

# Cycle Analysis of Profits to the Majority and Minority Shareholders of Listed Companies Based on the Symbiosis Theory

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**Abstract**—Symbiosis is not only a biometric identification mechanism, but also a method of social science management. Symbiosis theory and other biometric theories are widely applied in social and economic researches. The paper research cycle of profits to the majority and minority shareholders in publicly listed companies based on mathematical model for quadratic sum with symbiosis theory and come up with conclusion that mutual benefit can be realized when revenue contribution coefficient meets certain conditions.

**Keywords**-Company management; shareholder behavior; symbiosis theory; quadratic sum total model; revenue contribution

## I. INTRODUCTION

As the dominant force in the capital market, publicly listed companies play a significant and decisive role in national economy. Management situation and operation level of them have great impact on national economy, and the society as a whole. Shareholders are the main body of listed companies, among which, majority shareholders hold dominant position, while minority shareholders are in a subordinate status, their behavior and mutual relation become a hot topic that draws interests of more and more scholars, are they implacably opposed to each other or can they realize mutual benefit through cooperation? How to find out the means and models for their harmonious coexistence? Those are only part of series issues in this regard that people have been trying to figure out for a long time.

Demsetz [1], Morck [2] pointed out, in theory, that there are serious conflict between the majority and minority shareholders, their profits are usually not consistent, the majority shareholders are very likely to seek their own benefit at the expense of the minority shareholders. Denni and McConnell [3] argued that, in most cases, the majority shareholders took

means of “tunneling” to encroach on benefit of the minorities, for e.g, they may take advantage of dividend policies to reach their goals through thorough exploration of those policies. The problems are also revealed in results of domestic researches. Luo Danglun and Tang Qingquan [4] said that it is a common phenomenon that listed companies and their minority shareholders suffer losses from “tunneling” implemented by the shareholder who holds majority shares. Xu Guangwei [5] thought that the purpose of majority shareholders on minority ones is to grab extra gains. Li Haisheng [6] argued that extra gains from control power shall be restricted as the extraneous earnings; it is not the compensation for investment risks. Along with deepening development of reform of non-tradable shares, changes began to take place in the shareholding structure of listed companies, but, according to many researches [7], no evident amelioration has been done on the situation of minority shareholders. According to Zhang Lihong and Liu Guochang [8], reform of non-tradable shares only created necessary conditions for the development of capital market, other effective measures still need to be stimulated and implemented for sound development of capital market as well as for the protection of interests of minority shareholders. From another perspective, is relation between majority and minority shareholders so simple as “tunneling”? According to Friedman [9], controlling shareholders encroach on companies’ profits by tunneling, they may provide support with their private resources when the company is in trouble, from which, minority shareholders can benefit, this is called “propping”. Riyanto and Toolsema [10] thought that it is just because of “propping” behavior of controlling shareholders, pyramid ownership structure is able to attract investments of minority shareholders even with existence of “tunneling” behavior. With regard to the contradictory and complicated relations between majority and minority shareholders, Yang Songling and Liu Tingli [11] introduced the biometric concept of symbiosis into

research in this regard for the first time, which constituted a new breakthrough in the research in this field. According to definition of interspecies relation in biology, through analysis of relations between majority and minority shareholders, Yang Songling and Zhang Wei [12] they belong to different population, and they are in symbiosis relation.

The paper, based on mathematical model for quadratic sum, made mathematical analysis on symbiosis model of majority and minority shareholders of listed companies, with focus on revenue contribution coefficient and profits cycle, and expounded corresponding practical significance.

## II. ESTABLISHMENT OF MODEL

### A. Quadratic Sum Model and Cycle

The following quadratic sum total model is introduced in describing variation situation of total of two interacting species

$$\frac{dx_1}{dt} = (a_0 + a_1x_1 + a_2x_2)x_1, \quad (1-a)$$

$$\frac{dx_2}{dt} = (b_0 + b_1x_1 + b_2x_2)x_2, \quad (1-b)$$

where  $x_1(t)$  and  $x_2(t)$  stand for their quantity at the time of  $t$ ,  $a_i, b_i (i=0,1,2)$  are constant. In symbiosis environment, there is a high possibility that a certain balance state can be reached between two interacting species after a period that is sufficiently long.

After a certain amount of time, quantity of two species keeps constant respectively, namely,  $x_1(t) = M_1$ ,  $x_2(t) = M_2$ , at this time,  $\frac{dx_1}{dt} = \frac{dx_2}{dt} = 0$ , the constant value corresponds to the equilibrium points in model of (1-a)(1-b), make the right side of model of (1-a)(1-b) equal to zero as follows:

$$\begin{cases} (a_0 + a_1x_1 + a_2x_2)x_1 = 0 \\ (b_0 + b_1x_1 + b_2x_2)x_2 = 0 \end{cases} \quad (2)$$

then we get  $M_1$  and  $M_2$ . There has another balance state, in which, quantity of two species changes with periodicity, namely,  $x_1(t)$  and  $x_2(t)$  are non-constant periodic functions about  $t$ , both have same period. The corresponding figure is expressed as cycle (See Fig. 1). The analysis of property of the cycle has become a hot issue in the field of biology and ecology.

**Lemma** If the coefficient in differential equations (1-a) (1-b) meets either of following conditions:

$$A: a_1b_2 - a_2b_1 = 0, \quad (3)$$

$$B: a_1b_0(a_2 - b_2) - a_0b_2(a_1 - b_1) = 0. \quad (4)$$

Thus, there is non-equilibrium point existed in the original equation.

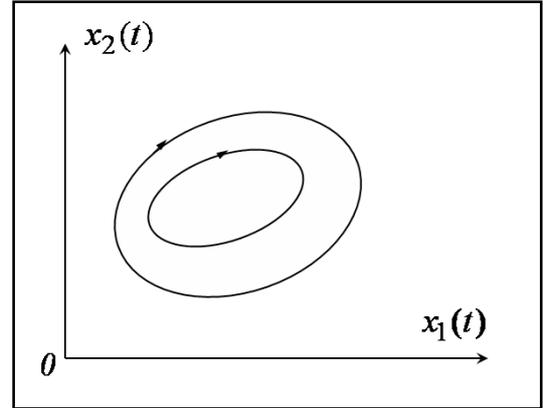


FIGURE 1. DIAGRAM OF THE CYCLE

### B. Symbiosis Model of Majority and Minority Shareholders of Listed Companies

In the Symbiosis relation of majority and minority shareholders of listed company, suppose that the company profit is  $x_1(t)$  when there are no minority shareholders in the company, correspondingly, company profit is  $x_2(t)$  when there are no majority shareholders.

Set up the symbiosis model as following differential equation:

$$\frac{dx_1}{dt} = r_1x_1\left(1 + \frac{\sigma_1x_2}{K_2} - \frac{x_1}{K_1}\right), \quad (5-a)$$

$$\frac{dx_2}{dt} = r_2x_2\left(-1 + \frac{\sigma_2x_1}{K_1} - \frac{x_2}{K_2}\right), \quad (5-b)$$

In which,  $r_i > 0$ ,  $i=1,2$  stands for respective average growth rate of company profit when there is only majority or minority shareholders.  $\sigma_i > 0$ ,  $i=1,2$  stands for contribution of each unit of one party to the profit of the other party.

## III. CYCLE PERFORMANCE ANALYSIS

**Theorem 1** There is four equilibrium points of differential equations (5-a) (5-b) and respectively are  $(0, 0)$ ,  $(K_1, 0)$ ,  $(0, -K_2)$  and  $\left(\frac{K_1(-1+\sigma_1)}{\sigma_1\sigma_2-1}, -\frac{K_2(-1+\sigma_2)}{\sigma_1\sigma_2-1}\right)$ . And all the above are saddle points.

**Proof** Suppose the right end of equation set (5-a) (5-b) is zero

$$\begin{cases} r_1 x_1 (1 + \frac{\sigma_1 x_2}{K_2} - \frac{x_1}{K_1}) = 0 \\ r_2 x_2 (-1 + \frac{\sigma_2 x_1}{K_1} - \frac{x_2}{K_2}) = 0 \end{cases}, \quad (6)$$

the solution of this equation set are respectively  $(0, 0)$ ,  $(0, -K_2)$ ,  $(K_1, 0)$  and  $(\frac{K_1(-1+\sigma_1)}{\sigma_1\sigma_2-1}, -\frac{K_2(-1+\sigma_2)}{\sigma_1\sigma_2-1})$ . The following part will take  $(0, 0)$  and prove this equilibrium point to be saddle points.

Suppose

$$\frac{dx}{dt} = Ax, \quad (7)$$

is the variation equation of (6-a) (6-b). Where  $x = (x_1, x_2)^T$ , coefficient matrix  $A = \begin{pmatrix} r_1 & 0 \\ 0 & -r_2 \end{pmatrix}$ . Solve the characteristic equation

$$|\lambda - A| = 0, \quad (8)$$

we can have

$$\lambda_1 = r_1 > 0, \lambda_2 = -r_2 < 0, \quad (9)$$

therefore this coefficient matrix  $A$  has two real characteristic root of opposite sign, that is, the equilibrium point  $(0,0)$  is the saddle point of variation equation.

Besides, the nonlinear term  $\frac{r_1 \sigma_1 x_1 x_2}{K_2} - \frac{r_1 x_1^2}{K_1}$  and  $\frac{r_2 \sigma_2 x_1 x_2}{K_1} - \frac{r_2 x_2^2}{K_2}$  of differential equations (2-a) (2-b) are meet the Perron first Theorem. We know the equilibrium point  $(0, 0)$  is the saddle points of the original equation set (2-a) (2-b), similarly, other equilibrium points could also be proved to be saddle points.

This equilibrium points express that the profits of majority and minority shareholders of listed company are constants and all of them can not change with time. However, we pay more attention to the condition that the profits of both sides are non-constant changes with periodicity and it is the major point in this paper.

**Theorem 2** If the coefficients in differential equations (5-a) (5-b) meet following conditions:

$$1) \sigma_1 \sigma_2 \neq 1 \text{ and } \sigma_1, \sigma_2 \neq 1, \quad (10)$$

$$2) \frac{r_1}{r_2} = \frac{\sigma_2 - 1}{\sigma_1 - 1}, \quad (11)$$

there exist cycle of the original equation.

**Proof** Equations (5-a) (5-b) are special form of equations (1-a) (1-b), in which

$$a_0 = r_1, a_1 = -\frac{r_1}{K_1}, a_2 = \frac{r_1 \sigma_1}{K_2}, \quad (12)$$

$$b_0 = -r_2, b_1 = \frac{r_2 \sigma_2}{K_1}, b_2 = -\frac{r_2}{K_2}, \quad (13)$$

through calculation,  $A \neq 0$  and  $B = 0$ . Based on Lemma, we come up with conclusion that there is cycle in equation (5-a) (5-b).

Condition 2) of Theorem 2 can be expressed as linear relation

$$\sigma_2 = \frac{r_1}{r_2} \sigma_1 + (1 - \frac{r_1}{r_2}). \quad (14)$$

Suppose that  $l_1, l_2$  and  $l_3$  respectively stands for the situation of line  $\sigma_2 = \frac{r_1}{r_2} \sigma_1 + (1 - \frac{r_1}{r_2})$  under condition of  $r_1 > r_2, r_1 = r_2$  and  $r_1 < r_2$ , as seen in Fig. 2. Obviously,  $l_1, l_2$  and  $l_3$  passes point  $(1,1)$ .

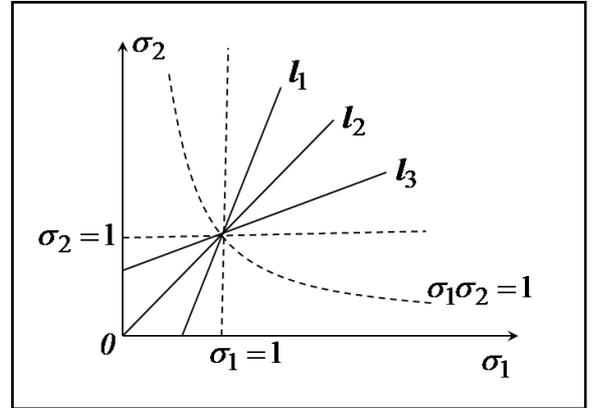


FIGURE 2. PLANE  $\sigma_1 \sigma_2$  AND LINE  $l_1, l_2$  AND  $l_3$ .

**Corollary** As can be seen from Fig. 3, there is cycle for differential equations (5-a) (5-b) in Zone **I**, **II** under the condition of Theorem 2.

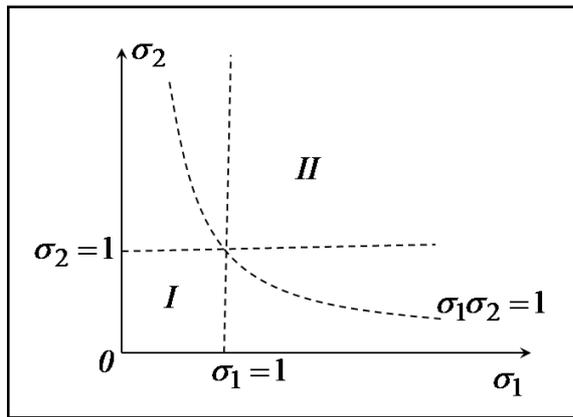


FIGURE 3. PLANE  $\sigma_1 \sigma_2$  AND ZONE I, II.

#### IV. EXPLANATION OF CYCLE PERFORMANCE OF MODEL

The paper discussed cycle of symbiosis model for majority and minority shareholders of listed companies under certain conditions of coefficient, in which, profits to both parties are positive and vary with periodicity.

- (1) Take line  $l_1$  as example, initial  $\sigma_2 < \sigma_1 < 1$  indicates that majority shareholders make larger contribution to minority shareholders; the “propping” behavior is evident.
- (2) After line  $l_1$  passes point (1,1),  $1 < \sigma_1 < \sigma_2$  indicates that revenue contribution of majority shareholders is less than that of minority shareholders, the former begins to encroach on the latter, in this case, “tunneling” behavior of majority shareholders is evident.
- (3) Persistent encroachment on minority shareholders will also reduce their own profits, to such situation, majority shareholders need to diminish their encroachment and increase their contribution to minorities, in this process, their own profits can be improved to some extent.
- (4) When such contribution reaches certain extent, driven by benefit, majority shareholders will relapse and begin to encroach on minority shareholders again, thus forming a cycle.

The situation of other lines can be analyzed in similar way.

#### V. CONCLUSION

The paper researched, based on quadratic mathematical model for sum total, combining symbiosis theory, cycle of profits to the majority and minority shareholders in publicly listed companies, and came up with following conclusions:

- (1) When revenue contribution coefficient of majority and minority shareholders meets certain conditions, profits of both are positive, and vary with periodicity.

- (2) There are possibilities existed for both parties to reach a mutual beneficial symbiosis relation, and a comparatively stable state of cycle.
- (3) It is suggested that supervision authorities take measures of policies, rules, regulations, external audits and others to forge a sound market environment in which majority and minority shareholders can reach a state of mutual benefit coexistence to contribute to better management of companies and sound development of capital market.

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