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ABSTRACT

This article decomposes the business-level profit rate of Japanese multi-business corporations by performing a variance components analysis on a large sample of publicly traded non-financial firms in 1998-2003. Consistent with U.S. evidence, estimation results demonstrate that profitability is predominantly determined by business-level factors, not corporate-level ones, suggesting that a typical multi-business corporation in Japan is a combination of relatively distinct businesses in terms of profit.

JEL classification: L23; L25

Key Words: Profitability; Variance component analysis; Diversification; Japan.

1. Introduction

Research has found that firm heterogeneity drives macro- as well as microeconomic phenomena importantly. Labor and industrial organization (IO) economists document that industry dynamics such as output, employment, and productivity growths are critically dependent on the heterogeneity of firms populating an industry (e.g. Davis et al., 1996; Sutton, 1997). Likewise, international economists have found that export and foreign direct investment flows are driven by firms that are more productive than industry peers (Helpman et al., 2004; Bernard et al., 2007). Though the literature abounds with evidence that firms are substantially different in economic performance, the origin of this heterogeneity is only imperfectly understood. Two strands of research have contributed to filling this gap. The first group of studies rooted in the IO tradition asks why profit rates fail to converge across firms even in the long-run and looks for product and factor market impediments to the competitive convergence. Recent contributions include Villalonga (2004) on U.S. firms and Maruyama and Odagiri (2002) on Japanese firms.

The second strand of research looks at the phenomenon very differently and stresses the fact that today's firms, especially large corporations, often operate in multiple industries. The profitability of such multi-business (diversified) corporations can vary because industries in which they operate are different in profit potentials, corporate-level factors are varying across firms (but constant across industries within a firm), and/or business-level (i.e. corporate-industry-specific) factors are varying from business to business even within a firm.[1] Research pioneered by Schmalensee (1985) and advanced by Rumelt (1991) has estimated the relative contribution of these factors to the dispersion of business-level profit rates. A robust finding from studies based on U.S. data is that business-level factors strongly

[1] Consistent with the literature, business in this article refers to the collection of operations a firm performs in a specific *industry*, not a business unit in the organizational sense, such as division and subsidiary.

dominate industry- and corporate-level ones in the determination of profit rates. This finding suggests that profitable multi-business corporations are typically average performers in most of their businesses. They perform excellently because they have a few “crown jewels” where they have exceptionally strong advantage unmatched by competitors. Firms that are superior performers in many businesses are rare. The finding also shows that intra-firm heterogeneity of productive efficiency can be as large as inter-firm heterogeneity despite the common use of firm-level data in many areas of empirical research to study the behavioral heterogeneity of productive organizations.

Does the profitability of multi-business corporations follow a similar dispersion pattern in Japan? Answering this question had been long infeasible because no business-level profit data was available from either firms’ financial statements or governmental statistics in Japan. However, new accounting standards introduced in the late 1990s required firms to disclose segment-level profits to investors.[2] Nowadays, large financial databases such as Nikkei NEEDS contain segment-level data that is comparable to the COMPUSTAT data widely used in the U.S. literature. In the present study, we capitalize on this development to provide the first comprehensive evidence on the profit rate dispersion of Japanese multi-business corporations.[3]

Our empirical method is a variance components analysis, simple but powerful technique introduced by Schmalensee (1985) to the literature. The sample is the population of publicly traded non-financial firms in 1998-2003. Estimation results reveal that the dispersion pattern of business-level profit rates in Japan is remarkably similar to that in the U.S. That is, the variance of profit rates is mostly brought about by business-level factors, not industry- or corporate-level ones. This finding explains a few stylized facts about the restructuring of

[2] Segment is a collection of similar/related businesses constructed for accounting and reporting purposes.
[3] Makino et al. (2005) has performed a variance components analysis on Japanese data but their focus is on foreign subsidiaries of multinationals, not the entire operation of domestic as well as multinational corporations.

Japanese firm after the late 1990s but also poses some puzzles to researchers. We will discuss these issues after presenting empirical results.

The plan of this article is as follows. The next section briefly reviews the literature. Our empirical method is presented in Section 3. Section 4 describes data in detail. Estimation results are reported in Section 5. Section 6 is for the discussion of empirical results. The final section concludes.

2. Literature

Schmalensee (1985) pioneered research of factors shaping the distribution of profit rates at the business-level. To estimate the relative importance (explanatory power) of corporate, industry, and business-specific factors in U.S. manufacturing, he performed a variance components analysis, simple but powerful technique to decompose data variation into components. His estimation based on the FTC's Line of Business cross-section data reveals that industry effects affecting all firms in the industry are by far the most important, suggesting that structural traits of industries in which firms operate are the most influential determinant of their profitability.

In reaching this conclusion, however, Schmalensee (1985) made a strong assumption that business-specific effects arose only though market share differences to overcome the dimensional constraint of cross-sectional data. This assumption was seriously challenged by Rumelt (1991) who performed a variance components analysis on the Line of Business panel data. He founds that, when business-specific effects are as comprehensively accounted for as industry effects, the former strongly dominates the latter in sharp contrast to Schmalensee's (1985) original finding. However, Rumelt (1991) agrees with Schmalensee (1985) in the point that corporate effects affecting all businesses within a firm are of negligible importance if any.

Since then, the decomposition of effects on profitability dispersion has been tried by many researchers including McGahan and Porter (1997, 1999, and 2002), McGahan (1999), and Kessides (1990). Not surprisingly, results vary depending on dataset, sample selection, and methodology. However, Rumelt's (1991) main conclusion that business-specific effects are the largest has been repeatedly confirmed by this literature.[4] Though corporate effects seem to be not so negligible as first claimed by Schmalensee (1985) and Rumelt (1991), the main driver of the profitability of multi-business corporations is at the business level despite the large literature on corporate-level strategy dating back to Penrose (1959) and Chandler (1962). In this article, we examine whether the profitability of multi-business corporations is similarly or dissimilarly distributed in Japan.

3. Variance Components Analysis

3.1. Model

To examine the dispersion of business-level profit rates, we assume the following model:

$$r_{ikt} = \mu + \alpha_i + \beta_k + \gamma_t + \delta_{it} + \phi_{ik} + \omega_{kt} + \varepsilon_{ikt}. \qquad (1)$$

In this specification, an annual business-level return r_{ikt} (year t return of industry i business of corporation k) is the sum of its overall mean μ and seven effects (deviations from the overall mean). There are three main effects (industry α_i, corporation β_k, and year γ_t), three interaction effects (industry-corporation δ_{ik}, industry-year φ_{it}, and corporation-year ω_{kt}) and an error term

[4] McGahan and Porter (2002) provide a more comprehensive review of the literature.

ε_{ikt}. One of the interactions is particularly important because industry-corporation is another name of business. Therefore, a specific business (of each corporation) is denoted *ik*, while an industry and a corporation are labeled *i* and *k*, respectively.

An important feature of our model is the nested structure of key effects. For instance, the business-specific effect δ is nested by higher-order industry (α) and corporate (β) effects. Because of this property, the conventional fixed effects regression (ANOVA) is unable to identify these effects unambiguously.[5] Following Schmalensee (1985) and Rumelt (1991) among others, we adopt a variance component approach and assume that all of the seven effects are randomly and independently generated with zero means and constant unknown variances. The independence assumption is not as constraining as it seems because all the interaction effects are taken into consideration in our specification in addition to the three main effects. Note also that we do not impose a parametric assumption such as normality.

Under the above assumption, the total variance of business-level profit rate can be decomposed into seven components:

$$\sigma_r^2 = \sigma_\alpha^2 + \sigma_\beta^2 + \sigma_\gamma^2 + \sigma_\delta^2 + \sigma_\phi^2 + \sigma_\omega^2 + \sigma_\varepsilon^2, \qquad (2)$$

where the right-hand side variables are variance components, variances of the seven random effects. We gauge the relative importance of an effect with the ratio of its variance component to the total variance. To estimate variance components, we adopt Henderson's Method I (Searle, 1971). This technique estimates variance components by equating the expected value

[5] The key concept, esitimability, is explained by Searle (1971, pp. 180-188). Incomplete estimability renders variance decomposition based on ANOVA sensitive to model specification and the order of variable entry. Moreover, ANOVA overstates the relative contribution of higher-order effects, which absorb some parts of lower-order effects. These problems are evident in our unreported ANOVA estimation results (available from the authors upon request).

of quadratic forms to sample counterparts and solving for the unknown population parameters (we relegate computational details to Appendix). Unlike the conventional regression analysis including ANOVA, this method of variance decomposition does not allow us to perform a significance test.[6] More parametric approaches overcoming this limitation are available in the methodological literature (Searle et al., 1992). However, these methods are difficult to implement on our data, which is unbalanced to the extreme as described in the next section. We therefore adhere to this more traditional approach adopted by Schmalensee (1985) and Rumelt (1991) in their pioneering works.

3.2. Remarks

Before proceeding, we make a few general remarks on profit rate decompositions. First, empirical isolation of variance components is at least to some extent data-dependent. For instance, the separation of industry and business effects is constrained by the precision of industry definition. In practice, industries for statistical classification popularly used in academic research, such as SIC and JSIC industries, are unlikely to match perfectly with economically meaningful “true” industries. The hierarchical structure of profit rate decomposition models implies that any measurement errors in industry effects are absorbed by lower-order business effects. In addition, the duration of observation can affect the relative importance of time-varying and constant effects. The balance would generally weigh more toward time-varying effects as the observation period increases because more factors become variable in the long-run.

Second, the variance component analysis is a purely descriptive method. It provides a compact and comprehensive summary of data variation but does not inform us why the

[6] Another weakness of Henderson’s Method I is that a variance component estimate can be negative even though variance is by definition non-negative. A common practice is to treat a negative estimate as a sign of misspecification and replace it with zero (Searle, 1971).

variation follows a specific pattern because factors causing the variation are not identified. Because of this property of variance component analysis, the interpretation of decomposition results can be ambiguous in non-experimental research such as ours. To mitigate this problem, we briefly describe theoretical factors to be captured by key effects in our model: i.e. industry (α), corporate (β), and business (ϕ)-specific effects.

Industry effects capture all factors similarly and stably affecting the profitability of all firms in the same industry. The industry structure variables traditionally studied in the IO literature such as market concentration, entry barriers, and differentiation are among the most likely candidates. Other structural determinants of industry profitability would include long-term demand growth, innovation opportunities, and regulations among others. The effect of short-run demand and supply shocks is captured by time-varying industry effects (δ).

Corporate effects capture all factors similarly and stably affecting a firm's businesses across industries. They are likely to be factors generating inter-business synergy because a positive corporate effect implies that the value of the whole (corporation) is larger than the sum of constituent parts (businesses).[7] Synergy can be operational or financial. Operational synergy arises if operating multiple businesses jointly in the same firm decreases (increases) the total cost (revenue) of these businesses. Resources sharable across businesses, such as proprietary technology and brand names, are the most fundamental driver of such economies of scope (Panzar and Willig, 1981). Financial synergy arises if diversification enhances a firm's ability to invest in positive NPV projects by increasing access to external capital and/or enabling a more efficient use of internally generated funds (Stein, 1997). Theoretically, synergy is the raison d'être of multi-business corporations. However, what corporate effects in a variance decomposition model represent (and what they do not) is a disputed issue in the

[7] A popular intuitive expression of synergy is 2+2=5.

literature (Bowman and Helfat, 2001). We will return to this issue after presenting empirical results.

Last, business effects capture all business-specific determinants of profit rates. The traditional competitive position variables in the IO literature such as market share and early-mover status are normally defined at the business-level, thus can differentiate profitability not only between but also within firms. Another important class of factors is business-specific resources, which Montgomery and Wernerfelt (1988) suggest are more important drivers of firm performance than resources sharable across many businesses. In practice, a resource sharable across narrowly defined businesses (e.g. refrigerators, microwave ovens, rice cookers, etc.) can be specific if these businesses are collectively defined as a business (e.g. household appliances). Depending on the empirical definition of industry/business, therefore, business effects in a variance component model can pick up synergy whose scope is limited to a subset of a firm's businesses.[8]

4. Data

We employ six-year panel data of non-financial segments of the universe of publicly traded Japanese firms excluding financial institutions from 1998 to 2003, which is provided by the Nikkei NEEDS financial QUEST database.[9] Nikkei NEEDS assigns up to three JSIC (Japan Standard Industry Classification) 4-digit codes to each segment reported in the annual reports (*Yukashoken Hokokusho*) submitted to the Ministry of Finance by each corporation. However, the disclosed segment information is usually too coarse to be reliably matched with a 4-digit JSIC code as Villalonga (2004) found out for U.S. firms in COMPUSTAT database. We therefore adopt the 3-digit rather than 4-digit code in assigning segment(s) to an industry.

[8] We appreciate the anonymous referee for directing our attention to this point.
[9] Although companies were required to report entity-based segment data for decades before 1998, disclosed segment information did not include operating income.

If a segment contains businesses of multiple 3-digit codes, we employ the code listed first by Nikkei NEEDS as it normally represents the segment's most important product. If multiple segments in a firm share the same 3-digit code thus assigned, we merge them into a single segment.

In the original data set, 33,990 observations with 408 3-digit industries and 3,151 firms have both segment income and asset data, which enables us to calculate return on assets (ROA). However, ROA ranges from -4,033 to 37,100 percents in this data set, which strongly suggests non-recurrent extraordinary situations and/or improper recording (reporting). We therefore eliminate 775 observations with ROA beyond 60 percent and below -50 percent. This elimination leads to 33,215 observations. Those eliminated are of a considerably smaller size and account for 0.08 percent of the total assets combined in the whole sample.

It is well known that the existence of single-business firms in a sample leads to the smaller corporate effects than those when only multi-business firms are included because the corporate effect in the former is set to zero in order to facilitate a separate identification of corporate and business effects (Bowman and Helfat, 2001). Because our main interest is in the relative contribution of three key effects to the profitability of multi-business corporations, our main sample excludes single-business firms. In addition, we exclude single-corporation industries (only one firm in an industry) but this elimination turns out to be without any material consequences.[10]

These considerations eliminate another 8,407 observations in total, leading to 24,808 observations as our main sample. Some descriptive statistics of these 24,808 observations are shown in Table 1. Our six-year data cover 335 industries and 1,712 corporations. Naturally the number of observations (24,808) is far smaller than the theoretical maximum (3,441,120

[10] Therefore, robustness checks based on the sample including single-corporation industries are not reported.

= 6 × 335 × 1,712), that is, unbalanced to the extreme. Because firms have nine 3-digit business segments at most and the maximum number of firms in an industry is 280, most cells are empty. The mean ROA (earnings before interest and taxes/operating assets) is 5.9 percent, while its standard deviation is 11.0 percent.

5. Empirical results

Table 2 shows the empirical results. Column (1) reports the estimation result of the full model with three main and three interaction components based on the main sample excluding single-business firms. We find that business effects overwhelmingly contribute to 53.1 percent of the total variance, while industry effects account for 5.0 percent, corporation 8.6 percent, year 0.3 percent, industry-year 1.6 percent, corporation-year 1.0 percent, and residual error 30.5 percent. As demonstrated in Columns (2)-(4), omitting one or two effects barely changes the picture. These results suggest that the relative importance of industry and corporate effects in the determination of company profit rate is not small, certainly not negligible, in Japan. However, they are clearly dominated by business-specific effects as earlier studies have found out for U.S. firms.

To check the robustness of the above finding, we examine alternative estimation samples. First, we omit non-manufacturing firms and non-manufacturing segments of manufacturing firms. This manufacturing only sample has 8,598 observations, roughly one third of the entire sample. Contrary to our initial expectation that there could be significant difference between manufacturing and non-manufacturing sectors, we obtain essentially the same results as shown in Column (5). The dominance of business effects (51.2 percent) remains, while both industry and corporate effects slightly decrease to 3.0 and 7.1 percent, respectively. The decrease of industry effects is consistent with the finding of McGahan and

Porter (1997) for U.S. firms that industry effects matter more in non-manufacturing industries. The decrease of corporate effects suggests that synergy is a bit more important differentiator of the performance of non-manufacturing firms.

Columns (6)-(8) perform three different robustness tests. Column (6) employs alternative ROA cut-off points. As reported, the change of cut-off points from -50 percent and 60 percent to -30 percent and 40 percent with the elimination of 783 observations (24,025 in total) does not change the overall picture at all. Column (7) uses coarser JSIC 2-digit classification reducing the number of observations to 22,174. The dominance of business effects (54.7 percent) remains but the contribution of industry effects decrease to 3.7 percent. This is unsurprising because aggregation of industries systematically lessens (increases) industry (business) effects (McGahan and Porter, 2005). Finally, we include single-business corporations and obtain similar results as shown in Column (8). While corporate effects (-0.3%) disappear as Schemalensee (1985) and Rumelt (1991) found out in their samples of U.S. manufacturing, the contribution of business effects increases to 60.7%.[11] These changes are unsurprising because we assume zero corporate effects for newly included single-business corporations as done in earlier research and persistent heterogeneity in these firms' profit rates is mostly captured as business effects.

6. Discussion

In interpreting the above results, we need to keep in mind two characteristics of our data. First, our observation period coincide with six years when the Japanese economy was extremely stagnant at low growth rates. We speculate that this unique economic background is partly responsible for the small contributions of time-varying effects in our decomposition

[11] As noted earlier, negative estimated values of variance sometimes occur with Henderson's Method I.

results.[12] The relative weights of constant and time-varying effects might be more balanced if one looks at Japan in a more normal state. Second, the contribution of business-specific effects can be somewhat inflated in our data because our industry classification, JSIC 3-digit, is relatively coarse.[13] As we noted earlier, a broad industry definition tends to increase (decrease) the variance component of business (industry) effects because measurement errors in industry effects are absorbed by lower-order business effects.

These reservations notwithstanding, it is worth emphasizing that our evidence on Japan is remarkably similar to U.S. evidence supplied by earlier authors in the point that business-specific effects dominate corporate-level ones in shaping the profitability dispersion of multi-business corporations. That is, the business-level profitability of firms operating in multiple industries is highly heterogeneous and only weakly correlated even within a firm. This finding is consistent with a few stylized facts about corporate restructuring in Japan around our observation period. First, refocusing was central to many firms' restructuring programs. If the profitability of a firm's businesses is only weakly correlated, the firm should be able to exit from a problematic business without worrying about adversarial effects on the remaining businesses. It is then unsurprising that an unprecedentedly large wave of closures, selloffs, and spinoffs arose in the late 1990s as firms exited from non-core businesses under the slogan "*sentaku to shuchu*" (choose and focus).

Second, restructuring often involved organizational reforms to increase the decision-making authority and responsibility of business-unit managers. These reforms include the reorganization of the entire firm into a holding company and subsidiaries and the adoption of

[12] Rumelt (1991) finds that the contributions of time-varying and constant industry effects are about the same size in a four-year panel of U.S. manufacturing.
[13] However, JSIC 3-digit is roughly comparable to the industry classification of FTC's Line of Business data, though it is clearly coarser than SIC and JSIC 4-digit.

"company system."[14] If businesses constituting a firms are mostly unrelated to each other as suggested by our data, their strategies and operations would require little coordination by headquarters. Increasing the autonomy of business units can therefore increase efficiency by speeding up decisions and operational responses with little adverse effects, if any.

Our results also pose a few puzzles. Researchers have long observed that Japanese and U.S. firms have very different diversification strategies in terms of motivation, growth direction, investment mode, etc. (e.g. Kagono et al., 1985; Prahalad and Hamel, 1990; Odagiri, 1992). Seen through the profitability lens, however, our results suggest that typical multi-business corporations in Japan and the U.S. are remarkably similar. Is this because the differences highlighted by earlier studies have diminished or are of little economic significance right from the start?[15] An even more perplexing puzzle is the rationale behind corporate diversification. If the performance of businesses constituting a firm is unrelated each other, why must they coexist in the same firm?

Readers interested in these controversial issues should keep in mind two limitations of our analysis. First, our random effects specification takes all managerial actions and decisions as exogenously given, though the performance of individual businesses is crucially preconditioned by the decisions and initiatives of corporate-level management. For instance, a business can never exist without the initial investment by corporate headquarters, which also develop and appoint managers who run the business. Because exogenous conditions in our model include factors deliberately set by managers, our estimation understates the role of corporate-level management in multi-business corporations.

Second, the corporate effect in a variance component model captures synergy only to

[14] The company system is a virtual subsidiarization of internal divisions to bestow division managers with the decision making right and responsibility that are comparable to those of a subsidiary president.

[15] See Itoh (2003) for a discussion on recent similarities and dissimilarities in the diversification behavior of Japanese and U.S. firms.

the extent that it increases the profitability of a firm's businesses similarly and simultaneously. However, we can imagine synergy that is more unbalanced on its effect on profitability. For instance, one business may unilaterally benefit form the existence of another business in the same firm by free-riding on the latter's investment in technology, brand name, distribution channels, etc. Because this one-way synergy increases only the profit of free-riding business, our model will capture it as a business-specific effect.[16] Synergy can be unbalanced in terms of timing as well. Consider financial synergy due to the internal capital market, which arises when excess cash flows earned in one business are reinvested in another with higher expected *future* returns (Stein, 1997). The timing of profitability increase is unlikely to be the same for the cash-flow generating and receiving businesses.

Because of these limitations, cautions are necessary to interpret results presented in this article. Nevertheless, the above puzzles should not be dismissed lightly because an indisputable fact about multi-business corporations is that their performance is generally low in Japan as in the U.S.[17] A large refocusing wave would not have occurred if economic benefits of diversification unidentified in our analysis were very large. Our results therefore suggest that more research on multi-business corporations is necessary to understand the existence and behavior of these economically influential organizations.

7. Conclusion

This article performs a variance component analysis to provide evidence on of the dispersion of business-level profit rates of Japanese multi-business corporations. We find that business-specific effects strongly dominate corporate- and industry-level effects as earlier

[16] As we note earlier, the business-specific effect can also pick up synergy whose scope is limited to a 3-digit business. However, unlike one-way synergy described above, this synergy does not explain why multiple 3-digit businesses coexist in a firm.

[17] The most tangible (and also disputed) evidence on this issue is the diversification discount in the corporate finance literature. See Lins and Servaes (1999) and Fukui and Ushijima (2007) for evidence on Japanese firms.

studies found out for U.S. firms. Though this finding explains a few stylized facts about the restructuring behavior of Japanese firms, it also poses some puzzles about multi-business corporations.

We conclude this article by pointing out an implication our results have for many areas of empirical research in common. Because the production unit customarily called firm in the standard economic theory operates only in one industry, its empirical counterpart for a multi-business corporation is the business, not the entire firm. Our finding that intra-firm heterogeneity of productive efficiency is as large as inter-firm heterogeneity suggests that gains from using data more disaggregated than that at the firm-level can be very large even for testing a theory of the “firm.”

Appendix

We have l_α industries, l_β corporations and l_γ years, while there are l_δ industry-year, l_φ industry-corporation (business) and l_ω corporation-year distinct combinations, respectively. That is, $l_\alpha = \#i$, $l_\beta = \#k$, $l_\gamma = \#t$, $l_\delta = \#it$, $l_\phi = \#ik$, and $l_\omega = \#kt$. If a distinct industry-corporation-year exists, $n_{ikt} = 1$ (0 otherwise). In total, we have N observations ($N = \sum_{i,k,t} n_{ikt} = \#ikt$). For each observation, we calculate returns on assets r_{ikt}.

Because the data is unbalanced to the extreme, we have to be careful in constructing moments. Different from the case of balanced data, we do not have definitive moments to estimate variance components. We employ Henderson's Method I (Searle, 1971). First we construct the following eight uncorrected sums of square:

$$T_o = \sum_{i,k,t} r_{ikt}^2 ,$$

$$T_\mu = \frac{\left(\sum_{i,k,t} r_{ikt} \right)^2}{N} ,$$

$$T_\alpha = \sum_i \left[\frac{\left(\sum_{k,t} r_{ikt} \right)^2}{\sum_{k,t} n_{ikt}} \right] ,$$

$$T_\beta = \sum_k \left[\frac{\left(\sum_{i,t} r_{ikt} \right)^2}{\sum_{i,t} n_{ikt}} \right] ,$$

$$T_\gamma = \sum_t \left[\frac{\left(\sum_{i,k} r_{ikt} \right)^2}{\sum_{i,k} n_{ikt}} \right],$$

$$T_\delta = \sum_{i,t} \left[\frac{\left(\sum_{k} r_{ikt} \right)^2}{\sum_{k} n_{ikt}} \right],$$

$$T_\phi = \sum_{i,k} \left[\frac{\left(\sum_{t} r_{ikt} \right)^2}{\sum_{t} n_{ikt}} \right],$$

$$T_\omega = \sum_{k,t} \left[\frac{\left(\sum_{i} r_{ikt} \right)^2}{\sum_{i} n_{ikt}} \right].$$

Then, we need the expected value of each sum of square to match. Unknowns are the square of the mean profitability μ^2 and the seven variances σ_*^2 for each effect. Each expected value can be constructed from (1) abiding by the stochastic (*i.i.d.*) assumption. Then the eight moment conditions become:

$$E(T_o) = N\mu^2 + N\sigma_\alpha^2 + N\sigma_\beta^2 + N\sigma_\gamma^2 + N\sigma_\delta^2 + N\sigma_\phi^2 + N\sigma_\omega^2 + N\sigma_\varepsilon^2,$$

$$\begin{aligned} E(T_\mu) = N\mu^2 &+ \frac{1}{N}\sum_i \left(\sum_{k,t} n_{ikt} \right)^2 \sigma_\alpha^2 + \frac{1}{N}\sum_k \left(\sum_{i,t} n_{ikt} \right)^2 \sigma_\beta^2 + \frac{1}{N}\sum_t \left(\sum_{i,k} n_{ikt} \right)^2 \sigma_\gamma^2 \\ &+ \frac{1}{N}\sum_{i,t} \left(\sum_{k} n_{ikt} \right)^2 \sigma_\delta^2 + \frac{1}{N}\sum_{i,k} \left(\sum_{t} n_{ikt} \right)^2 \sigma_\phi^2 + \frac{1}{N}\sum_{k,t} \left(\sum_{i} n_{ikt} \right)^2 \sigma_\omega^2 + \sigma_\varepsilon^2 \end{aligned},$$

$$
\begin{aligned}
E(T_\alpha) = {} & N\mu^2 + N\sigma_\alpha^2 + \sum_i \left[\frac{\sum_k \left(\sum_t n_{ikt} \right)^2}{\sum_{k,t} n_{ikt}} \right] \left(\sigma_\beta^2 + \sigma_\phi^2 \right) \\
& + \sum_i \left[\frac{\sum_t \left(\sum_k n_{ikt} \right)^2}{\sum_{k,t} n_{ikt}} \right] \left(\sigma_\gamma^2 + \sigma_\delta^2 \right) + l_\alpha \sigma_\omega^2 + l_\alpha \sigma_\varepsilon^2
\end{aligned},
$$

$$
\begin{aligned}
E(T_\beta) = {} & N\mu^2 + \sum_k \left[\frac{\sum_i \left(\sum_t n_{ikt} \right)^2}{\sum_{i,t} n_{ikt}} \right] \left(\sigma_\alpha^2 + \sigma_\phi^2 \right) \\
& + N\sigma_\beta^2 + \sum_k \left[\frac{\sum_t \left(\sum_i n_{ikt} \right)^2}{\sum_{i,t} n_{ikt}} \right] \left(\sigma_\gamma^2 + \sigma_\omega^2 \right) + l_\beta \sigma_\delta^2 + l_\beta \sigma_\varepsilon^2
\end{aligned},
$$

$$
\begin{aligned}
E(T_\gamma) = {} & N\mu^2 + \sum_t \left[\frac{\sum_i \left(\sum_k n_{ikt} \right)^2}{\sum_{i,k} n_{ikt}} \right] \left(\sigma_\alpha^2 + \sigma_\delta^2 \right) \\
& + \sum_t \left[\frac{\sum_k \left(\sum_i n_{ikt} \right)^2}{\sum_{i,k} n_{ikt}} \right] \left(\sigma_\beta^2 + \sigma_\omega^2 \right) + N\sigma_\gamma^2 + l_\gamma \sigma_\phi^2 + l_\gamma \sigma_\varepsilon^2
\end{aligned},
$$

$$E(T_\delta) = N\mu^2 + N\sigma_\alpha^2 + l_\delta \sigma_\beta^2 + N\sigma_\gamma^2 + N\sigma_\delta^2 + l_\delta \sigma_\phi^2 + l_\delta \sigma_\omega^2 + l_\delta \sigma_\varepsilon^2,$$

$$E(T_\phi) = N\mu^2 + N\sigma_\alpha^2 + N\sigma_\beta^2 + l_\phi \sigma_\gamma^2 + l_\phi \sigma_\delta^2 + N\sigma_\phi^2 + l_\phi \sigma_\omega^2 + l_\phi \sigma_\varepsilon^2,$$

$$E(T_\phi) = N\mu^2 + l_\omega \sigma_\alpha^2 + N\sigma_\beta^2 + N\sigma_\gamma^2 + l_\omega \sigma_\delta^2 + l_\omega \sigma_\phi^2 + N\sigma_\omega^2 + l_\omega \sigma_\varepsilon^2.$$

Now we have eight equations and eight unknowns, which should enable us to get the estimates of seven variances and a squared mean with rudimentary though tedious calculation, for which we construct a simple program using STATA®.

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Table 1: Descriptive statistics of the main sample

	Total	1998	1999	2000	2001	2002	2003
Number of observations	24,808	2,774	3,851	4,206	4,470	4,687	4,820
ROA							
Mean	5.9%	5.1%	5.8%	6.4%	5.3%	5.8%	6.8%
Standard deviation	11.0%	10.7%	10.8%	10.7%	11.1%	11.2%	11.2%
Maximum	60.0%	59.3%	59.7%	57.9%	59.6%	59.6%	60.0%
Minimum	-50.0%	-49.3%	-50.0%	-50.0%	-50.0%	-48.2%	-50.0%
Number of industries	335	257	287	291	302	307	309
Number of corporations	1,712	936	1,281	1,381	1,471	1,561	1,610
Numbers of 3-digit business in a corporation							
Mean	3	3	3	3	3	3	3
Maximum	9	8	8	8	9	9	8
Minimum	2	2	2	2	2	2	2
Number of corporations in an industry							
Mean	14.6	10.8	13.4	14.5	14.8	15.3	15.6
Maximum	280	166	228	240	246	258	280
Minimum	2	2	2	2	2	2	2

Table 2: Estimation results of variance components

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Data								
Cut-off points	-50&60%	-50&60%	-50&60%	-50&60%	-50&60%	-30&40%	-50&60%	-50&60%
Single-business Corporation	No	No	No	No	No	No	No	Yes
Non-manufacturing	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
JSIC code	3-digit	3-digit	3-digit	3-digit	3-digit	3-digit	2-digit	3-digit
Variance components								
Industry	5.0%	5.0%	5.0%	5.3%	3.0%	4.8%	3.7%	5.2%
Corporation	8.6%	8.7%	8.8%	8.7%	7.1%	7.7%	8.1%	-0.3%
Year	0.3%	0.3%	*	0.3%	1.3%	0.5%	0.3%	0.4%
Industry-Year	1.6%	1.6%	1.9%	*	0.9%	1.6%	1.0%	1.9%
Business (Industry-Corporation)	53.1%	52.9%	52.9%	52.6%	53.1%	51.2%	52.8%	60.7%
Corporation-Year	1.0%	*	*	*	0.2%	0.5%	1.1%	-5.2%
Error	30.5%	31.5%	31.5%	33.0%	36.4%	32.1%	31.2%	37.3%
Total variance	121.3	121.3	121.2	121.3	93.2	78.1	117.2	105.2
Number of observations	24,808	24,808	24,808	24,808	8,598	24,025	22,174	33,215

Note: Variance component estimates are reported as the ratio to total variance. Asterisk (*) denotes omitted effect.