sustainability

MDPI

Article

The Collective Strategies of Major Stakeholders in Land Expropriation: A Tripartite Game Analysis of Central Government, Local Governments, and Land-Lost Farmers

Qiuxiang Li [1], Haijun Bao [1,*], Yi Peng [1], Haowen Wang [2] and Xiaoling Zhang [3]

1 School of Public Administration, Zhejiang University of Finance & Economics, Hangzhou 310018, China; liqx@zufe.edu.cn (Q.L.); pengyihz@zufe.edu.cn (Y.P.)
2 School of Business Administration, Zhejiang University of Finance & Economics, Hangzhou 310018, China; wanghaoxiang1991@163.com
3 Department of Public and Social Administration, City University of Hong Kong, Hong Kong, China; xiaoling.zhang@cityu.edu.hk
* Correspondence: baohaijun@zufe.edu.cn

Academic Editor: Tan Yigitcanlar
Received: 19 February 2017; Accepted: 17 April 2017; Published: 21 April 2017

Abstract: Land expropriation, during the rapid urbanization process in China, results in rural conflicts and presents barriers in sustainable development. Collective strategies of major stakeholders should be clearly understood for finding effective measures to cope with conflicts. However, the existing studies usually assume two types of stakeholders, which overlook the complicated practices as, at least central, government, local governments, and land-lost farmers are three major stakeholders. This research aims to explore the collective strategies of the three major stakeholders and examine how various factors contribute to conflicts with a tripartite evolutionary game model. The tripartite model is established based on the evolutionary game theories and relationships among the central and local governments, and land-lost farmers. A simulation analysis is also conducted on the MATLAB platform, which shows that serious asymmetry of information between stakeholders leads to the low efficiency of the game or serious conflicts. Thorough discussions on the influencing factors have also been conducted. The findings can provide good references for the central and local governments to reduce conflicts during land expropriation.

Keywords: land expropriation; conflict; tripartite game analysis; evolutionary game model; simulation; China

1. Introduction

Land expropriation has been frequent in order to satisfy the very large demand on construction land during the rapid urbanization process in China. Large masses of farmland have, therefore, been transformed compulsively into non-farmland by government-led expropriation since the 1990s. Conflicts over collective land expropriation have arisen frequently in recent years, and created serious harms to social stability and sustainable development [1,2]. Challenges raised from land expropriation are quite comprehensive and may not be easy to address under the current land expropriation policy of China. These issues are rooted deeply in the institutional, fiscal, and administrative frameworks of China [3]. Scholars have investigated the characteristics, causes, influences, and governance strategies of the conflicts during land expropriation [4–10].

The central government, local government, and farmers are three main stakeholders involved in conflicts of land expropriation. Although any two of stakeholders may have comparatively similar interests under certain conditions, the three stakeholders usually have different concerns during land expropriation. The central government is assumed to take the responsibility of overall land management across China. Yet, entrusted by the central government, local governments usually take the power of land expropriation under the system of administration decentralization [11–14]. After the tax sharing system reform in 1994, local governments gradually rely on land finance to provide public infrastructure and services trapped with increasing public affairs, but a limited budget [15,16]. Local governments may, therefore, tend to illegally conduct land expropriation in order to gain more revenue in order to support land finance [17,18]. Illegal land expropriation may include expropriation without public interests, lowering compensation standards, and forceful land expropriation [19,20]. Farmers may resist the land expropriation if they want to maximize their own interests. Conflicts may, therefore, be generated between local governments and farmers during the land expropriation. If farmers cannot find effective measures to guarantee their interests, a petition (shang fang) or some violent action may be conducted. Therefore, the central government would usually take a supervisory measures in order to reduce conflicts and guarantee social stability [16].

Game analysis is increasingly used to investigate the collective strategies of major stakeholders during land expropriation. Land expropriation is a process of benefit redistribution, which is essentially suitable for game analysis of involved stakeholders [21,22]. Game analysis was developed in the 1950s and has been a well-known tool in exploring competitive phenomena and understanding strategic interactions among different stakeholders [23–25]. Existing studies on land expropriation with game analysis usually develops a game model between farmers and governments and investigates the correlative factors that can make the profit close to the equilibrium [4,5,26]. However, these studies usually assumed that all of the players are rational in pursing their own best interests with a static analysis, which are inconsistent in practice [27,28]. Therefore, evolutionary game theory is being used to analyze land expropriation conflicts, although there are very few. For example, Cheng [29] conducted an evolutionary game analysis between farmers and the local government in the conflicts of farmland acquisition and further discussed evolutionary stable equilibrium. However, this study merely considers two stakeholders in the game analysis, which overlooks the conflicts resulting with more stakeholders. On the other hand, few studies have been conducted on the static tripartite game analysis in the land field. Yuan and Yan [30] found the key of collective construction land transfer by adopting a trilateral game model. Zhou [16] developed a mathematically-trilateral game model in conflicts of farmland acquisition. Yet, these studies overlook the dynamic nature in land expropriation.

The previous studies provide details on the land expropriation and important references for practices. However, most of the game models are established based on game analysis of two stakeholders. Some other studies have considered a third stakeholder, but the problem was treated as static with complete rationality. Such limitations present barriers for effectively applying existing models in practice. Hence, we adopt the tripartite evolutionary game model to fill this gap, investigating the strategy selections and evolutions among the central and local governments, and land-lost farmers during land expropriation. We also analyze the interaction mechanisms and the related factors that influence the strategy selections using simulation. The results of this study can provide a theoretical basis to solve conflicts of land expropriation and achieve sustainable urban transformation in China.

2. Tripartite Evolutionary Game Model in Land Expropriation

This section firstly analyzes the profit game among the three critical stakeholders. Thereafter, we set up an evolutionary game model of the three stakeholders based on the replication dynamics mechanism to solve the model. Finally, we use the Jacobian matrix to analyze the stability of each equilibrium point.

2.1. The Tripartite Game Relationships

Central government, local governments, and land-lost farmers are three critical stakeholders in the conflict of land expropriation. Rural land can be expropriated by the government based on public interests and legal procedures. The central government, with the highest decision-making rights, generally represents public interests, and is responsible for the unified management of national lands. The central government also entrusts the local governments to exercise the power of land expropriation [4,5]. Whereas the local government mainly comprises the municipal and county governments, which possesses a dual identity both as the main body of policy implementation and as promoters of land expropriation. The local government pursues the largest profits with the advantages of information and system design. At present, illegal land expropriation is still possible because of the urging of the improvement of political achievements or other benefits generated in illegal procedures [28]. Conversely, the local government has to be responsible to the farmers and not infringe their rights blindly. Land-lost farmers generally occupy the least economic and organizational resources in society, which puts them always in a disadvantaged position. These land-lost farmers may resolve their needs illegally when the long-term interests are not expressed and realized properly. Some land-lost farmers even adopt extreme behaviors against land expropriation, which greatly influences the centripetal and cohesive forces of the government. In turn, the central government will take effective measures to regulate the land expropriation behavior of the local government, penalizing their illegal behaviors or negotiations.

Briefly, these three stakeholders represent different interest relations. The central government takes the role of the moderator; the local government assumes the role of the profiteers; and the farmers supposes the role of interest appeals. The three stakeholders have different social resources, information about land policy, benefits and compensation, and so on, thus forming complex game relationships, as shown in Figure 1 [4,5].

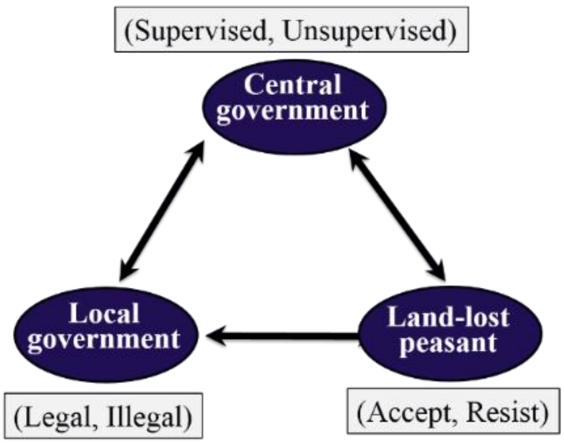


Figure 1. Illustration of the game relationship among the central government, local government, and land-lost peasant.

2.2. Symbol Descriptions

The three stakeholders involved in land expropriation all have bounded rationality. Based on the abovementioned discussions, the strategies of land-lost farmers are {Accept, Resist}. The optional strategies of local government are {Legal expropriation, Illegal expropriation} while the strategies of the central government are {Supervised, Unsupervised}.

The probability of selecting the "Accept" strategy for land-lost farmers is assumed to be α, and the probability of Resist is $1 - \alpha$. The probability of legal expropriation for the local government is β, and that of illegal expropriation is $1 - \beta$. The probabilities of supervised and unsupervised strategies for the central government are γ and $1 - \gamma$, respectively ($0 \leq \alpha, \beta, \gamma \leq 1$).

Corresponding parameters S_f, S'_f, C_f, and R_f, R_{gl}, R'_{gl}, P, K, for farmers, local governments, and the central government are described in Table 1.

Table 1. Parameter definitions.

Symbols	Stakeholders	Descriptions
IR_{gc}	Central government	The promotion of credibility when adopts the supervised strategy
C_{gc}		The supervision costs
IL_{gc}		The loss of credibility when adopts the unsupervised strategy
R_{gl}	Local government	The benefits when adopts the legal expropriation strategy
R'_{gl}		The benefits when adopts the illegal expropriation strategy
P		The punishment from central government when adopt illegal strategy
K		The extra compensation they pay to peasants when the illegal behavior is investigated by central government
S_f	Land-lost peasants	The compensation when local government adopt legal strategy
S'_f		The compensation when local government adopt illegal strategy $(S_f > S'_f)$
C_f		The costs in safeguarding their rights
R_f		The extra benefits when they resist local government's illegal strategy

Based on the above symbols, we can build the payoff matrix among the land-lost farmers, local governments, and the central government, as shown in Table 2.

Table 2. The payoff matrix among central government, local government, and land-lost farmers.

Local Government \ Land-Los Peasants		Central Government	
		Supervised (γ)	**Unsupervised (1 − γ)**
Legal (β)	Accept (α)	$\left(IR_{gc} - C_{gc}, R_{gl}, S_f\right)$	$\left(-IL_{gc}, R_{gl}, S_f\right)$
	Resist (1 − α)	$(IR_{gc} - C_{gc}, 0, -C_f)$	$(-IL_{gc}, 0, -C_f)$
Illegal (1 − β)	Accept (α)	$(IR_{gc} - C_{gc} + P, R'_{gl} - P - K, S'_f + K)$	$(-IL_{gc}, R'_{gl}, S'_f)$
	Resist (1 − α)	$\left(IR_{gc} - C_{gc} + P, -P, -C_f\right)$	$\left(-IL_{gc}, 0, -C_f\right)$

2.3. The Replicated Dynamic Equations of the Tripartite Game

According to the basic principle of replicator dynamics, the strategy better than the average level will be gradually adopted in a game group with bounded rationality, which brings changing strategy proportions over time [31]. In the following, we denote $U_{f1}, U_{f2}, U_{gl1}, U_{gl2}, U_{gc1}$, and U_{gc2} as the expected benefits of the land-lost farmer, and local and central governments under different strategies, we first analyze land-lost farmers. The expected benefits U_{f1} when adopting an "Accept" strategy and U_{f2} when adopting a "Resist" strategy can be calculated as below:

$$U_{f1} = \beta S_f + (1-\beta)[\gamma\left(S'_f + K\right) + S'_f - \gamma S'_f] = \left(\gamma K + S'_f\right)(1-\beta) + \beta S_f,$$
$$U_{f2} = -C_f.$$

The average expected benefits can be calculated by the formula $\overline{U_f} = \alpha U_{f1} + (1-\alpha)U_{f2}$. The replication dynamics equation for land-lost farmers can be achieved as follows:

$$F(\alpha) = \frac{d\alpha}{dt} = \alpha\left(U_{f1} - \overline{U_f}\right) = \alpha(1-\alpha)\left[\left(\gamma K + S'_f\right)(1-\beta) + \beta S_f + C_f\right]. \quad (1)$$

where t in the above replicated dynamic differential equation is the time of strategy changes in the evolutionary system. Similarly, the expected benefits of legal and illegal expropriation for the local government can be calculated by the following steps:

$$U_{gl1} = \alpha\gamma R_{gl} + \alpha(1-\gamma)R_{gl} = \alpha R_{gl},$$

$$U_{gl2} = \alpha\gamma\left(R'_{gl} - P - K\right) + \alpha(1-\gamma)R'_{gl} + (1-\alpha)\gamma(-P) = \alpha R'_{gl} - \alpha\gamma K - \gamma P.$$

The average benefits for land-lost farmers are computed by $\overline{U_{gl}} = \beta U_{gl1} + (1-\beta)U_{gl2}$. Then, the replication dynamics equation for the local government can be achieved by:

$$G_l(\beta) = \frac{d\beta}{dt} = \beta\left(U_{gl1} - \overline{U_{gl}}\right) = \beta(1-\beta)\left[\alpha(R_{gl} - R'_{gl}) + \alpha\gamma K + \gamma P\right] \tag{2}$$

The expected benefits of adopting "Supervised" and "Unsupervised" strategies can be obtained by:

$$U_{gc1} = \beta\left(\alpha\left(IR_{gc} - C_{gc}\right) + (1-\alpha)\left(IR_{gc} - C_{gc}\right)\right) + (1-\beta)\left(IR_{gc} - C_{gc} + P\right) = IR_{gc} - C_{gc} + P - \beta P,$$

$$U_{gc2} = \beta\left(-\alpha IL_{gc} - IL_{gc}(1-\alpha)\right) + (1-\beta)\left[-\alpha IL_{gc} - IL_{gc}(1-\alpha)\right] = -IL_{gc}.$$

The average benefits for the central government is computed by $\overline{U_{gc}} = \gamma U_{gc1} + (1-\gamma)U_{gc2}$. Then, the replication-dynamics equation for the central government can be achieved as follows:

$$G_c(\gamma) = \frac{d\gamma}{dt} = \gamma\left(U_{gc1} - \overline{U_{gc}}\right) = \gamma(1-\gamma)\left[IR_{gc} - C_{gc} + P + IL_{gc} - \beta P\right] \tag{3}$$

The dynamics of evolution equations of the expropriation system can be obtained from the combination of Equations (1)–(3):

$$\begin{cases} F(\alpha) = \frac{d\alpha}{dt} = \alpha\left(U_{f1} - \overline{U_f}\right) = \alpha(1-\alpha)\left[\left(\gamma K + S'_f\right)(1-\beta) + \beta S_f + C_f\right], \\ G_l(\beta) = \frac{d\beta}{dt} = \beta\left(U_{gl1} - \overline{U_{gl}}\right) = \beta(1-\beta)\left[\alpha(R_{gl} - R'_{gl}) + \alpha\gamma K + \gamma P\right], \\ G_c(\gamma) = \frac{d\gamma}{dt} = \gamma\left(U_{gc1} - \overline{U_{gc}}\right) = \gamma(1-\gamma)\left[IR_{gc} - C_{gc} + P + IL_{gc} - \beta P\right]. \end{cases}$$

2.4. Tripartite Evolutionary Game Equilibrium Analyses

The equilibrium in the dynamic replication system can make the game system reach equilibrium stabilized state. To obtain the above-mentioned equilibrium points, we first set equations $F(\alpha) = G_l(\beta) = G_c(\gamma) = 0$ and then obtain the following nine equilibrium points in a three-dimensional space $M = \{(\alpha, \beta, \gamma); 0 \le \alpha, \beta, \gamma \le 1\}$, which are three-dimensional points: P_1(1,1,1), P_2(1,1,0), P_3(1,0,1), P_4(1,0,0), P_5(0,1,1), P_6(0,1,0), P_7(0,0,1), P_8(0,0,0), and $P_9(\alpha^*,\beta^*,\gamma^*)$. The equilibrium points may not be evolutionary stable strategies (ESS); thus, we need to determine their local stability. The analysis of Friedman on system [23] stability states that the stability of equilibrium points can be estimated from the Jacobian matrix $\boldsymbol{J}$ of the dynamic system. First, we can obtain $\boldsymbol{J}$ from the set of Equation (4), which is calculated from the following formula:

$$\boldsymbol{J} = \begin{bmatrix} J_{\alpha1} \; J_{\beta1} \; J_{\gamma1} \\ J_{\alpha2} \; J_{\beta2} \; J_{\gamma2} \\ J_{\alpha3} \; J_{\beta3} \; J_{\gamma3} \end{bmatrix},$$

$$J_{\alpha1} = \frac{\partial F}{\partial \alpha} = (1-2\alpha)\left[\left(\gamma K + S'_f\right)(1-\beta) + \beta S_f + C_f\right],$$

$$J_{\beta1} = \frac{\partial F}{\partial \beta} = \alpha(1-\alpha)\left(-\gamma K - S'_f + S_f\right),\ J_{\gamma1} = \frac{\partial F}{\partial \gamma} = \alpha(1-\alpha)(1-\beta)K,$$

$$J_{\alpha2} = \frac{\partial G_l}{\partial \alpha} = \beta(1-\beta)\left(R_{gl} - R'_{gl} + \gamma K\right),$$

$$J_{\beta2} = \frac{\partial G_l}{\partial \beta}(1-2\beta)\left[\alpha(R_{gl} - R'_{gl}\right) + \alpha\gamma K + \gamma P],$$

$$J_{\gamma2} = \frac{\partial G_l}{\partial z} = \beta(1-\beta)(P + \alpha K),$$

$$J_{\alpha 3} = \frac{\partial G_c}{\partial \alpha} = 0,\ J_{\beta 3} = \frac{\partial G_c}{\partial \beta} = -\gamma(1-\gamma)P,$$

$$J_{\gamma 3} = \frac{\partial G_c}{\partial \gamma} = (1-2\gamma)\left(IR_{gc} - C_{gc} + P + IL_{gc} - \beta P\right).$$

Second, the determinants $\det(\boldsymbol{J})$ and trace $\mathrm{tr}(\boldsymbol{J})$ of the matrix at different equilibrium points are computed, respectively, and whether the equilibrium point is an ESS can be determined from the signs of $\det(\boldsymbol{J})$ and $\mathrm{tr}(\boldsymbol{J})$. We only consider the equilibrium points P_1–P_8 because of the equilibrium resolutions of group evolutionary game as a strict Nash equilibrium [32].

Next, the equilibrium point $P_1(1,1,1)$ is first analyzed, where the Jacobian matrix of the system is:

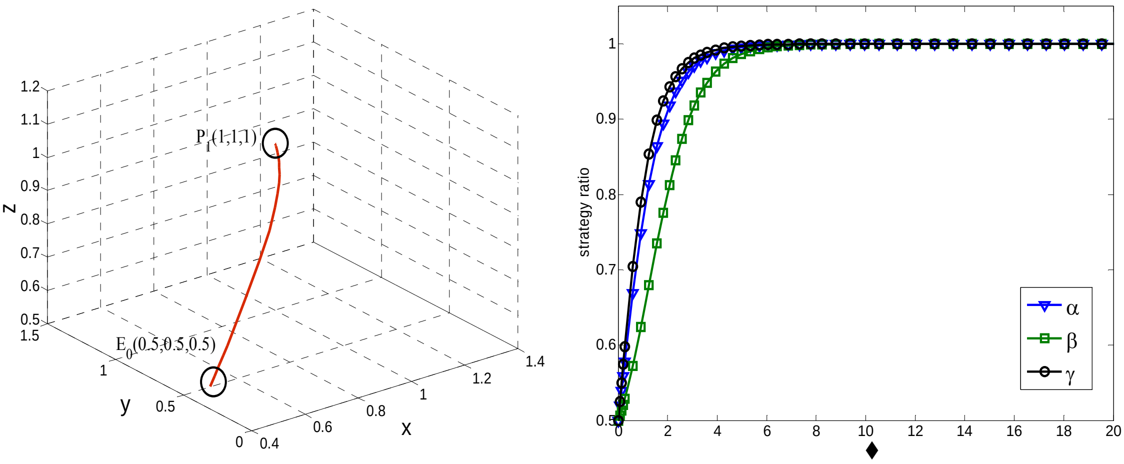
$$\boldsymbol{J}_{P_1(1,1,1)} = \begin{bmatrix} R'_{gl} - R_{gl} - P - K\ 0\ 0 \\ 0\ -C_f - S_f\ 0 \\ 0\ 0\ C_{gc} - IR_{gc} - IL_{gc} \end{bmatrix}.$$

Proposition 1 can be obtained from Lyapunov's indirect method.

Proposition 1. *(1) When the system satisfies $R'_{gl} < R_{gl} + P + K$, $C_f + S_f > 0$, $C_{gc} < IR_{gc} + IL_{gc}$, the equilibrium point P_1 is the ESS. (2) When the system satisfies $R'_{gl} > R_{gl} + P + K$, $C_f + S_f < 0$, $C_{gc} > IR_{gc} + IL_{gc}$, P_1 is an unstable point. (3) When $R'_{gl} - R_{gl} - P - K, -C_f - S_f, C_{gc} - IR_{gc} - IL_{gc}$ has one or two positives, P_1 is a saddle point.* The practical significance of Proposition 1 can be summarized as follows: When the supervised cost is small, the central government chooses the supervised strategy; when the illegal benefit R'_{gl} *is less than a certain value ($IR_{gc} + IL_{gc}$), the local government chooses the legal strategy. For land-lost farmers, they accept the expropriation as long as they can obtain a non-negative settlement.*

Numerical simulations were conducted to validate the evolutionary game analysis through the MATLAB platform. To realize the above model, namely, to establish the dynamic replication system of the central government, local government, and land-lost farmers, it is required to solve the nonlinear ordinary differential equations (Equation (4)). However, it is difficult to obtain analytical solutions of the complex differential equations, but they can be solved using numerical methods based on the widely-used Runge-Kutta method [33]. Runge-Kutta is one of the commonly-used high-accuracy algorithms to compute differential equations, which is derived from the theoretical basis of the Taylor formula and differential slope approximation. The solution of multiple differential equations is equivalent to solve each differential equation in parallel with the same step length. Therefore, we first assign a given initial strategy ratio to the first step of each differential equation, and then solve each equation together in each iteration until convergence. The above complicated calculation can be resolved by a simple implementation of the MATLAB software (R2010b, Version 7.11.0.584, The MathWorks, Natick, MA, USA), which has powerful numerical calculation functions. The ode45 is one of the most popular functions in MATLAB that can solve ordinary differential equations on the basis of the Runge-Kutta algorithm [34,35]. In this research, we used the ode45 functions in our computing program to numerically calculate the evolutionary process of the dynamic replication system.

We choose the related parameters in the evolutionary game model according to real situations that satisfy the conditions of Proposition 1: IR_{gc} = 1.5, ILR_{gc} = 0.5, C_{gc} = 1.0, R_{gl} = 1.0, R'_{gl} = 1.5, S_f = 0.6, S'_f = 0.5, C_f = 0.5, K = 0.5, and P = 0.7. All of the initial strategy ratios of the three parties are 0.5; that is, $\alpha(0) = \beta(0) = \gamma(0) = 0.5$, and the initial state of the strategy combination is point $E_0 = (0.5, 0.5, 0.5)$. Evolutionary results can be obtained by using the above data in the model in the MATLAB platform. Figure 2 shows that the strategy ratio of the legal expropriation of the local government increases with the ratio increase of the supervised strategy of the central government. Meanwhile, an increasing number of farmers choose the "Accept" strategy. Ultimately, all central governments choose the "Supervised" strategy, all local central governments choose the "Legal" strategy, and the farmers choose the "Accept" strategy, thus reaching the equilibrium point $P_1(1,1,1)$. The strategy set of the system is {Accept, Legal, Supervised}. This stable equilibrium strategy P_1 is an optimal result in actual land expropriations.



(a) **(b)**

Figure 2. The dynamic evolution of the tripartite game model under the condition of Proposition 1. (**a**) time evolution of (α, β, γ); (**b**) time evolutions of α, β and γ.

Similarly, the equilibrium points can be analyzed, and the corresponding Jacobian matrices are listed below:

$$J_{P_2(1,1,0)} = \begin{bmatrix} R'_{gl} - R_{gl}\ 0\ 0 \\ 0\ IR_{gc} - C_{gc} + IL_{gc}\ 0 \\ 0\ 0\ -C_f -\ S_f \end{bmatrix}, J_{P_3(1,0,1)} = \begin{bmatrix} -R'_{gl} + R_{gl} + P + K\ 0\ 0 \\ 0\ -C_f - S'_f - K\ 0 \\ 0\ 0\ C_{gc} - IL_{gc} - IR_{gc} - P \end{bmatrix},$$

$$J_{P_4(1,0,0)} = \begin{bmatrix} -R'_{gl} + R_{gl}\ 0\ 0 \\ 0\ IR_{gc} - C_{gc} + IL_{gc} + P\ 0 \\ 0\ 0\ -C_f - S'_f \end{bmatrix},\ J_{P_5(0,1,1)} = \begin{bmatrix} -P\ 0\ 0 \\ 0\ C_{gc} - IL_{gc} - IR_{gc}\ 0 \\ 0\ 0\ C_f +\ S_f \end{bmatrix},.$$

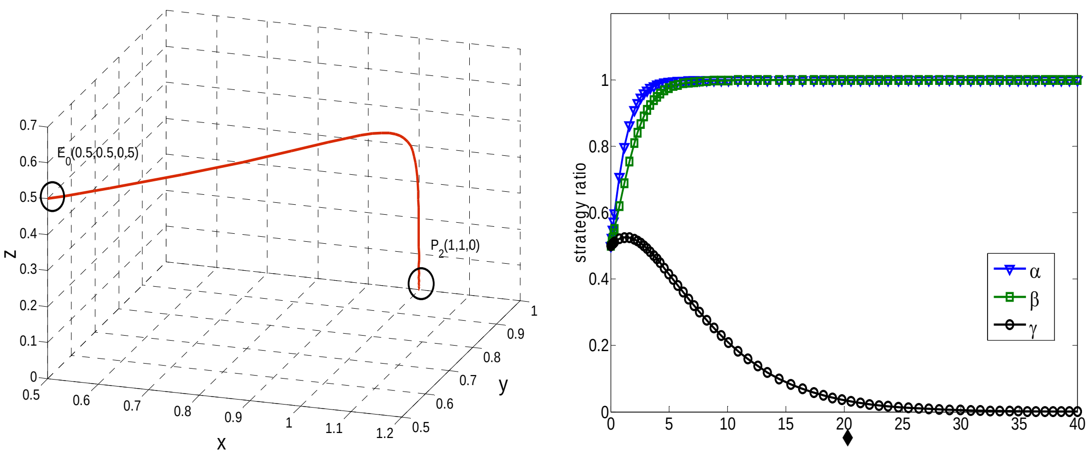
$$J_{P_6(0,1,0)} = \begin{bmatrix} 0\ 0\ 0 \\ 0\ IR_{gc} - C_{gc} + IL_{gc}\ 0 \\ 0\ 0\ R'_{gl} - R_{gl}C_f +\ S_f \end{bmatrix},\ J_{P_7(0,0,1)} = \begin{bmatrix} P\ 0\ 0 \\ 0\ C_{gc} - IL_{gc} - IR_{gc} - P\ 0 \\ 0\ 0\ C_f + K + S'_f \end{bmatrix}, \quad (4)$$

$$J_{P_8(0,0,0)} = \begin{bmatrix} 0\ 0\ 0 \\ 0\ IR_{gc} - C_{gc} + IL_{gc}\ 0 \\ 0\ 0\ C_f + S'_f \end{bmatrix}$$

The traces of equilibrium points P_5–P_8 satisfy $tr(\boldsymbol{J}) \geq 0$ according to the stability-checking rule, which suggests local instability; thus, we only discuss the equilibrium points P_2–P_4.

Proposition 2. *When the system satisfies* $R'_{gl} < R_{gl}$, $IR_{gc} + IL_{gc} < C_{gc}$, $C_f +\ S_f > 0$, *the equilibrium point* P_2 *is the ESS. The practical significance of Proposition 2 is, when the benefits of the local government obtained by means of illegal expropriation are larger than that from legal strategy, the supervised costs for the central government are larger than a certain value* ($IR_{gc} + IL_{gc}$)*; and when the settlements for farmers are non-negative, the dynamic system evolves to a balance over time. Eventually, all central governments choose the "Unsupervised" strategy, the local governments choose the "Legal" strategy, and the farmers choose the "Accept" strategy. That is to say, the system reaches the equilibrium state* $P_2(1,1,0)$. *The strategy set is {Accept, Legal, Unsupervised}.*

We set IR_{gc} = 0.3, ILR_{gc} = 0.5, C_{gc} 1.0, R_{gl} = 1.0, R'_{gl} = 0.8, S_f = 0.5, S'_f = 0.6, C_f = 0.5, K = 0.5, and P = 0.7, while validating Proposition 2 and obtain the simulation results of the game of the three parties. Figure 3 shows that the "Legal" strategy ratio of the local government and the "Accept" strategy ratio of farmers increase significantly with time, initially. However, as the supervised costs for the central government are relative high, the supervised strategy ratio gradually decreases with time. The system finally reaches equilibrium point $P_2(1,1,0)$, that is, the ESS is the strategy set {Accept, Legal, Unsupervised}. In this context, the local government adopts the Legal strategy, and the farmers can also actively collaborate with the land expropriation of the government. This strategy set P_2 will promote the local construction and development to some extent because it did not cause any conflicts.

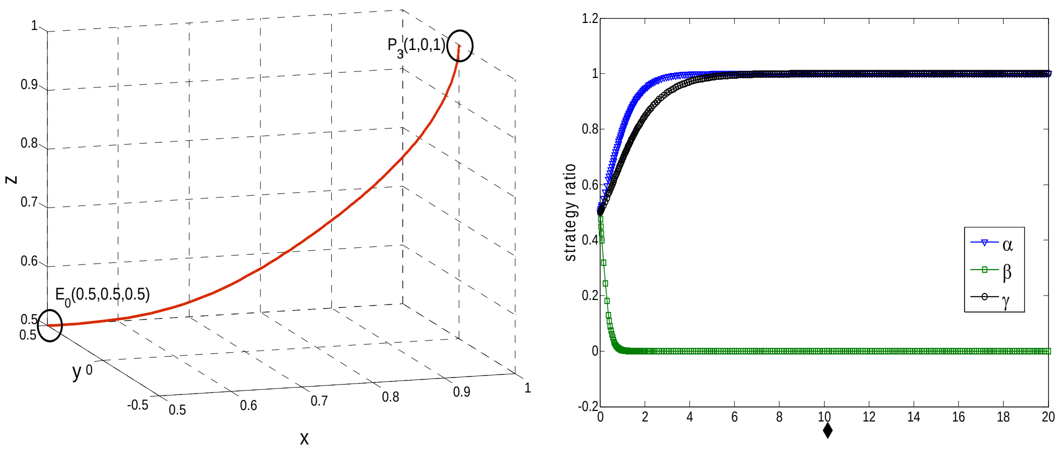


(**a**) (**b**)

Figure 3. The dynamic evolution of the tripartite game model under the condition of proposition 2. (**a**) time evolution of (α, β, γ); (**b**) time evolutions of α, β and γ.

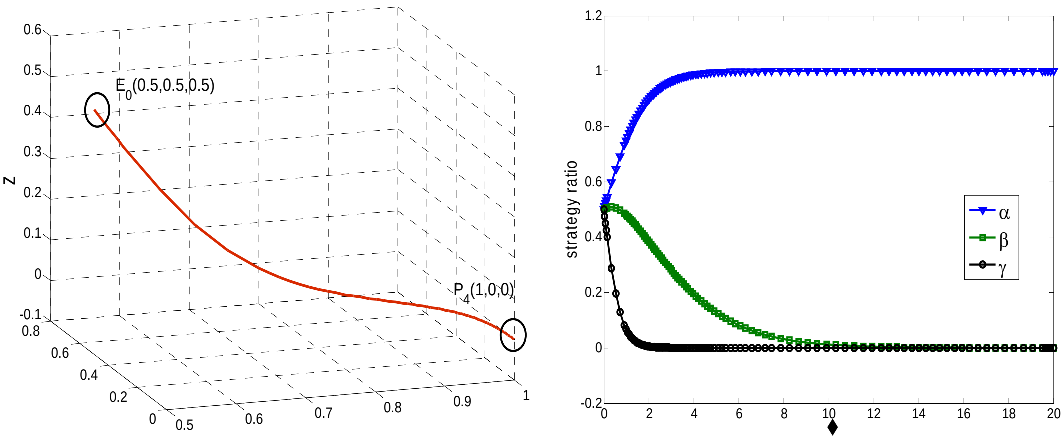
Proposition 3. *When the system satisfies* $R_{gl} + P + K < R'_{gl}$, $C_f + S'_f + K > 0$, $C_{gc} < IL_{gc} + IR_{gc} + P$, *point* $P_3(1,0,1)$ *is the ESS. The practical significance of Proposition 3 is, when the benefits of the local government obtained from illegal expropriation are larger than that from legal strategy, the supervised costs are less than a certain value* ($IL_{gc} + IR_{gc} + P$)*, and the settlements for farmers are non-negative. The system evolves to the equilibrium state {Accept, Illegal, Unsupervised} and reaches the ESS* $P_3(1,0,1)$. *We choose* IR_{gc} = 0.3, ILR_{gc} = 0.5, C_{gc} = 0.6, R_{gl} = 1.0, R'_{gl} = 10.8, S_f = 0.5, S'_f = 0.6, C_f = 0.5, K = 0.5, *and* P = 0.7, *in testing this proposition, which are considered in the model. Simulation results are shown in Figure 4. The "Supervised" strategy ratio of the central government and the "Accept" strategy ratio of farmers gradually increases with time. However, the local government is inclined to choose the "Illegal" strategy, in that the ratio increases rapidly with time because the illegal benefits are considerably large. Finally, the system reaches the equilibrium point* $P_3(1,0,1)$, *that is, the ESS is {Accept, Illegal, Supervised}.*

Proposition 4. *When the system satisfies* $R'_{gl} > R_{gl}$, $IR_{gc} + IL_{gc} + P < C_{gc}$, $C_f + S'_f > 0$, *the point* $P_4(1,0,0)$ *is the ESS. The practical significance of Proposition 4 is, when the local benefits of the local government obtained from the "Illegal" strategy are larger than that from the "Legal" strategy, the supervised costs are larger than a certain value* ($IR_{gc} + IL_{gc} + P$)*. The costs of farmers in safeguarding their rights and settlements are non-negative, and the evolutionary results are {Accept, Illegal, Unsupervised}, reaching the ESS* $P_4(1,0,0)$. *We choose* IR_{gc} = 1.5, ILR_{gc} = 0.5, C_{gc} = 0.5, R_{gl} = 1.0, R'_{gl} = 1.5, S_f = 0.5, S'_f = 0.6, C_f = 0.5, K = 0.5, *and* P = 0.7 *in testing this proposition, which are considered in the model. Simulations in Figure 5 show that the "Accept" strategy ratio of the farmers increases over time. The local government will change their "Legal" strategy into the "Illegal" strategy because of the benefits of the former. The "Supervised" strategy ratio for the central government gradually decreases due to the large supervised costs. Finally, the system reaches equilibrium point* $P_4(1,0,0)$, *which is consistent with Proposition 4.*



(**a**) (**b**)

Figure 4. The dynamic evolution of the tripartite game model under the condition of Proposition 3. (**a**) time evolution of (α, β, γ); (**b**) time evolutions of α, β and γ.



(**a**) (**b**)

Figure 5. The dynamic evolution of the tripartite game model under the condition of Proposition 4. (**a**) time evolution of (α, β, γ); (**b**) time evolutions of α, β and γ.

3. Analysis of Influencing Factors

The model involves the costs of the "Supervised" strategy and safeguarding the rights of farmers, and the variance of the creditability of the government and other factors, which will have a significant effect on the strategy selections. We discuss the above-mentioned factors on the evolutionary results thoroughly in this section. The settings of simulation parameters are shown in Table 3.

Table 3. The settings of simulation parameters.

Parameters	IR_{gc}	IL_{gc}	C_{gc}	P	R'_{gl}	R_{gl}	S_f	S'_f	C_f	K
Value Figures	1.5	0.5	[1.0, 1.8] Figure 6	[0.4, 1.5] Figure 7	[0.5, 2.0] Figure 8	1.0	0.6	0.5	[0.1,0.5] Figure 9	0.5

3.1. The Supervised Costs of the Central Government C_{gc}

In order to test the impact of supervised costs of the central government, the parameter C_{gc}, which is set to range from 1.0 to 1.8, while fixing other parameters. The simulation results in Figure 6 reveal that the "Supervised" strategy ratio decreases when the supervised costs of the central government increase from 0.3 to 1.8. The simulation results demonstrate that the supervised costs can hinder the central government in performing the supervised strategy.

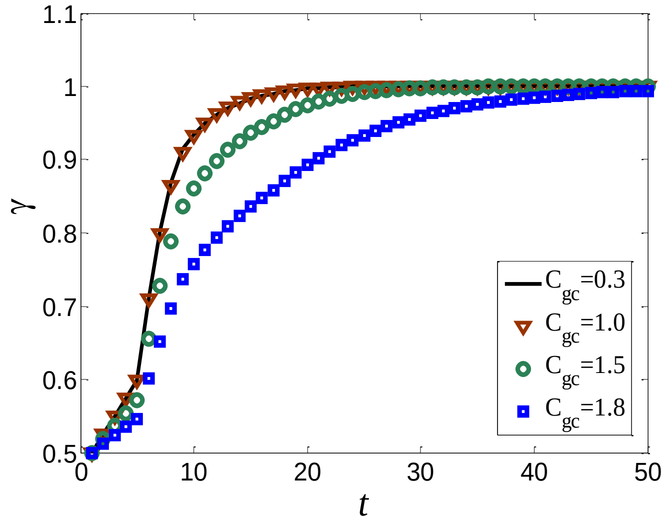


Figure 6. The effect of supervised costs on the evolutionary strategy of the central government.

This result coincides with the real practice. As a country with a vast territory and multi-hierarchy levels of management, the supervised cost for the central government to closely monitor local affairs is usually high, especially for the conflicts of land expropriation with negative impacts. Therefore, some negative incidents would happen as the local officials think they are outside the central government's control ("Tian Gao Huang Di Yuan" in Chinese old saying). Luckily, the supervised cost for the central government is reducing in the information era. With rapid development of mobile networks, it is much easier for the central government to know what is happening as the local people post relevant information during conflicts via social media to attract the attention of society and the upper government. In addition, with the development of NGOs, the voices of land-lost farmers as a group have more channels to be heard by the central government. Therefore, it is harder and harder for the local governments to conceal any affairs with negative impacts.

3.2. The Punishment for the Illegal Strategy of the Local Government P

Similarly, we fix other parameters and change the punishment for the illegal strategy of the local government P, which ranges from 0.4 to 1.5. Figure 7 shows that the decrease of punishment can lead the local government to change their strategy from legal (dotted lines) to illegal (straight line), because the costs of illegal expropriation decrease with the reduction of punishment.

In past decades, punishment for the illegal strategy of the local government during land expropriation was comparatively small due to various reasons. First is the high supervised cost of the central government, as mentioned previously. Covering up the illegal strategy was quite easy for the local government. Second is the awareness and the channels of rights protection were comparatively few for the land-lost farmers. Therefore, it was difficult to place more punishment on local officials. Third is the major concern of the past decades was development, which presented barriers in realizing fairness in solving conflicts of land expropriation. However, this condition is changing. With education improvement and information development, more and more people care about their rights and have more channels to express their opinions. In order to realize the future of common wealth, the central government is also paying attention to fairness and improve the punishment for local officials of illegal actions. Therefore, the punishment of the illegal strategy would become higher and higher, making the illegal strategy gradually unbearable.

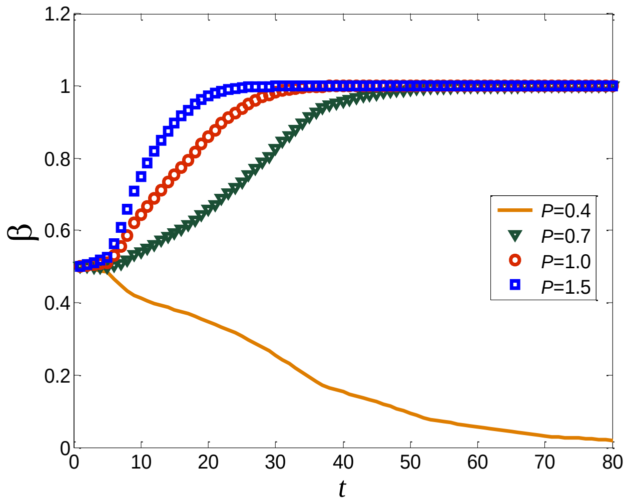


Figure 7. The effect of punishment for the illegal strategy on the evolutionary strategy of the local government.

3.3. The Benefits from Illegal Expropriation of the Local Government R'_{gl}

The effects of the illegal benefits are investigated by fixing other parameters and only changing R'_{gl}. Especially, R'_{gl} is chosen as R'_{gl} = 0.5, 1.0, 1.5, 1.8. The simulation results are calculated and shown in Figure 8. Simulation results indicate that the strategy of local government gradually changes from legal to illegal expropriation with an increase of illegal land revenue. Some local government will adopt the "Illegal" strategy in actual situations, such as decreasing the compensation and resettlement standards. Based on the results in Section 3.2, enhanced regulation from the central government is necessary.

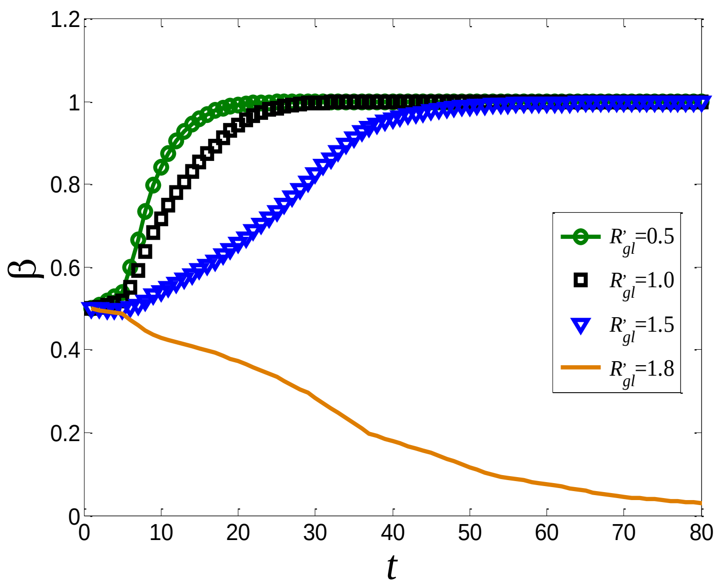


Figure 8. The effect of benefits from illegal expropriation on the evolutionary strategy of the local government.

The benefits of illegal land expropriation were very large as the local government mainly relied on land finance for infrastructure development and the provision of public services [36,37]. In addition to potential rent-seeking of the local officials, the local government would obtain more finances through transferring land with higher prices, but expropriating land with lower price. With more provisions of infrastructure and public services, the political achievement would help local officials to gain more promotions. Yet, as the central government is changing, the political performance evaluation, other issues, e.g., environment protection, and the population's happiness have also been considered. Therefore, the economic development incentive of the local government may be less, which further makes benefits of illegal land expropriation less attractive.

3.4. The Costs of Farmers in Safeguarding their Rights C_f

We investigate the effect of the costs of farmers in safeguarding their rights. Particularly, set $C_f = -0.5,\ 0.1,\ 0.3,\ 0.5$ and simulation results are shown in Figure 9. The system converges fast with an increase of the cooperation costs. When C_f is considerably large for the farmers in actual situations, the farmers will choose silence; they will not pursue or think that any defense measures are useless. In contrast, the convergence velocity slows down slightly with the decrease of C_f, because some farmers are hesitant to safeguard their rights. We continue to reduce C_f to a certain value. The land-lost farmers change their initial "Accept" strategy to resist against illegal land expropriation from the local government to protect their lawful rights and own interests. However, this value, in reality, does not exist, and is only used in the simulation model and the change rule of the observation strategy.

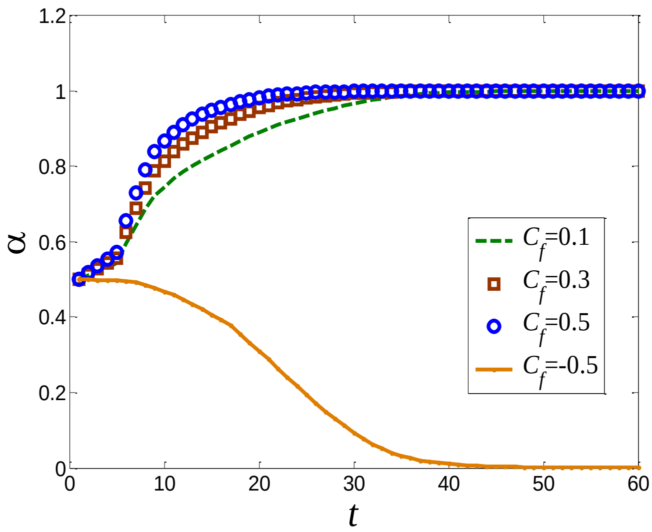


Figure 9. The effect of the costs of peasants in safeguarding their rights on the evolutionary strategy.

It is easy to understand that the rational farmers have to be silent when the cost is too high for them to protect their rights. If the cost is somewhat bearable (or irrationally considered as bearable), the land-lost farmers would usually take various measures to protect their rights during conflicts of land expropriation, especially when their awareness of rights protection has been awoken. The cost of rights protection has been reduced due to information and relevant NGOs' development. On the other hand, the central government should provide more channels and reduce the cost of rights protection in order to develop a harmonious society in China.

4. Conclusions and Suggestions

In China, conflicts on land expropriation have been investigated through various aspects by researchers. However, studies on the behavior of the central and local governments, and the land-lost farmers in the conflicts of land expropriation are limited. This paper fills this research gap through evolutionary game theory and the replicator dynamics model. A tripartite evolutionary game model, including the central and local governments, and land-lost farmers, is built to examine how different types of strategies of the stakeholders evolve dynamically under limited rational conditions. Game analysis and simulation results are summarized as follows: (1) When the regulatory costs of the central government are small, the illegal benefits of the local government are less than a certain value, and farmers can obtain certain compensation and resettlement; the ESS of the system is {Accept, Legal, Supervised}. (2) The game ESS changes into {Accept, Legal, Unsupervised} when the costs of supervision are raised. (3) The game ESS for the system will be {Accept, Illegal, Supervised} when the illegal income from land expropriation of the local government increases. (4) The stable strategy evolves to {Accept, Illegal, Unsupervised} when the costs of supervision continue to increase.

The process of land expropriation is partly caused by the defects of the system of land expropriation in contemporary China and information asymmetry. For the broad masses of farmers, losing land and shelter will make their lives considerably difficult. These farmers will also outrage at the expropriation of their land for low compensation even when they are compensated by the local government. Once they cannot maintain their rights and interests legally, their grievances cannot be released and can easily trigger land conflicts. Some local governments in a strong position take advantage of the system design and the aid of administrative rights in the land expropriation game to pursue their best interests. They even force land expropriation, and lower compensation and resettlement standards, consequently producing conflicts with farmers.

Serious asymmetric information makes it impossible for land-lost farmers to achieve satisfactory game equilibrium, and some even lead to the low efficiency of the game or severe conflict. Therefore, a fair and transparent game environment is necessary in the current transitional society. The evolution paths of game strategy for the central and local governments show that the central government should improve the legal system of land expropriation through better legislation, strict law enforcement, enhanced regulation capability, and increased penalties for illegal behavior. Conversely, the evolution path of strategy selection for farmers shows that constructing an unblocked channel of benefit expression and effectively protecting their legal rights are important in solving conflicts and achieving sustainable development. This research can provide good references for the central and local governments to reduce conflicts during land expropriation. Yet, it should be noted that there are still some limitations in the existing study due to preset research objective and limited time. Future studies should conduct investigations into the roles of other stakeholders, e.g., NGOs and the interacting role of "opinion leader" and "farmers' union". The model can also be extended to analyze four stakeholders in future studies.

Acknowledgments: This study is supported by the Department of Education of Zhejiang Province (Y201534476), and the National Natural Science Foundation of China (Grant No. 41371187, 71503228, 71673232). This study is also supported by the Natural Science Foundation of Zhejiang Province of China (Project No. LQ16G030006), Qianjiang Talents Program of Zhejiang Province (QJC1602006), Hangzhou Scientific Research Project (Grant No. 20150834M49), the Early Career Scheme of Hong Kong Research grant council (Project No. 9048039), the General Research Funding of Hong Kong Research grant council (Project No. 9042363), and the Lincoln Institute of Land Policy Foundation project (USA and China) (Project No. R-IND6604).

Author Contributions: The individual contribution and responsibilities of the authors are listed as follows: Qiuxiang Li developed the model, and conducted analysis; Haijun Bao proposed the research idea, and designed the research; Yi Peng developed the model, and wrote the paper; Haowen Wang conducted preliminary analysis; and Xiaoling Zhang gave some comments and helped edit the manuscript. All authors reviewed and approved the final manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Peng, Y. A comparison of two approaches to develop concentrated rural settlements after the 5.12 Sichuan Earthquake in China. *Habitat Int.* **2015**, *49*, 230–242. [CrossRef]
2. Bao, H.J.; Peng, Y. Effect of land expropriation on land-lost farmers' entrepreneurial action—A case study of Zhejiang Province. *Habitat Int.* **2016**, *53*, 342–349. [CrossRef]
3. Ding, C.R. Policy and praxis of land acquisition in China. *Land Use Policy* **2007**, *24*, 1–13. [CrossRef]
4. Tan, S.K. Exploring the causes of the frequent land conflicts in China. *China Land Sci.* **2009**, *23*, 44–50.

5. Tan, S.K.; Shan, T.U. The game theory analysis on the stakeholders involved in farmland-acquisition conflicts: Taking the local government and land-lost peasants as an example. *China Land Sci.* **2009**, *23*, 27–32.
6. Xu, Y.; Tang, B.S.; Chan, E.H.W. State-led land requisition and transformation of rural villages in transitional China. *Habitat Int.* **2011**, *35*, 57–65. [CrossRef]
7. Li, H.B.; Li, B.L.; Li, S.M. Governance mechanism on land-expropriation conflicts in the minorities areas of western China. *China Land Sci.* **2013**, *3*, 17–23.
8. Bao, H.J.; Ye, Q.Y.; Xu, S.M. Conflicts and governance of rural collective-ownership land expropriation: An interdisplinary literature comment. *China Land Sci.* **2014**, *28*, 82–88.
9. Song, Y.; Wang, M.Y.; Lei, X. Following the money: Corruption, conflict, and the winners and losers of suburban land acquisition in China. *Geogr. Res.* **2015**, *54*, 86–102. [CrossRef]
10. Feng, Y.Y. Review of the cause, strategy and theoretical orientation of rural land conflict research review. *Res. Soc. Dev.* **2016**, *1*, 219–232.
11. Lin, G.C.S.; Ho, S.P.S. The state, land system, and land development processes in contemporary China. *Ann. Assoc. Am. Geogr.* **2005**, *95*, 411–436. [CrossRef]
12. Lynette, H.O. State-led urbanization in China: Skyscrapers, land revenue and "concentrated villages". *China Q.* **2014**, *217*, 162–179.
13. Cao, G.; Feng, C.; Tao, R. Local "land finance" in China's urban expansion: Challenges and solutions. *China World Econ.* **2008**, *16*, 19–30. [CrossRef]
14. Guo, X.L. Land expropriation and rural conflicts in China. *China Q.* **2001**, *166*, 422–439. [CrossRef]
15. Ho, S.P.S.; Lin, G.C.S. Emerging land markets in rural and urban China: Policies and practices. *China Q.* **2003**, *175*, 681–707. [CrossRef]
16. Zou, X.Q.; Zhong, X.Y.; Xiao, Z.G.; Song, X. Dynamic game analysis among local government, central government, and peasants in the conflicts of farmland acquisition. *China Land Sci.* **2012**, *26*, 54–60. (In Chinese).
17. Sargeson, S. Violence as development: Land expropriation and China's urbanization. *J. Peasant. Stud.* **2013**, *40*, 1063–1085. [CrossRef]
18. Alvin, Y.S. Peasant conflict and the local predatory state in the Chinese countryside. *J. Peasant. Stud.* **2007**, *34*, 560–581.
19. Bao, H.J.; Zhu, X.T.; Cen, Y.Y.; Peng, Y.; Xue, J.B. Effects of social network on human capital of land-lost farmers: A study in Zhejiang Province. *Soc. Indic. Res.* **2017**. [CrossRef]
20. Peng, Y.; Shen, Q.P.; Shen, L.Y.; Lu, C.; Yuan, Z. A generic decision model for developing concentrated rural settlement in post-disaster reconstruction: A China study. *Nat. Hazards* **2014**, *71*, 611–637. [CrossRef]
21. Samsura, D.A.A.; Krabben, E.V.D.; Deemen, A.M.A.V. A game theory approach to the analysis of land and property development processes. *Land Use Policy* **2009**, *27*, 564–578. [CrossRef]
22. Bao, H.J.; Peng, Y.; Ablanedo-Rosas, J.H.; Gao, H.M. An alternative incomplete information bargaining model for identifying the reasonable concession period of a BOT project. *Int. J. Proj. Manag.* **2015**, *33*, 1151–1159. [CrossRef]
23. Weibull, J. *Evolutionary Game Theory*; MIT Press: Cambridge, MA, USA, 1995; Volume 38, pp. 847–858.
24. Peng, Y.; Shen, L.Y.; Zhang, X.L.; Ochoa, J.J. The feasibility of concentrated rural settlement in a context of post-disaster reconstruction: A study of China. *Disasters* **2014**, *38*, 108–124. [CrossRef] [PubMed]
25. Liang, X.; Peng, Y.; Shen, G.Q. A game theory based analysis of decision making for green retrofit under different occupancy types. *J. Clean. Prod.* **2016**, *137*, 1300–1312. [CrossRef]
26. Tan, S.K.; Qi, R. Analyzing land expropriation conflicts in China: Based on a newly-built game model. *China Land Sci.* **2010**, *24*, 25–41.
27. Peng, X.B.; Tan, R.; Hu, Y. A study on the game of the dispute of the urban house demolition and countermeasures. *J. Chongqing Univ.* **2005**, *11*, 19–23.
28. Hui, E.C.M.; Bao, H.J. The logic behind conflicts in land acquisitions in contemporary China: A framework based upon game theory. *Land Use Policy* **2013**, *30*, 373–380. [CrossRef]
29. Cheng, Y.L.; Liu, R.Y. Game analysis about conflict of interest between farmers and local government in farmland acquisition. *Resour. Dev. Mark.* **2016**, *32*, 196–202.
30. Yuan, F.C.; Yan, X.C. Trilateral game analysis on collective construction land transfer in view of local governments, rural collectives and land using enterprises. *China Land Sci.* **2009**, *23*, 58–63.
31. Xie, Z.Y. *Economic Game Theory*; Fu Dan University Press: Shanghai, China, 2004. (In Chinese)

32. Sun, Q.W.; Liu, L.U.; Yan, G.L.; Che, H.A. Asymptotic Stability of Evolutionary Equilibrium under Imperfect Knowledge. *Syst. Eng. Theory Pract.* **2003**, *7*, 11–16.
33. Ma, Z.E.; Zhou, Y.C. *Qualitative and Stability Method of Ordinary Differential Equation Qualitative and Stability Method*; Science Press: Beijing, China, 2001. (In Chinese)
34. Polkinghorne, J.C.; David, A. *Ordinary Differential Equations Using MATLAB*; Prentice Hall: New Jersey, NJ, USA, 1999.
35. Anyigor, C.; Afiukwa, J. Application of matlab ordinary differential equation function solver (ode45) in modelling and simulation of batch reaction kinetics. *Am. J. Sci. Ind. Res.* **2013**, *4*, 285–287. [CrossRef]
36. Liu, Y.; Yue, W.; Fan, P.; Peng, Y.; Zhang, Z. Financing China's suburbanization: Capital accumulation through suburban land development in Hangzhou. *Int. J. Urban Reg. Res.* **2017**, in press.
37. Peng, Y.; Lai, Y.N.; Li, X.W.; Zhang, X.L. An alternative model for measuring the sustainability of urban regeneration: The way forward. *J. Clean. Prod.* **2015**, *109*, 76–83. [CrossRef]