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Portfolio Management for Chemical Corporations with Managerial Efficiency and Growth Potential

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Abstract

This study takes into account business operational efficiency with a focus on dividend payout ratio in order to efficiently manage portfolio for the chemical sector. When constructing portfolio, business efficiency of corporations is reflected by DEA (Data Envelopment Analysis) method. When it comes to growth potential of the corporations, payout ratio is assessed by the scoring criteria proposed in the paper. This study tests the performance of the proposed portfolio management strategy for KOSPI and KOSDAQ-listed companies in the chemical industry sector.

Keywords: Chemical Corporations, DEA, Operational Efficiency, Portfolio Management, Stock

1. Introduction

In Korea, being one of the top 10 industries, chemical industry plays a major role in developing the medical, electronics, machinery, and automobile industries by supplying a variety of chemical products[1]. Figure 1 illustrates the supply of the domestic chemical industry of Korea from 2001 to 2010. Over recent 10 years, the production quantity rose by about 40% from 15.2 million tons (MT) to 21.2 MT, while imports decreased about 26%. Especially during 10 years, the average domestic consumption stays around 9.8 MT, but there has been significant change in exports from 6.9 MT at year of 2001 to 11.8 MT at year of 2010, which is 73% increase. Thus, with the increase in production and export for 10 years, chemical industry has a high contribution to the economic growth of South Korea.

The development of the chemical industry influences the financial markets. Looking at the current market capitalisation of the companies that are listed on the KRX (Korea exchange), market capitalisation of corporations belonging to the chemical sector amounts to about 80 trillion won, which is next to semiconductor and automobile sectors among total 24 industry sectors. In addition, 78 chemical-related companies are listed in KRX excluding preferred stocks and Exchange Traded Funds (ETF), and chemical sector accounts for the largest share of the Korean domestic financial market. Also there has been increasing investment in chemical sector after KODEX energy chemical ETF products were publicly traded on the KRX on October 09, 2009. Because the ETF products mainly use a market capitalisation weighted approach when selecting stocks and determining their portion, however, the company's growth and business efficiency cannot be taken into account. In fact, only approximately 2.32% of the excess return compared to benchmark is recorded since the time of initial listing of KODEX energy chemical products.

Existing research that has discussed the growth potential of corporation with focus on a dividend includes studies by Miller and Modigliani, etc.[2-5]. They were based on the logic that firms pursue growth through low dividends policy or by having more internal reserves, under the assumption that their growth potential is abundant. Therefore, these studies suggest that low dividends indicate the implications of not only a high growth rate but also future growth.

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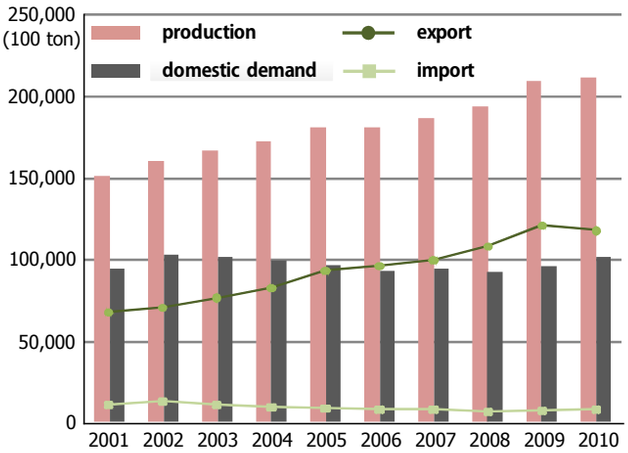

Figure 1. Market condition for Korean domestic chemical corporations.

This study therefore proposes a portfolio construction strategy using dividend payout ratio and DEA taking into account the company's growth potential and operational efficiency. In addition, we compare the rate of return according to each of the portfolio construction with benchmark market rate of return as illustrated in Figure 2. In order to measure and analyse the portfolio's performance, analysis measurements such as Sharpe Ratio, Jensen's alpha and the information ratio (IR) are employed.

The structure of this paper is as follows: Section 2 explains portfolio construction procedures using DEA method as well as scoring table. Section 3 analyses the rate of return of the portfolio constructed by using scoring table and financial data extracted from financial statements of chemical corporations listed on KRX, and the weights obtained and their correlation. Lastly, Section 4 presents the conclusion.

2. Strategies for Portfolio Selection

Aiming to minimise the risk of assets, there are two risks in a portfolio; systematic and non-systematic risk. In contrast with systematic risk that is unavoidable due to the economic downturn and anxiety of market, non-systematic risk that is caused by fluctuation of individual stock can be minimised by an efficient portfolio construction. In general, Markowitz's model is utilised to minimise the correlation between stocks included in the portfolio[6]. However, since Markowitz model depends only on the past stock prices when constructing a portfolio, there is limitation that cannot reflect operational efficiency and

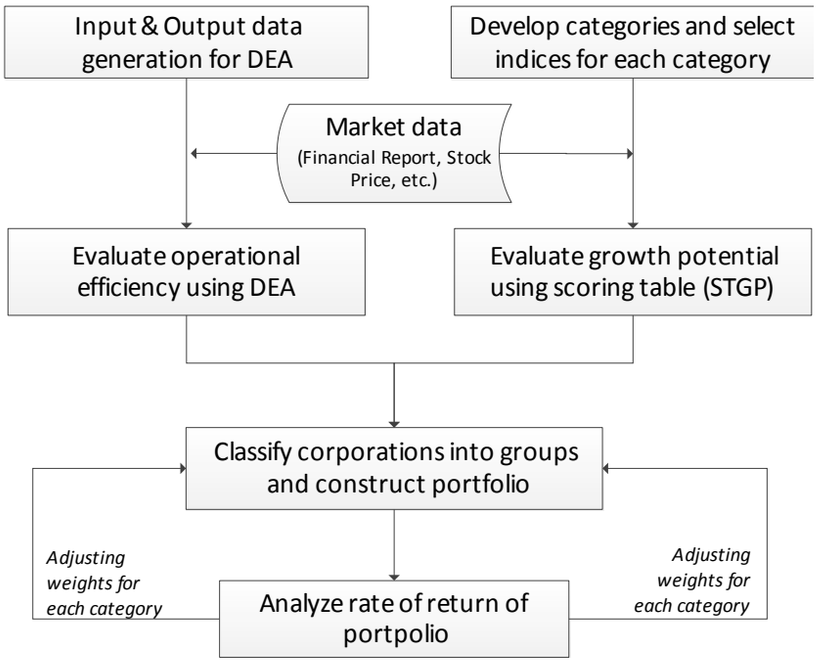

Figure 2. Portfolio construction procedures.

growth of corporates. Therefore, this study proposes a portfolio construction methodology using DEA technique and payout ratio to consider operational efficiency and growth potential of companies.

2.1 Operational Efficiency

DEA (Data Envelopment Analysis) is a ratio model on multiple inputs and multiple outputs, and very useful to determine the degree of efficiency of the decision-making alternatives[7]. Using the same input and output element, DEA methodology measures and evaluates the relative efficiency of the organisational unit or the DMU (Decision Making Unit), which performs a very similar function. One of the most important factors for evaluation of effectiveness through DEA is to select input and output elements. We define cost of sales, total assets and general overhead as input elements, and total sales as output elements. There are existing DEA models such as Charnes-Cooper-Rhodes (CCR), Banker-Charnes-Cooper (BCC), additive model, and slack-based measure model. This paper employs BCC model assuming the variability of return to scale (RTS), which is defined as follows[8-10].

$$Max \quad \eta_k \tag{1}$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} \geq x_{ik} \qquad i = 1,2...m. \tag{2}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq \eta_k y_{rk} \qquad r = 1,2...s. \tag{3}$$

$$\lambda_j \geq 0 \qquad \forall j. \tag{4}$$

$$\sum_{j=1}^{n} \lambda_j = 1 \tag{5}$$

Where,

n number of DMU

η_k the efficiency of the *k–th* DMU

x_{ij} *i–th* inputs of the *j–th* DMU

y_{rj} outputs of the *j–th* DMU

λ_j weight of *j–th* DMU

According to the decision made by model (1) ~ (5), portfolios are classified into 3 groups (A, B and C) depending on the operational efficiency. If the efficiency value of a company is greater than or equal to 0.95 and less than or equal to 1 ($0.95 \leq \eta_k \leq 1$), then the company belongs to A group. Else if the efficiency value of a company is greater than or equal to 0.5 and less than 0.95 ($0.5 \leq \eta_k < 1$), then the company belongs to B group. Otherwise, it belongs to C group.

2.2 Growth Potential

Growth potential of a company can be estimated by four categories – 1) continuity of the payment of dividends, 2) stability of the payment of dividends, 3) cash dividends, and 4) internal growth possibility – as a yardstick to measure the growth potential. It evaluates the corporation's growth potential as expressed in (6) by using the scoring table, which produces the scores for each category.

$$Growth\,Potential = f(x_1, x_2, x_3, x_4) \tag{6}$$

Where,

x_1 is dividend payment continuity and consists of the number of payments (x_{12}) and dividend payout ratio (x_{12}), and $x_1 = x_{11} + x_{12}$.

x_2 is dividend payment stability and consists of the increment of dividend payout ratio (x_{21}) and the change rate of net income against the change rate of dividend payout ratio (x_{22}), and $x_2 = x_{21} + x_{22}$.

x_3 is payout ratio of cash dividend

x_4 is internal growth possibility and consists of potential dividend payout ratio (x_{41}) and the return on equity (x_{42}), and $x_{41} = x_{41} + x_{42}$.

The detailed criteria for evaluating and the calculation of each index corresponding to the respective category are described Table 1.The Evaluation criteria for growth potential (ECGP) defines the candidate indices for assigning scores in each category.

Category 1: Consistency of dividend payment (x_1) - The consistency of dividend payment consists of the number of payments over the recent three years (x_{11}) and the ratio of dividend payment to net income (x_{12}). This category examines how reliable a corporation has been in making payments. It is also an index using which we can determine whether this consistency can be found in the earnest corporations in the future. Index 1–1 (x_{11}) places emphasis on reliability whether or not payments are seen over the previous three years. When it comes to minus net income where the dividend payment is unrealizable, index 1–2 (x_{12}) calculates the ratio, which is the numbers of dividend payment to the numbers of plus net income over last three years. The detailed criteria are laid out in the Category 1 section of Table 1.

Category 2: Steadiness of dividend payments (x_2) – The payout ratio is served as an indicator to assess the steadiness of dividend payments of companies. Category 2

Table 1. Evaluation criteria for growth potential (ECGP)

Category		Scoring Criteria		Score	Weight
1	x_{11}	The number of dividend payment over recent 3 years	3 times 1~2 times 0 times	0.5 0 –0.5	ω_1
	x_{12}	Ratio of the numbers of dividend payment to the numbers of plus net income over recent three years (X = the number of dividend payment / the number of net income incurred)	X = 1 0 < X < 1 X = 0	0.5 0 –0.5	
2	x_{21}	The trend of the payout ratio (payout ratio = dividend / net income * 100)	On the rise Otherwise	0.5 0	ω_2
	x_{22}	The change rate of net income (CNI) against that of the payout ratio (CPR)	CNI > CPR CNI < CPR	0.5 –1	
3	x_3	Payout ratio of cash dividend over recent 3 years (cash dividend rate = cash dividend / equity)	If increased at year (t) compared to year (t–1) Otherwise If increased at year (t–1) compared to year (t–2) Otherwise If increased at year (t-2) compared to year (t–3) Otherwise	0.5 –0.5 0.3 –0.3 0.2 –0.2	ω_3
4	x_{41}	Payout ratio	If it is within the bottom 30% If it is within the top 30%	0.5 –0.5	ω_4
	x_{42}	ROE	If it is within the top 30% If it is within the bottom 30%	0.5 –0.5	
Weight condition			$\omega_1 + \omega_2 + \omega_3 + \omega_4 = 0$ where $0 \le \omega_i \le 4 \quad (i = 1,2,3,4)$		
Grouping criteria			If weighted GP (refer to formula (4)) belongs to ① +2 ~ +4: Group A ② 0 ~ +1: Group B ③ –4 ~ –1: Group C		

examines whether the payout ratio follows growing trend (x_{21}) and the change rate of net income against that of the payout ratio (x_{22}). In some cases, companies can expand dividend payments in order to attract people, although drop in net income, which is the denominator of the payout ratio, is predicted. In order to prevent such illusions of the payout ratio, a criterion is required to recognize whether an increase is found in the dividend. In order to judge the relationship between the payout ratio and net income when the payout ratio increases, high values are given when the change rate of net income is higher than that of the payout ratio, by measuring that the increase in the payout ratio is not a result of the reduction in net income.

Category 3: Payout ratio of cash dividend (x_3) - The ratio of cash dividend that is used as an indicator to figure out the payout ratio of the cash dividend is the proportion of cash dividend in equity; an progress in the rate means that the financial structure of the respective company is sound, and profitability is moderate. Therefore, the corporation's need to save cash for the future is negligible. In other words, it represents positive prospects for

the company. In other words, it can be assumed that the growth could lead to increased value of the corporation. The ratio of cash dividend is compared with that of the last year (t–1) during the recent three years, and more weight is given to the cash dividend rate in the year closer to the current year, which weighs on the recent trend of payout ratio of the cash dividend. Values 0.5, 0.3, and 0.2 are assigned for the current year, the past year, and the year before respectively; therefore, an growth in the cash dividend rate in a more recent year scores higher while a decrease scores lower.

Category 4: Reserved growth potential (x_4) - It can be estimated that as long as ROE is not reduced, a low payout ratio can be followed by high dividend growth and the growth can lead to high dividends. Therefore, Category 4 examines whether a low payout ratio (x_{41}) and a high ROE (x_{42}) occur. Category 4 assigns higher scores when the payout ratio is within the bottom 30% while ROE is within the top 30% simultaneously, and vice versa.

Each category could change from -1 to 1. x_{11} assigns values of 0.5, 0, or –0.5 when three payments, one to two payments, or no payment are made for the recent three years, respectively. Further, x_{12} is 0.5 or –0.5 when (the number of dividend payments)/ (the number of net income occurred) for recent three years is one or zero respectively, and zero otherwise. Within Category 2, x_{21} allocates a value of 0.5 or 0 when the payout ratio increases or decreases respectively, and x_{22} is 0.5 or –1 when the variation rate of net income is bigger or smaller than the change rate of the payout ratio, respectively.

x_3 of Category 3, which examines the trend of the cash dividend rate, compares the current year's rate (t) to that of the previous year (t–1), and if a rise or fall in the cash dividend rate is turned out, 0.5 or –0.5 is allocated. Likewise, 0.3 or –0.3 is given between one (t–1) and two years (t–2) ago, and 0.2 or –0.2 is given between two (t–2) and three years (t–3) ago respectively. Lastly, in Category 4, x_{41} is 0.5 or –0.5 when the payout ratio is in the tail 30% or the head 30% respectively, and x_{42} is 0.5 or –0.5 when the ROE is in the head 30% or in the tail 30% respectively. Moreover, when classifying the corporations into three groups – A, B, and C – according to the total score values, the weights of each category are applied to analyse and adjust the effects of the categories on the final portfolio performance:

$$Weighted\ total\ score = \omega_1 x_1 + \omega_2 x_2 + \omega_3 x_3 + \omega_4 x_4 \quad (7)$$

That is, (7) varies from –4 to 4, and according to its total value, the individual company, which is DMU in case of DEA, could be classified as either group A (2 < total score < 4), B (0 < total score < 1), or C (–4 < total score < –1). The effect of changes in weights on portfolio rate of return is discussed in Section 3 with the experimental design.

3. Results and Analysis

3.1 Data for Experiments

Financial data of 78 chemical related corporations are collected out of the Korean Stock Exchange Index (KOSPI) and Korea Securities Dealers Association Index (KOSDAQ) that were listed on the Korea Exchange (KRX) from 2006 to 2010. We denote PM_{DEA} and PM_{GP} as a portfolio construction strategies using the DEA and growth potential, respectively. In order to verify the performance of portfolio constructed by the proposed strategies, rate of return for the market and the portfolio for four years from 2007 to 2010 are used for comparison. The details of the data collection and the period of assessment are as follows:

- Target: 78 corporations in chemical sector listed on KRX (KOSPI and KOSDAQ)
- Period: From 2007 to 2010 (data of 2006 were collected for 2007)
- Measures: Rate of return against benchmark portfolio, Sharpe Ratio, Jensen's alpha and the information ratio (IR)
- Assessment period: once per annum (constructed at the beginning of a year and assessed at the end of the year)

3.2 Analysis on Rate of Return

The portfolio results constructed by PM_{DEA} and PM_{GP} strategies show the numbers of stock item belonging to A, B and C group as illustrated in Figure 3. In case of PM_{GP}, relatively lots of stocks are included in B group, and PM_{GP} trategy classified stocks into A group more than PM_{DEA} except year of 2007. Table 2 summarises rate of return classified by group according to strategies PM_{DEA} and PM_{GP}, and corresponding rate of return of benchmark.

Figure 4 shows that the rate of return of portfolio was calculated based on the weighted average market capitalisation, and that of benchmark portfolio was computed using KOSPI index for the same time period as the proposed strategies. It can be seen that, except for the year 2009, as a whole the rate of return of group A is excellent compared to those of groups B and C. In 2008, a recession

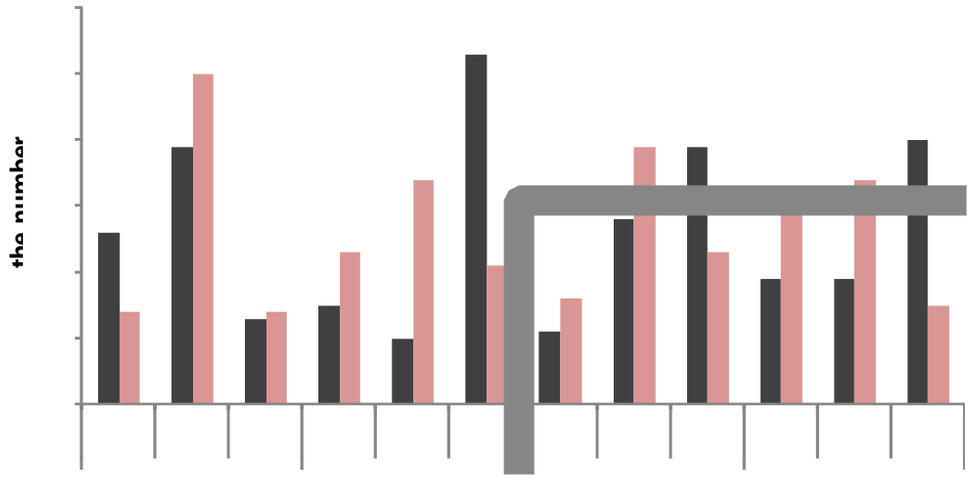

Figure 3. The number of stock items belonging to each portfolio group constructed by PM_{DEA} and PM_{GP} strategies.

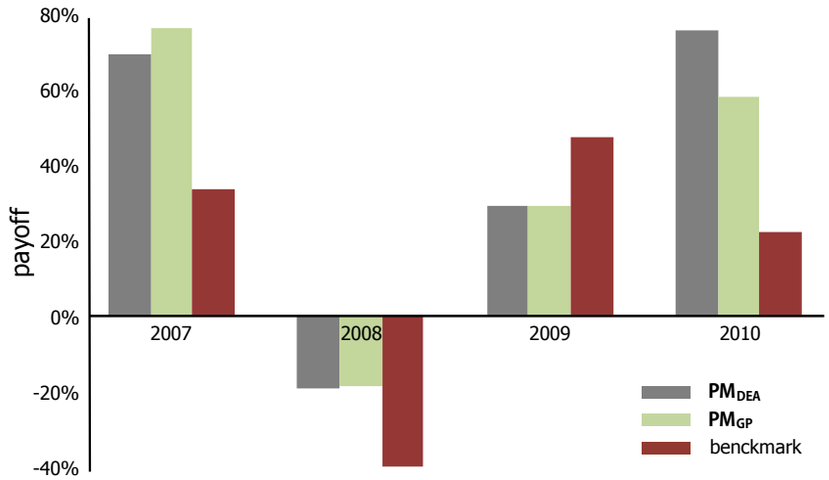

Figure 4. Performance comparison among PM_{DEA} (Group A), PM_{GP} (Group A), and benchmark portfolio

in the financial markets caused by the subprime mortgage event depreciated the overall return, but most portfolios constructed by PM_{DEA} and PM_{GP} strategies except for the C group by PM_{GP} show higher rate of return than the benchmark portfolio return (–39%) for the same year. In addition, it can be seen that the loss seen less negative as –18% and –19% respectively for year 2008, whereas it was –39% for benchmark.

3.3 Performance Evaluation

In general, volatility of returns, Sharpe ratio, Jensen's alpha and IR are indicators for measuring portfolio performance. Sharp ratio is an indicator that measures the extent of the excess returns to the unit risk of the portfolio and can be expressed by (8).

$$Sharp\ Ratio = (R_i - R_f)/\sigma_i \quad (8)$$

Table 2. Performance comparison between proposed strategies and benchmark in terms of rate of return

Year	PM_{DEA}			PM_{GP}			Benchmark
	A	B	C	A	B	C	
2007	66%	4%	31%	73%	72%	–8%	32%
2008	–19%	–18%	–22%	–18%	–38%	–44%	–39%
2009	28%	76%	61%	28%	78%	59%	45%
2010	72%	19%	53%	56%	18%	99%	21%

Table 3. Evaluation of portfolio performance in terms of 4 indicators

Group	PM_{GP}				PM_{DEA}			
	Volatility	Sharp Ratio	Jensen's Alpha	IR	Volatility	Sharp Ratio	Jensen's Alpha	IR
A	42%	77%	26%	57%	40%	75%	24%	53%
B	40%	39%	9%	15%	54%	52%	17%	40%
C	37%	71%	19%	45%	65%	34%	13%	24%

Where,

R_i rate of return of portfolio i

R_f risk free rate of return (treasury notes with three year maturity)

σ_i standard deviation of portfolio i

Jensen's alpha means an indicator of how high a rate of return than the return of portfolio under condition of balance, i.e. the rate of return of portfolio minus the expected return and is expressed by (9).

$$Jensen's\ Alpha = (R_i - R_f) - \beta_p (K_i - R_f) \quad (9)$$

Where,

β_p beta of portfolio

K_i rate of return of market

IR represents the excess return divided by the tracking error of the portfolio as an indicator to measure the ability of the portfolio manager, and also known as Reward-to-Variability Ratio (RVR). For all three measurements, the higher measured values are, the higher investment value is, and in practice in the United States evaluated to have "excellent" if around 50% in the case of IR. IR is defined in (10).

$$IR = (R_i - K_i) / TR \quad (10)$$

Where,

TR standard deviation of tracking error

Table 3 shows the performance of a portfolio constructed by PM_{DEA} and PM_{GP} strategies for each group. According to Table 3, we can find that the performance of all group A portfolios constructed by PM_{DEA} and PM_{GP} strategies is relatively high, and in the case of IR, A and 53% of each group as 57% and it is higher than 50% can be seen. In the case of IR, group A portfolios constituted by Both PM_{DEA} and PM_{GP} strategies recorded 57% and 53% respectively. Also, 4-year average volatilities of returns for groups A, B and C portfolios constructed by PM_{DEA} and PM_{GP} strategies are 40% and 53%, respectively. That is, the deviation of rate of return by PM_{DEA} strategy is lower than that by PM_{GP} strategy.

4. Conclusion

This study presents a method to consider a portfolio of business management efficiency and growth potential for companies listed on the KOSPI chemical industry study. The proposed method for construction of portfolio employs DEA technique and the evaluation criteria for growth potential table (ECGP). This approach is based on the theory that business management efficiency and

dividend payout ratio will affect the future prospects of the stock price. The portfolio construction using ECGP is based on the theory that dividend activity can influence future prospects. Unlike simple classic portfolios that discern only high dividend stocks, the portfolio proposed in this study, which estimates the quality of stocks using ECGP, has proved its effectiveness in comparison with the rate of return for the market portfolio (KOSPI). In addition, the performance of the two investment portfolio strategies presented in this study is validated through the comparison with that of benchmark market. Because the business management efficiency and the growth potential of corporations is an important yardstick for decision making of fund management, further investigation over the nation's five largest industries including the semiconductor, automotive, construction, ship building related companies as well as chemical sectors will be valuable future research.

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