Productive Efficiency of Chaebols and Non-Chaebol Firms in Korea: Stochastic Production Frontier Estimation using Panel Data

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Abstract

This paper first compares productive efficiency of chaebols and non-chaebol firms in Korea. The first contribution of this paper lies in that we have treated each chaebol group as a single entity consisting of tens of affiliated firms. This is important since affiliated firms in a business group are not really independent firms in Korea. They are subject to centralized control, evaluation and resource allocation. Using a rigorous econometric technique and utilizing the advantage of panel data models, we have found that the average level of productive efficiency of chaebols is lower than that of non-chaebols although the difference is not significant. When we divide chaebols into the top 4 and the bottom 18 chaebols in terms of asset size, the top 4 chaebols are shown to be significantly less efficient than average non-chaebol firms. When we divide the non-chaebols into the superior and the inferior in terms of productive efficiency, chaebols are shown to be significantly less efficient than the superior non-chaebol firms.

We have also found that estimated productive efficiency is an important determinant of profitability. When we control for productive efficiency, the capital-labor ratio, the debt-equity ratio, and asset growth, profitability of chaebol's is shown to be significantly lower than that of non-chaebol firms. We claim that such lower profitability in chaebols has to do with their pursuit of growth through acquisition of assets.

1. Introduction

Nowadays, such company names as Samsung, Hyundai, Daewoo, and LG are representative of the whole Korean economy. Chaebols have been the backbone of the economy and their combined share in the economy is substantial. While nobody can doubt their past contributions to the rapid growth of the Korean economy, the chaebols are now criticized as being responsible for the 1997 Korean economic crisis leading to the IMF emergency loans. Actually, even before the unfolding of the crisis in late 1997, early 1997 saw the successive bankruptcy of several chaebols. The post-crisis corporate reform has fuelled again the long lasting debate on the relative efficiency of the chaebol and non-chaebol firms in Korea.[1]

There is no doubt that Korean chaebols are a variant of the business groups in general. Business groups are somewhat common throughout the world and their importance has been increasingly recognized in the literature. Granovetter (1995) defines business groups as those collections of firms bound together in some formal and/or informal ways, characterized by an intermediate level of binding, namely neither bound merely by short term strategic alliances nor legally consolidated into a single entity. The Korean chaebols fit into this definition, and are also consistent with Strachan (1976)'s definition as there are strong personal and operational ties among the member or affiliate firms in a chaebol.[2]

As noted in the literature, specific forms the business groups take in each country vary depending upon not only economic but also political and legal conditions of the countries. In the case of Korea, protected domestic market, state-controlled banking sector, and active industrial policy by the government have been so far important influencing factors for the development of chaebols. In this paper the term, chaebol, is used to indicate the whole business group as a unit consisting of numerous member or affiliate companies. The terms *member firm, group-affiliate firm, or chaebol firm (or company)*, are used interchangeably to refer to an individual firm belonging to a chaebol business group.

[1]. For earlier debate on chaebols, see Steers, Shin and Ungson (1989), Cho (1992) and Jeongand Yang (1992).

[2]. This is how Strachan (1976) distinguishes the typical American conglomerate from business groups. In the case of the former, component companies are acquired and divested mainly on financial grounds and there are few operational or personal ties among the member firms. Thus, conglomerates are inherently unstable. Recited from Granovetter (1995).

These affiliate firms are legal persons and are often listed in the stock market and are inter-locked by circular share-holdings, whereas a business group or chaebol itself is not a legal person.

There exists a large volume of literature on the empirical analysis of the economic performance of chaebols, although most of these studies are in Korean. The literature can be divided into two types. One type examines the performance of chaebols using chaebol data only (for instance Chang and Choi 1988), without comparing chaebols and non-chaebol firms. The other type is the comparative analysis of chaebols vs. non-chaebol firms. Most of the previous studies including Choi and Cowing (1999), use data on individual member firms when they conduct comparative quantitative analysis of chaebols vs. non-chaebol firms. Typically, researchers have used the data on firms listed in Korean stock markets. Such analysis compares performance of the firms belonging the business groups (usually top 30 chaebols) with the performance of other firms. However, it would be more useful and meaningful to treat each business group as a single firm considering the affiliated firms as something similar to divisions in an M-form firm. This makes sense since, although each is a separate legal person and is separately listed, affiliated firms in a chaebol do not enjoy managerial autonomy. They are different from independent companies.

Thus, in this paper, we treat each business group as a single entity and for this purpose, we use the consolidated financial statement of the group that puts together all of the financial statements of the member firms canceling out within-group transactions.[3] This cancellation is very important as it enables us to obtain data on the real size of the output values and profits and so on, which are substantially smaller than the simple summation of the outputs and profits of the member firms.

The analyses in this paper utilize 4-year panel data to estimate stochastic frontier production functions in order to compare technical efficiency of chaebols and non-chaebol firms. This methodology is useful since it allows one to get an estimate of productive efficiency of individual firms. Also using panel data allows us to tackle the problem of possible endogeneity of capital or labor input variables. The results show that chaebols are in general less efficient than non-chaebol firms.

The following section explains the data and basic features of chaebol and non-chaebol firms.

[3]. Lee and Han (1997) is one of the few works which carries the group-level analysis. However, they do not compare chaebol vs non-chaebol firms. They investigate the relationship between diversification and profitability using only business group data. While Jeong and Yang (1992) has compiled some useful data on the top 30 chaebols, they do not analyze these data to compare chaebol and non-chaebol firms. Cho (1992) has collected much useful information, and carried out some preliminary analyses.

Sections 3 and 4, present the estimation methods and results. Discussion of the results follows in the final section.

2. Defining Chaebol as a CMS firm

In Korea, chaebols are usually perceived as family-controlled business groups. One important feature of the chaebols is that the actual share of the controlling families is quite small. It is usually around 10 percent in the case of top 30 chaebols. La Porta, de-Silanes, and Shleifer (1998) and Bebchuk, Kraakman, and Triantis (1999) find that such firms with controlling minority structures (CMS), as in the case of Korean chaebols, are widespread around the world. In the controlling minority structure firm, a shareholder exercises control while retaining only a small fraction of the equity claims on a company's cash flow. Such a radical separation of control and cash flow rights can occur in three principal ways: through a dual-class share structure, stock pyramids, and cross-ownership ties. These three methods are exactly what are used by the Korean chaebols. Table 1 shows the share composition in the chaebol firms. On average, the owner and relatives own only about 10 percent of eyaity in the top 30 business groups. More than 30 percent of the stocks are owned by other member firms in the same chaebol group. However, these stock cross-holdings are mutual among the firms comprising the chaebol. For example, firm A in a chaebol group owns a share of firm B worth 100 million Won, firm B owns a share of firm C worth 100 million Won, and finally firm C owns a share of firm A worth 100 million Won. These 100 million Won shares do not represent any real asset. It is merely a paper asset existing only in the accounting system. However, this paper asset contributes to maintenance of control by the family owners and relatives. As Table 1 shows, the sum of the shares owned by the owner-relatives and the member firms are as high as 44 percent in the 30 largest chaebols in Korea. In the way, the owner-families were able to keep control over a large number of the member firms with only a fractional share of real financial capital invested in these firms.

The CMS structure a resembles controlled structure in that it insulates the controller from the market for corporate control, but it resembles dispersed ownership in that it places corporate control in the hands of an insider who holds a small fraction of equity (Bebchuk, Kraakman and Triantis 1999).[4] The nature of the agency costs of the controlling families in the chaebols is interesting and also important because the CMS threatens to combine the incentive problems associated with both the

[4]. In a controlled structure a large block holder owns a majority or large plurality of a company's shares.

controlling structure and the dispersed ownership in a single ownership structure, as was noted by Bebchuk, Kraakman and Triantis (1999).

One kind of agency cost in the CMS firm has to do with fact that CMS firms tend to acquire, or enter into, businesses which are often not justifiable in terms of returns on investment. A theoretical model presented in Bebchuk, Kraakman and Triantis (1999) provides a persuasive reason for this behavior. The model explains why inefficient projects are chosen and unprofitable expansions are pursued under CMS. The basic idea of the model is as follows: suppose that there are two alternative projects, each of which produces a cash flow (S) (available to all shareholders) and a private control benefit (B) in different combinations. Then, between the two alternative projects, the model shows that the probability that the project generating bigger private benefits is chosen increases sharply as α decreases (α is cash flow rights of the controlling minority shareholder).[5]

Another model in Bebchuk, Kraakman and Triantis (1999) shows that given any distribution of opportunities to expand and contract, the likelihood that a CMS firm will make an inefficient decision--and thus incur the expected agency cost--grows larger as the controller's equity stake becomes smaller.[6] In this modelas as well the deciding factor is the magnitude of private benefits accruing to the controller when he keeps or acquires the asset. Often, private benefits tend to come from self-dealing or appropriation opportunities. In the Korean context, typical private benefits take the form of arbitrary and preferential borrowing from the firms and many kinds of outright cash payments to the controlling shareholders. These models suggest that the unique agency cost structure of the CMS firms pushes chaebols to pursue growth.

Each year the Korean Fair Trade Commission designates the top 30 business groups in terms of asset size and puts them under special monitoring and restrictions. These 30 groups are perceived as representing the so-called chaebols. Firms Then, what are the real differences between the top 30 "chaebols" and the "non-chaebols", given that most of the "non-chaebols" are also family-owned and controlled? For example, how can we say the 30th group is a chaebol but the 31st is not,

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[5]. For example, with a value of α as 10 % and B as 5 % of V, a controller will reject the efficient project unless the value gap between the two projects is more than 27%.

[6]. A controller will prefer to expand (or not to contract) a firm if $\alpha(V-B) + B > P$, where P is the buying or selling prices of the asset. For example, with a value of α as 10% and B = 5% of V, the controller will refuse to sell the asset unless the firm receives a price 45% higher than the real value of the asset to the firm. Equivalently, the controller will acquire the asset unless the price is more than 45% higher than its real value to the firm.

simply relying on the criterion of asset size? As a matter of fact, people sometimes talk about the top 60 or 75 business groups in Korea. Furthermore, many firms in Korea take the form of a business group. In a sense, all firms are chaebols. In this case, how can we conduct any meaningful comparison of chaebol vs. non-chaebol firms?

To tackle these problems, and to define chaebols meaningfully, we rely on the concept of CMS firms. A firm with substantial owner-manager share holdings is not taken as a chaebol; it is a firm of the controlling structure, and in this type of firm, the agency cost problem cannot be serious. Specifically, we take as chaebols those business groups with a very high ratio of affiliate firms' share holdings to the owners' share holdings. In our empirical analysis, we adopt a ratio of 70 percent of ratio as the dividing line.[7]

Although it sounds somewhat arbitrary, this criterion enables us to classify business groups with a somewhat high share held by owner-families into non-chaebols, although they belong to the top 30 chaebols. Table 1 presents the shares held by the owner families and the affiliate firms. There are 8 business groups belonging to the top 30 that we classify as non-chaebols; Dong-ah, Dong-yang, Mi-won, Halla, Kukdong Refinery, Tongil, Hanbo, and Poongsan. In most of these cases, the owners shares range from 25 to 65 percent, and the shares held by affiliate firms range from negligible to 18 percent.

As was said earlier, it is important to treat affiliate firms in a business group not as independent firms but as divisions in an M-form firm, and thus, to treat each business group consisting of tens of affiliated firms as a single business entity. Therefore, we need a consolidated balance sheet for each group. The only available and reliable source of the consolidated statements of the chaebols is one compiled by the KIS (Korea Credit Investigation Services) for the period of 1986-1989. Table 2 illustrates the reason for using the consolidated balance sheet rather than simple summing up of each balance sheet of the affiliate firms; there are substantial double-counting problems in the latter case. For example, table 2 shows that simple sum of profits of each group is substantially larger than true values shown in the consolidated balance sheets.

Our database consists of 222 firms, which include the 30 business groups and 192 independent firms. Out of the top 30 business groups, 22 are treated as chaebols and the remaining 8 as

[7]. To exclude rare cases with a higher than 70 percent ratio of the affiliate firms' shares to the owners' share but with a very low shares held by affiliated firms, such as 1 percent, we also put an additional restriction on the definition of chaebols that the shares owned by the affiliated firms should be at least 10 percent.

non-chaebols. Thus, the total number of the non-chaebols firms in the sample is 200. Actually, we had a data of 289 firms listed in the stock market. Out of these 289 firms, 97 firms are member firms of the top 30 business groups, and the remaining 192 firms are independent firms. Of course, among the non-top-30 business groups, some may have listed two or more of their member firms in the stock market. We have checked on this possibility, and it turns out to be very remote.

Table 3 presents some basic features of these firms. The 22 chaebols are further classified into the top 4 and bottom 18 in terms of their asset size. Most importantly, it is shown that the size gap between chaebols and non-chaebols is huge. The same is true between the top 4 and bottom 18 chaebols. Thus, it seems to be meaningful to compare three kinds of firms: the top 4 chaebols, the bottom 18 chaebols, and the non-chaebols. We will also try to divide the non-chaebols into two groups, the superior and the inferior, and each of them will be compared with the two types of chaebols.

3. Methodology

3.1. Stochastic Production Function

To compare the productive efficiency of the chaebol and non-chaebol firms, we estimate the following stochastic frontier production function (Aigner et al. 1977; Bauer 1990).

$$\ln Y_{it} = \alpha_0 + \alpha_L \ln L_{it} + \alpha_K \ln K_{it} + v_{it} - u_{it}, \qquad i = 1 \ldots N, \quad t = 1 \ldots T. \tag{1}$$

Here, i indexes firms and t indexes years. Y_{it}, L_{it}, and K_{it} are output, labor input, and capital input, respectively. A simple Cobb-Douglas production function is assumed.

The function $\alpha_0 + \alpha_L \ln L_{it} + \alpha_K \ln K_{it}$ is a production frontier that gives us a maximum expected amount of (log) output from a given input vector when there is no technical inefficiency. The disturbance term consists of two components: v_{it} represents pure statistical noise in production, whereas the term u_{it} represents technical inefficiency, capturing the gap between the frontier and actual production. The bigger the term u_{it}, the lower the technical efficiency. We assume that $u_{it} \geq 0$ with a probability of one.

If v_{it} and u_{it} are independent not only over time but also across firms, then the panel data formulation has no advantage over the cross-sectional formation. But if we make further assumptions about the property of the inefficiency, we can find some merits in the panel data analyses. Assuming that u_{it} is time-constant, we obtain

$$\ln Y_{it} = \alpha_0 + \alpha_L \ln L_{it} + \alpha_K \ln K_{it} + v_{it} - u_i \ , \qquad i = 1 \ldots N, \quad t = 1 \ldots T. \qquad (2)$$

Equation (2) is a familiar panel data model, except that the mean of the inefficiency term, u_i, is not equal to zero due to the assumption $u_i \geq 0$. So rewrite equation (2) as follows:

$$\begin{aligned} \ln Y_{it} &= \alpha_0 - E[u_i] + \alpha_L \ln L_{it} + \alpha_K \ln K_{it} + v_{it} - (u_i - E[u_i]) \\ &= \alpha_0^* + \alpha_L \ln L_{it} + \alpha_K \ln K_{it} + v_{it} - u_i^* , \qquad i = 1 \ldots N, t = 1 \ldots T. \qquad (3) \end{aligned}$$

Now $E[u_i^*] = 0$ and we can apply the standard panel data estimation technique. Using panel data has several advantages over cross-section models as pointed out by Schmidt and Sickles (1984). For instance, we can estimate the efficiency level of each firm. Also, we need not assume that the firm-specific level of inefficiency is uncorrelated with the input levels. Later we will discuss these issues more thoroughly.

If we treat u_i as a firm-specific constant, equation (3) can be estimated by ordinary least squares after adding dummy variables for each firm (as in a "fixed effect" model). Alternatively, one can use a "mean-deviation" operation and get the "within estimator," which is exactly the same as the fixed effect estimator. Then, firm specific efficiencies can be derived from the firm specific mean residual values.

Let lower case letters represent log output and log inputs for convenience. Averaging each term in equation (2) over time, we obtain

$$\bar{y}_{i\bullet} = \alpha_0 + \alpha_L \bar{l}_{i\bullet} + \alpha_K \bar{k}_{i\bullet} + \bar{v}_{i\bullet} - u_i \ . \qquad (4)$$

By subtracting (4) from (2) we get

$$(y_{it} - \bar{y}_{i\bullet}) = \alpha_L (l_{it} - \bar{l}_{i\bullet}) + \alpha_K (k_{it} - \bar{k}_{i\bullet}) + (v_{it} - \bar{v}_{i\bullet}) \qquad (5)$$

Finally we obtain the "within estimator" by applying the OLS estimation method to equation (5).

We can also treat u_i as a random variable and apply the GLS estimation method to equation (3) (a "random effect" model). The estimation consists of two steps. In the first step, we estimate the variance-covariance of the disturbance term in equation (3). It is

$$\text{Var}(v - u) = \text{var}(v_{it}) \cdot \Omega = \text{var}(v_{it}) \cdot [\, I_N \otimes [M_0 + \frac{1}{\theta^2} P_0]\,], \tag{6}$$

Where v is an NT × 1 vector defined as $v = (v_{11} \; \ldots \; v_{1T} \ldots v_{N1} \; \ldots \; v_{NT})'$, u is defined similarly as $u = (u_1 \; \ldots \; u_1 : u_N \; \ldots \; u_N)'$, I_N is an N by N identity matrix, ⊗ is the Kronecker product operator, M_0 is a mean deviation operator defined as $M_0 = I - \frac{1}{T} 1 \cdot 1'$ with 1 being a T x 1 vector of ones, P_0 is a mean extraction operator defined as $P_0 = \frac{1}{T} 1 \cdot 1'$, and θ is defined as $\left[\frac{\text{var}(v_{it})}{\text{var}(v_{it}) + T * \text{var}(u_i)} \right]^{1/2}$.

In order to render the GLS estimation feasible, we only need to compute θ. Note that $\Omega^{-1/2} = I_{NT} - (1-\theta) I_N \otimes P_0$. The form of $\Omega^{-1/2}$ says that the GLS transformation is to apply a (1-θ) fractional mean deviation to each observation. By applying OLS estimation to equation (5), we obtain the within group estimator, and to equation (4), the between group estimator. The variance components, $\text{var}(u_i)$ and $\text{var}(v_{it})$, are computed using the sum of squared residuals from these two regressions.

$$\text{var}(v_{it}) = SSE_w / N(T-1), \quad \text{and} \quad \text{var}(u_i) = SSE_b / N - \text{var}(v_{it})/T, \tag{7}$$

where SSE_w, SSE_b are the sum of squared residuals obtained from within estimation and between estimation, respectively.

In the second step, we apply OLS to the following transformed equation. The resulting estimator is called the random effect estimator.

$$\hat{y}_{it} = \theta\alpha_0 + \alpha_L \hat{l}_{it} + \alpha_K \hat{k}_{it} + \hat{v}_{it} - \theta u_i \;, \tag{8}$$

where $\hat{z}_{it} = z_{it} - (1-\theta)\bar{z}_i$ and $z_{it} = y_{it}, l_{it}, k_{it}, v_{it}$.

The random effect estimator is more efficient than the fixed effect estimator under the assumption that the right hand side variables are all exogenous. The fixed effect estimation suffers from the loss of degrees of freedom when there are many cross-sectional units as in our data set. But one crucial difficulty in random effect estimation arises when the right side variables are not all exogenous. Because inputs are chosen in an optimal way by firms, right hand side variables are less likely to be exogenous. If a firm knows its level of efficiency, it is natural to think that the firm should adjust its input choices according to that knowledge, resulting in correlation between inputs and u_i.

We cannot use the rationale suggested by Zellner et al. (1966) to interpret the disturbance term in a production function as unexpected shocks. Under their formulation, the disturbance term does not affect the input choices and there arises no endogeneity problem. In our model, Zellner's rationale can only be applied to v_{it} which, as pure white noise, lies beyond the firm's control. But there is no compelling reason to assume that u_i is uncorrelated with input levels : technical inefficiency of an individual firm doesn't change over time, so a firm is likely to know its inefficiency level and to choose the input levels taking into account this information.

Within estimation has an important advantage in this regard. It need not to assume that firms' inefficiencies are uncorrelated with the input levels. It is because the within transformation in (5) gets rid of the problematic u_i term. Note that in the GLS transformed equation in (8), u_i still exists and potentially causes the endogeneity problem. But the within estimator has some defects. If there are time-constant covariates, such as managerial characteristics or location, the within estimator cannot identify these effects because all time-invariant variables are eliminated by the within transformation. Another defect is the within estimator is not fully efficient since it ignores variation between firms.

3.2. Hausman and Taylor's IV/GLS estimator

Hausman and Taylor (1981) propose a more satisfactory estimator. Assume that some regressors are correlated with u_i but others are not. Using the Hausman and Taylor (HT, hereafter) procedure we can get a more efficient estimator and also estimate the coefficients of time-invariant covariates.

To apply HT's so-called IV/GLS estimation procedure, one needs to classify covariates into exogenous and endogenous cases. This classification affects the estimation results. However, an important feature of the HT approach is that the validity of the classification can be tested. The HT's IV/GLS estimation method applies the IV estimation procedure to equation (8) using as instruments all exogenous variables themselves and the mean deviations of all covariates.

We can test the null hypothesis that a certain subset of regressors is exogenous by comparing two different estimators. The within estimator is consistent even when all regressors are correlated with u_i. At the other extreme, the GLS estimator (random effect estimator) is consistent only when all regressors are uncorrelated with u_i . HT's IV/GLS estimator lies in between. It is consistent when the a prior chosen subset of regressors is uncorrelated with u_i .

For example, comparing the within estimator with the GLS estimator, we can test the null hypothesis that the u_i are uncorrelated with all regressors. Comparing the within estimator with HT's IV/GLS estimator, we can test the null hypothesis that the u_i are uncorrelated with the a priori chosen subset of regressors. Using Hausman's (1978) specification test idea, we can easily notice that the variances of the difference of two estimates can be written as the variance of the inefficient estimator minus the variance of the efficient estimator under the null hypothesis. The within estimation is less efficient, whereas the GLS estimator is most efficient. HT's IV/GLS estimator again lies in-between.

3.3. Rescaling the data : Controlling the aggregate size effect

Our sample is composed of a few large sized chaebols and many small sized non-chaebol firms. On average, chaebols are much bigger than non-chaebols (table 3). Due to this difference in firm size, we cannot treat our sample firms as homogeneous. Without adequately controlling the size effect, inefficiency by firm size will be confounded with scale economies or diseconomies.

Let us take an example. Suppose that chaebols are less efficient than non-chaebols, and that the production technology exhibits constant returns to scale in both chaebol and non-chaebol firms. When we pool the chaebol and non-chaebol firms, we may spuriously obtain a production function which shows decreasing returns to scale. It is because inefficiency of chaebols may be wrongly captured through scale diseconomies. As a result, chaebol firms would not necessarily turn out to be inefficient.

The above example clearly indicates that the size effect and the efficiency level are confounded, creating an identification problem. Then what are the causes of this identification problem? Size has two channels to affect production. One is through production technology. Under decreasing returns to scale, for example, chaebol firms produce less outputs than non-chaebol firms per unit input. The other channel is through the efficiency level. In this paper, we allow that chaebol and non-chaebol firms to differ in their inefficiency levels. Therefore the size difference in inefficiency level is confounded with the size effect due to technology.

Although these two effects play an important role in reality, we have no natural way of handling these two effects separately. So we should make a choice, that is, we should concentrate on estimating one effect after blocking out the other effect. Our choice is to get rid of the size effect due to technology. To handle this problem, we propose to rescale the size of each firm to have a unit size. Let s_i denote the i-th firm's size. The rescaled production function is

$$\frac{y_{it}}{s_i} = \alpha_0 + \alpha_L \frac{l_{it}}{s_i} + \alpha_K \frac{k_{it}}{s_i} + v_{it} - u_i \tag{9}$$

Once all input and output data are divided by firm size, there remains only the difference in relative input-output ratios across sample firms. So the systematic size difference between chaebol and non-chaebol firms is now eliminated. In terms of these rescaled data, chaebol firms do not necessarily take larger values of inputs and outputs than non-chaebol firms. Have we made the right choice? We believe so, considering un-related diversification of Korean chaebol firms. A big combined size has nothing to do with economies of scale or scope if the combination is over unrelated industries.

Korean chaebol firms are characterized by the well-known "unrelated diversification". The typical growth strategy of Korean chaebol is characterized by entry into many different industries that have no distinct relationship with each other. (See Table 1 showing the number of affiliates and the number of industries for the Korean chaebols.) We can neither think that the capital input in the chemical industry raises the efficiency of capital inputs in the construction industry due to the economies of scale, nor think that there are synergy effects between the labor inputs in the steel industry and labor inputs in the department store business. So we reasonably assume that Korean chaebol's huge size is not directly related to gaining efficiency by expanding their size and/or enjoying synergy effects by entering into a related industry.

Rather, Korean chaebols are better regarded as simply a collection of many firms under one group name which are not highly related with each other in terms of production strategy. For example, when we refer to the input or output of Hyundai or Samsung, what we actually mean is the summation, after cancelling out within-group transactions, of the input or output of thirty to forty affiliates which are spread from the amusement park business to semi-conductors, or from life insurance to automobiles. Note that in our empirical anelyses, each chaebol enters into the study as a single firm.

Suppose that a chaebol consists of ten affiliates of the same size, say unit size, and that all non-chaebol firms are also of the unit size. The input and output level of the chaebol is the summation of those ten affiliates, after within-group transactions are cancelled out. What we use for this calculation is simple summation, so the chaebol seems to produce ten units of output from ten units of input (assuming no cancellation). When each chaebol affiliate is equally efficient as non-chaebol firms, whether we rescale the chaebol group data or not, we will get the same result.

However, when there is difference in the level of efficiency between chaebol affiliates and non-chaebol firms, rescaling matters a lot. For example, suppose that chaebol affiliated firms are less efficient than non-chaebol firms of the same size. That is, the combined output of the chaebol as a whole is less than ten times the output of a typical non-chaebol firm. In this case, without rescaling the data, we will obtain a spurious, decreasing returns to scale production function, and chaebol firms would not seem to be inefficient. This is quite misleading because the ten chaebol firms are all of unit size (no scale effect) and they are operating in unrelated industries (no scope effect). To prevent this distorted image, we have decided to rescale the data. Only after rescaling, we can expect to obtain a meaningful efficiency comparison between chaebol and non-chaebol firms in Korea.

Through this rescaling, we can block out the size effect, which doesn't seem to exist in the Korean chaebol context or at least matters less than the efficiency issue, and concentrate on the inefficiency comparison between chaebol and non-chaebol firms. This identification issue has not been treated adequately in the literature because most existing studies focus on a single industry: Cornwell, etc. (1990) on the U.S. airline industry, Kumbhakar (1988) on the U.S. railroad industry, and Ferrier and Lovell (1990) on the U.S. banking industry, for example.

A benefit of our rescaling approach is that the inefficiency estimate of each firm is less sensitive to the economy of scale estimate, $\alpha_L + \alpha_K$. The reason is that chaebols are not necessarily bigger in terms of rescaled input levels. Previously, what makes the inefficiency level so sensitive to the size effect was that all chaebols are much larger than non-chaebols. Our approach is particularly useful when the estimate of $\alpha_L + \alpha_K$ is not robust to different estimation methods.

Practically, we rescale our data by dividing all inputs and output by the logarithm of asset size averaged over the sample years for each firm. Therefore, our data consists of inputs and output per unit size. Also, this approach has another advantage in alleviating heteroskedasticity of the error terms resulting from size differences.

4. Results

4.1. Estimating the production frontier

We have obtained the following result by estimating equation (9). The output is value-added, inputs are labor and capital, and all variables are divided by the logarithm of asset size.

Table 4 above gives the results of various models for our sample. In each case the coefficients of labor and capital inputs and the overall constant term are reported. The t-values are in parentheses.

The last row reports the value of Hausman's specification test statistic, which is defined as

$$(\beta_{within} - \beta_a)' \cdot (Var(\beta_{within}) - Var(\beta_a))^{-1} \cdot (\beta_{within} - \beta_a), \quad (10)$$

where "a" denotes alternative estimators, a = GLS, IV/GLS I, and IV/GLS II.

In the first column of table 4, we present the within estimates of the production frontier. Note that the labor coefficient is above twice the size of the capital coefficient. The second column shows the GLS estimates. The labor coefficient from the GLS estimation is much different from the corresponding within estimate. Comparing the within and GLS, estimates we test the hypothesis that both labor and capital inputs are uncorrelated with the firm specific inefficiency level u_i. Under the null hypothesis, the test statistic follows a chi-square distribution with two degrees of freedom. Since the Hausman statistic is 17.55, we reject the null. This rejection implies that we may not treat both labor and capital inputs as exogenous variables. Therefore one or both of our regressors are suspected to be correlated with u_i.

Since we do not have any persuasive reasons a priori to identify the variable that is endogenous, we have to examine each case in turn. First let us consider the case that one input level is correlated with u_i and the other is not.

In the third column of table 4 we present IV/GLS estimates assuming labor input is exogenous and capital input is endogenous. Note that the coefficients are very similar to the GLS estimates rather than the within estimates. The last row reports the Hausman test statistic, which tests the null hypothesis that labor is exogenous. Under the null, the test statistic is distributed according to a chi-square distribution with one degree of freedom. The statistic takes a value of 15.79, so we reject the null. This means that labor input may not be treated as exogenous.

The fourth column displays the IV/GLS results assuming capital is exogenous and labor is endogenous. Note that the result is very similar to the within estimates. To test the null hypothesis that capital is uncorrelated with u_i, we compute the Hausman statistic in the last row. Under the null, the test statistic is distributed as a chi-square distribution with one degree of freedom. The critical point of the null distribution is 3.84 at 5% size. So we cannot reject the null hypothesis at the 5% significance level. Therefore the assumption that labor is endogenous and that capital is exogenous looks reasonable.

What happens if both capital and labor inputs are endogenous? In our setting this implies that all the regressors are correlated with u_I and the model is 'just-identified'. In this case, the IV/GLS estimates are identical to the within estimates which have already been reported.

From the results above, we may reasonably assume that "labor input is endogenous and capital is exogenous," which assumption forms our 'benchmark model'. We further compare the benchmark model estimates with the GLS estimates to test the null hypothesis that labor input is exogenous given that capital is exogenous. Since the Hausman test statistic is 13.28, we reject the null. So we confirm again that labor is better treated as endogenous.

4.2. Comparing the inefficiency level across the chaebol and non-chaebol firms.

Once we estimate the production frontier, we can derive an estimate of the efficiency component of each firm as $\hat{\alpha}_i = \frac{1}{T} \Sigma_{t=1}^{T} (\frac{y_{it}}{s_i} - \hat{\alpha}_L \frac{l_{it}}{s_i} - \hat{\alpha}_K \frac{k_{it}}{s_i})$. Then

$$\text{plim } \hat{\alpha}_i = \text{plim } \frac{1}{T} \Sigma_{t=1}^{T} (\frac{y_{it}}{s_i} - \hat{\alpha}_L \frac{l_{it}}{s_i} - \hat{\alpha}_K \frac{k_{it}}{s_i}) = \text{plim } \frac{1}{T} \Sigma_{t=1}^{T} (\alpha_0 + v_{it} - u_i) = \alpha_0 - u_i$$

$$\text{since plim } \hat{\alpha}_L = \alpha_L, \quad \text{plim } \hat{\alpha}_K = \alpha_K, \text{ and } \text{plim} \frac{1}{T} \Sigma_{t=1}^{T} v_{it} = 0, \quad i = 1... N. \qquad (11)$$

The larger $\hat{\alpha}_i$, the greater the efficiency of firm i. Now, define the inefficiency level $\hat{u}_i$ as

$$\hat{u}_i = \max_{1 \le j \le N} (\hat{\alpha}_j) - \hat{\alpha}_i, \qquad i = 1 ... N. \qquad (12)$$

This definition implies that the most efficient firm in the sample is 100% efficient (a zero inefficiency level) and all the other firms have positive inefficiency levels. Using the estimates from our benchmark model, we compute $\hat{u}_i$ using equation (12). Table 5 reports the estimates of the inefficiency level and the efficiency ranking of the chaebol firms. Note that the total number of firms in our sample is 222.

According to table 5, the (unweighted) average inefficiency level of the 22 chaebols is 0.129 which means that the average chaebol firm is about 13% less efficient than the most efficient firm. This value is very close to the average inefficiency level of the non-chaebol firms. The top 4 chaebols of Hyundai, Daewoo, Samsung, and LG appear to be less efficient that the next 18 chaebols. To check on the statistical significance of the differences between the various sub-groups of chaebol and non-chaebols, we run regressions of the inefficiency level on a constant term and a group dummy variable, which takes the value of one for firms classified along the columns and zero for firms classified along the rows. We can test the significance of the coefficient estimate of the dummy variable using a t-test. To compute robust standard errors of the estimates, we adopt White's heteroscedasticity consistent covariance formula. Table 6 shows our results.

First of all, the difference between chaebols and non-chaebols turns out to be insignificant, with a t-value of only 1.526. However, when compared with the superior half of the non-chaebol firms (those with less than average inefficiency level), chaebols turn out to be 3.4% less efficient.

Second, when we divide the 22 chaebols into the top 4 and the bottom 18 in terms of asset size, we obtain more interesting results. The top 4 chaebols are shown to be significantly less efficient than the non-chaebol firms, whereas the top 4 chaebols are not significantly different from the inferior half of the non-chaebol firms.

Third, the inefficiency difference between the bottom 18 chaebols and the non-chaebols is not significant. However, the bottom 18 chaebols are shown to perform significantly poorer than the superior half of the non-chaebols, but significantly better than the inferior half.

Last, the top 4 chaebols are shown to be about 2% less efficient than the bottom 18 chaebols.

In sum, the efficiency comparison suggests the following order of efficiency among the various subgroups of firms. From best to worst, superior non-chaebols, bottom 18 chaebols, and finally top 4 chaebols and inferior non-chaebols.

5. Discussion: Asset Growth, Productive Efficiency and Financial Efficiency in a CMS Firm

Low productive efficiency of chaebols, exogeneity of capital inputs and endogeneity of labor inputs, is consistent with our view of chaebols as CMS firms. Given higher agency costs, the chaebol firms tend to acquire more and more assets without due consideration of returns, and to adjust only labor inputs endogenously. Such a behavioral pattern is consistent with the hypothesis of higher growth propensity and low profitability of chaebols vis-a-vis non-chaebol firms. Table 7 first checks the difference between chaebol and non-chaebol firms in annual growth rates of several variables. Among others, annual growth rates of assets and sales in chaebols are shown to be significantly higher than in non-chaebol firms. The table also compares several indicators of profitability. In most cases, chaeobol's profitability is shown to be significantly lower than that of non-chaebol firms.

To compare profitability differences more rigorously, we run regressions of profitability on several variables. These regressions use the 4-year average value of variables. Thus, the number of observations is 222. The results are shown in table 8. Although one might say Tobin's q or other measures utilizing stock market performance are better measures of profitability, we cannot use them since many affiliates of chaebols are not listed in the stock exchange. Thus, we try two measures of profitability as dependent variables, the operating profits to assets and operating profits to sales. Table 8 presents the results when the dependent variable is the operating profit to asset ratio. The results with the other measure of profitability are basically the same (see the appendix table). Explanatory variables include the capital-labor ratio, the debt equity ratio, asset growth, a chaebol dummy, and the inefficiency level estimated previously.

First of all, the chaebol dummy is shown to be significantly negative, indicating lower profitability of chaebol firms. Although the earlier work by Chang and Choi (1988) reported higher profitability of chaebols relative to non-chaebol firms, more recent studies uniformly show lower profitability of chaebol firms. For example, Choi and Cowing (1999) and Jo (1998) shows such results in comparing individual group-affiliated firms and non-group firms. G. Lee (1999) estimates the group-affiliation premium in terms of profitability over the 1980s and 1990s and finds that the premium has decreased from positive values to negative values. Yoon (1998) estimates the long term trends of profitability of the Korean firms by size (small, medium and large-sized firms), and finds that before the late 1980s, profitability of large sized firms was higher than smaller-sized firms, whereas the opposite has been true since the 1980s. All these findings suggest that while chaebols might have been an effective institutional arrangement in the 1970s and up to the early 1980s, its superiority over non-chaeobls has continued to decline over the next decade.

Asset growth rates are shown to be significant and positively related to profitability. Given that asset growth rates, like sales growth, represent the growth propensity of the firms, this finding is not surprising and is consistent with the typical results reported in the literature. When we additionally include in the regression equation the interaction term between asset growth and chaebol dummy, the interaction term turns out to be negative and marginally significant. This suggests that in chaebol firms higher asset growth is negatively associated with profitability, which is consistent with our hypothesis that chaebols behave as CMS firms pursuing unjustifiable expansion.

The estimated productive inefficiency is also shown to be significant, and negatively related to profitability. This result naturally confirms the link between productive efficiency and financial efficiency. Next, the capital-labor ratio turns out to be negative and significant, which is consistent with the findings by Yoon (1998) that more capital intensive firms tend to show lower profitability.

The debt-equity ratio is negatively related to profitability. This seems to reflect the soft, not hard as in the standard textbooks, nature of debts and high agency costs of debt holders in the Korean context. Although additional variables capturing market power are typically included in profitability regressions, we cannot do that since most chaebols operate in many different markets.

6. Summary

This paper first compares the productive efficiency of chaebols and non-chaebol firms in Korea, using panel data covering the 1986-1989 period. The first contribution of this paper lies in that we have treated each chaebol group as a single entity consisting of affiliated firms. This is important since affiliated firms in a business group are not really independent firms in Korea. They are subject to centralized control, evaluation and resource allocation. Using a rigorous econometric technique and utilizing the advantage of panel data models, we have found that the average level of productive efficiency of chaebols is lower than that of non-chaebols although the difference is not significant. When we divide chaebols into the top 4 and the bottom 18 chaebols in terms of asset size, the top 4 chaebols are shown to be significantly less efficient than average non-chaebol firms. When we divide the non-chaebols into the superior and the inferior in terms of productive efficiency, chaebols are shown to be significantly less efficient than the superior non-chaebol firms.

We have also found that the estimated productive efficiency is an important determinant of profitability. When we control for productive efficiency, the capital-labor ratio, the debt-equity ratio, and asset growth, chaebol's profitability is shown to be significantly lower than that of non-chaebol firms. We claim that such lower profitability in chaebols has to do with their pursuit of unjustifiably high growth through acquisition of more and more assets.

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<Table 1> Share Composition and the Number of Affiliates in Chaebols & Non-chaebols

	chaebol	owner & relatives share	affiliates share	No. of affiliates	No. of listed affiliates
Hyun-Dae	1	20.98	28.57	28	9
Dae-woo	1	6.49	24.35	18	7
LG	1	5.00	30.20	44	8
Sam-sung	1	8.50	30.11	27	12
Ssang-Yong	1	6.45	35.95	15	7
Han-Jin	1	27.73	20.36	12	5
Han-Wha	1	6.61	29.60	17	6
Kukdong Const.	1	11.29	43.24	3	2
SK	1	12.62	22.94	13	3
Dae-Rim	1	5.72	17.07	12	5
Lotte	1	36.05	35.74	22	3
Kia	1	2.48	21.29	8	2
Dong-Kuk steel	1	21.22	37.70	10	4
Kum-Ho	1	16.31	14.20	10	5
Hyo-Sung	1	18.56	18.64	11	2
Doo-San	1	13.88	43.19	17	5
Han-il	1	23.91	28.35	11	5
Sam-mi	1	15.33	25.64	6	2
Dong-Bu	1	14.36	25.52	6	5
Kolon	1	4.57	37.92	12	4
Koryo textile	1	5.33	29.76	5	1
Hai-Tai	1	6.38	30.09	5	2
Dong-Ah	0	25.63	6.43	12	4
Dong-Yang	0	32.94	5.34	4	3
Mi-Won	0	33.67	10.70	14	2
Keuk-Dong oils	0	23.79	9.93	4	0
Halla	0	45.29	17.61	5	1
Tong-il	0	46.44	0.00	9	3
Han-Bo	0	69.27	0.00	3	0
Poong-San	0	37.43	3.54	2	1
22 chaebols (mean)		13.17	28.66	14.18	4.73
top 4 (mean)		10.24	28.31	29.25	9.00
other 18 (mean)		13.82	28.73	10.83	3.78
non-chaebol business groups (mean)		39.31	6.69	6.63	1.75

Notes: 1. As of 1989.
2. LG's data is not available, so we have taken it from Jeong & Yang (1992).

<Table 2> Consolidated vs Simple Aggregate Balance Sheet Data for Chaebols (hundred million won)

	sales			net profit		
	consolidated	aggregated	difference (%)	consolidated	aggregated	difference (%)
Hyun-Dae	105423	146466	27.36	1533	1642	7.93
Dae-woo	61047	83700	26.93	-736	-369	350.83
LG	78394	112217	30.20	1015	1386	26.96
Sam-sung	95321	137577	31.51	1345	1817	37.38
Ssang-Yong	28534	34024	16.25	661	703	10.24
Han-Jin	23785	24404	2.54	-277	-264	2.55
Han-Wha	17452	20033	13.09	114	148	10.17
Kukdong Const.	2284	2291	0.29	-172	-172	0.25
SK	42449	56496	24.95	761	836	9.65
Dae-Rim	10387	11088	6.28	14	27	30.78
Lotte	15806	18382	14.95	575	636	10.01
Kia	16785	21861	22.55	263	310	15.44
Dong-Kuk steel	11396	11977	4.84	198	208	8.85
Kum-Ho	6480	7109	9.47	116	140	12.80
Hyo-Sung	17358	19310	10.23	109	139	32.93
Doo-San	12691	15102	16.04	145	214	33.83
Han-il	8758	9451	7.37	-343	-292	37.47
Sam-mi	6390	10112	36.61	114	180	59.48
Dong-Bu	8979	10777	15.66	195	208	8.77
Kolon	11038	12553	12.13	170	195	13.02
Koryo textile	4247	5189	17.92	49	68	30.18
Hai-Tai	6582	6674	1.35	-13	-12	3.40
average (top 4)	85046	119990	29	789	1119	106
average (other 18)	13967	16491	13	149	182	18
average (all 22)	26890	35309	16	265	352	34

Note : 1986-1989 average values.

<Table 3> Basic Statistics of the Sample Firms (hundred million won)

A. By Type

		mean	median	s.d.	min	max	No. of obs.
whole sample	value-added	1022	188	3377	7	30424	222
	sales	4207	836	14413	41	125102	222
	asset	4217	793	13171	45	107455	222
	employment	4858	1245	15191	58	144086	222
22 chaebol	value-added	7589	4140	8232	847	30424	22
	sales	31777	16757	35830	2731	125102	22
	asset	31294	20342	30668	6740	107455	22
	employment	32052	15812	38917	2596	144086	22
top 4	value-added	23538	22214	5220	19301	30424	4
	sales	100472	102231	23036	72324	125102	4
	asset	90507	88892	13434	76788	107455	4
	employment	108770	100140	24886	90713	144086	4
other 18	value-added	4045	3290	2397	847	9846	18
	sales	16512	13294	11626	2731	50365	18
	asset	18135	14529	11029	6740	47166	18
	employment	15003	12479	8308	2596	32009	18
non-chaebol	value-added	299	161	471	7	4949	200
	sales	1175	745	1400	41	13139	200
	asset	1238	674	1853	45	18057	200
	employment	1866	1170	2391	58	18470	200

Note : 1986-1989 average values.

B. chaebol

	value added	sales	asset	employment
Hyun-Dae	30424	125102	107455	144086
Dae-woo	19301	72324	94405	91901
LG	19679	92566	76788	90713
Sam-sung	24749	111895	83380	108378
Ssang-Yong	7437	33735	33324	18380
Han-Jin	9846	28244	47166	29017
Han-Wha	5274	20668	21649	19601
Kukdong Const.	847	2731	7618	3542
SK	7770	50365	34351	20556
Dae-Rim	4236	12302	21412	12059
Lotte	5337	18441	22724	22622
Kia	5201	19645	22402	24377
Dong-Kuk steel	3058	13556	11813	10574
Kum-Ho	2706	7567	11279	9513
Hyo-Sung	3269	20452	14875	11939
Doo-San	4044	15072	14182	13243
Han-il	3310	10459	19272	32009
Sam-mi	2168	7547	11136	6570
Dong-Bu	2237	10628	8187	9250
Kolon	2784	13032	10708	11315
Koryo textile	1673	4994	7599	2596
Hai-Tai	1604	7777	6740	12898

<Table 4> Production Frontier Estimation. (dependent variable is value-added)

	within	GLS	IV/GLS (capital is endogenous)	IV/GLS (labor is endogenous)
labor	0.65 (7.97)	0.36 (9.83)	0.36 (9.7)	0.62 (7.79)
capital	0.26 (6.5)	0.29 (8.3)	0.3 (7.62)	0.24 (6.32)
constant	0.21 (3.91)	0.36 (10.22)	0.35 (9.23)	0.25 (5.24)
specification test		χ_2^2 = 17.55	χ_1^2 = 15.79	χ_1^2 = 2.87

Note : Within parentheses are t-values.

<Table 5> The Estimated Level of Inefficiency

	Inefficiency level	efficiency ranking out of whole 222 sample firm	efficiency ranking out of 22 chaebol (A)	asset ranking out of 22 chaebol firms (B)
Hyun-Dae	0.145	174	19	1
Dae-woo	0.151	185	20	2
LG	0.143	170	18	4
Sam-sung	0.141	165	16	3
Ssang-Yong	0.117	90	5	7
Han-Jin	0.134	142	14	5
Han-Wha	0.129	132	13	10
Kukdong Const.	0.122	112	10	20
SK	0.118	97	7	6
Dae-Rim	0.118	96	6	11
Lotte	0.136	148	15	8
Kia	0.141	166	17	9
Dong-Kuk steel	0.114	80	2	15
Kum-Ho	0.123	116	11	16
Hyo-Sung	0.127	127	12	13
Doo-San	0.115	83	3	14
Han-il	0.170	203	22	12
Sam-mi	0.116	86	4	17
Dong-Bu	0.119	99	8	19
Kolon	0.121	107	9	18
Koryo textile	0.089	37	1	21
Hai-Tai	0.154	189	21	22
average : chaebol	0.129	* spearman rank correlation coefficient between (A) and (B) : -0.431		
top 4	0.145			
other 18	0.126			
average : non-chaebol	0.122			
superior non-chaebol	0.094			
inferior non-chaebol	0.15			

<Table 6> Significant Test of Efficiency Difference

estimated coefficients of the chaebol dummy

chaebol vs non-chaebol	non-chaebol	superior non-chaebol	inferior non-chaebol
22 chaebol	0.006	0.034	-0.02
	(1.53)	(8.09)	(-4.56)
top 4	0.022	0.05	-0.005
	(6.95)	(17.17)	(-1.54)
other 18	0.003	0.031	-0.024
	(0.71)	(6.8)	(-5.02)

top 4 vs other 18 chaebols	bottom 18 chaebols
top 4 chaebols	0.019 (4.374)

Notes: 1. The t-values using White's formula are in the paratheses.
Notes: 2. Significant positive t-values mean that chebols are less efficient

<Table 7>

A. Growth, Profitability, and Productivity in Chaebols & Non-chaebols

		chaebol		non-chaebol		chaebol: top 4		chaebol: other 18		non-chaebol: superior		non-chaebol: inferior	
		mean	median	mean	median	mean	median	mean	median	mean	median	mean	median
growth rate	asset	0.114	0.114	0.094	0.093	0.133	0.138	0.110	0.108	0.091	0.096	0.097	0.088
	value added	0.133	0.104	0.090	0.099	0.157	0.147	0.128	0.102	0.091	0.099	0.088	0.100
	sales	0.071	0.049	0.058	0.059	0.083	0.055	0.068	0.049	0.052	0.063	0.063	0.054
	labor	0.044	0.052	0.006	0.014	0.053	0.059	0.042	0.052	0.012	0.018	0.000	0.005
	fixed capital	0.152	0.170	0.104	0.095	0.132	0.148	0.156	0.170	0.099	0.106	0.108	0.082
profit rate	operating income/asset	0.061	0.066	0.097	0.090	0.064	0.062	0.060	0.067	0.111	0.106	0.084	0.078
	normal income/asset	0.020	0.025	0.057	0.053	0.019	0.027	0.020	0.022	0.075	0.070	0.039	0.034
	operating income/equity	0.474	0.358	0.387	0.321	0.375	0.349	0.496	0.371	0.412	0.322	0.364	0.317
	normal income/equity	0.065	0.122	0.166	0.175	0.110	0.154	0.055	0.114	0.185	0.204	0.149	0.139
	operating income/sales	0.063	0.062	0.093	0.085	0.056	0.055	0.064	0.065	0.105	0.099	0.081	0.075
	normal income/sales	0.014	0.023	0.051	0.050	0.014	0.022	0.015	0.023	0.067	0.067	0.035	0.029
productivity	labor productivity	0.279	0.258	0.183	0.152	0.217	0.214	0.293	0.279	0.253	0.233	0.114	0.107
	capital productivity	0.500	0.471	0.617	0.562	0.527	0.552	0.494	0.455	0.679	0.649	0.555	0.502

B. Significant Test of the Mean Difference : "Chaebols" - "Non-chaebols".

		coefficient	t-value
growth rate	asset	0.043	2.346
	value added	0.013	0.553
	sales	0.038	2.895
	labor	0.047	2.082
	fixed capital	0.02	1.295

profit rate	operating income/asset	-0.036	-5.542
	normal income/asset	-0.036	-6.056
	operating income/equity	0.086	0.683
	normal income/equity	-0.101	-2.037
	operating income/sales	-0.03	-3.084
	normal income/sales	-0.036	-4.116

<Table 8> Determinants of profitability
(dependent variable is "operating profits / asset")

	constant	inefficiency	cap/lab	debt /equity	chaebol dummy	asset growth	chaebol*asset growth	R square
estimates	0.18	-0.60	-0.04					
t-value	16.10	-7.54	-5.28					
	***	***	***					0.25
estimates	0.18	-0.59	-0.04	0.00				
t-value	16.62	-7.50	-5.02	-2.31				
	***	***	***	**				0.27
estimates	0.15	-0.51	-0.03			0.07		
t-value	14.42	-6.36	-3.59			2.21		
	***	***	***			**		0.22
estimates	0.18	-0.61	-0.04	0.00		0.08		
t-value	16.19	-7.82	-5.45	-2.09		2.68		
	***	***	***	**		***		0.29
estimates	0.18	-0.57	-0.03	0.00	-0.02			
t-value	16.67	-7.34	-4.52	-2.20	-2.48			
	***	***	***	**	**			0.29
estimates	0.18	-0.59	-0.04	0.00	-0.02	0.09		
t-value	16.25	-7.67	-4.95	-1.96	-2.64	2.83		
	***	***	***	**	**	**		0.32
estimates	0.16	-0.51		0.00	-0.03	0.07		
t-value	14.76	-6.38		-2.42	-3.42	2.04		
	***	***		**	***	**		0.24
estimates	0.18	-0.60	-0.04		-0.03	0.09		
t-value	16.07	-7.72	-5.18		-2.74	3.01		
	***	***	***		***	***		0.30
estimates	0.18	-0.58	-0.03	0.00			-0.10	
t-value	16.59	-7.39	-4.78	-2.29			-1.40	
	***	***	***	**			*	0.28
estimates	0.18	-0.61	-0.04			0.10	-0.14	
t-value	15.94	-7.78	-5.47			3.16	-1.95	
	***	***	***			***	*	0.29

estimates	0.18	-0.60	-0.04	0.00		0.09	-0.13	
t-value	16.14	-7.73	-5.21	-2.03		2.97	-1.88	
	***	***	***	**		***	*	0.31

Appendix table: Determinants of profitability
(dependent variable is "operating profits / sales")

	constant	inefficiency	cap/lab	debt/ equity	chaebol dummy	asset growth	chaebol dummy*asset growth	R square
estimates	0.16	-0.48	-0.01					
t-value	11.26	-4.91	-1.61					
	***	***						0.10
estimates	0.16	-0.48	-0.01	0.00				
t-value	11.30	-4.85	-1.47	-1.12				
	***	***						0.11
estimates	0.15	-0.46	-0.01	0.00	-0.02			
t-value	11.27	-4.68	-1.06	-1.01	-2.08			
	***	***			**			0.13
estimates	0.15	-0.49	-0.02	0.00		0.06		
t-value	10.93	-4.98	-1.68	-0.98		1.49		
	***	***	*					0.12
estimates	0.15	-0.47	-0.01	0.00	-0.03	0.06		
t-value	10.89	-4.82	-1.28	-0.86	-2.16	1.59		
	***	***			**			0.14
estimates	0.16	-0.47	-0.01	0.00			-0.08	
t-value	11.25	-4.77	-1.32	-1.10			-0.88	
	***	***						0.11
estimates	0.15	-0.48	-0.01	0.00		0.07	-0.10	
t-value	10.85	-4.90	-1.53	-0.94		1.65	-1.14	
	***	***				*		0.12
estimates	0.15	-0.49	-0.02			0.07	-0.10	
t-value	10.82	-4.96	-1.66			1.75	-1.17	
	***	***	*			*		0.12
estimates	0.15	-0.48	-0.01	0.00		0.07	-0.10	
t-value	10.85	-4.90	-1.53	-0.94		1.65	-1.14	
	***	***				*		0.12