A comprehensive analysis of business portfolios using a quantitative model

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Business diversification has advantages and disadvantages, which need to be assessed in a multifaceted way. In this paper, we propose a comprehensive model for analyzing business portfolios that takes into account industry factors, synergies, economies of scale, risk diversification, and the conglomerate discount. The model enables simulations and analyses of various diversification strategies and can be used to make business portfolios more efficient. At the end of the paper, we provide a sample analysis of a fictitious company.

1. Introduction

Similar to a stock portfolio, a business portfolio refers to a collection of multiple businesses that a company runs. In the latter half of the 1990s, the inefficiencies of diversification came to be recognized, and thereafter investors tended to prefer companies with a selective focus. Following the global financial crisis around 2008, however, the merit of business portfolios has been reconsidered from the perspective of risk diversification. Compared with US and European companies, Japanese companies tend to be more diversified and have complex business portfolios, and consequently interest in business portfolio optimization is high. Diversification has advantages and disadvantages, making it difficult to come up with optimal solutions. The advantages include synergies between different businesses, a reduction in risk from diversification, and economies of scale. The disadvantages are referred to as the conglomerate discount and include a decline in profits from inefficiencies in internal capital markets and an increase in the cost of capital owing to greater information asymmetries. In addition to these positive and negative aspects of diversification, executives need to consider the growth, profitability, risks, and other characteristics of the industries they are thinking of investing in. An investment in an industry driven by prospects for synergies would lead to a decline in ROA and the value of the company if the industry were not very profitable. And, if an investment in a profitable, fast-growing industry involved few synergies but a substantial conglomerate discount, the company would be less efficient than a specialized company and an increase in the company's value could not be expected. Coming up with an optimal business portfolio strategy

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and increasing the value of a company requires overall rather than localized optimization of business portfolios.

Based on this point, we propose in this paper a quantitative model for comprehensively analyzing five core factors that affect the efficiency of business portfolios: industry factors (the industry's profitability and risks), synergies, economies of scale, diversification, and the conglomerate discount. The model consists of two business portfolio analyses, one based on fundamentals (ROA) and the other based on the market (the cost of capital).

This paper is structured as follows. Section 2 explains the data, Section 3 the fundamentals (ROA)-based model, and Section 4 the market (cost of capital)-based model. Section 5 gives applications of the model. Finally, we conclude with a summary in Section 6.

2. Segment Data and Business Portfolio Matrices

2.1. Segment data

Many publicly traded companies mention their business segments in their annual securities filings, but they do not use uniform criteria for classifying them. As a result, cross-segment comparisons are difficult. In this paper, we use the Nikkei NEEDS segment database, which covers not only sales, assets, and other financial data but also business classifications based on the Japan Standard Industry Classification (JSIC) for each company's business segments.[1]

2.2. Business portfolio matrices

The matrix A_{iJ} represents the amount of assets invested by company i in industry *J*. A_{iJ} is obtained from each segment's JSIC and assets from the Nikkei NEEDS database.[2] From A_{iJ}, the business portfolio matrix R_{iJ} is defined as follows:

$$R_{iJ} = \frac{A_{iJ}}{A_i}, \left(A_i = \sum_J A_{iJ} \right) \tag{1}$$

R_{iJ} defined in this manner shows the weighting of company i's assets in industry *J*, and the total for each company is 100%. A_i represents total assets excluding consolidated holdings; for many companies, it is essentially equal to total consolidated assets.

3. Fundamentals (ROA)-based Model

3.1. The model

To assess the impact of a business portfolio on a company's fundamentals (ROA), we use regression analysis to break down each company's ROA into industry factors (A), synergies (B), economies of scale (C), and a conglomerate discount (D).

A. Industry factors (industry ROA)

Since a company's ROA is greatly affected by the industries it is involved in, proper comparison of companies with different business portfolios is difficult. Many previous studies have compared diversified companies with specialized companies in the same industry, as Berger and Ofek (1995) did. However, it is difficult to use the same method for Japanese listed companies because few are specialized. Companies that could be considered specialized based on JSIC group classifications amounted to less than one-third of all publicly traded Japanese companies in fiscal 2008. Hence, with this approach, the analysis needs to be based on broader JSIC categories, such as major

1 We use the 11th revision of the Japan Standard Industrial Classification, published in 2002. The system consists of 27 divisions, 97 major groups, 420 groups, and 1,269 industries. In this paper, we use different levels of groupings depending on the model and indicator. Grouping levels used are appropriately noted in the text.

2 A_{iJ} represents assets in industry *J*. In the case of different segments that are regarded as the same industry *J* based on Nikkei NEEDS segment data, A_{iJ} represents total assets in both segments. But, in the case of one segment encompassing multiple industries, up to three industry classifications are shown, in order of the amount of sales in the database. If two industry classifications are recorded for one segment, we assume 75% of the assets are in the first industry and 25% in the second. Similarly, if three industry classifications are recorded for one segment, we assume 60% of the assets are in the first industry, 30% in the second, and 10% in the third. Since these assumptions are arbitrary, we ignore the second and third industries and use only the first industry for supplementary analysis to test the robustness of the results.

groups. In this paper, we avoid this issue with the statistical model below.

To take into account industry-specific factors, we need to estimate the average ROA of each industry (= industry ROAs). The industry ROA of industry J is designated by β_J^{Ind}. If company i has assets A_{iJ} in industry J, then profits of $\beta_J^{\text{Ind}} \times A_{iJ}$ can be expected from this industry. Similarly, company i's total profits in all industries, ignoring synergies, scale, and other factors, are as follows, on average:

$$\text{Company } i\text{'s total operating profits} = \sum_{J=1}^{N} \beta_J^{\text{Ind}} \times A_{iJ} \tag{2}$$

Hence, company i's ROA is as follows, on average:

$$\text{ROA}_i = \sum_{J=1}^{N} \beta_J^{\text{Ind}} \times \frac{A_{iJ}}{A_i} = \sum_{J=1}^{N} \beta_J^{\text{Ind}} \times R_{iJ} \tag{3}$$

Equation (3) shows that a company's consolidated ROA matches the average of the industry ROAs, weighted by the allocations of assets to each industry. By adding a residual term to the right side of equation (3) and effecting a regression analysis, we can estimate β_J^{Ind}, which represents industry ROA. In other words, to incorporate industry factors into the model, we can just add the business portfolio matrix R_{iJ} to the independent variables. Actual estimates (using equation (5)) also include indicators for synergies, economies of scale, and a conglomerate discount.

A previous study that estimated industry factors using both specialized companies and diversified ones is Nakano and Yoshimura (2004).

B. Synergies

We assume that the extent of synergies mainly depends on the combination of industries, and we express them by adding interaction term R_{iJ} to the regression equation. More precisely, we use $\sqrt{R_{iJ}R_{iK}}$, the square root of the product of the asset weightings. In this case, we use the 97 major industry groups for industry classifications J and K to curb the number of independent variables. This indicator is greater than 0 and synergies are created only when company i is in industries J and K at the same time. $\beta_{JK}^{\text{Synergy}}$ in equation (5) shows the synergies between industries J and K.

C. Economies of scale

Economies of scale lead to various advantages, such as greater bargaining power, lower R&D and marketing expenses, and more efficient corporate management. They are one incentive for companies to diversify.

We use total assets and market share as proxies for economies of scale. Total assets increase as a result of growth in scale from diversification and are closely related to mainly marketing expenses (brand value) and the efficiency of corporate management. Market share increases through concentrated investments in a particular industry and is closely related to mainly bargaining power, R&D expenses, and advertising expenses. For market share by sales for each of the 1,269 industry classifications, we use sales data for about 1.2 million companies in Japan in Teikoku Databank's COSMOS2 database, so as to also take into consideration the sales of privately held companies. For companies with multiple businesses, we take the weighted average of the market shares of each business, based on the company's business portfolio.

D. Conglomerate discount

Since the latter half of the 1990s, many conglomerate discount studies have been made, primarily in the US, and the notion that diversification hurts the value of a company has come to be broadly accepted among both academics and practitioners. Berger and Ofek (1995) found through an analysis based on a share price multiple method that diversified companies are valued at a roughly 15% discount to the total value of equivalent specialized companies. As to the reason, Rajan, Servaes, and Zingales (2000) and Scharfstein and Stein (2000) mentioned inefficiencies in internal capital markets, which encourage additional investments in businesses that are not worth continuing—this reflects the allocation of funds to each business segment being determined by parties inside the companies who apply weaker scrutiny than would outside investors. In this case, diversification hurts ROA and other fundamentals. In contrast, some attribute the conglomerate discount to an increase in information asymmetries owing to the greater complexity of operations. According to this hypothesis, diversification results in an increase in the cost of capital. Villalonga (2004) and a number of other recent empirical studies, however, have not found any conglomerate discount. There is currently considerable debate on the subject.

Here, we analyze the relationship with ROA using four proxies for the conglomerate discount: the number of segments, the number of subsidiaries, the number of equity-method affiliates, and a business diversification index. The greater the number of segments, the more opportunities there are to allocate funds through an internal capital market and the more that funds are inefficiently allocated. The number of subsidiaries and equity-method affiliates reflect a corporate group's complexity; the greater the number of subsidiaries and affiliates, the greater the management costs and the lower ROA. The business diversification index measures unrelated diversification based on major group classifications. With major industry group identifier *J*:

$$\text{Business diversification index}_i = 1 - \sqrt{\sum_{J=1}^{N} {R_{iJ}}^2} \qquad (4)$$

The second term on the right-hand side is the Herfindahl-Hirschman Index (HHI), an index of industry concentration used in antitrust cases. A high business diversification index figure indicates a highly diversified company. The highest the index figure can be is 1. The minimum is 0, when a company is in only one industry, based on major group classifications. If a company is in two industries, with 90% of its assets in one and 10% in the other, the business diversification index is only 0.1. If the assets are evenly split between the same two industries, the business diversification index is higher, 0.3. Hence, the index reflects not only the number of segments but also the decentralization of assets. A high business diversification index figure reflects relative difficulty in reaching unified decisions and having the different businesses understand each other, and greater inefficiencies in internal capital markets.

We use the four indicators above (A through D) in the following regression equation for ROA:

$$\begin{aligned}\mathrm{ROA}_i = &\sum_{J=1}^{N} \beta_J^{\mathrm{Ind}} \times R_{iJ} \\ &+ \sum_{\substack{\{\text{combinations for at least 10 cos}\} \\ \{J,K\}}} \beta_{JK}^{\mathrm{Synergy}} \times \sqrt{R_{iJ} R_{iK}} \\ &+ \beta^{\mathrm{Asset}} \times \mathrm{ASSET}_i + \beta^{\mathrm{Share}} \times \mathrm{Share}_i \\ &+ \beta^{\mathrm{Seg}} \times \mathrm{SEG}_i + \beta^{\mathrm{Aff}} \times \mathrm{Aff}_i \\ &+ \beta^{\mathrm{eqAff}} \times \mathrm{eqAff}_i + \beta^{\mathrm{DIV}} \times \mathrm{DIV}_i \\ &+ \varepsilon_i\end{aligned} \qquad (5)$$

R_{iJ}: business portfolio matrix,
ASSET: total assets, Share: market share
SEG: number of segments,
Aff: number of consolidated subsidiaries,
eqAff: number of equity − method affiliates,
DIV: business diversification index

The first line on the right-hand side represents industry factors, the second line synergies, the third line economies of scale, and the fourth and fifth lines the conglomerate discount. The last line represents the residual, which shows company-specific factors ignored by the model, such as technological strengths, brand strength, and the quality of management. Figures for total assets, number of segments, number of consolidated subsidiaries, and number of equity-method affiliates are natural logs.

3.2. Estimate results

In this section, we summarize the estimate results of our analysis.

(1) Estimate results for economies of scale and the conglomerate discount

Figure 1 shows the estimate results for economies of scale and the conglomerate discount. We use a panel data set for five years, from fiscal 2004 to fiscal 2008, except in model 3. A fiscal year dummy variable is included. The estimates are executed by both ordinary least squares and Bayesian methods, but only the Bayesian estimates are shown because of space limitations. For the Bayesian regressions, we use a Markov chain Monte Carlo (MCMC) simulation. The prior distributions are non-informative distributions for variables other than the industry factors and normal distributions for the industry factors, with cutoffs at the 1st and 99th percentiles for all companies' ROA. Using two Markov chains with different initial values, we eliminate the first 1,000 times and use the next 3,000 samplings to obtain the posterior distribution for β. Figure 1 shows the average for posterior distribution of β [av(β)] and the average divided by the standard deviation [av(β)/sd(β)]. Since each distribution of β is close to normal, an absolute value of av(β)/sd(β) that is greater than 2 signifies statistical significance. Using Geweke's approach for the convergence diagnostic, we confirm convergence is not rejected at the 5% confidence level for all models and variables. For details on Bayesian regressions using a Markov chain Monte Carlo simulation, see Iba et al. (2005). Models 1 and 2 in Figure 1 show estimate results for major group and group classifications, respectively. As the betas for total assets and market share are positive and statistically significant in both models, economies of scale contribute to a rise in ROA. Similarly, the betas for number of segments, number of subsidiaries, number of equity-method affiliates, and the business diversification index are all negative and statistically significant, suggesting that the conglomerate discount hurts ROA. Model 3 shows the results for fiscal 2007 only. Generally, the absolute value of av(β)/sd(β) declines, but the direction of the sign does not change. An analysis of the years from fiscal 2004 to fiscal 2006 yields the same results as for fiscal 2007, but for fiscal 2008, the av(β)/sd(β) for market share is less than 1 and low for other factors. As the number of segments, number of subsidiaries, and number of equity-method affiliates have a strong correlation (coefficient of 0.7) with total assets, in model 4 we divide these figures by total assets. The estimates in this case are consistent with the results so far, but the estimates for the number of equity-method affiliates divided by total assets are not statistically significant. The results for model 5, excluding the synergy term, are estimated in the same way as for model 2. In this case also, the estimates do not show major changes.

Fig. 1: Fundamentals (ROA)-based model estimates

	1		2		3		4		5	
	Industry factors = major groups		Industry factors = groups		Industry factors = groups Fiscal 2007		Industry factors = groups No. of segments / total assets		Industry fa tors = groups Estimates excluding synergies	
	av(β)	av(β) / sd(β)	av(β)	av(β) / sd(β)	av(β)	av(β) / sd(β)	av(β)	av(β) / sd(β)	av(β)	av(β) / sd(β)
Total assets	0.0073	14.17	0.0073	13.24	0.0118	9.52			0.00 5	1 .87
Market share	0.0024	7.76	0.0040	10.70	0.0025	3.12	0.0013	4.44	0.0038	10.17
No. of segments	-0.0078	-8.03	-0.0075	-7.58	-0.0085	-3.56			-0.0054	-8.72
No. of subsidiaries	-0.0037	-5.96	-0.0057	-9.04	-0.0068	-4.52			-0.0051	-7.49
No. of equity-method affiliates	-0.0047	-6.85	-0.0050	-7.42	-0.0058	-3.58			-0.0073	-7.49
Business diversification index	-0.0179	-3.96	-0.0164	-3.63	-0.0198	-1.83	-0.0164	-3.63	-0.0105	-2.92
No. of segments / total assets							-28.47	-7.55		
No. of subsidiaries / total assets							-23.92	-12.36		
No. of equity-method affiliates / total assets							-3.438	-0.70		
	R^2 = 0.517 N = 18,862		R^2 = 0.551 N = 18,694		R^2 = 0.587 N = 3,804		R^2 = 0.545 N = 18,694		R^2 = 0.532 N = 18,694	

Source: Nomura.

Note: Universe consists of all Japanese publicly traded companies. Panel data is for fiscal 2004-08, except for model 3. Industries with fewer than three publicly traded companies are excluded from independent variables. Values below the 1st percentile or above the 99th are replaced with values at the respective percentile cutoffs (treatment of outliers). R-squared is calculated using the following regression, with no intercept: $R^2=1-\Sigma(\text{actual-estimate})^2/\Sigma(\text{actual})^2$

Below, we consider model 2, with detailed industry classifications and high absolute values for av(β)/sd(β), the base model, and discuss the estimate results for industry ROA and synergies.

(2) Estimate results for industry ROA

In model 2, industry ROA is estimated for about 300 major group classifications with at least three publicly traded companies. The average industry ROA is 3.93% and the standard deviation 4.33%, and at least three quarters of the industries have ROA estimates in the range of 0-10%.

(3) Estimate results for synergies

Synergies are determined by the combination of industries a company is in (based on major group classifications). We estimate synergies for 84 combinations of industries that exist for at least 10 publicly traded companies. The average of the 84 $\beta_{JK}^{Synergy}$ estimates from model 2 is 0.6% and the standard deviation 4.4%. $\beta_{JK}^{Synergy}$ is positive for about 60% of the combinations and negative for 40%. For combinations with a negative value, indicating negative synergies (anergies), companies would tend to improve their ROAs by being in only one of the industries. As such combinations account for almost half, many companies clearly have difficulty generating synergies.

Figures 2 and 3 show all the statistically significant industry combinations with an absolute value for

Fig. 2: Industry combinations with synergies, ie, av(β) / sd(β) of at least 2

No.	Industry 1	Industry 2	av(β) %	av(β) / sd(β)
1	Information services	Retail trade (furniture, household utensils & household appliances)	9.4	3.89
2	Information services	Real estate lessors & managers	8.9	2.96
3	Iron & steel	General machinery	8.5	3.59
4	Chemical & allied products	Electronic parts & devices	7.7	3.81
5	Construction work, general including public & private construction work	Real estate lessors & managers	7.0	3.27
6	Chemical & allied products	General machinery	6.4	3.93
7	Electronic parts & devices	Transportation equipment	5.8	3.19
8	Nonferrous metals & products	Fabricated metal products	4.8	2.17
9	General machinery	Electronic parts & devices	4.7	3.18
10	Road freight transport	Warehousing	4.6	2.03
11	Information services	Miscellaneous business services	4.5	2.64
12	General machinery	Precision instruments & machinery	4.4	3.06
13	General machinery	Information & communication electronics equipment	3.9	2.31
14	Electrical machinery, equipment & supplies	Electronic parts & devices	2.8	2.46
15	Fabricated metal products	General machinery	2.8	2.09

Source: Nomura.

Fig. 3: Industry combinations with negative synergies, ie, av(β) / sd(β) of less than 2

No.	Industry 1	Industry 2	av(β) %	av(β)/sd(β)
1	Internet-based services	Video picture, sound information, character information production & distribution	-21.3	-6.13
2	Information & communication electronics equipment	Information services	-12.0	-4.99
3	Information services	Professional services, N.E.C.	-9.2	-6.16
4	Communications	Information services	-5.1	-2.14
5	Real estate agencies	Real estate lessors & managers	-3.6	-3.22
6	General machinery	Electrical machinery, equipment & supplies	-2.9	-2.25

Source: Nomura.

av(β)/sd(β) of at least 2. Figure 2 shows those combinations with large positive synergies and high ROA. Combinations of information services with either retail trade (furniture, household utensils & household appliances) or real estate lessors & managers have the highest synergies. The information services category includes data processing/information services as well as software development. The combination of IT-driven information services with retail or real estate leasing probably leads to accurate information for consumers and improvement in ROA. Next, combinations of iron & steel with general machinery, chemical & allied products with electronic parts & devices, and chemical & allied products with general machinery have high synergies, indicating that involvement in basic material/ processing industries and downstream manufacturing industries at the same time improves ROA. Figure 3 shows combinations with negative synergies and low ROAs. The weakest combination is Internet-based services with video picture, sound information, character information production & distribution. This indicates that Internet-based video distribution services have not led to sales and profits so far. Combinations of general machinery with electrical machinery, equipment & supplies, classifications that cover many Japanese electronics companies, have negative synergies, indicating that combinations of heavy industrial machinery and consumer electrical products do not lead to an improvement in ROA.

4. Market (cost of capital)-based Model

In this section, we estimate the impact of business portfolios on share prices. We use basically the same method as in the previous section but include a risk diversification index. Below, we explain how the risk diversification index is calculated and then outline the model and the estimate results.

4.1. Risk diversification index

Diversification of risk through a portfolio of businesses is qualitatively easy to understand and recognized by many executives, but it has rarely been quantitatively analyzed, probably because it is difficult to calculate the inter-industry correlation coefficients needed to quantify risk diversification. Also, it is unclear whether a company's diversification of business risks leads to a lower cost of capital, because investors can easily diversify risks through their stock portfolios. To express this point, it is necessary to take into consideration distress costs and default costs. We first quantify the extent of risk diversification and calculate the risk diversification index, and then confirm, based on a regression analysis, that the risk diversification index is significantly correlated with the cost of capital.

We next explain how the risk diversification index is calculated. Given that the lower the correlations between businesses, the greater the risk diversification, based on portfolio theory, correlation coefficients need to be calculated to quantify risk diversification. For stock portfolios, it is easy to estimate correlation coefficients using stock returns. For business portfolios, though, stock returns cannot be used because businesses do not have stock prices. It is possible to use financial data for each business, but it is difficult to obtain enough data because of the low frequency of the data and short period for which data is available (the past 10 years or so). Just as we break down the company's ROA into industry ROAs for each business, we estimate the monthly industry stock price return for each business from publicly traded companies' monthly stock price returns. Using these industry stock price returns, we calculate the risk σ_i of company i, which reflects business risk diversification, and risk $\bar{\sigma_i}$ of company i, which reflects no business risk diversification at all (see Appendix A). The risk diversification index D_i is defined as follows:

$$D_i = \frac{\bar{\sigma_i} - \sigma_i}{\bar{\sigma_i}} \quad (6)$$

The numerator shows the amount of risk reduction owing to diversification. The higher the index value, the greater the risk reduction is from a portfolio of businesses. As $0 \leq D_i (\leq 1)$, given that $\sigma_i \leq \bar{\sigma}_i$, specialized companies have the lowest index value, 0.

4.2. The model

Similar to equation (5) in Section 3.1, the following equation is a regression of company i's cost of equity capital CCE_i against the industry factors, risk diversification, economies of scale, and conglomerate discount.

$$
\begin{aligned}
\mathrm{CCE}_i = & \sum_{J=1}^{N} \beta_J^{\mathrm{Ind}} \times R_{iJ} \\
& + \beta^D \times D_{\mathrm{i}} \\
& + \beta^{\mathrm{Asset}} \times \mathrm{ASSET}_i + \beta^{\mathrm{Share}} \times \mathrm{Share}_i \\
& + \beta^{\mathrm{Seg}} \times \mathrm{SEG}_i + \beta^{\mathrm{Aff}} \times \mathrm{Aff}_i \\
& + \beta^{\mathrm{eqAff}} \times \mathrm{eqAff}_i + \beta^{\mathrm{DIV}} \times \mathrm{DIV}_i \\
& + \beta^{\mathrm{lev}} \times \mathrm{LEV}_i \\
& + \varepsilon_i
\end{aligned} \tag{7}
$$

R_{iJ}: business portfolio matrix,
D: Risk diversification index
ASSET: total assets, Share: market share
SEG: number of segments,
Aff: number of consolidated subsidiaries,
eqAff: number of equity − method affiliates,
DIV: business diversification index,
LEV: shareholders′ equity ratio

The first line on the right-hand side represents the industry's average cost of equity capital, the second line risk diversification, the third line economies of scale, and the fourth and fifth lines the conglomerate discount. The sixth line shows a financial leverage adjustment term. The higher the shareholders' equity ratio is, the lower the stock risk and the lower the cost of equity capital are. The last line shows the residual.

As is the case so far, the business portfolio matrix shows asset proportions based on book values.[3] Economies of scale show scale-related reductions in credit risk, liquidity risk, and information asymmetries. The cost of equity capital, the term on the left-hand side, is calculated in an implied manner, based on estimated earnings and actual share prices (see Appendix B).

4.3. Estimate results

The estimate results for each factor, except the industry factors, are shown in Figure 4. The sample period is fiscal 2008. Financial figures are for fiscal 2008, and the share prices and Toyo Keizai's earnings estimates used to calculate the cost of equity capital are as of the end of August 2008. From September 2008 onward, it is not possible to calculate the cost of equity capital because many of the earnings estimates are in fact losses, owing to the impact of the global financial crisis. The sample excludes companies with net loss forecasts for the following fiscal year. The prior distribution and convergence diagnostic are the same as in Section 3.2.

In Figure 4, the risk diversification index betas for all models are negative and statistically significant. This result indicates that investors like companies with business risk diversification, and hence these companies have a reduced cost of capital. Similarly, an increase in total assets contributes to a lower cost of capital. The betas for market share are negative, and the beta in model 2 is statistically significant. The betas for number of segments and other factors that reflect the conglomerate discount are mostly negative (and not significant), counter to the expectation that they would be positive. The beta for number of segments is positive only in model 3, but it is not significant. The implied cost of equity capital thus does not confirm a conglomerate discount. This result is consistent with that in Nakano and Yoshimura (2004).

The industry factor estimates in model 3 have an average of 10.9% and a standard deviation of 4.8%.

3 Asset proportions should be based on market values because the cost of capital is usually the cost of the market value of capital. However, we use book values because it is not possible to obtain the market values of companies' assets by business. For this reason, the weightings of businesses with lower assets by book value than by market value may be understated. An analysis of the cost of capital using book values, like the one in this paper, is justifiable when the correlation coefficient between book values and market values is close to 1. However, we do not believe there is much bias in the estimate results based on book values because the correlation coefficient (as of the end of March 2009, for all publicly traded companies) is 0.92, based on a conversion of market values and the book values of net assets into logarithms.

Fig. 4: Market (cost of capital)-based model estimates

	1		2		3		4	
	av(β)	av(β) / sd(β)	av(β)	av(β) / sd(β)	av(β)	av(β) / sd(β)	av(β)	av(β) / sd(β)
Risk diversification index	-0.1103	-4.43	-0.1124	-4.78	-0.1172	-5.66	-0.1242	-6.80
Total assets	-0.0018	-1.39	-0.0050	-4.47	-0.0051	-6.70	-0.0052	-6.99
Share	-0.0024	-2.68	-0.0026	-3.03				
No. of segments	-0.0005	-0.20			0.0029	1.29		
No. of subsidiaries	-0.0016	-1.01						
No. of equity-method affiliates	-0.0019	-1.20						
Business diversification index	0.0022	0.21	0.0009	0.09				
No. of segments / total assets			-1.3230	-0.19				
No. of subsidiaries / total assets			-2.6710	-0.68				
No. of equity-method affiliates / total assets			-21.5900	-2.33				
Shareholders' equity to total assets	-0.0458	-8.50	-0.0457	-8.69	-0.0438	-8.55	-0.0435	-8.59
	R^2=0.801 N =3,617		R^2=0.800 N =3,617		R^2=0.796 N =3,617		R^2=0.796 N =3,617	

Source: Nomura.

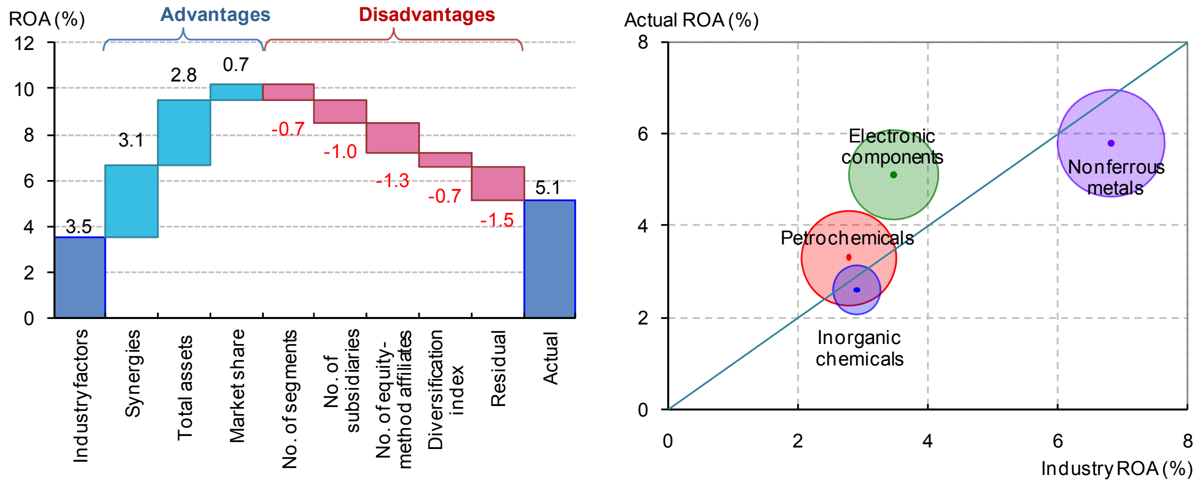
Note: Universe consists of all Japanese publicly traded companies (except financials). Financial data is for fiscal 2008. Risk diversification index and CCE figures are as of end-August 2008. Industries with fewer than three publicly traded companies are excluded from independent variables. Values below the 1st percentile or above the 99th are replaced with values at the respective percentile cutoffs (treatment of outliers). Industry factors are based on groups in all cases. R-squared is calculated using the following regression, with no intercept: R^2=1-Σ(actual-estimate)^2/Σ(actual)^2.

5. Applications of the Model

In this section, we apply the model to a fictitious chemical company X. The left-hand side of Figure 5 shows a breakdown of ROA into the model's factors. Such a breakdown indicates the strengths and weaknesses of a business portfolio. For example, a comparison by industry shows that chemical companies tend to have strong synergies, while electronics companies have large conglomerate discounts and weak synergies. Also, with an analysis of changes around the time of M&As, the advantages and disadvantages of M&As can be estimated.

The right-hand side of Figure 5 is a sample application of the industry factor portion. The actual ROAs of company X's four segments are compared with the ROAs of the industries the businesses are in. Using this approach, the segments can be assessed on a relative basis even with few specialized companies in the same particular industry. The same approach could also be used for industry ROA to estimate growth rates for each industry from sales forecasts, with the results used for business investment planning. We do not cover this topic in this paper, though.

Fig. 5: Model-based sample business portfolio analysis for a fictitious chemical company



Source: Nomura.

6. Conclusion

In this paper, we model the relationship between five core business portfolio factors (industry factors, synergies, economies of scale, risk diversification, and the conglomerate discount) and ROA as well as the cost of capital. Many previous studies have looked at synergies and the conglomerate discount separately. The model here is new and unprecedented in that it comprehensively analyzes all of these five factors.

The estimate results show that economies of scale increase ROA and lower the cost of capital. Risk diversification also lowers the cost of capital. The conglomerate discount lowers ROA but does not have a statistically significant correlation with the cost of capital. These results suggest that the reason for the conglomerate discount is a deterioration in fundamentals from inefficiencies in internal capital markets. We also estimate average ROAs, the cost of capital, and inter-industry synergies for different industries.

For business portfolio strategies, executives have often depended only on qualitative judgments based on experience, but quantitative analyses can also be incorporated using the model in this paper.

Appendix

A. Calculation of industry stock price returns

We estimate industry stock price returns β_J^{Ind} using the regression equation below, with an error term added to the right-hand side and each company's financial leverage-adjusted stock price return substituted into the left-hand side of equation (3), which breaks down a company's ROA into industry ROAs:

$$\tilde{r}_i = \sum_{J=1}^{N} \beta_J^{\text{Ind}} \times R_{iJ} + \epsilon_i \tag{8}$$

$$\left(\tilde{r}_i = \frac{r_i - r_f}{1 + (1-T)\frac{D_i}{E_i}} + r_f \right) \tag{9}$$

Here, r_i is the stock price return, $\tilde{r}_i$ the financial leverage-adjusted stock price return, r_f the risk-free rate, D_i the book value of liabilities, and E_i the market value of the stock. We use a uniform 40% for the effective tax rate T. Equation (9) is derived from expression (10) in Hamada (1972) and CAPM.

$$\beta_{\text{Unlevered}} = \frac{\beta_{\text{Levered}}}{1 + (1-T)\frac{D}{E}} \tag{10}$$

Using the derived 36-month industry stock price return, we estimate the inter-industry correlation coefficient ρ_{JK}^{Ind} and each industry's standard deviation σ_J^{Ind}. Based on ρ_{JK}^{Ind}, σ_J^{Ind}, and R_{iJ}, company i's average stock risk σ_i is

$$\sigma_i = \sqrt{\sum_{J,K} \left(R_{iJ}\sigma_J^{\text{Ind}}\right) \rho_{JK}^{\text{Ind}} \left(R_{iK}\sigma_K^{\text{Ind}}\right)} \tag{11}$$

In the case of a perfect correlation for all industries ($\rho_{JK}^{\text{Ind}} = 1$), the left-hand side is the weighted average σ_J^{Ind} for business portfolio R_{iJ}.

$$\bar{\sigma}_i = \sum_J \left(R_{iJ}\sigma_J^{\text{Ind}}\right) \tag{12}$$

$\bar{\sigma}_i$ corresponds to risk in the case where the business portfolio provides no risk diversification at all.

B. Calculation of the implied cost of equity capital (CCE)

We solve for CCE in the two-period EBO model below by inputting market value V^S, latest shareholders' equity B_0, estimated net income for the current fiscal year E_1, estimated net income for the following fiscal year E_2, and estimated dividends d.

$$V^S = B_0 + \frac{E_1 - \text{CCE} \times B_0}{1 + \text{CCE}} + \frac{E_2 - \text{CCE} \times (B_0 + E_1 - d)}{(1 + \text{CCE}) \times \text{CCE}} \tag{13}$$

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