UNIVERSITI PUTRA MALAYSIA

DYNAMIC GAME THEORETIC MODELS IN PREDICTING RESPONSES OF COMPETITORS IN OLIGOPOLISTIC MARKETS

REZA SHAHRJERDI

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By

REZA SHAHRJERDI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

April 2014

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DEDICATION

To my lovely MOTHER and dearest FATHER, for their close cooperation in this long journey,

and to my family for their continuous moral support

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Doctor of Philosophy

DYNAMIC GAME THEORETIC MODELS IN PREDICTING RESPONSES OF COMPETITORS IN OLIGOPOLISTIC MARKETS

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April 2014

Chairman: **Mohd Khairol Anuar Bin Mohd Ariffin, PhD**
Faculty: **Engineering**

Differential games theory can be considered as new theory in economic analysis for the oligopolistic market competition. The game theory is used to find the importance interaction between firms. Therefore, in this thesis the author attempted to assess the competition between firms in the oligopolistic market. Previous game theory model is focused on static and monopolistic market. However, the actual market condition cannot be considered as static. Therefore, there is a need to represent this static condition of the previous model to dynamics model. Currently there are few models represent the dynamic market conditions, however it is failed to incorporate continuous-time condition in oligopolistic markets with related to price and quantity issues. In dynamic market model, strategies of the games theory play an importance rule. These strategies namely as open loop, closed loop and feedback. The different between open loop and close loop strategies is only on reaction effects. Due to this, it is expected that open-loop differential games will generate same results such as static competition. In the other hand, the concept of equilibrium feedback strategy is found to be more natural and interesting in the present problems because the firms cannot deviate separately from equilibrium strategy. Therefore, this research work attempts to developed and solve models for differential oligopolistic game theory, which include sticky prices and advertising, Research and Development (R&D) process, as well as capital accumulation and subsidy parameters. In this model the authors solved the dynamics open market by enhancing the three different strategies namely open loop, close loop andfeedback for homogeneous or differentiated products using Hamilton-Jacobian-Bellman (HJB) method.The main findings of this studyshows that advertising initiatives employed in a setting based on the open loop, close loop andfeedback strategy increase the product differentiation, price stickiness, and promotional efficiency. On the hand the advertising effort efficiencyin the feedback strategy shows in opposite way.Feedback and close-loop equilibriums can separately be differentiated more efficient compared to open-loop competition in the event of high R&D productivity or close product substitutes. The scenario of feedback competition also consistently shows that social welfare (SW) and consumer surplus (CS) is higher than in close loop and open loop strategy.

This research proposed the usage of an engineering applicationto solvea very challenging economic problem pertaining to the capital accumulation of electrical market. For instance, the author has implemented this model for finding the effects of subsidy due to deregulating of electricity markets. It can be observed that by using this model, the social welfare is increase with the increasing of subsidy effort. However, the number of power plants that manage to survive over time decreases. In other words, social welfare increases due to an increase in consumer surplus, while additional power plants would initiate an increase in capital or output, leading to a decrease in electricity price.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

SUKAN DINAMIK MODEL-MODEL TEORITIS DALAM MERAMALKAN SAMBUTAN PESAING DI PASARAN OLIGOPOLISTIK

Oleh

REZA SHAHRJERDI

April 2014

Pengerusi: **Mohd Khairol Anuar Bin Mohd Ariffin, PhD**
Fakulti: **Kejuruteraan**

Teori permainan perbezaan dapat dipertimbangkan sebagai teori baru di analisa ekonomi untuk persaingan pasaran oligopolistik. Teori permainan digunakan untuk mencari interaksi kepentingan antara firma. Lantarannya, di tesis ini pengarang cuba untuk menilai pertandingan antara firma di pasaran oligopolistik. Model teori permainan yang sebelumnya ditumpukan di pasaran statik dan monopolistik. Bagaimanapun, keadaan pasaran sebenar tidak boleh dianggap sebagai statik. Lantarannya, terdapat satu keperluan mewakili keadaan statik ini model sebelumnya kepada dinamik model. Kini terdapat beberapa model mewakili syarat-syarat pasaran dinamik, bagaimanapun ia gagal untuk memasukkan keadaan masa selanjar di pasaran oligopolistik dengan berkaitan dengan berharga dan isu-isu kuantiti. Di pasaran dinamik model, strategi teori permainan main satu kepentingan memerintah. Strategi-strategi ini iaitu sebagai gelung terbuka, gelung tertutup dan maklum balas. Yang berbeza itu antara gelung terbuka dan hampir strategi-strategi gelung hanya di kesan reaktif. Oleh yang demikian, dijangka perbezaan gelung-buka itu permainan akan menjana kajian serupa seperti pertandingan statik. Di samping itu, konsep strategi maklum balas keseimbangan didapati lebih semulajadi dan menarik di masalah kini kerana firma tidak boleh menyimpang secara berasingan dari strategi keseimbangan. Lantarannya, kerja penyelidikan ini cuba untuk memajukan dan menyelesaikan model untuk teori permainan oligopolistik perbezaan, yang termasuk harga lekit dan mengiklankan, proses Research and Development, serta pengumpulan modal dan bersubsidi parameter. Dalam model ini pengarang menyelesaikan pasaran terbuka dinamik dengan mempertingkatkan tiga strategi lain iaitu gelung terbuka, hampir gelung dan maklum balas untuk homogen atau keluaran terbeza menggunakan Hamilton Jakobian Bellman kaedah. Dapatan utama kajian ini menunjukkan pengiklanan itu inisiatif diambil bekerja dalam sebuah latar berdasarkan gelung terbuka, hampir strategi gelung dan maklum balas meningkatkan pembezaan produk, kelekitan harga, dan kecekapan promosi. Di samping itu, kecekapan usaha pengiklanan di strategi maklum balas kelihatan dalam lorong bertentangan. Keseimbangan maklum balas dan gelung hampir boleh secara berasingan dibeza-bezakan lebih cekap berbanding dengan pertandingan gelung-buka

jika berlaku produktiviti R&D yang tinggi atau hampir produk menggantikan. Senario pertandingan maklum balas juga sentiasa menunjukkan kebajikan masyarakat (SW) dan lebihan pengguna (CS) itu berada lebih tinggi daripada di gelung hampir dan strategi gelung terbuka.

Penyelidikan ini mencadangkan penggunaan aplikasi kejuruteraan menyelesaikan masalah ekonomi yang amat mencabar berkaitan dengan pengumpulan modal pasaran elektrik. Misalnya, pengarang telah melaksanakan model ini untuk mencari kesan subsidi dijangka menggugurkan peraturan pasaran tenaga elektrik. Ia boleh diperhatikan dengan menggunakan model ini, kebajikan masyarakat menunjukkan peningkatan dengan penambahan usaha subsidi. Bagaimanapun, pertumbuhan jumlah kuasa yang berjaya hidup sepanjang masa mengurangkan. Dengan kata lain, kebajikan masyarakat meningkatkan disebabkan satu peningkatan di kalangan pengguna, manakala pertumbuhan kuasa tambahan akan memulakan satu peningkatan di modal atau output dapat membawa kepada satu pengurangan dalam harga elektrik.

ACKNOWLEDGEMENTS

I wish to express my deepest gratitude to the numerous people who have walked with me along the journey of this thesis. First and foremost, I would like to express my deep gratefulness to my supervisor Assoc. Prof. Dr. Mohd Khairol Anuar Bin Mohd Ariffin for his kind assistance, support, critical advice, encouragement, suggestions and direction throughout my research and preparation of this thesis. Many ideas originated in our frequent discussions and his constant support and patience over the years have been of invaluable help.

I also wish to extend my sincere gratitude and appreciation to my co-supervisor, Prof. Dr. Napsiah Binti Ismail for her guidance, patience, understanding, encouragement and supervision throughout the course of the study until the completion of this thesis. I truly admire him for his openness, honesty and sincerity and appreciate the time he devoted in advising me and showing me the proper directions to continue this research. I would also like to express my gratitude towards my co-supervisors Assoc. Prof. Dr. Faizal Bin Mustapha for their supervision, helpful advice and fruitful discussions that made an invaluable contribution to this dissertation. My sincere appreciation goes to all the people who have helped and supported me. Last but not the least, my heart-full gratitude and love to my parents whose unconditional support and love has made this dream comes true to me.

I certify that a Thesis Examination Committee has met on 12 June 2014 to conduct the final examination of Reza Shahrjerdi on his thesis entitled "Dynamic Game Theoretic Models in Predicting Responses of Competitors in Oligopolistic Markets" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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DECLARATION

Declaration by the student

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