

The Study of Leverage Ratio on the Operation Efficiency of PPP Project Enterprises in China

Analysis Based on DEA-Tobit Model

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Abstract—In recent years, the PPP mode as a new model of guiding the social capital and the government, its use and development is more and more brought to the attention of the countries. However, due to the impact of many national leveraged policies since the subprime crisis in 2008, the operation and development of PPP project enterprises have been greatly challenged. On the basis of the listed PPP project enterprises micro data in China in 2014-2017, this paper first constructed the analysis and evaluation system of comprehensive efficiency, pure technical efficiency and scale efficiency of sample companies with DEA model, and then further analyzed the impact of enterprise leverage ratio on the operation efficiency in China with the Tobit panel data model. The study found that the operating efficiency of enterprises was seriously affected by the stock market crash in 2015, and there were certain differences in different efficiency conditions. Increasing the leverage ratio obviously promotes the operation efficiency of enterprises, but it shows some difference in the pure technical efficiency. It is suggested to increase debt financing, expand enterprise scale, form scale efficiency, reduce operating costs, and improve the operating efficiency of PPP project enterprises, promote technological innovation and increase the core competitiveness of enterprises, establish and improve the supervision system of PPP model, and guard against political chaos when PPP projects run into problems in the relevant policy.

Keywords—*debt leverage; the PPP mode; DEA model; Tobit model; enterprise operating efficiency*

I. INTRODUCTION

The Public Private Partnership (PPP) has been developing continuously in recent years. From the exploration stage to the pilot stage, and from the introduction of foreign capital to the utilization of domestic capital, PPP has gradually developed and improved in China. Advocated by the government and social capital in our country in 2015 launched the PPP mode of cooperation. The application of PPP model to provide for the elderly care, water conservancy construction, transportation, municipal engineering and other projects, not only can attract into all kinds of market and social power, expand the source of funds for the construction of projects, improve the existing projects such as weak infrastructure, imperfect system engineering, and can give

full play to the advantages of various government and market, arouse the enthusiasm of social capital, through the PPP mode to realize the government and social capital fusion, form the multi-level services market, And can make full use of Internet technology to improve the efficiency of project construction. In the process of development, the PPP model has gradually formed a variety of financing models based on BOT, including BOO, ROT, BT. Although there are many financing modes, there is no fundamental difference in the overall process: first, the government department authorizes the private subject, and then the private subject is responsible for the construction, operation and management of the project within the agreed period. After the authorization period expires, the private subject of the project is transferred to the government and exits. As of May 2019, the PPP model has been applied to all provinces in our country's public services and infrastructure projects, all warehousing projects across the country to 8839, the actual financial investment reached 13.5 trillion yuan. This is only the project that has completed the identification stage. If the identification stage is added, the number of PPP projects will exceed 10,000. It can be seen that the development of PPP model in China has received extensive attention from the government and all sectors of society. In this context, the development of PPP project enterprises will directly affect the application and development of PPP model in China. Therefore, it is of great practical significance to study the development of PPP project enterprises.

In addition, since the subprime crisis in 2008, in order to restore the normal speed of economic development and avoid excessive economic fluctuations, China has successively introduced several rounds of leveraged policies. The economy has gradually recovered and grown, but China has also entered a state of high leverage ratio. The leverage ratio of China's total debt is constantly increasing. According to the latest data from Wind database, the leverage ratio has reached about 255% by the end of 2017 [1]. Among them, the debt leverage level of non-financial enterprise sector is much higher than that of government sector and residential sector. Although the higher the debt level of enterprise, the greater the multiplier benefit of corporate earnings, but if the enterprises suffers losses, the corresponding debt will also magnify the loss of equity capital. The higher the corporate

leverage ratio is, the greater the potential risk of the enterprises will be, and the higher the probability of bankruptcy will be when the enterprise encounters financial difficulties. Therefore, the level of corporate leverage ratio plays a very important role in the development of the enterprises.

This paper first studies the operational efficiency of individual PPP project enterprises through DEA model, and then further studies the impact of enterprise leverage ratio on the operational efficiency of PPP project enterprises. Our paper consequently makes two contributions. First, on the one hand, it is helpful to deepen the understanding of the enterprise leverage ratio of PPP projects in China and further adjust the enterprise leverage ratio. On the other hand, it can provide certain policy suggestions for the country to promote the rapid development of enterprises and improve the application efficiency of PPP model.

II. LITERATURE REVIEW

A. *The Application and Development of PPP Model*

From the independent operation of government capital and social capital to their mutual cooperation is a very long process. Since Nick (2002) abandoned the traditional research ideas and methods when dealing with sewage discharge and achieved great success by introducing franchising, the PPP model gradually developed, and it is generally regarded as the PPP model's embryonic form [2]. Then, for the applicability of PPP model, Chris & Colin (2006) pointed out that the PPP model is based on the cooperation between the government and social capital, so many small projects are not applicable [3]. The unique financing model of PPP is more suitable for large projects, which is conducive to improving the utilization efficiency of funds. Halid & Paul (2014) found that value-for-money theory is a standard to judge whether public infrastructure and public products projects are suitable for PPP model [4]. Through the comparison and calculation between the traditional mode and PPP mode, the applicability of PPP mode in projects can be judged. Ji Fuxing and Wang Jingling (2018) established a dynamic three-party game model and found that it was effective to apply PPP model in many fields under the premise that the government kept its promise [5].

B. *DEA Model and Its Application with Tobit Model*

Since the DEA model was proposed by Charnes (1978), it has been constantly improved and developed [6]. It has gradually become a classic model of efficiency evaluation, and its application range is very wide, including bank performance, corporate operating efficiency and environmental efficiency evaluation. With the development of DEA model, more and more scholars combine DEA model and Tobit model for research. The biggest advantage of DEA-Tobit model is that it cannot only evaluate the efficiency of related enterprises or things, but also further find the relevant factors that affect the efficiency of that. Bang (2019) used DEA-Tobit model to discuss the environmental and energy cost efficiency of 119 listed companies and their influencing factors, it found that

enterprise performance and administrative cost were the main factors affecting enterprise efficiency [7]. Zhu Nan (2004) also used DEA-Tobit model to study the production efficiency and influencing factors of 14 large commercial Banks in China [8]. This study made up for the lack of domestic studies at that time, which could not compare the efficient commercial Banks. Yan Xiaochang (2018) used both the BCC model and Malmquist index model in DEA method to evaluate the annual and inter-temporal efficiency of medical institutions in various provinces, and then constructed four Tobit models to study the impact of government investment on them [9]. It can be seen that with the continuous expansion of theory and application field, DEA-Tobit model has become an important efficiency evaluation and influence factor analysis method with two-stage analysis system.

C. *Leverage Ratio and Enterprise Management*

In terms of the influence of leverage ratio on enterprise operation, most scholars start from the perspective of enterprise performance or enterprise's own value, and there are some differences in their views. Yang (2016) pointed out that high debt level would increase the cost of debt agency and financial distress of enterprises, which could reduce the operating performance of enterprises to a certain extent [10]. Therefore, the leverage ratio of enterprises was negatively correlated with operating performance. Zhang Rushan and Shi Dongkai (2017) found that an enterprise's increase in debt could expand its scale and improve its own value, so as to further improve its own performance [11]. Therefore, the leverage ratio of an enterprise had a positive impact on its operating performance. In addition, according to Frank (2004) and other scholars, enterprises with different development conditions have different choices of financing methods [12]. Enterprises with faster development tend to use debt financing, while those with slower development tend to use equity financing, so the relationship between enterprise leverage ratio and enterprise value is not clear. The relationship between corporate leverage ratio and corporate performance is not just a simple linear relationship, but a complex non-linear relationship: corporate performance will rise first and then fall with the increase of corporate leverage ratio. Similar to the "inverted U-shaped" trend, Cohn (2014) concluded that most enterprises have an optimal capital structure suitable for themselves, and the lower leverage ratio of enterprises is positively correlated with corporate performance; otherwise, there will be a negative correlation [13]. Zhu Yuchun and Liu Jianping (2009) further proved the "inverted U-shaped" relationship between corporate debt level and corporate performance by using the data of listed enterprises in China [14].

It can be seen that there is a gradual process for domestic and foreign scholars to study leverage ratio and enterprise management. They take enterprise operating performance as the measurement index of enterprise operating and obtain the correlation between them from different perspectives. However, few scholars take enterprise operating efficiency as the proxy variable of enterprise operating and study the

relationship between leverage ratio and enterprise operating efficiency.

This paper takes PPP project enterprises as the research object. On the one hand, using DEA model concluded the operating efficiency of PPP project enterprise; On the other hand, this paper further studies the relationship between corporate leverage ratio and corporate operating efficiency by using the conclusion of enterprise operating efficiency. Our research is conducive to improving the operation efficiency of PPP project enterprises, and can provide evidence for enterprise financing, so as to promote enterprises to choose financing methods suitable for themselves.

III. EFFICIENCY EVALUATION OF PPP PROJECT ENTERPRISES

A. Selection of Study Samples

In order to ensure the reliability and accuracy of the empirical analysis, all companies that have been ST and PT were excluded to avoid outliers. Finally, 107 PPP project enterprises were selected as research samples. In terms of the selection of sample period, the Ministry of Finance of China established the PPP center in 2014. Therefore, this paper determined the sample period as 2014-2017, and relevant data were obtained from Wind database and China statistical yearbook.

B. Selection of Input-output Indicators

When using DEA method to measure project efficiency, the selection of input and output indexes of DMU is very important. In this paper, operating cost, fixed assets input, number of employees and salary payable are selected as the input indicators to measure the operation of PPP project enterprises, and the company's comprehensive income, earnings per share and return on equity are selected as the output indicators.

- Input index. In this paper, the investment indicators of PPP project enterprises are selected from three aspects of human resources, material resources and financial resources: In terms of material resources,

fixed assets as the material basis for the operation of an enterprise, are the necessary conditions for the normal operation of an enterprise. In terms of human resources, this paper selects the total number of employees and the salary payable as the index of human resources investment. In terms of financial resources, this paper selects enterprise operating cost as the input index.

- Output index. The business objectives of most enterprises are to maximize their earnings. Therefore, this paper selects the comprehensive earnings, earnings per share and return on equity as output variables to measure the earnings of enterprises.

However, when collecting data, it is found that some companies have negative net profit and some enterprises have data less than or equal to 0, which will affect the accuracy of empirical analysis of DEA model. Therefore, this paper carries out standardized processing on the selected indicators, and the processing modes are as follows:

$$A = \text{Max } X_{ij} \quad (1)$$

$$B = \text{Min } X_{ij} \quad (2)$$

$$x_{ij} = 0.1 + 0.9 * (x_{ij} - B) / (A - B) \quad (3)$$

Max X represents the maximum value of each input or output index, Min X represents the minimum value for each input or output index. In this paper, input-output index data of 107 selected enterprises are processed by equation (3).

C. Empirical Analysis of Enterprise Operating Efficiency

In order to increase the reliability of empirical analysis with DEA model, this paper further tests the data obtained, the data meet the rule of thumb proposed by Banker, the number of decision units cannot be less than twice the input and output variables. After that, this paper analyzed and processed the data by using the input-oriented BCC model with Deap2.1 software, and calculated the comprehensive efficiency, pure technical efficiency and scale efficiency of 107 PPP project enterprises. The specific empirical results are shown in "Table I".

TABLE I. PPP PROJECT ENTERPRISE EFFICIENCY ANALYSIS RESULTS

Year	Types of efficiency	Mean	St.Dev.	Min.	Max.
2014	comprehensive technical efficiency	0.761	0.106	0.344	1
	pure technical efficiency	0.977	0.060	0.502	1
	scale efficiency	0.779	0.098	0.344	1
2015	comprehensive technical efficiency	0.735	0.141	0.393	1
	pure technical efficiency	0.973	0.073	0.461	1
	scale efficiency	0.756	0.137	0.393	1
2016	comprehensive technical efficiency	0.670	0.141	0.370	1
	pure technical efficiency	0.979	0.053	0.595	1
	scale efficiency	0.685	0.141	0.375	1
2017	comprehensive technical efficiency	0.729	0.106	0.356	1
	pure technical efficiency	0.971	0.061	0.675	1
	scale efficiency	0.751	0.104	0.361	1

From "Table I", we can see that the 107 PPP project enterprises selected in this paper have great differences in comprehensive technical efficiency, pure technical efficiency

and scale efficiency, but the overall operating efficiency is high. It indicates that China attaches great importance to the development and application of PPP model in China in

recent years, and actively implements preferential policies to support PPP projects and related enterprises. Moreover, the PPP center was established in 2014 to further promote its development.

In general, the operation efficiency of PPP project enterprises in China was relatively high in 2014. However, due to the huge impact of the stock market crash in 2015, it affects the normal operation of the capital chain of the enterprises, which not only causes a sharp decline in the business performance of the enterprises, but also reduces the operating efficiency of the enterprises and forces them to enter the adjustment period. With the development of the economy and the adjustment of the market, the operation efficiency of PPP project enterprises has been restored until 2017. After the market crash, the comprehensive efficiency of PPP project enterprises recovered after 2016, which is more obvious in the scale efficiency. It shows that through appropriate adjustment, the capital chain of the enterprises is constantly strengthened in operation, and the enterprises strictly control all aspects of operation in supervision, and have gradually achieved remarkable results. In terms of pure technical efficiency, the enterprise efficiency of PPP project is relatively high and stable during the research period. It shows that the company is very strict in its management. It not only pays attention to the input of the enterprise to avoid redundant input, but also strengthens the output supervision of the enterprise. At the same time, it also pays attention to the cultivation of personnel technology and independent research and development innovation ability, so as to ensure the high-quality operation of the enterprise.

IV. EMPIRICAL ANALYSIS ON ENTERPRISE EFFICIENCY OF PPP PROJECTS

A. Selection and Processing of Variables

1) *The explained variable:* There are many proxy variables to measure corporate performance, including

return on assets (ROA), tobin's Q value and return on equity (ROE), etc. Some scholars also used comprehensive variable method to properly deal with various financial indicators of enterprises to measure their operating performance. However, there are few studies on the operational efficiency of enterprises. In this paper, we select the enterprise efficiency index discussed above as the explained variable to measure the enterprise operating efficiency, including comprehensive efficiency variable (over), pure technical efficiency variable (tech) and scale efficiency variable (sech).

2) *Core explanatory variables:* The core explanatory variable studied in this paper refers to the leverage ratio of PPP project enterprises, and there are many variables to measure the leverage ratio of enterprises. In order to ensure the accuracy and reliability of data acquisition, we select the asset-liability ratio (DAR) of each enterprise as the core explanatory variable to measure the corporate leverage ratio. Asset-liability ratio can not only measure the financing obtained by enterprises through debt financing, but also measure the level of equity financing, so it is relatively reliable.

3) *Control variables:* In this paper, we control the variables of the model from three levels: first, we select the per capita gross domestic product (GDP) of different provinces to control the differences in economic development; Secondly, at the enterprise level, this paper controls the enterprise scale (size), total operating time (age), return on assets (ROA), shareholding ratio (SH), current ratio (CR) and net profit growth rate (Pro) of the enterprises, so as to control the individual difference of the enterprises. Finally, we use the matrix of time dummy variable to control the time and avoid the influence of time factor.

The variables, definitions and its types used in this paper are shown in "Table II":

TABLE II. MODEL ESTIMATION RESULTS

Variable types	Variables	Definition
enterprise efficiency	over	Comprehensive efficiency of enterprises
	tech	The pure technical efficiency of the enterprise
	sech	Scale efficiency of an enterprise
Enterprise leverage ratio	DAR	The asset-liability ratio of enterprises
Control variables	GDP	The log of per capita GDP
	size	The log of the enterprises assets
	ROA	The return on assets of enterprises
	age	Total operating time of the enterprises
	SH	The largest shareholder shareholding ratio
	Pro	Net profit growth rate of the enterprises
	CR	Current ratio of the enterprises
	year	Time control variables

B. Model Design

The explained variables used in this paper are limited, so the regression results using OLS are not unbiased. In order to enhance the reliability and accuracy of empirical analysis, we uses truncated Tobit model for empirical analysis. Therefore, we constructed the following three models to

further analyze the impact of the leverage ratio on the operating efficiency of PPP project enterprises, the models are as follows:

$$y_{nit} = \alpha + \beta_1 b_{it} + \beta_2 GDP_{jt} + \beta_3 c_{it} + \beta_4 T_t + u_{it} \quad (4)$$

Where the enterprise efficiency y of enterprise efficiency n of enterprise i at time t is written as a function of the enterprise operating efficiency variable. A set of the leverage ratio of PPP project enterprises, b ; a set of per capita GDP control variables in provinces j , GDP ; a set of enterprise-level control variables, c ; and a set of the time control variable, T , which are common to all enterprises.

C. The Empirical Analysis

In this paper, we used stata13 to conduct descriptive statistical analysis of the data, and the results are shown in "Table III".

TABLE III. MODEL ESTIMATION RESULTS

variables	Mean	St.Dev.	Min.	Max.
over	0.723	0.128	0.344	1
tech	0.975	0.062	0.461	1
sech	0.743	0.126	0.344	1
DAR	0.527	0.203	0.028	0.922
GDP	11.14	0.407	10.17	11.77
size	13.34	1.559	9.748	18.25
ROA	0.059	0.054	-0.175	0.524
age	17.38	5.161	4	35
SH	0.331	0.150	0.045	0.773
Pro	0.063	1.885	-19.57	14.85
CR	1.986	2.422	0.123	35.02

From "Table III", we can see that the average leverage ratio of PPP project enterprises in the sample period is 52.7%, which indicates that the scale of corporate debt is relatively moderate, but there are some enterprises whose corporate leverage ratio even exceeds 90%, it indicates that there are some enterprises with high liabilities in PPP project enterprises.

Then we used Tobit model to conduct empirical regression on the correlation between the leverage ratio of and the operating efficiency of PPP projects enterprises, and the estimated results are shown in "Table IV".

TABLE IV. MODEL ESTIMATION RESULTS

Variables	Over	Tech	Sech
DAR	0.0706** (2.29)	0.00374 (0.14)	0.0784*** (2.75)
GDP	-0.0309* (-1.81)	-0.0175 (-1.29)	-0.0110 (-0.68)
size	0.00603 (1.21)	-0.0219*** (-5.91)	0.0214*** (4.55)
ROA	1.905*** (17.57)	0.156** (2.25)	1.798*** (18.08)
age	0.00278** (1.99)	0.00124 (1.09)	0.00161 (1.21)
SH	0.0238 (0.58)	-0.0260 (-0.91)	0.0604 (1.57)
Pro	0.00384** (2.18)	-0.000587 (-0.60)	0.00437*** (2.72)

Variables	Over	Tech	Sech
CR	0.00481*** (3.07)	0.00201 (0.59)	0.00592*** (4.14)
_cons	0.784*** (4.09)	1.449*** (9.42)	0.382** (2.09)
sigma_u	0.0621*** (11.57)	0.0527*** (12.07)	0.0600*** (11.95)
sigma_e	0.0543*** (24.00)	0.0281*** (22.42)	0.0493*** (24.07)
rho	0.5672	0.7791	0.5972
Wald chi2	598.04***	66.91***	733.88***
Log likelihood	479.74***	558.34***	514.35***
T	Controlled	Controlled	Controlled
N	412	412	412

a. * Statistical significance at the 1% level.
 b. ** Statistical significance at the 5% level.
 c. *** Statistical significance at the 10% level

From "Table IV", we can see that Wald-test and the Log likelihood test in the empirical at 1% significance level through the test, it showed that the model is significant. Most of the control variables also passed significance tests at different levels in the model.

The core explanatory variable (DAR) has a significant positive impact on the comprehensive efficiency and scale efficiency of enterprises. On the one hand, it shows that the development and application of PPP model in China have been paid more and more attention by the state in recent years, and the country has issued a series of preferential policies to further promote the development of PPP project enterprises. In addition, the overall leverage ratio of the enterprises are relatively moderate, so it can increase the capital scale and the operating cash flow of the company, which is conducive to the expansion of the enterprise scale and the improvement of the enterprise operating efficiency, and can promote the healthy and sustainable development of the enterprise. On the other hand, it also shows that with the increase of corporate leverage ratio, the interest expense of corporate debt gradually rises and the repayment pressure gradually increases, which increases the financial cost of the enterprise. In this case, only by further improving the operating efficiency and accelerating the turnover speed of the enterprise's capital chain can the enterprise continue to develop in the ever-expanding debt pressure and fierce market competition, and it also can avoid the enterprise bankruptcy.

From the point of enterprise efficiency, first of all, the leverage has significant positive influence on the comprehensive efficiency and scale efficiency of the PPP project enterprise, It shows that under the background of PPP model being valued by the state, the increase of enterprise leverage ratio and debt financing can increase the comprehensive operating efficiency of enterprises, and can improve the competitiveness of enterprises, which can form economies of scale and promote enterprise development; Then, the leverage ratio has no significant impact on the pure technical efficiency of PPP project enterprises. It indicates

that the innovation, research and investment in technology of enterprises are more susceptible to the decisions of the management. Corporate planning and decisions by corporate management determine the amount of money spends on research. Therefore, the influence of leverage ratio on the pure technical efficiency of enterprises is not obvious.

V. CONCLUSIONS AND RECOMMENDATIONS

In this paper, we takes PPP project enterprises in China as the research object, and builds an efficiency evaluation system based on DEA model to evaluate the operating efficiency of them. Then, we further used Tobit model to study the impact of the leverage ratio on the operating efficiency of the PPP projects enterprises. And it reveals a strong correlation between the leverage ratio and the operating efficiency. Based on this empirical study, we draw the following conclusions and relevant suggestions.

A. Conclusions

According to the evaluation results of the operation efficiency of PPP project enterprises in China, although there are differences in the comprehensive efficiency, pure technical efficiency and scale efficiency, the operation efficiency level is relatively high and the operation development situation is relatively ideal. It reflects that China attaches great importance to the application and development of PPP model in China, and strictly checks every link from project application, demonstration, review, bidding, contract signing to project approval and warehousing. Meanwhile, it conducts strict review on the operation status of PPP project companies. Even if the enterprise is impacted by the market, it can enter the adjustment period in a timely manner, continuously strengthen the operation and supervision of the enterprise itself, and pay attention to the cultivation of talents and technologies, so as to ensure the overall operation and development of the PPP project enterprises with higher efficiency.

According to the empirical results, the leverage ratio has a significant positive impact on the comprehensive efficiency and scale efficiency of PPP projects enterprises, except the pure technical efficiency because of enterprises decision-making. On the one hand, it shows that the debt leverage ratio of PPP project enterprises in China is generally low and has a good development prospect. Therefore, debt financing can expand the scale of enterprises, improve the competitiveness of enterprises and further promote the development of enterprises. On the other hand, it also reflects that increasing debt financing and leverage ratio can increase the enterprise's sense of crisis, and it can use the ever-expanding operating costs to encourage enterprises to improve their operating efficiency, so as to ensure the efficient operation of enterprises in the fierce market competition.

B. Recommendations

In enterprise development planning, because the debt leverage level of PPP project enterprises in China is not high,

and the empirical analysis also finds that increasing leverage ratio can improve the operation and development efficiency of enterprises. Therefore, PPP project enterprises should start from their own perspective to find the appropriate optimal capital structure and leverage ratio. On this basis, an enterprise can expand its development scale through debt financing, and realize scale benefit in the process of expanding its operation scale, so as to reduce its operating cost and promote its more healthy and sustainable development. In addition, improving the R & D level of enterprises is an important step to enhance the comprehensive competitiveness of enterprises, so PPP project enterprises should pay attention to their own research and development and scientific and technological investment. By making a good enterprise planning through the decision of the management, the enterprise can ensure better R & D and innovation, improve the technical operation efficiency of the enterprise, and occupy a favorable position in the fierce market competition.

Strengthen the PPP project planning and design, perfect the laws and regulations and regulatory system of PPP. After the establishment of public-private partnership (PPP) center in China, many enterprise projects introduced PPP model, which deepened the cooperation between government departments and private capital. Therefore, it is necessary to classify and plan different types of PPP projects from the perspectives of environment, risk, technology and performance. Design different application projects to improve the efficiency of enterprise operation. In addition, laws, regulations and supervision system of PPP should be further established and improved, so as to avoid the political chaos when PPP projects encounter problems in reality. At the same time, government departments should also strengthen the supervision of PPP projects. PPP projects generally have a strong public welfare nature and need to follow specific laws and regulations for construction, operation and management. Especially some non-profit nature of the PPP project and social capital requirement for a return on investment has the conflict, it is more necessary to design and manage the operation mode, transaction structure, operation and maintenance of such projects in a scientific and reasonable way, and to comprehensively supervise the construction period and operation period, so as to improve the operation and development efficiency of PPP projects and related enterprises.

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