科技部補助專題研究計畫成果報告
期末報告

非短視雙占在不同數據情境下之認定問題

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中 文 摘 要 ： 本研究計畫的主要目的是建構一個非短視廠商策略性進入市場時間點決策的估計模型。主要是將賽局選擇權的概念與決策架構帶入由Bresnahan and Reiss (1990) 與Berry (1992) 開創的實證進入賽局文獻中。本計畫的主要創新為將文獻中慣用的短視假設鬆綁。在此短視的意思為廠商不理會等待進入時機的選擇權價值。第一階段的估計模型建立將面臨如何將賽局選擇權的理論架構轉換為計量架構的挑戰。本計畫預計會使用美國航空公司國內線的數據進型理論模型的估計。自從八零年代美國政府對航空業的政策鬆綁後，美國航空公司進入自由競爭的狀態，使得我得觀察到許多的進入時間決策點。而在市場觀察到並不是每一個城市對的市場都是由規模較大且用軸心輻射狀方式經營航線的大家航空公司率先進入市場，這正好與計畫主持人先前的理論研究結果相符。本計畫用數據主要回答的問題為是否能判定廠商在做進入時間點決策是短視或是非短視? 非短視模型的估計和文獻中以短視模型估計的結果有何不同?

中文關鍵詞： 進入模型、離散選擇模型估計、策略性時間決策、不確定性、實選擇權

英 文 摘 要 ： This paper provides a method to estimate the payoff functions of players in complete information duopoly entry game with uncertainty. With respect to the empirical literature on entry games originated by Bresnahan and Reiss (1990) and Berry (1992), the main novelty of this research is to relax the assumption that the firms disregard the option value of "waiting to enter". The main challenge is to setup the game theoretical real option model with parametric specification for the firms' payoff function and have the econometrician able to identify the distribution of the unobservable. One goal of the paper is to empirically test which entry decision behavior match the firms ' entry decisions better, the NPV rule or the real options method? I'll use the U.S. domestic airline data to estimate my empirical model of strategic entry timing. As we observe the sequence of entries in different city pairs, the major airlines are not always the leaders. This observation not only match the theoretical results from my previous research, but also in the airline industry, it allows me have many observations of entry and the fact that it has been deregulated since 1980s allows me to observe the nature of competition between airlines. Can I identify the firms ' entry methods used? How different is the estimations of my model from the literature?

英文關鍵詞： Entry models, inference in discrete games, uncertainty, real options, strategic timing

1 Identification of Non-myopic Duopoly under Different Data Scenarios

This research proposal initially seeks to identify the firms' payoff functions and the nature of competition in a "non-myopic" duopoly entry game under different data scenarios. To be more explicit, based on the equilibrium results in Chiang (2014), I wanted to investigate what parts of the theoretical model can be identified depending on how much information the econometrician can observed. The duopoly entry game is a game of complete information with two asymmetric firms under uncertainty and the two firms both use the real options method to strategically make their optimal timing decision. However, since the econometrician only observes the timing, sequence of entry and other firm specific characteristics, I was not able to do further non-parametrically point identify or partial identify the structural elements of the theoretical model without imposing specific forms for the firms' payoff functions.

After struggling for several months on the identification of the original model with different observables for the econometrician and developing an incomplete information game with real options, the result is not of satisfaction. I continue in the research of bridging the gap between the pure theory game theoretic real options and the empirical entry models by reconstructing an entry model with the real option entry rule, but with more insights of econometric setting. The goal now is to find the probabilities of each type of equilibrium occurring, then do the identification, and finally estimation. During this time, I also started to collect the U.S. airline data. The U.S. airline data is commonly used to study empirical entry models [Ciliberto and Tamer (2009); Berry (1992)], therefore it would be interesting to compare my results with the literature as the firms in my research have a different entry rule.

The remaining parts of this report is a summary of the empirical entry game literature, especially the papers that are most related to my research, and a summary of the new modeled developed.

2 Motivation and Literature

When we consider timing under uncertainty, the real options method is most useful because it takes into consideration the opportunity cost of immediate investment. A static model is insufficient to depict how a firm's optimal decision was made in an environment with uncertainty. In the past, game theoretic real options have focused on pure theory, and the literature of empirical entry games have long assumed that firms to do not take into the consideration of the opportunity to wait and enter later when the environment contains some sort of uncertainty. My principal objective is to construct an empirical model to estimate firm's non-myopic entry behavior, and so to fill this gap in the literature.

A myopic model in which assumes that the firms disregard the option value of "waiting to enter" is not sufficient to depict the fact that there are two different forces going in two opposite directions that affect a firm's timing decision. One is the fear of being preempted which hastens a firm's entry. The other is the option to wait and gain more information about the environment uncertainty which delays the entry. Being able to identify the "nature of competition" then becomes very important when we study the interactions of timing decisions between firms. Theoretically, a firm's entry timing decision under uncertainty differs between using the net present vale (NPV) rule and the real options method. A firm which bases its entry decision on the NPV invest rule is a firm which enters when, at a given state, its expected present value of future profits is positive. However, such type of firms do not take into consideration of the opportunity cost of waiting and enter later. The real options approach emphasizes the fact that performing an irreversible action when payoffs are stochastic involves sacrificing the option to perform this action in the future. Capital budgeting of corporations has been significantly influenced in recent years by the insights of the real options literature. Empirical entry games are useful tools in the analysis of economic and social phenomena whenever strategic interactions are an important aspect of individual behaviors. In this research proposal, I call a firm which neglects the opportunity to wait and gain more information about the uncertainty of the environment, and thus delay the timing of its entry a "myopic" firm. In this research, a firm which considers this opportunity cost of waiting and take action later is considers as a "non-myopic" firm.

Motivation. We observe that in new markets, it is not always true that the advantaged firm or the an incumbent of similar or nearby market is the first to enter the new market, for example the smart phone market. In the cell phone market, Nokia had the largest market share, approximately 40%. Since it is a handset manufacturer, one would naturally think Nokia had the advantage to enter the smartphone market as the leader. Here, the smartphone market is merely a new market for a new type of cell phone. However, Research in Motion (RIM) was the first company to introduce the first smartphone—Blackberry, and then Apple entered the smart phone market with iphone. Nokia entered very late and had than 10% of the market share in smartphones. One may want to question why did the cell phone giant Nokia wait so long to enter? After all Nokia was one of the world's largest handset manufacturers with the largest market share for more than 10 years, it definitely was at a very advantaged position to be the leader of the new market.

Another example is the U.S. domestic airline market. Nonstop flight between each city pair is considered a market, and the potential entrants are major airlines and regional airlines. Major airlines operate in a hub-spoke structure. If one of the city in the city pair serves as a hub for the major airline, then asymmetry between the major and regional airlines would be large. As we observe the sequence of entries in different city pairs, the major airlines are not always the leaders. As I mentioned earlier, the U.S. airline data is commonly used to study empirical entry models [Berry (1992); Ciliberto and Tamer (2009)], therefore it would be interesting to compare my results with the literature as the firms in my research have a different entry rule.

In my previous research, Chiang (2014), I showed that with multi-dimensional asymmetric duopoly the leader's entrance may have occurred because its optimal entry time has arrived rather than being triggered by the fear of being preempted and I solved the puzzle why the "disadvantaged" firm preempts and becomes the leader of the new market. I also non-parametrically identified the joint distribution of the unobserved investment cost and find the probability of the first entrant being triggered by preemption. In this research, I plan to push this topic further and empirically test which entry decision behavior match the firms' entry decision better, the NPV rule or the real options method?

This research will contribute to two growing literatures: empirical entry games and game-theoretic real options.

In the empirical discrete games, Tamer (2003) makes a distinction between incoherent models and incomplete models, and then analyses the model in the presence of multiple equilibria, showing that the model contains enough information to identify the parameters of interest and to obtain a well defined semi-parametric estimator. Berry and Tamer (2006) study simple versions of both static and dynamic entry models. For simple static models, they show how natural shape restrictions can be used to identify competition effects. Ciliberto and Tamer (2009) provide a method to estimate the payoff functions of players in complete information, static, discrete games. The identified features of their model are sets of parameters (partial identification) such that the choice probabilities predicted by the econometric model are consistent with the empirical choice probabilities estimated from the data. Honoré and de Paula (2010) study the identification of a duration model in which the players play a static coordination game. They show that even though a unique solution to the game is not always attainable, the structural elements of the economic system are shown to be semi-parametrically identified. The real options approach is not considered in the references mentioned above, as they consider either static models [Bresnahan and Reiss (1991a,b); Mazzeo (2002); Tamer (2003); Ciliberto and Tamer (2009)] or even in dynamic models [Pakes, Ostrovsky, and Berry (2008); Pesendorfer and Schmidt-Dengler (2003)] the potential entrants are "myopic", in the sense that they disregard the option value of waiting to enter. Abbring (2012) considers the option value of waiting for a single agent problem by studying mixed hitting-time models that specify durations as the first time a Lévy process, a continuous-time process with stationary and independent increments, crosses a heterogeneous threshold.

The game-theoretic real options is a strand of literature that incorporates game-theoretic concepts into the real-options framework. Grenadier (1996, 2002), Lambrecht (2000, 2001), Weeds (2002), Mason and Weeds (2010) modeled investment decisions using diffusion processes. Grenadier (1996) and Weeds (2002) modeled the strategic interactions in leader-follower games under complete information. Lambrecht and Perraudin (2003) introduce incomplete information into a preemption game of firms facing real investment decisions. Grenadier and Wang (2007) extend the the real options framework to model the investment-timing decisions of entrepreneurs with time-inconsistent preferences. Thijssen, Huisman, and Kort (2006) analyze the influence of uncertainty and competition on the strategic considerations of a firm's investment decision, where the firm receives imperfect signals about the profitability of an investment project. They find a preemptive or an attrition equilibrium depending on a trade-off between first and second mover advantages. More recently, Thijssen (2010) studies a two-player real option preemption game where payoffs are driven by a player-specific stochastic state variable. Boyarchenko and Levendorskiĭ (2014) consider a preemption game where the stochastic demand admits positive jumps. Thijssen (2012) studies timing games in continuous time where payoffs are stochastic, strongly Markovian, and spectrally negative. The main interest is in characterizing equilibria where players preempt each other along almost every sample path as opposed to equilibria where one of the players acts as if she were the (exogenously determined) leader in a Stackelberg game.

Empirical studies of real options is important, however not much has been done. For example, Rust (1987) and Moel and Dufano (2002) did not take into consideration of strategic interactions. This research will contribute to this literature by introducing strategic interactions into empirical real options.

3 Empirical Entry Model and Methodology

In this section, I first make a short review on the papers most related to my research. In this review, I focus on the components that my model resembles the most to and point out later the novelty of my research.

Berry (1992) makes the important step of estimating empirical entry models by providing a new set of estimates with simulated estimators and focuses on the import role firm heterogeneity. The model estimated in Berry (1992) is a static and complete information game with K_m heterogeneous players in market m. Though the outcome of the entry game may have multiple equilibria in the ordering of the firms which entered market m, the number of firms entered, N_m^*, in all pure strategy equilibria in market m is unique. It is necessary to place some structure on the profit function to ensure the uniqueness of N. The parametric specification for the post-entry profit of firm i in market m is

$$\pi_{mi} = v_i(N) + \phi_{mi} = \underbrace{X_m\beta + h(\delta, N) + \rho u_{mo}}_{v_m(N)} + \underbrace{Z_{mi\alpha} + \sigma u_{mi}}_{\phi_{mi}},$$

where $v(\cdot)$ is the portion of profits that is common to all firms and is strictly decreasing, ϕ_{mi} is the firm-specific portion of profits; X_m is a vector of market characteristics, N is the equilibrium number of firms, h is a nonlinear function of N and the elasticity of demand, δ, Z_{mi} is a vector of firm characteristics, and β, δ, ρ, α, and σ are parameters to be estimated. From a Cournot model with constant and identical marginal costs together with a constant-elasticity demand function, Berry (1992) set $h(\delta,N)$ equal to $-\delta\ln(N)$. Note that profits depend on observed and unobserved (to the econometrician) components., where the obseved component is

$$r_{mi}(N) = X_m\beta - \delta\ln(N) + Z_{mi}\alpha,$$

and the unobserved component is

$$\varepsilon_{mi} = \sigma u_{mi} + \rho u_{mo}.$$

Firm i enters market m if

$$r_{mi}(N) + \varepsilon_{mi} \geq 0. \tag{1}$$

The probability of $N^* = N$ is found. The empirical work in Berry (1992) employs two assumptions on the order of entry. The first is that the most profitable firms move first. The second assumption is that incumbents move first, with more profitable incumbents moving before other incumbents and more profitable entrants move before other entrants. Firm heterogeneity is obviously crucial to a study of differences in profitability between firms, is found to present difficulties. The region of integration of the integral defining the probability of events is exceedingly complex. Simulation estimators presents a solution to this problem.

Ciliberto and Tamer (2009) provide a practical method to estimate the payoff function of players in complete information, static, discrete games. The main novelty of their framework is to allow for general forms heterogeneity across players without making equilibrium selection assumptions. They apply their methods to data from the airline industry, where each observation is a market (a trip between two airports). They find evidence of heterogeneity across airlines in their profit functions and that the competitive effects of large airlines (American, Delta, United) are different from those of low cost carriers and Southwest. We can observe that airlines can be classified into two types as I do in this paper.

The fully structural form expression of the profit function should be written in terms of prices, quantities and cost. However, because of lack of data on prices, quantities, and costs, most of the previous empirical literature on entry games had to specify the profit function in a reduced form. The profit function for firm i in market m is

$$\pi_{mi} = S'_m\alpha_i + Z'_{mi}\beta_i + W'_{mi}\gamma_i + \sum_{j\neq i}\Delta^i_j y_{mj} + \sum_{j\neq i} Z'_{jm}\phi^i_j y_{mj} + \varepsilon_{mi} \tag{2}$$

where S_m is a vector of market characteristics which are common among the firms in market m; $Z_m = (Z_{m1}, ..., Z_{mK})$ is a matrix of firms characteristics that enter into the profits of all the firms in the market; K is the total number of potential entrants in market m; $W_m = (W_{m1}, ..., W_{mK})$ are firm characteristics where W_{mi} enters only into firm i's profit in market m; ε_{mi} is the part of the profits that is unobserved to the ecnometrician. Let $X_m = (S_m.Z_m.W_m)$. The effect on the profit of firm i of having firm j in its market is captured by $\{\Delta^i_j, \phi^i_j\}$. These competitive effects could measure not only a particularly aggressive behavior of one airline against another airline, but also measure the extent of product differentiation across airlines and cost externalities among airlines at airports. Again, since this is a static model, in a pure strategy equilibrium, Firm i enters market m if

$$\pi_{mi} \geq 0 \tag{3}$$

Following Bresnahan and Reiss (1990); Berry (1992); Mazzeo (2002), they also do not consider mixed strategy equlilibria. I follow these papers by looking only in pure strategy equilibrium. It can be easily seen from subsection 3.1, a brief summary of the equilibrium in Chiang (2014), that mixed strategy is not a generic case.

It is important to note that when uncertainty is introduced into the model the post entry payoff of the firms are in expected value terms. However the game to be identified and estimated is different from a dynamic game in the sense that the players are only playing the game once. Once they have taken an action and their actions are irreversible, the game is over. The crucial difference from the static games mentioned so far is that the environment is no longer deterministic. In my model, the firms are using the optimal stopping time method, *i.e.* the real options method, to decide their optimal entry timing.

Ciliberto and Tamer (2009) provide an evidence that the airlines can be categorized into two types. I call the larger firms(American, Delta, United) the advantaged firms and those of low cost carriers and Southwest the "disadvantaged" firms. The concept of be more advantaged at an airport of a city-pair can be the advantage of being an incumbent at the airport or having one side of the city -pair be a hub. In some region of the parameters, the low-revenue firm has no incentive to the leader of entering a new market, and the high-revenue firm enter at its monopolist optimal entry threshold. The firms will enter sequentially, and each entering at its optimal entry thresholds. In another region of the parameters, both firms have the incentive to be the leader. If the leader entered due to the fear of being preempted by the other potential entrant, then leader entered earlier than its optimal entry threshold. The goal of this new research is to identify the the nature of the competition and to estimate the competition effects on the timing point of the firms.

3.1 Sketch of the Empirical Entry Model

In order to empirically work with non-myopic firms, it is important to construct an entry model in the context of data which is different from the way a pure theory model is setup. I consider a binary discrete choice model. Following Tamer (2003), I will start the setup with two potential entrants.

$$y_i = \begin{cases} 1 & \text{if firm } i \text{ enters} \\ 0 & \text{othewise} \end{cases} \qquad \text{for } i = 1,2 \tag{4}$$

This research differs from the literature of empirical entry games in allowing the firms to take into consideration of the value of waiting. Hence expressions of the thresholds of the firms' entry decision will be different from the simple expression of entering when the profit is greater than zero in the static case or when the expected present value is positive in the dynamic case .

It is necessary to place some structure form on the profits of the firms. It is no longer possible to non-parametrically identify the model if the econometrician cannot observe the profit functions of the firms in a monopoly case, $M(\cdot)$, and in a duopoly, $D(\cdot)$ [1]. At time time t, the firms receive the following profit flow:

$$\pi_{1t}(x_1, z_t) = [x_1'\beta_1 + y_2\Delta_1]e^{z_t} - \gamma u_1, \text{ and} \tag{5}$$

$$\pi_{2t}(x_2, z_t) = [x_2'\beta_2 + y_1\Delta_2]e^{z_t} - \gamma u_2, \tag{6}$$

where $x = (x_1, x_2) \in \mathbb{R}^m$ represents a vector observed exogenous variables, $z = (z_1, ..., z_T)' \in \mathbb{R}^T$ represents the exogenous source of uncertainty in the environment, $u = (u_1, u_2)$ is a random vector of latent variables with conditional distribution F_u that represents unobserved (to the econometrician) profits, and $\beta = (\beta_1, \beta_2, \Delta_1, \Delta_2)$ are parameters of interest.

The theoretical model that I proposed in Chiang (2014) assumed that monopoly profits are larger than duopoly profits. This matches the intuition that the firms are worse off by having their

[1] For details on the definitions of these notations please Chiang (2014).

opponent in market to share the demand of the market. This implies that $\Delta_1, \Delta_2 < 0$. Following Ciliberto and Tamer (2009), this is the case that I start out with.

This step of setting a parametric specification for the payoffs of the firms is important. Because in my previous research, in the section of identification, there is no parametric form specified for the payoffs of the firms and the econometrician observes the revenue part. However, this is no longer the case and it is necessary to place some structure form on the profits of the firms if I want to move further into this topic.

Before I discuss the probability of which equilibrium is observed by the econometricain, it is important that we understand how the firms make their entry decisions and the equilibrium of the game the firms played. Though the referee of this research proposal did not like me mentioning the summary of my previous research, it is very important that I provide a brief summary on previous results and methodology as it is the equilibrium of the game that this research is trying to identify and estimate. What is there to identify and estimate if no game is mentioned or defined? To my understanding, almost all papers in the literature of empirical entry models have a section defining the game and the equilibrium, of course including the timing of the game and strategy space of the players. Almost all papers of my field, the game theoretic real options literature, begin the setting of their model by defining the exogenous shock with the Brownian motion or Lévy process if the time is continuous, and then describe the strategy space of the real-option firms by using the standard second ordered differential equations in the terms of the setting of the paper. How can it be possible to discuss the equilibrium of a game without defining the strategy space? Therefore, please allow me to show the graph of the equilibrium the firms are playing. I will do my best to refrain myself to not explain everything in detail, because if I do explain every thing in detail, I would inevitably have to use the commonly used math equations in game theoretic real options. [2]

A firm enters when the realization of the uncertainty is greater or equal to its entry threshold.

[2]Please refer to Chiang (2014) for details about the following notations and equilibrium results. Even though math context is now for a parametric specification, rather than a non-parametric setting, I once again apologize for not being able to explain the definition of the game and notations clearly here. As this is a final report for this research proposal, I do not wish to irritate the referee by using the math that the referee thought unnecessary. All logics and explanations will be written in detail in my paper when this research is finished.

Firm i enters the market at time t if the exogenous state variable, Z_t, crosses its entry threshold, h_i, from below:

$$Z_t = z \geq h_i, \tag{7}$$

where Z_t is the exogenous shock that affects all markets, such as international oil price; z is the realization of Z_t at time t. It is assumed that Z_t evovles exogenously and stochastically according to a Brownian motion. The entry threshold of firm i, h_i, is decided by using the real options approach. It is a function of the firm's discount factor, revenue and cost, and the exogenous shock. To be more explicit, with the parametric specification in equation (5) and equation (6), the entry threshold of firm i is such that

$$e^{h_i^f} = \frac{\gamma u_1}{\kappa^-(1)(x_1\beta_1 + y_2\Delta_1)}, \tag{8}$$

where γ is the firms' common discount factor, $\beta^{\pm}$ are the roots of $\gamma - \Psi(\beta) = 0$ and $\beta^- < 0 < 1 < \beta^+$, and $\kappa^{\pm}(y) = \beta^{\pm}/(\beta^{\pm} - y)$; $\Psi(\cdot)$ is defined by parameters of the Brownian motion state variable, Z_t.

From my previous work, I find that for each pair of asymmetric potential firms, there is an unique equilibrium. This is a nice feature, so that there is no need to make equilibrium selection assumptions. The equilibrium outcome could be categorized into three cases: (1) the advantaged firm is the leader and its entry is not triggered by preemptive motives; (2) the advantaged firm is the leader, but it entered earlier than its optimal entry timing due to the fear of being preempted by its opponent; (3) the "disadvantaged" firm is the leader. The equilibrium concepts that will be used in this research will be the one of Markov-perfect equilibrium. Based on the results in Chiang (2014), I will use the following two terms and definition.

Definition 3.1. *An equilibrium is called sequential entry equilibrium if the leader entered at its monopolist's threshold.*

Definition 3.2. *A preemptive equilibrium is an equilibrium such that the leader entered earlier than the monopolist's threshold due to the fear of being preempted by its counterpart.*

The firms are heterogeneous in their observed and unobserved characteristics. Figure 1 shows how equilibrium types are distributed depending on the level of asymmetry between the two potential entrants. In Figure 1, firm 1 is the advantaged firm and firm 2 is the "disadvantaged" firm. The

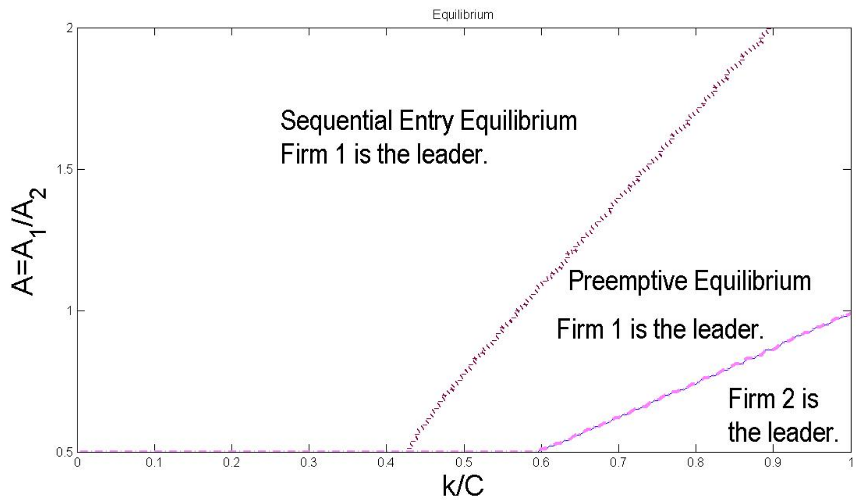

Figure 1: Equilibrium in the Parameter Space.

horizontal axis measures the asymmetry between the two firms' observable characteristics and unobservable characteristics. The vertical axis measures the asymmetry between the two firms' observable characteristics. The two firms becomes more symmetric when the measurements are closer to one. At the point where, both measurements are equal to one, the two firms are identical. When the horizontal measurement is closer to zero, the advantaged firm is a more advantaged. And when the vertical measurement is further away from zero, the advantaged firm is a more advantaged in the observable characteristics. For a detailed analysis of how the resulted equilibrium is derived for entry thresholds, please refer to Chiang (2014).

I illustrate the main idea starting with the case where (Δ_1, Δ_2) are negative. The probability of interest is the probability of which type of firms entered when and in what ordering. The choice probabilities predicted by the model are

$$\begin{aligned}(9)\qquad \Pr(1,1|X) &= \Pr(h_1 \leq h_2 \leq z) + \Pr(z \geq h_1 > h_2), \\ &= \Pr\left(e^z \geq e^{\min\{h_1^M, z_L\}}; e^z \geq e^{h_2^f}\right) + \Pr\left(e^z \geq e^{h_1^f}; e^z \geq e^{\min\{h_2^M, z^*\}}\right);\end{aligned}$$

$$(10)\qquad \Pr(1,0|X) = \Pr(h_1 \leq z \leq h_2) = \Pr\left(e^{h_2^f} \geq e^z \geq e^{\min\{h_1^M, z_L\}}\right);$$

$$(11)\qquad \Pr(0,1|X) = \Pr(h_2 \leq z \leq h_1) = \Pr\left(e^{h_1^f} \geq e^z \geq e^{\min\{h_2^M, z^*\}}\right);$$

$$(12)\qquad \Pr(0,0|X) = \Pr(z \leq h_1; z \leq h_2) = \Pr\left(e^z \leq e^{\min\{h_1^M, z_L\}} \text{ or } e^z \leq e^{\min\{h_2^M, z^*\}}\right),$$

where h_i^f is the optimal entry threshold of firm i as the follower; h_i^M is the monopolist entry threshold of firm i; z^* is the left boundary of the preemption zone of firm 1, and z_L is the left boundary of the preemption zone of firm 2.

I am currently working on probabilities of the equilibrium and the identification. While doing so, it requires to go back and forth between the setup and assumptions of the model, especially the choice of parametric specification.

3.2 Data Description

The data has been collected from the U.S. Bureau of Transportation Statistics (BTS), which also contains the *Origin and Destination Survey of Air Passenger Traffic*, which is commonly referred to as the O&D survey. The O&D consists in its most basic form of a 10% random sample of all airline passenger tickets issued by U.S. airlines. This data bank gives the number of passengers who travelled on a given airline between two cities on an "origin and destination" basis. This means that passengers are tracked from starting to ending point (on a single airline) without regard to connection which may have been made. Entry on an origin and destination basis need not involve any nonstop flights between the cities of a pair. The origin and destination basis of the data leads naturally to a definition of a market as the market for air passenger travel between two cities, irrespective of intermediate transfer point.[Berry (1992)]

Also from BTS, the table of Air Carrier Statistics (Form 41 Traffic) T-100 domestic segment (U.S. Carriers) table contains monthly data of U.S. domestic nonstop flight data from 1990 through 2014. This table includes flight data, such as the origin and destination airport, city and states, departure and arrival time, number of available seats, number of passengers transported, available payload (pounds), freight (pounds), distance between airports (miles) and aircraft group/type. This provides me market-specific variables. Firm-specific variables are collected from the air carrier financial reports, which is also on the BTS. Data on firms' operation strategy are also found, especially the hubs of the airlines operating in the hub-stroke structure.

The data has been collected and includes data from 1990 through 2014. It still requires quite amount of time to clean the data, to construct binary entry status variable in equation (4) and some descriptive statistics. Berry (1992) and Ciliberto and Tamer (2009) used the same data source, but from earlier years.

3.3 Possible Barriers and Solutions

(A) The first main challenge will be combining the game-theoretic real options framework into empirical entry game framework. As pure game theoretic models and econometric models do not share the same contexts and assumptions, it is important that while transforming from one to the other, the assumptions and contexts do not contradict with each other. Mapping theoretic framework to econometric framework, and defining the observable and unobservable variables will be the first and the toughest challenge for this research.

(B) In the stage of identification, I find that non-parametric identification is no longer possible. I had to set some assumptions for semi-parametric or parametric identification. To find reasonable assumptions in the literature will be a solution to this.

(C) In using the airline data, an important issue arises concerning the definition of markets and of firms that operate within markets. How a market is defined is crucial. If I plan to define a market as a nonstop route between city pairs, more investigation of the data bank needs to be done. The sample used in Berry (1992) includes only the city pair routes which connect the fifty largest U.S. cities. I am not certain at this moment on whether or not I will follow him regarding this. A better picture on how many markets to include into this analysis will be obtained after the data is cleaned. One major issue here is that airlines may entered and exited multiple times in a market during the sample duration.

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移地研究報告

時間：2015/01/26-02/05，共計 11 日。
地點：Department of Economics, University of Texas at Austin, U.S.A.

Department of Economics, University of Texas at Austin 是計畫主持人的博士班母校，此次回母校主要分別和 Dr. Svetlana Boyarchenko 和 Dr. Haiqing Xu 進行研究相關之討論。討論主題分為兩部分，第一部分是與 game theoretic real option (簡稱 GTRO) 相關的理論研究，第二部分是 estimation of games。

第一部分的主要討論對象是 Dr. Boyarchenko，分為兩個主題討論:

- Incomplete information game 的 GTRO 模型。此為本計畫模型中的其中一個環節，這段期間我們討論各種經濟環境下的模型建構與各種情況下的均衡，試圖找出符合經濟意義與可解的模型。Incomplete information game 或許有利下一階段的計量研究部分，但在不確定性的動態模型中，即便只有兩個玩家的情況，也未必能找到 pure strategy Nash equilibrium，而我們找的解是 Markov perfect equilibrium.
- Oligopoly in ambiguous environment。Ambiguity 是比 uncertainty(不確定性)更為複雜，因為在(不確定性下可以知道分布的參數值，只是不知道 the realization of a random variable。而 ambiguity 是連同分布的參數都是未知。目前的文獻主要探討個人在 ambiguity 下的決策行為，若要在 ambiguity 的環境中加入 strategic interactions，雖然與現實世界更為相符，但將會使模型快速複雜化。這部分尚待計畫主持人對文獻進行更小心謹慎的研讀。

第二部分是和 Dr. Xu 主要討論本計畫【非短視雙占在不同數據情境下之認定問題】。我們首先討論了放寬計量學家減少在本計畫主持人的博士論文模型中觀察到的部分，看是否能 non-parametrically identify something。然而經過幾番推演，我們的仍找不到方法。回國後，本計畫主持人同時試著前一段所述之 incomplete information game of GTRO，若有結果就繼續。然而，結果相當不令人滿意，於是計畫主持人決定換個方向延續之前的研究。

科技部補助計畫衍生研發成果推廣資料表

日期:2016/01/20

科技部補助計畫	計畫名稱: 非短視雙占在不同數據情境下之認定問題
	計畫主持人: 江品慧
	計畫編號: 103-2410-H-004-023- 學門領域: 產業組織與政策

無研發成果推廣資料

103年度專題研究計畫研究成果彙整表

計畫主持人：江品慧			**計畫編號：**103-2410-H-004-023-				
計畫名稱：非短視雙占在不同數據情境下之認定問題							
成果項目			量化：實際已達成數（被接受或已發表）	量化：預期總達成數（含實際已達成數）	量化：本計畫實際貢獻百分比	單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
其他成果（無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。）		無					

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

科技部補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估
   □達成目標
   ■未達成目標（請說明，以100字為限）
      □實驗失敗
      □因故實驗中斷
      ■其他原因
   說明：
   Non-parametric identification經歷多次多種方法的切入推演未能找到證明，最後決定在同一個基礎上改以semi-parametric 方式修改模型。

2. 研究成果在學術期刊發表或申請專利等情形：
   論文：□已發表 □未發表之文稿 ■撰寫中 □無
   專利：□已獲得 □申請中 ■無
   技轉：□已技轉 □洽談中 ■無
   其他：（以100字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以500字為限）
   An economic agent is ""non-myopic"" in the sense that he/she considers the opportunity cost of taking action today versus some other time in the future. Thus the study of game theoretic real option continues to be very important. The literature of empirical entry models has been developing during the past twenty to thirty years. However, the concept of ""waiting has value"" has yet not been incorporated into this literature and game theoretic real option remains to be purely theory. Hence it is crucial that game theoretic real option is brought to the empirical studies. This will help econometricians and the government to understand more about the industry and the firms, and these understandings may provide the government a different insight on how an industry policy is made.