The Impact of New Investment on the Transmission and Distribution Price

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Abstract. The reform of transmission and distribution price is the core of power system reform. There are few studies on the impact of new investment on the transmission and distribution price. This paper discussed the impact of new investment on the transmission and distribution price under different depreciation rate, asset liability ratio and new investment included in fixed asset rate. The results showed that the asset liability ratio does not have a significant impact on the electricity prices, while the change of the depreciation rate and the ratio of newly increased investment included in fixed assets will have a direct impact on electricity prices.

Keywords: Transmission and distribution price, New investment, Scenario analysis.

1. Introduction

The reform of transmission and distribution prices is the core of the reform of the power system, which directly affects the company’s operating income, profit model, economic benefits and development capabilities. At present, there is little research on this aspect at home and abroad. Chen Kai et al. established the relationship model of investment, electricity, and electricity price, and set up different scenarios to measure the trend of transmission and distribution prices under different investment and electricity conditions, and concluded that grid investment and electricity growth have a significant impact on transmission and distribution prices. Liu Siqiang and others based on the provincial power grid transmission and distribution price pricing method, introduced adjustable parameters, optimized the transmission and distribution price pricing model, through the analysis of the attribute of each parameter and the relationship between the parameters, constructed the regulatory model of transmission and distribution price, combined with the specific calculation of parameter regulation under the price policy objectives, carried out the regulatory strategy discussion.

This article built a transmission and distribution price estimation model, and then analysed the impact of new grid investment on transmission and distribution prices under different scenarios. Finally, a certain area in the Southwest of China was selected for case analysis. The rest of this article is structured as follows: Section 2 constructed the transmission and distribution price calculation model, Section 3 built the impact model of the new grid investment on the transmission and distribution price under different scenarios, and Section 4 is case analysis, then the conclusions are drawn in Section 5.
2. Transmission and distribution price calculation model

The "Provincial Grid Transmission and Distribution Price Pricing Measures" stipulate that in determining the provincial grid transmission and distribution price, the permitted income of the power grid enterprise's transmission and distribution business should be first verified, and then the transmission and distribution price should be approved based on the permitted income. In accordance with the calculation formula of "permitted cost plus permitted income plus tax within the price" and the provisions of the "Measures" for each specific approved item, the impact of new fixed asset investment on the transmission and distribution price of provincial power grid companies is calculated. As shown in Figure 1.

![Diagram of the permitted income composition of grid companies](image)

**Figure 1.** Diagram of the permitted income composition of grid companies

2.1. Permitted costs

2.1.1. Depreciation expenses. Depreciation expenses refer to the depreciation expenses accrued by enterprises for fixed assets related to transmission and distribution business according to regulations. The formula for calculating depreciation fee $F_z$ is:

$$F_z = C_i \times \alpha_i \times \lambda_i$$  \hspace{1cm} (1)

Where: $F_z$—depreciation expense; $C_i$—planned new investment in fixed assets of transmission and distribution equipment; $\alpha_i$—new investment is included in fixed assets Asset ratio; $\lambda_i$—pricing depreciation rat.

2.1.2. Operation and maintenance costs. The composition of operation and maintenance costs includes material costs, repair costs, and employee salaries, etc. Material cost refers to the cost of consumable materials and accident spare parts consumed by enterprises to maintain the safety of grid operation and ensure stable power transmission and distribution. Repair costs refer to the various repair costs incurred by the company in the process of maintaining the safe operation of the power grid and ensuring the power transmission and distribution, including the daily repair costs of fixed assets, the repair costs of houses, buildings, equipment, tools, and meters entrusted to outside units, and the repair costs of production furniture and appliances. Employee compensation refers to the salary expenses paid by the company to employees serving in the transmission and distribution business.
Other expenses refer to the expenses that should be included in the transmission and distribution costs incurred in the process of maintaining the safety of the power grid and ensuring the transmission and distribution of electric energy, but are not included in the expenses of the above cost items.

2.2. Permitted income
The permitted income is the reasonable income of the power grid enterprises approved by the relevant government departments, and the permitted income in China is determined by the product of the effective assets $A_i$ that can withdraw income and the allowable return rate $W_r$.

2.2.1. The effective assets. The effective assets with accrual income refer to the total investment asset value of power grid. Such effective assets are the basis for power grid to provide power services to users and the asset value for which investment returns can be accrued. The calculation formula of the effective asset $A_{i,t}$ with accrued income is:

$$A_{i,t}=A_{i,t-1}+\Delta A_{i,t}$$

Where: $A_{i,t}$—effective assets with accrued income; $A_{i,t-1}$—effective assets in the base period; $\Delta A_{i,t}$—new (decrease) effective assets in the regulatory cycle.

2.2.2. Permissible rate of return. The calculation formula of allowable rate of return $W_r$ is:

$$W_r = R_c \times (1-r) + R_d \times r$$

Where: $W_r$—permissible rate of return; $R_c$—return on equity; $R_d$—The rate of return on debt to capital; $r$—the rate of debt to assets.

2.3. Taxes
Taxes are the expenses required for business operations in accordance with relevant national laws. The taxes of power grid companies are mainly composed of value-added tax $F_m$, corporate income tax $F_n$, urban construction and maintenance tax and education fee surcharge $F_f$. Among them:

$$F_n = (A_i \times (1-r) \times R_c) / (1- \theta) \times \theta$$

$$F_f = ((E_i + R_i + F_n) \times \delta) / (1- \lambda - \eta) \times (\lambda + \eta)$$

$$F_m = (E_i + R_i + F_n + F_f) \times \delta$$

Where: $F_m$—value added tax; $F_n$—corporate income tax; $F_f$—urban construction and maintenance tax and education fee Additional; $E_i$—permitted cost; $R_i$—permited income; $\theta$—income tax rate; $\delta$—value added tax rate; $\lambda$—urban construction and maintenance tax rate; $\eta$—education fee surcharge rate.

2.4. Transmission and distribution price

$$P = I / S$$

Where: $I$—total permitted income including value-added tax; $S$—provincial power transmission and distribution volume.

3. Model of the impact of new investment on transmission and distribution prices
The example in this article takes "the impact of each additional 1 billion fixed asset investment on the company's transmission and distribution prices" as the objective function, the sensitivity analysis is
carried out by selecting different boundary conditions such as "incremental comprehensive depreciation rate", "asset liability ratio" and "ratio of new investment included in fixed assets". The specific parameter adjustment is shown in the table below:

| Table 1. Scenarios of transmission and distribution price impact |
|---------------------------------------------------------------|
| **Incremental comprehensive depreciation rate** | **Remark** |
| base scenario | 5.85% | Company's 2018 actual value |
| High scenario | 7% | Reference upper limit |
| Low scenario | 5% | Reference lower limit |
| **Asset liability ratio** | **Remark** |
| Base scenario | 69.88% | Company's 2018 actual value |
| High scenario | 70.88% | Increase by one percentage point |
| Low scenario | 68.88% | Decline One percentage point |
| **New investment included in fixed assets ratio** | **Remark** |
| base scenario | 75% | Maximum value specified |
| High scenario | 70% | Five percentage points down |
| Low scenario | 65% | Ten percentage points down |

4. Case analysis

In this paper, the actual operation of power grid in Southwest China is analyzed as an example. The material cost, repair cost, employee compensation and other expenses are determined according to the provincial power grid transmission and distribution price pricing method. The return on equity capital and the rate of return on debt capital are provided by the company according to the actual situation, and other relevant tax rates are verified according to the relevant national tax laws (relevant data source: National Statistical Yearbook and relevant laws and regulations).

| Table 2. Scenario analysis of the impact of 1 billion yuan of fixed asset investment on transmission and distribution price |
|-------------------------------------------------------------------------------------------------------------------|
| **Incremental comprehensive depreciation rate** | **Value added of transmission and distribution price (cents/kWh)** |
| base scenario | 5.85% | 0.0606 |
| High scenario | 7% | 0.06570 |
| Low scenario | 5% | 0.05680 |
| Assets and liabilities | **Value added of transmission and distribution price (cents/kWh)** |
| Base scenario | 69.88% | 0.0606 |
| High scenario | 70.88% | 0.06068 |
| Low scenario | 68.88% | 0.06051 |
| New investment included in fixed assets ratio | **Value added of transmission and distribution price (cents/kWh)** |
| base scenario | 75% | 0.0606 |
| High scenario | 70% | 0.05751 |
| Low scenario | 65% | 0.05443 |
Using the above model for empirical calculation, under the base scenario, the provincial company will increase the transmission and distribution price by 0.0675 cents/kWh for every 1 billion yuan of fixed asset investment.

Further calculation of the impact for different scenarios shows that the grid company is in the base scenario with an incremental comprehensive depreciation rate of 5.85% and an asset-liability ratio of 69.88%, when the ratio of new investment included in fixed assets is 70% (high scenario) and 65% (low scenario), each additional 1 billion yuan in fixed asset investment will increase transmission and distribution price by 0.05751 cents/kWh and 0.05443 cents/kWh.

Grid company under the base scenario where the incremental comprehensive depreciation rate is 5.85% and the new investment included in fixed assets ratio is 75%, when the asset-liability ratio is 68.88% (low scenario) and 70.88% (high scenario), each additional 1 billion yuan in fixed asset investment will increase transmission and distribution price by 0.06051 cents/kWh and 0.06068 cents/kWh.

In the base scenario where the asset-liability ratio is 69.88% and the new investment included in the fixed assets ratio of the grid company is 75%, when the incremental comprehensive depreciation rate is 5% (low scenario) and 7% (high scenario), each an increase of 1 billion yuan in fixed asset investment will increase transmission and distribution price by 0.05680 cents/kWh and 0.06570 cents/kWh.

![Figure 2](image.png)

**Figure 2.** The impact of every 1 billion yuan invested on the value-added transmission and distribution price under different scenarios

As can be seen from the above figure, in the high scenario mode, when the depreciation rate is 7%, the value-added of the transmission and distribution price has the greatest impact, reaching 0.0657 cents/kWh, while in the low scenario mode, the depreciation rate is 5%, the added value of the transmission and distribution price is 0.0568 cents/kWh. It can be seen that the adjustment of depreciation rate has the greatest impact on the added value of transmission and distribution price. Similarly, different ratio of new investment included in fixed assets will also have a certain impact on the added value of transmission and distribution price.

5. Conclusion
Through setting different parameters of depreciation rate, asset liability ratio and the ratio of new investment included in fixed assets, this paper investigates the impact of the same amount of
investment on the added value of transmission and distribution price in different situations. The difference of asset-liability ratios will not have a significant impact on the added value of transmission and distribution price, while the change depreciation rates and the ratio of new investment included in fixed assets will have a substantial impact on the added value of transmission and distribution price. The main reason is that the depreciation fee and the cost of new investment included in fixed assets will directly affect the permitted cost, permitted income, and there is no fluctuation in electricity. Therefore, the adjustment of the depreciation rate and the rate of new investment included in fixed assets will affect the transmission and distribution price directly.

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