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Sources of Revenue Change in the Taiwan Cement Industry: 1994-2001

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Abstract

This study incorporates the productivity changes decomposition method into the revenue change decomposition model, in which four main sources of revenue change are identified, namely: (1) the price effect, (2) the technical change effect, (3) the pure technical efficiency effect, and (4) the scale efficiency effect, and applies it to the determination of the relative prominence of various sources of operating revenue change in the Taiwanese cement industry during 1994-2001. The analytical results reveal that the main source of downward pressure on revenue change was scale efficiency effect, while the main source of upward pressure was technical change effect.

Keywords: Revenue Change, Cement Industry

Introduction

Enterprises generally attempt to maximize their profits, and have various options for doing so. For example, enterprises can seek to increase productivity (Uctum and Viana, 1999; Lazear, 2000; Stiroh, 2000), improve energy efficiency (Ingram, 1999; Nikiforuk, 1999), or change their price structure (Uctum and Viana, 1999; Hangstefer, 2000). Reviewing production and sales in the Taiwanese cement industry during the last ten years, the construction industry has declined and public utility construction has slowed, the use of Slag and Fly Ash cement has increased, buildings have begun to use more steel framed structures, imported cement is flourishing and negatively affecting local production, and domestic demand is continuously declining, with ordinary cement domestic sales in 2001 being just 62% of their 1993 level. According to the income statements contained within the Taiwan Securities and Futures Market Development Foundation database (covering the period from 1994 Q1 to 2001 Q4). The calculation results indicate that the industry’s net profits have gradually declined over this period. This situation result from a sharp reduction in operating revenue, while operating costs did not change significantly. Consequently, this study takes a major step towards explaining the causes of revenue change in the Taiwanese cement industry during 1994-2001 by determining the relative prominence of various sources of change. The research results attempt to find out the major reasons for revenue change occurring, and provide a valuable reference for decision-makers.

Methodology

We are now prepared to decompose a producer's revenue change between period t and period t+1 into seven distinct sources. We begin by decomposing revenue change into two basic components: a price effect and quantity effect. One possible decomposition of revenue change into a price effect and quantity effect is R^{t+1}-R^t=(p^{t+1} - p^t)^T y^t + p^{tT} (y^{t+1} - y^t) and another is R^{t+1}-R^t=(p^{t+1} - p^t)^T y^t + p^{t+1T} (y^{t+1} - y^t). In first equation, the price effect is a Passche type of input price index and the quantity effect is a Laspeyres type of input quantity index. In second equation, the price effect is a Laspeyres type of input price index and the quantity effect is a Passche type of input quantity index. In light of the well-know deficiencies of Passche and Laspeyres types of index, Bennet (1920) recommended a decomposition of cost change by means of the arithmetic mean of first and second equation. Consequently, This study adopts Bennet (1920) to decompose the effects causing changes in revenue.

Revenue changes decomposition framework

This study considers an enterprise that produces one product, denoted by the output vector Y = (Y_1). Furthermore, the enterprise's product price vector is P = (P_1). R^t denotes the enterprise's revenue in period t. Moreover, total revenue in period t may be denoted by: $R^t = p_1^{tT} y_1^t$. This study attempts to decompose the effects of changes in the enterprise's revenue between two periods, as denoted by R^{t+1}-R^t. In value terms, one of three types of revenue could occur, namely, positive revenue, negative revenue or zero revenue. The revenue changes in the two periods may be decomposed into seven influencing effects covering four steps. In the first step, the revenue is decomposed into a quantity effect and a price effect, and this step of decomposition is similar to that adopted in the model developed by Kurosawa (1975), and Eldor and Sudit (1981). In the second step, the quantity effect is decomposed into a productivity effect, similar to the model proposed by Kurosawa (1975) and Miller (1984, 1987). In the third step, productivity change is decomposed into a technical change effect and a technical efficiency effect. Finally, in the fourth step, the change in technical efficiency is decomposed into a pure technical efficiency effect and a scale efficiency effect.

Steps involved in decomposing revenue change

Step 1

According to the above-mentioned revenue can be decomposed using Eqn. 1 to obtain the quantity effect and price effect.

[Rt+1-Rt]
= Pt+1TYt+1 - PtTYt
= (1/2)[(yt+1 + yt)T (pt+1 - pt)]   price effect
+ (1/2) [(pt+1 + pt)T (yt+1 - yt)]   quantity effect   (1)

Step 2

The quantity effect in Eqn. (1) may be decomposed into the productivity effect, as shown by Eqn. 2 below:

$(1/2)\ [\ (\ p^{t+1} + p^{t}\ )^{T}\ (\ y^{t+1} - y^{t}\ )\ ]$

$= (1/2)\ (\ p^{t+1} + p^{t}\ )^{T}\ [\ (\ y^{B} - y^{t}\ ) - (\ y^{C} - y^{t+1}\ ) + (\ y^{C} - y^{B}\ )\ ]$ productivity effect(2)

The decomposition in this step may be explained using Fig. 1. The two period output differential, $y^{t+1} - y^{t}$, includes:

1. $(y^{B} - y^{t})$ is the difference between maximum output (y^{B}) and actual output (y^{t}) at a given quantity of input in period t. Positive $(y^{B} - y^{t})$ indicates inefficient production, reducing revenue.
2. $(y^{C} - y^{t+1})$ is the difference between maximum output (y^{C})and actual output (y^{t+1}) at a given quantity of input in period t+1. Positive $(y^{C} - y^{t+1})$ indicates inefficient production, reducing revenue.
3. $(y^{C} - y^{B})$ is the increase in maximum output at a given quantity of input in period t+1. Negative $(y^{C} - y^{B})$ indicates inefficient production, reducing revenue.

Certain data appear in this step that are not provided by this study (such as y^{B} and y^{C}). Such data can be obtained using a DEA-like method [9].

Step 3

The productivity change effect in Eqn. (2) may be decomposed into an efficiency change effect and a technical change effect, as shown in Eqn. (3) below:

$(1/2)\ (p^{t+1} + p^{t})^{T}\ [\ (y^{B} - y^{t}) - (y^{C} - y^{t+1}) + (y^{C} - y^{B})\ ]$
$= (1/2)\ (p^{t+1} + p^{t})^{T}\ [\ (y^{B} - y^{A}) + (y^{C} - y^{B})\ ]$ technical change effect
$- (1/2)\ (p^{t+1} + p^{t})^{T}\ [\ (y^{C} - y^{t+1}) - (y^{A} - y^{t})\ ]$ efficiency change effect (3)

The productivity change effect is explained in Fig. 1. The technical change effect includes the following:

1. $(y^{B} - y^{A})$ is the amount by which maximum output increases at a given quantity of input in period t. The main reason for this being the technical improvements. Consequently, technical progress can achieve increased revenue.
2. $(y^{C} - y^{B})$ is the amount by which maximum output increases at a given quantity of input in period t+1. The main reason for this being the technical improvements. For this reason, the revenue will increase.

The efficiency change effect includes the following:

1. $(y^{C} - y^{t+1})$ is the difference between maximum output and actual output at a given quantity of input in period t+1. Positive $(y^{C} - y^{t+1})$ indicates inefficient production, reducing revenue.
2. $(y^{A} - y^{t})$ is the difference between maximum output and actual output at a given quantity of input in period t. Positive $(y^{A} - y^{t})$ indicates inefficient production, reducing revenue.
3. If efficiency change improves during the period, then efficiency gains contribute positively to revenue change.

Step 4

The efficiency change effect in Eqn. (3) may be decomposed into a pure technical efficiency effect and a scale efficiency effect, as shown in Eqn. (4):

$(1/2)\ (p^{t+1} + p^{t})^{T}\ [\ (y^{C} - y^{t+1}) - (y^{A} - y^{t})\ ]$
$=\ (1/2)\ (p^{t+1} + p^{t})^{T}\ [\ (y^{E} - y^{T+1}) - (y^{D} - y^{t})\ ]$ pure technical efficiency effect
$+ (1/2)\ (p^{t+1} + p^{t})^{T}\ [\ (y^{C} - y^{E}) - (y^{A} - y^{D})\ ]$ scale efficiency effect (4)

The efficiency change effect probably arises from the pure technical efficiency effect and the scale efficiency effect. The pure technical efficiency effect includes the following:

1. $(y^{E} - y^{t+1}) - (y^{D} - y^{t})$ is the difference between maximum output in period t+1 under variable returns to scale and actual output in period t+1, less the difference between maximum output in period t under variable returns to scale and actual

output in period t. Positive ($y^E - y^{t+1}$) - ($y^D - y^t$) indicates improvement in pure technical efficiency for period t+1, increasing revenue.

2. ($y^C - y^E$) - ($y^A - y^D$) is the difference between period t+1 maximum output under constant returns to scale and maximum output under variable returns to scale, less the difference between period t maximum output under constant returns to scale and maximum output under variable returns to scale. Positive ($y^C - y^E$) - ($y^A - y^D$) indicates improved scale efficiency for period t+1, increasing revenue.

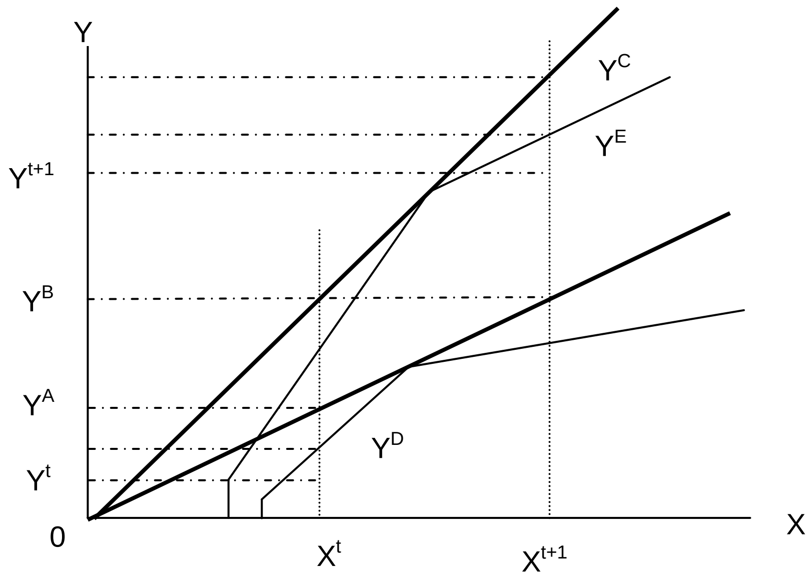

Fig. 1. Decomposition of Change in

We can summarize our derivation by referring first to Eqn. (1). The quantity effect of that equation was decomposed in Eqn. (2). Moreover, the productivity change effect of that equation was decomposed in Eqn. (3). The technical efficiency effect of that equation was decomposed in eq. (4). Finally, this study repeats below to complete its equation set:

Table 1 Decomposition of change in revenue

Source	Equation
1. Price effect	$(1/2)[(y^{t+1} + y^t)^T (p^{t+1} - p^t)]$
2. Quantity effect	$(1/2)[(p^{t+1} + p^t)^T (y^{t+1} - y^t)]$
3. Productivity effect	$(1/2)(p^{t+1} + p^t)^T [(y^B - y^t) - (y^C - y^{t+1}) + (y^C - y^B)]$
4. Technical change effect	$(1/2)(p^{t+1} + p^t)^T [(y^B - y^A) + (y^C - y^B)]$
5. Efficiency change effect	$(1/2)(p^{t+1} + p^t)^T [(y^C - y^{t+1}) - (y^A - y^t)]$
6. Pure technical efficiency effect	$(1/2)(p^{t+1} + p^t)^T [(y^E - y^{T+1}) - (y^D - y^t)]$
7. Scale efficiency effect	$(1/2)(p^{t+1} + p^t)^T [(y^C - y^E) - (y^A - y^D)]$

Application

The decomposition equations presented in section 2 were applied to the analysis of revenue change in the Taiwanese cement industry during 1994-2001. This period was chosen primarily because during that period operating revenue in the Taiwanese cement industry trended downwards.

According to the Taiwan Cement Industry Review (2002), the Taiwan Cement Manufacturers' Association has 13 members, including: Taiwan Cement Corp., Asia Cement Corp., Universal Cement Corp., Chia Hsin Cement Corp., Southeast Cement Corp., Chien Tai Cement Co., Ltd., Lucky Cement Co., Ltd., Hsing Ta Cement Corp., China Rebar Company Ltd., Hsin Hsin Cement Enterprise Corp., Cheng Tai Cement Corp., Nanhua Cement Corp., and Taiwan Oil Product Corp. Nine of these companies are listed on the Taiwan stock exchange, namely: Taiwan Cement Corp., Asia Cement Corp., Universal Cement Corp., Chia Hsin Cement Corp., Southeast Cement Corp., Chien Tai Cement Co., Ltd., Lucky Cement Co., Ltd., Hsing Ta Cement Corp., and China Rebar Company Ltd.,. Among the listed companies, China Rebar Co., Ltd. is involved in other products besides cement, and its income statement dies not contain sufficiently detailed data to allow a separate analysis of its cement business. Consequently, China Rebar Co., Ltd. was not included in this study. Moreover, the unlisted companies also were not included in this study due to the difficulty in obtaining their income statements. The actual period covered by this study extends from 1994 to 2001, and the data sources include the following: the Taiwan Securities and Futures Market Development Foundation Database, Input-Output Tables, Taiwan Area, the Republic of China; the Monthly Bulletin of Earnings and Productivity Statistics, Taiwan Area, the Republic of China; Energy Balances in Taiwan Republic of China; and the Taiwan Cement Industry Review.

Output and Sales Conditions in Taiwan's Cement Industry

Recently, slow progress in major local public infrastructure projects and a worsening international economic environment has caused decreasing annual sales of domestically manufactured cement. For example, total domestic production of ordinary cement in 2001 totaled 18,011,117 metric tons, of which 14,364,970 metric tons were sold domestically. However, compared with 1993, when sales reached a historical high, the respective shares were only 75.19% and 62.2%, representing a huge decline, as shown in Table 2:

Table 2 Cement Production and Sales in Taiwan, Various Years (in Metric tons)

Year	Production	Sales (Local)	Sales (Foreign)	Total Sales
1994	22,705,132	22,199,922	476,070	22,675,992
1995	22,466,822	21,778,005	607,914	22,385,919
1996	21,517,869	19,600,934	1,844,901	21,445,835
1997	21,509,649	19,063,609	2,439,801	21,503,410
1998	19,637,602	17,810,860	1,715,692	19,526,552
1999	18,168,003	15,956,724	2,230,,824	18,187,548
2000	17,561,976	14,821,052	2,722,706	17,543,758
2001	18,011,117	14,364,970	3,434,648	17,799,618

Source of data: Taiwan Cement Industry Review (2002 edition)

Profit and Loss Conditions in the Taiwan's Cement Industry

This study uses data obtained from the income statements contained within the Taiwan Securities and Futures Market Development Foundation database (covering the period from 1994 Q1 to 2001 Q4). After rearrangement, the industry's net profit (loss) is calculated using the following formula: Operating Profit (Loss) = Operating Revenue – Operating Cost. The calculation results indicate that the industry's net profits have gradually declined over this period, primarily because major local infrastructure projects did not progress as expected, and international economic situation continued to decline. This situation led to a sharp reduction in operating revenue (caused by the decrease in production), while operating costs did not change significantly. Table 3 clearly illustrates this:

Table 3 Income Statements for the Taiwan's Cement Industry (in Millions of NT dollars)

Year	1994	1995	1996	1997	1998	1999	2000	2001
Operating Revenue	52,625	51,344	50,100	47,853	48,893	45,943	45,211	41,561
Operating Cost	43,005	43,563	42,750	43,455	43,356	42,573	45,572	43,218
Operating Net Income	9,620	7,781	7,350	4,398	5,537	3,370	-361	-1,657

Source of data: Taiwan Securities and Futures Market Development Foundation

Data

According to the production theory of economics, Q=F (K, L, E, M), which states that production input may be divided into four input factors, namely, capital (K), labor (L), energy (E), and intermediate raw materials (M). These four input factors should be able to include the important production factors needed by the cement industry, and the costs generated by these factors comprise the total operating costs included in this study. The method used to deal with them is explained as follows:

Quantity of labor input is determined by the number of workers hired in the cement industry over this period, and adjusted for the average number of hours worked, while simultaneously considering number of employees and fluctuations in average number of work hours. This data is obtained from the DGBAS's Yearbook of Earnings and Productivity Statistics, Taiwan Area, Republic of China.

The value of the capital input is determined by the quantity of capital consumed. The data are obtained from the DGBAS's Input-Output Tables, Taiwan Area, Republic of China.

The energy input is based on cement industry's energy consumption over the years (all of which are measured in terms of K. L. O. E.) The data are obtained from the Ministry of Economic Affairs Energy Commission's publication entitled Energy Balances in Taiwan, Republic of China.

Because the cement industry requires many different kinds of intermediate raw materials, this study derives the total price of the intermediate inputs (represented by the wholesale price index for cement and cement products) by subtracting the labor costs, capital costs and energy costs from total operating cost.

Cement output is calculated using the total number of metric tons of cement sold, according to data provided by the Taiwan Cement Manufacturers' Association.

Results

Table 4 lists the results of the decomposition analysis of revenue change. Table 4 lists levels of revenue change for each effect attributable to each of the decomposition equations. The levels of change are summarized in relation to the individual sources revenue change, as follows:

1. The revenue decomposition in Step 1 comprises two effects, a price effect and a quantity effect. Generally, changes in revenue in the cement industry have exhibited a downward trend, with the extent of the reduction increasing over time. From this it can be seen that the cement industry' operating conditions are indeed poor. Moreover, the reduction in revenue is mainly results from the quantity effect being negative in six out of the seven years in the study period, and with the decline

increasing over this period. This is the main reason for the poor operating efficiency of the cement industry. From Table 3 it can be clearly seen that the negative quantity effect has occurred due to the gradual decline in operating revenue from 1994 to 2001, while the changes in operating costs have been insignificant, causing revenue to decrease. The situation regarding the price effect is exactly opposite, as caused by increased output prices. When the two of them are offset against each other, the overall result is still negative.

2. Decomposing the revenue in Step 3 reveals that it comprises of two kinds of effects, namely, the technical change effect and the technical efficiency effect. The productivity effect may be decomposed into two kinds of effects, namely, the technical change effect and the technical efficiency effect. Table 4 shows that technical inefficiency increases costs and thus reduces revenue. However, the positive technical change effect indicates that the cement industry has continually made an effort to improve its production techniques.

The revenue in Step 4, when decomposed, consists of a pure technical efficiency effect and a scale efficiency effect. Technical efficiency may be further decomposed into two kinds of effects, namely, the pure technical efficiency effect and the scale efficiency effect. Table 4 shows that both these effects are negative, from which it can be inferred that the scales of these effects are too large, inefficient input use and consequent wastage. If the pure technical efficiency under variable returns to scale, then the influence is relatively small.

Table 4: Sources of Change in Revenue in the Taiwan Cement Industry: 1994-2001 (in Millions of NT dollars)

Source / Year	Price Effect	Quantity Effect	Productivity Effect	Technical Change Effect	Technical Efficiency Effect	Pure Technical Efficiency	Scale Efficiency Effect	Revenue Chang
1995-1994	-2,076	237	-552	1,546	-2,098	-210	-1,888	-1,839
1996-1995	1,320	-1,751	-2,169	1,336	-3,505	-185	-3,320	-431
1997-1996	-1,750	-1,202	-1,019	1,677	-2,696	-254	-1,442	-2,952
1998-1997	4,413	-3,274	-2,918	1,803	-4,721	-326	-4,395	1,139
1999-1998	2,234	-4,401	-3,659	881	-4,540	-426	-4,114	-2,167
2000-1999	1,491	-5,222	-1,533	5,346	-6,879	-3,213	-3,666	-3,731
2001-2000	674	-1,970	-1,157	1,659	-2,816	-1,012	-1,804	-1,296

Conclusion

Business operations inevitably involve risks, and sometimes result in profits and at other times result in losses. Determining the sources of this profit or loss is an important issue for all business managers. This study integrates relevant contributions in the literature to develop an analytical model to decompose the main sources that affect changes in revenue, and provide policy-makers with directions for improving revenue. This study thus decompose revenue into a total of 7 effects using a four-step process, the results presented here indicate that the main determinant of revenue changes in the Taiwanese cement industry during the 1994-2001 period was the absence of marked productivity owing to inappropriate scale of operations. The principal reason for this, in turn, was the lackluster performance of the international economy, increased imports of cement, and slower than expected progress in major local infrastructure projects. The result was underutilized capacity and the inability to manufacture efficiently. Therefore, the most pressing matter presently facing the cement industry is the need to increase productivity.

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Biography

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