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Choosing Third-Party Logistics for Biomedical Companies with Improved CAPM Model

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Abstract: Biomedical industry is an emerging industry in China, where new companies are not good at selecting special third party logistics. This paper analyzed the domestic and international research in this region first, then made some improvements and extension on capital asset pricing model for the choice of biomedical logistics enterprises, pointing out that the total relatively expected cost of choosing a third party biomedical logistics company should include risk-free offer cost, cost of risk loss, as well as the adjustment of risk loss influenced by the discrepancy of risk loss volatility between some third-party logistics and the market. Therefore, the factors used to appraise the third-party logistics in the biomedical industry are transferred to be the cost factors, and expressed with the form of price. Then, a case study is also given to get a better understand of this approach. Ultimately, this paper proposed an easy but feasible way to calculate the total relatively expected cost of choosing third-party biomedical logistics, helping biomedical products enterprises to choose the third-party logistics with quantitative standards. *Copyright © 2013 IFSA.*

Keywords: Biomedical products, Biomedical logistics enterprises, Improved CAPM, Total relatively expected cost.

1. Introduction

Biomedical industry is an emerging industry in China, which are developed with fast increase of GDP and improvements in medical technology. The same as other industry, when market of biomedical products grew big enough, special logistics enterprises are beginning to appear. The appearance of special biomedical products logistics enterprises improved efficiency of biomedical products logistics and motivated biomedical industry in return. On one hand, not all the logistics enterprises could ship biomedical products due to the special requirements of time and temperature. On the other hand, there is rigid control over the qualification of biomedical products logistics by the government. Therefore, there are only a few special biomedical logistics enterprises. Since there are already some biomedical logistics enterprises in the market, biomedical product companies would have right to select the right logistics enterprises for the purpose of assuring products quality and saving cost. As there are only a few biomedical logistics enterprises in the market and saving cost is of great significance to new founded companies, it is possible and worth to develop a quantitative model to measure the goodness of biomedical logistics enterprises.

Cost and revenues are a unity of opposites. Therefore, this paper would improve CAPM (capital asset pricing model) by transforming the concept of

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revenues to cost under the basic principles of CAPM and some assumptions. Through comparing the total cost that they would spend if chose a certain biomedical logistics companies, biomedical products companies could make their optimal decisions from the view of cost accurately and easily.

2. Literature Reviews on the Methods of Third Party Logistics Selection

In the early of 1990s, there were already a few scholars who have put forward the advantages of selecting third-party logistics and the originals of third party logistics enterprises. Then, scholars began to consider how to choose third-party logistics and put forward their own proposals on the procedures of third party logistics selection. Gooley (1993) [1] proposed that in international business, selecting third party logistics providers should consider the following four steps: establish goals, identify candidate companies, ask for quotes, gather and focus on the details. Seyed-Mahmoud Aghazadeh (2003) [2] proposed that when selecting third-party logistics service providers (ISPs), employers should follow these five steps: making decisions, identify standards and objectives, selection, choose the best suppliers, and cooperation. David (2008) [3] proposed that to successfully established good relationships with suppliers should follow five steps: 1) lists the advantages of the region; 2) focus on assessing your strengths and weaknesses; 3) seeking to determine your strengths; 4) list suppliers who meet your needs; 5) consider human factors seriously. At the same time, scholars also launched hot discussion for third-party logistics provider selection criteria. Mohan K. Menon (1998) [4] proposed that third-party logistics service provider selection criteria can be divided into two categories: Perceived performance and perceived capabilities. Perceived performance includes punctuality performance, performance of ability to fulfill promises, effectiveness of senior leadership and the fault rate of senior leader; perceived capabilities include perceived management and creation abilities and perceived financial soundness. Ackerman Ackerman (2000) [5] considered that in the evaluation of potential third-party logistics providers, employers can refer to the following fourteen criteria: market coverage, inventory management and control, order receiving and processing system, pick and pack, order fulfillment, assembly, packaging and value added activities, credit rating, invoicing, credit and collection, pre-sorting capabilities, returns processing, traceability, management structure, organization, strategic direction, financial stability. America magazine INDUSTRYWEEK magazine (2009) [6] introduced the opinions of Marc Tanowitz on how should manufacturers choose third-party logistics providers. There are five basic elements according to Marc Tanowitz, who is a senior leader of a third party outsourcing consulting company: 1) Know your needs; 2) Control forecast; 3) Require responsibility; 4) Establishment of clear and direct expect; 5) Measure business results. Szakonyi (2011) [7] proposed that selecting third-party logistics provider should be based on experience, technology, transport mode, partnerships and safety.

Based on the above analyses, it is easy to find that as the selection of third party logistics provider is a complex thing, most of the researchers are focused on qualitative methods, while quantitative methods are not placed with enough emphases. Currently in practice, some biomedical products companies evaluate the third party logistics by calculating the actual average cost of logistics enterprise. But this is only the actual costs including third-party logistics companies offer cost and the average damage or loss caused in distribution. This part of loss did not consider the size of the average risk of loss. Consequently, if the two logistics companies to be compared not only charge the same price, but also have the same average loss rate caused by transporting, how to choose? At this point, biomedical products companies still can compare the average loss volatilities, namely the size of variance. However, in reality, there is may also the situation that the third party supplier not only offer the same prices with the same average loss caused by transporting, but also have the same variance of the average size of the loss. In this time, how should biomedical products companies make decisions?

In view of this situation, this paper started with the purpose of comparison and merely calculated the relative costs. According to the basic principles of classic western finance capital asset pricing model, this paper pointed out that the total expected relative cost should include risk-free offer cost, cost of risk loss, as well as the adjustment of risk loss influenced by the discrepancy of risk loss volatility between some third-party logistics and the market.

3. The Building of Improved CAPM for Biomedical Products Companies

3.1. Basic Assumptions

CAPM is a classical model of western finance, whose deduction is based on a few assumptions. When improving CAPM under the surroundings of biomedical products logistics, it is essential to take these assumptions into consideration. Besides, in order to deduct the improved CAPM model, we should also add some new assumptions to simplify the model.

H1: The optional third-party biomedical logistics businesses that biomedical products enterprises face is the entire third-party biomedical logistics enterprises market.

As for biomedical products enterprises, gathering the information of all third-party logistics companies

on the market is a huge project, plus each third-party logistics enterprise's actual situation is also in flux, it is not feasible to take the whole party logistics enterprise market as inspection object in practice. However, the number of third-party logistics enterprises a certain biomedical products company can understand and choose is limited. If these businesses that have been known were taken as entire third-party biomedical logistics enterprise market, the calculation would be easier. Businesses can get the information directly from third-party logistics enterprises, or from their own historical data statistics. There are not many biomedical logistics enterprises in the market. Moreover, the biomedical logistics enterprises do not know have little influence to them. Consequently, we could make this assumption.

H2: Biomedical products companies do not have bargaining power and discounts optional third-party biomedical logistics companies. They are the recipient of the third party biomedical logistics companies' proposed offers.

This paper assumed there are no bargaining power and no ability to obtain volume discounts for biomedical products companies. This is also the basic assumption of CAPM.

H3: Biomedical products companies' logistics cost is proportional to the quantity of products. Namely, each unit of product's cost is same.

Under this assumption, the third-party biomedical logistics company offer is proportional to the number of products.

H4: The value of per unit of product is same.

This is an important assumption of this model, which is of great importance in the calculation of the adjustment of risk loss influenced by the discrepancy of risk loss volatility between some third-party biomedical logistics and the market.

H5: Biomedical products enterprises go after the goal of minimum cost.

The purpose of a business is to make profit. In general, there are two ways to make more profit, namely increasing revenues and reducing costs. Realizing the lowest cost is biomedical products companies' driving force to seek and try more cost-cutting methods.

H6: Biomedical products companies own adequate information of optional third-party biomedical logistics enterprises.

In order to make scientific decisions, biomedical products companies need the information of transportation risk about the optional third-party biomedical logistics enterprises. This part of information could be got either from optional third-party biomedical logistics companies, or from the historical data of other businesses or biomedical products enterprises themselves.

H7: there are no tax differences and transaction costs

This is also an assumption from original CAPM.

H8: other subjective factors are not considered, such as the relationship between biomedical products companies and third-party biomedical logistics enterprises, customer preferences, etc.

In the actual delivery process, biomedical logistics companies' selection decision of third-party biomedical logistics enterprise may be influenced by their mutual relationship. In addition, hospitals and pharmacies may have special preferences over the third party biomedical enterprises, which may also influence biomedical products companies' decision.

Based on above eight fundamental assumptions, this paper would improve CAPM in the surroundings of making third-party biomedical logistics selection decisions. In the following part, this paper made a few new assumptions so as to make calculation and illustration simple and easy to understand.

3.2. The Building of Improved CAPM for Biomedical Products Enterprises

Suppose there are n kinds of products for a certain biomedical products company. Cik represents the expected cost of selecting the third party biomedical logistics company i or the third party biomedical logistics enterprises portfolio i to ship a unit of product k. ak stands for the quantity of product k. consequently, the expected cost of selecting the third party biomedical logistics company i or the third party biomedical logistics portfolio i to ship product k Ct is equal to:

$$C_t = \sum_{k=1}^{n} C_{ik} * a_k \tag{1}$$

Based on the above assumptions, this paper would divide the selection of third party biomedical logistics enterprises into three situations according to the offers of third party biomedical logistics enterprises and the similarity of average lost value of per unit product. In order to simplify the calculation, this paper made the following assumption:

Biomedical products companies only ship one kind of product A, and Ci represents the expected relative delivery cost of one unit of product.

3.2.1. Case1: Optimal Third Party Biomedical Logistics Enterprises Have Same Offer and Same Average Lost Value of Per Unit Product

This paper would take revenues of CAPM as costs, and take the offers of third party biomedical logistics enterprises as risk-free cost. Thus, this paper got the cost model of third party biomedical logistics enterprises selection based on CAPM:

$$C_i = C_F + \beta_i (C_m - C_F), \tag{2}$$

where C_i is the expected relative cost of selecting the third party biomedical logistics company i or the third party biomedical logistics enterprises portfolio i to ship a unit of product A; C_F is the offer of optimal third party biomedical logistics company or the third party biomedical logistics enterprises portfolio to ship a unit of product A; β_i is the sensitivity coefficient of the third party biomedical logistics company i or the third party biomedical logistics enterprises portfolio i to the fluctuation of average loss of per unit of product A; C_m is the average total cost of all the third party biomedical logistics enterprises.

In it, average lost value of per unit product refers to the loss caused by the third party biomedical logistics company during the transportation of one unit of product. That is, loss per unit of product is equal to the quotient between the total loss during transportation and the quantity of products.

β's calculation method is as follows:

$$\beta_i = \frac{Cov(c_i, c_m)}{Var(c_m)} = \frac{\sum_{t=1}^{n}\left[C_{it} - \overline{C}_i\right]\left[C_{mt} - \overline{C}_m\right]}{\sum_{t=1}^{n}\left[C_{mt} - \overline{C}_m\right]^2}, \quad (3)$$

where $Cov(c_i, c_m)$ refers to covariance between the loss of per unit of product of selecting the third party logistics company i and the average loss of per unit of product of all the third party biomedical logistics companies. $Var(c_m)$ refers to the variance of average loss of per unit of product of all the biomedical logistics enterprises. C_{it} refers to the loss of per unit product of the third party biomedical logistics company i in time t; $\overline{C}_i$ refers to the average loss of per unit product of the third party biomedical logistics company i; C_{mt} refers to the average loss of per unit product of all the third party biomedical logistics enterprises in time t; $\overline{C}_m$ refers to the average loss of per unit product of all the third party bio-medical logistics enterprises.

3.2.2. Case2: Optimal Third Party Biomedical Logistics Enterprises Have Same Offer but Different Average Lost Value of Per Unit Product

In this case, as for each optional third-party logistics companies, the average value of the loss per unit of product is different, but its average value of the loss per unit of product there may fluctuate with same sensitivity coefficients. As the capital asset pricing model assumes that all securities have the same risk would have the same income, this situation does not meet the capital asset pricing model assumptions and could not be solved with original CAPM directly. In the case of capital asset pricing model, selecting the third party biomedical logistics company i or third-party logistics enterprise risk portfolio i is expected to cost βi (Cm-CF), which includes not only the average loss of selecting the third party biomedical logistics company i or portfolio of some third-party biomedical logistics companies i, but also the loss of risk fluctuation of choosing that third party biomedical logistics company or portfolio compared with all the third party biomedical logistics enterprises.

If sensitivity coefficient of the third party biomedical logistics company i or the third party biomedical logistics enterprises portfolio i to the fluctuation of average loss were equal to 1, that is, the third party biomedical logistics or biomedical logistics portfolio risk is equal to the average of all the third-party biomedical logistics enterprises, and the corresponding loss of risk fluctuations would be 0. Consequently, the total expected cost is equal to the third party logistics enterprises in the offer plus the average loss of choosing that biomedical logistics company in the history.

If sensitivity coefficient of the third party biomedical logistics company i or the third party biomedical logistics enterprises portfolio i to the fluctuation of average loss were smaller than 1, that is, the third party biomedical logistics or biomedical logistics portfolio risk is less than the average of the third-party biomedical logistics enterprises, and the corresponding loss of risk fluctuations would be less than 0. Consequently, the total expected cost is less than the third party logistics enterprises in the offer plus the average loss of choosing that biomedical logistics company in the history.

If sensitivity coefficient of the third party biomedical logistics company i or the third party biomedical logistics enterprises portfolio i to the fluctuation of average loss were bigger than 1, that is, the third party biomedical logistics or biomedical logistics portfolio risk is bigger than the average of the third-party biomedical logistics enterprises, and the corresponding loss of risk fluctuations would be bigger than 0. Consequently, the total expected cost is bigger than the third party logistics enterprises in the offer plus the average loss of choosing that biomedical logistics company in the history.

In summary, the expected total relative cost of selecting the third party biomedical logistics company i or the third party biomedical logistics enterprises portfolio i to ship a unit of product A Ci is equal to:

$$C_i = C_F + \overline{C}_{ik} + (\beta_i - 1) * (C_m - C_F) \quad (4)$$

$\overline{C}_{ik}$ refers to the average loss of per unit product of the third party biomedical logistics company i or portfolio in time k; other letters are the same with situation 1.

3.2.3. Case3: Optimal Third Party Biomedical Logistics Enterprises Have Different Offers and Different Average Lost Value of Per Unit Product

In this case, as optimal third party biomedical logistics enterprises have different offers, it fits the assumptions of CAPM even less compared with situation 2. However, compared with situation 2, it is the same except the offer. Deduce according to situation 2, we could get the conclusion that the total expected relative cost should include risk-free offer cost, cost of risk loss, as well as the adjustment of risk loss influenced by the discrepancy of risk loss volatility between the third-party biomedical logistics company or portfolio and the market. Of course, there is some difference. As the offers are different, should also be adjusted to the difference between the average total cost of optimal third party biomedical logistics enterprises and the average offer.

In summary, the expected relative total cost of selecting the third party biomedical logistics company i or the third party biomedical logistics enterprises portfolio i to ship a unit of product A Ci is equal to:

$$C_i = C_{Fi} + \overline{C}_{ik} + (\beta_i - 1) * (C_m - \overline{C}_F) \qquad (5)$$

In this formula, $\overline{C}_F$ refers to the offer of optimal third party biomedical logistics company or the third party biomedical logistics enterprises portfolio i to ship a unit of product A; $\overline{C}_{ik}$ refers to the average loss of per unit product of the third party biomedical logistics company i or portfolio in time k; $\overline{C}_F$ refers to the average offer of optimal third party biomedical logistics company or the third party biomedical logistics enterprises portfolio to ship a unit of product A; other letters are the same with situation 1.

4. Case Study

A company has 350 units of biomedical products to distribute in the April of 2013. X, Y and Z are three logistics that could offer the service at \$8, \$8 and \$8.3 for each unit of the products. This kind of biomedical products worth of \$100 per unit. The historical data of loss caused by the above shipping companies is shown in Table 1.

First, we need to calculate the average lost value of 1 unit biomedical products in each month, as is shown in Table 2.

Then, we could compute the sensitivity coefficient of X, Y, Z to the fluctuation of average loss of per unit product. The average total cost and total offer price could also be gained. β_x is the sensitivitity coefficient of X company, while similarly, β_Y and β_Z are the sensitivitity coefficient of Y company and Z company.

Table 1. Historical loss data caused by logistics companies.

Quantities / Logistics / /loss / Month	X	Y	Z
January	200/200	100/130	50/50
February	200/180	80/72	50/40
March	200/220	100/80	20/18

Table 2. Average lost value of 1 unit biomedical products per month for logistics companies.

loss / Logistics / per / unit / Mont	X	Y	Z	Average/Month
January	\$1	\$1.3	\$1	\$1.1
February	\$0.9	\$0.9	\$0.8	\$0.867
March	\$1.1	\$0.8	\$0.9	\$0.933
Average of X,Y,Z	\$1	\$1	\$0.9	\$0.967

$$\beta_X = \frac{\sum_{t=1}^{n}\left[C_{xt}-\overline{C}_x\right]\left[C_{mt}-\overline{C}_m\right]}{\sum_{t=1}^{n}\left[C_{mt}-\overline{C}_m\right]^2} = \frac{(0.9-1)*(0.987-0.967)+(1.1-1)*(0.933-0.067)}{(1.1-0.967)^2+(0.867-0.967)^2+(0.933-0.967)^2} = \$0.2288 \quad (6)$$

$$\beta_Y = \frac{\sum_{t=1}^{n}\left[C_{Yt}-\overline{C}_y\right]\left[C_{mt}-\overline{C}_m\right]}{\sum_{t=1}^{n}\left[C_{mt}-\overline{C}_m\right]^2} = \$1.9657 \quad (7)$$

$$\beta_Z = \frac{\sum_{t=1}^{n}\left[C_{Zt}-\overline{C}_Z\right]\left[C_{mt}-\overline{C}_m\right]}{\sum_{t=1}^{n}\left[C_{mt}-\overline{C}_m\right]^2} = \$0.8078 \quad (8)$$

$$\text{Total Cost } C_m = \frac{8+1+8+1+8.3+0.9}{3} = \$9.067 \quad (9)$$

$$\text{Average offer } \overline{C}_F = \frac{8+8+8.3}{3} = \$8.1 \quad (10)$$

With the above information, we could calculate the total relatively expected cost when shipping one unit of biomedical product. CTX, CTY, CTZ are total relatively expected cost of X, Y and Z company.

$$C_{TX} = C_{FX} + \overline{C}_{XK} + (\beta_X - 1)*(C_m - \overline{C}_F) = 8+1+(0.2288-1)*(9.067-8.1) \quad (11)$$

$$C_{TY} = 8+1+(1.9657-1)*(9.067-8.1) = S9.9338 \quad (12)$$

$$C_{TZ} = 8.3+0.9+(0.8078-1)*(9.067-8.1) = S9.0141 \quad (13)$$

By comparison, we could find that the total relatively expected cost of X is the lowest, therefore, it the optimal choice for A company. For Y, though the offer and average loss of per unit product are the same with X, the total relatively expected cost is obviously higher, for the reason of high risk fluctuation cost. What is more, Y company's total relatively expected cost is even higher than Z company, whose offer price is much higher.

If a company needs to ship several kinds of products, they could calculate out the total relatively expected cost of each product first, then weight these total relatively expected costs with their quantities to get the overall total relatively expected cost.

5. Managerial Implications

The above three cases have already covered the situation of choosing third-party logistics in biomedical industry fundamentally. By comparing the expected costs of various optional third-party biomedical logistics companies or third-party biomedical logistics enterprise portfolio, biomedical businesses can clearly understand the cost gap of different choices between different third-party biomedical logistics enterprises. For those large biomedical products companies who have bargaining capacity with the third-party biomedical logistics enterprise, this method could also be helpful in determining the required minimum discount when selecting a certain biomedical logistics company. This minimum discount refers to the discount that makes the total expected cost of choosing a certain biomedical logistics company be the lowest compared with other choices. For the large biomedical products businesses that have their own logistics systems, this model can also be used for comparing the cost with other third party biomedical logistics enterprises and selecting third party biomedical logistics enterprises when necessary with the consideration of cost.

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