# Government-Led Restructuring of Firms' Excess Capacity and Its Limits: Korean "Big Deal" Case

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Based on the statistical analysis of a panel data composed of 26 Korean Big Deal-related firms' financial information over the sample period of 1988-98, this paper rigorously examines which factors determine the scale of excess capacity. The statistical analysis in this study demonstrates that a firm's strategic decision to maximize profits subject to the constraints existing in its business environment may be a rational behavior at the firm level even if it may bring about excess capacity at the industry level ex-post. Statistical results imply that government-led resource allocation, such as the "Big Deals," has limits in its function and effectiveness because government can not ex ante control firm's strategic behaviors.

*Keywords*: Excess capacity, Strategic interaction, Industrial Policy

*JEL Classification*: L1, L6

## I. Introduction

Chronic excess capacity or over-investment has been a key issue whenever Korea experiences economic difficulties. The Korean government has repeatedly interfered with market mechanisms to solve

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structural excess capacity problem since it started full scale restructuring in the early 1980s. The purpose of this policy was to cure the adverse effects of excessively redundant investment in heavy and chemical industries after the second oil shock in 1979. Then, with the enactment of the Industry Development Law in the mid 1980s, the government initiated the restructuring of facilities in declining industries such as textiles, dyeing/processing, and fertilizers in which chronic excess capacity had existed for a long time. The Korean government continued to indirectly engage in resource allocation through its "Core Business Specialization" program in the 1990s because it believed that excessive business diversification and over-investment on the part of the chaebol might weaken the country's international competitive edge in major industries. The government came up with the "Big Deal" policy, in which the 5 largest chaebols were asked to swap 8 businesses in key industries to alleviate chronic excess capacity in these businesses, which was pointed out as being one of the key factors bringing about the financial crisis of 1997. The eight major industries targeted by the "Big Deal" were the semiconductor, petrochemical, aerospace, railway vehicle, power-generator/ship-engine, oil refining, electronics, and automobile industries.[1] Looking back on past industrial policies vis-à-vis excess capacity since the 1980s, the latter has been continuously mentioned at the center of industrial policy, and without exception, the government has taken an active part in resource reallocation to solve that problem.

It is generally accepted among scholars that "Big Deal" policy is failed in terms of economic performance, as of the end of 2001. Hynix (Hyundai and LG) is continuously under liquidity crisis. Hyundai Oilbank Corporation (Hyundai, Han Hwa, Inchon) is under legal management. Rotem, former Korea Rolling Stock Corporation (Hyundai, Daewoo, Hanjin) has been in the red, with three labor unions in a single firm existing. Korea Aerospace Industries, Ltd. (Daewoo, Samsung, Hyundai) was failed to attract foreign investment and got in big deficit. Only HSD Engine Co., Ltd. (Doosan, Samsung) goes into the black. A variety of positive

[1] More precisely explaining, auto industry does mot belong to "Big Deal" industries. This industry is put in the study sample because auto manufacturers (KIA, Samsung) were going through restructuring by way of M&A or asset sale.

analyses on the competitive consequences of the "Big Deal" confirm that the resulting mergers may significantly be detrimental to effective competition and, furthermore, be adverse to social welfare. The "Big Deal" policy to clear up chronic excess capacity is going too far in the sense that these business swaps, mergers and acquisitions, may considerably deepen market concentration in relevant markets, and thus significantly impair fair competition. The Korea Fair Trade Commission (KFTC) has not played its fundamental role of fairly and transparently analyzing the anti-competitive effects of mergers.[2]

Based on the statistical analysis of a panel data composed of 26 Big Deal-related firms' financial information over the sample period of 1988-98, this paper rigorously examines which factors determine the scale of excess capacity. This research shows that the size of excess capacity is influenced by demand shocks, market structure, capital intensity, and a variety of strategic interactions among oligopolistic firms. Statistical results illustrate that government-led resource allocation, such as the "Big Deal," has limits in its function and effectiveness. This paper is organized as follows. Section II describes the extent and the general determinants of excess capacity in the eight industries concerned. Section III explains the data, empirical model, and test results of model specification. Section IV contains empirical estimation results and statistical inferences. The paper ends with a summary and concluding remarks in section V.

## II. Determinants of Excess Capacity

### A. Does Chronic Excess Capacity Exist?

Excess capacity that can be a considerable burden on the national economy as well as on the firms concerned is called chronic excess capacity. Chronic excess capacity refers to a state of constant over-capacity during normal economic phases as well as during peak demand. It is not natural excess capacity or temporary excess capacity due to some particularities of the market structure or economic fluctuations.[3] Redundant and excessive facility invest-

[2] See Lee (2000) for detailed story.

[3] Bain (1962) defines chronic excess capacity as a "persistent tendency

**TABLE 1**
GROWTH RATE OF SALES

(Unit: %)

| Industry | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|
| Semiconductor | – | 24.39 | 17.66 | 93.14 | 69.52 | 54.95 |
| Petrochemical | 12.07 | 3.17 | 32.73 | 28.96 | 104.12 | 9.24 |
| Auto | 20.94 | 12.84 | 29.51 | 8.71 | 10.99 | 23.07 |
| Aerospace | 27.00 | -3.82 | 17.10 | 118.54 | -25.17 | 30.22 |
| Railway Vehicle | 39.78 | 19.00 | 70.39 | 3.11 | 120.50 | 8.01 |
| Power-generator/ Ship-engine | 3.66 | 8.44 | 40.87 | 42.35 | 16.92 | 5.70 |
| Oil refining | 23.23 | 42.05 | 29.31 | 28.58 | 20.29 | 4.78 |
| Electronics | 31.94 | 11.62 | 7.74 | 22.18 | 14.55 | 15.81 |
| All Manufacturing | 17.55 | 8.38 | 17.08 | 11.12 | 8.98 | 11.46 |
| **Industry** | **1994** | **1995** | **1996** | **1997** | **1998** | **Aver-age** |
| Semiconductor | 69.11 | 79.86 | -12.91 | 18.08 | 18.52 | 45.5 |
| Petrochemical | 21.13 | 7.49 | 9.55 | 31.45 | 5.93 | 23.0 |
| Auto | 22.99 | 19.80 | 18.16 | 9.64 | -23.44 | 13.9 |
| Aerospace | 91.41 | 86.10 | 33.68 | 31.45 | 56.20 | 42.4 |
| Railway Vehicle | 43.57 | -12.52 | 24.82 | -3.62 | -23.90 | 26.0 |
| Power-generator/ Ship-engine | 15.50 | 28.61 | 15.58 | 18.48 | -15.75 | 16.4 |
| Oil refining | 7.64 | 14.18 | 21.44 | -1.72 | -25.46 | 14.9 |
| Electronics | 28.16 | 33.66 | 16.16 | 33.46 | 9.93 | 20.4 |
| All Manufacturing | 14.71 | 15.48 | 8.47 | 4.75 | – | 11.7 |

ment resulting from imprecise forecasting of future demand and supply can be said to have occurred ex-post. In such a case the concept of ex-ante excess capacity is not validated.

toward redundant capacity at times of maximum or peak demand."

**TABLE 2**
CAPACITY OPERATING RATE

(Unit: %)

| Industry | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|
| Semiconductor | 90.59 | 87.64 | 77.69 | 88.00 | 96.49 | 94.00 |
| Petrochemical | 82.00 | 86.33 | 92.98 | 104.03 | 93.04 | 98.66 |
| Auto | 64.49 | 65.26 | 64.94 | 62.79 | 62.01 | 80.00 |
| Aerospace | 58.98 | 65.52 | 78.12 | 77.86 | 54.19 | 67.24 |
| Railway Vehicle | 74.96 | 72.56 | 77.26 | 67.29 | 66.26 | 55.91 |
| Power-generator/ Ship-engine | 86.35 | 56.43 | 73.73 | 70.23 | 66.96 | 79.09 |
| Oil refining | 91.52 | 91.35 | 93.93 | 96.30 | 82.98 | 89.48 |
| Electronics | 75.90 | 70.95 | 78.74 | 77.01 | 83.97 | 76.17 |
| All Manufacturing | 79.20 | 76.30 | 78.30 | 79.50 | 78.40 | 77.90 |

| Industry | 1994 | 1995 | 1996 | 1997 | 1998 | Aver-age |
|---|---|---|---|---|---|---|
| Semiconductor | 102.40 | 98.33 | 96.78 | 91.75 | 89.55 | 92.2 |
| Petrochemical | 106.21 | 96.67 | 94.50 | 89.84 | 88.81 | 93.8 |
| Auto | 88.00 | 81.87 | 89.83 | 76.12 | 56.65 | 72.0 |
| Aerospace | 140.46 | 54.65 | 45.29 | 68.52 | 87.07 | 79.0 |
| Railway Vehicle | 74.33 | 71.59 | 65.83 | 65.45 | 84.22 | 69.6 |
| Power-generator/ Ship-engine | 82.33 | 81.62 | 83.56 | 85.00 | 91.50 | 77.8 |
| Oil refining | 92.52 | 97.73 | 98.03 | 96.29 | 85.38 | 92.1 |
| Electronics | 85.96 | 82.24 | 83.39 | 86.12 | 85.67 | 80.5 |
| All Manufacturing | 81.30 | 81.00 | 81.80 | 79.90 | – | 79.3 |

Facility investment efficiency equivalent to the value-added/ tangible fixed asset ratio, or current profit rate, is often utilized as a proxy variable for excess capacity. However, these terms, as a proxy variable for excess capacity, are vulnerable in the sense that they are significantly affected by market structure and cost-related disturbances. In this study a variable of unutilized capacity, that is, a measure of idle facility for each firm, is designed as a proxy variable. A detailed explanation of unutilized capacity used in this study is temporarily postponed.

The yearly average growth rate of sales in "Big Deal" industries over the sample period of 1988-98 is 23.48%, which is almost double the yearly average growth rate of sales (11.79%) for all industries in the manufacturing sector. The annual average growth rate of sales in "Big Deal" industries is as follows: 45.58% for semiconductors, 23.01% for petrochemicals, 13.93% for autos, 42.41% for aerospace, 26.01% for railway vehicles, 16.40% for power-generators/ship-engines, 14.94% for oil refining, and 20.47% for electronics.

The average capacity operating rate by industry over the sample period was as follows: 92.27% for semiconductors, 93.83% for petrochemicals, 72% for autos, 79.05% for aerospace, 69.67% for railway vehicles, 77.89% for power-generator/ship-engines, 92.14% for oil refining, and 80.56% for electronics. Over the same period the annual average capacity utilization rate for the manufacturing sector was 79.36%. The rate fluctuated annually within a band of $\pm$1~2% around 80%.

It is inferred that a capacity operating rate of 80% is usually regarded as the normal level in manufacturing industries, even though the normal capacity operating rate is slightly different by industry. I also use 75% as a benchmark for the capacity operating rate during recessions. The average capacity utilization rate in 1989, a year of economic downswing in the sample period, was 76.35%, still higher than the benchmark of 75%. Average capacity utilization rates in 1994-6, years of economic upswings, rose to 81~82%. The number of years in which capacity operating rates fell short of 75% and 80% respectively, and ratios of the number of the years falling under each category to the number of total sample years are summarized in Table 3.

The ratios by industry defined under the benchmark rate of 80% are considerably high for the auto (63.64%), aerospace (81.82%), railway vehicle (90.91%), power-generator/ship-engine (45.45%), and electronic (45.45%) industries. Even the ratios based on the benchmark rate of 75%, defined as the capacity operating rate in economic downturns, turn out to be high for the auto (54.54%), aerospace (63.64%), railway vehicle (81.82%), and power-generator/

**TABLE 3**

NUMBER OF YEARS AND RATIOS ACCORDING TO BENCHMARK USED

| Industry | Semicon-ductor | Petro-chemical | Auto | Aero-space | Railway Vehicle | Power-generator/ ship-engine | Oil refining | Elec-tronic |
|---|---|---|---|---|---|---|---|---|
| Number of years (benchmark of 75% ) (ratio: %) | 0 (0.00) | 0 (0.00) | 6 (54.54) | 7 (63.64) | 9 (81.82) | 4 (36.36) | 0 (0.00) | 1 (9.09) |
| Number of years (benchmark of 80% ) (ratio: %) | 1 (9.09) | 0 (0.00) | 7 (63.64) | 9 (81.82) | 10 (90.91) | 5 (45.45) | 0 (0.00) | 5 (45.45) |

ship-engine (36.36%) industries. These ratios indicate that there has been an accumulation of structurally excessive capacity from continual over-investment in these industries far in excess of growing aggregate demand over the sample period.

### *B. Discussion on the Determinants of Excess Capacity*

Almost all theoretical and empirical studies on the interaction of market structure, market behavior, and market performance tackle the issue of allocative efficiency. These studies commonly use the mark-up rate as an indicator of market performance. On the other hand, there are few papers that look into the interaction of strategic market behavior and market structure with excess capacity, another important dimension of market performance.[4] Of the major empirical studies dealing with the relationship between market structure and excess capacity (Bain, 1962; Meehan 1967; Scherer 1969; and Esposito *et al.* 1974, 1986), only the articles of Bain (1962) Esposito *et al.* (1974, 1986) directly associate market structure[5] with the degree of chronic excess capacity. Esposito *et*

[4]Chamberline (1957) was the first economist to raise the economic theory that excess capacity exists in monopolistic competition markets. He regards as excess capacity the gap between capacity output, defined as the lowest point on the total average cost curve, and actual output. He explains excess capacity as an inevitable cost deriving from the output variety of products in monopolistic competition markets.

[5]Bain (1962) observed that chronic excess capacity did not appear in six sample industries with “substantial” or “very high” entry barriers but did

*al.* (1974) investigated the quantitative relationship between market structure and a direct measure of excess capacity for 35 American industries in the manufacturing sector. In order to capture chronic excess capacity, the dependent variable is measured over a period of rising aggregate demand, 1963-6. The results suggest that partial oligopolies experience significantly more excess capacity during periods of growing aggregate demand than do tight oligopolistic or competitive industries. In a statistical analysis of 273 U.S. industries, Esposito *et al.* (1986) find excess capacity levels in periods of peak demand to be 2.8 percentage points higher on average in middling oligopolies than in either competitively structured or tightly oligopolistic industries, taking into account demand variability, demand growth, capital intensity, and also plant durability.

Economic theory clearly defines the expected excess capacity outcomes when perfectly competitive markets are faced with a permanent increase in market demand.[6] It is less clear in defining excess capacity in oligopolistic industries where strategic interactions among rival firms about choice variables such as price and output matter. For oligopolistic industries with high sales concentration, high barriers to entry, and less degree of product differentiation, the probability of collective action to share maximal

appear in three industries with "moderate to low" entry barriers. Meehan (1967) investigates how industries adjust their capacity when faced with a permanent increase in demand. Using a sample of five industries, he finds that the same degree of excess capacity develops in the two competitive industries (soft coal mining and flour milling) as in the two oligopolistic industries (steel and cement manufacturing). In the prewar aluminum industry, a monopoly, there was no evidence of excess capacity. Scherer (1969) approaches the problem by trying to explain the degree of investment instability. He constructs a measure of investment instability for the period of 1954-63 and regresses this measure against market concentration and a measure of demand instability. He finds a positive and significant relationship between market concentration and investment instability.

[6]Perfectly competitive markets experience the entry of new firms and the over-expansion of existing firms because the elasticity of price expectation of each firm is one. As a result, the expanded industry capacity output exceeds quantity demanded at the long-run equilibrium price and aggregate industry capacity is underutilized. In contrast, monopolists adjust their capacity to the expected long-run equilibrium price and excess capacity does not occur. Since entry is effectively deterred, the capacity output defined by the monopolists is not disturbed.

industry profit is very high. If the formation of 'focal points' among competing firms, equivalent to cartel-like behavior, is followed, one expects a rather smooth adjustment toward the new long-run equilibrium capacity level given a permanent increase in demand. Capital is fully utilized much in the same manner as in the monopolies. On the other hand, excess capacity can arise even in a tight oligopolistic industry if at least one of the oligopolists views an increase in industry demand as a good opportunity to increase its sales and market share. In this situation excess capacity is avoided only if the non-ambitious oligopolists allow decreases in their market shares.

Excess capacity is related with market behavior to strategically deter new entries. Excess capacity has been considered to have commitment value since it satisfies Geroski's pre-conditions: observability, durability, and irreversibility. Spence (1977), in a seminal paper, argues that excess capacity enables incumbents to threaten to expand output and cut prices following entry, thereby making entry unprofitable. This so-called excess capacity hypothesis argues that entry deterrence is achieved by intensifying the level of post-entry competition anticipated by the entrants, and parts of the capacity installed pre-entry will be left idle after entry has been deterred. Similar theoretical arguments can also be found from Eaton and Lipsey (1979), Spulber (1981), Perrakis and Warsket (1983), and Reynolds (1985).[7] However, empirical studies do not consistently support the validity of this hypothesis.[8]

Even though market structure and strategic investment for entry deterrence can have an effect on the existence of excess capacity, there are other determinants of excess capacity. An oligopolist may also create excess capacity in order to retain his own buyers and service his rivals' customers in case unanticipated future increases in demand occur. In turn, the fear of a future loss of market share

[7]Dixit (1980) questions this hypothesis on the grounds that the equilibrium examined by Spence is not 'perfect.' He shows that when the requirement of subgame perfection is imposed, capacity still can be strategically used to deter entry, but idle capacity is not observed in equilibrium. In a variant Dixit model, however, Bulow, Geanakoplos, and Klemperer (1985) show that excess capacity can be found in perfect equilibrium if competing products are strategic complements.

[8]Refer to empirical studies carried out by Hilke (1984), Ghemawat (1984), Kirman and Masson (1986), Masson and Shaanon (1986), and Liberman (1987).

may impel rival oligopolists to increase capacity beyond what is needed to meet their current demand. Uncertainty in future industry demand is likely to be reflected in a disproportionate increase in capacity for all firms. Firms optimistic about future market demand will aggressively expand their production facility. Firms also strategically maintain over-investment to gain better bargaining position in the negotiation of bank loan. In Korea firm size matters in securing enough bank loan. Besides these factors, capital intensity, demand shock, and firm size competition may affect the degree of excess capacity. In summary, uncertainty in market demand and strategic interactions between rival firms in oligopolistic industries may inevitably bring about excess capacity.

## III. Data and Empirical Model

### *A. Data*

Industry data was collected from the National Statistical Office's Mining and Manufacturing Survey (1987-98), and various financial data at the firm level was taken from the Annual Report of Korean Companies provided by the Korea Investors Service and from firms' auditing documents. The number of sample industries and firms are eight and twenty-six respectively. The sample industries and firms are listed in Table 4.

### *B. Empirical Model*

For the empirical analysis I assume a casual relationship between excess capacity and its determinants as follows:

$$EXCA_{jt} = \gamma_j + \alpha_1 GROWTHSA_{jt} + \alpha_2 INVEST_{jt} + \alpha_3 KASA_{jt} \\ \alpha_4 GROWTHSA{*}KASA_{jt} + \alpha_5 ENTRY_{jt} + \alpha_6 TIGHT_{jt} + \varepsilon_{jt} \quad (1)$$

$j$ : firm index
$t$ : time index
$\varepsilon_{jt}$ : error terms

$\gamma_j$, the constant term in this estimation equation, reflects the time-invariant firm specific effect, a feature of the panel data. Also,

**TABLE 4**
LIST OF SAMPLE INDUSTRIES AND FIRMS

| Industry | Korea Standard Industry Classification | | Name of Firm | Listed or Unlisted | Year of Establish ment | Old Name of Firm |
|---|---|---|---|---|---|---|
| | 87~90 | 91~97 | | | | |
| Semicon-ductor | 3834 | 321 | HYUNDAI ELECTRONICS IND. CO.,LTD. | listed (96) | | |
| | | | LG SEMICON CO.,LTD. | listed (96) | | GOLDSTAR ELECTRON CO.,LTD |
| | | | SAMSUNG ELECTRONICS CO.,LTD. | listed | | |
| Petrochem-ical | 3511 3512 3513 3515 | 241 | SAMSUNG GENERAL CHEMICAL CO.,LTD | unlisted | | |
| | | | HYUNDAI PETROCHEMICAL CO.,LTD. | unlisted | 1988 | |
| | | | SK CORPORATION | listed | | YUKONG LIMITED |
| | | | LG CHEMICAL LTD. | listed | | LUCKY LTD. |
| Auto | 38431 | 341 | HYUNDAI MOTOR CO. | listed | | |
| | | | DAEWOO MOTOR CO.,LTD. | unlisted | | |
| | | | KIA MOTORS CORPORATION | listed | | |
| | | | SAMSUNG MOTORS | unlisted | 1995 | |
| Aerospace | 3845 | 353 | SAMSUNG AEROSPACE INDUSTRIES LTD. | listed | | |
| | | | HYUNDAI SPACE & AIRCRAFT CO.,LTD. | unlisted | 1994 | |
| | | | DAEWOO HEAVY INDUSTRIES LTD. | listed | | |
| Railway Vehicle | 3842 | 352 | DAEWOO HEAVY INDUSTRIES LTD. | listed | | |
| | | | HYUNDAI PRECISION AND INDUSTRY CO.,LTD. | listed (89) | | |
| | | | HANJIN HEAVY INDUSTRIES LTD. | listed | | |
| Power-generator/ Ship-engine | 3821 3829 3831 3841 | 291 311 351 | SAMSUNG SHIPBUILDING AND INDUSTRY CO.,LTD. | listed (94) | | |
| | | | HYUNDAI HEAVY INDUSTRIES CO.,LTD. | unlisted | | |
| | | | KOREA HEAVY INDUSTRIES AND CONSTRUCTION CO.,LTD. | unlisted | | |

(Table Continue)

**TABLE 4**

LIST OF SAMPLE INDUSTRIES AND FIRMS

| Industry | Korea Standard Industry Classification 87~90 | Korea Standard Industry Classification 91~97 | Name of Firm | Listed or Unlisted | Year of Establish ment | Old Name of Firm |
|---|---|---|---|---|---|---|
| Oil refining | 353 | 232 | HYUNDAI OIL CO.,LTD. | listed | | |
| | | | HANHWA ENERGY CO.,LTD. | listed | | |
| | | | LG CALTEX OIL REFINERY CO.,LTD. | unlisted | | |
| | | | SSANGYONG OIL REFINING CO.,LTD. | listed | | KYUNGIN ENERGY CO.,LTD. |
| | | | SK CORPORATION | listed | | HONAM OIL REFINERY CO.,LTD. |
| Electronic | 3832<br>3833 | 293<br>322<br>323 | SAMSUNG ELECTRONECS CO.,LTD. | listed | | |
| | | | DAEWOO ELECTRONICS CO.,LTD. | listed | | |
| | | | DAEWOO TELECOM CO.,LTD. | listed | | |
| | | | LG ELECTRONICS INC. | listed | | GOLDSTAR CO.,LTD. |
| | | | HYUNDAI ELECTRONICS IND. CO.,LTD. | listed (96) | | |

the least square dummy variable approach can be extended to include a firm-invariant time-specific effect as well. Statistical inferences of estimated coefficients of an extended model with a time dummy variable are not significantly different from statistical inferences of the estimated coefficients of the preceding model without a time dummy variable.

The variables used in this analysis are as follows.

- ***EXCA***, a dependent variable representing the estimated percentage of a firm's unutilized capacity. Excess capacity is the unutilized capacity of a firm's planned maximum capacity. The economic definition of planned maximum capacity refers to a firm's short-run minimum average cost output under the assumption that labor and raw materials are available as needed. Following the empirical model of Esposito *et al.* (1974), I assume that the designed maximum capacity at which firms prefer to operate approximates the short-run minimum average cost definition of economic capacity. The excess capacity variable indicates what percentage of capacity is under-utilized according to the economic norm of excess capacity. Numerical values of excess capacity are calculated using the following equation.

***EXCA***=(planned maximum capacity measured in money − actual output measured in money)/planned maximum capacity measured in money×100.

· ***GROWTHSA***, growth rate of sales, which is the percentage change in demand fluctuation for each firm. This variable, deflated by the producer price index, measures the degree of demand shocks.[9] All else equal, we would expect excess capacity to be negatively correlated with this variable.

· ***INVEST***, a ratio of the growth rate of tangible fixed asset in the current period to the growth rate of sales in the preceding period. This variable is a control for the degree of under-investment and over-investment in the current period against the growth rate of sales in the preceding period.[10] It is assumed that firms forecast the size of sales in the current year based on the size of sales in the previous year. Then, it can be presumed that firms will determine the size of investment in the current year by taking into account the forecasted size of sales. This variable is designed to control for the effect of errors in demand forecasting on excess capacity. Other things being equal, unutilized capacity is likely to rise if the size of demand forecasting error increases. We would expect the estimated coefficient of ***INVEST*** to be positive.

· ***KASA***, a tangible fixed asset/sales ratio as a measure of a firm's capital intensity. Since investment is likely to be lumpier in capital intensive industries, capital stock may increase by an amount greater than that required by a permanent increase in demand. It may also not be easy to reduce capital stocks quickly or by the appropriate amount when demand decreases. Thus, we would expect a positive relationship between excess capacity and

[9]The data for the producer price index was collected from the Annual Ecomonic Statistics issued by the Bank of Korea.

[10]Investment decision may be endogenously made. Investment and the level of excess capacity mat be simultaneously determined in a single system. Hausman specification test reveals that the ratio of the growth rate of tangible fixed asset in the current period to the growth rate of sales in the preceding period is an exogenous variable.

the tangible fixed asset/sales ratio. On the contrary, since the ratio of fixed to variable costs is relatively high in capital intensive industries, firms in these industries may reduce prices more quickly during periods of declining demand in order to avoid significant amounts of unutilized capacity. I.O. folklore tells us that the temptation to renege on price agreements may be particularly strong during business downturns for firms bearing a heavy fixed cost burden. Then, we would expect a negative relationship between excess capacity and the tangible fixed asset/sales ratio. So we need to identify the value of the estimated coefficient for this variable in order to find out whether a negative relationship between two variables dominates a positive relationship.

- ***GROWTHSA*KASA***, an interactive variable between the growth rate of sales and the tangible fixed asset/sales ratio. This interactive term captures the differences in demand influenced by the level of capital intensity.
- ***ENTRY***, a dummy variable capturing the effects of strategic investment for entry deterrence on the level of excess capacity. This variable's value is one for the year just prior to the one in which a new firm actually enters the market, and zero for all other years.[11] This study only deals with the cases where incumbents accommodate new entries in the end. Even though there may theoretically be cases where incumbents successfully deter a potential new entry, I did not observe such cases in the sample industries.
- ***TIGHT***, a dummy variable to control for the effects of market structure on excess capacity. This variable's value is one if a firm operates in a tight oligopolistic industry where the three-firm concentration ratio is 70 or above, and zero if it operates in a partial oligopolistic industry where the three-firm concentration ratio is less than 70.[12]

[11]There were three industries where a mew firm entered the market over the sample period: the petrochemical industry (HYUNDAI PETROCHEMICAL CO. in 1988), the auto industry (SAMSUNG MOTORS CO. in 1995), and the aerospace industry (HYUNDAI SPACE & AIRCRAFT CO. in 1994). The year of 1994 when SAMSUNG MOTORS CO was legally established, is chosen as a base year because the Korean government officially blocked Samsung's entry in April of 1994 and finally changed its position in November of the year to allow the company's entry in the auto industry. Some investments take several years to consummate. I will try to enlarge construction span to $t$-2. However, the estimation result is not changed.

### *C. Model Specification Test*

First, I test the hypothesis that firm-specific effects do not exist. Under the null hypothesis that the constant terms are equal, the efficient estimator is pooled least squares. The F-statistic (7,242) for the pooled OLS model vs. the fixed effect model is 3.43, rejecting the OLS on pooled data at the 1% significance level.[13] Thus, firm specific effects need to be considered in the empirical estimation. The null hypothesis that the firm specific effects are uncorrelated with the other regression variables is also tested to identify the validity of the random effects model. If the firm-specific effects are correlated with the other explanatory variables, then the estimated coefficients based on the random effects model are not consistent. $\chi^2(6)$ in the fixed effects model vs. the random effects model is 32.54, rejecting the null hypothesis that the firm specific effects are not correlated with the other explanatory variables. I also statistically check the heteroscedasticity that disturbances have a different variance across firms. $\chi^2(24)$ is 22.25, not rejecting, even at the 50% significance level, the null hypothesis that disturbances have the same variance across firms. In addition, multicollinearity between measured variables is also statistically verified. We can conclude that multicollinearity, affecting the precise analysis of explanatory variables, can be ignored based on the eigenvalue, the numerical values of $\eta_i$, and the variance proportion. $\eta_i$=(maximal eigenvalue/*i*th eigenvalue)$^{1/2}$. The general principle states that if $\eta_i$ is greater than 30 and the value of the variance proportion is high, a multicollinearity problem exists. The statistics in Table 5 show that the values of $\eta_i$ and the variance proportion are very low.

[12]This classification of market structure follows Esposito *et al.* (1974). According to this classification, five sample industries are tight oligopolistic industries; the semiconductor, auto, aerospace, railway vehicle, and power-generator/ship-engine industries.

[13]The $F$ ratio used for the test is

$$F(n-1, nT-n-K) = \{((R^2_u - R^2_p)/(n-1))/((1-R^2_u)/(nT-n-K))\}$$

$R^2_u$: sum of squared residuals for the fixed effect model; $R^2$: sum of squared residuals for the pooled OLS model; $(nT-n-K)$: degree of freedom for the fixed effect model; and $(n-1)$: and degree of freedom for the pooled OLS model.

**TABLE 5**

$\eta_i$ AND THE VARIANCE PROPORTION

| No. | Eigen-value | Variance Proportion | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $\eta_i$ | GROW-THSA | INVEST | KASA | GROW-THSA* KASA | ENTRY | TIGHT |
| 1 | 1.36590 | 1.20757 | 0.1550 | 0.2368 | 0.0259 | 0.2504 | 0.0031 | 0.0015 |
| 2 | 0.17278 | 3.39530 | 0.0036 | 0.0000 | 0.0027 | 0.0062 | 0.0083 | 0.9057 |
| 3 | 0.99703 | 1.41340 | 0.0061 | 0.0194 | 0.5929 | 0.0006 | 0.3293 | 0.0000 |
| 4 | 0.92809 | 1.46496 | 0.4146 | 0.2002 | 0.0952 | 0.0631 | 0.1611 | 0.0146 |
| 5 | 0.83052 | 1.54863 | 0.3330 | 0.0728 | 0.1061 | 0.2555 | 0.3361 | 0.0017 |
| 6 | 0.71390 | 1.67033 | 0.0805 | 0.4701 | 0.1558 | 0.4230 | 0.1200 | 0.0098 |

## IV. Empirical Results and Implications

The estimated ***GROWTHSA*** coefficient, as expected, is negative and statistically significant at the 1% level. It is clear that the scale of excess capacity moves in the opposite direction with changes in demand. Evaluated at the mean value of ***KASA*** (67.08%), $\partial EXCA/\partial GROWTHSA = -0.2066$. The level of excess capacity in sample firms is found to be sensitive to firm-specific demand shocks.

The estimated ***INVEST*** coefficient is positive and statistically significant. Firms are assumed to forecast the size of sales in the current year based on the size of sales in the last year. Then, it can be presumed that firms will determine the size of investment in the current year by taking into account the forecasted size of sales. Excess capacity increases if facility investment in the current year rises much compared with the increase in sales in the preceding year. In this case excess capacity is interpreted as ex-post excess capacity due to demand forecasting errors.

The annual average growth rate of sales in "Big Deal" industries over the sample period of 1988-98 was 23.48%. Despite such a remarkable increase in demand, the existence of chronic excess capacity in five industries suggests that firms' expectations of future demand is very optimistic, and thus firms actively engaged in the excessive enlargement of production capacity. During the first half (1988-93) of the sample period, the tangible fixed asset/sales ratio was 63%, and during the second half (1994-8) the ratio rose to 77%. Excessive facility investment resulting from

**TABLE 6**

FIXED EFFECTS MODEL WITH INTERACTIVE TERMS

| Explanatory Variable | Estimated Coefficient | Standard Error | T-value | Prob>\|T\| |
|---|---|---|---|---|
| GROWTHSA | -0.10817 | 0.03142 | -3.443 | 0.0007 |
| INVEST | 0.00486 | 0.00069 | 7.731 | 0.0001 |
| KASA | -0.03101 | 0.01944 | -1.595 | 0.1119 |
| GROWTHSA*KASA | -0.00147 | 0.00050 | -2.916 | 0.0039 |
| ENTRY | 12.95303 | 5.72682 | 2.262 | 0.0246 |
| TIGHT | 2.04743 | 2.36765 | 0.865 | 0.3880 |
| Obs. | 255 | | | |
| $R^2$ | 0.3131 | | | |
| F Value | 20.372 | | | |
| Prob>F | 0.0001 | | | |

optimistic demand forecasting during the second half of the sample period, including the business bubble of 1994-6, was observed. It is also noteworthy that over-investment can originate from other institutional factors. In countries with advanced market institutions, the profitability and the competitiveness of firms are key barometers to determine the success or failure of firms. However, in countries with poor market infrastructure, firms' external size plays an important role in bargaining with financial institutions and the government. Under this incentive structure, firms often pursue a size maximization strategy, which may result in excessive investment.

The estimated ***KSAS*** coefficient is negative and statistically significant. Since firms and industries characterized by relatively high capital intensity usually bear a heavy fixed cost burden, the fixed costs per unit matters in business slumps. Even if the demand conditions are not actually bad in "Big Deal" industries, firms in these industries facing chronic excess capacity over a long period of time may have an incentive to spread high fixed costs over more units of output. In this process, an increase in firms' output causes oversupply in the market, triggers a price-cutting war among competing firms, and results in declining profits. Indeed, five industries with structural excess capacity recorded low rates of return.[14] Evaluated at the mean value of ***GROWTHSA*** (67.08%),

[14]For example, the average current profit rate during the sample period

$\partial EXCA/\partial KASA = -0.0655$. Empirical results with respect to the tangible fixed asset/sales ratio in this study are in essence the same as F. and L. Esposito's study in which the tangible fixed asset/value-added ratio was used as a control variable for capital intensity. As mentioned in section III, investment is likely to be lumpier in capital intensive industries. Thus, it may not be easy to reduce capital stocks quickly, or by the appropriate amount, when demand decreases. However, statistical results show that the indivisibility effect of investment turns out to be dominated by the fixed cost effect.

The estimated ***GROWTHSA*KASA*** coefficient, which captures the differences in demand influenced by the level of capital intensity, is negative and statistically significant. Note that $\partial^2 EXCA/(\partial GROWTHSA\ \partial KASA) = -0.00147$. In other words, an increase in capital intensity leads to lower excess capacity based on demand effects since firms have an incentive to raise their capacity utilization rates to spread high fixed costs over more units of output, particularly in economic downturn.

The positive and statistically significant ***ENTRY*** coefficient indicates that incumbent firms maintain excess capacity to strategically deter new entries. After controlling for other effects, we find that unutilized capacity rises by 12.95% on average when there is a potential entry. This statistical result verifies the theoretical inference that an excess capacity strategy may enable incumbents to threaten to expand output and cut prices following entry, thereby making entry unprofitable. It is also worth noting that this statistical result may be partially attributable to incumbents' exploitation of entry regulation policies. In cases where new entry is strictly prohibited by law, incumbent firms have no incentive to retain excess capacity to deter potential competitors. However, most entry regulations are administered in such a way that the government prohibits some entries and permits others at its own discretion. Under this incentive structure, potential entrants might lobby for a permit to enter a market and incumbents might maintain excess capacity to signal to the government that new entries would lead to redundant investments and deepen the excess capacity problem. In this study it is inferred that an excess

was -2.16% for the auto industry, -0.26% for the aerospace industry, and -0.06 for the railway vehicle industry.

capacity strategy is exercised as a double strategy. One strategy is to utilize excess capacity as a commitment value to deter potential entry. The other is to exploit excess capacity as a justification for entry regulations.[15]

The estimated ***TIGHT*** coefficient is positive and not statistically significant. This empirical result is not consistent with Esposito *et al.*'s statistical evidence that partial oligopolies experience significantly more excess capacity during periods of growing aggregate demand than do tight oligopolistic industries. All else equal, for oligopolistic industries with high sales concentration the collective action to share maximal industry profit or to form a focal point on the optimal level of investment among competing firms is more likely to happen. In tight oligopolistic industries one might expect a rather smooth adjustment toward the new long-run equilibrium capacity level given an increase or decrease in demand. The statistical results in this study, contrary to the general expectation, imply that tacit investment coordination does not work well in tight oligopolistic industries.[16] Thus, it is not surprising that chronic excess capacity exists in tight oligopolistic industries such as automobiles, aerospace, railway vehicles, and power-generators/ship-engines.

## V. Summary and Concluding Remarks

The yearly average growth rate of sales for "Big Deal" industries over the sample period is almost double the yearly average growth rate of sales for the manufacturing sector. Despite such favorable conditions on the demand side, the number of years in which capacity operating rates fell short of the 75% benchmark, defined as the capacity operating rate in economic downturns, is shown to be high for the auto, aerospace, railway vehicle, and power-generator/ship-engine industries. This statistical evidence indicates that structurally excessive capacity due to continual over-investment far in excess of growing aggregate demand over the sample period has existed for the above-mentioned industries. The

[15]As of 2001, entry regulation is exercised in 115 four-digit level manufacturing industries.

[16]This empirical results may be attributed to the small sample size in a restricted set of heavy industries.

level of excess capacity turns out to closely reflect demand shocks, after controlling for the effects of other explanatory variables. Nevertheless, reckless facility investment due to overly optimistic demand forecasting in the second half of the sample period (1994-8), including the business bubble period of 1994-6, is observed.

From the statistical analysis in this study, we can conclude that it is not feasible to attain the policy goal of successful industrial restructuring by way of governmental intervention as a tool for resource allocation since the government can not ex-ante control a variety of strategic behavioral patterns on the part of competing firms in an oligopolistic industry. For example, firms and industries with structurally high capital intensity or long-term chronic excess capacity usually have high fixed costs. Thus, they have a strategic incentive to spread high fixed costs over more units of output. In this case, the government cannot forcefully control firms' strategic behavior in response to changes in the business environment, and its ex-post intervention in line with industrial policy may inevitably distort efficient resource allocation.

A firm's strategic decision to maximize profits subject to the constraints existing in its business environment must be a rational behavior at the firm level even if it may bring about excess capacity at the industry level ex-post. The statistical results in this study verify the theoretical inference that an excess capacity strategy may enable incumbents to threaten to expand output and cut prices following a competitor's entry, thereby making entry unprofitable. It is also worth noting that this statistical result is partially attributable to incumbents' exploitation of entry regulation policies. Incumbents seek to influence governmental entry regulations by intentionally keeping a certain level of excess capacity whenever a potential competitor tries to enter the market. If this inference holds true, entry deregulation will significantly reduce incumbents' incentives to take such actions and engage in socially wasteful expansions of facilities.

The statistical result showing that the estimated ***TIGHT*** coefficient is positive and not statistically significant is contrary to general expectations. This empirical result shows that tacit investment coordination does not work well among competitors in tight oligopolistic industries such as the auto, aerospace, railway vehicle, and power-generator/ship-engine industries. As a result, we can observe chronic excess capacity in these industries. However, the so called "Big Deal" policy to clear up chronic excess capacity is going too far in the sense that these business swaps, and mergers and acquisitions, may considerably deepen market concentration in relevant markets and thus significantly impair fair competition. It might be more desirable to allow a temporary cartel to be formed, for example in the form of autonomous output and investment coordination among competing firms, until the markets get back on the right track. However, institutional improvements in corporate governance of firms and in the credit assessment system of financing industry, leading to strengthened market discipline, are the most effective and essential remedies for the chronic excess capacity problem in the long run.

## Appendix

**APPENDIX 1**

FIXED EFFECTS MODEL WITH INTERACTIVE TERM AND TIME DUMMY

| Explanatory Variable | Estimated Coefficient | Standard Error | T-value | Prob>\|T\| |
|---|---|---|---|---|
| GROWTHSA | -0.11299 | 0.03187 | -3.546 | 0.0005 |
| INVEST | 0.00488 | 0.00061 | 8.048 | 0.0001 |
| KASA | -0.02103 | 0.01894 | -1.110 | 0.2681 |
| GROWTHSA*KASA | -0.00156 | 0.00050 | -3.145 | 0.0019 |
| ENTRY | 9.55895 | 5.83317 | 1.639 | 0.1026 |
| TIGHT | 1.81597 | 2.27288 | 0.799 | 0.4251 |
| 1990 | -4.13198 | 4.98834 | -0.828 | 0.4083 |
| 1991 | -5.99836 | 4.92611 | -1.218 | 0.2245 |
| 1992 | -3.74463 | 5.01250 | -0.747 | 0.4558 |
| 1993 | -9.10298 | 4.94060 | -1.842 | 0.0666 |
| 1994 | -22.08962 | 4.79585 | -4.606 | 0.0001 |
| 1995 | -13.77812 | 4.82655 | -2.855 | 0.0047 |
| 1996 | -11.49770 | 4.77812 | -2.406 | 0.0169 |
| 1997 | -10.01537 | 4.81317 | -2.081 | 0.0385 |
| 1998 | -11.71659 | 4.93592 | -2.374 | 0.0184 |
| Obs. | 255 | | | |
| $R^2$ | 0.3687 | | | |
| F Value | 10.297 | | | |
| Prob>F | 0.0001 | | | |

**APPENDIX 2**

FIXED EFFECTS MODEL WITHOUT INTERACTIVE TERM AND WITH TIME DUMMY

| Explanatory Variable | Estimated Coefficient | Standard Error | T-value | Prob>\|T\| |
|---|---|---|---|---|
| GROWTHSA | -0.12182 | 0.03232 | -3.769 | 0.0002 |
| INVEST | 0.00534 | 0.00060 | 8.916 | 0.0001 |
| KASA | -0.02562 | 0.01923 | -1.332 | 0.1840 |
| ENTRY | 9.10113 | 5.93792 | 1.533 | 0.1267 |
| TIGHT | 2.08174 | 2.31281 | 0.900 | 0.3690 |
| 1990 | -2.24470 | 5.04259 | -0.445 | 0.6566 |
| 1991 | -4.52988 | 4.99354 | -0.907 | 0.3652 |
| 1992 | -1.38773 | 5.04671 | -0.275 | 0.7836 |
| 1993 | -6.02048 | 4.93086 | -1.221 | 0.2233 |
| 1994 | -20.85632 | 4.86713 | -4.285 | 0.0001 |
| 1995 | -11.21870 | 4.84436 | -2.316 | 0.0214 |
| 1996 | -10.28550 | 4.84957 | -2.121 | 0.0350 |
| 1997 | -7.95141 | 4.85534 | -1.638 | 0.1028 |
| 1998 | -10.50868 | 5.01087 | -2.097 | 0.0370 |
| Obs. | 255 | | | |
| $R^2$ | 0.3454 | | | |
| F Value | 10.610 | | | |
| Prob>F | 0.0001 | | | |

**APPENDIX 3**

FIXED EFFECTS MODEL WITHOUT INTERACTIVE TERM AND TIME DUMMY

| Explanatory Variable | Estimated Coefficient | Standard Error | T-value | Prob>\|T\| |
|---|---|---|---|---|
| GROWTHSA | -0.11563 | 0.03178 | -3.638 | 0.0003 |
| INVEST | 0.00529 | 0.00062 | 8.513 | 0.0001 |
| KASA | -0.03549 | 0.01967 | -1.804 | 0.0724 |
| ENTRY | 13.27615 | 5.81104 | 2.285 | 0.0232 |
| TIGHT | 2.24927 | 2.40189 | 0.936 | 0.3499 |
| Obs. | 255 | | | |
| $R^2$ | 0.2925 | | | |
| F Value | 22.083 | | | |
| Prob>F | 0.0001 | | | |

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