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Cooperation or Non-Cooperation: A Bargaining Game Model Between Mobile Operator and Financial Institution in Mobile Payment Market

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ABSTRACT

With the growing prevalence of the electronic commerce and the widespread use of mobile Internet and mobile payment, a new type of channel is emerging, called mobile commerce, or m-commerce. Mobile payment business has become the key of mobile value-added business. The major players in the mobile payment market are carrying on an intensive competition to grab market share to maximize profits. In this paper, the game between mobile operators and financial institution is studied on the basis of Nash Bargaining game theory. We propose a game theoretical framework that will help the mobile operators and the financial institution to determine the optimal strategy to cooperation or non cooperation. Then, the influences of cooperation costs and betrayal incomes in the cooperation strategies between the parties are analyzed. The result shows that the cooperation of both sides has a negative relation with the cooperation costs and betrayal income; with the increase of cooperation costs and betrayal incomes, the parties will not be willing to cooperative.

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INTRODUCTION

Mobile payment means that both parties involved in certain trade carry out transaction in mobile devices. As an emerging means of payment, mobile payment is attracting more and more attention throughout the world due to it can improve user experience and provide new opportunities for financial institutions, operators, TPP providers and merchants. The mobile payment industry has been growing rapidly in recent years both in terms of user base and transaction volume. According to Durlarcher Research [1], the potential of m-commerce remains enormous, predicting that the market could be worth €23 billion in Europe by year 2003. Therefore, many mobile and financial industries have prompted to claim that it is time to promote mobile payments in order to accelerate the development, acceptance and use of the m-commerce. It is one of the hot spots in recent years.

With the development of mobile payment, a lot of researches have been done in this field. Some studies analyzed the factors limiting the rapid development of mobile payment [2-4]. Violins and Karnouskos, Ondrus, Pigneur analyze the advantages and disadvantages of some mobile payment service providers [5]. With considering Brazil as a prime example, Diniz *et al*. [6] discussed the possibilities and restrictions of implementing a mobile payment system in developing countries. Moreover, some exploratory studies on the business model of mobile payment have been done. For example, Yong [7] and Lei *et al*. [8] study mobile payment with game theory. By using Cournot Game Model, Miao *et al*. [9] presented an analysis from mobile operators, banks, and third-party payment services providers' perspective. An evolutionary game model between bounded rational mobile and financial institution has been proposed by Zhang and Cao [10]. Hongtao [11] and Teng [12] classify the business model into four categories.

Due to the gaps in the literature, there are two main contributions in this research. First, the cooperation problem in mobile payment market, as an important subject, is regarded as the game subject. Second, although some research has focused on the game theoretical models in mobile payment market, they did not use the Bargaining game model in this market. Therefore, in this paper, to analyze the game between mobile operator

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and financial institution and discuss the factors influencing the cooperation mechanism, the Bargaining game theory has been used and a game theoretical model is proposed for such decision making framework.

Game theory is an important research method. Game theory models, also called equilibrium models, optimize the bidding strategies by investigating players' interactions and analyzing economic equilibria of the system. Typically, in a game, each player chooses the strategy from its own strategy set; then a payoff will be assigned to each player by the payoff function; as a result the optimal solution can be reached via Nash equilibrium. Nash equilibrium is a strategy combination of all players in which no player can increase its payoff by changing its own strategy alone so that every player will finally choose its strategy exactly as the equilibrium strategy combination. Game theory models provide analytical rationale and explanation on how market power can be exercised via strategic behavior, but the assumption that all players are rational usually does not hold in practice [13]. Also, it is limited by the requirement of common knowledge on all generation companies actual production costs [14]. However, the research conclusions that exist are reached based on the hypothesis that the participants are fully rational. Therefore, this paper analyzes the game between rational mobile operator and financial institution with the Bargaining game theory and discusses the factors influencing the cooperation mechanism.

The rest of the paper is organized as follows. "The Model": elements of the proposed model and the benefit matrix are presented. "Bargaining game': briefly discusses the Bargaining game and its application. "Breakdown point": A breakdown point has been introduced and the algorithm of game procedure is presented. In ‘‘Numerical example’’, a numerical example is presented. Then in "Numerical example analysis", the results have been analyzed. Eventually, concluding remarks and suggestions for the future research are given in "Conclusion".

The Model:

This paper studies the relationship between mobile operator and financial institution. They both have two options: cooperation or noncooperation with the other party. Each selected strategy has different levels of profit for the parties. To establish the model, the parameters and variables used in the model formulae are as follows**:**

π_1 The normal income of mobile operators, when both parties choose noncooperation

π_2 The normal income of financial institutions, when both parties choose noncooperation

$\Delta\pi$ The excess income they obtain when the successfully cooperate

$\Delta\pi_1^{'}$ The incremental income that the mobile operator obtains when it wants to cooperate and the financial institution doesn't cooperate

$\Delta\pi_2^{'}$ The incremental income that the financial institution obtains when it wants to cooperate and the mobile operator doesn't cooperate

β The proportion of excess income allocation, if we set the mobile operator's proportion of excess income allocation as β, then financial institution's is $1-\beta$

C_1 The cost of the mobile operator has to undertake when two parties cooperate

C_2 The cost of the financial institution has to undertake when two parties cooperate

E_1 The betrayal income of the mobile operator that obtains from the gentle market strategy that the other party adopts

E_2 The betrayal income of the financial institution that obtains from the gentle market strategy that the other party adopts

The profit function for the mobile operator is formulated as follows:

$$\Pi_1 = \pi_1 + k_1(\beta\Delta\pi - C_1) + u_1(\Delta\pi_1^{'} - C_1) + v_1(E_1) \tag{1}$$

where k_1, u_1, v_1 and $k_1 + u_1 + v_1 \in \{0,1\}$. If both of parties choose to cooperate, $k_1 = 1,\ u_1 = v_1 = 0$, if the mobile operator want to cooperate but the financial institution does not want, $u_1 = 1,\ k_1 = v_1 = 0$. When the mobile operator is not willing to cooperate and the financial institution is willing, $v_1 = 1,\ k_1 = u_1 = 0$. If both of parties are not willing to cooperate, $v_1 = 0,\ k_1 = u_1 = 0$.

Similarly, the profit function for the financial institution is formulated as follows:

$$\Pi_2 = \pi_2 + k_2((1-\beta)\Delta\pi - C_2) + u_2(\Delta\pi_2^{'} - C_2) + v_2(E_2) \tag{2}$$

The profit functions (1) and (2), show that each party's profit has a positive relation with incomes and a negative relation with cooperation costs.

Therefore, the benefit matrix of this game between mobile operators and financial institutions, pertaining to various combinations of strategies that the mobile operators and financial institutions may play, is presented in Table 1.

Table 1: The benefit matrix of the game between mobile operators and financial institutions.

		financial institutions	
		Cooperation	Non-cooperation
Mobile	Cooperation	(A,B)	(C,D)
operators	Non-cooperation	(E,F)	(G,H)

Where,

$$A = \pi_1 + \beta\Delta\pi - C_1, \tag{3}$$

$$B = \pi_2 + (1-\beta)\Delta\pi - C_2, \tag{4}$$

$$C = \pi_1 + \Delta\pi_1^{'} - C_1, \tag{5}$$

$$D = \pi_2 + E_2, \tag{6}$$

$$E = \pi_1 + E_1, \tag{7}$$

$$F = \pi_2 + \Delta\pi_2^{'} - C_2, \tag{8}$$

$$G = \pi_1, \tag{9}$$

$$H = \pi_2. \tag{10}$$

Bargaining Game:

In this study, the equilibrium point of the game with the presented benefit matrix in Table 1, is achieved using the Nash bargaining game. Therefore, we briefly introduce the Nash bargaining game approach. The goal of the Nash Bargaining game, as a cooperative game, is dividing the benefits or utility between two players based on their competition in the market place. The Nash bargaining game model requires the feasible set to be compact and convex [15]. It contains some payoff vectors, so that each individual payoff is greater than the individual breakdown payoff. Breakdown Payoffs or Breakdown points are the starting point for bargaining which represent the possible payoff pairs obtained if one player decides not to bargain with the other player.

If $\vec{u}$ and $\vec{b}$ are the payment (benefit) and breakdown payoffs vector for the individuals, respectively, they must maximize $\prod_{i=1}^{2}(u_i - b_i)$ by solving the following maximization problem:

$$\begin{aligned} \max \quad & (u_1 - b_1)(u_2 - b_2) \\ s.t \quad & u_1 \geq b_1 \\ & u_2 \geq b_2 \end{aligned} \tag{11}$$

where $(u_1, u_2) \in \{(A,B),(C,D),(E,F),(G,H)\}$.

Breakdown points:

As mentioned in Binmore *et al*. [16], the choice of the breakdown point is a matter of modeling judgment. In the benefit matrix, presented in Table 1, let $\theta_{\min}^1 = \min\{A,C,E,G\}$ and $\theta_{\min}^2 = \min\{B,D,F,H\}$. Therefore, $\theta_{\min}^1$ and $\theta_{\min}^2$ are the worst achievable benefit for mobile operators and financial institutions, respectively. It is believed that a player does not stay in the business unless it can meet his minimum benefit; therefore, we use $\theta_{\min}^1$ and $\theta_{\min}^2$ as breakdown point.

The algorithm of the game procedure is as follows: according to the data of the mobile operator and the financial institution, first the benefit matrix is calculated. Then, the optimal strategies for this game are obtained from the Nash bargaining problem (11).

Numerical example:

In this section, we provide the numerical examples to discuss how the theoretical results in this paper can be applied in practice. It is supposed that there are a mobile operator and a financial institution in a mobile payment market. They both have two options: cooperation or noncooperation with the other party. To demonstrate how the cooperation costs, C_1 and C_2, and betrayal incomes, E_1 and E_2, affect the market equilibrium, we consider 30 different examples. These examples are distinctive according to the cooperation costs and betrayal incomes for each party. Data for this numerical example are presented in Table 2. Moreover, the benefit matrix for the game between the mobile operator and financial institution, in this example, is shown in Table 3.

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Table 2: Data for numerical example.

Variable		Variable	
π_1	900	β	0.7
π_2	700	$\Delta\pi_1^{'}$	100
$\Delta\pi$	250	$\Delta\pi_2^{'}$	80

Table 3: The benefit matrix of the game between mobile operators and financial institutions in the numerical example.

		financial institutions	
		Cooperation	Non-cooperation
Mobile operators	Cooperation	(900+0.7*250-C_1, 700+0.3*250-C_2)	(900+100-C_1, 700+E_2)
	Non-cooperation	(900+E_1, 700+80-C_2)	(900, 700)

All the calculations are done with MATLAB 14. First, for 10 different levels of (E_1,E_2), when $(C_1,C_2)=(30,30)$, then by considering $(E_1,E_2)=(50,40)$, for 20 different levels of (C_1,C_2), the model is solved and the results are summarized in Table 4 and Table 5.

Table 4: Numerical results for 10 different levels of (E_1,E_2) when $(C_1,C_2)=(30,30)$

(E_1,E_2)	$(\theta^1_{\min},\theta^2_{\min})$	equilibrium strategy	(E_1,E_2)	$(\theta^1_{\min},\theta^2_{\min})$	equilibrium strategy
(30,30)	(900,700)	(A,B)	(80,80)	(900,700)	(A,B)
(30,80)	(900,700)	(A,B)	(80,120)	(900,700)	(C,D)
(30,140)	(900,700)	(C,D)	(80,140)	(900,700)	(C,D)
(80,30)	(900,700)	(A,B)	(140,80)	(900,700)	(E,F)
(140,30)	(900,700)	(E,F)	(160,80)	(900,700)	(E,F)

Table 5: Numerical results for 20 different levels of (C_1,C_2) when $(E_1,E_2)=(50,40)$

(C_1,C_2)	$(\theta^1_{\min},\theta^2_{\min})$	equilibrium strategy	(C_1,C_2)	$(\theta^1_{\min},\theta^2_{\min})$	equilibrium strategy
(30,30)	(900,700)	(A,B)	(80,80)	(900,695)	(C,D)
(30,80)	(900,695)	(C,D)	(80,100)	(900,675)	(C,D)
(30,100)	(900,675)	(C,D)	(80,120)	(900,655)	(C,D)
(30,120)	(900,655)	(C,D)	(80,140)	(900,635)	(C,D)
(30,140)	(900,635)	(C,D)	(100,80)	(900,695)	(E,F)
(80,30)	(900,700)	(A,B)	(120,80)	(880,695)	(E,F)
(100,30)	(900,700)	(A,B)	(140,80)	(860,695)	(E,F)
(120,30)	(880,700)	(E,F)	(200,200)	(800,570)	(G,H)
(140,30)	(860,700)	(E,F)	(0,20)	(900,700)	(A,B)
(160,30)	(840,700)	(E,F)	(20,0)	(900,700)	(A,B)

Numerical example analysis:

In the numerical example, the Nash equilibrium strategy has been calculated for 30 different levels of (C_1,C_2,E_1,E_2). In the constant (C_1,C_2), The results show that the equilibrium strategies for the game, depend upon entirely on (E_1,E_2). In the high betrayal income for mobile operator, for example $E_1=140$, the mobile operator is not willing to cooperate and in the high betrayal income for financial institution, for example $E_2=120$, the financial institution is not willing to cooperate. Also, the results show that, in the constant (E_1,E_2), the equilibrium strategies for the mobile operator and the financial institution, depend upon entirely on (C_1,C_2). In the constant C_1, with the increase of C_2, the financial institution does not want to cooperate. Similarly, with the constant C_2 and the increase of C_1, the mobile operator is not willing to cooperate. For example, when (C_1,C_2)= (0, 20) or (30, 30), the equilibrium strategy is (A,B). It means, both of parties want to cooperation with other side. But when (C_1,C_2)= (30, 100) or (80, 140), in the high amounts of C_2, the equilibrium strategy is (C,D), the non-cooperative strategy for financial institution. When (C_1,C_2)= (120, 30) or (140, 80), in the high amounts of C_1, the non-cooperation strategy is the equilibrium strategy for the mobile operator, (E,F). When both of (C_1,C_2) have high amounts, for example (200, 200), the parties are unwilling to cooperate and the equilibrium strategy is (G,H).

Conclusion:

To answer the question "cooperation or non-cooperation?", the game between mobile operator and financial institution is studied on the basis of Bargaining game. The proposed framework helps the mobile operator and financial institution to determine the optimal strategies in a mobile payment market. To be more specific, the model, allows the mobile operator and financial institution to choose the optimal strategy regarding their costs and profits in each possible strategy. A numerical example was presented to illustrate the model's performance in 30 different levels of the cooperation costs and the betrayal incomes. The results show that the equilibrium strategies depend upon entirely on the cooperation costs and the betrayal incomes. With the increase of costs, the parties will be unwilling to cooperation. Also, in the constant cooperation costs, with the increase of betrayal incomes, the parties will not be willing to cooperation.

There are several directions and suggestions for future research. First of all, to calculate the equilibrium strategy of the game, the Nash bargaining game model has been used, in the future research it can be calculated and analyzed by other game theory models. Secondly, the proposed model can be easily extended to the case where more than two mobile operator and financial institution exist. Moreover, it would be very interesting but challenging to consider the uncertainty on model parameters such as cooperation costs or benefits of parties. Eventually, the proposed framework can be used in other markets.

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