



Cournot Duopoly Under Asymmetric Demand Uncertainty

Yasunori Fujita

Professor of Economics, Keio University 2-15-45 Mita Minato-ku Tokyo Japan

ABSTRACT

In the present paper, we compare Cournot equilibrium, Ryu-Kim equilibrium and Sakai equilibrium by constructing a duopolistic model where there is asymmetry of demand information between the two firms in a sense that one firm has only partial information, while the other firm has perfect information concerning the demand. It is revealed that as for the output of the firm which has only partial information, Cournot equilibrium is the largest, followed by Sakai equilibrium and Ryu-Kim equilibrium, while as for the output of the firm which has perfect information, Sakai equilibrium is the largest, followed by Cournot equilibrium that is equal to Ryu-Kim equilibrium.

KEYWORDS

Cournot equilibrium, Asymmetry of Demand information, Common knowledge

INTRODUCTION

Cournot equilibrium model, which was constructed by Cournot (1838) and is said to apply for the petroleum market in India (Singh and Kaur (2015)), have been progressing taking notice of information sharing with rivals (Novshek and Sonnenschein (1982), Clarke (1983a, 1983b), Gal-Or (1986), Shapiro (1986), Kirby (1988) and so on), with masterpieces being Sakai (1990, 1991) and Ryu and Kim (2011, 2014).

Sakai (1990, 1991) focus on duopolistic market where there is asymmetry of demand information between the two firms in a sense that one firm has only partial information, while the other firm has perfect information. In Sakai (1990, 1991), it is also assumed that one firm i with partial information mistakenly perceives that the other firm j with perfect information recognizes the economic environment just like firm i . Ryu and Kim (2011, 2014), on the other hand, introduce sequence of mutual conjectures into the Cournot equilibrium model. More precisely, Ryu and Kim (2011, 2014) construct a duopolistic model where each firm i conjectures the other firm j 's output, knowing that firm i 's output is conjectured by firm j which knows that firm j 's output is conjectured by firm i , and so on ad infinitum, as in the modeling of common knowledge (Aumann (1976) etc.).

Despite the novelty of the above two models, relationship between them is not examined enough. Although Ryu and Kim (2014) suggest the similarity of their model to Sakai model, process of the analysis, as well as the analytical framework, is unclear, since the two models are not compared in the same situation. In fact, according to Ryu and Kim (2014), effect of cost uncertainty in Ryu and Kim (2014) is similar to that of demand uncertainty in Sakai model. Thus, in the present paper, we construct a duopolistic model where one firm has only partial information, while the other firm has perfect information concerning the demand, to compare Cournot equilibrium, Ryu-Kim equilibrium and Sakai equilibrium.

Structure of this paper is as follows. Section 2 lays out a basic model and Section 3 derives Ryu-Kim equilibrium, followed by Section 4 that compares Cournot equilibrium, Ryu-Kim equilibrium and Sakai equilibrium. Concluding remarks are made in Section 5.

BASIC MODEL

Let us consider a duopolistic market where two firms (1,2), which produce identical goods, engage in quantity competition facing a linear demand,

$$p = a - q_1 - q_2,$$

where p , a and q_i ($i=1,2$) denote price, demand intercept and firm i 's output. Here, slope of inverse demand curve is assumed to be unity for the simplicity of analysis. We also assume that firm i 's marginal cost is constant at c_i ($c_i \geq 0$) and no fixed costs are required.

With reference to demand intercept, we assume that firm 1 has only partial information, while firm 2 has perfect information. Letting E and θ denote expectations operator and a positive constant that expresses the uncertainty to firm 1, the above asymmetry of information is formulated as

$$E(a|\Omega_1) = a + \theta;$$

$$E(a|\Omega_2) = a,$$

where Ω_1 and Ω_2 are information sets available to firm 1 and firm 2, respectively, with $E(a|\Omega_1) = a + \theta$ meaning that firm 1 mistakenly perceives the demand intercept as $a + \theta$ owing to the lack of information. We assume also $E[(a|\Omega_1)|\Omega_2] = E(a|\Omega_1) = a + \theta$ (i.e., $E(a + \theta|\Omega_2) = a + \theta$), which means that firm 2 conjectures firm 1's conjecture exactly, and $E[(a|\Omega_2)|\Omega_1] = E(a|\Omega_1) = a + \theta$, which means that firm 1, owing to the lack of information, mistakenly perceives that firm 2 conjectures the demand intercept as $a + \theta$.

We assume that conjectures on both firm are common knowledge in that each firm i ($i=1,2$) conjectures the other firm j 's ($j \neq i$) output based on her/his own information set Ω_i , knowing that firm i 's output is conjectured by firm j which knows that firm j 's output is conjectured by firm i , and so on ad infinitum. In this setting, expected profits of firm 1 and 2 are described, respectively, as

$$E(\pi_1|\Omega_1) = \{a + \theta - q_1 - E(q_2|\Omega_1) - c_1\} q_1;$$

$$E(\pi_2|\Omega_2) = \{a - E(q_1|\Omega_2) - q_2 - c_2\} q_2,$$

where $E(q_2|\Omega_1)$ and $E(q_1|\Omega_2)$ are to be determined later. Note that use is made of here that $E(c_i|\Omega_i) = c_i$ and $E(q_i|\Omega_i) = q_i$ for every $i=1,2$, $E(a|\Omega_1) = a + \theta$ and $E(a|\Omega_2) = a$.

From these expected profits, reaction functions of firm 1 and firm 2 are derived, respectively, as

$$q_1 = \frac{1}{2} \{a + \theta - c_1 - E(q_2|\Omega_1)\}; \quad (1)$$

$$q_2 = \frac{1}{2} \{a - c_2 - E(q_1|\Omega_2)\}. \quad (2)$$

Since each firm conjectures, as mentioned above, the other firm's output, knowing that both of them conjecture each other's reaction, first of all, $E(q_1|\Omega_2)$ is transformed into

$$E(q_1 | \Omega_2) = E\left\{\frac{1}{2}[a + \theta - c_1 - E\left\{\frac{1}{2}[a - c_2 - E(q_1 | \Omega_2) | \Omega_1]\right\} | \Omega_2]\right\}, \quad (3)$$

by substituting (2) into $E(q_2 | \Omega_1)$ in (1), and substituting the q_1 just derived into $E(q_1 | \Omega_2)$, while $E(q_2 | \Omega_1)$ is transformed into

$$E(q_2 | \Omega_1) = E\left\{\frac{1}{2}[a - c_2 - E\left\{\frac{1}{2}[a + \theta - c_1 - E(q_2 | \Omega_1) | \Omega_2]\right\} | \Omega_1]\right\}, \quad (4)$$

by substituting (1) into $E(q_1 | \Omega_2)$ in (2), and substituting the q_2 just derived into $E(q_2 | \Omega_1)$, each of which, respectively, reduces to

$$E(q_1 | \Omega_2) = \left(\frac{1}{2} - \frac{1}{4}\right)(a + \theta) - \frac{1}{2}c_1 + \frac{1}{4}c_2 + \frac{1}{4}E(q_1 | \Omega_2); \quad (5)$$

$$E(q_2 | \Omega_1) = \left(\frac{1}{2} - \frac{1}{4}\right)(a + \theta) + \frac{1}{4}c_1 - \frac{1}{2}c_2 + \frac{1}{4}E(q_2 | \Omega_1), \quad (6)$$

by making use of $E(c_i | \Omega_i) = E[(c_i | \Omega_i) | \Omega_i] = E[(c_i | \Omega_j) | \Omega_i] = c_i$ for every $i=1,2$ and $j \neq i$, $E(a | \Omega_1) = E[(a | \Omega_1) | \Omega_2] = a + \theta$, $E(a | \Omega_2) = a$ and $E[(a | \Omega_2) | \Omega_1] = a + \theta$, to yield

$$E(q_1 | \Omega_2) = \left(\frac{1}{2} - \frac{1}{4} + \frac{1}{8}\right)(a + \theta) - \left(\frac{1}{2} + \frac{1}{8}\right)c_1 + \frac{1}{4}c_2 - \frac{1}{8}E[(q_2 | \Omega_1) | \Omega_2]; \quad (7)$$

$$E(q_2 | \Omega_1) = \left(\frac{1}{2} - \frac{1}{4} + \frac{1}{8}\right)(a + \theta) + \frac{1}{4}c_1 - \left(\frac{1}{2} + \frac{1}{8}\right)c_2 - \frac{1}{8}E[(q_1 | \Omega_2) | \Omega_1], \quad (8)$$

by substituting (1) into (5) and (2) into (6), respectively.

Let's call these two formulas firm 2's conjecture on firm 1's output and firm 1's conjecture on firm 2's output in round 1, respectively.

DERIVATION OF RYU-KIM EQUILIBRIUM

Interaction of mutual conjectures does not stop here. By carrying out similar calculation, we have firm 2's conjecture on firm 1's output and firm 1's conjecture on firm 2's output in round n , respectively as

$$E(q_1 | \Omega_2) = \left\{\frac{1}{2} - \left(\frac{1}{4} - \frac{1}{8}\right) \sum_{k=1}^n \left(\frac{1}{4}\right)^{n-k}\right\}(a + \theta) - \left\{\frac{1}{2} + \frac{1}{8} \sum_{k=1}^n \left(\frac{1}{4}\right)^{n-k}\right\}c_1 + \frac{1}{4} \sum_{k=1}^n \left(\frac{1}{4}\right)^{n-k}c_2 + \frac{1}{8} \left(\frac{1}{4}\right)^{n-1}E[(q_2 | \Omega_1) | \Omega_2]; \quad (9)$$

$$E(q_2 | \Omega_1) = \left\{\frac{1}{2} - \left(\frac{1}{4} - \frac{1}{8}\right) \sum_{k=1}^n \left(\frac{1}{4}\right)^{n-k}\right\}(a + \theta) + \frac{1}{4} \sum_{k=1}^n \left(\frac{1}{4}\right)^{n-k}c_1 - \left\{\frac{1}{2} + \frac{1}{8} \sum_{k=1}^n \left(\frac{1}{4}\right)^{n-k}\right\}c_2 + \frac{1}{8} \left(\frac{1}{4}\right)^{n-1}E[(q_1 | \Omega_2) | \Omega_1]. \quad (10)$$

Thus, we have firm 2's conjecture on firm 1's output and firm 1's conjecture on firm 2's output in the limit, respectively, as

$$E(q_1 | \Omega_2) = \frac{1}{3}(a + \theta - 2c_1 + c_2); \quad (11)$$

$$E(q_2 | \Omega_1) = \frac{1}{3}(a + \theta + c_1 - 2c_2). \quad (12)$$

Series of firm i 's conjecture on firm j 's output ($i=1,2, j \neq i$) are shown graphically as in Figure 1(a)(b).

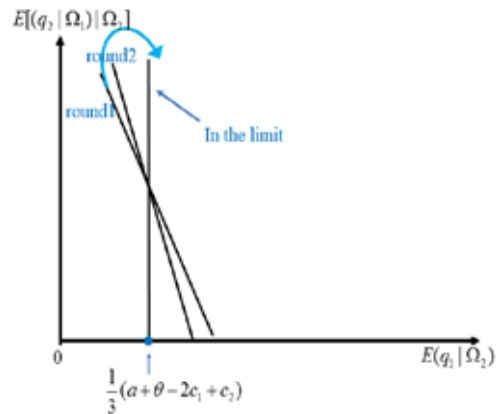


Figure 1(a)
series of firm 2's anticipation of firm 1's output

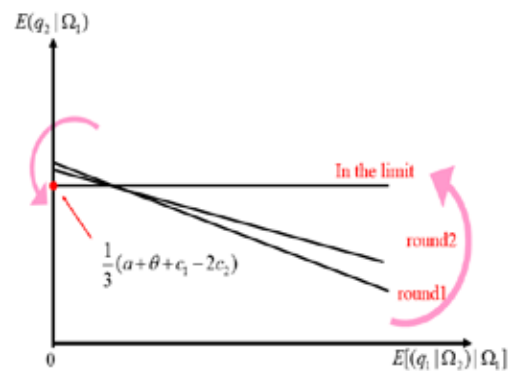


Figure 1(b)
series of firm 1's anticipation of firm 2's output

By substituting (12) into (1) and (11) into (2), we have the reaction functions of firm 1 and firm 2 in the limit, respectively, as

$$q_1 = \frac{1}{3}(a - \theta - 2c_1 + c_2); \quad (13)$$

$$q_2 = \frac{1}{3}(a - \theta + c_1 - 2c_2). \quad (14)$$

Therefore, the equilibrium is shown as the intersection of the two reaction curves as in Figure 2, which we call Ryu-Kim equilibrium. Note that outputs in Ryu-Kim equilibrium (q_1^{RK}, q_2^{RK}) are equal to (13) and (14), since reaction curves of firm 1 and firm 2 are vertical and horizontal in q_1 - q_2 space, respectively.

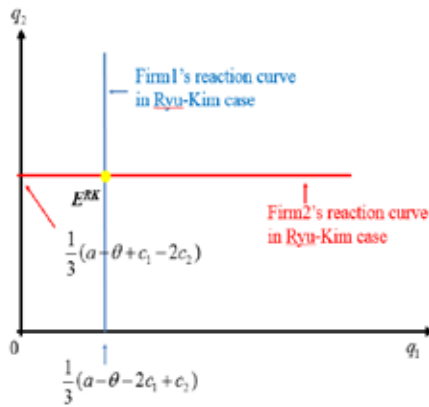


Figure 2
derivation of Ryu-Kim equilibrium

COMPARISON OF EQUILIBRIUMS

If we assume that each firm maximizes expected profit taking the other firm's output as given i.e., in a Cournot fashion, since expected profits of firm 1 and 2 are described as

$$E(\pi_1) = (a + \theta - q_1 - q_2 - c_1)q_1;$$

$$E(\pi_2) = (a - q_1 - q_2 - c_2)q_2,$$

reaction functions of firm 1 and firm 2 in this case are derived, respectively, as

$$q_1 = \frac{1}{2}(a + \theta - c_1 - q_2);$$

$$q_2 = \frac{1}{2}(a - c_2 - q_1),$$

to yield the Cournot equilibrium, by solving these simultaneous equations with respect to q_1 and q_2 , as

$$q_1^C = \frac{1}{3}(a + 2\theta - 2c_1 + c_2); \quad (15)$$

$$q_2^C = \frac{1}{3}(a - \theta + c_1 - 2c_2), \quad (16)$$

which is shown at the point E^C in Figure 3.

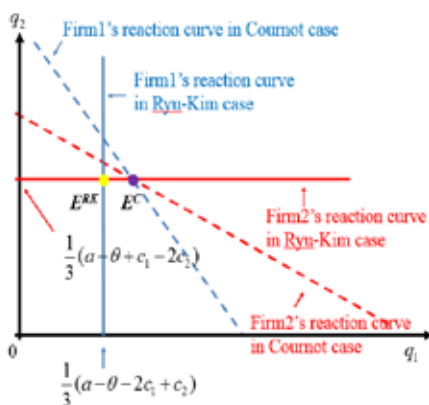


Figure 3
Ryu-Kim equilibrium and Cournot equilibrium

By comparing the Cournot equilibrium (point E^C) with

the Ryu-Kim (point E^{RK}) equilibrium, we have the following proposition.

Proposition1: Output of the firm which has only partial information in Ryu-Kim equilibrium is smaller than her/his output in Cournot equilibrium, while output of the firm which has perfect information in Ryu-Kim equilibrium is the same as her/his output in Cournot equilibrium.

Now, we can derive the equilibrium that was presented in Sakai (1990) where firm i with partial information mistakenly perceives that the other firm j with perfect information recognizes the economic environment just like firm i , and firm i 's output is determined as the intersection of firm i 's reaction function and firm j 's reaction function mistakenly perceived by firm i , while firm j 's output is determined by substituting firm i 's output just derived into firm j 's real reaction function.

In the case of the present paper, firm 1's reaction function and firm 2's reaction function mistakenly perceived by firm 1 are, respectively

$$q_1 = \frac{1}{2}(a + \theta - c_1 - q_2);$$

$$q_2 = \frac{1}{2}(a + \theta - c_2 - q_1).$$

Thus, firm 1's output is derived as the intersection of these reaction functions as

$$q_1^S = \frac{1}{3}(a + \theta - 2c_1 + c_2),$$

which in turn yields firm 2's output as

$$q_2^S = \frac{1}{3}(a - \frac{1}{2}\theta + c_1 - 2c_2),$$

by substituting q_1^S into firm 2's real reaction function

$$q_2 = \frac{1}{2}(a - c_2 - q_1),$$

which is shown in Figure 4, where E^S is Sakai equilibrium (q_1^S, q_2^S).

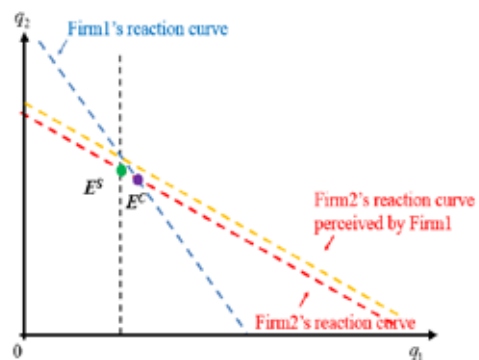


Figure 4
Sakai equilibrium

Since we have the relationship among the three equilibria as in Figure 5, following

proposition is derived.

Proposition2: *With reference to the output of the firm which has only partial information, Cournot equilibrium is the largest followed by Sakai equilibrium and Ryu-Kim equilibrium, while with reference to the output of the firm which has perfect information, Sakai equilibrium is the largest followed by Cournot equilibrium that is equal to Ryu-Kim equilibrium.*

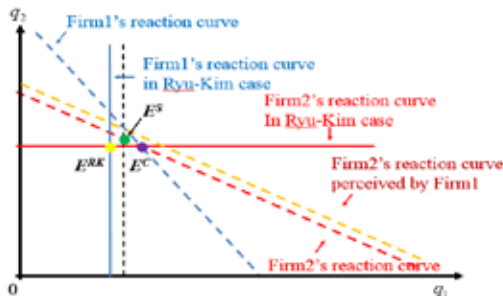


Figure 5
comparison of three equilibriums

REFERENCES

- Ahangar, R. G. (2011). 'The relationship between intellectual capital and financial performance: An empirical investigation in an Iranian company', *African J. of Business Man.*, 5, pp. 88-95. Anderson, A. R. and Miller, C. J. (2003). 'Class matters: Human and social capital in the entrepreneurial process', *J. of Socio-Economics*, 32, pp. 17-36. Anderson, A., Park, J. and Jack, S. (2007). 'Entrepreneurial social capital: Conceptualizing social capital in new high-tech firms', *International Small Business J.*, 25 (3), pp. 245-272. Ariss, A. A. and Syed, J. (2011). 'Capital mobilization of skilled migrants: A relational perspective', *British Journal of Management*, 22, DOI: 10.1111/j.1467-8551.2010.00734.x, pp. 289. Ax, C. and Marton, J. (2008). 'Human capital disclosures and management practices', *J. of Intellectual Capital*, 9, pp. 433-445. Bates, T. (1990). 'Entrepreneurial human capital inputs and small business longevity', *The Review of Economics and Statistics*, 72 (4), pp. 551-559. Bhartesh, K. R. and Bandyopadhyay, A. K. (2005). 'Intellectual capital: Concept and its measurement', *Finance India*, 19 (4), pp. 1365. Bosma, N., Van-Praag, M., Thurik, R. and De Wit, G. (2004). 'The value of human and social capital investments for the business performance of startups', *Small Business Economics*, 23 (3), pp. 227-236. Bosma, N., Van-Praag, M., Thurik, R. and De Wit, G. (2002). 'The value of human and social capital investments for the business performance of startups', Tinbergen Institute Discussion Paper, pp. 1-11. Cansiz, M. (2008). 'SMEs in Turkey and KOSGEB (Türkiye'de Kobilir ve KOSGEB)', SPO Specialization Theses (DPT Uzmanlık Tezleri), Ankara [in Turkish]. Castrogiovanni, G. J. (1996). 'Pre-start-up planning and the survival of new small firms', *J. of Man.*, 22 (6), pp. 801-823. Chong, H. (2008). 'Measuring performance of SMEs: The grounded theory approach', *J. of Business and Public Affairs*, 2 (1), pp. 1-10. Coleman, S. (2007). 'The role of human and financial capital in the profitability and growth of women-owned small firms', *J. of Small Business Management*, 3 (45), pp. 303-319. Cooper, A. C., Gimeno-Gascon, F. J. and Woo, C. Y. (1994). 'Initial human and financial capital as predictors of new venture performance', *J. of Business Venturing*, 9 (5), pp. 371-395. Cote, S. (2001). 'The contribution of human and social capital', ISUMA, Spring, pp. 29-36. Covin, J. and Slevin, D. (1989). 'Strategic management of small firms in hostile and benign environments', *Strategic Man. J.*, 10, pp. 75-87. Daou, A., Karuranga, E. and Su, Z. (2013). 'Intellectual capital in Mexican SMEs from the perspective of the resource-based and dynamic capabilities views', *J. of Applied Business Research (JABR)*, 29 (6), pp. 1673-1688. Davidsson, P. and Honig, B. (2003). 'The role of social and human capital among nascent entrepreneurs', *J. of business venturing*, 18 (3), pp. 301-331. DeCarolis, D. M., Litzky, B. E. and Edleston, K. A. (2009). 'Why networks enhance the progress of new venture creation: The influence of social capital and cognition', *Entrepreneurship Theory and Practice*, 33 (2), pp. 527-545. Edvinsson, L. and Malone, M. S. (1997). 'Intellectual capital: Realizing your company's true value by finding its hidden brainpower', New York: Harper Business. Ergun, N. (2012). 'The place and importance of SMEs and entrepreneurs in Turkish economy (Kobi'ler ve Girişimcilerin Türk ekonomisindeki yeri ve önemi)', *The Key in Development Productivity Journal (Kalkınmada Anahtar Verimlilik Dergisi)*, Ministry of Science, Industry and Technology, Nov. 2012, 287, pp. 4. Fatoki, O. O. (2011). 'The impact of human, social and financial capital on the performance of small and medium-sized enterprises (SMEs) in South Africa', *J. Social Science*, 29, pp. 193-204. Florin, J., Lubatkin, M. and Schulze, W. (2003). 'A social capital model of high-growth ventures', *Academy of Man. J.*, 46 (3), pp. 374-384. Glaeser, E. L., Laibson, D. and Sacerdote, B. (2002). 'An economic approach to social capital', *Economic J.*, 112 (483), pp. 437-458. Liao, J. and Welsch, H. (2005). 'Roles of social capital in venture creation: Key dimensions and research implications', *J. of Small Business Man.*, 43 (4), pp. 345-362. Leitão, J. and Franco, M. 'Non-economic organizational performance of SMEs: Is there a rationale for a cognitive entrepreneur?', <http://webs2002.uab.es/edp/workshop09/Papers%20Workshop5Joao.pdf>. Leitch, C. M., McMullan, C. and Harrison, R. T. (2013). 'The development of entrepreneurial leadership: The role of human, social and institutional capital', *British J. of Management*, 24, DOI: 10.1111/j.1467-8551.2011.00808.x, pp. 351. Lee, R. and Jones, O. (2008). 'Networks, communication and learning during business start-up: The creation of cognitive social capital', *International Small Business J.*, 26 (5), pp. 559-594. Loury, G. (1977). 'A dynamic theory of racial income difference', P. Wallace, and A. LaMond (eds), *Women, Minorities and Employment Discrimination*, Lexington Books, Lexington, pp. 153-186. Marimuthu, M., Arokiasamy, L. and Ismail, M. (2009). 'Human capital development and its impact on firm performance: Evidence from developmental economics', *The J. of International Social Research*, 2, pp. 265-272. Marshall, M. I. and Oliver, W. N. (2005). 'The effects of human, financial, and social capital on the entrepreneurial process for entrepreneurs in India', Paper prepared for presentation at the Allied Social Science Associations Annual Meeting, Jan 7-9, Philadelphia, Pennsylvania. Mert, A. (2007). 'The impact of CEO and human capital characteristics on SME export performance', A thesis submitted to the graduate school of social sciences of Middle East Technical University, In partial fulfillment of the requirements for the degree of Master of Science in dep. of business administration. [in Turkish]. Modigliani, F. and Miller, M. H. (1963). 'Corporate income taxes and the cost of capital: A correction', *American Economic Review*, 53, pp. 433-444. Neergaard, H., Shaw, E. and Carter, S. (2005). 'The impact of gender, social capital and networks on business ownership: A research agenda', *International J. of Entrepreneurial Behavior and Research*, 11 (5), pp. 338-357. Nijkamp, P., Stough, R. and Sahin, M. (2004). 'Impact of social and human capital on business performance of migrant entrepreneurs - A Comparative Dutch-US Study', OECD SMEs in Turkey: Issues and Policies, OECD Publications, 2 rue André-Pascal, 75775 Paris Cedex 16, France, pp. 1-83. Nunnally, J. C. (1978). 'Psychometric theory', McGraw-Hill, 2nd Ed. OECD (2004). 'Small and medium-sized enterprises in Turkey-Issues and policies', OECD Pub., pp.28. Okafor, R. G. (2012). 'The role of human, financial and social capital in the performance of small businesses in Nigeria: A second look', *J. of Economics and Sustainable Development*, 3 (14), pp. 213-220. Ozbilgin, M. and Tatli, A. (2005). 'Understanding Bourdieu's contribution to organization and management studies', *Academy of Management Review*, 30 (4), pp. 861. Putnam, R. (2001). 'Social capital: Measurement and consequences', ISUMA: Canadian J. of Policy Research, 2, pp. 41-51. Ramos-Rodríguez, A. R., Medina-Garrido, J. A., Lorenzo-Gómez, J. D. and Ruiz-Navarro, J. (2010). 'What you know or who you know? The role of intellectual and social capital in opportunity recognition', *International Small Business J.*, 28 (6), pp. 566-582. Regulations (2005). Official Gazette, Turkey, Nov. 18, S. 25997, pp. 1-2. [in Turkish]. Schuller, T. (2001). 'The complementary roles of human and social capital', Birkbeck College, University of London. ISUMA, Spring, pp. 18-24. Segal, G., Borgia, D. and Schoenfeld, J. (2009). 'Founder human capital and small firm performance: An empirical study of founder-managed natural food stores', *J. of Man. and Marketing Research*, 4, pp. 1-10. Smith, N., Bracker, J. and Miner, J. (1987). 'Correlates of firms and entrepreneur success in technologically innovative companies', N. Churchill ed. *Frontiers of Entrepreneurship Research*, Wesley, MA: Babson College Press, pp. 57-71. Sriyani, G. T. W. (2010). 'Human capital and its impact on small firm success', ICBI 2010, University of Kelaniya, Sri Lanka. Stiles, P. and Kulvisaechana, S. (2003). 'Human capital and performance: A literature review', University of Cambridge, Judge Institute of Man., Cambridge's Business School, Trumpington St., Cambridge CB2 1AG, pp. 1-39. Tentime, Z. T. and Pansiri, J. (2004). 'Small business critical success/failure factors in developing economies: Some evidence from Botswana', *America J. of Applied Sciences*, 1, pp. 18-25. Totterman, H. and Sten, J. (2005). 'Start-ups, business incubation and social capital', *International Small Business J.*, 23 (5), pp. 487-511. TÜİK (2008). Turkish Statistical Institute. Innovation Research 2004-2006, News Bulletin, 23 [in Turkish]. Unger, J. M., Rauch, A., Frese, M. and Rosenbusch, N. (2011). 'Human capital and entrepreneurial success: A meta-analytic review', *J. of Business Venturing*, 26, pp. 341-358. Wong, P. K., Ho, Y. P. and Autio, E. (2005). 'Entrepreneurship, innovation and economic growth: Evidence from GEM data', *Small Business Economics*, 24, pp. 335-350. http://ec.europa.eu/eurostat.ec.europa.eu/statistics_explained/index.php/Unemployment_statistics (Accessed on Jan. 5, 2012). <http://www.haberler.com/antalya-kobi-ler-107-milyon-tl-kosgeb-kredisi-haberi> (Accessed on April 5, 2012). [in Turkish]. Zahra, S. (1991). 'Predictors and financial outcomes of corporate entrepreneurship: An explorative study', *J. of Business Venturing*, 6, pp. 259-285. Zehir, C., Altındag, E. and Acar, A. Z. (2011). 'The effects of relationship orientation through innovation orientation on firm performance: An empirical study on Turkish family-owned firms', *Procedia Social and Behavioral Sciences*, 24, pp. 900.

CONCLUDING REMARKS

In the present paper, we constructed a duopolistic model where one firm has only partial information, while the other firm has perfect information concerning the demand, to compare Cournot equilibrium, Ryu-Kim equilibrium and Sakai equilibrium.

Main conclusions are: (1) with reference to the output of the firm which has only partial information, Cournot equilibrium is the largest followed by Sakai equilibrium and Ryu-Kim equilibrium, while (2) with reference to the output of the firm which has perfect information, Sakai equilibrium is the largest followed by Cournot equilibrium that is equal to Ryu-Kim equilibrium.

We truly hope this research note will contribute to better understanding of the distinguished framework Cournot (1838) provided.