Customer Lifetime Value Promotion Strategy Analysis Based

on System Dynamics model

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Abstract: Customer lifetime value (CLV) is the core content of customer relationship management. With the increasingly fierce market competition, more and more enterprises realize the importance of maintaining long-term strategic partnership with customers. In this paper, we established a system dynamics model of CLV and use SF Company as an example. The model simulation results showed that the intensity of competition, price levels and investment levels all affect CLV. Reducing the intensity of competition can increase the CLV. More investment will raise service quality and then promote CLV. Reducing the price level increases CLV in the short term. However, in the long run, less income leads to less profit and less investment which can decrease CLV.

Keywords: customer lifetime value; system dynamics; Modeling and Simulation

1. Introduction

Customer lifetime value (CLV), or sometimes known as lifetime customer value or lifetime value, is the net present value of the cash flows attributed to the relationship with a customer (Shaw & Stone, 1988).. CLV plays an important role in customer segmentation management, helping companies to identify quality customers and reflecting companies' marketing achievements and predict their future profits (F. Robert Dwyer, 1989; Ma Te 2011).

In recent years, the express delivery market in China enjoys a rapid growth at a rate of more than 30% per year, and the amount of registered express enterprises in the Trade and Industry Bureau has reached 2000 (Liu Xiaohong 2011). In such a highly competitive environment, it is full of strategic significance for express companies to find policies to increase CLV value.

Based on the concept of CLV, the calculation model of CLV is the sum of the discounted value of company's profit throughout the life cycle of a client, as presented by equation 1.

$$\text{CLV} = \sum_{t=1}^{n} a_t (1+d)^t \qquad (1)$$

where a_t is profit earned from a customer's purchasing in year t; n is the length of life cycle (in years); d is the discount rate per year.

As profit is income minus cost, 4 factors—income, cost, life cycle and discount rate—affect the CLV.

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The income

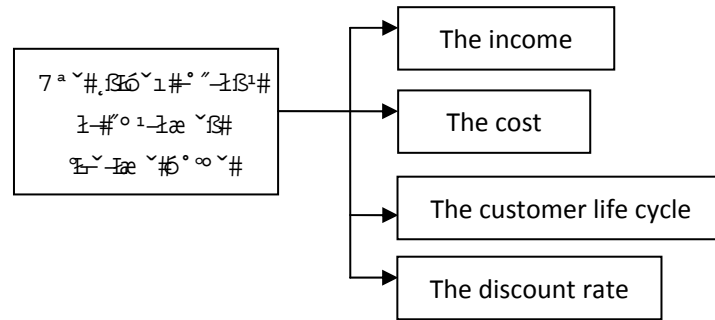The cost

The customer life cycle

The discount rate

Figure 1 Impact factors dividing diagram

Income is directly determined by price: the higher the prices, the more the company's income. However, the management should not only consider the current income, but need to take into consideration of future income. Future income can be divided into the purchase of existing customers and attracting new customers. Higher price might cause lost of existing customers and fewer new customers. At the same time, higher customer satisfaction can generate positive reputation and new customers. Reasonable price levels and high-quality service is the premise of good customer satisfaction. And high-quality service mainly relies on the company's investment in hardware and software. For example, updating equipment and systems can usually improve the efficiency service and training of employees can raise their service quality. Meanwhile, these investments will raise the cost of operation. We apply system dynamics model to study how price level and investment level affect CLV in the long run. A famous Chinese express company SF is used as a case for this study.

The rest of the paper is organized as follows: we introduce the system dynamics model in section 2, and analyze simulation results of different scenarios in section 3. In section 4, we provide our conclusion.

2. The model of system dynamics

System dynamics builds model based on the casual structure of the feedback loops in the system. Differential equations are adopted in system dynamics models to capture the accumulation process. The reason we select system dynamics to study the CLV is: firstly, CLV needs to be studied from a long-term perspective; secondly, CLV is affected by many factors with dynamic and feedback features. System dynamics applies feedback loop to investigate problems dynamically which can compensate the defects of static models which might end up at local optimization, not global optimization.

2.1. Subsystems

As we analyzed above, income, cost and customer life cycle all affect CLV. At the same time, these factors are affect and are affected by customer satisfaction. As a result, we divide the whole system into 4 subsystems—income, cost, customer life cycle and customer satisfaction.
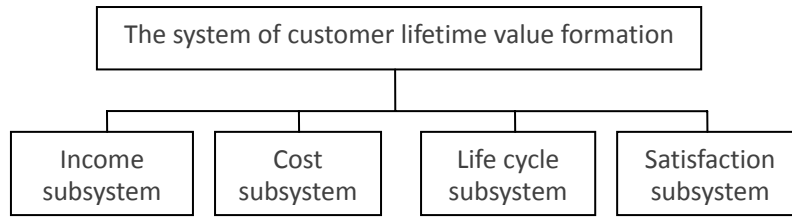
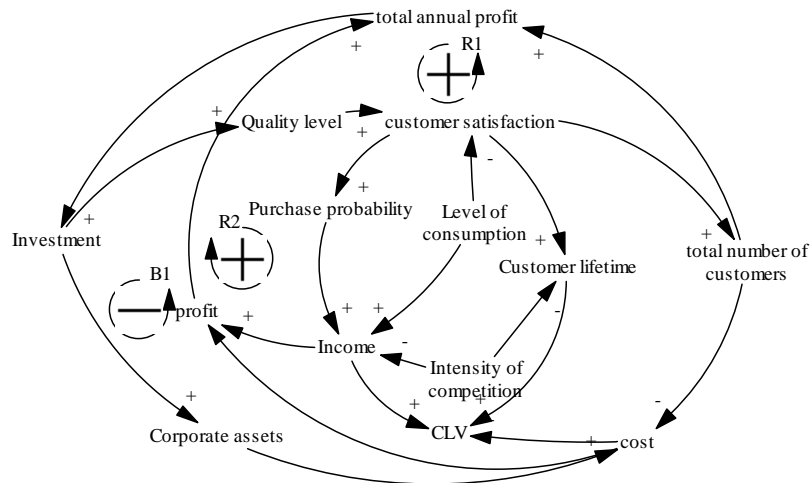Figure 2 The division of subsystem diagram

2.2. Causal loop diagram

Figure 3 System causal diagram

There are two positive feedback loops (R1, R2) and a negative feedback loop (B1) in the causal loop diagram.R1: When a company increases investment, customer satisfaction will rise as service quality is improved. As a result, the total number of customers will go up, and then the total profits will naturally go up, which in turn prompted the increase of investing amount. R2: The increase of customer satisfaction, after enhancing investing amount, leads to incremental purchase from existing customer, which in turn improves profit and investment. B1: After the rise of investment, cost will go up leading to decrease profits and investment.

Price levels have dual influence for income. On one hand, the rise of price levels means higher income for each service. On the other hand, it will also lower customer satisfaction so that existing customer might purchase less and fewer new customer will be attracted.

2.3. Stock and flow diagrams

Based on the above-mentioned causal loop diagram, we will introduce the 4 subsystems' structure.

1) Income subsystem

The subsystem describes the change of the income. Income is defined as average annual revenue brought by each customer to the company and it is determined by income growth rate. Income growth rate can be either positive (when the income increases) or negative (when the income decreases). It is the difference between the expected income and current income divided by income adjustment time. Expected income is decided by purchase probability, intensity of

competition and average income. Purchase probability, which is determined by customer satisfaction, quantifies customer purchasing intension, and its value is between 0 and 1. If the customer satisfaction of a certain company is higher than the average one in the market, the probability of purchasing the company's products will go up. Intensity of competition makes a negative influence on expected income. It is measured by the reciprocal of a company's market share. The average income is the product of the price levels and the number of times that each customer purchases the corporate's service annually.
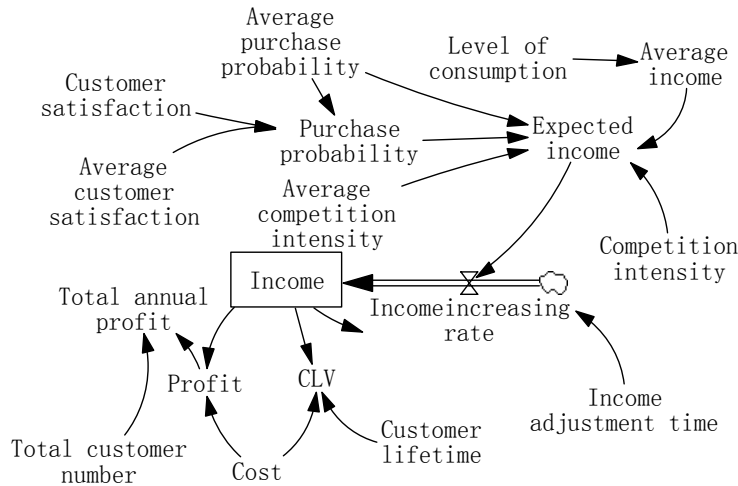

Figure 4 Stock and flow system of Income subsystem

The followings are the main equations in this subsystem:

$$\frac{d\,\text{Income}}{d_t} = \text{Income increasing rate} \tag{2}$$

Purchase probability = average purchase probability * (customer satisfaction / average customer satisfaction) (3)

CLV = (income-cost)* customer lifetime (4)

2) Cost subsystem

This subsystem describes the changes of cost, the total number of customers, and corporate assets. Firstly, cost, which is decided by cost changing rate, is average expenses paid by company on every customer yearly. Cost changing rate is the difference between expected cost and cost divided by adjustment time of cost. The expected cost is the sum of annual variable costs (assume it does not change in current study) and the fixed cost (which is the annual depreciation of assets allocated to each customer). Thus cost is determined by depreciation, which is directed related to company assets and the total number of customers. The company assets are based on annual investment and its depreciation. Investment accounts for a certain proportion of annual profits (the rate of investment). Moreover, the total number of customers is decided by the customer number changing rate in the range of the total market demand, and when they are positive, the total number of customers will increase, otherwise it will reduce. The variation of customers, which is decided by customer satisfaction, will rise if it is higher than the market average customer satisfaction.
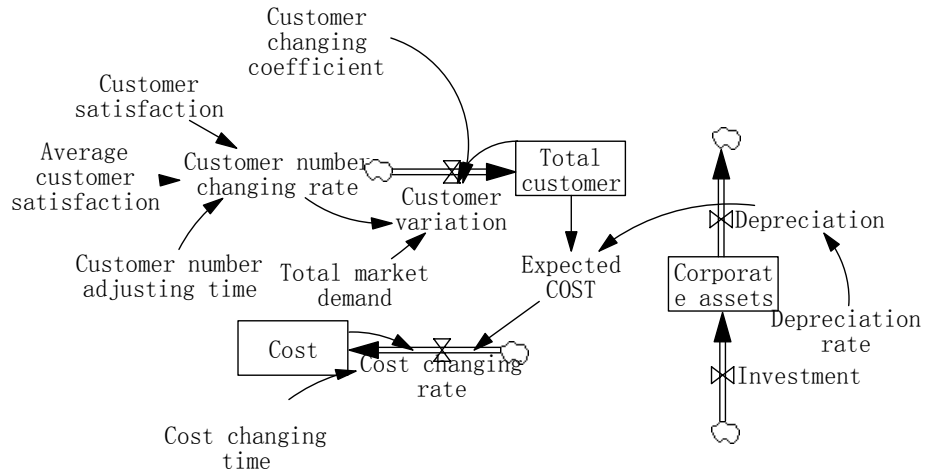
Figure 5 Income subsystem flow diagram

The followings are the main equations in this subsystem:

$$\frac{d_{Cost}}{dt} = cost\ changing\ rate \tag{5}$$

The total number of customers(t) = the total number of customers(t-1) + customer variation (t) （6）

Corporate assets (t) = Corporate assets (t-1) + investment (t) - depreciation (t) （7）

3) The customer life cycle subsystem

The system describes the changes of customer lifetime. The customer lifetime, years as a unit, refers to the length of time of a customer to maintain stable relationship with a company. However, it cannot unlimitedly prolong. In fact, customer lifetime is decided by the lifetime changing rate in the range of maximum lifetime. When being positive, it presents the ascending of life cycle, on the contrary descending. And also the lifetime changing rate is determined by the customer satisfaction and the intensity of market competition. When customer satisfaction is higher than average customer satisfaction in the market, it can promote current customers to keep a longer customer relationship and extend the customer lifetime.
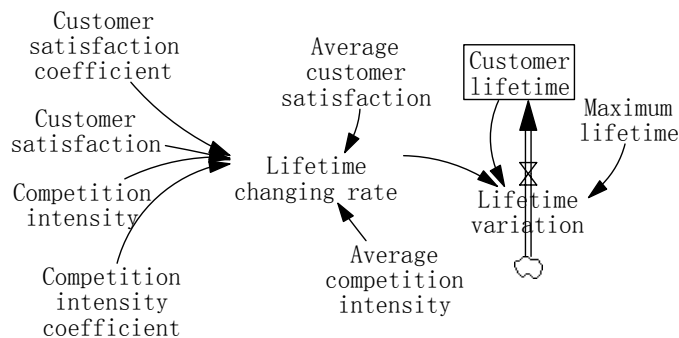

Figure 6 The life cycle subsystem flow diagram

The followings are the main equations in this subsystem:

Customer lifetime (t) = Customer lifetime (t-1) + lifetime variation (t) （8）

Lifetime changing rate = (average competition intensity / competition intensity -1)* competition

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intensity rate + (customer satisfaction / average customer satisfaction -1) * customer satisfaction rate

（9）

4) The customer satisfaction subsystem

This subsystem describes the changes of customer satisfaction. The customer satisfaction, whose value is between 0 and 1, is to demonstrate whether customers are satisfied with the company's service or not. And it can be decided by the changing rate of customer satisfaction: the difference between expected customer satisfaction and customer satisfaction divided by the time of perception of customer satisfaction. The expected customer satisfaction is determined by the perceived service quality and price levels. Hence, when the quality that customers have perceived is much higher or the price level of service is lower than the industry average, the satisfaction will naturally go up. Perceived quality is propositional to the level of quality, but it has delay. Furthermore, the level of quality is based on the changing rate of quality level determined by annual investment and the assets' depreciation of the corporate. If investment is greater than depreciation, it means that the company would still has extra investment to update hardware and software in order to enhance the quality of service except for the compensation for the depreciation, which makes the changing rate of quality level positive and makes the level of quality increase. In addition, the annual investment is the product of the total annual profit and the rate of annual investment.
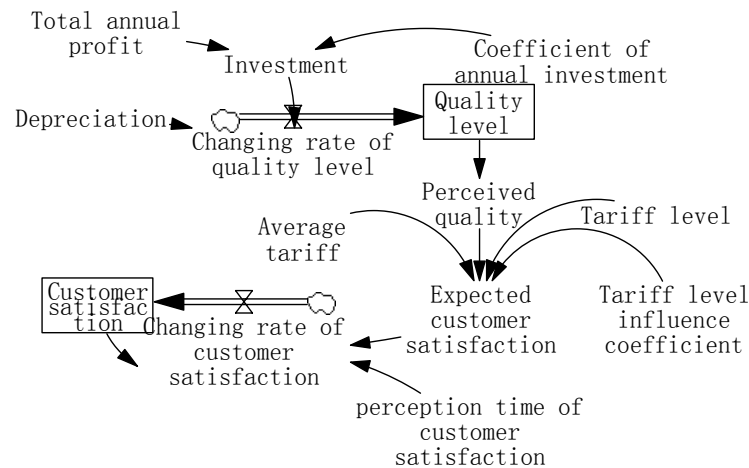

Figure 7 Customer satisfaction subsystem flow diagram

The followings are the main equations in this subsystem:

$$\frac{d\text{Customer satisfaction}}{dt} = \text{Changing rate of customer satisfaction}$$

（10）

$$\frac{d\text{Quality level}}{dt} = \text{Changing rate of quality level}$$

（11）

Expected customer satisfaction = perceived quality * (average price / (price level * price level influence rate))

（12）

3. The modeling simulation and the resulting analysis

3.1. Model parameter settings and data sources

Before formally entering into simulation, we need to define every parameter's value of the model. The model parameters are set based on the case of SF express. The data of company comes from "The SF Cup Third National Students Logistics Design Competition Case". In addition, some parameters were estimated by the experts in the field. And the list of parameters used in the model is as follows.

Table 1 List of model parameters

Parameter name	Value	Source	Parameter name	Value	Source
The average purchasing probability	0.5	Case	competition intensity rate	0.68	Case
The average customer satisfaction	0.5	Case	price level influence rate	0.51	Expert
The average intensity of competition	3	Case	The rate of depreciation	10.125%	Case
The rate of customer satisfaction	0.82	Expert	Maximum length of the life cycle	30 years	Expert
The rate of annul investment	0.3	Expert	The average price	18 yuan	Case

3.2. Strategic analysis

This part aims to observe the variation of CLV by altering 2 influential factors' value in the model —annual rate of investment and price levels to analyze the effect of different factors on CLV. Thus, we can find key factors and measures to improve CLV.

1) The influence of rate of investment on CLV. We have three scenario simulations: basic level, high investment, low investment, where only the rate of annual investment is changed, and the other parameters remain the same. More details are set out in the table below.

Table 2 Scenario simulation parameters changing table --the level of investment

Situation	Basic level	High investment	Low investment
The rate of annul input	30%	33%	27%
The legend	base	The rate of annul input（0.33）	The rate of annul input（0.27）
Graphic mark	Blue line, there is number 1	Red line, there is number 2	Green line, there is number 3

Figure 8-13 shows the simulation results of the three scenarios. The 1st curve represents the basic scenario, where the annual rate of investment is 0.3 and CLV (figure 8) could maintain a constant value for 1350 yuan. The system is in a state of equilibrium. that the investment offsets the depreciation exactly every year. The assets and costs (figure 10) remain unchanged. The quality of service (figure 11) stays the same as well. Customer satisfaction (figure 12) has not changed; thus, customer life cycle (figure 13), income and the number of customers (figure 9) also have not changed. As a result, CLV remains at a constant level. The 2nd curve represents the

high investment scenario. However, when the rate of investment goes up to 0.33, at the beginning of simulation (2012-2015), CLV (figure 8) is essentially unchanged, which is caused by delays in the system--Effects are not obvious in the early stages of increasing input. But the effects become obvious after 2016. Especially during 2022 and 2028, CLV increases rapidly and it stabilizes at 5518.46 yuan in the end. The above phenomenon is due to the increase of the quality of service (figure 11), customer satisfaction (figure 12), and the customer life cycle (figure 13), the number of customers and the income after increasing investment. Although, as we can see, raising investment also increase cost, the variation of cost is far less than the growth of income due to the increase in the number of customers. More customers reduce the average allocation of fixed cost. Consequently, though total cost increase, the average cost per customer does not change as much. Hence, the CLV is greatly increased. The 3rd curve presents the low investment. When the rate of annual investment fell to 0.27, the CLV (figure 8) has dropped down to 0 in more than 10 years, which means the bankrupt of the company. Because the quality of service dropped when investment is reduce, so as the number of customers. Although the lower investment reduced the cost at the beginning (figure 10), in the long term, the cost of each customer goes up due to the decrease of the number of customers. In conclusion, in the scenario, companies will go into the vicious circle where income decreases, costs ascend, the quality of service drops so that the available investment is fewer and fewer.
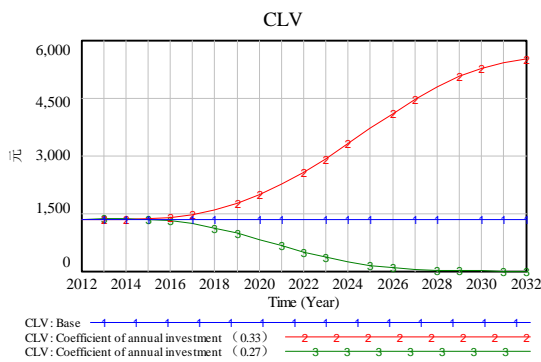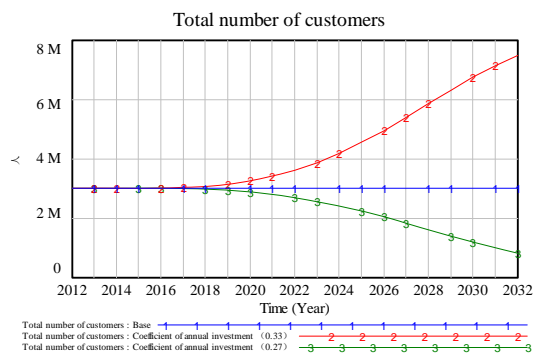

Figure 8 The influence of input rate on CLV

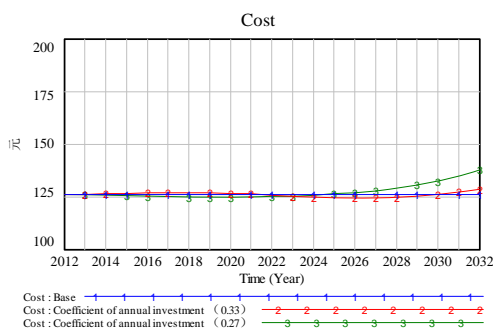**Figure 9 The influence of input rate on the total number of customers**

Figure 8 The influence of input rate on cost

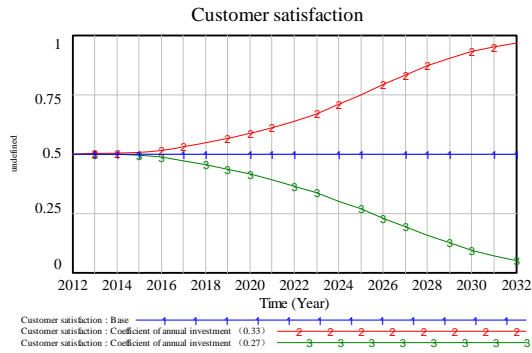**Figure 9 The influence of input rate on the level of quality**

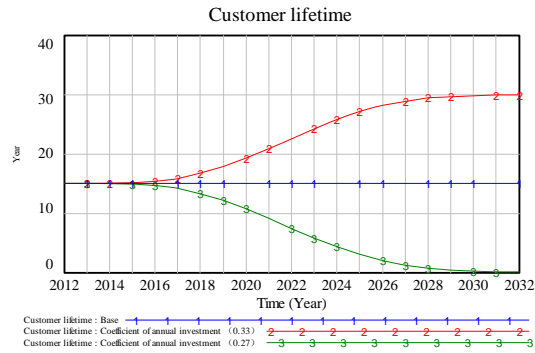**Figure 8 The influence of input rate on customer satisfaction**

Figure 9 The influence of input rate on customer lifetime

2) The influence of price levels on CLV. Next, we will present another three scenarios: base, high price levels, low price levels, where only price levels are changed, while the other parameters remain the same. More details are set out in the table below.

Table 3 Scenario simulation parameters changing table -- the level of price

Situation	Basic level	The high level of price	The low level of price
The level of price	18	19.8	16.2
The legend	base	The level of price （19.8）	The level of price (16.2)
Graphic mark	Blue line, there is number 1	Red line, there is number 2	green line, there is number 3

Figure 14-19 shows the simulation results for the three scenarios. The 1st curve represents the basic scenario. When the price level is at 18, the CLV maintains the constant value of 1350. At this time, the system is at a state of equilibrium: under this exact price level, the investment of the company's just covers depreciation. Thus, the quality of service and the customer satisfaction (figure 15) remain equal, which attributes to the length of customer life cycle (figure 16), the number of customers (figure 17) and the cost (figure 18) all are the same as before, and CLV keeps the constant level. The 2nd curve shows that when the price level goes up to 19.8 yuan, CLV has a slightly decline in the early days. But after 2016 CLV goes up steadily and stablizes at 5581.69 yuan. The increase of the price levels immediately brings about the decrease of customer satisfaction (figure 15), the shorter of life cycle (figure 16), the reduction of the total number of customers (figure 17), and the decline of purchasing probability (figure 19) along with other adverse reactions. However, as price level goes up, profit has increased, resulting in more investment. Overtime, the service quality has improved, which improves customer satisfaction rate, leading to more new customers and high purchasing probability of the existing customers. Thus, the income increases again after 2016 and with that, even more investment could be made to enhance the advantage of the company. As such, the company is in a virtual circle that drives the CLV up. The 3rd curve presents scenario of the lower price, at the level of 16.2 yuan. For a short time, lower price attracts more customers. However, as the less profit is made with lower income, the investment is lowered. In the long run, the service quality of the company falls. This results in the existing customers reduce purchase probability or even end their relationship with the company and the low reputation of the company could not attract new customers. In 2024, the total number of customers has dropped to below the initial level, and it continues to decline,

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eventually leading to CLV lowering to zero and the company going bankrupt.
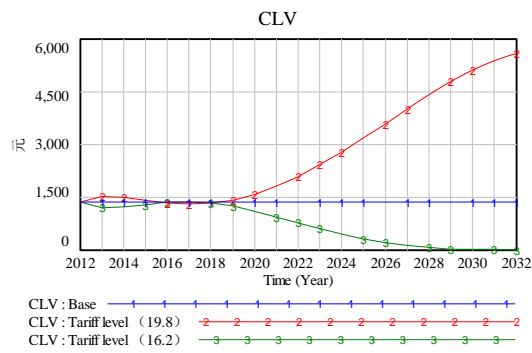

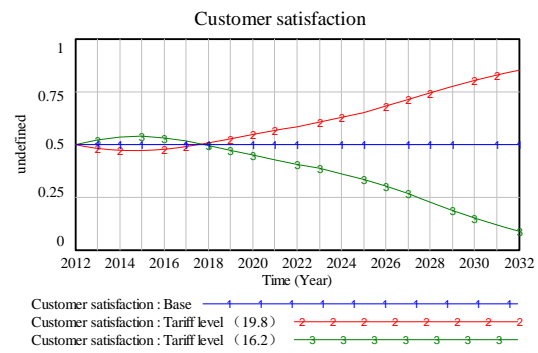Figure 14 The influence of the level of price on CLV

Figure 15 The influence of the level of price on customer satisfaction
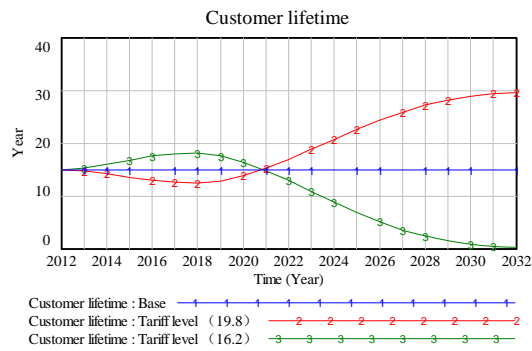

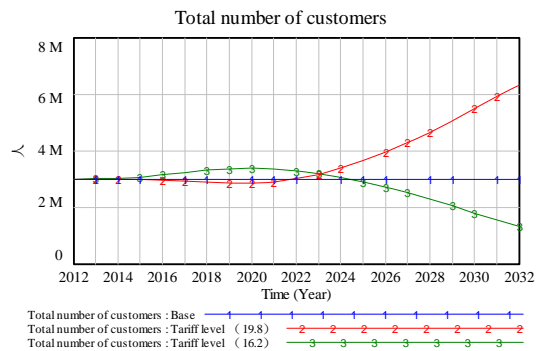Figure 16 The influence of the level of price on customer lifetime

Figure 17 The influence of the level of price on the total number of customers
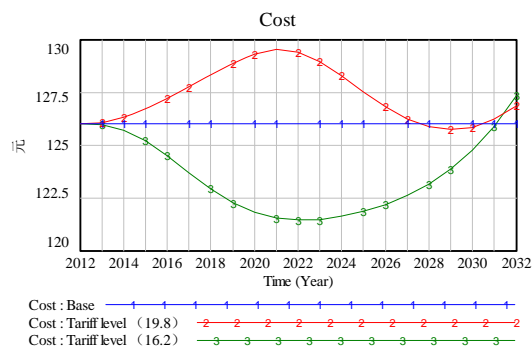

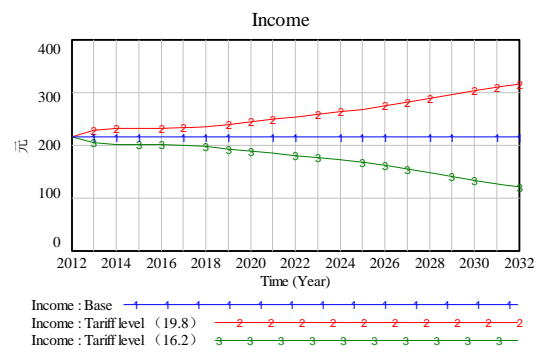Figure 16 The influence of the level of price on cost

Figure 17 The influence of the level of price on income

4. Conclusion

In this essay, referring to the theories of CLV and using system dynamics method, we have established dynamic model of CLV for express companies, which is based on a specific case of a big Chinese express company SF express. Using the model, we studied various scenarios and find the following insights:

When the rate of annul investment is increased, which means that companies will put a larger proposition of the total profit into upgrading the software and hardware, the quality of customer service will be improved. Though there is an increase on cost at the beginning, with the increase of customer satisfaction, existing customers' make more purchase and the number of new customers increases. As a result, the average cost for each customer will be reduced. Moreover, high degree of customer satisfaction can increase customer loyalty and then extend its

life cycle. Thus, CLV will rise. Yet, when the level of price is improved, for the short time, customer satisfaction will reduce and the company will lose those price-sensitive customers. Nevertheless, for a long time, the improvement of price levels will lead to higher profit and the company has more money to make investment so as to improve service quality, which may also help improve customer satisfaction. After a delay for improving service quality, the company will be able to get more income from the existing and new customers. And eventually, CLV will rise. In a high competition environment, most companies think that lower the price level could help them to attract more customers and make more profit. However, our study shows that what really matters is high investment level to improve service quality. As long as the service quality is high, increase the price level will not really hurt the company in the long run. On the contrary, with more money, the company could work on innovation, develop new technology, and different itself with other companies. In this way, the company will have high CLV in the long run.

SF express decided to raise its the price of certain express lines since October 8th, 2011, with an average amplitude modulation of 2%-4%. In spite of the raising price, the customer satisfaction always keeps at a quite high level. SF express is the only few companies that promise to come to fetch the package within one hour after customer places an order. And SF express will send an message to the sender when the receiver has got the package. They now have delivery-within-one-day for big cities such as Shanghai, Beijing, Guangzhou and Chendu. As a result, raising its price has not resulted major customer decline for SF express. And it has been developing into international express business now. SF's experience also supports our findings with the model. Faced with the fierce competition, companies should place more emphases on promoting service quality as well as attracting and retaining customers instead of carrying out a price battle.

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