What Drives the Profitability of Japanese Multi-Divisional Corporations?
A Variance Components Analysis

Running Title: Decomposing the Profitability of Japanese Firms

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Summary
As is the case in the United States first shown by Richard Rumelt using a variance components analysis, we report that by far the largest contribution to the dispersion of returns is brought about by business-unit effects in Japan, though industry and corporate effects exert some influence. Our finding suggests that the dominance of business-unit effects over corporate ones is not dependent on any particular economic and institutional environments, representing a fundamental research question in strategy.

Key Words: Variance component analysis; Profitability dispersion; Multi-divisional corporations; Japanese firms.

1. Introduction

The level of factors affecting the performance of multi-divisional corporations is of considerable interest to strategic management researchers. A seminal paper of Schmalensee (1985), which has introduced a variance components analysis, a simple but powerful technique, in the field, claims that industry effects are dominant. However, Rumelt (1991) gives us a different answer. He shows that business-unit effects are much larger than industry effects in accounting for the difference of returns among major U.S. corporations though he agrees with Schmalensee (1985) in the point that corporate effects are of negligible importance.

Since then, the decomposition of effects on return dispersion has been tried by many researchers with various techniques as well as a variance component approach.[1] Results vary depending on dataset, sample selection, and methodology. However, Rumelt's (1991) main conclusion that business-unit effects are the largest has been repeatedly confirmed by this burgeoning literature. Though corporate effects seem to be not so negligible as first claimed by Rumelt (1991) and Schmalensee (1985), the main driver of multi-divisional corporations' performance is at the business-unit level, not corporate or industry level.

Then, why is it worth writing another paper on this seemingly settled research question? McGahan and Porter (2002, p. 848) claim that "Additional studies using similar approaches are less likely to generate important new insights because they are limited technically, by data and by method." However, they also point out that "The most direct opportunities for further research reside in exploring new data. Reliable and comparable data on the accounting profits of firms in other parts of the world would

[1] Notable contribution are, though not intended to be comprehensive, McGahan (1999), McGahan and Porter (1997, 1999, 2002), Roquebert et al. (1996), and Ruefli and Wiggins (2003).

yield insight on questions about the relationships between national economic environment and industrial performance." (p. 849)[2]

We take heed of this suggestion and study firms headquartered in Japan, which provides an interesting study ground for two main reasons. First, the sheer size of Japan's national economy, the second largest in the world, makes it the first logical candidate of alternative research arena to perform a large sample study of firm performance. Second, though the U.S. and Japan have many similarities as large industrialized economies, they also have many differences in such areas as financial and industrial systems and corporate behavior, which may differentiate patterns of return dispersions in the two economies. For instance, the dominant mode of organizing economic transactions is characteristically different. Broadly speaking, the U.S. is more market-oriented in dealing with corporate finance, labor, and business-to-business transactions while Japan is more organization-oriented as pointed out by Imai and Itami (1984) and Williamson (1991) among others.

In the area of corporate behavior, Japanese firm are often said to be growth-oriented rather than profitability-oriented (Odagiri 1992; Porter and Sakakibara 2004). Performance difference among Japanese competitors may then appear mainly in market shares not in profitability, decreasing the dispersion of returns in the same industry. In addition, firm growth in Japan is predominantly internal. The emphasis on internal growth leveraging innate capabilities makes unrelated diversification difficult. If the growth of Japanese firms is more synergy-driven than that of U.S. firms as suggested by Prahalad and Hamel (1990), corporate effects may be relatively large in Japan, though the tendency of Japanese competitors to enter similar industries will limit

[2] Furman (2000) on Australia, Canada and the United Kingdom, and Khanna and Rivkin (2001) on emerging markets are among those few studies, though neither of them employs a variance components approach.

synergy gains to all firms by increasing competition (Porter and Sakakibara 2004). Fukui and Ushijima (in press) observe that coherence of leading Japanese firms is stable despite long-time increase in diversification but does not much contribute to long-term performance.

These and other considerations suggest that Japan represents an interesting research opportunity to increase our knowledge on the relative importance of factors shaping the performance of multi-divisional corporations. Makino et al. (2005) is the only published study that has capitalized on this opportunity. Their study is unique as it examines the profitability of foreign affiliates, not conventional business-units. They find relatively large corporate (parent) effects. However, their analysis is confined to the foreign operations of multinational corporations. In this article, we supply more general evidence by performing a variance component analysis of the business-unit profitability of multi-divisional corporations. As our research sample is the universe of publicly traded manufacturers, it covers firms operating only in Japan as well as multinational corporations operating in a number of countries.

Our analysis has several data limitations. First, the availability of segment-level profitability data is limited to recent years, forcing us to work with relatively short panel data. Since our sample period 1998-2003 is the time when Japan was said to be trapped in a low growth equilibrium, our results may understate the importance of time-varying factors compared to studies covering a full business cycle. Second, our data source comparable to Compustat shares its problem in the precision of matching reported segments and industries. Measurement errors in industry classification may overstate business-unit effects and understate industry effects. Third, Japan’s financial crisis reached its peak in our sample period, distorting competition and firm performance in such industries as finance, construction, real estate, and distribution (Caballero et al. 2005). Our focus on manufacturing circumvents this problem but at the cost of generalizability of our results.

These and other limitations notwithstanding, we find that Rumelt's (1991) conclusion that neither industry nor corporate but business-unit effects are the main driver for the dispersion of returns holds for Japanese multi-divisional corporations. As in Makino et al. (2004), we identify relatively large corporate effects. However, the pattern that the variance attributable to business-unit effects is the largest and dominant consistently appears, surviving various robustness checks. Our finding suggests that the dominance of business-unit effects over corporate ones is not dependent on any particular economic and institutional environments, representing a fundamental research question in strategy, not an idiosyncratic phenomenon in particular countries.

This article is organized as follows. We explain our method for investigation, a variance components model in Section 2. Section 3 introduces data. Section 4 presents estimation results. Section 5 is a brief conclusion.

2. Variance Components Analysis

In order to disaggregate the dispersion of business-unit returns into components, we conduct a variance components analysis. In this framework, a return measure r_{ikt} is the sum of its overall mean μ and random components. Specifically, 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 ε_{ikt}. One of the interactions is particularly important because industry-corporation is another name of business-unit. A specific business-unit is denoted *ik*, while an industry and a corporation are labeled *i* and *k* respectively. Then, the model becomes:

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

Note that our model includes corporation-year effects which earlier authors have omitted. Bowman and Helfat (2001) and Adner and Helfat (2003) contend that the omission is a major drawback when the importance of corporate-level management as a driver of corporate performance is at issue. Our model including the time-varying corporate effect formally addresses their concern.

Because our model is a random-effects one, not only a random error term ε_{ikt} but also all of the other six effects are independently generated with zero means and constant unknown variances though normality is not assumed. Therefore, while we relegate computational details to Appendix, the total variance can be decomposed into seven components:

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

We adopt a variance components approach instead of a more familiar fixed-effects analysis of variance (ANOVA) because the variance components of a nested model like ours are estimable but "regression methods cannot deliver unambiguous estimates of the relative importance of classes of effects" (Rumelt 1991, p. 172).[3] More specifically, higher-level industry and corporate effects cannot be disentangled from lower-level industry-corporate (business-unit) effects under a regression (including ANOVA) framework, while they can be under a variance components approach.

The method adopted here has encountered several types of criticism. We take

[3] The key concept, esitimability, is rigorously explained by Searle (1971, pp. 180-188) and more intuitively by Rumelt (1997).

up two popular ones *inter alia* and offer some defense of its use.[4] First, an assumption of the method that effects are randomly generated might be too restrictive. However, as a first-order approximation, variance decomposition could paint a reasonably accurate picture of profitability dispersion patterns. The method cannot capture any feedback (causal) mechanism between profitability and managerial actions, but we do not claim we can with a variance components analysis. We only report a fact which we believe is important enough for other researchers to know.

Second, even if the first criticism were alleviated, our specific sample would not be a representative one. Based on simulation studies, Brush and Bromiley (1997) show it is not rare to find very small corporate effects in a particular sample even though these effects are substantial in the population. However, "this criticism is based on a misconception" (McGahan and Porter 1997, p. 19). We do *not* intend to infer "population" characteristics from our specific "sample." Rather we strive to expand our coverage, though limited due to data constraint, and describe what is going on in Japanese multi-divisional corporations. As instructors, we calculate the mean and standard deviation of a test score in order to know the effectiveness of our teaching as well as the characteristics of our students. The usefulness of these statistics would not diminish whether our students were "representative" of a hypothesized "population" or not. If an exam were a national aptitude test, its own characteristics would tell us all the more valuable insights. So those of our economy-wide data would, which itself is a "population."

[4] For more on methodological debate, see Brush and Bromiley (1997), and McGahan and Porter (2005).

3. Data

We use six-year segment data of publicly traded Japanese manufacturing corporations from 1998 to 2003, which is provided by the Nikkei NEEDS financial QUEST database. 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. A relatively short time span (six years) of our data base is entirely due to the data constraint: Japanese listed companies were not required as comprehensively as they are now to disclose their segment information on a consolidated basis until 1998.[5] Because of this short time window, we do not consider serial correlations explicitly. Japan's entire economy was stagnant during our sample period. This particular feature of our research setting may lead to an underestimation of the relative weight of time-varying factors dynamically affecting firm performance.

In addition, the disclosed segment data is usually too coarse to be reliably matched with a 4-digit JSIC code as Villalonga (2004) finds for U.S. firms in Compustat database. We therefore adopt the 3-digit rather than 4-digit code in assigning segments to an industry. If a segment contains multiple 3-digit codes, we employ the code listed first by Nikkei NEEDS as it represents the segment's most important product. If multiple segments share the same 3-digit code thus assigned, we merge them into a single segment. Our use of a relatively coarse industry classification may underestimate variance attributable to industry-effects and overestimate variance due to business-unit effects.

We focus on manufacturing because Japan's financial crisis reached its peak at

[5] Although companies were required to report entity-based segment data for decades before 1998, disclosed segment information did not include operating income.

the turn of the last millennium. According to recent studies such as Peek and Rosengren (2005), Caballero et al. (2005), and Nishimura et al. (2005), Japanese banks subsidized poorly performing firms during the crisis even at the cost of successful ones for window-dressing balance sheets. Such perverse lending behavior of banks was likely to distort competition in industries severely affected by the collapse of the so-called bubble economy including construction, real estate, and distribution (Caballero et al. 2005). Because our research interest is in patterns of return dispersions in the normal state of competition, we focus on manufacturing which has been free from substantial distortions. This focus is consistent with Schmalensee (1985) and Rumelt (1991), pioneering studies based on U.S. data.

In the original data set, 18,602 observations with 328 industries and 1,634 corporations have both segment income and asset data, which enables us to calculate return on assets (ROA).[6] However, in this data set, ROA ranges from -4,033 to 37,100 percents, which strongly suggests non-recurrent extraordinary situations and/or improper recording (reporting). Therefore we decide to eliminate 179 observations (less than one percent of the total) with ROA beyond 60 percent and below -50 percent. This elimination leads to 18,423 observations. Those eliminated are of a considerably smaller size and their combined assets account for 0.04 percent of the total assets combined in the whole sample.[7]

[6] The fact that operating assets are basically recorded at book value in Japan (as well as in the United States) may distort our results due to the possible inter-segment systematic difference of the current-to-book value ratio. However, we have decided to use book value as those using U.S. data did because the price-to-book value ratios (PBR) of Japanese manufacturing companies are comparable to those of U.S. counterparts in our research window, and we have no practical way to rectify this problem in segment data, if ever exists, whose correction would need the estimation of current asset value for each segment.

[7] We understand that excluding only abnormal data based on close inspection of segment performance would be preferable to using mechanical cut-off points. However, the fact that virtually no information but numerical values themselves are disclosed on segment data prevents us from conducting the former more appropriate method.

It is well known that the existence of single-divisional corporations would lead to the smaller corporate effects than only multi-divisional corporations are included because the corporate effect in the former is conventionally set to zero in order to facilitate a separate identification of corporate and business-unit effects. Although there are the pros and cons of elimination[8], we decide to exclude single-divisional corporations from our data set because it is better to err on the side of overestimation rather than otherwise when the smallness of corporate effects is at issue. We reason that the elimination would lead to the upper limit estimate of corporate effects. In addition, we exclude single-corporate industries (only one corporation in an industry) but this elimination turns out to be without any material consequences.[9]

Our original data set consists of corporations classified as manufacturers. We eliminate non-manufacturing business-units from our main data set for three reasons. First, they are expected to have characteristics different from those of manufacturing ones. Second, non-manufacturing business-units of manufacturers may not be representative of the whole industry. Third, last but not least, distorted competition in non-manufacturing industries is likely to bias our variance component estimates. As we will report in the next section, however, this elimination does not affect our main conclusion at all.

These considerations eliminate another 9,825 observations in total, leading to 8,598 observations as our final data set. Some descriptive statistics of these 8,598 observations are shown in Table 1. Our six-year data cover 127 industries and 687 corporations. Naturally the number of observations (8,598) is far smaller than the theoretical maximum (523,494 = 6 × 127 × 687), that is, unbalanced to the extreme.

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[8] Among leading researchers, Bowman and Helfat (2001) endorse the elimination of single-segment corporations, while McGahan and Porter (2002) oppose it.

[9] Therefore, not reported in Section 4.

Because corporations have seven business-units at most and the maximum number of corporations in an industry is 127, most cells are empty. The mean ROA (Earnings before interest and taxes/Operating assets) is 5.7 percent, while its standard deviation is 9.6 percent.

In spite of the elimination above, our data universe accounts for 47.4 percent and 72.2 percent of the entire Japanese manufacturing operating revenue and income respectively in fiscal year 2003, the last year of our data window. Therefore, it is not unreasonable to claim that our data is a fairly representative sample of the Japanese manufacturing sector.[10]

4. Empirical results

4.1. Variance component estimations

Table 2 shows the empirical results. Under the full model with three main and three interaction components reported in Column (1), business-unit effects overwhelmingly contribute to 51.2 percent of the total variance, while industry effects account for 3.0 percent, corporation 7.1 percent, year 1.3 percent, industry-year 0.9 percent, corporation-year 0.2 percent, and residual error 36.4 percent. Our estimate of the share of variance due to corporate effects is comparable to Makino et al.'s (2004). They find that corporate effects account for 8-11% of the total variance of profitability of foreign affiliates. As shown in Columns (2)-(4), omitting one or two components barely changes the picture. Therefore, consistent with Rumelt (1991) and other studies, business-unit effects make by far the largest contribution to the return dispersion in Japanese multi-divisional corporations.

[10] The data on the entire Japanese manufacturing sector is from Financial Statements Statistics of Corporations by Industry, reported quarterly by the Ministry of Finance.

To check the robustness of dominant business-unit effects, we examine different data sets as shown in Table 3. First, we change the cut-off points of ROA from -50 percent and 60 percent to -30 percent and 40 percent. With this change, we lose another 137 observation leading to 8,461 in total, but obtain very similar results as shown in Column (1). Column (2) uses ROS (Earning before Interest and Taxes/Sales) instead of ROA, but again we obtain very similar results with 8,628 observations. In Column (3), we include non-manufacturing business-units resulting in substantially more 12,876 observations. Though the dominance of business-unit effects (52.2 percent) remains, industry effects increase to 4.8 percent but corporate effects decrease to 5.3 percent. This increase of industry effects is consistent with the finding of McGahan and Porter (1997) that non-manufacturing corporations have larger industry effects. Meanwhile, the decrease of corporate effects suggests that the corporate-level advantage held by multi-divisional manufacturers tends to be confined to manufacturing industries. Column (4) uses coarser JSIC 2-digit classification reducing the number of observations to 6,489. Again, business-units effects (53.1 percent) are dominant, but both industry and corporate effects decrease to 2.0 percent and 4.7 percent respectively. The decrease of industry effects is not surprising because, as McGahan and Porter (2005, p. 879) point out, aggregation of business-units would systematically lessen industry effects. All in all, the dominance of business-unit effects is robust and stable.

Table 4 compares our results with those of Rumelt (1991) and McGahan and Porter (1997), another major study employing a variance components analysis.[11] The unmistakable pattern that business-unit effects contribute most to the dispersion of returns emerges across the board. However, there are some discernible differences

[11] We use Rumelt's (1991) Sample B result while showing McGahan and Porter's (1997) results based on all data and manufacturing only.

among three studies. On the one hand, corporate effects are larger in our study (7.1 percent) than those in Rumelt (1.6 percent) and McGahan and Porter (4.3 percent for all data and nil for manufacturing only) though the magnitude in our study is still small relative to the large variance attributable to business-unit effects. Actually, our larger corporate effects are to be expected because the exclusion of single-divisional corporations in our study increases corporate effects compared to the other two studies which include these corporations. On the other hand, industry effects are substantially smaller in our study (3.0 percent) than in McGahan and Porter (18.7 percent for all data and 10.8 percent for manufacturing only) while comparable to those in Rumelt (4.0 percent). We infer this discrepancy is brought about by the fact that our study uses a coarser industry classification which reduces industry effects.[12]

4.2. ANOVA estimations

As we noted earlier, the nested structure of our model does not allow us to isolate effects of different levels (e.g. business-unit vs. corporate effects) within the conventional regression framework due to the estimability problem (Serle 1971; Rumelt 1997). Nevertheless, we conduct a conventional ANOVA and compare our results with those of Rumelt (1991) as shown in Table 5.[13] We report incremental R^2 as a measure for relative importance omitting corporation-year effects to be in line with Rumelt' results. In addition to the above mentioned point that higher-level effects are inseparable from lower-level ones, incremental R^2 cannot be determined uniquely because ordering matters.

[12] McGahan and Porter (1997) employ the SIC 4-digit classification whereas the FTC Line of Business's classification in Rumelt (1991) lies in somewhere between SIC3-digit and 4-digit levels. In addition, our industry-year effects (0.9 percent) are smaller than those in Rumelt (5.4 percent) probably due to period specific reasons.

[13] Again we use his Sample B results.

As in Rumelt (1991), we try two regressions, entering business-unit (corporation-industry) effects last and industry-year effects last. Notice that entering either industry or corporate effects after business-unit ones is impossible because the latter is nested in the former two effects. In both specifications, while business-unit effects are still the largest (37.0 percent and 37.9 percent), corporate effects (25.2 percent and 28.9 percent) are much larger than those under a variance components approach (7.1 percent), as is the case in Rumelt's results (10.9 percent and 11.6 percent versus 1.6 percent). This substantial increase of corporate effects (to a lesser degree, industry effects) is brought about by the fact that the incremental R^2 of higher-level corporate (industry) effects includes inseparable lower-level business-unit ones under a conventional ANOVA.

5. Conclusion

As McGahan and Porter (2002, p. 848) succinctly summarize the research conducted so far on US panel data since the pioneering work of Rumelt (1991), business-specific effects are more important than year, industry, and corporate-parent effects in the variance of business-specific profitability." In this paper, we show that the same conclusion holds for Japanese data using a variance components analysis. Although corporate effects exert non-negligible influence, by far the largest contribution to the dispersion of returns is brought about by business-unit effects even in Japan where diversified corporations have allegedly evolved around their core competence (Prahalad and Hamel 1990).

We conclude this article with a few remarks. First, we are agnostic about why business-unit effects are dominant in Japan as well as in the United States. Our aim is simply to report a fact to be explained. In this vein, however, our report is incomplete because we only examine corporations designated as manufacturers to avoid biases due to distorted competition in non-manufacturing sectors. Indeed McGahan and Porter (1997) show that manufacturing may not be representative of the entire economy, which suggests a more comprehensive industry coverage be necessary to confirm the dominance of business-unit effects as a stylized fact of Japanese economy beyond reasonable doubt. We relegate this job to future researchers studying different time periods.

Second, we should keep in mind that the larger share of business-unit effects per se does not necessarily mean that these effects are more decisive than others in pondering corporate management. Goldberger (1998, pp. 113-114) illustrates the point with a hilarious example. The weight of an adult is largely determined by his/her height. But is it illuminating to tell health conscious executives that height, which is almost fully exogenous to adult individuals, is more important than physical exercise to control weight? Likewise, even if the performance of business-units is largely determined by business-level factors, it does not necessarily mean that corporate-level policies initiated by the CEO and her cadre are irrelevant to corporate management, not to mention their decisions to enter new businesses.

Third, it is important to recognize that, to the extent that corporate effects exert not uniform influence on each business-unit, the substantial clout of headquarters would not be revealed in the magnitude of corporate effects. In this regard, one may contend that our approach, which is standard in the literature, understate corporate effects as a proxy for the influence of corporate management by implicitly focusing on a specific type of synergy (i.e. parallel increase/decrease in profitability) if so interpreted, as

Schmalensee's (1985) focus on market share effects fails to fully appreciate business unit effects (Rumelt, 1991). However, as McGahan and Porter (2005, p. 875) emphasize, because managerial actions could either amplify or dampen corporate effects in various ways, we should not infer any facile conclusion on the influence of corporate management from our descriptive results.

These limitations notwithstanding, our evidence from Japan confirms one of the stylized yet puzzling facts about corporate performance that should be explained by strategic management researchers. In the meantime, more attention should be paid on the strategy of a business-unit itself, at least as much attention as now focused on corporate strategy, in order to understand factors affecting multi-divisional corporations' performance.

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-unit) and l_ω corporation-year distinct combinations respectively. If a distinct industry-corporation-year exists, n_{ikt} = 1 (0 otherwise). In total we have N observations. For each observation, we calculate returns on assets r_{ikt}.

$$l_\alpha = \#i,\ l_\beta = \#k,\ l_\gamma = \#t,\ l_\delta = \#it,\ l_\phi = \#ik,\ l_\omega = \#kt,\ N = \sum_{i,k,t} n_{ikt} = \#ikt\ .$$

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. Following Rumelt (1991), we employ Henderson's Method I.[14] First we construct the following eight uncorrected sums of square:

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

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

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

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

[14] See Searle (1971) for mathematical details, and Sahai and Ojeda (2005) for the recent theoretical and statistical development of variance components methods.

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

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

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

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

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:

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

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

$$E\left(T_\alpha\right)=N\mu^2+N\sigma_\alpha^2+\sum_i\left[\frac{\sum_k\left(\sum_t n_{ikt}\right)^2}{\sum_{k,t}n_{ikt}}\right]\left(\sigma_\beta^2+\sigma_\phi^2\right)$$

$$+\sum_i\left[\frac{\sum_t\left(\sum_k n_{ikt}\right)^2}{\sum_{k,t}n_{ikt}}\right]\left(\sigma_\gamma^2+\sigma_\delta^2\right)+l_\alpha\sigma_\omega^2+l_\alpha\sigma_\varepsilon^2,$$

$$E\left(T_\beta\right)=N\mu^2+\sum_k\left[\frac{\sum_i\left(\sum_t n_{ikt}\right)^2}{\sum_{i,t}n_{ikt}}\right]\left(\sigma_\alpha^2+\sigma_\phi^2\right)$$

$$+N\sigma_\beta^2+\sum_k\left[\frac{\sum_t\left(\sum_i n_{ikt}\right)^2}{\sum_{i,t}n_{ikt}}\right]\left(\sigma_\gamma^2+\sigma_\omega^2\right)+l_\beta\sigma_\delta^2+l_\beta\sigma_\varepsilon^2,$$

$$E\left(T_\gamma\right)=N\mu^2+\sum_t\left[\frac{\sum_i\left(\sum_k n_{ikt}\right)^2}{\sum_{i,k}n_{ikt}}\right]\left(\sigma_\alpha^2+\sigma_\delta^2\right)$$

$$+\sum_t\left[\frac{\sum_k\left(\sum_i n_{ikt}\right)^2}{\sum_{i,k}n_{ikt}}\right]\left(\sigma_\beta^2+\sigma_\omega^2\right)+N\sigma_\gamma^2+l_\gamma\sigma_\phi^2+l_\gamma\sigma_\varepsilon^2,$$

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

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

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

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. We construct a simple program for computation using STATA®9.

We stick to this classical method of computation because maximum-likelihood based estimation does not have any known better properties without additional assumptions, while its computational burden is formidable.

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Table 1: Descriptive Statistics		Total
Number of Observations		8,598
ROA	Mean	5.7%
	Standard Deviation	9.6%
	Maximum	60.0%
	Minimum	-49.3%
Number of Years		6 (1998 - 2003)
Number of Industries		127
Number of Corporations		687
Numbers of Business-Units in a Corporation		
	Maximum	7
	Minimum	2
Number of Corporations in an Industry		
	Maximum	118
	Minimum	2

		1998	1999	2000	2001	2002	2003
Number of Observations		1,081	1,340	1,450	1,539	1,585	1,603
ROA	Mean	4.7%	5.7%	7.0%	4.2%	5.3%	6.8%
	Standard Deviation	9.4%	9.3%	9.4%	9.6%	9.7%	10.0%
	Maximum	57.6%	52.8%	53.6%	56.7%	54.0%	60.0%
	Minimum	-43.0%	-49.3%	-44.2%	-45.9%	-44.0%	-49.2%
Number of Industries		112	113	116	121	120	120
Number of Corporations		434	528	559	595	614	619

Table 2: Variance Components I

	(1)	(2)	(3)	(4)
Dependent Variable	ROA	ROA	ROA	ROA
Data Censoring				
Cut-off Points	-50&60%	-50&60%	-50&60%	-50&60%
Non-Manufacturing	Excluded	Excluded	Excluded	Excluded
JSIC Code	3-digit	3-digit	3-digit	3-digit
Component				
Industry	3.0%	3.0%	2.7%	3.1%
Corporation	7.1%	7.2%	7.2%	7.2%
Year	1.3%	1.3%	*	1.3%
Industry-Year	0.9%	0.9%	2.1%	*
Business-Unit (Industry-Corporation)	51.2%	51.2%	51.2%	51.0%
Corporation-Year	0.2%	*	*	*
Error	36.4%	36.6%	36.7%	37.4%
Total Variance	93.2	93.2	93.0	93.2
Number of Observations	8,598	8,598	8,598	8,598

In (2), (3) and (4), some component(s) designated * are excluded in estimation.

Table 3: Variance Components II

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	ROA	ROA	ROS	ROA	ROA
Data Censoring					
Cut-off Points	-50&60%	-30&40%	-50&60%	-50&60%	-50&60%
Non-Manufacturing	Excluded	Excluded	Excluded	Included	Excluded
JSIC Code	3-digit	3-digit	3-digit	3-digit	2-digit
Component					
Industry	3.0%	3.5%	3.8%	4.8%	2.0%
Corporation	7.1%	8.2%	8.0%	5.3%	4.7%
Year	1.3%	1.4%	1.4%	0.6%	1.6%
Industry-Year	0.9%	1.1%	0.9%	1.7%	0.4%
Business-Unit (Industry-Corporation)	51.2%	49.3%	49.3%	52.2%	53.1%
Corporation-Year	0.2%	0.3%	-0.9%	0.1%	2.3%
Error	36.4%	36.2%	37.5%	35.2%	35.9%
Total Variance	93.2	72.9	69.6	98.9	85.7
Number of Observations	8,598	8,461	8,628	12,876	6,489

In all five specifications, single-divisional corporations and single-corporate industries (only one company in an industry) are excluded.

Table 4: Variance Components III

Component	This Study	Rumelt (1991)	McGahan &Porter (1997)	
			All	Manufacturing Only
Industry	3.0%	4.0%	18.7%	10.8%
Corporation	7.1%	1.6%	4.3%	0% (-2.0%)
Year	1.3%	--	2.4%	2.3%
Industry-Year	0.9%	5.4%	--	--
Business-Unit (Industry-Corporation)	51.2%	44.2%	31.7%	35.5%
Others	0.2%	--	-5.5%	-2.3%
Error	36.4%	44.8%	48.4%	53.7%
Number of Observations	8,598	10,866	58,132	18,298

Table 5: Analysis of Variance

	Business-Unit (Corporation-Industry) Entering Last					
		This Study			Rumelt (1991)	
Source	df	Incr. R^2	F-Value	df	Incr. R^2	F-Value
Year	5	1.1%	51.36	3	0.1%	6.09
Industry	126	7.4%	13.62	241	10.3%	10.28
Industry-Year	570	4.0%	1.64	721	7.1%	2.36
Corporation	686	25.2%	8.51	462	10.9%	5.70
Business-Unit (Industry-Corporation)	1,370	37.0%	6.27	2,106	41.3%	4.72
Model	2,757	74.8%	6.29	3,533	69.6%	4.75
Error	5,840	25.2%		7,332	30.4%	
Mean	1			1		
Total	8,598			10,866		

	Industry-Year Entering Last					
		This Study			Rumelt (1991)	
Source	df	Incr. R^2	F-Value	df	Incr. R^2	F-Value
Year	5	1.1%	51.36	3	0.1%	6.09
Corporation	686	28.9%	9.77	462	11.6%	6.05
Industry	126	4.1%	7.57	241	9.8%	9.76
Business-Unit (Industry-Corporation)	1,371	37.9%	6.40	2,106	41.4%	4.74
Industry-Year	569	2.8%	1.13	721	6.8%	2.26
Model	2,757	74.8%	6.29	3,533	69.6%	4.75
Error	5,840	25.2%		7,332	30.4%	
Mean	1			1		
Total	8,598			10,866		

df: degree of freedom

Incr. R^2: Incremental R^2