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RESEARCH ON THE EVOLUTION MECHANISM AND INTERVENTION STRATEGY OF DOING BUSINESS ENVIRONMENT

Huipo Wang and Juan Chen

School of Economics and Management
Dalian University
No. 10, Xuefu Street, Jinzhou New District, Dalian 116622, P. R. China
wanghuipo@aliyun.com

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Abstract. *A good Doing Business Environment plays an important role in site selection of enterprise investment. The researchers' researches focus on "how can the governments improve the local Doing Business Environment". However, few papers have noticed the influence made by the enterprise on the improvement of the Doing Business Environment. The local government and the enterprises are interacting with each other in the process of improving the Doing Business Environment. So, this paper constructs an evolutionary game model with the participation of local governments and enterprises. Results show that under some conditions the evolution model has an ideal evolutionary equilibrium solution. This means that the government can greatly improve the Doing Business Environment by way of adjusting tax rate imposed on the companies, considering reputation loss and providing subsidies to the companies.*
Keywords: Doing Business Environment, Evolutionary game, Enterprise investment location, Intervention strategy

1. **Introduction.** Since the reform and opening up, attracting investment has become an important task for local governments across China. In 2013, construction of Doing Business Environment was upgraded to the national development strategy officially. The Chinese central and local governments have taken various measures to improve the Doing Business. For enterprises, the Doing Business Environment is one of the most important conditions while choosing their location [1]. So, optimizing the Doing Business Environment can retain existing enterprises and attract new enterprises. Many researchers have done a lot of work on the relation of Doing Business, choosing company's location and the economic growth of the region. Yang and Li believed that high degree of attention to the Doing Business has become the consensus of the companies to choose their locations [2]. Dong and Dunning pointed out that Doing Business Environment is a key factor for a company to select its location [3,4]. Other researchers' researches show that Doing Business Environment has a significant effect on starting a business, decision-making, even improving the development of enterprises [5-8]. At present, the research on business environment mainly focuses on China, Africa, India and other emerging market countries [9-11]. Besley studied the nature of the World Bank's business environment project and its impact [12]; Corcoran and Gillanders studied the impact of business environment on FDI [8]; Syeedun and Ritika studied the similarities and differences of business environment index under different cultural models [13]. However, there are no researches on the relationship between attraction of company investment and the Doing Business Environment and how they interact to each other. This means that the local government and the enterprises are playing a dynamic game. So, the contributions of this paper are: the

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game relationship between government and enterprises is introduced into the analysis of business environment, and the basic model, government reputation model and government subsidy model are constructed respectively. It is found that in the basic model, the government tends to treat business environment negatively while the enterprises tend to leave; after considering the loss of government's reputation, the government tends to respond positively to business environment; after considering government's subsidies, the government tends to actively improve business environment, while enterprises tend to stay.

This paper is arranged as the following: the first part is the introduction, the second part is model hypothesis and establishment, the third part is solution and analysis of evolutionary game model, the fourth part is to consider the local government's reputation loss, the fifth part is to consider the government financial subsidy, and the sixth part follows thereafter as the conclusion.

2. **Model Hypothesis and Establishment.** The two participants in the evolutionary game are the enterprises and the local government. There are two strategies for enterprises: STAY or LEAVE. STAY means that the company is still operating in the original city. LEAVE means that the company leaves the original city and goes to other cities. Similarly, the local government also has two strategies: actively improving the Doing Business (A for short) or inactively improving the Doing Business (I for short). Assume that the enterprise's probability to stay is x $(0 \leq x \leq 1)$, and then the probability to leave is $1-x$. The probability for the local government to take strategy A is y $(0 \leq y \leq 1)$, and the probability to take strategy I is $1-y$. Assume that π_E and π_G are the economic performances of the company and the local government when the strategy profile (STAY, I) is selected, and $\pi_E > 0$, $\pi_G > 0$. Besides the enterprise has to pay extra cost C_E to maintain good relations with the government. Then the payoff matrix can be gotten and shown in Table 1.

TABLE 1. The payoff matrix of the game between the enterprise and the government

Game		Local government	
		A y	I $1-y$
Enterprise	S x	$\pi_E + (1-\alpha)V, \pi_G - C_G + \alpha V$	$\pi_E - C_E, \pi_G$
	L $1-x$	$\pi_E + (1-\alpha)V - C + \Delta, \pi_G - C_G - T$	$\pi_E - C + \Delta, \pi_G - T$

The meanings of other parameters are: C_G, the cost of improving the Doing Business for the local government, including improving infrastructure; V, the income from the increase in sales caused by the local government's active improvement of the Doing Business; α, the tax rate for the local government to implement tax on the increase in the sales volume of the company; C, the sunk cost for the company to choose to leave, including handling equipment; T, the comprehensive income lost by the local government due to the departure of the enterprise, including taxes; Δ, the economic benefit of the difference between the Doing Business of the relocated city and the original city.

Suppose the expected return of the enterprise's STAY is U_x, the expected return of the enterprise's LEAVE is U_{1-x}, and the average expected return of the enterprise is $\overline{U_E}$.

$$U_x = y[\pi_E + (1-\alpha)V] + (1-y)(\pi_E - C_E) = \pi_E - C_E + [C_E + (1-\alpha)V]y$$
$$U_{1-x} = y[\pi_E + (1-\alpha)V - C + \Delta] + (1-y)(\pi_E - C + \Delta) = \pi_E - C + \Delta + (1-\alpha)yV$$
$$\overline{U_E} = xU_x + (1+x)U_{1-x}$$

The replication dynamic equation (RDE for short) of enterprise is

$$F_{(x)} = \frac{dx}{dt} = x\left(U_x - \overline{U_E}\right) = x(1-x)(U_x - U_{1-x}) = x(1-x)(C - \Delta - C_E + yC_E) \quad (1)$$

Suppose the expected return of the local government's A strategy is U_y, the expected return of the local government's I strategy is U_{1-y}, and the average expected return of the local government is $\overline{U_G}$.

$$U_y = x(\pi_G - C_G + \alpha V) + (1-x)(\pi_G - C_G - T) = \pi_G - C_G - T + x(\alpha V + T)$$
$$U_{1-y} = x\pi_G + (1-x)(\pi_G - T) = \pi_G - T + xT$$
$$\overline{U_G} = yU_y + (1-y)U_{1-y}$$

The RDE for the local government is

$$F_{(y)} = \frac{dy}{dt} = y\left(U_y - \overline{U_G}\right) = y(1-y)(U_y - U_{1-y}) = y(1-y)(x\alpha V - C_G) \tag{2}$$

3. Solution and Analysis of Evolutionary Game Model.

3.1. **Evolutionary stability analysis of enterprise.** Take the first order derivative of $F_{(x)}$: $\frac{dF_{(x)}}{dx} = (1-2x)(C-\Delta-C_E+yC_E)$. If $y = \frac{C_E+\Delta-C}{C_E}$, $F_{(x)} = 0$. There is no difference for the enterprise to stay or leave. If $y \neq \frac{C_E+\Delta-C}{C_E}$, let $F_{(x)} = 0$, then $x = 0$ and $x = 1$ are two possible stable states of the evolution. According to the stability condition of the evolutionary game, when $\frac{dF_{(x)}}{dx}\big|_{x=x^*} < 0$ is satisfied, the x^* is a stable solution.

1) If $C_E + \Delta - C < 0$, then $y > \frac{C_E+\Delta-C}{C_E}$, so $x = 1$ is an evolutionary stability strategy, and bounded rational enterprises will choose "S" strategy.

2) If $C_E + \Delta - C > 0$, it is discussed in two cases:

When $y > \frac{C_E+\Delta-C}{C_E}$, $\frac{dF_{(x)}}{dx}\big|_{x=0} > 0$, $\frac{dF_{(x)}}{dx}\Big|_{x=1} < 0$, so $x = 1$ is an evolutionary stability strategy. Enterprises will choose "S" strategy.

When $y < \frac{C_E+\Delta-C}{C_E}$, $\frac{dF_{(x)}}{dx}\big|_{x=0} < 0$, $\frac{dF_{(x)}}{dx}\Big|_{x=1} > 0$, so $x = 0$ is an evolutionary stability strategy. Enterprises will choose "L" strategy.

3.2. **Evolutionary stability analysis of local government.** Take the first order derivative of $F_{(y)}$: $\frac{dF_{(y)}}{dy} = (1-2y)(x\alpha V - C_G)$. If $x = \frac{C_G}{\alpha V}$, $F_{(y)} = 0$. There is no difference for the government to choose "A" or "I" strategy. If $x \neq \frac{C_G}{\alpha V}$, let $F_{(y)} = 0$, then $y = 0$ and $y = 1$ are two possible stable solutions of evolution.

1) If $C_G - \alpha V > 0$, then $x < \frac{C_G}{\alpha V}$, so $y = 0$ is an evolutionary stability strategy, and bounded rational local government will choose "I" strategy.

2) If $C_G - \alpha V < 0$, the cost of improving the Doing Business of the local government is lower than the tax on the income from the increase in sales volume of the company, which is discussed in two cases:

When $x > \frac{C_G}{\alpha V}$, $\frac{dF_{(y)}}{dy}\big|_{y=0} > 0$, $\frac{dF_{(y)}}{dy}\big|_{y=1} < 0$, so $y = 1$ is an evolutionary stability strategy. Local government will choose "A" strategy.

When $x < \frac{C_G}{\alpha V}$, $\frac{dF_{(y)}}{dy}\big|_{y=0} < 0$, $\frac{dF_{(y)}}{dy}\big|_{y=1} > 0$, so $y = 0$ is an evolutionary stability strategy. Local government will choose "I" strategy.

3.3. **Analysis of mixed strategy of enterprise and local government.** According to the RDEs (1) and (2), when $0 < \frac{C_G}{\alpha V} < 1$, $0 < \frac{C_E+\Delta-C}{C_E} < 1$, there are five Nash equilibrium points in the dynamic evolution system: $A(0,0)$, $B(0,1)$, $C(1,0)$, $D(1,1)$, $E\left(\frac{C_G}{\alpha V}, \frac{C_E+\Delta-C}{C_E}\right)$. The local stability of the evolutionary system can be analyzed by the Jacobian matrix of the system, and then the Jacobian matrix of the system is

$$J = \begin{bmatrix} \frac{\partial F_{(x)}}{\partial x} & \frac{\partial F_{(x)}}{\partial y} \\ \frac{\partial F_{(y)}}{\partial x} & \frac{\partial F_{(y)}}{\partial y} \end{bmatrix} = \begin{bmatrix} (1-2x)(C-\Delta-C_E+yC_E) & x(1-x)C_E \\ y(1-y)\alpha V & (1-2y)(x\alpha V - C_G) \end{bmatrix}$$

TABLE 2. The Jacobian matrix of the dynamic system

Equilibrium point	$\det(J)$	$tr(J)$
$A(0,0)$	$-C_G(C-\Delta-C_E)$	$C-\Delta-C_E-C_G$
$B(0,1)$	$C_G(C-\Delta)$	$C-\Delta+C_G$
$C(1,0)$	$(C_E+\Delta-C)(\alpha V-C_G)$	$C_E+\Delta-C+\alpha V-C_G$
$D(1,1)$	$(C-\Delta)(\alpha V-C_G)$	$\Delta-C-\alpha V+C_G$
$E\left(\frac{C_G}{\alpha V},\frac{C_E+\Delta-C}{C_E}\right)$	$\frac{(\Delta-C)(\alpha V-C_G)(C_E+\Delta-C)C_G}{\alpha V C_E}$	0

Substitute the five Nash equilibrium points into Jacobian matrix. The determinant and trace of it are shown in Table 2. According to the evolutionary game stabilization conditions, the equilibrium point must satisfy $\det(J)>0$ and $tr(J)<0$. For $E\left(\frac{C_G}{\alpha V},\frac{C_E+\Delta-C}{C_E}\right)$, $tr(J)=0$, not satisfied $tr(J)<0$, so point E is not an evolutionary stable equilibrium point. Therefore, the following will analyze the possibility that the four system balance points become ESS.

State 1: When $0<\frac{C_G}{\alpha V}<1$, $0<\frac{C_E+\Delta-C}{C_E}<1$, the equilibrium point analysis is shown in Table 3. The evolutionary stability strategies are $(0,0)$ and $(1,1)$, and the instability points of the system are $(0,1)$ and $(1,0)$. That means (S, A) and (L, I) are ESS of the evolutionary game. The evolution dynamic phase is shown in Figure 1.

TABLE 3. Local stability of the equilibrium point corresponding to state 1

Equilibrium point	$\det(J)$	$tr(J)$	Stability
$A(0,0)$	+	−	ESS
$B(0,1)$	+	+	Unstable point
$C(1,0)$	+	+	Unstable point
$D(1,1)$	+	−	ESS

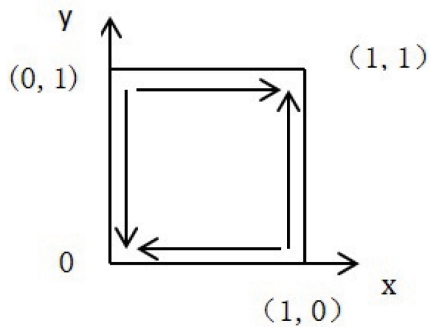

FIGURE 1. The dynamic phase of state 1

State 2: When $\frac{C_G}{\alpha V}>1$, $0<\frac{C_E+\Delta-C}{C_E}<1$, the equilibrium point analysis is shown in Table 4. The system has a unique ESS $(0,0)$, the system's instability point is $(0,1)$, and the system's saddle points are $(1,0)$ and $(1,1)$. That means only (L, I) is an ESS of the evolutionary game. The evolution dynamic phase is shown in Figure 2.

TABLE 4. Local stability of the equilibrium point corresponding to state 2

Equilibrium point	det(J)	$tr(J)$	Stability
$A(0,0)$	+	−	ESS
$B(0,1)$	+	+	Unstable point
$C(1,0)$	−	Indefinite	Saddle point
$D(1,1)$	−	Indefinite	Saddle point

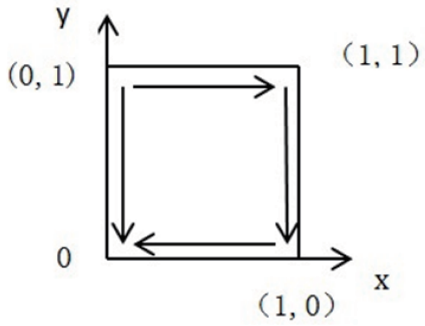

FIGURE 2. The dynamic phase of state 2

4. **Considering the Local Government's Reputation Loss.**

4.1. **Modeling the local government's reputation loss.** Through the above analysis, when $\frac{C_G}{\alpha V} > 1$, $0 < \frac{C_E+\Delta-C}{C_E} < 1$, only (L, I) is an ESS of the evolutionary game. Bergara et al. believed that the credibility and effectiveness of government agencies are the basic conditions for various commercial transactions, including enterprises [14]. The government's credit system in some areas is not perfect, and the untrustworthy behavior has repeatedly led to the poor image of the government and business reputation, which seriously affects the decision-making of enterprise's location selection. Therefore, it is necessary to consider that if the local government takes "I" strategy, it will suffer credibility losses. The payoff matrix is shown in Table 5.

TABLE 5. The payoff matrix of considering the government's reputation

Game		Local government	
		A y	I $1-y$
Enterprise	S x	$\pi_E + (1-\alpha)V, \pi_G - C_G + \alpha V$	$\pi_E - C_E, \pi_G - R$
	L $1-x$	$\pi_E + (1-\alpha)V - C + \Delta, \pi_G - C_G - T$	$\pi_E - C + \Delta, \pi_G - T - R$

Suppose the expected return of the enterprise's stay is U_x^*, the expected return of the enterprise's leave is U_{1-x}^*, and then the average expected return of the company is $\overline{U_E^*}$.

$$U_x^* = y[\pi_E + (1-\alpha)V] + (1-y)(\pi_E - C_E) = \pi_E - C_E + [C_E + (1-\alpha)V]y$$

$$U_{1-x}^* = y[\pi_E + (1-\alpha)V - C + \Delta] + (1-y)(\pi_E - C + \Delta) = \pi_E - C + \Delta + (1-\alpha)yV$$

$$\overline{U_E^*} = xU_x^* + (1-x)U_{1-x}^*$$

The RDE of enterprise is:

$$F_{(x)}^* = \frac{dx}{dt} = x\left(U_x^* - \overline{U_E^*}\right) = x(1-x)\left(U_x^* - U_{1-x}^*\right) = x(1-x)(C - \Delta - C_E + yC_E) \quad (3)$$

Suppose the expected return for local government taking "A" strategy is U_y^*, the expected return of the local government to taking "I" strategy is U_{1-y}^*, and then the average expected return of the local government is $\overline{U_G^*}$.

$$U_y^* = x(\pi_G - C_G + \alpha V) + (1-x)(\pi_G - C_G - T) = \pi_G - C_G - T + (\alpha V + T)x$$

$$U^*_{1-y} = x(\pi_G - R) + (1-x)(\pi_G - T - R) = \pi_G - T - R + xT$$
$$\overline{U^*_G} = yU^*_y + (1-y)U^*_{1-y}$$

The RDE for the local government is:

$$F^*_{(y)} = \frac{dy}{dt} = y\left(U^*_y - \overline{U^*_G}\right) = y(1-y)\left(U^*_y - U^*_{1-y}\right) = y(1-y)(R - C_G + x\alpha V) \tag{4}$$

4.2. **Analysis of the model.** Because the analysis process is similar to Section 3 and the length limitation of the paper, we will state the results here only:

1) When $0 < \frac{C_G - R}{\alpha V} < 1$, $0 < \frac{C_E + \Delta - C}{C_E} < 1$, we get the same result as the state 1.

2) When $\frac{C_G - R}{\alpha V} < 0$, $0 < \frac{C_E + \Delta - C}{C_E} < 1$, $(1,1)$ is the only evolutionary stability strategy for the system, $(1,0)$ is the unstable point of the system, $(0,0)$ and $(0,1)$ are the saddle points of the system, and the (S, A) is the ESS of the evolutionary game.

5. Considering Government's Financial Subsidy.

5.1. **Model government's financial subsidy strategy.** A sound Doing Business enables companies to efficiently use government subsidies [15]. So the government can provide financial subsidy to the enterprise to improve the Doing Business Environment. Suppose the local government gives the company a subsidy S. The payoff matrix is shown in Table 6.

Table 6. The payoff matrix of the evolutionary game

Game		Local government	
		A y	I $1-y$
Enterprise	S x	$\pi_E + (1-\alpha)V + S, \pi_G - C_G + \alpha V - S$	$\pi_E - C_E, \pi_G$
	L $1-x$	$\pi_E + (1-\alpha)V - C + \Delta, \pi_G - C_G - T$	$\pi_E - C + \Delta, \pi_G - T$

Because the length limitation of the paper, the authors will show the RDEs of the above model directly.

The RDE of enterprise is

$$\begin{aligned} F^{**}_{(x)} &= \frac{dx}{dt} = x\left(U^{**}_x - \overline{U^{**}_E}\right) = x(1-x)\left(U^{**}_x - U^{**}_{1-x}\right) \\ &= x(1-x)[C - \Delta - C_E + (S + C_E)y] \end{aligned} \tag{5}$$

The RDE of the local government is

$$F^{**}_{(y)} = \frac{dy}{dt} = y\left(U^{**}_y - \overline{U^{**}_G}\right) = y(1-y)\left(U^{**}_y - U^{**}_{1-y}\right) = y(1-y)[(\alpha V - S)x - C_G] \tag{6}$$

5.2. **Analysis of the model.** Because the analysis process is similar to Section 3 and the length limitation of the paper, we will state the results here only:

1) When $0 < \frac{C_G}{\alpha V - S} < 1$, $0 < \frac{C_E + \Delta - C}{C_E + S} < 1$, we get the same result as the state 1. The evolution dynamic phase is shown in Figure 1.

2) When $0 < \frac{C_G}{\alpha V - S} < 1$, $\frac{C_E + \Delta - C}{C_E + S} < 0$, $(1,1)$ is the only evolutionary stability strategy for the system, $(0,1)$ is the unstable point of the system, $(0,0)$ and $(1,0)$ are the saddle points of the system, and the (S, A) is the ESS of the evolutionary game.

6. Conclusion.

Based on the Doing Business in China, this paper constructs the evolutionary game model of enterprises and local governments, and explores the evolution process of the two parties. Comparing the different equilibrium results of the five equilibrium points in the model, draw the following conclusions.

In the basic model, the means of governing the business environment by the government are limited. Enterprises and governments can only make choices according to the actual situation. If $C_E + \Delta - C < 0$, the best choice for enterprises is to leave. If $C_G - \alpha V > 0$, the choice of the government is to improve the business environment negatively. At this situation, the measures that the government can take are very limited.

If we consider the loss of government's reputation and government's subsidies, there will be a good interaction between the government and enterprises. That is, if the $0 < C_G - R < C_G < \alpha V - S < \alpha V$ conditions are satisfied, or the $0 < \frac{C_G}{\alpha V - S} < 1$, $\frac{C_E + \Delta - C}{C_E + S} < 0$ conditions are satisfied, the government and enterprises will form a win-win situation. Finally, the government will actively improve the business environment, while the enterprises choose to stay. Therefore, this study has important guiding significance for local governments to improve business environment.

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