Research on the Applicable Method of Valuation of Pure Electric Used vehicles

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Abstract. With the rapid growth in the ownership of pure electric vehicles, the research on the valuation of used electric vehicles has become the key to the development of the pure electric used vehicle market. The paper analyzed the application of the three value assessment methods, current market price method, capitalized earning method and replacement cost method, in pure electric used vehicles, and draws a conclusion that the replacement cost method is more suitable for pure electric used car. At the same time, the article also conducted a parametric correction exploration research, aiming at the characteristics of pure electric vehicles and replacement cost of the constituent factors. Through the analysis of the applicability parameters of physical devaluation, functional devaluation and economic devaluation, the revised replacement cost method can be used for the valuation of purely used electric vehicles for private use.

1. Background
In response to the global environment of energy security and environmental pollution, the development of pure electric vehicles has become an important measure for all countries to save energy and reduce emissions. With the improvement of people's awareness of environmental protection, the improvement of charging infrastructure, the implementation of subsidy policy of private individuals buying electric cars, pure electric vehicles in the market continue to be popular. In recent years, the number of electric vehicles also increased rapidly, pure electric used car market transactions more and more. Combined with the theory of asset valuation, commonly used asset valuation methods include current market price method, Capitalized earning method and replacement cost method, etc. These methods have been well applied in the evaluation of traditional fuel vehicles, and the details of the applicable parameters and models have been discussed. However, the application of evaluation methods of pure electric used cars is still blank. As a result, it is very important to study the method of EV evaluation, accurately assess the value of pure electric used vehicles, and Choose what method to evaluate. It plays an important role in the development of pure electric used car market and will indirectly affect the development of the entire automotive industry.
2. The Development of Pure Electric Used Car Market

2.1 Sales of pure electric used cars
In 2016, the total global sales of new energy vehicles (EV and PHEV) were 774,000, 40% increasing over the same period and accounting for 0.85% of global vehicle sales. In all countries, sales in China, the United States, and the European market have increased rapidly. The total number of sales in the three major markets is 702,100, accounting for 90.7% of the global market.

![Figure 1: Global new energy vehicle sales and growth rate in 2012-2016](image1)
In recent 3 years, China's new energy vehicles have maintained a rapid growth trend, with an average annual growth rate of 30%. In 2016, the production and sales of new energy vehicles in China were 517,000 and 507,000, creasing 51.7% and 53% respectively. The production and sales of pure electric vehicles were 417,000 and 409,000, accounting for 80.6% of the total output of new energy vehicles in China. In the first 11 months of 2017, China sold 604,300 new energy vehicles.

![Figure 2: The production, sales and growth of new energy vehicles in China in 2010-2016](image2)

2.2 Problems of pure electric used car industry
With the increase in sales and ownership of new energy vehicles, it has been more than four years since the beginning of 2012 in major cities. This time is close to the average change cycle of most car owners for 6-8 years. In the mainstream used car website, there are already some pure electric car sources, but the price of the same type of car is very different. And from the time of posting information, many pure electric cars were unmanned in the months after they were released, and the value of the pure electric used cars was low relative to the new ones. From the entire electric used car industry, there are three main problems. First, due to the lack of pure electric used car value assessment industry standards and the difference of the
components between the pure electric car and the traditional fuel car, we can’t evaluate pure electric cars based on the industry standard of conventional fuel cars. Second, due to the lack of professional practitioners, most of the used car practitioners in our country do not understand the related knowledge of pure electric cars and it is hard to make scientific judgments on the state of the three electric core components. Third, due to the lack of viable pure electric used car value assessment method, there are valuation methods that apply to traditional fuel vehicles on the market. For purely electric vehicles, there is a lack of accepted methods in this field.

3. Applicability analysis of used vehicle evaluation method

3.1 Analysis of the applicability of current market price method
The current market price method is a method to determine the price of the vehicle to be assessed by comparison. It uses the market survey to select one or several vehicles that are the same or similar to the vehicles to be assessed as the reference to analyze the structure, function, performance, old and new, regional differences, trading conditions and transaction prices of the reference objects. Then find out the difference between the two and reflected in the price difference, after adjustment, calculate the price of the old motor vehicle. The prerequisites for application include four aspects. The first is to have an active, fair market with sufficient reference to choose. The second is that at least one recent, comparable, already traded, or already priced reference vehicle has not been concluded. Third is the reference material compared with the evaluation vehicle, the technical parameters, such as the data can be collected, and the price factors are clear and can be quantified. The fourth is to have a relatively sound car trading information system.

For pure electric used cars, this is a new field that comes with the development of electric cars. Because the application conditions of the current market price law are unable to be realized, there is no sufficient reference, no index comparison, quantitative differences, and no fair, sound automobile trading information system. Therefore, if the current market price method is applied on pure electric used cars, it will bring great difficulty to the evaluation.

3.2 Analysis of the applicability of Capitalized earning method
Capitalize earning method, also known as income recovery method, refers to an asset valuation method that determines the value of the vehicle to be assessed by estimating the expected future return on the assets being evaluated. The essence of this method is to convert the future earnings of the automobile into the present value of the asset and use it as the revaluation value of the asset to be evaluated. The basic theoretical formula can be expressed as the revaluation of used cars equals the sum of the expected annual return of the car. The calculation formula as follows:

$$P = \sum_{t=0}^{n} \frac{A_t}{(1+i)^t} = \frac{A_0}{(1+i)^1} + \frac{A_1}{(1+i)^2} + ... + \frac{A_n}{(1+i)^n}$$

In the formula, P represents the evaluation value. At represents the expected future income of the future t income period and the residual value of the vehicle is negligible in general estimation. N represents the number of years of income. i represents the discount rate. t represents the period of return, usually by year.

Remaining economic life span refers to the period from the base date of assessment to the time when vehicles reach the end of life, according to "car scrapped standards" to determine the remaining life of the car economy life. For example, the average life span of the fuel taxis is
calculated in 8 years, and the electric taxis are calculated for 6 years due to the particularity of their battery pack. Capitalized earning method is more suitable for the pure electric vehicle in the operation of the investment. This method is not applicable to most of the current pure electric cars are used by families for their own use. Therefore, capitalized earning method can only be used to evaluate the value of a few operating pure electric vehicle, and can not be applied to the value evaluation of a non-operating pure electric vehicle.

3.3 Analysis of the applicability of replacement cost method

The replacement cost method refers to the total cost required to re-purchase a new state of the vehicle under the current conditions, minus the difference between the old depreciation of the valuation vehicle and the current price of the vehicle being assessed. The old devaluation of the vehicles being assessed includes physical devaluation, functional devaluation and economic devaluation.

\[ P = B - D_1 - D_2 - D_3 \]

In the expression: \( P \) represents the evaluation value of the vehicle being assessed. \( B \) represents the reset cost. \( D_1 \) represents substantial devaluation. \( D_2 \) represents functional devaluation. \( D_3 \) represents economic devaluation.

The replacement cost method is practical because of the replacement cost of used cars and all kinds of old devaluation fully being considered. The replacement cost method is used to evaluate the value of used cars, mainly determining the full cost of replacement cost, all kinds of old depreciation, or estimating the depreciation situation by determining the new rate. In the above discussion of evaluation methods, only the replacement cost method is applicable to the vast majority of pure electric used cars. Because the replacement cost method takes full consideration of the loss of the vehicle, the results of the evaluation tend to be more fair and reasonable. However, due to the different structure of pure electric vehicles and traditional fuel vehicles, the different market environment, so the value of its influencing factors are different. The total weight of individual assembly parts is larger than that of the total vehicle value. Therefore, when using the replacement cost method to evaluate the value of the pure electric second-hand vehicle, the original parameters should be improved based on the replacement cost method. This can be more accurate to determine the new rate of pure electric vehicles.

4. Analysis of influencing factors of replacement cost method

The pure electric vehicles have some characteristics that battery components are of great value and the loss of battery, motor and electric control is difficult to be measured directly. Therefore, there are many factors that affect their value. The replacement cost method can analyze the factors influencing the value of pure electric vehicles from three aspects: entity deprecation, function devaluation and economic devaluation.

| Influencing factors of \( EV \) residual value |
|-----------------------------------------------|
| Basic new rate parameters                     |
| Useful life                                   |
| Battery life                                  |
| New rate correction parameters                |
| entity deprecation                            |
| function devaluation                          |
| economic devaluation                          |
Figure 3: Factors affecting the residual value of pure electric vehicles

4.1 Correction analysis of entity devaluation parameters
Due to the limitation of endurance, pure electric cars are mainly used for short distance transportation in working life at present, and the working conditions are mostly urban roads. Therefore, the working conditions of pure electric cars cannot be considered.

(1) Vehicle condition
Physical loss is more obvious in pure electric vehicles, solid loss, for example, the battery life of a pure electric car will decline with the increase of charge and discharge times. The detection of pure electric vehicles is divided into 6 main aspects: internal detection, lighting detection, body appearance and chassis detection, battery system detection, drive motor system detection, and road test detection.

(2) Maintenance condition factors
The maintenance is different from the comprehensive physical parameters of the vehicle. The comprehensive physical parameters of the vehicle are aimed at the parts of the whole vehicle, while the maintenance status reflects the level of vehicle maintenance and maintenance. The timely maintenance of vehicles can increase the new rate of vehicles. Maintenance records can be determined by the improvement of the maintenance records of the 4S store.

(3) Working nature
For pure electric vehicles, their working nature is the same as that of traditional cars, mainly for private use, business (business) and operation. The loss of pure electric cars is also different with different working properties. Based on this situation, different coefficients are required for different work properties.

(4) Accident conditions
For vehicles, whether there is a serious accident has a great impact on the value of the vehicle. Because the vehicle repaired by overhaul is usually very poor even though it has been restored to its service performance, so it is difficult to restore the original technology and the possibility of expansion of the fault location.

4.2 Correction analysis of function devaluation parameters
The factors that affect the functional devaluation mainly include the stability of the new car price and the rate of the upgrading of the model. In China, the pure electric car is still in its development stage, and has not yet formed its scale. If we want to make technological breakthroughs and reduce costs, it will be very difficult for new models to replace, so the price of new cars will hardly change much. The influence factors of this part are often related to the market share, which can be considered in combination with the factors of economic devaluation.

4.3 Correction analysis of economic devaluation parameters
Economic devaluation is the impact of macro environment on the value of used cars, such as market factors, national policies, etc. For pure electric used cars, besides the brand value and supply and demand factors, the factors that affect their economic depreciation should include factory quality assurance policy and market share.

(1) Brand value
The impact of the brand on the residual value of a pure electric vehicle has nothing to do with the vehicle's own car condition. At the present stage, the electric vehicle brand in our country
is less. We can divide it into three levels, one is the joint venture brand, the other is the high awareness of the independent brand, and the third is the general brand in the independent brand.

(2) Manufacturers warranty policy
In the same brand awareness of the models, its manufacturers warranty policy also affects the evaluation of pure electric cars. In the quality assurance policy of the manufacturer, BYD is a life-long warranty of the electric core, and the whole vehicle enjoys a super long warranty of 6 years /15 million kilometers. Bei qì new energy vehicles can be replaced by the old new, providing a vehicle for 3 years /12 million kilometers, the core components for 5 years /15 million kilometers of quality assurance services. According to these different quality assurance policies, different coefficients are chosen.

(3) market share
In the assessment of pure electric used cars, the market share has a certain impact on the value of the car. For cars with high market share, their used cars will be favored by consumers.

(4) supply and demand
In the used car market, the used cars with large supply and demand tend to have a relatively high evaluation price.

5. Conclusion
Through the application analysis of the existing value evaluation method in pure electric used car evaluation, replacement cost method is more feasible, due to more factors and more reasonable. At the same time, in the application of replacement cost method to evaluate the pure electric second-hand vehicle, we can modify the three main factors of entity depreciation, functional devaluation and economic depreciation. On the basis, the revised reposition cost method can be used to evaluate the value of pure electric used cars for private use.

Reference lists
[1] Zhou you. Study on the value evaluation method of used cars based on the replacement cost method [D]. Liaoning University of Technology, 2014
[2] GAO Wei, DENG Zhaowen, YU Yang. Improvement of Production Costs Method for Second-Hand Car and Its Evaluation System Design[J]. Tractor & Farm Transporter, 2015 (6) : P32-35

Acknowledgments
Supported by Project of Science and Technology Support Program of Sichuan Province (2016GZ0017), Key Laboratory of Automotive Engineering in Sichuan Province (szjj2014-072), Chengdu Science and Technology Project (2016-RK00-00151-ZF).