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The Impact of Generic Strategy and Firm Life Cycle on Operational Efficiency

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Abstract

This paper documents whether a firm's operational efficiency is affected by its business strategy and firm life cycle stage. The sample comprises manufacturing firms listed on the Korean Stock Exchange over the period 2002-2012. The operational efficiency includes the aggregate and technical efficiencies. Empirical results are summarized as follows. First, for our pooled sample, the means of the aggregate and technical efficiency scores are 0.772, and 0.791, respectively, implying that sample firms have a significant level of inefficiency and still have room for improvement. Second, we find that firms in the maturity stage of life cycle are more efficient than are firms in the other stages, and that differentiators are more operationally efficient than cost leaders in the Korean manufacturing sector. This evidence implies that firms in the maturity stage and pursuing differentiation strategy are statistically associated with higher operational efficiency. Results of this study may provide manufacturing firms with practical guideline as to which factors should be emphasized to improve operational efficiency.

Keywords: *Aggregate efficiency, Technical efficiency, Firm life cycle, Differentiation, Cost leadership*

1. Introduction

Profitability is an essential object for the Korean manufacturing sector. Miller (1984) decomposes profitability into efficiency and price recovery [14]. Under the circumstance where price recovery is deteriorated by market competition, efficiency is the primary means of improving profitability. To maximize efficiency, firms formulate business strategy to achieve competitive advantage in the market place. To this end, they have engaged in a number of innovative practices related to the business functions of their value chain. Some firms focus more on R&D and design, and others emphasize production activity to improve efficiency. This study begins with the idea that operational efficiency may differ across a firm's life cycle stages and strategies the firm follows.

Firm life cycle theory identifies how a firm grows, matures, and declines [15]. Unlike product or industry life cycle, firm life cycle considers the firm as a combination of distinct life cycle stages [6]. These stages are discerned by firm-specific attributes such as sales growth, capital expenditures, investment opportunities, the number of employees, age, and so on.

In the growth stage, revenues and capital expenditures grow rapidly, there are more opportunities for investments, earnings are likely to get behind, and the firm starts to build efficiencies in production and sales activities. This stage requires more employees to meet

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operational activities. As the firm moves to maturity, the market for the firm's products becomes more competitive and begins to saturate. The firm focuses on improving efficiency in process and reducing overall operating costs. In the decline stage, revenues and earnings decrease, unutilized capacity increases, and managers are faced with a decision as to whether to downsize their production capacity.

Firm life cycle and generic strategy theories can provide an alternative economic framework for studying firms. A number of researchers have investigated the effects of firm life cycle stages and strategic positioning on the performance measures. However, to date, little literature has incorporated a firm's life cycle and business strategy into its operational efficiency. Therefore, we address the following research question: Do the life cycle stages and generic strategies affect the operational efficiency?

2. Research Design and Hypothesis

The aim of this paper is to estimate the impact of firm life cycle stage and generic strategy on operational efficiency. To achieve our research objective, we measured the operational efficiency scores of firms, classified firms into one of three life cycle stages, and categorized each firm into two different generic strategies.

2.1. Operational Efficiency

Koopmans (1951) defined full efficiency as that attained by a firm if and only if none of its outputs can be improved without worsening some of its other outputs. In most real applications, the theoretical levels of efficiency will not be known [11]. Farrell (1957) suggested a measure of efficiency with the information that is empirically available [8]. According to this approach, a firm is technically efficient when it succeeds in producing as large as possible outputs from a given set of inputs [8]. Charnes *et al*. (1978) suggested the data envelopment analysis (DEA) model, which measures the efficiency of a firm relative to similar firms [5]. The DEA model utilizes a linear programming technique to determine a piecewise envelopment surface from the observed levels of inputs and outputs of firms. The envelopment surface is referred to as the efficient frontier. Firms that form the frontier are termed efficient relative to the rest of their peers; those that do not are termed inefficient.

This study applies DEA in measuring the operational efficiency of manufacturing firms. DEA models will have two orientations: input-oriented and output oriented. The input- (or output-) oriented DEA model is used to test if a firm can reduce (or increase) its inputs (or outputs) while keeping the outputs (or inputs) at their current levels [7]. In recent years, Korean manufacturing firms have been required to meet different clients' needs to survive the fierce global competition, and they have typically attempted to improve efficiency by managing outputs rather than inputs. Accordingly, we choose the output-oriented DEA model for the present study [19].

The technique used for measuring the operational efficiency of each firm follows Charnes *et. al.*, (1978), and Banker et al. (1984) [3-5]. For each firm-year observation (j, t) for manufacturing firms j=1,…, J, and year t=1,....., T, y_{jt} is a vector of R outputs and x_{jt} is a vector of I inputs, while for the entire sample, there is an I×J input matrix, X, and an R×J output matrix, Y. The operational efficiency score, $\hat{\theta}_{kt}$, of an observation, k, in period t is the reciprocal of $\hat{\Phi}_{kt}$, which is obtained from the following linear programming problem.

$$\hat{\Phi}_{kt} = \max \ \Phi_{kt} \tag{1}$$

subject to: $\sum_{t=1}^{T} \sum_{j=1}^{J} \lambda_{jt} x_{ijt} \le x_{ikt}$, i =1, 2, ..., n

$$-\sum_{t=1}^{T}\sum_{j=1}^{J}\lambda_{jt}y_{rjt}+\Phi_{kt}y_{rkt}\leq 0 \text{, r = 1, 2, ..., M}$$

$$\lambda_{jt},\Phi_{kt}\geq 0$$

where, x_{ijt} is the quantity of input i consumed by a firm-year observation (j, t), y_{rjt} is the quantity of output r produced by a firm-year observation (j, t), λ_{jt} the weight placed on a firm-year observation (j, t) data, and x_{ikt} and y_{rjt} are quantities of inputs and outputs, respectively, for a firm-year observation (j, t) being evaluated.

For each firm-year observation (j, t), $\hat{\theta}_{kt}$ is a scalar ($0 \leq \hat{\theta}_{kt} \leq 1$), with $\hat{\theta}_{kt}$ = 1 indicating an efficient firm-year observation that is on the frontier and $\hat{\theta}_{kt}$ < 1 indicating an inefficient firm-year observation that is below the frontier [3-5]. By solving equation (1), which is based on the assumption of constant returns-to-scale of activities, we compute an efficiency score for each firm-year observation and define it as aggregate efficiency [3-5]. Employing equation (1) in envelopment form to obtain an optimal solution ($\lambda_1^*,\ldots,\lambda_J^*$), returns-to-scale at this point can be determined from the following conditions [3-5]:

Increasing returns-to-scale (IRS) prevails if $\sum \lambda_j^* < 1$ for all optimum solutions.

Constant returns-to-scale (CRS) prevails if $\sum \lambda_j^* = 1$ for all optimum solutions.

Decreasing returns-to-scale (DRS) prevails if $\sum \lambda_j^* > 1$ for all optimum solutions.

As mentioned above, equation (1) imposes the restriction of CRS on the technology. This is somewhat misleading because firms may be operated under the technology of IRS or DRS. Banker et al. (1984) introduced the variable returns-to-scale DEA model to relax the restriction and measured the technical efficiency of firms. We compute the technical efficiency of firms based on this new model [3].

2.2. Generic Strategy

Although there are several business strategy typologies [1-13], we use the Porter (1980) typology to define firms' business strategy [17]. According to this typology, differentiation and cost leadership are two broad generic strategies for achieving a competitive advantage in the market place. Firms pursuing a differentiation strategy can successfully differentiate their products or services from their competitors by being a technology leader or by creating a high degree of customer intimacy. Differentiators focus on new product development, brand building, distribution and marketing, quality control, and fast delivery, and they can easily pass the costs incurred in activities for differentiating on to their customers by setting prices high [17].

Cost leaders emphasize cost control activities, standardized product design, and tight budgetary control of overhead costs, R&D expenses, and sales and advertising expenses [17]. The customers targeted by cost leaders are usually very sensitive to the sales price of the product or service, and they value price dimensions of a product or service much more than do customers of differentiators [9-16]. It is crucial for a cost leader to set prices low and maintain current market share.

Overall, we expect that differentiators will determine prices that are high relative to cost leaders in the market place; consequently, the operational efficiency of differentiators will be higher than that of cost leaders.

Hypothesis 1: Operational efficiency of firms pursuing a differentiation strategy is higher than that of firms following a cost leadership strategy.

We classify firm-year observations into two generic strategies using the following five financial indicators used in prior research [10]: the ratio of SG&A cost to sales (SG&A cost ratio), the ratio of R&D to sales (R&D intensity), market to book ratio, the ratio of total asset to sales (asset intensity), and the ratio of total costs to sales (total costs ratio). The procedure of classifying firm-year observations into the two strategies is as follows:

First, the five financial indicators for each firm-year observation are calculated. All indicators are computed using a rolling average of the respective yearly ratios over the prior three years. Second, we rank each of the five indicators by forming quintiles. Third, for each of the five indicators, firms in the top quintile receive a score of 5, those in the bottom quintile receive a score of 1. Thus, the composite score of each firm-year observation ranges from five to twenty-five. Fourth, a composite score tertile is created. Firm-year observations in the top tertile are classified as differentiators, and those in the bottom tertile are classified as cost leaders.

2.3. Firm Life Cycle

Life cycle theory suggests that a firm possesses different economic attributes across life cycle stages [20]. The purpose of life cycle analysis is to group firm-year observations into similar categories and then use these categories as a framework for analyzing several firm characteristics over the life cycle. Black (1998) noted that firms in the same life cycle stage are relatively more homogeneous across multiple financial characteristics than a pooling of all firm-year observations [4].

Firms start to build operational efficiency in production and sales activities at the Growth stage. As firms move on to the Maturity stage, they focus on improving efficiency in various business functions. In the Decline stage, the operational efficiency recedes due to a decrease in sales revenue and an increase in unutilized capacity. This leads to our second hypothesis:

Hypothesis 2: Operational efficiency of firms in the Maturity stage is higher than that of firms in the other life cycle stages.

This study classifies firm-year observations into three life cycle stages (Growth, Maturity, and Decline) using the following six descriptors commonly used in prior researches on firm life cycle [2, 4, 18]: sales growth, change in capital expenditure, market to book ratio, change in the number of employees, retained earnings ratio, and firm age.

Table 1. Firm Life Cycle Descriptor

Life Cycle Stage (score)	Sales Growth	Change in Capital Expenditure	Market to Book Ratio	Change in the Number of Employees	Retained Earnings Ratio	Firm Age
Growth (1)	H	H	H	H	L	L
Overlapped (2)	2nd	2nd	2nd	2nd	2nd	2nd
Maturity (3)	3rd	3rd	3rd	3rd	3rd	3rd
Overlapped (4)	4th	4th	4th	4th	4th	4th
Decline (5)	L	L	L	L	H	H

Note: H and L indicate highest and lowest, respectively.

Classifying firm-year observations into the Growth, Maturity, and Decline stages by using the six descriptors is as follows:

First, the six life cycle descriptors for each firm-year observation are computed. We selected the median value of the prior five years for each variable to mitigate the yearly variations. Second, quintiles are calculated for each of the descriptors. Third, the six classification variable observations for each firm-year observation are assigned to each quintile of the same variable, and they are given a score as shown in Table 1. Accordingly, the composite score ranges from six to thirty. Fourth, a composite score quintile is formed, and firm-year observations in the first, third, and fifth quintiles are classified as Growth, Maturity, and Decline stages, respectively. We discarded firm-year observations in the second and fourth quintiles because they are likely to defy definitive categorization.

2.4. Empirical Estimation

To test hypotheses 1 and 2, we estimate the following equation using panel regression models:

$$\begin{aligned} \ln\hat{\theta} = {} & \alpha + \beta_1{*}Growth + \beta_2{*}Maturity + \beta_3{*}Decline \\ & + \beta_4{*}Differentiation + \beta_5{*}Cost\ leadership + \beta_6{*}Returns\text{-}to\text{-}scale \\ & + \beta_7{*}\Delta\ln SALES + \beta_8{*}\Delta\ln COGS + \beta_9{*}\Delta\ln SG\&A + \beta_{10}{*}\Delta\ln NPPE \\ & + \beta_{11}{*}\Delta\ln Inventory + \beta_{12}{*}\Delta\ln Employee + \beta_{13}{*}Debt\ ratio + \beta_{14}{*}\ln Age + \varepsilon \end{aligned} \quad (2)$$

In equation (2), $\ln\hat{\theta}$ is the natural logarithm of the operational efficiency scores: aggregate and technical efficiency. Following prior studies [12-18], we select nine contextual variables that could moderate each efficiency score. Table 2 reports the factors affecting manufacturing firms' efficiency. In equation (2), we can accept our hypotheses if the estimates of β_1, β_2, β_3, β_4, and β_5 are significantly (-), (+), (-), (+), and (-), respectively.

Table 2. Independent Variable

Proxy	Variable	Measurement
Firm life cycle	Growth	1 if the firm's life cycle stage is Growth, 0 otherwise
	Maturity	1 if the firm's life cycle stage is Maturity, 0 otherwise
	Decline	1 if the firm's life cycle stage is Decline, 0 otherwise
Strategy	Differentiation	1 if the firm is a differentiator, 0 otherwise
	Cost leadership	1 if the firm is a cost leader, 0 otherwise
Firm characteristic	Returns-to-scale	Returns-to-scale has the value of 1, 0, or -1, if the firm experiences IRS, CRS, or DRS, respectively.
Managerial ability	$\Delta\ln SALES$	$\ln SALES_t - \ln SALES_{t-1}$, Growth in sales revenue
	$\Delta\ln COGS$	$\ln COGS_t - \ln COGS_{t-1}$, Growth in cost of goods sold
	$\Delta\ln SG\&A$	$\ln SG\&A_t - \ln SG\&A_{t-1}$, Growth in selling, general, and administrative cost
	$\Delta\ln NPPE$	$\ln NPPE_t - \ln NPPE_{t-1}$ Growth in net property, plant and equipment (NPPE)
	$\Delta\ln Inventory$	$\ln Inventory_t - \ln Inventory_{t-1}$, Growth in inventory
	$\Delta\ln Employee$	$\ln Employee_t - \ln Employee_{t-1}$, Growth in the number of employees (Employee)
Financial ability	Debt ratio	$Debt_t / Stockholders'equity_t$
Age	$\ln Age$	Age equals one plus the difference the year under investigation and the firm's year of inception.

3. Sample Selection and Descriptive Statistics

3.1. Sample Selection

The sample selection begins with all manufacturing firms (Korean Industry Standard codes 031001-033302) listed on the Korean Stock Exchange from 2002 to 2012. We focus on manufacturing firms to maintain homogeneity in the sample. Five years of data are required to compute life cycle descriptors.

We impose the following criteria for our sample: (i) those firms whose fiscal year ends on December 31, and (ii) those firms whose financial data can be obtained from KIS-VALUE. All monetary value items have been deflated to 2010 Korean won using the consumer price index disclosed by the Bank of Korea. Our final full sample consists of 2,890 firm-year observations.

3.2. Descriptive Statistics

3.2.1. Operational Efficiency: we adopt the output-oriented four-input one-output DEA model. Prior studies have used sales revenue as output in estimating efficiency [12-18].

Table 3. Explaining Sales Revenue

Independent variables	Parameter estimate (p-value)		
	OLS	Fixed-effect	Random-effect
$\ln COGS$	0.822 (<0.01)***	0.857 (<0.01)***	0.834 (<0.01)***
$\ln SG\&A$	0.195 (<0.01)***	0.149 (<0.01)***	0.174 (<0.01)***
$\ln NPPE$	-0.004 (0.223)	0.011 (0.041)**	0.001 (0.912)
$\ln Employee$	-0.002 (0.623)	0.033 (<0.01)***	0.013 (0.067)*
F-statistics	94719.3 (<0.01)***	8486.03 (<0.01)***	33543.7 (<0.01)***
Adjusted R-square	0.991	0.819	0.977
F test for individual effect	12.194 (<0.01)***		n/a
Hausman test	n/a	x^2 =43.043 (<0.01)***	

Note: Intercepts are estimated but not reported in the table.
*, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Regarding input, relevant studies in the context of manufacturing firms have utilized cost of goods sold (COGS), selling, general and administrative cost (SG&A), net property, plant and equipment (NPPE), and the number of employees (employee). In order to determine input variables that are more appropriate, we estimate pooled ordinary least square (OLS) and panel data regression models. The results of OLS, fixed-effect, and random-effect models are reported in Table 3. Results of F test for individual effect and Hausman test suggest that the fixed-effect model is more appropriate. Therefore, this paper uses COGS, SG&A, NPPE, and Employee as input variables which are each significant in the fixed-effect model.

Table 4 provides descriptive statistics for output, input, and efficiency scores. The median values of the output variable and the four input variables are all much smaller than their mean values, indicating that the data are skewed to the left. In contrast, the median values of the aggregate efficiency scores are slightly larger than mean values, indicating that the data are skewed to the right. The mean of the aggregate efficiency scores is 77.2% and the median is 77.9%. The lower and upper quartiles for the aggregate efficiency of our pooled data are 72.7% and 82.6%, respectively. These results suggest that there is a significant level of inefficiency and that there remains room for improvement.

Table 4. Distribution of Output, Input and Efficiency Score

Description		Mean	Std. Dev.	Q1	Median	Q3
Output	Sales Revenue	1,473	6,542	109	219	506
Input	COGS	1,180	4,952	83	177	410
	SG&A	173	1,013	11	22	65
	NPPE	501	2,067	35	72	192

	Employee	1,808	6,886	225	417	855
Efficiency Score	Aggregate	0.772	0.098	0.727	0.779	0.826
	Technical	0.791	0.095	0.736	0.792	0.844

Note: All monetary value items are expressed in billion Korean won and have been deflated to 2010 Korean won using the index of consumer prices.

3.2.2. Generic Strategy: Table 5 shows the number of observations across the different generic strategies of the sample firms.

Table 5. Distribution of Financial Indicator for Generic Strategies

Strategy	Variable	Mean	Std. Dev.	Q1	Median	Q3
Full sample (N=2,890)	SG&A ratio	0.226	0.285	0.076	0.125	0.229
	R&D intensity	0.012	0.048	0.000	0.002	0.011
	Market to book ratio	1.133	2.197	0.453	0.718	1.206
	Asset intensity	1.229	0.715	0.828	1.079	1.419
	Total cost ratio	0.953	0.133	0.915	0.950	0.977
Differentiation (N=535)	SG&A ratio	0.439	0.353	0.178	0.311	0.620
	R&D intensity	0.026	0.040	0.004	0.017	0.036
	Market to book ratio	1.794	1.501	0.900	1.328	2.083
	Asset intensity	0.998	0.316	0.772	0.952	1.159
	Total cost ratio	0.896	0.057	0.869	0.902	0.935
Cost leadership (N= 608)	SG&A ratio	0.116	0.250	0.052	0.075	0.109
	R&D intensity	0.001	0.007	0.000	0.000	0.000
	Market to book ratio	0.448	0.241	0.298	0.405	0.541
	Asset intensity	1.518	0.805	1.043	1.304	1.807
	Total cost ratio	0.993	0.212	0.951	0.972	1.000

The numbers of firm-year observations for the differentiation and cost leadership strategies are 535, and 608, respectively. The sample firm-year observations were decreased from 2,890 in the measurement of operational efficiency to 1,143 (=535+608) in the classifying generic strategies, because we discarded firm-year observations in the middle tertile. The mean values of SG&A ratio, R&D intensity, and Market to book ratio in the differentiation firms are higher than those in the cost leadership firms. On the other hand, the mean values of Asset intensity and Total costs ratio in the cost leadership firms are higher than those in the differentiation firms.

3.2.3. Firm Life Cycle: Table 6 shows the number of observations across the three different life cycle stages of the sample firms. The number of firm-year observations for the Growth, Maturity, and Decline stages are 719, 513, and 517, respectively. The sample firm-year observations were decreased from 2,890 in the measurement of operational efficiency to 1,749 (=719+513+517) in the analysis of firm life cycle. This is because we excluded the firm-year observations classified into the second and fourth quintiles, as they defy concise categorization, as mentioned above. The mean values of sales growth, changes in capital expenditure, market to book ratio, and changes in the number of employee decrease as the firm goes from the Growth to the Decline stage. On the other hand, the mean values of retained earnings ratio and firm age increase from the Growth to the Decline stage.

Table 6. Distribution of Descriptors for Firm Life Cycle Stages

Life cycle stage	Variable	Mean	Std. Dev.	Q1	Median	Q3
Full sample (N=2,890)	Sales growth	0.082	0.140	0.019	0.073	0.129
	Change in capital expenditure	0.021	0.084	-0.028	0.006	0.057
	Market to book ratio	1.053	1.988	0.442	0.685	1.159
	Change in the number of employees	-0.005	0.065	-0.031	-0.003	0.025
	Retained earnings ratio	7.031	16.966	1.089	2.602	6.634
	Firm age	38.662	13.966	31.000	38.000	47.000
Growth (N=719)	Sales growth	0.196	0.218	0.111	0.158	0.213
	Change in capital expenditure	0.099	0.095	0.035	0.084	0.146
	Market to book ratio	1.792	1.780	0.835	1.390	2.173
	Change in the number of employees	0.051	0.070	0.011	0.040	0.076
	Retained earnings ratio	3.450	5.019	0.673	1.944	4.190
	Firm age	30.006	13.599	21.000	31.000	38.000
Maturity (N=513)	Sales growth	0.079	0.079	0.036	0.078	0.120
	Change in capital expenditure	0.025	0.068	-0.020	0.017	0.060
	Market to book ratio	1.046	1.062	0.548	0.775	1.148
	Change in the number of employees	0.001	0.043	-0.016	0.000	0.024
	Retained earnings ratio	6.675	14.133	0.991	2.580	6.805
	Firm age	37.140	13.957	29.000	36.000	43.000
Decline (N=517)	Sales growth	0.010	0.073	-0.027	0.017	0.057
	Change in capital expenditure	-0.028	0.050	-0.048	-0.029	-0.008
	Market to book ratio	0.518	0.361	0.321	0.438	0.604
	Change in the number of employees	-0.048	0.057	-0.065	-0.034	-0.015
	Retained earnings ratio	10.429	21.778	1.857	4.074	10.479
	Firm age	46.229	11.506	39.000	46.000	52.000

4. Regression Results

Table 7 summarizes the regression results. The results of F test for individual effect and Hausman test suggest that the fixed-effect model is more appropriate. Therefore, we discuss the results of panel data regression analysis focusing on the fixed-effect model.

In panel A, we report the empirical results of estimating equation (2) when the dependent variable is aggregate efficiency. We find that the coefficient for Growth is -0.038 (p-value=<0.01), which suggests firms in the Growth stage are less efficient than firms in the other two stages. The coefficient for Maturity is estimated to be 0.019 (p-value=<0.01), implying that firms in the Maturity stage are more efficient than firms in the other two stages. However, the coefficient for Decline is not significant at the 10% level. As for generic strategies, we find that the coefficient for Differentiation is 0.035 (p-value=<0.01), suggesting that firms pursuing a differentiation strategy are more operationally efficient than firms following a cost leadership strategy in the Korean manufacturing sector. The economic significance between firms' generic strategies and aggregate efficiency is based on the interpretation of the coefficient for Differentiation (or Cost leadership). Because equation (2) is the natural log specification, the coefficient for an independent variable reflects the effect of a 1% increase in that variable on the dependent variable. For example, for every 1% increase in Differentiation, there is a 3.5% increase in aggregate efficiency. Similarly, for every 1% decrease in Cost leadership, there is a 3.5% increase in aggregate efficiency. This evidence implies that firms in the Maturity stage as well as Differentiation are statistically associated with higher operational efficiency. Therefore, hypotheses 1 and 2 are accepted.

The estimated coefficient of returns-to-scale is negative and statistically significant at the 1% level with respect to the aggregate efficiency, whereas growth in sales ($\Delta \ln SALES$) positively relates to aggregate efficiency scores. This implies that the sales volume may have been instrumental in raising manufacturing firms' efficiency. The estimated coefficients of $\Delta \ln SALES$, growth in inventory ($\Delta \ln Inventory$), and growth in employee ($\Delta \ln Employee$) are positive and significant, suggesting that the efficiency of manufacturing firms can be improved by each. The estimated coefficients of growth in cost of goods sold ($\Delta \ln COGS$), SG&A ($\Delta \ln SG\&A$**),** and net property, plant and equipment ($\Delta \ln NPPE$) are negative and significant. This implies that efficiency is related to the ability of these firms to control operating costs and production capacity.

Panel B show the empirical results of estimating equation (2) when the dependent variable is technical efficiency, and overall findings are the same as those of Panel A.

Table 7. Empirical Results of Estimating Equation (2) Measuring Impact of Generic Strategy and Firm Life Cycle Stage on Operational Efficiency

Panel A: When the dependent variable is aggregate efficiency

Independent variable		Parameter estimate (p-value)		
		OLS	Fixed-effect	Random-effect
Firm life cycle	Growth	-0.035 (<0.01)***	-0.038 (<0.01)***	-0.038 (<0.01)***
	Maturity	0.036 (<0.01)***	0.019 (<0.01)***	0.024 (<0.01)***
	Decline	0.013 (0.08)*	0.007 (0.180)	0.008 (0.148)
Generic strategy	Differentiation	0.026 (<0.01)***	0.035 (<0.01)***	0.031 (<0.01)***
	Cost leadership	-0.019 (<0.01)***	-0.035 (<0.01)***	-0.030(<0.01)***
Managerial ability	Return-to-scales	-0.017 (<0.01)***	-0.012 (<0.01)***	-0.013 (<0.01)***
	$\Delta \ln SALES$	0.541 (<0.01)***	0.548 (<0.01)***	0.546 (<0.01)***
	$\Delta \ln COGS$	-0.455 (<0.01)***	-0.475 (<0.01)***	-0.471 (<0.01)***
	$\Delta \ln SG\&A$	-0.016 (0.229)	-0.039 (<0.01)***	-0.037 (<0.01)***
	$\Delta \ln NPPE$	-0.019 (0.035)**	-0.037 (<0.01)***	-0.033 (<0.01)***
	$\Delta \ln Inventory$	0.039 (<0.01)***	0.025 (<0.01)***	0.026 (<0.01)***
	$\Delta \ln Employee$	0.031 (0.098)*	0.056 (<0.01)***	0.054 (<0.01)***
Financial ability	Debt ratio	-0.139 (<0.01)***	-0.059 (0.014)**	-0.097 (<0.01)***
Age	$\ln Age$	-0.028 (<0.01)***	0.068 (<0.01)***	-0.003 (0.759)
F-statistics		49.173 (<0.01)***	62.665 (<0.01)***	72.073 (<0.01)***
Adjusted R-square		0.222	0.255	0.294
F test for individual effect		10.65 (<0.01)***		n/a
Hausman test		n/a	x^2 =92.113 (<0.01)***	

Panel B: When the dependent variable is technical efficiency

Independent variable		Parameter estimate (p-value)		
		OLS	Fixed-effect	Random-effect
Firm life cycle	Growth	-0.035 (<0.01)***	-0.035 (<0.01)***	-0.036 (<0.01)***
	Maturity	0.039 (<0.01)***	0.018 (<0.01)***	0.025 (<0.01)***
	Decline	0.009 (0.178)	0.006 (0.273)	0.006 (0.272)
Generic strategy	Differentiation	0.027 (<0.01)***	0.033 (<0.01)***	0.028 (<0.01)***
	Cost leadership	-0.012 (0.061)*	-0.033 (<0.01)***	-0.029 (<0.01)***
Managerial ability	Return-to-scales	-0.019 (<0.01)***	-0.016 (<0.01)***	-0.017 (<0.01)***
	$\Delta \ln SALES$	0.453 (<0.01)***	0.465 (<0.01)***	0.461 (<0.01)***
	$\Delta \ln COGS$	-0.422 (<0.01)***	-0.443 (<0.01)***	-0.437 (<0.01)***
	$\Delta \ln SG\&A$	-0.038 (<0.01)***	-0.052 (<0.01)***	-0.051 (<0.01)***
	$\Delta \ln NPPE$	-0.006 (0.461)	-0.025 (<0.01)***	-0.019 (<0.01)***

	Δ ln *Inventory*	0.038 (<0.01)***	0.032 (<0.01)***	0.031 (<0.01)***
	Δ ln *Employee*	0.051 (<0.01)***	0.061 (<0.01)***	0.063 (<0.01)***
Financial ability	Debt ratio	-0.142 (<0.01)***	-0.120 (<0.01)***	-0.135 (<0.01)***
Age	ln *Age*	-0.025 (<0.01)***	0.082 (<0.01)***	-0.002 (0.803)
F-statistics		48.168 (<0.01)***	52.984 (<0.01)***	62.315 (<0.01)***
Adjusted R-square		0.218	0.226	0.265
F test for individual effect		8.656 (<0.01)***		n/a
Hausman test		n/a	χ^2 =40.412 (<0.01)***	

Note: Intercepts are estimated but not reported in this table.
*, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

5. Conclusion

We examine whether a firm's operational efficiency is affected by its business strategy, firm life cycle stage, and the characteristics of managerial and financial capability. The sample consists of manufacturing firms listed on the Korean Stock Exchange over the period 2002-2012. The operational efficiency includes the aggregate and technical efficiencies. Empirical results are summarized as follows.

First, we measure operational efficiency scores adopting the output-oriented four-input one-output DEA model. The output is sales revenue, and the inputs are cost of goods sold, SG&A cost, net property, plant and equipment, and the number of employees. The mean of the aggregate and technical efficiency scores are 0.772 and 0.791, respectively, implying that Korean manufacturing firms have a significant level of inefficiency and that there remains room for improvement.

Second, this study creates the measures of differentiation and cost leadership designed to provide scores that reflect the business strategy adopted by sample firms. We use this score to categorize firms as differentiators and cost leaders. The numbers of firm-year observations classified as differentiator and cost leader are 535 (18.5%) and 608 (21.0%), respectively.

Third, we grouped firm-year observations into three life cycle stages. The numbers of firm-year observations classified as the growth, maturity, and decline stages are 719 (24.9%), 513 (17.8%), and 517 (17.9%), respectively. Samples in the growth stage are far more prevalent than those in the other stages.

Fourth, we find that firms in the maturity stage are more efficient than are firms in the other stages, and differentiators are more operationally efficient than cost leaders in the Korean manufacturing sector. This evidence implies that firms in the maturity stage and pursuing differentiation strategy are statistically associated with higher operational efficiency.

Results of this study may provide manufacturing firms with practical implications regarding what factors should be emphasized to improve efficiency and to achieve their strategic goals.

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