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Analysis of the Game Behavior of Real Estate Mortgage Securities Issuers Based on Reciprocal Preferences

Tian Tan[1,a,*]

[1]*Faculty of Engineering, The University of Sheffield, Sheffield, 2HE237, UK*
a. 15060140320@ xs.hnit.edu.cn
**corresponding author*

Abstract: In recent years, the Chinese government has gradually begun to pay attention to the development of real estate investment trusts (REITs) and hopes to use REITs to increase the securitization of assets in the real estate market, making it possible to accelerate the circulation of funds in the real estate market. In order to enable issuers to price REITs effectively to form a mutually beneficial transaction model with investors, to increase the willingness and success rate of both parties and to ultimately create a harmonious and efficient REITs market, it is important to study the pricing decisions of issuers when issuing REITs. This study analyzes and investigates the issue of pricing decisions of REITs based on reciprocal preferences and evolutionary game theory. It is found that when the proportion of REITs issuers choosing to construct a reciprocal initial pricing decision is greater than the equilibrium probability of REITs issuers choosing a reciprocal pricing strategy, and when the initial proportion of investors choosing a reciprocal investment decision is greater than the equilibrium probability of investors choosing a reciprocal investment strategy, the overall REITs transaction market tends to be a reciprocal and harmonious transaction market at this time, the overall happiness of the REITs trading market is the highest, and the success rate of trading increases and the capital circulation of the real estate market is accelerated. Therefore, it is recommended that issuers choose reciprocal competitive decisions when pricing REITs in order to increase the success rate of their own REIT holdings; and it is recommended that the government, when regulating the pricing of REITs, pays attention to the psychological factors of reciprocal preferences of issuers and investors and that the government penalizes REIT issuers and investors when they choose self-serving decisions and rewards them when they choose reciprocal decisions.

Keywords: real estate investment trusts (REITs), behavioral economics, evolutionary game theory, reciprocity preference, issue pricing

1. Introduction

With the development of the economy in China, more and more attention is being paid to the function of asset securitization, especially in the real estate sector, where there is a desire to accelerate the construction of real estate investment trusts (REITs) to improve the circulation of capital in the real estate market. However, the construction of REITs in China is still in its infancy, and the rules are still being worked out. Recently, to accelerate the standardized development of the housing rental financial market, the People's Bank of China and the China Banking and Insurance Regulatory

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Commission jointly drafted the Opinions on Financial Support for the Development of the Housing Rental Market (Draft for Public Comments) and opened it to the public for comments. Under such circumstances, it is necessary to study the game between REITs issuers and investors to provide useful suggestions for issuers' issuance pricing decisions. This study can also provide the Chinese government with references for effective and feasible measures in the regulation of REITs issuance pricing to gradually built a harmonious and effective REITs trading market in China.

2. Literature Review

2.1. Real Estate Investment Trusts (REITs)

In 1960, the United States amended the Real Estate Investment Trust Act, from which REITs came into being. In the past 60 years, REITs have been developing in the United States, and the financial markets of other countries have followed suit. Guo and Ma mentioned that REITs, or real estate investment trusts, are financial instruments that raise funds by issuing shares or income certificates; REITs are invested in the real estate sector by professional institutions and operated and managed accordingly, and finally, the fund proceeds are distributed proportionally to investors [1]. Following extensive years of research and development, studies on the pricing of REITs have mainly focused on the determination of influencing factors and the setting of pricing models. For example, investors' personal preferences, future cash flows of the underlying building, the structure of investors, dividend distribution policies of REITs, tax incentives, investors' attention, diversified distribution of assets, and even natural disasters can be factors in the pricing of REITs [2-6]. In terms of setting up a pricing model for REITs, Martin et al attempted to apply a Monte Carlo model in real estate valuation to analyze the uncertainty in the evaluation of the pricing process [7].

2.2. The Development of Evolutionary Game Theory and its Application in the Securities Market

Since the 1990s, evolutionary game theory has developed rapidly under the direct impetus and tireless efforts of economists such as Binmore, Fudenberg, and Young. Subsequently, game models gradually entered the field of economics, and economists used evolutionary game theory to study various economic problems. In the analysis of securities market behavior, previous studies based on evolutionary game theory have focused on noise trading, the herding effect, and insider trading. For example, Meng and Meng and Wang used evolutionary game theory to study the impact of noise traders on the Chinese stock market [8]; Li and Feng used evolutionary game theory to analyze the dynamic system evolution of the two overall groups when the noise traders in the institutional investor group and the noise traders in the individual investor group have different attitudes [9]. Wang, Wu, and Huang developed and analyzed a dynamic evolutionary game model for the market herding effect of fund managers [10]. Shen and Zhou established an evolutionary game model of insider information manipulation regulation and explored the intrinsic mechanism of insider information manipulation regulation [11]. It can be understood from the previous literature that the core ideas of evolutionary game theory are the evolutionarily stable strategy and the replicator dynamic equation [12-14]. The evolutionary stable strategy can be reflected in the fact that when random pairings are made in the game model, the level of payment effects for REITs issuers and investors will be higher than the level of effects for later entry into the REITs trading market; and the replication dynamics equation reflects the differential equation of the frequency of adoption of a particular strategy among the REIT issuer population. Thus, both core ideas can be fully reflected in the pricing game between REIT issuers and investors.

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2.3. Reciprocal Preferences of Behavioral Economics

Orthodox economics is based on the assumption of "economic man", which holds that the improvement of social welfare is based on the individual's greatest pursuit of self-interest. However, in actual economic activity, not all participants are completely rational and they have some degree of desire to build a harmonious economic activity. The emergence of behavioral economics and the underlying assumption of behavioral economics, reciprocal preferences, established a solid theoretical platform for such aspirations. Reciprocal preference is a hot issue in the current altruistic thought system. Reciprocal preference dominates the development direction of altruistic thought and is considered by behavioral economics as the most socially altruistic psychology, which can truly reveal the original face of economic and social development. Therefore, in recent years, reciprocity preferences have received extensive attention in the field of economics and have had far-reaching effects on the development of the economy and society, showing increasingly significant economic and managerial effects [15].

In 1993, Professor Matthew Rabin defined "reciprocity" as "being nice to others when these people are nice to behavior recipients and being unkind to others when these people are unkind to behavior recipients." Rabin's unique contribution is to specify the concept of reciprocity as "people are defined as being unkind to others if people sacrifice own utility to the detriment of others' utility; people are defined as being kind to others if people sacrifice own utility to enhance the utility of others" [16]. In 2001, Professor Rabin constructed a new system of game theory by introducing elements of reciprocal preferences. This new theory is based on the "mental game" proposed by John Geanakoplos, David Pearce and Ennio Stacchetti. Professor Rabin guided the discovery of the "reciprocal equilibrium", which is qualitatively more welfare-oriented than the traditional "rational equilibrium", thus establishing the preeminence of reciprocal preference research in the field of behavioral economics [17].

2.4. Research Gap

It can be seen from previous papers that the REITs market in the U.S. has been established and developed for many years, and the research on REITs pricing has mainly focused on the determination of objective influencing factors and the setting of REITs pricing models and has accumulated a large amount of mature theoretical research and practical experience. Meanwhile, scholars are well-established in the study and application of reciprocal preference theory and evolutionary game theory. However, up to date, no studies have considered the psychological factors of issuers in the pricing process of REITs issues, and there is a lack of research on how reciprocity preferences affect issuers' pricing decisions in the pricing process of REITs issues.

3. Construction of an evolutionary game model based on reciprocity preferences

Due to the existence of information asymmetry and selfishness of issuers in the REITs trading market, the competition is intense. Based on the aspect of REITs issuers, the model introduces the theory of reciprocal preferences of the microscopic basis of behavioral economics into the evolutionary game model, establishes the replicator dynamic equation of happiness and reciprocity between REITs issuers and investors, and analyzes the stability of the dynamic phase diagram of the game of happiness and reciprocity.

3.1. The introduction of an evolutionary game for REITs issuers and investors

In the REITs trading market, there is a conflict of interest between REITs issuers and investors as the two main actors in REITs pricing, which essentially means that there is an intense game. For example,

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if the issue price is set low, the purpose of financing with REITs will not be achieved and the meaning of REITs issuance will be lost, but if the issue price is set too high, no investors will be willing to invest, and the purpose of financing will also not be achieved. Depending on the conflicting relationships between issuers and investors in the REITs trading market, where each side can represent a competing group, pricing competition between the two sides is the most dominant form of competition in the REITs trading market.

In the pricing stage of REITs issuance, an issuer uses a mortgaged property as the underlying to determine a certain REIT issuance price and form a long-term benefit for the issuer, while other issuers also determine the same price as the optimal REIT issuance price based on their own mortgaged properties of the same quality, thus forming a competition between them for the same price. For the evolutionary process of competitive behavior of REITs issuers, the pricing strategy (strategy formed by the efficiency function) between the two sides of the game competitors replaces the lower strategy with the higher strategy over the time dimension as the degree of information disclosure gradually grows and the concept of happiness and reciprocity takes hold. In this process, the concept of happiness and reciprocity between the two parties begins to change due to changes in time and information, but their utility formation strategies are consistent; second, neither REITs issuers nor investors can systematically, holistically, and normatively interfere with and influence the actions taken by other actors in the face of the new situation. Because these characteristics are characteristic of evolutionary games, the study introduces the evolutionary game theory of pricing competition between issuers and investors from the perspective of REITs issuers and analyzes the competitive behavior of the two parties from the perspective of happiness and reciprocity.

3.2. Construction of an Evolutionary Game Model of Reciprocal Preferences

3.2.1. Basic conditions for model building

Condition 1: Because the REITs trading market is capital intensive and more significantly influenced by the quality of mortgaged real estate products, there is intense competition between the interests of issuers seeking to maximize their financing profits and investors seeking to purchase quality and affordable REITs products for themselves; REITs issuers and investors, as the two antagonistic interest groups in the REITs trading market, determine the harmony of the overall REITs trading market, thus this model builds on the competition between the REITs issuer group and the investor group based on reciprocity preferences.

Condition 2: Because self-interested individuals and reciprocity-oriented individuals have different psychological preferences for payment in the same competitive environment, both sides of the interest confrontation take different strategic actions. Thus, to facilitate the model analysis, the desired goals of both parties can be quantified in dosage units.

Condition 3: In this evolutionary game, REITs issuers and investors will choose the corresponding strategies considering each other's decisions, and the prerequisite for the establishment of a strategy space is that both parties are free to choose between selfish strategies and reciprocal strategies.

Condition 4: On the basis of information symmetry between the two parties, the strategy space for REITs issuers is (reciprocal strategies, selfish strategies); the strategy space for investors is (reciprocal strategies, selfish strategies).

Condition 5: For REITs trading market issuers, the probability of choosing the reciprocal strategies is **p** and the probability of choosing the selfish strategies is **1-p** according to the psychological expectation of investors; for rival investors, the probability of choosing the reciprocal strategies is **r** and the probability of choosing the selfish strategies is **1-r** according to the psychological expectation of issuers.

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Condition 6: For quantified payments and quantified expected returns, the mutual utility is **(a, b)** if the REITs issuer chooses reciprocal strategies and the investor meets certain expected goals and chooses to buy; the mutual utility is **(c, d)** if the REITs issuer chooses reciprocal strategies and the investor does not meet the expected goals and chooses selfish strategies; similarly, the utility of the REITs issuer choosing a selfish competitive strategy and the investor choosing to buy is **(e, f)**; the utility of the REITs issuer choosing selfish strategies and the investor choosing selfish strategies is **(g, h)**.

Thus, the game utility matrix is formed from the above conditions as shown in the Table 1

Table 1: The game utility matrix.

	investors		
REITs issuers	Probability	reciprocal strategies(r)	selfish strategies (1-r)
	reciprocal strategies(p)	a,b	c,d
	selfish strategies (1-p)	e,f	g,h

3.2.2. The construction of the replicator dynamic equation

Based on the establishment conditions of the game from the basic conditions, the utility of REITs issuers in choosing reciprocal strategies when forming reciprocal preferences for investors is:

$$E_H(k)=r\times a+(1-r)\times c \tag{1}$$

The utility of REITs issuers in choosing selfish strategies is:

$$E_L(k)=r\times e+(1-r)\times g \tag{2}$$

The expected average utility is:

$$\overline{E(k)}=p\times E_H(k)+(1-p)E_L(k) \tag{3}$$

Based on equation (3), the replicator dynamic equation principle in evolutionary game theory yields the replicator dynamic equation for the issuers' choice of reciprocal strategies as:

$$\frac{dp}{dt}=p[E_H(k)-\overline{E(k)}]=p\times(1-p)\,[E_H(k)-E_L(k)]=p\times(1-p)\,[r(a-e-c+g)+(c-g)] \tag{4}$$

From equation (4), the probability of the equilibrium point is:

$$r^*=\frac{(g-c)}{(a-e)+(g-c)} \tag{5}$$

The utility of investors in choosing reciprocal strategies when forming reciprocal preferences for REITs issuers is:

$$E_B(G)=p\times b+(1-p)\times f \tag{6}$$

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The utility of investors issuers in choosing selfish strategies is:

$$E_N(G) = p \times d + (1-p) \times h \tag{7}$$

The expected average utility is:

$$\overline{E(G)} = r \times E_B(G) + (1-r) \times E_N(G) \tag{8}$$

Based on equation (8), the replicator dynamic equation principle in evolutionary game theory yields the replicator dynamic equation for the investors' choice of reciprocal strategies as:

$$\frac{dr}{dt} = r[E_B(G) - \overline{E(G)}] = r \times (1-r)\,[E_B(G) - E_N(G)] = r \times (1-r)[p(b-d-f+h)+(f-h)] \tag{9}$$

From equation (9), the probability of the equilibrium point is:

$$p^* = \frac{(h-f)}{(b-d)+(h-f)} \tag{10}$$

In summary, the evolutionary game equilibrium probability is:

$$\left(\frac{(g-c)}{(a-e)+(g-c)}, \frac{(h-f)}{(b-d)+(h-f)}\right) \tag{11}$$

4. Dynamic phase diagram analysis of evolutionary games

First of all, the replicator dynamic equation for REITs issuers choosing reciprocal strategies is analyzed. In the occasion of r=r*, dp/dt is constant to 0, which means all p is at a steady state; in the occasion of r>r*, p*=0 and p*=1 are the two steady states of p, and p*=1 is the evolutionary stable strategy; in the occasion of r<r*, p*=0 and p*=1 are the two steady states of p, and p*=0 is the evolutionary stable strategy. The dynamic phase diagram corresponding to p is shown in the figure 1.

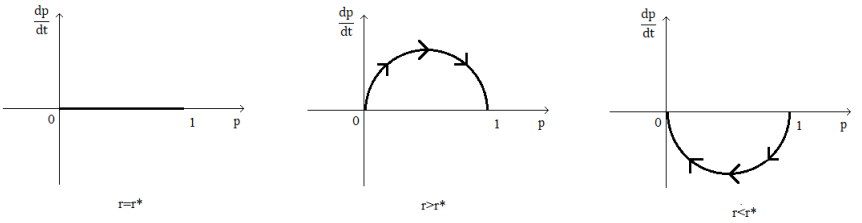

Figure 1: The dynamic phase diagram corresponding to p.

Similarly, the replicator dynamic equation for investors choosing reciprocal purchase strategies is analyzed. In the occasion of p=p*, dr/dt is constant to 0, which means all r is at a steady state; in the occasion of p>p*, r*=0 and r*=1 are the two steady states of r ,and r*=1 is the evolutionary stable strategy; in the occasion of p<p*, r*=0 and r*=1 are the two steady states of r, and r*=0 is the evolutionary stable strategy. Therefore, the dynamic phase diagram corresponding to r is shown in the figure 2.

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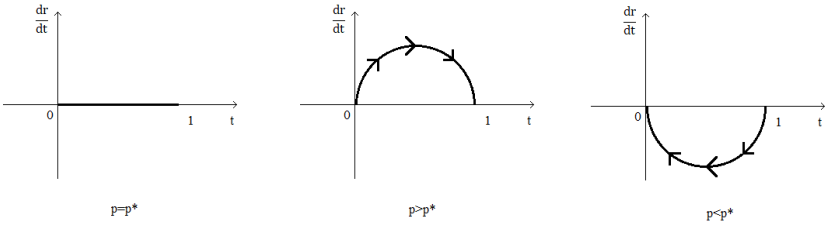

Figure 2: The dynamic phase diagram corresponding to r.

Replication dynamics of the proportion of strategies choices (reciprocal strategies, reciprocal strategies) taken by issuers and investors in selecting reciprocal strategies are represented in the same plane coordinate system, as shown in the figure 3.

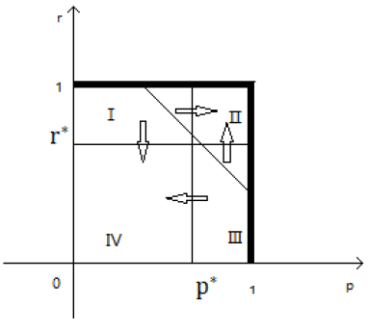

Figure 3: The dynamic phase diagram corresponding to r and p.

From this evolutionary game, it can be seen that (p=0,r=0) and (p=1,r=1) are the two evolutionary stable strategies of this evolutionary game. In this evolutionary game of duplicative dynamic, when the initial situations of both parties in the REITs trading market fall in the Ⅱ area, they converge to the evolutionary stable strategy (p=1,r=1) , i.e., REITs issuers and investors adopt (reciprocal strategies, reciprocal strategies) based on reciprocal preferences; when the initial situations of both parties fall in the Ⅳ area, they converge to the evolutionary stable strategy (p=0,r=0), i.e., the two parties choose (selfish strategies and selfish strategies); when the initial situation of both sides falls in the Ⅰ and Ⅲ spaces, the vast majority of them converge to the evolutionary stable strategy (p=0,r=0), based on the evolution of the reciprocal preferences of both sides of the REIT trading market. Thus, as p* and r* decrease, the area of region II and the areas of I and III where converge to (p=1,r=1) will increase, i.e., the possibility of forming reciprocal preferences and choosing (reciprocal strategies, reciprocal strategies) in the pricing process of REITs issuance increase. However, to make r*obtain a smaller value, it is necessary to make (g-c) decrease and (a-e) increase, and to make p*decrease, it is necessary to make (h-f) decrease and (b-c) increase.

To sum up, when the proportion of REITs issuers choosing reciprocal pricing strategies in the REITs trading market is greater than r*=((g-c))/((a-e)+(g-c)), the expected returns for reciprocal REITs issuers exceed average market returns, and the evolution of the competitive group of REITs issuers will evolve to a stable state with p*=1, which means that whole issuers in the REITs trading market will become reciprocal individuals; the happiness and harmony in the REITs trading market will be fundamentally improved; the antagonistic behavior and selfishness will be reduced, and the actors will enjoy certain degrees of happiness in the trading process. On the contrary, when the

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proportion of REITs issuers choosing reciprocal strategies in REITs trading markets is less than r*=((g-c))/((a-e)+(g-c)), the expected returns of reciprocal issuers are lower than the average market returns, and the issuer group will evolve to a stable state with p*=0, which means that all issuer actors will return to the state of fully rational economic men, the traditional competitive mechanism (under the assumption of selfishness) will occupy the absolute position in the market, and the process of building a REITs trading market full of harmonious competition will come to a failure. Meanwhile, when the proportion of investors choosing reciprocal purchasing strategies in the REITs trading market is greater than p*=((h-f))/((b-d)+(h-f)), the expected returns for reciprocal investors exceed average market returns, and the evolution of the investors will evolve to a stable state with r*=1, i.e., all investors in the REITs trading market become reciprocal individuals, and the second competitive actor in the market enjoys the maximum happiness from the pricing of REITs. Similarly, when the proportion of investors who adopt the reciprocal purchasing strategies in the investor group is less than the probability of the equilibrium point, the expected returns for reciprocal investors are lower than average market returns, and the investor group evolves to a stable state with p*=0, i.e., the process of constructing a reciprocal and harmonious type of all investors fails, selfishness prevails, traditional economy rules the minds of investors, and happiness decreases. Therefore, in the occasion of r>r* and p>p*, the whole REITs trading market tends to evolve towards a and reciprocal harmonious market, and the overall happiness of the REITs trading is the highest.

5. Conclusion

This study suggests that REITs issuers should choose reciprocal strategies when pricing REITs issuance so that the proportion of REITs issuers choosing reciprocal pricing strategies in the REITs trading market is greater than the probability of the equilibrium point, i.e., the group of REITs issuers will evolve into a reciprocal group, thus increasing the issuance success rate of their own REITs holdings. The study further suggests that the government should pay attention to the psychological factor of reciprocal preferences of issuers and investors in pricing REITs and introduce a reward and punishment mechanism. The government should reward REIT issuers and investors who choose reciprocal strategies and punish those who choose selfish strategies, so as to reduce the probability of the equilibrium points of REIT issuers and investors choosing reciprocity strategies. As a result of this regulatory measure, the proportion of REITs issuers and investors who initially choose a reciprocal strategy is easily greater than the respective probabilities of the equilibrium points. Therefore, the increase in the proportion of reciprocal REITs issuers and investors can prompt the REITs transaction market as a whole to evolve toward the trend of happiness, harmony and reciprocity, increasing the transaction willingness of both parties and the success rate of mutual transactions, and accelerating the circulation of funds in the real estate market.

Based on the concept of reciprocal preferences in behavioral economics and combined with the evolutionary game approach, this study investigates the impact of psychological factors on REITs issuers' decision-making choices when pricing REITs and provides recommendations for REITs issuers in decision-making choices when pricing REITs in order to improve the success rate of their REITs holdings, and suggestions about the regulation of REITs issuance are given to the government in order to construct a harmonious REITs trading market and to enhance the efficiency of the capital circulation in the real estate market. Future research can split and refine the utility values of REITs issuers and investors and introduce the influence of government incentives and penalties into the utility values of each decision of both sides of the game, so as to facilitate in-depth research on this topic and give issuers and government regulators more detailed advice on REITs issue prices.

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