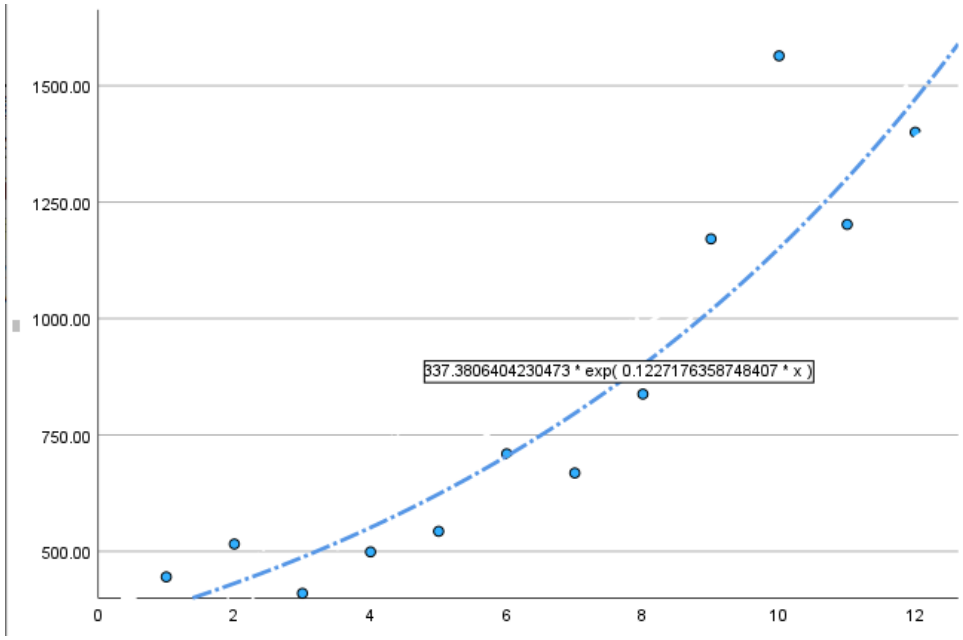

Figure 3. Trend of BYD's Sales Revenue, 2020-2023

Based on the function shown in figure 3, after combining with SPSS computing software, this paper provides a reasonable forecast of BYD's sales revenue for the next five quarters, shown in table 3.

Table 3. BYD's Main Business Revenue Forecasts, 2024-2028

season (sports)	Revenue from main business (￥billion)
2023Q3	1663.270387
2023Q4	1880.435526
2024Q1	2125.954863
2024Q2	2403.530468
2024Q3	2717.347772

5.1.2. Net sales margin (MOS)

Net sales margin refers to the proportion of net profit earned by an enterprise from sales revenue to sales revenue. As an important indicator for measuring the profitability and operating efficiency of an enterprise, net sales margin can help an enterprise to assess its profitability, operating efficiency and the effect of capital operation, and provide investment reference for investors, as well as a decision-making basis for the management of the enterprise. BYD's net sales margin for the past 12 quarters is shown in Table 4.

Table 4. Net Sales Margin of BYD Company, Q3 2020-Q2 2023

season (sports)	Sales revenue (￥billion)	Net profit (￥billion)	Net sales margin (%)
2020Q3	445.2	25.18	5.66
2020Q4	515.8	11.12	2.16
2021Q1	409.9	5.111	1.25
2021Q2	498.9	13	2.61
2021Q3	543.1	14.86	2.74
2021Q4	709.5	6.707	0.95
2022Q1	668.3	9.115	1.36
2022Q2	837.8	30.22	3.61
2022Q3	1171	60.55	5.17
2022Q4	1564	77.25	4.94
2023Q1	1202	43.7	3.64
2023Q2	1400	70.7	5.05

From the data collated in Table 4 and with the help of the software can get the trend graph of the change of BYD's net sales margin, as shown in Figure 4.

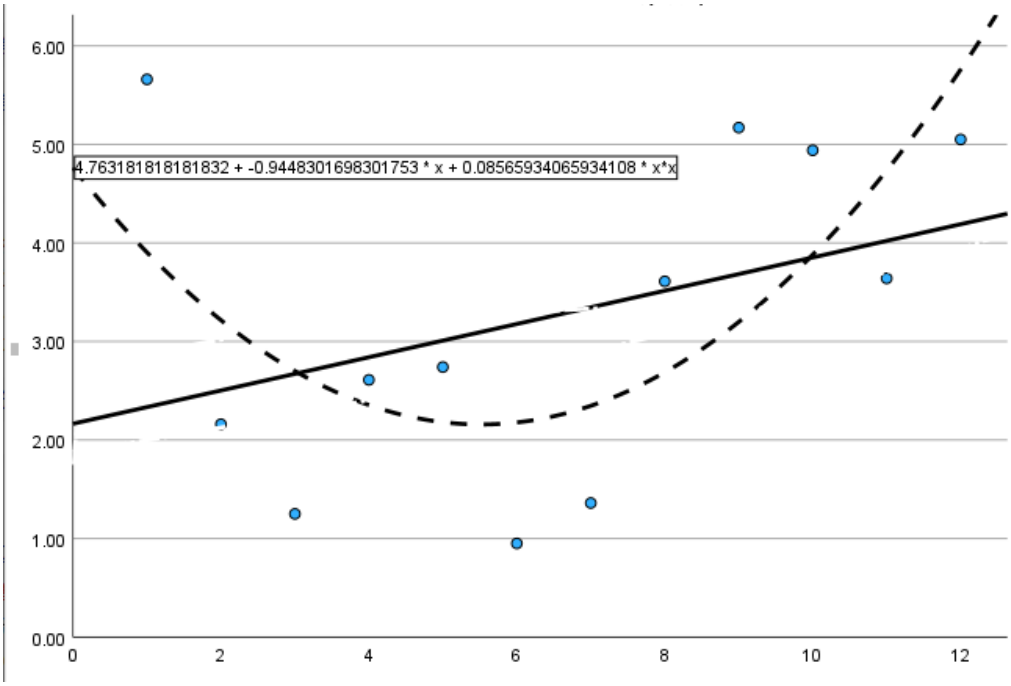

Figure 4. Trend of BYD's Net Sales Margin Change 2020-2023

In the prediction of BYD's sales revenue from 2024 to 2028, using time as the independent variable and net sales interest rate as the dependent variable, the exponential function, second-order linear function and logarithmic function are used to fit the sales revenue data of the past 12 quarters, so that Q3 of 2020 takes the value of 1, and the R2 of each function is 0.133, 0.453, 0.013. Based on this, it is concluded that the second-order linear function mode is better to fit the data in comparison. It is concluded that the second-order linear function model is comparatively better for fitting the data. The fitted correlation equation: y = 4.763181818181832 - 0.9448301698301753 * x + 0.08565934065934108 * x * x.

Based on this in combination with SPSS computing software this paper on the next five quarters of BYD's net sales interest rate to make a reasonable prediction, and its prediction results are shown in Table 5.

Table 5. BYD's Net Sales Margin Forecast, 2024-2028

season (sports)	Net sales margin (%)
2023Q3	6.96%
2023Q4	8.32%
2024Q1	9.86%
2024Q2	11.57%
2024Q3	13.46%

5.1.3. Total Asset Turnover (ATO)

The total asset turnover ratio indicates the ability of an enterprise to convert total assets into sales revenue through operational activities within a certain period. It is an important indicator for measuring the efficiency of asset utilization and operational effectiveness of an enterprise, which can help the enterprise to assess the efficiency of asset utilization, operational effectiveness and the effectiveness of capital operation, and provide a reference for the decision of asset allocation. BYD's total asset turnover ratio for the past 12 quarters is shown in Table 6.

Table 6. BYD's Total Asset Turnover Ratio from Q3 2020 to Q2 2023

season (sports)	Sales revenue (￥billion)	Total assets (￥billion)	Total asset turnover
2020Q3	445.2	1968	0.226
2020Q4	515.8	2010	0.257
2021Q1	409.9	2238	0.183
2021Q2	498.9	2229	0.224
2021Q3	543.1	2519	0.216
2021Q4	709.5	2958	0.240
2022Q1	668.3	3171	0.211
2022Q2	837.8	3459	0.242
2022Q3	1171	4262	0.275
2022Q4	1564	4939	0.317
2023Q1	1202	5471	0.220
2023Q2	1400	5911	0.237

Table 6 shows that BYD's total asset turnover ratio fluctuates slightly within the range of 0.2 to 0.3 in most cases, although there are slight variations in the total asset turnover ratio over the years. This paper suggests that the main reason for this performance is that the actual market environment is less affected by the overall management level of the company's assets, in addition to the relative stability of the company's total asset turnover ratio over a certain economic cycle. Therefore, this paper believes that the probability of BYD's total asset turnover ratio fluctuating in the foreseeable future is relatively small, and therefore selects the average of the company's total asset turnover ratio of 0.2371 in the past 12 quarters as the forecast value.

5.1.4. Equity Multiplier (EM)

Equity multiplier is one of the financial indicators to measure the capital structure and financial leverage of a company, which indicates the relationship between the total assets and net assets of a company, i.e. the ability of a company to expand its assets by borrowing funds. BYD's equity multiplier for the past 12 quarters is shown in Table 7.

Table 7. BYD's equity multiplier from Q3 2020 to Q2 2023

season (sports)	Total assets (￥billion)	Owners' equity (￥billion)	equity multiplier
2020Q3	1968	678.6	2.90
2020Q4	2010	644.5	3.12
2021Q1	2238	890	2.51
2021Q2	2229	892.9	2.50
2021Q3	2519	911.8	2.76
2021Q4	2958	1042	2.84
2022Q1	3171	1054	3.01
2022Q2	3459	1062	3.26
2022Q3	4262	1126	3.79
2022Q4	4939	1214	4.07
2023Q1	5471	1261	4.34
2023Q2	5911	1304	4.53

Fitting the equity multiplier through data regression analysis shows that both binomial and first-order linear fit are not high. Given the new energy automobile industry's capital shortage of generality, as well as the new energy automobile exhibition industry production capacity is insufficient and the relatively long delivery cycle of the status quo is still unchanged, this paper estimates that the new energy automobile enterprise debt ratio in the future will not have a substantial reduction, so through the calculation of the average value of the historical data of 3.3, will be used as a predictive equity multiplier for BYD Company.

5.1.5. Cost of equity capital (r)

The cost of equity capital is the cost that a firm has to pay to raise funds by issuing shares, also known as the cost of equity or the cost of equity. It is important for capital budgeting decisions, shareholder return assessment, capital structure optimization and enterprise valuation. In this paper, the CAPM model will be used to determine the cost of equity capital of BYD, whose formula is shown in equation (12).

$$r = R_f + \beta \ （R_m - R_f）\tag{12}$$

Where r represents the investor's expected rate of return on investment, i.e., the cost of equity capital; β represents the market risk coefficient of the stock; Rm represents the market risk rate of return; and Rf represents the risk-free rate of return.

Unlike other bonds, government bonds have a high level of creditworthiness and a very low risk of default. Therefore, this paper chooses the 5-year government bond yield as the risk-free rate, and the latest 5-year government bond rate is 2.97% as of this writing. Meanwhile, the β coefficient of BYD provided by the financial platform is 1.22, while the expected market return is Rm This paper calculates the annual return through the closing price of the SZSE Composite Index 1910.28 on 28th September 2023, which results in the expected market return of 3.51%.

Thus, BYD's cost of equity capital r = 2.97% + 1.22 x (3.51% - 2.97%) = 3.63%.

5.2. Ohlson Model Equity Valuation Calculation

The valuation in this paper takes the end date of the second quarter of BYC, i.e. 30 June 2023, as the base date, so the opening book value in the model is the amount of the owner's equity as shown in the balance sheet in the financial statements of BYC in the second quarter of 2023, which is $130,401,156,000, and then the predicted value of each financial statement parameter indicator in Chapter 5.1 is Substituting the predicted values of each financial statement parameter indicator in Chapter 5.1 into the model formula, to measure the enterprise value of the case company.

The expression of the valuation model used for the case company value is formula (11).

The enterprise value of BYD as of 30 June 2023 is estimated as follows

V = sum of the book value of net assets at the beginning of the period + the present value of residual income over the forecast period

= 130,401,156,000 + 745841981630.56

= 876243137630.56 (￥)

5.3. Analysis of the Results of the Ohlson Model Calculations

By substituting the predicted values of each parameter into the improved Ohlson model, the enterprise value of the case company is measured as $876,243,137,630.56, which is divided by a total of 2,911,142,855 shares issued by BYD on the base date to get the value of $300.996 per share, and the query of the historical data gets the stock market closing price of BYD on the base date to be about 257, the difference between the two is 16.73%. This indicates that the difference between the appraisal value measured by the modified Ohlson residual income model and the market value of the stock is not large, which can explain the enterprise value to some extent.

In short, the modified Ohlson residual income model affirms the influence of the book value of equity-on-equity value, which is in line with the characteristics of new energy automobile enterprises that account for a large proportion of fixed assets and a book value of equity and can fully consider the future profitability of the enterprise, which is a better assessment of the real equity value and is believed to make up for the deficiencies of the traditional valuation methods.

6. Conclusion and Future Work

6.1. Conclusions of the Study

This paper applies the three main theories of financial statement analysis, residual income model, and DuPont's financial analysis system to study BYD Company, a new energy automobile enterprise. It involves analyzing the company's financial and operational conditions using its financial statements and understanding its economic environment, which forms the basis for predicting its development trends and data indicators. The improved Ohlson residual income model is then used to assess the company's value.

The research concludes that the modified Ohlson residual income model is feasible and valuable for new energy vehicle enterprise value assessments. Compared with the conventional discounted earnings model, it offers enhanced explanatory power for stock market value and enables a more accurate evaluation of these enterprises' values.

Additionally, the Ohlson model's evaluation process emphasizes value creation, reflecting the intrinsic value of the enterprise more accurately. The model's modification transforms residual income prediction into accounting indicator predictions, like equity multiplier and net sales margin, making it more operative with valuation results closer to reality. Lastly, the improved model takes market risk factors into account, aligning the model assumptions with reality, resulting in more scientific valuations.

6.2. Research Outlook

Up to now, the value evaluation system for new energy automobile enterprises remains imperfect, with disagreement between traditional and novel assessment methods. This paper uses an improved Ohlson residual income model to study these enterprises, proposing several thoughts.

First, it's essential to enhance valuation methods for such enterprises, as the current ones lack perfection and require refinement. In light of fierce market competition and emerging business risks, introducing more accurate models and indicators will better reflect these enterprises' characteristics and value creation ability, demanding a robust enterprise value assessment system.

Second, strengthening data analysis and establishing databases for new energy vehicle enterprises is crucial. The scarcity of data accumulation hampers further research into their value assessments, particularly when employing innovative assessment methods. By analyzing comprehensive industry and financial data, accurately evaluate enterprises' financial status, operational performance, and market competitiveness will be possible, thus providing reliable data support for evaluations. Lastly, continuous improvement and updating of assessment methods is necessary considering market competition, technological and policy risks, along rapid industry changes. Enterprises should monitor industry trends and recent research results, adapting and enhancing their assessment methods accordingly.

In conclusion, the new energy automobile enterprise value assessment system calls for enhancement. This implies improving enterprise assessment methods, reinforcing data analysis and database establishment, and constantly updating assessment methods. All this is to offer more precise methods and guidance for their value assessment, promoting the development of the new energy automobile industry.

Author Contributions

All the authors contributed equally and their names were listed in alphabetical order.

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