

Research on the Application of Entropy Method and Efficiency Coefficient Method in Financial Risk Early Warning of Enterprises

-- Taking Shandong Longda Meishi Co., Ltd. as an Example

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Abstract: In the process of development, enterprises need to focus on two major issues, namely the increasingly fierce competition and the problems in the financial management of the enterprise. If you don't want the financial situation of the enterprise to deteriorate, you need to pay attention to the internal operation and management of the enterprise, because if there are problems in the internal financial management of the enterprise, it will lead to the change of the market environment and the lack of timely and accurate information, so as to make wrong decisions. Therefore, it is necessary to build a financial risk early warning model to reduce losses. Taking Shandong Longda Meishi Co., Ltd. as an example, this paper uses the entropy method and the efficacy coefficient method to construct a financial risk early warning model, and gives a risk early warning to the financial data of Shandong Longda Meishi Co., Ltd. from 2018 to 2022. The empirical results show that the early warning results are consistent with the actual situation of the enterprise, which proves that the early warning model built by this method is scientific and effective.

Keywords: Entropy method; Efficiency coefficient method; Financial risk early warning.

1. Introduction

The intensification of market competition, geopolitical uncertainty and other factors make the environment of enterprises more severe and face more risks. Therefore, before enterprises face financial crisis, it is important to early warning and control potential financial risks in advance according to the characteristics of industry development and the situation of enterprises. The domestic research on financial risk early warning has become mature, mainly through quantitative methods to build early warning models. Li Changshan et al. (2018) used Logistic regression method to identify financial risks in manufacturing industry^[1]; Wang Yuwen et al. applied BP neural network model to risk early warning of small and medium-sized enterprises^[2]; Liu Cheng et al. used the combination of entropy method and decision tree method to judge whether listed manufacturing enterprises will fall into financial crisis^[3]; Hou Xuhua et al. (2019) applied the combination of entropy method and efficacy coefficient method to financial early warning of insurance industry^[4]. However, the current research is mainly horizontal research for the industry, and there are few researches on risk early warning for specific enterprises. Judging specific enterprise risks with predicted industry risks will reduce the accuracy and applicability, and the entropy method and efficacy coefficient method are more scientific than other weighted evaluation methods. Therefore, this paper based on quantitative methods to build a targeted financial risk early warning model for Longda cuisine, to provide a specific basis for the enterprise to take preventive measures.

2. Financial Risk Early Warning Model Based on Entropy Value Method and Efficacy Coefficient Method

2.1. Entropy method

Entropy method is an objective weighting method, which effectively avoids human subjectivity. The greater the entropy of entropy method, the smaller the weight of the index, the weaker the impact on risk early warning, and vice versa. The related steps are as follows: First, the initial data matrix X_{nm} of the evaluation index is constructed. Where n and m refer to the m th index in the n th year respectively. The original matrix is:

$$X_{nm} = \begin{bmatrix} X_{11} & X_{12} & \dots & X_{1m} \\ X_{21} & X_{22} & \dots & X_{2m} \\ \vdots & \vdots & \dots & \vdots \\ X_{n1} & X_{n2} & \dots & X_{nm} \end{bmatrix} \quad (1)$$

second step is the standardization of indicators. Since different indicators reflect different financial information, the measurement units of various indicators are also different. It is meaningless to directly calculate with unprocessed indicators. The measurement units of various indicators need to be unified and the standardized indicators are used for calculation. For very small indicators, that is, the smaller the value of the indicator is, the better the situation is reflected, and its forward processing is:

$$Y_{nm} = \frac{X_{\max} - X_{nm}}{X_{\max} - X_{\min}} \quad (2)$$

For very large indexes, the larger the value of the index, the better the situation reflected, and its forward processing is:

$$Y_{nm} = \frac{X_{nm} - X_{min}}{X_{max} - X_{min}} \quad (3)$$

For moderate indicators, the value of the index is not the greater or the smaller the better, but the better the response is when the value is within a certain range, such as the asset-liability ratio, its forward processing is:

$$Y_{nm} = \begin{cases} \frac{X_{max} - X_{nm}}{X_{max} - X_0} & X_{nm} \geq X_0 \\ \frac{X_{nm} - X_{min}}{X_0 - X_{min}} & X_{nm} < X_0 \end{cases} \quad (4)$$

The standardized data matrix Y_{nm} is obtained after the above processing.

Step 3: Processing the above standardized data matrix Y_{nm} to determine the information entropy of the m th index.

$$E_m = -K \sum_{n=1}^i P_{nm} \ln P_{nm} \quad (5)$$

among which

$$K = 1 / \ln i \quad (6)$$

$$P_{nm} = Y_{nm} / \sum_{m=1}^j Y_{nm} \quad (7)$$

Step 4: Calculate the weight of the m th index

$$W_m = \frac{1 - E_m}{\sum_{m=1}^j 1 - E_m} \quad (8)$$

2.2. Establish a comprehensive evaluation system of indicators by using the efficacy coefficient method

The efficacy coefficient method can comprehensively reflect the score of multiple aspects of individual indicators, which is more comprehensive and can score each indicator separately, improving the accuracy of early warning results.

$$\text{Single index score} = \text{basic score of this file} + \text{adjustment score} \quad (9)$$

Basic score of this file = single index weight \times standard coefficient value of this file

Formula (10)

$$\text{Basic score of the upper file} = \text{single index weight} \times \text{standard coefficient value of the upper file} \quad (11)$$

$$\text{Adjustment score} = \text{efficacy coefficient value} \times (\text{basic score of the upper file} - \text{basic score of this file}) \quad (12)$$

$$\text{Efficacy coefficient value} = \frac{\text{actual value of the index} - \text{standard value of this file}}{\text{standard value of the upper file} - \text{standard value of this file}} \quad (13)$$

Among them, if the actual value of the index exceeds the excellent file, the efficacy coefficient is 1; if the actual value is lower than the poor file, the efficacy coefficient is 0. The total scoring is:

$$\text{Classification index score} = \sum \text{basic index scores of major categories} \quad (14)$$

$$\text{Total basic index score} = \sum \text{basic index scores of various categories} \quad (15)$$

Table 1. Evaluation index interval and financial risk level

interval	Risk Level	Risk profile
[0.90, 1]	No	Financial performance is good, basically no financial risk
[0.70, 0.90)	Lower	Financial status is relatively stable, but individual indicators are not good.
[0.50, 0.70)	Medium	The financial status is unstable, and some indicators are abnormal.
[0.30, 0.50)	Higher	The financial situation is very unstable, and most indicators are abnormal.
[0, 0.30)	Upper	The financial situation is extremely poor, all indicators are abnormal, and there is a possibility of bankruptcy.

3. Financial Situation of Shandong Longda Meishi Co., Ltd.

3.1. Introduction to Longda Cuisine

Longda Cuisine, founded in 1996, is the full name of Shandong Longda Cuisine Co., Ltd. At present, the main business of Longda Cuisine can be divided into prepared dishes, slaughtering and aquaculture. The strategic planning of the company is to develop a prepared food enterprise with prepared dishes as the core and slaughtering and aquaculture as the two wings. At present, Longda Cuisine is in an important strategic transformation stage, and the market competition is fierce, facing a series of financial risks.

3.2. Analysis of Shandong Longda Meishi Co., Ltd.'s Financial Situation

(1) Analysis of solvency

Table 2. Comparison of solvency index of Shandong Longda Meishi Co., Ltd. and the industry average

Company	index	2022-12-31	2021-12-31	2020-12-31	2019-12-31	2018-12-31
Shandong Longda Meishi Co., Ltd.	asset-liability ratio(%)	56.0779	58.8189	56.7863	59.4291	40.0881
	quick ratio (%)	82.2075	93.1791	92.5712	57.1764	106.0828
	Operating cash flow ratio(%)	28.1314	-2.3699	32.8227	-36.8481	-7.1522
industry mean value	asset-liability ratio(%)	43.7472	43.383	39.9981	41.3662	42.2108
	quick ratio (%)	172.2127	195.6634	180.8148	157.222	152.8782
	Operating cash flow ratio(%)	37.747	33.1639	35.8823	33.085	23.8902

From the quick ratio. Compared with the industry average, the quick ratio of Shandong Longda Meishi Co., Ltd. is

lower than the industry average throughout the analysis period, especially in 2021, which is far lower than the industry

average of 157.222%. This indicates that compared with the industry average, Shandong Longda Meishi Co., Ltd. has certain problems in liquidity management and weaker solvency than peer companies. The company needs to pay attention to its liquidity management, improve accounts receivable and inventory management, and reasonably control short-term liabilities to reduce future liquidity risks. At the same time, it also needs to pay attention to industry trends to ensure that its financial strategy is consistent with industry best practices. The ratio of net cash flow generated by operating activities to current liabilities of Shandong Longda Meishi Co., Ltd. in the past five years shows an unstable trend and is lower than the industry average in most of the time. Specifically, the negative ratio in 2018 and 2019 and the extremely low value in 2021 indicate the potential cash flow shortage and liquidity pressure faced by the company. Only in

2020 and 2022, the ratio returned to positive value, but it is still lower than the industry average, which means that Shandong Longda Meishi Co., Ltd. has a relatively weak ability to repay debts through operating activities in the short term. From the asset-liability ratio. From 2018 to 2022, except for 2018, the asset-liability ratio of Shandong Longda Meishi Co., Ltd. was higher than the industry average in the other four years, indicating the company's relatively active financial leverage strategy. Although moderate financial leverage can improve the efficiency of capital utilization and may increase shareholder value, an excessive leverage ratio will also increase the company's financial risks, especially in the case of economic fluctuations or increasing market uncertainties.

(2) Profitability analysis

Table 3. Comparison of Profitability Index of Shandong Longda Meishi Co., Ltd. and Industry Average

Company	index	2022-12-31	2021-12-31	2020-12-31	2019-12-31	2018-12-31
Shandong Longda Meishi Co., Ltd.	return on equity(%)	2.8906	-23.9298	31.1409	12.3595	9.6097
	Operating profit margin(%)	0.7364	-4.5941	4.2279	2.0820	2.4681
	profit margin on costs(%)	0.6941	-4.5606	4.4024	2.1758	2.6170
industry mean value	return on equity(%)	-0.5463	1.2704	12.1515	12.4497	6.8524
	Operating profit margin(%)	3.2718	3.2217	-6.2633	7.8439	2.1549
	profit margin on costs(%)	3.9967	4.1893	2.7103	8.9357	4.9897

From the return on equity. In the past five years, the ROE of Shandong Longda Meishi Co., Ltd. showed fluctuations, with outstanding performance in 2020 and a large decline in 2021. The company's ROE returned to positive in 2022, but the overall profitability is still lower than the industry's best level. This fluctuation of ROE is related to a variety of factors such as the company's market strategy, cost control, asset management efficiency and macroeconomic environment. From the operating profit margin. In the past five years, the operating profit margin of Shandong Longda Meishi Co., Ltd. fluctuated greatly, with strong operating efficiency in 2020, and significantly lower than the industry average in

other years such as 2021 and 2022. The fluctuation of operating profit margin reflects the company's different degrees of response to cost control and market adaptability. From the cost margin. In the past five years, the cost margin of Shandong Longda Meishi Co., Ltd. fluctuated, with good performance relative to the industry average in 2020, but in other years, especially 2021 and 2022, the company's profitability was significantly lower than the industry average. This fluctuation reflects the company's instability in cost control, pricing strategy and market competitiveness.

Table 4. Comparison of operation capacity index of Shandong Longda Meishi Co., Ltd. and industry average

Company	index	2022-12-31	2021-12-31	2020-12-31	2019-12-31	2018-12-31
Shandong Longda Meishi Co., Ltd.	Total Asset Turnover (times)	1.988403	2.324743	3.241738	3.340166	2.787554
	Inventory Turnover (times)	9.424502	9.20123	8.568254	8.793463	10.789146
	Accounts receivable turnover (times)	22.183023	29.537865	54.40121	47.690641	32.01743
industry mean value	Total Asset Turnover (times)	1.165704	1.246296	1.295615	1.285494	1.176877
	Inventory Turnover (times)	6.262748	7.392654	7.27307	8.026062	8.116476
	Accounts receivable turnover (times)	50.285788	56.862475	64.393314	95.487663	203.162515

From the perspective of total assets turnover, in the past five years, the total assets turnover of Shandong Longda Meishi Co., Ltd. has been significantly higher than the industry average, which means that the company has shown strong efficiency in using its total assets to generate revenue. A high turnover rate usually indicates that the company's asset management and operation processes are effective, and the company can achieve higher sales with a lower asset base. Inventory turnover. In the past five years, the inventory turnover of Shandong Longda Meishi Co., Ltd. has always been higher than the industry average, which indicates that the company has effectively managed its inventory during this

period and quickly converted inventory into sales, thereby optimizing the efficiency of capital use and reducing inventory holding costs. From the perspective of accounts receivable turnover. In the past five years, the accounts receivable turnover of Shandong Longda Meishi Co., Ltd. has always been far lower than the industry average. This situation may be caused by a variety of factors, such as lax credit policies, customer structure problems, or inadequate collection processes. The slow recovery of accounts receivable has adversely affected the company's cash flow and may limit the company's operational capacity and development potential.

Table 5. Comparison of Growth Ability Index of Shandong Longda Meishi Co., Ltd. and Industry Means

Company	index	2022-12-31	2021-12-31	2020-12-31	2019-12-31	2018-12-31
Shandong Longda Meishi Co., Ltd.	Growth rate of total assets(%)	-3.1100	-3.7217	35.3474	68.2760	47.6053
	operating profit growth rate(%)	113.2403	-187.9601	190.9477	61.6517	10.1291
industry mean value	Growth rate of total assets(%)	16.3016	19.1173	24.6634	26.4628	15.2310
	operating profit growth rate(%)	-19.0254	-64.9631	74.4304	13.1311	6.0492

Growth rate of total assets During the five years analyzed, the growth rate of total assets of Shandong Longda Meishi Co., Ltd. has shown significant fluctuations. The company's asset growth rate exceeded the industry average in 2019 and 2020, indicating the company's strong growth potential and active expansion strategy. However, in 2021 and 2022, the company's total asset growth rate turned negative, far lower than the industry average, which may reflect the company's difficulties in asset management and utilization, or the company may face market and operational challenges. Operating profit growth rate During the past five years, the operating profit growth rate of Shandong Longda Meishi Co., Ltd. has shown significant fluctuations. In 2022 and 2020, the company's profitability has significantly increased, with the growth rate far higher than the industry average, indicating strong market competitiveness and good revenue growth. On the contrary, in 2021, the company's operating profit has declined significantly, possibly due to factors such as the deteriorating market environment or poor internal cost control. However, except for the negative growth in 2021, the company's growth rate has been higher than the industry average in other years, indicating the company's strong profitability and market adaptability.

4. Construction of Financial Risk Early Warning Model -- Taking Shandong Longda Meishi Co., Ltd. as an Example

4.1. Primary Indicators

According to the analysis of Shandong Longda Meishi Co., Ltd.'s financial status in the foregoing, in order to fully reflect the actual situation of the enterprise, this paper will select 11 indicators from four aspects of solvency, profitability, operation ability and development ability to build a financial risk early warning system.

4.2. Determine the weight by entropy value method

(1) Normalization of indicators

In the primary indicators, except for the solvency index, which is a moderate index, the others are positive indicators. Standardize the indicators according to 2 and 3.

(2) Determine the entropy value and weight

Substitute the standardized data into 5 to get the entropy value, difference coefficient and weight of each index of company 8. Get the entropy value and weight of each evaluation index of the company.

Table 6. Financial risk evaluation index data

First-level Indicators	Secondary Indicators	2022	2021	2020	2019	2018
Profitability	return on equity(%)	0.028906	-0.239298	0.311409	0.123595	0.096097
	Operating profit margin(%)	0.007364	-0.045941	0.042279	0.02082	0.024681
	profit margin on costs(%)	0.006941	-0.045606	0.044024	0.021758	0.02617
solvency	asset-liability ratio(%)	0.560779	0.588189	0.567863	0.594291	0.400881
	quick ratio (%)	0.822075	0.931791	0.925712	0.571764	1.060828
	Operating cash flow ratio(%)	0.281314	-0.023699	0.328227	-0.368481	-0.071522
Operating capacity ability to grow	Total Asset Turnover (times)	1.988403	2.324743	3.241738	3.340166	2.787554
	Inventory Turnover (times)	9.424502	9.20123	8.568254	8.793463	10.789146
	Accounts receivable turnover (times)	22.183023	29.537865	54.40121	47.690641	32.01743
	operating profit growth rate(%)	-0.0311	-0.037217	0.353474	0.68276	0.476053
	Growth rate of total assets(%)	1.132403	-1.879601	1.909477	0.616517	0.101291

Table 7. Standardized matrix

Secondary Indicators	2022	2021	2020	2019	2018
return on equity(%)	-0.1767	-1.5219	1.2402	0.2982	0.1603
Operating profit margin(%)	-0.0737	-1.6611	0.9660	0.3270	0.4419
profit margin on costs(%)	-0.1089	-1.6490	0.9779	0.3253	0.4547
asset-liability ratio(%)	-1.2871	-0.7084	0.8692	1.0385	0.0878
quick ratio (%)	0.0796	-0.1773	-0.9059	-0.6467	1.6503
Operating cash flow ratio(%)	-1.1191	-0.5698	1.2873	0.7861	-0.3846
Total Asset Turnover (times)	0.2288	0.5701	0.3170	0.6461	-1.7620
Inventory Turnover (times)	-0.2203	0.3785	0.3453	-1.5864	1.0828
Accounts receivable turnover (times)	0.8859	-0.1857	1.0507	-1.3970	-0.3537
Growth rate of total assets(%)	-1.0077	-1.0270	0.2038	1.2411	0.5899
operating profit growth rate(%)	0.5301	-1.5807	1.0746	0.1685	-0.1925

Table 8. Normalization of financial risk early warning indicators

Secondary Indicators	2022	2021	2020	2019	2018
return on equity(%)	0.4870	0.0000	1.0000	0.6590	0.6090
Operating profit margin(%)	0.6042	0.0000	1.0000	0.7568	0.8005
profit margin on costs(%)	0.5863	0.0000	1.0000	0.7516	0.8008
asset-liability ratio(%)	0.0000	0.2488	0.9272	1.0000	0.5912
quick ratio (%)	0.3855	0.2850	0.0000	0.1014	1.0000
Operating cash flow ratio(%)	0.0000	0.2283	1.0000	0.7917	0.3052
Total Asset Turnover (times)	0.8267	0.9685	0.8634	1.0000	0.0000
Inventory Turnover (times)	0.5118	0.7362	0.7237	0.0000	1.0000
Accounts receivable turnover (times)	0.9327	0.4949	1.0000	0.0000	0.4262
Growth rate of total assets(%)	0.0085	0.0000	0.5426	1.0000	0.7129
operating profit growth rate(%)	0.7949	0.0000	1.0000	0.6588	0.5228

Table 9. Entropy and weight of various evaluation indexes of the company

First-level Indicators	Secondary Indicators	information entropy value	information utility value	weight coefficient	Weight of first-level indicators
Profitability	return on equity(%)	0.8511	0.1489	7.42%	0.2121
	Operating profit margin(%)	0.8622	0.1378	6.87%	
	profit margin on costs(%)	0.8611	0.1389	6.92%	
solvency	asset-liability ratio(%)	0.8095	0.1905	9.49%	0.347
	quick ratio (%)	0.7163	0.2837	14.14%	
	Operating cash flow ratio(%)	0.7779	0.2221	11.07%	
Operating capacity	Total Asset Turnover (times)	0.8688	0.1312	6.54%	0.2203
	Inventory Turnover (times)	0.8559	0.1441	7.18%	
	Accounts receivable turnover (times)	0.8332	0.1668	8.31%	
ability to grow	Growth rate of total assets(%)	0.7018	0.2982	14.86%	0.2206
	operating profit growth rate(%)	0.8554	0.1446	7.20%	

5. Validation of the financial risk early warning model -- taking Shandong Longda Meishi Co., Ltd. as an example

First of all, the early warning index data of Shandong Longda Meishi Co., Ltd. in 2022 are substituted into the established financial risk early warning model. Then,

according to the efficacy coefficient method, the score of each index is calculated and the early warning level is determined. Finally, the comparison with the actual situation of the enterprise is made. If the situation is consistent, it indicates that the early warning model is effective. The financial early warning index data of Shandong Longda Meishi Co., Ltd. in 2022 are substituted into the to calculate the single score and comprehensive score.

5.1. Calculate the score of early warning index

Table 10. Comprehensive evaluation value of financial risk of Shandong Longda Meishi Co., Ltd. in 2022

First-level Indicators	Secondary Indicators	weight	actual value	coefficient of efficacy	This document is a basic part	Adjusting score	Secondary Indicators One-way Indicator Score	single evaluation index of first-level index
Profitability	return on equity(%)	7.42	2.8906	0.735192982	2.968	1.091026386	4.059026386	9.747818704
	Operating profit margin(%)	6.87	0.7364	0.670458333	1.374	0.92120975	2.29520975	
	profit margin on costs(%)	6.92	0.6941	0.452010526	2.768	0.625582568	3.393582568	
solvency	asset-liability ratio(%)	6.46	335.6014397	-35.08617631	6.46	-45.33133979	6.46	17.32606011
	quick ratio (%)	6.54	56.0779	0.38442	3.924	0.50282136	4.42682136	
	Operating cash flow ratio(%)	7.18	82.2075	0.195848708	4.308	0.281238745	4.589238745	
Operating capacity	Total Asset Turnover (times)	8.31	28.1314	-0.272914027	8.31	-0.453583113	8.31	34.7
	Inventory Turnover (times)	11.07	2218.3023	-106.6845777	11.07	-236.199655	11.07	
	Accounts receivable turnover (times)	14.14	942.4502	-81.67107018	14.14	-230.9657865	14.14	
ability to grow	Growth rate of total assets(%)	9.49	198.8403	-164.70025	9.49	-312.6010745	9.49	13.44501026
	operating profit growth rate(%)	14.86	-3.11	0.101282051	5.944	0.301010256	6.245010256	
	Secondary Indicators	7.2	113.2403	-8.596635593	7.2	-12.37915525	7.2	
Total score						75.21888907		

The scores for the years following similar steps are as follows:

Table 11. Risk assessment index of four capabilities of Shandong Longda Meishi Co., Ltd. company

Year	2022(medium)	2021(medium)	2020(lower)	2019(lower)	2018(lower)
Total score of financial risk assessment	75.21888907	53.86791843	86.54932198	77.3364	75.97022697

5.2. Analysis of the effectiveness of the financial risk early warning model

The above financial risk warning results show that the financial situation of Shandong Longda Meishi Co., Ltd. from 2018 to 2022 has some ups and downs. From the light alert state in 2018 to the medium alert state in 2021. After that, the comprehensive score gradually rose to the medium alert state in 2022. Compared with 2018, the reasons for the significant decline in the comprehensive score in 2021 are as follows. First, the emergence of the epidemic led to closure everywhere, which affected the stability of the enterprise's supply chain and product sales. As an industry that gradually grows with the development of cold chain technology, pre-made dishes have a strong dependence on the supply chain. At the same time, as an enterprise mainly based on B-end sales, the large area of catering industry has undoubtedly had a significant impact on the revenue of Shandong Longda Meishi Co., Ltd.. The comprehensive score gradually rose in 2022, mainly because the C-end business began to grow steadily. The emergence of pre-made dishes has satisfied people's pursuit of convenience and the sense of "small certainty" in the epidemic life. The topic search heat of pre-made dishes showed a substantial increase in that year. At this time, Shandong Longda Meishi Co., Ltd. also took the opportunity to increase e-commerce business. While expanding business, related performance costs and expenses also led to pressure on performance. In addition, regional business expansion led to an increase in management and terminal personnel, which also increased expenses. By 2022, B-end e-commerce business has performed well and retail business has been steadily developed. At this time, the company's brand influence has been strengthened and it has begun to absorb new channel customers to promote revenue growth. In summary, the early warning results have a strong

correlation with the actual situation of the enterprise, indicating that the financial risk early warning model constructed in this paper is effective.

6. Conclusion

Through the verification of the financial risk of Shandong Longda Meishi Co., Ltd. from 2018 to 2022, this paper finds that the predicted results and the actual results of the enterprise are highly consistent, which means that the use of the combination of entropy method and efficacy coefficient method can indeed predict the financial risk of Shandong Longda Meishi Co., Ltd. well. At the same time, it also means that the financial risk early warning model built for Shandong Longda Meishi Co., Ltd. has certain reference significance. Other enterprises can also use this model to predict the hidden financial risks of the enterprise, and make a series of countermeasures in advance, so that the enterprise can develop more smoothly.

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