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FINANCIAL STRUCTURE OF FIRMS IN OLIGOPOLY EVIDENCE FROM KOREA

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This paper examines the effect of the product market structure on firms' financial structure. Following Brander and Lewis (1986), several recent papers show that a firm can use leverage to favorably improve its position in the product market. The present paper constructs the model that exhibits the linkage between the product market structure and financial structure of firms. The model is tested empirically using data taken from Korean firms. The empirical test finds that, contrary to theoretical predictions, debt levels of Korean firms are negatively correlated to market concentration. Combined with the test result of Cheong and Lee (1999), this result indicates that the Brander-Lewis hypothesis does not hold in Korea.

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I. INTRODUCTION

Following the seminal work of Modigliani and Miller (1958), many authors have examined the relationship between the capital structure of a firm and the value of the firm. A list of important contribution includes Harris and Raviv (1988, 1990, 1991), Heinkel (1982), Jensen and Meckling (1976), Leland and Pyle (1977), Myers (1984), Ross (1977), and Stulz (1988). These studies focus on the determinants of firms' capital structure.

Several recent papers have recognized the link between the product market structure and the financial structure of firms. They have developed theoretical

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models that show the relationship between the financial structure of firms and market structures. Examples of contribution are Brander and Lewis (1986), Scott and Martin (1975), Showalter (1995, 1999), Titman (1984), and Cheong and Lee (1999). Specifically, Brander and Lewis (1986) illustrate that financial decisions and product market decisions are linked in Cournot oligopoly with limited liability. They show that a leveraged firm with limited liability tends to be more aggressive in output markets when financial and output decisions are sequentially made in the Cournot duopoly. However, they have not examined the relationship between the product market structure and firms' financial structure in oligopoly with more than two firms.

Cheong and Lee (1999) extend the Brander-Lewis model to the case with more than two firms. Their empirical test based on Korean data weakly support the theoretical findings. They conclude that, while oligopolistic market structures have had some effect on the financial structure of Korean firms, there remain other important determinants of financial structure as well. We surmise that one of important variables omitted in Cheong and Lee (1999) is the share of export in firms' output. The purpose of this paper is to further examine the relationship between the product market structure and firms' financial structure. Building on Cheong and Lee (1999) we offer a refined test result that reflects Korean situation. The empirical test finds that, contrary to theoretical predictions, debt levels of Korean firms are negatively correlated to market concentration. Combined with the test result of Cheong and Lee (1999), this result indicates that the Brander-Lewis hypothesis does not hold in Korea.

This paper is organized as follows. Section II develops a two-stage Cournot-Nash oligopoly model in which financial and output decisions follow in sequence. We examine the effect of the number of firms on each firm's debt level. Empirical test results based on Korean data are presented in Section III. The final section provides concluding remarks.

II. THE MODEL[1]

Consider a Cournot-Nash oligopoly with n identical firms, where $n \geq 2$. The firms compete in two stages. In the first stage, the manager[2] of each firm determines his or her firm's level of debt, taking the debt levels of the other firms as given. Then, the firms compete in the output market in the second stage. Each firm decides its own output level, taking output levels of the other firms as given.

The equilibrium is subgame-perfect. Thus, decisions of managers of the firms are sequentially rational. The output decisions in the second stage are correctly

[1] This section is based on Cheong and Lee (1999).

[2] The manager of each firm makes financial and output decisions on behalf of equity-holders. Thus the managerial incentive issue is assumed away.

anticipated by the managers of the firms when they make financial decisions in the first stage. We obtain the solution by backward induction. In the first place, we examine the output decisions of the firms, given their debts. The optimal borrowings by the firms in the first stage are then examined.

Market demand for the product is uncertain. There are two states of nature, good state (high demand) and bad state (low demand). The probability of the good state is θ. Accordingly, the probability of the bad state is $1-\theta$. The state of nature is realized after the firms' production. The price of the product is determined at the market-clearing level.

Market demand is a linear function given by

$$P=A-bQ+u, \tag{1}$$

where Q denotes total production level and u the random variable. The value of u is $h(>0)$ for high demand, and 0 for low demand. $r=1$. No cost is incurred in the production process so that average variable cost net of borrowing costs is 0.[3]

In the first stage firm i borrows W_i on condition that it will pay back D_i after production and sales. If variable profit is greater than the debt D_i in the low demand state, it should be greater than D_i in the high demand state as well. Then, firm i is not bankrupt in any state. The expected profit of firm i is given by

$$EV^i=\theta[(A+h-bQ)q_i-D_i]+(1-\theta)[(A-bQ)q_i-D_i] \tag{2}$$

where q_i denotes the output of firm i. If the variable profit of firm i is less than the outstanding debt D_i, the firm is bankrupt and the remaining profit accrues to the bond-holders. When production and sales are completed, the salvage value of each firm's asset is assumed to be 0. Thus, nothing is left to equity-holders in case of bankruptcy.

(1) The Case of Expected Profit Maximization

For a firm to maximize the expected profit, variable profit should not be less than the outstanding debt D_i in any state. These conditions are as follows:

$$(A+h-bQ)q_i-D_i\geq 0, \text{ for } i=1, \cdots, n. \tag{3}$$

$$(A-bQ)q_i-D_i\geq 0, \text{ for } i=1, \cdots, n. \tag{4}$$

[3] This is equivalent to assuming that marginal cost is constant. When the marginal cost is constant and positive, we can subtract the cost from the vertical intercept of the (inverse) demand curve and analyze it as a case with no production cost.

The weak inequality (3) gives the upper limit of debt. No firm can borrow more than the profit it earns in a high demand state. We assume that inequality (3) is satisfied for all firms. Inequality (4) denotes a condition under which a firm is not bankrupt in a low demand state. When inequality (4) is satisfied for each firm, each firm can maximize its expected profit. We first analyze firms' behaviour in the case where the condition (4) is satisfied for every firm and then calculate the value of each firm. Secondly, we analyze the case in which the condition (4) is not satisfied for any firm. In this case, equity-holders focus on maximization of the profit in a high demand state. The equity-holders are only concerned about the state of high demand, since the firms are bankrupt in a low demand state.

Without risk of bankruptcy, firm i maximizes its expected profit EV^i

$$\text{Max } EV^i = \theta[(A+h-bQ)q_i - D_i] + (1-\theta)[(A-bQ)q_i - D_i)] \quad \text{for } i = i, \cdots, n. \tag{5}$$

The first-order condition for maximization of EV^i is

$$\partial EV^i/\partial q_i = \theta[(A+h-bQ) - bq_i] + (1-\theta)[(A-bQ) - bq_i] = 0, \quad \text{for } i = 1, \cdots, n.$$

Utilizing the symmetry condition, and denoting $q_i = q_2 = \cdots = q_n = q^*$, we obtain

$$q^* = (A+\theta h)/b(n+1) \tag{6}$$

$$Q^* = nq^* = n(A+\theta h)/b(n+1) \tag{7}$$

From equations (6) and (7) we find that output levels are not affected by outstanding debts provided that they are sufficiently low. Inserting equation (7) into (4), we obtain the following conditions.

$$(A-n\theta h)(A+\theta h)/b(n+1)^2 \geq D_i, \quad i = 1, \cdots, n. \tag{8}$$

When condition (8) is satisfied for every firm, each firm can maximize expected profit without worrying about bankruptcy. The upper limit to the debt satisfying condition (8), D^*, is given as

$$D^* = (A-n\theta h)(A+\theta h)/b(n+1)^2. \tag{9}$$

It is easy to find that D^* is a decreasing function of n. That is, the more firms in the industry, the smaller the upper limit to the debt without bankruptcy risk.

(2) The Case of Maximization of Expected Wealth of Equityholders

If the outstanding debt of each firm exceeds D^*, the firms are bankrupt when demand is low. The equity-holders are aware of this risk. They are only interested in the profits the firms earn in the high demand state. The objectives of the managers are given as follows.

$$\text{Max } EV^i = \theta[(A+h-bQ)q_i - D_i] + (1-\theta)0, \text{ for } i=1, \cdots, n. \tag{10}$$

The second term on the right hand side of the equation (10) indicates that equity-holders earn zero profits if the firm is bankrupt due to low demand. The first-order condition for maximization is :

$$\partial EV^i/\partial q_i = \theta[A+h-bQ-bq_i] = 0, \text{ for } i=1, \cdots, n.$$

Solving this equation, we obtain

$$q^* = (A+h)/b(n+1) \tag{11}$$

$$Q^* = n(A+h)/(n+1) \tag{12}$$

Comparing equation (7) with (12), we find that the output level of each firm with debt exceeding D^* is greater than that of a firm with debt not exceeding D^*. This result can be intuitively explained as follows. With high debt the firm is bankrupt in the case of low demand. Thus equity-holders of firms are only interested in the profits the firms earn in the high demand state. Hence the managers of these firms determine output levels expecting high demand.

(3) Debt Levels of Firms and Firm Values

We now examine the debt levels and the values of the firms. As in Brander and Lewis (1986), the debt raised in period 0 is distributed to equity-holders. The bond-holders who provide the debts to the firms have rational expectations about the bankruptcy risk and profits of firms in case of bankruptcy.

Case 1

If the outstanding debt does not exceed D^*, the firm is free from the bankruptcy risk. In this case, the value of the debt which pays D_i in the second period is exactly equal to D_i if interest payments are disregarded. The value of firm i is the sum of EV^i and D_i, given by

$$EV^i + D_i = \theta[(A+h-bQ)q_i - D_i] + (1-\theta)[(A-bQ)q_i - D_i] + D_i$$
$$= \theta(A+h-bQ)q_i + (1-\theta)(A-bQ)q_i \quad (13)$$

From equation (13), we find that the value of the firm is not affected by the level of the debt. This result is similar to the well-known result of Modigliani and Miller (1958). However, this invariance result holds only when each firm's debt does not exceed D^*. Note that the upper limit D^* decreases in the number of firms. While not explicitly modelled in this paper, we can reasonably assume that each firm issues debt up to D^*.[4]

Case 2

If each firm's debt exceeds D^*, the firm is bankrupt in the case of low demand. Rational bond-holders are well aware of this. Thus, the net value W_i of outstanding debt D_i is

$$W_i = \theta D_i + (1-\theta)(A-bQ)q_i. \quad (14)$$

From equation (14)[5], we find that bond-holders receive D_i in the case of high demand, and claim variable profit smaller than D_i in the case of low demand. The value of firm i is $EV^i + W_i$, which is

$$EV^i + W_i = \theta[(A+h-bQ)q_i - D_i] + (1-\theta)0 + \theta D_i + (1-\theta)(A-bQ)q_i$$
$$= \theta(A+h-bQ)q_i + (1-\theta)(A-bQ)q_i \quad (15)$$

The functional form of equation (15) is the same as that of equation (13). The value of the firm is not affected by D_i. However, the value of the firm given in (15) is smaller than that given in (13). This is due to the difference in output levels. If the debts exceed D^*, the firms produce more output than in the case when $D_i \leq D^*$. The debt not exceeding D^* has no effect on the firm values. However, if the debt of each firm exceeds D^*, each firm's value is smaller than that given in (13).

From Cases 1 and 2, we find that the value of the firms with low debts is greater than that with high debts. This indicates that the firms issue debt up to D^*. Note that D^* decreases in n.

[4] In many countries including Korea, some proportion of interest payment to bond-holders is deductible from corporate income tax. This practice induces firms to borrow as much as they can.

[5] Here we assume that variable profit in the case of low demand is greater than 0. This assumption, not essential to the results, is adopted to simplify the analysis.

Ⅲ. EMPIRICAL TEST

We now test the model developed in the previous section, using data taken from Korean industries. The Korean situation offers a good environment for empirical test of the model. First, most of Korean industries are oligopolistic, as in the model of the previous section. Second, as Korean firms in general have high debt-equity ratios (see "Business Survey Analysis"), to derive viable policies to reduce their debt-equity ratios, it is necessary to understand the underlying reasons of such high debt-equity ratios. For empirical test, we classify Korean market structures based on the market concentration index. Then we construct ordinary least squares (OLS) regressions which explain the relationship between the market structures and the debt-equity ratios of Korean industries.

(1) Hypothesis

We now derive hypotheses about the financial structure of the firms. Each firm is assumed to issue debt up to the upper limit D^*. Another possible assumption is that the debts of the firms are uniformly distributed in the closed interval $[0, D^*]$. Then the average debt of the firms in the industry is $D^*/2$. We adopt the former assumption that the firms issue debt up to the limit[6] We then obtain the following comparative statics results: $\partial D^*/\partial n<0$ and $\partial D^*/\partial A>0$. An increase in n indicates a decrease in market concentration. If every firm has the same amount of capital, this implies that the more concentrated the output market, the higher the debt-equity ratio. An increase in A means an upward shift of the demand curve. This also increases the debt-equity ratio. From these comparative statics results, we derive the following hypotheses for empirical test.

Hypothesis 1
An increase in market concentration increases debt-equity ratios.

Hypothesis 2
An increase in market demand increases debt-equity ratios.

(2) Data for Empirical Test

We use the concentration ratio CR_k as the index of market structure. This ratio denotes how large proportion of the market the upper k firms have and is defined as

$$CR_k = \sum_{i=1}^{k} 100 s_i.$$

[6] This is the case if there exist some benefits such as tax exemption associated with debt financing. The two assumptions yield the same hypothesis, however.

where $s_i (0 \leq s_i \leq 1)$ denotes i-th firm's market share. For these concentration ratios, we use unpublished 1989 CR_3 index.[7] They are classified according to the four-digit Standard Industrial Classification (SIC) code. These data are available for fifty-two industries. In fact, they cover almost all industries. We use dummy variable CR80 for highly concentrated markets ($CR_3 \geq 80\%$), CR8060 for medium concentrated markets ($60\% \leq CR_3 < 80\%$), and CR60 for low concentrated markets ($CR_3 < 60\%$), respectively. Debt-equity ratios and sales data are obtained from the "Business Survey Analysis" of the Bank of Korea.

(3) Test results

We estimate the following OLS regression equation:

$$DEBT = \beta_1 CR80 + \beta_2 CR8060 + \beta_3 CR60 + \beta_4 SALES_t + \beta_5 EX + \beta_6 D_1 + \beta_7 D3 + \beta_8 X3 + \beta_9 X36 + \beta_{10} X40 + \beta_{11} X47 + \beta_{12} X52 \quad (16)$$

where DEBT denotes industry debt-equity ratio(%), EX represents the ratio of exports to sales. While our early study omitted the variable EX (Cheong and Lee (1999)), we recognize that the export ratio has had a significant effect on debt-equity ratios of firms. This is mainly because Korea has maintained export-driven growth strategy for several decades. Naturally, exporting firms are given various favors in credit rationing. Thus, they would have large credit shares, i.e., high debt-equity ratios. SALESt represents the rate of sales increase. We estimate regression equation (16) using three rates of sales increase: sales increase in the current year 1989, sales increase in the next year 1990 and the average rate of 1989 and 1990, respectively.

The industries are divided into five groups based on the second digit of the SIC code. The five groups classified are Food & Beverages (D1); Textiles, Wearing Apparel and Leather (D2); Chemicals, Petroleum, Coal, Rubber & Plastics (D3); Non-metallic Mineral Products (D4); and Fabricated Metal Products, Machinery and Equipment (D5). However, since D4 and D5 turn out to be insignificant in the preliminary regression analysis, these variables are excluded in the final regression. The variable X is used as a dummy variable to treat outliers.[8] X3, X36, X40, X47 and X52 denote outliers with extremely high debt-equity ratios for SIC Code 3115, 3812, 3824, 3834 and 3852, respectively.

Tables 1 to 3 present the regression results of equation (16). In all three regressions, quite unexpectedly, CR80 and CR8060 have negative coefficients, with the absolute value of the former greater than that of the latter. These empirical results show that the higher the concentration index, the lower the

[7] These data are filed for internal use by Korea Development Institute.

[8] An outlier exceeds the values of other observations in the sample by a large amount, typically more than three or four standard deviations away from the mean value of all the observations. For technique of controlling outliers, see Gujarati (1988).

Table 1. Regression Results of Equation(16) with 1989 Sales Increase

dependent variable : debt ratio $SALES_t$ =1989 sales increase		
CR80	-1.8	(-3.6)
CR8060	-1.2	(-2.9)
CR60	4.1	(7.6)
$SALES_t$	3.9	(2.9)
EX	2.1	(4.1)
D1	107.5	(3.9)
D3	-103.6	(-4.1)
X3	259.9	(3.9)
X36	323.3	(5.0)
X40	350.0	(5.3)
X47	-171.6	(-2.5)
X52	224.5	(3.3)
$\overline{R^2}$	0.683	
D-W	1.90	
F-statistics	10.9	
Number of observations	52	

Notes: 1) Numbers in parentheses are t-values.
2) $\overline{R^2}$ is the coefficient of determination adjusted for the degree of freedom.
3) D. W. is the Durbin-Watson statistic.

Table 2. Regression Results of Equation(16) with 1990 Sales Increase

dependent variable : debt ratio $SALES_t$ =1990 sales increase		
CR80	-1.7	(-2.9)
CR8060	-1.3	(-3.1)
CR60	4.3	(6.9)
$SALES_t$	1.8	(1.9)
EX	1.7	(3.4)
D1	125.7	(4.3)
D3	-105.4	(-4.0)
X3	254.9	(3.6)
X36	207.7	(4.0)
X40	365.3	(5.3)
X47	-200.9	(-2.8)
X52	241.7	(3.2)
$\overline{R^2}$	0.647	
D-W	2.0	
F-statistics	9.5	
Number of observations	52	

Notes: See notes in Table 1.

Table 3. Regression Results of Equation(16) with Average Sales Increase

dependent variable : debt ratio $SALES_t$ =average sales increase of 1989 and 1990		
CR80	-1.4	(-2.5)
CR8060	-1.1	(-2.6)
CR60	3.6	(5.5)
$SALES_t$	4.2	(3.0)
EX	2.1	(4.1)
D1	121.4	(4.5)
D3	-104.1	(-4.2)
X3	268.7	(4.0)
X36	292.1	(4.6)
X40	339.9	(5.2)
X47	-180.0	(-2.7)
X52	259.6	(3.7)
$\overline{R^2}$	0.687	
D-W	1.97	
F-statistics	11.2	
Number of observations	52	

Notes: See notes in Table 1.

debt-equity ratio. The results are statistically significant. In the case of sales, sales increase in the current year turns out to have the statistically significant positive effect on the debt-equity ratio. Sales increase in the future year 1990 has a relatively small effect on the debt-equity ratio. The ratio of export to sales, EX, turns out to have the statistically significant positive effect on the debt-equity ratio.

While the model is only slightly modified from Cheong and Lee (1999), the test result is in sharp contrast with the result in Cheong and Lee (1999) reported in Table 4. Note that the results in Table 4 are weakly in accordance with theoretical predictions. That is, the higher the concentration index, the higher the debt-equity ratio. However, the result is not statistically significant. The discrepancy between the two studies can be explained as follows. First, the statistical result in Cheong and Lee (1999) was not statistically significant. Thus, in a sense, the result of the present paper is not that much surprising. Second, the present paper has incorporated the important variable, the export ratio, the inclusion of which has significantly altered the results. The effect of demand increase turns out to be statistically significant in both studies. In the early assessment based on our studies, the Brander-Lewis hypothesis does not seem to fit into Korean situation. However, it should be noted that this is a very preliminary assessment. To reach a concrete conclusion, more work both in theoretical part and empirical test is required.

Ⅳ. CONCLUDING REMARKS

The present paper has constructed the model that exhibits the linkage between

Table 4. Regression Results of Cheong and Lee (1999)

Variables	(1) Regression Coefficients with 1989 Sales Increase	(2) Regression Coefficients with 1990 Sales Increase	(3) Regression Coefficients with Average Sales Increase
Constant	252.0 (14.4)	254.6 (9.5)	235.2 (9.5)
CR80	47.6 (1.3)	57.3 (1.4)	57.3 (1.5)
CR8060	22.0 (1.0)	19.4 (0.8)	19.2 (0.8)
$SALES_1$	2.7 (2.4)	–	–
$SALES_2$	–	0.9 (0.9)	–
$SALES_A$	–	–	2.6 (2.0)
D1	54.4 (2.0)	73.4 (2.6)	69.3 (2.6)
D2	48.5 (1.6)	40.0 (1.2)	54.5 (1.7)
D3	-105.2 (-4.1)	-105.2 (-3.9)	-102.6 (-3.9)
X3	273.6 (4.1)	267.1 (3.8)	276.4 (4.1)
X40	286.4 (4.4)	305.9 (4.5)	289.7 (4.3)
X52	247.4 (3.7)	249.6 (3.3)	269.9 (3.8)
$\overline{R^2}$	0.685	0.650	0.685
D.W.	2.1	2.1	2.1
F-statistics	13.4	11.5	13.4
Number of Observation	52	52	52

Notes: See notes in Table 1.
Source: Cheong and Lee (1999)

the product market structure and financial structure of firms. The model is empirically tested using data taken from Korean firms. The empirical test has found that, contrary to theoretical predictions, debt levels of Korean firms are negatively correlated to market concentration. Combined with the test result of Cheong and Lee (1999), this result indicates that the Brander-Lewis hypothesis does not hold in Korea. Some further research is required to reach a concrete conclusion, however.

This paper remains to be extended in several respects. First, empirical test of the model can be strengthened. An empirical test based on more recent data would offer more up-to-date information on determinants of the financial structure of Korean firms. Second, the theoretical model developed in this paper can be extended to allow for continuous distribution of states of nature.

REFERENCES

Bank of Korea (1991), *Business Survey Analysis.*

Brander, J.A., and T.R. Lewis (1986), "Oligopoly and Financial Structure: The Limited Liability Effect," *American Economic Review*, 76, 956-970.

Cheong, K., and S. Lee (1999), "Financial Structure in Oligopoly," *Advances in Applied Microeconomics* (JAI Press), Vol. 8: Oligopoly, 209-221.

Gujarati, D.N. (1988), *Basic Econometrics*, 353-397.

Harris, M., and A. Raviv (1988), "Corporate Control Contests and Capital Structure," *Journal of Financial Economics*, 20, 55-86.

_____(1990), "Capital Structure and Informational Role of Debt," *Journal of Finance*, 45, 321-349.

_____(1991), "The Theory of Capital Structure," *Journal of Finance*, 46, 297-355.

Heinkel, R. (1982), "A Theory of Capital Structure Relevance Under Imperfect Information," *Journal of Finance*, 37, 1141-50.

Jensen, M., and W. Meckling (1976), "Theory of the Firm: Managerial Behavior, Agency Costs, and Capital Structure," *Journal of Financial Economics*, 3, 305-60.

Korea Development Institute (1989), "Concentration Index," Unpublished Internal Data.

Leland, H., and D. Pyle (1977), "Information Asymmetries, Financial Structure and Financial Intermediation," *Journal of Finance*, 32, 371-388.

Modigliani, F., and M. Miller (1958), "The Cost of Capital, Corporation Finance, and the Theory of Investment," *American Economic Review*, 48, 261-97.

Myers, S.C. (1984), "The Capital Structure Puzzle," *Journal of Finance*, 39, 575-92.

Ross, S. (1977), "The Determination of Financial Structure: The Incentive-Signalling Approach," *Bell Journal of Economics*, 8, 23-40.

Scott, D., and J. Martin (1975), "Industry Influence on Financial Structure," *Financial Management*, 67-73.

Showalter, D. (1995), "Oligopoly and Financial Structure: Comment," *American Economic Review*, 85, 647-653.

_____(1999), "Strategic Debt: Evidence in Manufacturing," *International Journal of Industrial Organization*, 17, 319-333.

Stulz, R. (1988), "Managerial Control of Voting Rights: Financing Policies and the Market for Corporate Control," *Journal of Financial Economics*, 20, 25-54.

Titman, S. (1984), "The Effect of Capital Structure on a Firm's Liquidation Decision," *Journal of Financial Economics*, 13, 137-51.