

## **A Simulation Method for the Supply-Demand Conditions of Credits Under CAFC and NEV Credit Policy**

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### **Executive Summary**

The price of NEV credit is determined by a combination of factors including the value of credits, supply and demand relationship (supply-demand ratio and concentration), and prior price expectations. Among them, the supply-demand ratio of credits is the most sensitive price signal for enterprises, but the industry currently lacks an effective method for solving the supply-demand ratio of credits. This paper introduces a simulation method with multiple steps-based offset logic, which based on the offset principle of CAFC and NEV Credit Policy, divides the enterprises' credit compliance strategy into five stages with 11 steps for offset, and builds a simulation software of "Supply-Demand Conditions of CAFC and NEV Credit" based on this simulation method to enable the scientific, accurate and efficient solution of the supply-demand ratio of credits in the industry. The above simulation method and software have been applied in the NEV credit price prediction and CAFC and NEV Credit Policy research.

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### **1 Introduction**

Since the implementation of Measures for the Parallel Management of CAFC and NEV Credit of Passenger Car Enterprises (hereinafter referred to as the CAFC and NEV Credit Policy) in April 2018, the industry has completed 3 credit transactions and offsets, and the volume of NEV credit transactions is 4,710k credits accumulatively. The accumulative transfer volume of CAFC credits is 4,260k credits, and the accumulative transaction amount is RMB4.3 billion<sup>[1]</sup>. The credit policy has played an effective role since its replacement of financial subsidies which has been withdrawn. With the price of credit more in line with its value, the Chinese auto industry has seen the situation in which the conventional energy vehicle manufacturers in return provide economical endorsement for NEV manufacturers.

But at the same time, the price of credit fluctuated sharply in the past years. The average price of credit in the industry dropped from more than RMB800 per credit in the first year of the transaction to a low point in 2018, and then quickly climbed to more than RMB1,000 in 2019, which has brought greater risks and challenges to the implementation of the CAFC and NEV Credit Policy and product planning of enterprises. Therefore, the research of credit pricing is particularly important. The research has found out that the price of NEV credit is determined by various factors such as the value of credit, relationship between supply and demand (supply-demand ratio and concentration ratio), and prior price expectations<sup>[2]</sup>. Among them, the supply-demand ratio of credits is the most sensitive price signal. But the industry currently lacks an effective method for solving the supply-demand ratio of credits.

## 2 Status Quo of CAFC and NEV Credit Policy

The CAFC and NEV credit management has gone through the retrospective management stage from 2016 to 2017, transitional management stage in 2018 and CAFC and NEV credit parallel assessment stage from 2019 to 2020, as shown in Table 1. Affected by the different policy management objectives at various stages, the supply and demand relationship of the credit market fluctuated, making the price of NEV credit show a trend of declining first and then rising, as shown in Figure 1.

Table 1: Division of Management Stages of CAFC and NEV Credit Policy and Characteristics

Calculation Year	Stage Division	Characteristics in Different Stages	Policy Objectives
2016-2017	Retrospective Management Stage	CAFC credits carried over from third stage are allowed to be used	Introduction of energy-saving and new energy technologies in the early stage is encouraged
2018	Transition Management Stage	Percentage of NEV credits is not assessed	The management transition period for NEV credit is given
2019-2020	Parallel assessment stage of CAFC and NEV credit	NEV credits are allowed to be borrowed and carried over	Play the role of credit parallel management

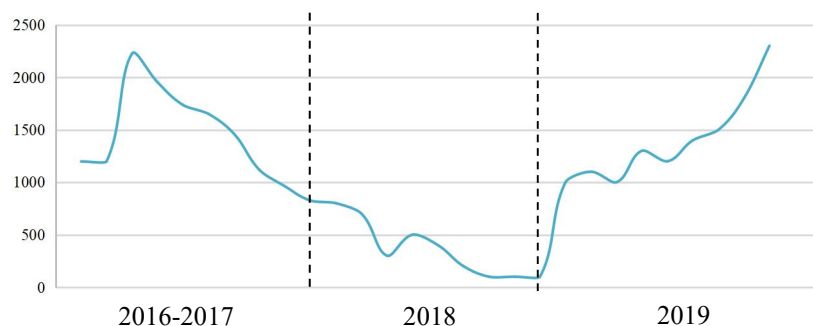


Figure 1: Trend of NEV Credit Price from 2016 to 2019 (Yuan/Credit)

The supply and demand relationship of credit is one of the important factors that affects the price of NEV credit. In order to reflect the tightness of the credit market in supply more intuitively, we introduce the concept of supply-demand ratio of credit. The supply-demand ratio of credit is inversely proportional to the price of credit. The higher the supply-demand ratio of credit is, the more abundant the credit market supply is, and the price of credit will decrease. Conversely, the lower the supply-demand ratio of credit is, the tighter the supply of credit is, and the price of credit will increase. The formula to calculate the supply-demand ratio of credit is as follows:

Supply-demand ratio of credit = supply of NEV credit surplus/(demand for the offset of CAFC credit deficit + demand for the offset of NEV credit deficit)

Among them, the supply of NEV credit surpluses and demand for the offset of credit deficits involve the CAFC and NEV credits generated by the passenger car enterprises in the current year that have been offset by their own carry-over credits and have received transfer of CAFC credit surpluses from related enterprises.

## 3 Simulation Method of Credit Supply-demand Ratio

### 3.1 Simulation Principle

The CAFC and NEV Credit Policy in China stipulates that the carry-over credits are valid for 3 years. Related enterprises can transfer CAFC credit surpluses, while NEV credit surpluses can be freely traded. In other words, a one-way linkage mechanism of CAFC and NEV credit surpluses has been established. The offset rules are as shown in Figure 2.

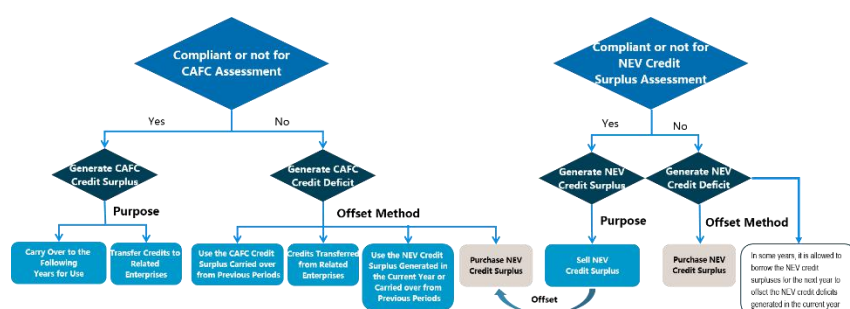


Figure 2: Rules on the Offset of CAFC and NEV Credit of Passenger Car Enterprises

Relying on the offset principle of CAFC and NEV Credit Policy, the 2020 credit offset logic of enterprises can be disassembled into 5 stages as their own carry-over CAFC credit surpluses to offset the CAFC credit deficits in the current year (offset step 1-3), and their own carry-over NEV credit surpluses to offset the NEV credit deficits in the current year (offset step 4), and their own carry-over NEV credit surpluses to offset the CAFC credit deficits (offset step 5-6), transfer of CAFC credit surpluses among related enterprises (offset step 7-10) and free trading of credit market (offset step 11). The first 4 stages are the problem-solving stage of credit supply-demand ratio. Enterprises may arbitrarily combine offset step 1-10 according to their own conditions, which will inevitably lead to more possibilities for the calculation of credit supply-demand ratio in the industry.

Table 2: Disassembly of Credit Offset Logic

Offset Steps	Step Description
Step 1	Use the own carry-over CAFC credit surpluses in 2017 to offset the CAFC credit deficits in 2020
Step 2	Use the own carry-over CAFC credit surpluses in 2018 to offset the CAFC credit deficits in 2020
Step 3	Use the own carry-over CAFC credit surpluses in 2019 to offset the CAFC credit deficits in 2020
Step 4	Use the own carry-over NEV credit surpluses in 2019 to offset the NEV credit deficits in 2020
Step 5	Use the own carry-over NEV credit surpluses in 2019 to offset the CAFC credit deficits in 2020
Step 6	Use the own NEV credit surpluses in 2020 to offset the CAFC credit deficits in 2020
Step 7	Use the carry-over CAFC credit surpluses among related enterprises in 2017 to offset the CAFC credit deficits in 2020
Step 8	Use the carry-over CAFC credit surpluses among related enterprises in 2018 to offset the CAFC credit deficits in 2020
Step 9	Use the carry-over CAFC credit surpluses among related enterprises in 2019 to offset the CAFC credit deficits in 2020
Step 10	Use the carry-over CAFC credit surpluses among related enterprises in 2020 to offset the CAFC credit deficits in 2020
Step 11	Free trading of NEV credit surpluses

Take the 8 related enterprises under the same group as an example. In 2020, the CAFC credit surpluses and deficits registered 256k and 771k respectively, while NEV credit surpluses and deficits were 317k and 137k respectively. The CAFC and NEV credit surpluses carried over from the previous period were 744k and 1k respectively from 2017 to 2019. When related enterprises adopt a combination of different offset strategies, the supply-demand ratio of credits fluctuates between 0.4 and 2.0, as shown in Tables 3 and 4. However, through long-term follow-up researches, it is found that the supply-demand ratio of credits under the maximum transfer strategy within the allowable scope of policy and offset strategy under the real scenario have a greater impact upon the credit market.

Table 3: Different Credit Offset Strategies

Offset Strategy	Strategy Description	Credit Offset Order
A	Maximum transfer strategy within the allowable scope of policy	1,7,2,3,8,9,10
B	Maximum offset strategy under real scenarios	1,7,4,5,6,2,8,3,9,10
C	Strategy that some enterprises retain the carry-over CAFC credit surpluses between 2018 and 2019	1,7,4,5,6,2,8,3,9,10+1,7,4,5,6,8,9,10
	.....	

Table 4: The Impact of Different Credit Offset Strategies of Related Enterprises under the Same Group on the Supply-Demand Ratio of Credits

Offset Strategy	Supply of NEV Credit Surpluses	Demand for the Offset of CAFC Credit Deficits	Demand for the Offset of NEV Credit Deficit	Supply-Demand Ratio
<b>A</b>	<b>31.9</b>	<b>2.6</b>	<b>13.7</b>	<b>2.0:1</b>
<b>B</b>	<b>31.7</b>	<b>3.6</b>	<b>13.7</b>	<b>1.8:1</b>
C	31.7	58.7	13.7	0.4:1
		.....		
D	31.9	66.8	13.7	0.4:1

### 3.2 Software Development

Based on the above credit offset simulation method, the simulation software of Supply-Demand Situation of CAFC and NEV Credits of Passenger Car Enterprises was developed.

Figure 3 shows the software login interface. With the "Data Import", the annual credit data, data of credits carried over from the previous period, and design of credit offset strategy are imported. "Simulation Offset" allows the one-button acquisition of supply-demand ratio of industry credits. We define the supply-demand ratio of the maximum transfer strategy within the allowable range of the CAFC and NEV Credit Policy as the maximum theoretical supply-demand ratio (corresponding to the functional option containing the word "MAX"). The supply-demand ratio of the offset strategy under the real scenario is defined as the real supply-demand ratio. "Data Export and MAX Data Export" displays the credit distribution of various enterprises after the 11 offset steps and credit supply-demand ratio data of the industry in EXCEL format. "Interactive Information Prompt Bar" will indicate the results of each operation in the software. "Table Options and MAX Table Options" intuitively display the distribution of corporate credits under the selected offset stage on the user interface.



Figure 3: Simulation Software Interface for the "Supply and Demand Situation of CAFC and NEV Credit of Passenger Car Enterprises"

(The software has been granted the certificate of computer software copyright registration by the National Copyright Administration of the People's Republic of China (registration No.: 2021SR1586830))

## 4 Practical Application under the CAFC and NEV Credit Policy

According to the data released by Ministry of Industry and Information Technology, there were 4,367k CAFC credit surpluses and 11,714k CAFC credit deficits, and 4,370k NEV credit surpluses and 1,066k NEV credit deficits generated in the industry in 2020<sup>[3]</sup>. The CAFC credit surpluses and NEV credit surpluses carried over from 2017-2019 to 2020 exceeded 10 million and 2 million respectively<sup>[1]</sup>. These

data, in combination with the offset strategies of various enterprises in the previous research, were imported into the simulation software for the supply and demand situation of CAFC and NEV credit of passenger car enterprises. The simulation results show that the demand for the offset of credit deficits in the industry was 4,127k and supply of NEV credit surpluses was 5,735k. The real supply-demand ratio registered 1.4:1. The top 10 enterprises in credit deficits account for 66%, while the top 5 enterprises in NEV credit surpluses account for 64%. The supply of credit surpluses in the industry was relatively sufficient.

The research has found that after the annual supply and demand situation of credits is determined, the credit buyers and sellers can only refer to the previous transaction price and combine the price expectation and credit supply and demand relationship to determine the current price. In terms of corporate price expectation, based on the average price of credit in 2019, i.e. RMB1,204 per credit, and in consideration of increase in the cost of credit compliance caused by the tightening of standards<sup>[4]</sup> and price tail-raising and other factors during the later stage of transaction in 2019, the buyers and sellers' expectation of credit price in 2020 was higher than that in 2019. In terms of supply and demand relationship, via the above calculations, the supply and demand relationship of credits in the industry in 2020 was tightened compared with that of 2019. As a result, based on the theory of supply and demand, it was predicted that the main range for the price of NEV credit in 2020 would be above RMB2,000 per credit. The price of credit would be more in line with the value of credit. The credit market would play a more important role in allocating resources and further stimulating the vitality of the trading market.

In addition to a quick assessment of the current and future credit supply and demand relationship in the industry, when the simulation of supply and demand relationship is more aligned with reality, it will play a more instructive role to the future research and improvement of the CAFC and NEV Credit Policy. For example, the accurate supply and demand relationship of credits in the industry will lead to stable credit price expectation, which is crucial to the formulation of economic penalties and regulations. Each management stage is confronted with different policy objectives and key tasks. In response to fluctuating supply and demand relationship, accurate policy implementation helps the long-term and stable development of the CAFC and NEV Credit Policy.

## 5 Conclusion

Based on the offset principle of the CAFC and NEV Credit Policy, we have innovatively divided the corporate credit compliance strategy into 11 deduction steps across 5 major stages for the simulation offset logic. Depending on the simulation method under this multi-offset logic, we have developed the first-ever simulation software for the supply and demand situation of CAFC and NEV credit of passenger car enterprises. The output result is more aligned with the supply and demand situation of credit under the real situation of the industry, which covers the distribution of credits of each accounted enterprise, supply and demand relationship (supply-demand ratio and concentration ratio), and potential buyers and sellers in the credit market. At present, the supply and demand relationship of credits in the industry calculated using this simulation software has greatly supported the researches of CAFC and NEV Credit Policy and credit price by government authorities.

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