Analysis of Marginal Profit of Power Grid Enterprises Based on Differential Correction Factor Analysis

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Abstract. Under the new electric power system reform, the power grid enterprise has been greatly impacted and their profit pattern have changed. It is of great significance to analyze the profit of power grid enterprises. From the perspective of financial management, this paper studies the causal relationship between each factor and marginal profit, and makes differential correction to the factor analysis method. The differential modified factor analysis method is used to establish the marginal profit analysis model of electricity sales. In this paper, a provincial power grid enterprise in China is taken as the research object, and the model is used to analyze the impact of various factors on marginal profit. The analysis results verify the correctness of the selling electricity marginal profit analysis model of power grid enterprises based on differential correction factor analysis.

1. Introduction

Factor analysis is a method throughout the analysis of enterprise economic activities. The accuracy of its analysis is of great significance for the enterprise to improve its management and economic benefits. The traditional factor analysis method has certain subjective judgment when selecting the replacement order of factors. By modifying the traditional factor analysis method with three factor space and mathematical model, the influence degree of each factor change to target object can be obtained more accurately [1]. Literature [2] establishes an objective, practical and applicable safety risk assessment system for complex power grids through multi-factor analysis. Literature [3] ~ [4] start with the analysis of the factors affecting the profit of thermal power enterprises, study the factors affecting the cash flow of business activities, and propose measures to maximize the profit of thermal power enterprises. Literature [5] studies the power grid pricing model of power generation enterprises and its impact on profits through factor analysis.

Cost and profit issues have attracted extensive attention from power enterprises. As a common application means, the main index of marginal analysis is the marginal profit of actual selling units and the marginal profit of selling electricity [6]. Marginal profits reflect the ability to increase sales of products to increase profits for enterprises, and the marginal profit greater than zero is the minimum requirement for the enterprise to maintain the most basic production and operation [7]. In reference [8], it is concluded that the optimization of "volume and price" should be based on the maximization of the marginal profit of power generation under the centralized matching mode. It can be used for reference

for the management and decision-making of coal-fired power enterprises. In the paper [9], the marginal analysis of heating cost and generating profit is carried out with the concrete production process of cogeneration, and the accurate analysis conclusion is given. The paper [10] ~ [11] analyzes the economic benefits of new generating units in power generation enterprises from the angle of microeconomics, and establishes a mathematical model. Literature [12] studies the long-term marginal generation cost of interconnected power grids based on the cost accounting method, and proposes the accounting method of electricity price on this basis.

Under the situation of power system reform, it is of great significance to study the influence of various factors of power grid enterprises on the marginal profit of electricity sales. In this paper, the factors affecting the marginal profit of electricity sales in power grid enterprises are analyzed by the factor analysis method after differential correction, and an analysis model of marginal profit of electricity sales is established. The model is applied to analyze the marginal profit of electricity sales of power grid enterprises. This paper analyzes the marginal profit based on the data of electricity sales and electricity prices in the first three quarters of a province to provide data support for the operation and management of power grid enterprises.

2. Methodology
The analysis of the operation activities of power grid companies is mainly centered on profit, followed by the analysis of costs and revenues, which requires further detailed analysis of the impact of these three elements.

2.1 Factor analysis method
According to the relationship between the analysis index and its influencing factors, factor analysis method determines quantitatively the influence direction and degree of each factor on the analysis index. Factor analysis not only can comprehensively analyze the influence of each factor on a certain economic index, but also can separately analyze the influence of a certain factor on the analysis index. Assuming that an analytical indicator F is affected by the relevant and economically significant factor $x, y, z \cdots \cdots$, the relationship exists as follows:

$$F = f(x, y, z, ...)$$ (1)

There is only one factor that affects the analysis index when it changes:

$$\Delta F_i = F_i - F = \partial F(\Delta i)$$ (2)

When the factors change incrementally under certain conditions, the combined effects of each factor on the analysis index are as follows:

$$\Delta F = F' - F = F(x + \Delta x, y + \Delta y, z + \Delta z, ...) - F(x, y, z, ...)$$ (3)

Where, i is the i-th factor, ΔF_i is the influence of the i-th factor on the analysis index, ΔF is the influence of each factor on the analysis index together; F, F' are the value of the analysis index before and after the change of each factor.

2.2 Differential correction of factor analysis method
The chain substitution method is usually used to measure the influence of various factors on the comprehensive economic index, but its defect is that it is only suitable for the form that the comprehensive index is the product of several factors. Therefore, we need to make a differential correction to the factor analysis method.

The overall differences between the reporting period and the base period are as follows:

$$\Delta F = f_1(x_1, y_1, z_1) - f_0(x_0, y_0, z_0)$$ (4)

Where, ΔF is the overall difference between the reporting period and the base period; 0, 1 are the base period and the reporting period respectively; x, y, z are factors.

$$\Delta Fx = fx_1(x_1, y_0, z_0) - fx_0(x_0, y_0, z_0) \tag{5}$$

$$\Delta Fy = fy_1(x_1, y_1, z_0) - fy_0(x_1, y_0, z_0) \tag{6}$$

$$\Delta Fz = fz_1(x_1, y_1, z_1) - fz_0(x_1, y_1, z_0) \tag{7}$$

$$dF = \frac{\partial f}{\partial x} \cdot dx + \frac{\partial f}{\partial y} \cdot dy + \frac{\partial f}{\partial z} \cdot dz = f'_x \cdot dx + f'_y \cdot dy + f'_z \cdot dz \tag{8}$$

Equation (8) is the basic formula after differential correction of factor analysis. Where, ΔFx, ΔFy, ΔFz are the influence of the factor x, y, z on the analysis index F, respectively.

According to the differential principle, dF indicates the degree of influence of the change of each factor on the function F, and equation (8) can reflect the degree of influence of the change of factors x, y, z on the function.

According to Lagrange's mean value theorem:

$$\Delta F = f'(x + \theta_1 \cdot \Delta x, \quad y, \quad z) \cdot \Delta x + f'(x + \Delta x, \quad y + \theta_2 \cdot \Delta y, \quad z) \cdot \Delta y$$
$$+ f'(x + \Delta x, \quad y + \Delta y, \quad z + \theta_3 \cdot \Delta z) \cdot \Delta z \tag{9}$$

$$f'(x + \theta_1 \cdot \Delta x, y, z) \cdot \Delta x = f'_x(x, y, z) \cdot \Delta x = f'_x \cdot \Delta x \tag{10}$$

$$f'(x + \Delta x, y + \theta_2 \cdot \Delta y, z) \cdot \Delta y = f'_y(x, y, z) \cdot \Delta y = f'_y \cdot \Delta y \tag{11}$$

$$f'(x + \Delta x, y + \Delta y, z + \theta_3 \cdot \Delta z) \cdot \Delta z = f'_z(x, y, z) \cdot \Delta z = f'_z \cdot \Delta z \tag{12}$$

Therefore, $f'_x \cdot \Delta x$, $f'_y \cdot \Delta y$ and $f'_z \cdot \Delta z$ can reflect the influence of various factors on the function. This conclusion is extended to the case of more than three factors, and the factor analysis method after differential correction is obtained as follows.

$$\Delta F = f'_x \cdot \Delta x + f'_y \cdot \Delta y + f'_z \cdot \Delta z + \cdots \cdots \tag{13}$$

Denote $\Delta F(x)$ as the effect of factor x on the increment of F, then the rate of its effect on the increment F of is $\Delta F(x) \cdot F(x)^{-1}$.

2.3 Marginal profit analysis model of electricity sale for power grid enterprises based on differential correction factor analysis

The marginal profit of electricity sales mainly has the following influencing factors, which are studied by differential modified factor analysis method, and the model of marginal profit analysis of electricity sales is established.

$$P = (SDSY + JYSY) \cdot (SDL + JYDL)^{-1} \tag{14}$$

$$SDSY = SDL \cdot PSDJ - GDL \cdot PGDJ \tag{15}$$

$$JYSY = JYDL \cdot SPDJ \tag{16}$$

Where, P is the marginal profit from selling electricity; $SDSY$ is the planned revenue from electricity sales; $JYSY$ is the direct trading electricity revenue; SDL is the planned electricity sales; $JYDL$ is the direct transaction power; $PSDJ$ is the average selling price; GDL is the amount of electricity purchased; $PGDJ$ is the average purchase price; $SPDJ$ is the comprehensive transmission and distribution price.

Model analysis is shown in Table 1:

Table 1. Marginal Profit Analysis

Factors Affecting Profits	Cumulative for the year	The same period of last year	Year-on-year growth rate	Specific gravity change	Contribution rate of growth
Marginal profit from electricity sales	P_1	P_0	$(P_1 - P_0)/P_0$	—	—

Revenue from planned electricity sales	$SDSY_1$	$SDSY_0$	$(SDSY_1-SDSY_0)$ $/SDSY_0$	$(SDSY_1/BJLR_1)/(SDSY_0/BJLR_0)$	$(SDSY_1-SDSY_0)/(BJLR_1-BJLR_0)$
Planned electricity sales	SDL_1	SDL_0	(SDL_1-SDL_0) $/SDL_0$	$(SDL_1/BJLR_1)/(SDL_0/BJLR_0)$	$(SDL_1-SDL_0)/$ $(BJLR_1-BJLR_0)$
Average selling price	$PSDJ_1$	$PSDJ_0$	$(PSDJ_1-PSDJ_0)$ $/PSDJ_0$	$(PSDJ_1/BJLR_1)/(PSDJ_0/BJLR_0)$	$(PSDJ_1-PSDJ_0)/$ $(BJLR_1-BJLR_0)$
Direct Transaction Electricity Revenue	$JYSY_1$	$JYSY_0$	$(JYSY_1-JYSY_0)$ $/JYSY_0$	$(JYSY_1/BJLR_1)/(JYSY_0/BJLR_0)$	$(JYSY_1-JYSY_0)/$ $(BJLR_1-BJLR_0)$
Direct transaction power	$JYDL_1$	$JYDL_0$	$(JYDL_1-JYDL_0)$ $/JYDL_0$	$(JYDL_1/BJLR_1)/(JYDL_0/BJLR_0)$	$(JYDL_1-JYDL_0)/$ $(BJLR_1-BJLR_0)$
Comprehensive transmission and distribution price	$SPDJ_1$	$SPDJ_0$	$(SPDJ_1-SPDJ_0)$ $/SPDJ_0$	$(SPDJ_1/BJLR_1)/(SPDJ_0/BJLR_0)$	$(SPDJ_1-SPDJ_0)/$ $(BJLR_1-BJLR_0)$
Purchase power	GDL_1	GDL_0	(GDL_1-GDL_0) $/GDL_0$	$(GDL_1/BJLR_1)/(GDL_0/BJLR_0)$	$(GDL_1-GDL_0)/$ $(BJLR_1-BJLR_0)$
Average purchase price	$PGDJ_1$	$PGDJ_0$	$(PGDJ_1-PGDJ_0)$ $/PGDJ_0$	$(PGDJ_1/BJLR_1)/(PGDJ_0/BJLR_0)$	$(PGDJ_1-PGDJ_0)/$ $(BJLR_1-BJLR_0)$

3. Case Study

This paper takes the data of the first three quarters of 2017 to 2018 in A Province as an example, and analyses the variation law of marginal profit of electricity sales in this province according to the main factors. Table 2 shows data on electricity purchases and prices for the first three quarters of 2017-2018.

Table 2. Purchase and sale of electricity and price of purchase and sale of electricity

	Planned purchase of electricity (billion kWH)	Planned purchase price (yuan/MWh)	Planned electricity sales (billion kWH)	Planned sale price (yuan/MWh)	Market transaction power (billion kWH)	Transmission and distribution price (yuan/MWh)
Current period	1219.37	372.82	1143.12	643.73	219.69	179.57
The same period	1129.30	362.10	1039.97	646.52	201.91	189.44

It can be seen that compared with the previous period, the planned purchase power, planned sale power and market transaction power have all increased. The planned sale price and power transmission and distribution price have decreased, but the planned purchase price has slightly increased.

Based on the differential correction factor analysis method, the analysis process and results of the marginal profit of electricity sales in power grid enterprises are shown in Table 3.

Table 3. Analysis Process of Marginal Profit from Electricity Sale

Factors Affecting Profits	Current period	The same period	Increment	Specific gravity change	Contribution rate of growth

Planned transaction	Purchase power	1219.37	1129.3	90.07	111.46%	-1185.13%
	Electricity purchase price	372.82	362.1	10.72	106.29%	-141.05%
	Sales of electricity	1143.12	1039.97	103.15	113.47%	-1357.24%
	Price of electricity sales	643.73	646.52	-2.79	102.78%	36.71%
	Income	281.26	263.44	17.81	110.21%	-234.34%
	Price difference	270.91	284.42	-13.51	98.33%	177.76%
Market transaction	Electric quantity	219.69	201.91	17.78	112.32%	-233.95%
	Transmission and distribution price	179.57	189.44	-9.87	97.85%	129.87%
	Income	39.4	38.2	1.2	106.47%	-15.79%
	Marginal profit	235.3	242.9	-7.6	—	—

In the first three quarters of the year, in the planned transaction part, the purchase price increased by 10.72 yuan/MWh, the sale price decreased by 2.79 yuan/MWh and the price difference decreased by 13.51 yuan/MWh. In the market transaction part, the price of power transmission and distribution dropped by 9.87 yuan/MWh. Marginal profit from electricity sales decreased by 7.60 yuan/MWh year on year.

4. Conclusion

As an important infrastructure department of the national economy, power grid enterprises play a very important role in supporting and protecting the lives of residents, maintaining social stability and development. In order to improve the accuracy of the analysis, the traditional factor analysis method is modified, and the analysis model is established. Through the analysis of the marginal profit of electricity sales of power grid enterprises to understand the main business operations such as the purchase and sale of electricity to a certain extent reflects the profitability of the main business of power grid enterprises. This is beneficial to improve the management level of power grid enterprises, enhance the competitiveness of enterprises, and provide data reference for enterprises to formulate strategies.

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