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# ANALYZING COMPANY PRODUCTIVITY
# - CASE IN ELEVATOR INDUSTRY



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ABSTRACT

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# ANALYZING COMPANY PRODUCTIVITY - CASE IN ELEVATOR INDUSTRY

The objective of the study was to scan possibilities provided by company-level productivity analysis and to apply suitable methods for companies in the elevator industry.

The study is divided into two parts. The state-of-the-art part was a desk study on company-level productivity measurement and different applications found from literature. The application part consists of empirical company-level productivity analysis in the elevator industry and development of an internal productivity analyzing system for an elevator company. In the case application the world's second and the third biggest elevator companies, Kone and Schindler, were selected to be analyzed closer. Company labor, capital and total factor productivity, as well as capital intensity trends and levels were constructed over the past 20 years. Company relative total factor productivity level and labor costs were studied as possible predictors of company relative profitability. Calculations were done by using the index number measurement approach and with publicly available data. Finally an internal productivity analyzing system for an elevator company was developed.

The result of the empirical case application was that the productivity trends and levels for both companies are very similar. This was no surprise because both companies are operating mainly in the same markets with a similar product range. Kone has grown more aggressively than Schindler and it has been more capital intensive. The total factor productivity of both companies has grown mainly because of increased productivity of labor, which is a very common result from other studies as well. The productivity growth of capital has been close to zero, even negative with Kone. It seemed that large acquisitions weaken, at least temporarily, the capital productivity. The result in analyzing factors explaining profitability, a higher relative total factor productivity turned out to be a statistically significant predictor of higher relative profitability. In developing the internal productivity analyzing system for an elevator company, the needed input and output data were identified and the required analyzing system was outlined. Based on the outlined system, it seems to be possible to find reasonable inputs and outputs in the elevator manufacturing process and to build a productivity analyzing system into a normal part of the company management. Data collection could be done by using the current financial reporting system directly by adding quantity data there.

Based on the study, it is recommended to start building an internal productivity analyzing system as an integral part of company management system. Implementation could be done gradually by testing it first in a selected pilot product line and process and then, after getting, experience implementing it wider.

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# 1. INTRODUCTION

## *1.1 Preface*

During the last decades, interest in productivity has greatly increased. At the national level, productivity is a major element of economic growth and progress. Labor productivity in terms of gross national product (GNP) per inhabitant is the most commonly used measure of living standards in country comparisons. At the industry level, above-average productivity growth leads to relative declines in costs and prices. In both domestic and international markets, this increases the competitiveness of the firms of the progressive industries, which consequently tend to grow faster than average.

On a company level there is a long tradition to measure profitability, financial position and liquidity. There are plenty of various indicators developed by accountants for that purpose. However, they are only monetary indicators. They don't tell anything about productivity of the real business process. Measures produced by financial management systems might give a totally misleading picture of the company performance. The management and other employees might have incentive and compensation systems related to these financial measures. The personnel might get a salary increase because the world market price of the company output has temporarily risen or the price of essential input material has gone down - or a certain exchange rate happens to fluctuate in a nice way. The company personnel have very little influence on these issues. What if the price development is totally different later on? Wages are very flexible upwards but rather rigid downwards. In addition to fluctuating markets, sometimes increased profitability due to government devaluations make the management of an export company overestimate their company performance. In the long run, only those companies who have taken care of their real process productivity have earned the right to stay alive.

Understanding the problems of fluctuating world input and output prices has made progressive companies implement productivity measurement systems as an integral part of company management. Especially in mature industries and in other similar conditions where you have to survive with lower costs, understanding and improving company productivity is a question of survival.

In the empirical analysis of industry economics, the aim is constantly to get closer to the company level. Deeper analysis on company level increases understanding on where aggregate phenomena in industry and economy level are coming from. Aggregate events are caused by company-level actions - a company is the level where the decisions influencing aggregate productivity are done.

## 1.2 Background of this study

Productivity analysis is an actual issue both in Finland and internationally. For example in Finland, the Economy Council decided to start a national productivity program with various projects related to productivity development on plant, company and public sector office level in February 1993. By studying fresh literature one can find numerous productivity studies. Company management seminars are also full of programs about productivity management.

This raises questions. What is productivity management and how to use it on the company-level? What is the relationship between productivity and profitability? What could productivity analysis offer to a single company working in a specific industry?

Kone Elevators, a company in the elevator industry, became interested in making a prestudy on company-level productivity analysis. Prior studies in the elevator industry weren't found.

## 1.3 Objectives of the study

The objectives of the study are:

- Scan possibilities provided by company-level productivity analysis
- Apply company-level methods to companies in the elevator industry, based on public data
- Develop a system for internal analysis in an elevator company

## 1.4 Approach

The first research step was to do a desk study by scanning literature and trying to understand what is the state of the art in company-level productivity analysis. In the application part suitable ideas found from literature are applied for companies in the elevator industry. The approach is intended to be as practical as possible. The point of view is a company-management point of view.

# 2. ANALYZING COMPANY PRODUCTIVITY - STATE OF THE ART

The purpose of this chapter is to find answers to the following questions

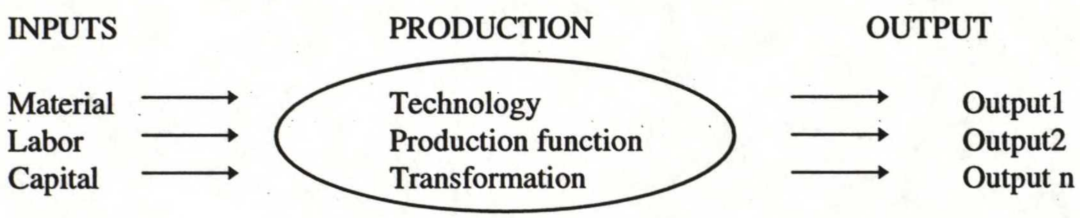
- What is productivity analysis?
- How to use productivity analysis as a tool to improve productivity and profitability at the company-level?

## *2.1 Measuring company productivity*

### 2.1.1 Basic concepts

Production means transforming various inputs to various outputs by using a selected production technology (figure 2.1.1-1). It is simply an action using resources to create products and services with a value in the market place.

**FIGURE 2.1.1-1 Production is transforming inputs to outputs by a using selected production technology.**




*Single and total factor productivity*

Productivity is a measure of the efficiency with which physical inputs are converted to physical outputs (means service as well). Various productivity measures can be computed depending on the treatment of inputs and outputs. Single factor productivity ratios give the output per unit of input of a single type. The basic idea of productivity is a comparison of outputs with inputs; more specifically how output/input relationships change over time and, for example, how they differ across firms or industries.

$$\text{(2.1.1-1)} \qquad \textit{single factor productivity} = \frac{\textit{output}}{\textit{single input}}$$

Total factor (or multi-factor) productivity (TFP) ratios are computed by dividing the weighted sum of outputs by a weighted sum of all input types:

$$\text{(2.1.1-2)} \qquad \textit{Total factor productivity (TFP)} = \frac{\textit{weighted sum of all outputs}}{\textit{weighted sum of all inputs}}$$

How the weighting of inputs and outputs is done will be shown later. Labor productivity (output per unit of labor) and capital productivity (output per unit of capital) are only partial indexes (single factor productivity) and can thus give misleading indications of the performance level. For example, labor productivity can be augmented by simply raising the level of capital input - in other words, at the expense of capital productivity. Total factor productivity, which attempts to measure the change in all inputs, is commonly regarded as a more appropriate measure of productivity.

*Link between productivity and profitability*

It is important not to mix the concepts of productivity and profitability. The connecting link between productivity and profitability is the relative change of input prices and output prices. For the purpose at hand we define productivity as a ratio of output to inputs of labor and other resources, in real terms (like kg, pcs, $m^3$, $m^2$, m etc.).

$$(2.1.1\text{-}3) \qquad \textit{profitability} = \frac{\textit{output x unit price}}{\textit{input x unit price}} = \textit{productivity x price relation}$$

It can be seen from equation 2.1.1-3 that productivity is the real process factor in the profitability formula - input/output price being the second part. In a rapidly growing industry it might be reasonable to temporarily expand production capacity even at the cost of productivity, and collect extra profits by winning more market share from the competition. This must be a well-understood decision however, because in the long run extra profits will disappear and only companies which have taken care of their productivity as well will survive when markets are becoming mature.

### 2.1.2 Measuring inputs and outputs

*Labor input*

The amount of labor input is quite easy to allocate to a certain accounting period. The average number of workers or working hours are the most commonly used measures of labor input (Lehtoranta 1995). In addition to that, labor input can be divided into different homogeneous quality categories if desired. This can be done e.g. on the basis of education or wage level.

*Capital input*

Measuring capital input is one of the most difficult tasks given to economists. When a durable input is purchased in one accounting period, the entire cost cannot be charged against that period's income. The question is: what fraction of the purchase cost should be charged to the current period and what fraction should be charged to future periods. Accountants and economists have been struggling with this question for hundreds of years, and a universally accepted consensus on the answer has not yet been achieved (Diewert 1989). In practice, capital-input can be constructed on the basis of investments and using industry or company-specific depreciation figures for different asset type categories. The example formula:

$$K(t) = (1-\delta)K(t-1) + I(t)/P(t) \qquad (2.1.2\text{-}1)$$

where

- $K(t)$ = Capital stock at the time t
- $\delta$ = the rate of economic depreciation
- $P(t)$ = deflator for investments
- $I(t)$ = investments in year t

In practice, comparisons of capital input levels between different companies need special attention to achieve reliable results, compared to labor input comparisons, which can be easily done in a proper way.

*Material input*

Measuring material input is easy to do if you can isolate clear homogeneous material categories. In some industries this might be easy to do, e.g. Finnish forest industry companies are doing material productivity analysis separately for wood, energy and chemical inputs (Harjunkoski 1996). In many cases it is enough if you concentrate on the most important material items.

*Output*

In practice, company output consists of various products and services. In some cases, it is not reasonable to try to measure quantities of different products and services produced by companies, because the output mix is changing so rapidly. In such a case turnover is a good output measure. It must be deflated with a suitable price index to describe quantities, however. As a deflator, one can use industry price index or one can construct company-specific price indexes, if more accurate information on the production structure of the company is available. In some cases, added value has been used as output measure. In the case of using added value as an output measure, material productivity can not be analyzed, and there is no clear price index for added value. In empirical studies, added value is a commonly used measure of output, however.

### 2.1.3 Index number approach to total factor productivity measurement

The traditional method for measuring total factor productivity (Solow 1957; Denison 1967; Grilles and Jorgensson 1967) takes it as a residual; the growth of real output net of the growth of factor inputs.

In this formulation, the relationship at time t between output, Q(t), and the two inputs, capital, K(t), and labor, L(t), is expressed in terms of a production function:

$$Q(t) = A(t)\, F[K(t), L(t)] \qquad (2.1.3\text{-}1)$$

where *A(t)* is a time-varying efficiency parameter that allows for neutral shifts in the production function. Thus *A(t)* may be identified as a measure of the level of the total factor productivity. By taking the logarithmic derivate of equation 2.1.3-1 and reorganising terms gives

$$\frac{\dot{A}}{A} = \frac{\dot{Q}}{Q} - e_k \frac{\dot{K}}{K} - e_l \frac{\dot{L}}{L} \qquad (2.1.3\text{-}2)$$

where $e_k$ and $e_l$ are the production elasticities with respect to capital and labor.

$$e_k = \frac{\partial Q}{\partial K}\frac{K}{Q} \qquad (2.1.3\text{-}3)$$

$$e_l = \frac{\partial Q}{\partial L}\frac{L}{Q} \qquad (2.1.3\text{-}4)$$

The growth rates of inputs and outputs are directly observable. The production elasticities are not, and must be estimated, under the assumption of constant returns to scale $e_k + e_l = 1$. If output and input markets are competitive, so that capital and labor are paid their respective marginal products, then the production elasticities, $e_k$ and $e_l$ , are identical to the income (or equivalently, the value-added) shares of capital and labor, , $s_k$ and $s_l$. Data on labor income share are commonly available but data on the capital share are not. However, under the assumption of constant returns to scale, capital income share can be estimated as the residual, 1- $s_l$.. Under these assumptions, the growth rate of total factor productivity can be computed as

$$\frac{\dot{A}}{A} = \frac{\dot{Q}}{Q} - (1 - s_l)\frac{\dot{K}}{K} - s_l \frac{\dot{L}}{L} \qquad (2.1.3\text{-}5)$$

Approximating the continuous growth rates on the right-hand side of equation 2.1.3-5 by annual differences in the natural logarithms of the variables gives

$$\frac{\dot{A}}{A} \cong Ln\left(\frac{Q_t}{Q_{t-1}}\right) - (1 - \bar{s}_l)Ln\left(\frac{K_t}{K_{t-1}}\right) - \bar{s}_l\, Ln\left(\frac{L_t}{L_{t-1}}\right) \qquad (2.1.3\text{-}6)$$

where $\bar{s}_l = \frac{1}{2}(s_{l,t} + s_{l,t-1})$. This representation of the total factor productivity is often referred to as the "Törnqvist" index (Törnqvist 1936).

If the output market is not competitive but input market is, so that capital and labor are paid their marginal revenue products, then production elasticities can be estimated as cost shares of labor and capital, $w_k$ and $w_l$. ,which sum to unity

( 2.1.3-7) $$\frac{\dot{A}}{A}=\frac{\dot{Q}}{Q}-(1-w_l)\frac{\dot{K}}{K}-w_l\frac{\dot{L}}{L}$$

This can be approximated with a Törnqvist index as in equation 2.1.3-5.

In order to be able to estimate the TFP level one has to assume a certain production function and create an index number based on that. Let's use the simple basic Cobb-Douglas production function with neutral technological change

( 2.1.3-8) $$Q(t)=A(t)K(t)^{\alpha}L(t)^{\beta}$$

where $\alpha$ and $\beta$ are the production elasticities with respect to capital and labor. Under the assumption of constant returns to scale, $\alpha + \beta = 1$, the production function can be written in the form

( 2.1.3-9) $$Q(t)=A(t)K(t)^{1-\beta}L(t)^{\beta}$$

Reorganising the terms to get the TFP level on left side gives

( 2.1.3-10) $$TFP(t)=A(t)=e^{\{(1-\beta)Ln[(Q(t)/K(t)]+\beta Ln[(Q(t)/L(t)]\}}$$

Based on equation 2.1.3-10, TFP level can be estimated as a weighted sum of labor productivity (Q/L) and capital productivity (Q/K). Either cost or income share can be used as a weight ($\beta$), depending on the assumption on input and output market competitiveness. This formula (2.1.3-9), using income shares as weights, will be used in TFP level estimations in the application part of this study.

## 2.2 Using productivity measures

The major motivation for company management to develop productivity measurement is the realisation of the importance of levels and changes in productivity to profit rates and the need to track productivity explicitly as an aspect of cost control (Kendrick 1984). By themselves, the productivity indexes are somewhat vague. They must be analyzed and interpreted to be of use in sparking action. This involves comparisons - comparisons over time within firms, distinguishing the movements of various partial productivity ratios; comparisons among the components of a firm; and comparisons with competing firms or plants, or with averages for the industry or industries within which the firm and/or its establishments are classified (Kendrick 1984).

### 2.2.1 Analyzing single plant productivity

A simple company can consists only of one plant. In that case, plant-level measurement is an analysis for the whole company at the same time. Bigger companies can consist of many similar or different plants or profit centers. An example of this level analysis is the productivity analyzing system used by the Finnish forest industry in chapter 2.3.1. This level requires company internal data as data source. The American Productivity Center (APC) has developed a systematic method for plant-level analysis (Kendrick 1984). The basic idea is to divide profitability into productivity and price recovery in the following way:

$$\textit{Profitability} = \textit{productivity} \times \textit{price recovery} \qquad (2.2.1\text{-}1)$$

$$\Rightarrow \frac{\textit{output value}}{\textit{input value}} = \frac{\textit{quantity sold}}{\textit{quantity used}} \times \frac{\textit{unit price}}{\textit{unit cost}}$$

The next tables explain the required data, methology and provided output information quite well. The first step is to find inputs and outputs of the plant, and prices and quantities for them (table 2.2.1-1).

**TABLE 2.2.1-1 Example of a productivity calculation system for plant level - APC measurement system, required data.**

| | Period 1 | | | Period 2 | | |
|---|---|---|---|---|---|---|
| Product or Resource | Value | Quantity | Price ($) | Value | Quantity | Price ($) |
| | A | B | C | D | E | F |
| OUTPUT | | | | | | |
| Chairs | 50,000 | 1,000 | 50.00 | 66,000 | 1,200 | 55.00 |
| Tables | 40,000 | 200 | 200.00 | 33,600 | 160 | 210.00 |
| **Total output** | 90,000 | | | 99,600 | | |
| INPUT | | | | | | |
| Materials | | | | | | |
| Maple stock | 20,000 | 20,000 | 1.00 | 25,200 | 21,000 | 1.20 |
| Varnish | 1,000 | 100 | 10.00 | 1,200 | 100 | 12.00 |
| Screws | 200 | 200 | 1.00 | 160 | 148 | 1.08 |
| *Total materials* | 21,200 | | | 26,560 | | |
| Labor | | | | | | |
| Woodworker | 24,000 | 4,000 | 6.00 | 30,400 | 3,800 | 8.00 |
| Finisher | 8,000 | 1,000 | 8.00 | 8,320 | 800 | 10.40 |
| *Total labor* | 32,000 | | | 38,720 | | |
| Energy | | | | | | |
| Electricity | 3,000 | 30,000 | 0.10 | 3,780 | 27,000 | 0.14 |
| Capital | | | | | | |
| Cash | 600 | 8,000 | 0.075 | 560 | 7,000 | 0.080 |
| Leases | 1,800 | 24,000 | 0.075 | 1,920 | 24,000 | 0.080 |
| Inventory | 900 | 12,000 | 0.075 | 810 | 10,125 | 0.080 |
| Depreciation | 15,000 | 300,000 | 0.050 | 15,300 | 300,000 | 0.051 |
| Pretax return | 14,100 | 300,000 | 0.047 | 15,120 | 315,000[b] | 0.048 |
| *Total capital* | 32,400 | | | 33,710 | | |
| Miscellaneous | | | | | | |
| Taxes & insurance | 1,400 | 1,000 | 1.40 | 1,500 | 1,000 | 1.50 |
| **Total input** | 90,000 | | | 104,270 | | |
| DIFFERENCE | 0 | | | (4,670) | | |

Note: Parentheses signify negative value

*Source: Kendrick 1984*

This information is quite easily obtainable from normal accounting systems. After that one can start to analyze what are the impacts of different factors on productivity and profitability (table 2.2.1-2). Following the different indicators graphically makes it more easy to understand trends (figure 2.2.1-1). These rather simple curves can provide a dramatic demonstration of important economic interrelationships. More information on the methodology and practical experiences so far is available in Kendrick (1984).

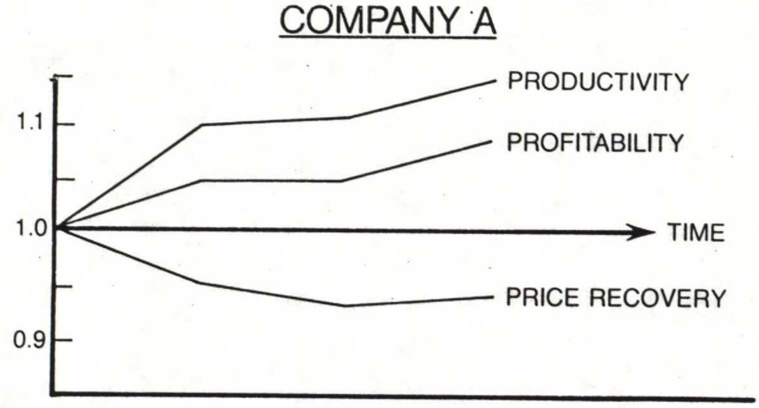
**TABLE 2.2.1-2 APC measurement system. Productivity and profitability measures calculated based on the data in table 2.2.1-1.**

| Change Ratios | | | Performance Ratios | | | Effect on Profits | | |
|---|---|---|---|---|---|---|---|---|
| $V_2/V_1$ | $Q_2/Q_1$ | $P_2/P_1$ | Chg. in Profitability | Chg. in Productivity | Chg. in Price Recovery | Chg. in Profitability | Chg. in Productivity | Chg. in Price Recovery |
| G | H | J | N | R | S | T | U | W |
| 1.3200 | 1.2000 | 1.1000 | | | | | | |
| 0.8400 | 0.8000 | 1.0500 | | | | | | |
| 1.1067 | 1.0222[a] | 1.0826[a] | | | | | | |
| 1.2600 | 1.0500 | 1.2000 | 0.8783 | 0.9735 | 0.9022 | (3,067) | (556) | (2,511) |
| 1.2000 | 1.0000 | 1.2000 | 0.9222 | 1.0222 | 0.9022 | (93) | 22 | (115) |
| 0.8000 | 0.7400 | 1.0800 | 1.3834 | 1.3814 | 1.0014 | 61 | 56 | 5 |
| 1.2528 | 1.0447[a] | 1.1992[a] | 0.8834 | 0.9785 | 0.9028 | (3,099) | (478) | (2,621) |
| 1.2667 | 0.9500 | 1.3333 | 0.8737 | 1.0760 | 0.8120 | (3,840) | 1,733 | (5,573) |
| 1.0400 | 0.8000 | 1.3000 | 1.0641 | 1.2778 | 0.8328 | 533 | 1,778 | (1,245) |
| 1.2100 | 0.9125[a] | 1.3260[a] | 0.9146 | 1.1202 | 0.8165 | (3,307) | 3,511 | (6,818) |
| 1.2600 | 0.9000 | 1.4000 | 0.8783 | 1.1358 | 0.7733 | (460) | 367 | (827) |
| 0.9333 | 0.8750 | 1.0667 | 1.1857 | 1.1682 | 1.0150 | 104 | 88 | 16 |
| 1.0667 | 1.0000 | 1.0667 | 1.1429 | 1.0222 | 1.1180 | 72 | 40 | 32 |
| 0.9000 | 0.8438 | 1.0667 | 1.2296 | 1.2115 | 1.0150 | 186 | 161 | 25 |
| 1.0200 | 1.0000 | 1.0200 | 1.0850 | 1.0222 | 1.0614 | 1,300 | 333 | 967 |
| 1.0723 | 1.0500 | 1.0213 | 1.0320 | 0.9735 | 1.0601 | 485 | (392) | 877 |
| 1.0404 | 1.0151[a] | 1.0249[a] | 1.0637 | 0.9878 | 1.0768 | 2,147 | (230) | 1,917 |
| 1.0714 | 1.0000 | 1.0714 | 1.0329 | 1.0222 | 1.0105 | 49 | 31 | 18 |
| 1.1586 | 0.9815[a] | 1.1804[a] | 0.9552 | 1.0415 | 0.9171 | (4,670) | 3,661 | (8,331) |

[a] Weighted.
[b] Added land was purchased for $15,000 at the beginning of Period 2.

*Source: Kendrick 1984*

**FIGURE 2.2.1-1 APC system. Graphical presentation of performance trends. These can be presented on a total basis and for each major individual factors**




*Source: Kendrick 1984*

The benefit of productivity indexes is that they help to establish realistic targets and check-points for diagnostic activities during an organizational development process, pointing to bottle-necks and barriers to performance. To achieve a balance between productivity, profits and prices, a sound productivity measurement system must be an integral part of the management information system (Prokopenko 1991). Furthermore, there can be no improvement in industrial relationships or proper correspondence between productivity, wage levels and gain sharing policies without a sound measurement system. According to Prokopenko every announcement, installation and operation of a measurement system can improve labour productivity, sometimes by 5 to 10 per cent, with no other organizational change or investment (Prokopenko 1991). Dividing inputs into homogeneous subcategories helps to understand productivity trends in more detail and in making development plans (figure 2.2.1-2).

**FIGURE 2.2.1-2 Evaluation of productivity trends**

TOTAL PRODUCTIVITY

| LABOR PRODUCTIVITY | | | | CAPITAL PRODUCTIVITY | | | |
|---|---|---|---|---|---|---|---|
| By type | By shift | By functional area | Etc. | Land | Building and structures | Machines and equipment | Etc. |
| Direct | 1. shift | production | | | | | |
| Indirect | 2. shift<br>3. shift | marketing<br>finance | | | | | |

*Source: Avedillo, Cruz 1984*

Finally, the last, but far from the least important, consideration: How and to what extent will the management want to track cause and effect in its productivity experience, the analysis of the factors which determined the space and direction of productivity change? For such tracking to be truly effective, a parallel data collection and analysis system is required. Some of the requisite information is certainly already in the company records - but some must be generated de novo. A few examples of such factors should suffice (Kendrick 1984):

- changes in plant machinery and equipment
- revisions in plant layout and work flow
- introduction of new product lines or changes in product design
- switches in the type of power used and how it reaches the individual machine center
- changes in the structure and average skills of the work force
- introduction of new hours worked and shift schedules
- adoption of additional and/or newer types of computer controls, automation and robotization of plant equipment
- variations in the utilization of the plant's designed capacity
- new on-stream operation of major plant installations

The assembly and use of analytical information of this type in conjunction with the statistics on productivity dynamics provide the management with another effective tool for decision-making.

### 2.2.2 Intercompany or interplant comparisons

"The secret of success is to copy success" (Kendrick 1984).The most effective way of using productivity analysis takes place when one starts to compare a company's performance with others. There are two different types of comparisons:

- trend comparison over time
- level comparison at certain time point

These comparisons can be used simultaneously. It has become increasingly popular for firms in the same industry to make their data available on a voluntary and confidential basis to other organizations (industrial departments, national productivity centers, consultants etc.) Firms engage in comparison in order to improve their productivity and profitability. This can be organized by an external organization or consultant. It is an exchange of information regarding costs, performance, efficiency and other relevant data between firms engaged in similar activities. Among the main objectives are (Prokopenko 1991):

- to show how a firm's performance compares with that of similar enterprises
- to draw attention to areas of comparative weakness and strength within the business
- to give an objective basis for judging progress and effectiveness

Some trade associations and accounting firms offer services providing productivity comparisons. Typical of financial measures customarily developed and used in industry are so-called operating ratios or financial ratios, which are regularly collected by trade associations and accounting firms, based on individual company data for specific industries. Such figures are customarily published both in the form of industry averages and as interfirm comparisons (Kendrick 1984). Some trade associations regularly produce and assemble physical productivity measures based on individual-plant records showing either industry averages or direct print out interplant comparisons. U.S. - Canada companies have already a long tradition in interfirm comparisons (table 2.2.2-1).

**TABLE 2.2.2-1 U.S. - Canada interfirm comparisons.**

| Year | Industry | Number of U.S companies | Number of Canadian companies |
|---|---|---|---|
| 1990 | Hotels | 10 | 30 |
| 1990 | Printed Circuit Boards | 10 | 20 |
| 1991 | Hardwood Plywood and Veneer | 9 | 18 |
| 1991 | Country Inns | 15 | 45 |
| 1992 | Residential Furniture | 12 | 23 |
| 1992 | Electronic Contract assembly | 10 | 12 |
| 1993 | Wood Windows and Doors | 5 | 14 |
| 1993 | Wood-based Panel Products | 14 | 16 |
| 1993 | Folding Paper Boxes | 7 | 7 |
| 1993 | Plastic Film | 7 | 23 |

*Source: U.S. - Canada interfirm comparisons (1993)*

In using interplant comparisons, it is important to keep in mind that many influences may combine to determine a particular plant's level. These may include, for example, variations in (Kendrick 1984):

- size
- diversification of output
- age and condition of machinery
- process applied
- average product or product line
- percentage of designed plant capacity utilized

*Benchmarking*

Productivity analysis is very close to the company management tool known as benchmarking (see e.g. Karlöf & Österblom 1993 and Tuominen 1993). Benchmarking is making different types of level comparisons among various organizations (table 2.2.2-2). After comparing company performance with others one can plan development actions to catch up the best practices. A systematic benchmarking was first used by the Xerox company in 1979 (Uusi-Rauva 1996).

**TABLE 2.2.2-2 Example of benchmarking measures from the auto industry**

| Measure | Japanese car factories in Japan | Japanese car factories in USA | American car factories | European car factories |
|---|---|---|---|---|
| Productivity: hours/car | 17 | 21 | 25 | 36 |
| Quality: defect/100 cars | 60 | 65 | 82 | 97 |
| Required space: $m^2$ /car/year | 0,5 | 0,8 | 0,7 | 0,7 |
| Working capital: stocking time of 8 components | 0,2 | 1,6 | 2,9 | 2,0 |
| Number of subcontractors | 170 | 238 | 508 | 442 |
| % of personnel in team work | 69 | 71 | 17 | 0,8 |
| Work rotation 0-4 | 3,0 | 2,7 | 0,9 | 1,9 |
| Improvement proposals/employee | 62 | 51 | 0,4 | 0,4 |
| Profession groups | 12 | 9 | 67 | 15 |
| Education hours/new employee | 380 | 370 | 46 | 173 |

*Source: Hellin 1991*

There are three types of benchmarking. In internal benchmarking, similar units in the same company are compared, in external benchmarking units between different companies are compared and in operational benchmarking company products, services or working processes are compared with companies and organizations which represent world top excellence in that operational area (Uusi-Rauva 1996). The objective in operational benchmarking is to search for the best behaviour you can get everywhere, it doesn't have to be even close to your own industry sector. If a company is using activity based costing (ABC), it usually makes benchmarking easier. ABC offers a natural data source for operational comparisons (Uusi-Rauva 1996).

### 2.2.3 Industry comparisons

Productivity levels of companies coming from different industries can not be directly compared with each other, because e.g. labor productivity can be increased simply by increasing the capital input. However, industry comparisons can provide the management of a single company with valuable information e.g. on reasons for productivity differences. A good example of such a study is the example presented in chapter 2.3.3. In any case a reasonable industry comparison is to compare company performance to own industry data or to data from similar industries all over the world.

For carrying out an industry comparison, plenty of suitable statistics and raw data is available. The BLS (Bureau of Labor Statistics in the United States) publishes time series of output per labor-hour or per employee for more than hundred industries and can provide unpublished estimates for most of the rest on request (Kendrick 1984). Physical productivity measures are developed for the economy as a whole and for specific industries (Kendrick 1984).

### 2.2.4 Improving productivity

To improve productivity, measuring is not enough, it also requires a selection of improvement tasks and every day actions at company level. Productivity improvement is not just doing things better: more importantly, it is doing the right things better. Productivity goes up either by reducing inputs with given output or increasing output by given inputs.

*Productivity factors*

According to Mukherjee and Singh (1975) there are two major categories of productivity factors (figure 2.2.4-1):

- External factors (not controllable)
- Internal factors (controllable)

Factors external to a company can be internal to governments, national or regional institutions, associations and pressure groups. Governments can improve the tax policy, develop better labor legislation, provide better access to natural resources, improve social infrastructure, price policy and so on, but individual organizations can not (Prokopenko 1991).

**FIGURE 2.2.4-1 An integrated model of company productivity factors.**

COMPANY PRODUCTIVITY FACTORS

INTERNAL FACTORS

| Hard factors | Soft factors |
|---|---|
| • product<br>• plant and equipment<br>• technology<br>• materials and energy | • people<br>• organisation and systems<br>• work methods<br>• management styles |

EXTERNAL FACTORS

| Structural adjustments | Natural resources | Government and infrastructure |
|---|---|---|
| • economic<br>• demographic and social | • manpower<br>• land<br>• energy<br>• raw materials | • institutional mechanisms<br>• policies and strategy<br>• infrastructure<br>• public enterprises |

*Source: Mukherjee and Singh 1975*

Better production technology can be received from others or it can be developed in-house (table 2.2.4-1). On the level of economy, research and development and other productivity investments have many positive spillover effects to economy as a whole. For that reason governments usually encourage technological progress in many ways e.g. giving direct public support to research and development or offering tax breaks, and setting patent rights (Mankiw 1992).

**TABLE 2.2.4-1 Sources of improved production technology.**

| Direct technology inputs | Indirect technology inputs |
|---|---|
| in-house R&D | Technology in intermediate inputs<br>• domestic/imported<br>Technology in capital inputs<br>• domestic/imported<br>Other transactions-based technology<br>• patents licences etc.<br>Other technology diffusion<br>• education, learning etc.<br>• spillovers |

*Source: Vuori 1994*

*Empirically studied productivity factors*

A certain productivity level is the result of a productivity development trend in the past. There has been developed several theories on productivity growth in economics e.g. catch-up and convergence patterns (see e.g. Crafts). Most of the public studies have been done on the level of an industry. Possible explanators of productivity levels studied empirically both in Finland and abroad include e.g. capital intensity (labor productivity), industry structure, plant sizes, human capital and level of competition (see e.g. McKinsey 1993, Van Ark 1995, Maliranta 1996). In studying the effects of human capital e.g. the following indicators can be used as a human capital data source (Becker 1962):

| | |
|---|---|
| 1. Education | general and arranged by employer |
| 2. Work experience | general and with the same employer |

In Finland, Leiponen (1995) has statistically estimated the effects of human capital on profit and growth rates of the biggest Finnish companies. This was done based on ideas by Benhabib and Spiegelin (1994), using research and development, the level of human capital and exocen technological progress as predictors in the model. The level of competition can be measured e.g. by using the following indicators (McKinsey 1993)

- number of factories established by productivity leader in the studied country
- exposed competition with the productivity leader in the home country, in productivity leader country or elsewhere
- number of competition restrictions

Maliranta (1996) analyzed the effects of exposed competition in the Finnish industry by using the export share of total deliveries as a measure of openness of competition. Many other reasons for productivity differences have been studied, see for example chapters 2.3.1 and 2.3.2. The general result of empirical studies has been that an important amount of productivity differences can not be explained with traditional predictors. A large extent of the reasons behind good productivity seems to be so-called soft factors like organization of tasks, management systems and other intangible items.

*Productivity management*

The question how to utilize human, capital and material resources effectively to produce outputs which have high value in the market place is a subject of extensive research. Engineering sciences try to develop better product and process technologies, marketing is studying what are the products and services with a high value in the market place, and management sciences try to understand human nature as a source of a better productivity. The industrial production process is a complex, adaptive, on going-social system. The inter-relationships between labor, capital and the socio-organizational environment are important in the way they are balanced and co-ordinated into an integrated whole (Prokopenko 1991). Productivity improvement depends upon how successfully we identify and use the main factors of the socioproduction system (Prokopenko 1991). The success of productivity improvement depends largely upon a clear understanding by all parties concerned (enterprise managers, workers, employers, trade union organizations and government institutions) of why productivity measurement is important for the effectiveness of the organization (Prokopenko 1991). The answer is that it indicates where to look for opportunities to improve and also shows how well improvement efforts are faring (Prokopenko 1991).

## *2.3 Examples of productivity analysis*

Good examples explain a lot. The intention is not to have a comprehensive review of productivity studies but to introduce three presentable studies on different levels. The examples are:

1. Plant/company level with internal data from Finnish forest industry
2. Company level with public data US vs. Japanese car manufacturers
3. Industry and country comparison, Japan vs. Germany vs. US in various industries

The first example describes the systematic productivity analysis work which has been done in the Finnish forest industry. The second is interesting because industry-level methods have been used at the company-level and with public data. The third one is presentable because its ambiguous target has been to find both internal and external reasons for productivity differences e.g. differences in production processes and competition. Because interviews, for example, have been used as a research method, the approach is quite non-standard.

### 2.3.1 Productivity analyzing system in the Finnish forest industry

The source here is the Harjunkoski presentation (1996) about systematic productivity development work done in the Finnish forest industry over the past 15 years. The starting point in developing a productivity analyzing system was that productivity information is needed to:

- complement profitability information
- analyse resource utilization efficiency
- target setting and planning
- improve competitiveness

*Measurement system*

The first main principle was to measure total factor productivity, thus all inputs (material, labor and capital) must be included in the system (table 2.3.1-1). The second main principle was to build a productivity analyzing system on existing data, so creating an additional data collection system would be not needed. The natural data source for such information was the profit and loss account. Only quantity data had to be added to make a productivity analysis possible.

TABLE 2.3.1-1 Data used for productivity analysis in the Finnish forest industry

| Output | Material input | Labor | Capital input |
|---|---|---|---|
| Product 1<br>Product 2 | Wood<br>• wood type 1<br>• wood type 2<br>Energy<br>• electricity<br>• steam | Labor type 1<br>Labor type 2 | Capital type 1<br>Capital type 2 |

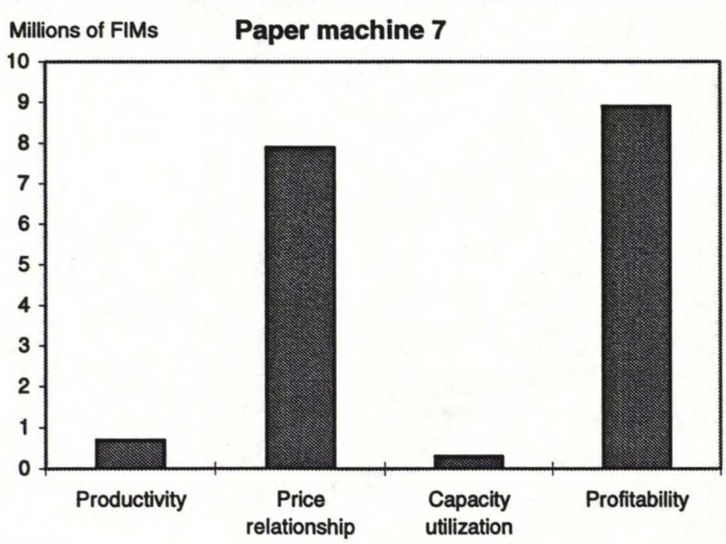
*Source: Harjunkoski (1996)*

The system is using indexes with fixed prices as weights. These indexes are continuously linked to each other. The system provides e.g. the following information as output:

- pure physical quantity index (tons)
- price-weighted quantity index
- quality index
- single and total factor productivity
- price relationships
- unit cost index

Increase in the quality index indicates that larger amount (in tons) of higher-priced paper types have been produced. This productivity analyzing system is a profitability analyzing system at the same time. The change in profitability can be decomposed into changes in productivity, price relationship and capacity utilization ratio (figure 2.3.1-1). The capacity utilization ratio is an important productivity factor in the forest industry and it is analyzed separately.

FIGURE 2.3.1-1 Net profitability change decomposed into changes in productivity, price relationship and capacity utilization ratio. This example here is calculated for one paper machine.




*Source: Harjunkoski 1996*

*Productivity management in the Finnish forest industry*

Productivity measurement has been linked to normal planning systems. In operational budgeting, targets have been divided into productivity targets and price targets, which in turn, are based on forecast on the company outlook. There are different areas of productivity management in Finnish forest industry

Productivity measurement
- partial and total factor productivity measures
- linking productivity to profitability
- price analysis

Productivity and quality improvement
- technology improvement
- product and process improvement
- resource utilization improvement

Productivity collaboration
- productivity education
- productivity teams

Linking productivity to normal planning systems
- productivity and price objectives
- productivity budgeting

Linking productivity to compensation systems
- proper measures
- applications

Productivity comparisons
- intercompany
- international
- benchmarking

An essential feature of the system is that development actions are based on measures and targets and they are set in collaboration with various parties. Intercompany comparison form a solid basis for productivity management. One can find homogeneous plant groups in the forest industry. In Finland, 50 plants participate in regular productivity comparisons (table 2.3.1-2). These 50 plants form almost 50% of the value of the Finnish forest industry export.

**TABLE 2.3.1-2 Output categories and measurement levels in the Finnish forest industry measurement system**

| Output categories | Levels of measurement |
|---|---|
| • newspaper or corresponding<br>• fine paper<br>• sc and lwc-paper<br>• paper board<br>• celluloid factories<br>• integrates<br>• sawmills | • machine<br>• department<br>• unit<br>• profit center<br>• company |

*Source: Harjunkoski 1996*

Harjunkoski points out that quality development programs and productivity development programs are close to each other and none of them can replace each other. Understanding the importance of participation of all personnel, thousands of people have participated in productivity measurement education. Also books about productivity has been published jointly with the labor unions.

### 2.3.2 Japanese vs. US motor vehicle manufacturers

This is an interesting company-level productivity analysis based on public data as the data source. The source here is an article in Management Science (Liebermann, M.B. Lau, L.J. Williams, M.D. 1990)

*Objectives of the study*

Objectives of the study were:

- Compare 3 US and 3 Japanese motor vehicle manufacturers - General Motors, Ford, Chrysler, Toyota, Nissan and Mazda - from the early 1950's through to 1987
- Evaluate potential determinants of growth, including economies of scale, JIT manufacturing and changes in top management

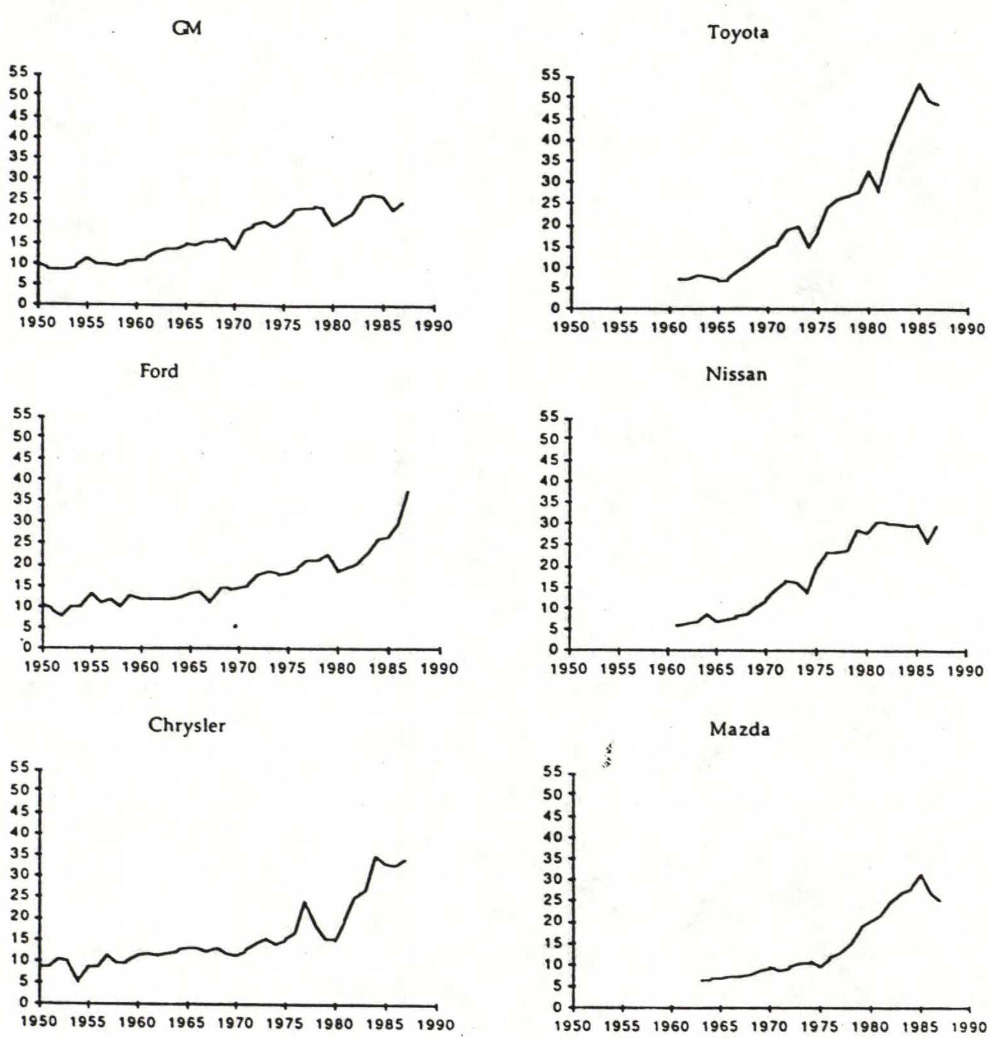
*The approach*

Techniques of productivity measurement, conventionally applied at the level of industries or national economies, are adapted for the analysis. Both index number and econometric methods were used. The index used was the Törnqvist index and the estimated econometric function was the Cobb-Douglas production function with a neutral technological change (Törnqvist index and Cobb-Douglas production function are introduced in chapter 2.1.3, equations 2.1.3-6 and 2.1.3-9).

All company-specific data is from annual reports. Price deflators and data on labor hours are from government sources. Added value, deflated by price index for vehicles was used as the output measure (figure 2.3.2-1). Labor input was taken as the total number of employees for the firm during the observation year, multiplied by the measure of average working hours in the auto industry. Real capital stock series for each firm was constructed for each firm using a perpetual inventory capital adjustment equation.

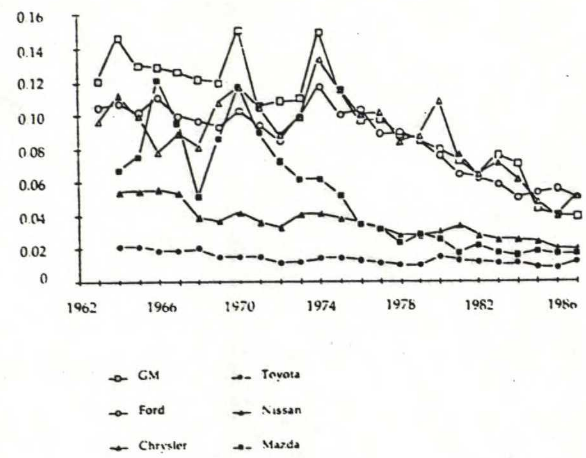
Some potential reasons for productivity growth differences - economies of scale, JIT manufacturing (figure 2.3.2-2) and changes in top management - were tested with statistical methods.

**FIGURE 2.3.2-1 Added-value per worker-hour in car industry in 1985 US$.**




*Source: Lieberman, Lau, Williams 1990*

**FIGURE 2.3.2-2** The work-in-process inventory level was used to analyse JIT (Just In Time) manufacturing effects. The data consists of year end work-in-process plus raw materials inventory as a fraction of annual costs of goods sold




*Source: Lieberman, Lau, Williams 1990*

*The results*

The summarized productivity results were:

- Productivity improvement in the auto industry has been attained primarily through more efficient utilization of labor; long-term capital productivity growth was close to zero for most firms
- All three Japanese producers in the sample had attained significant labor productivity advantages over US rivals by the late 1970's. More recently, though, considerable divergence has occurred among firms within each country

Summary on results on explanationary hypothesis

- The early post-war growth of Japanese producers was derived in part from the attainment of scale economies, but this source of improvement was largely exhausted by the mid-1960's
- In more recent years, adoption of JIT manufacturing systems appears to have contributed to productivity gains both in Japan and in the US
- The strongest statistical findings relate to effects of managerial succession; for all companies except Toyota, changes in top management were followed by significant shifts in the level and growth of total factor productivity (tests do not however, rule out the possibility that management turnover and productivity change were stimulated by common, external factors)

*Problems when using annual reports as data source*

Maliranta made a similar study, based on the Lieberman approach, about companies in the Finnish forest industry (Maliranta 1993). He mentioned a couple of problems in using company reports as data source. Companies might be not reporting the data required to calculate added value or the number of personnel. Accounting rules are changing and comparability of the figures is difficult to trace. Companies are merged into each other and figures have been changed afterwards. Variations in reporting practices of fixed asset categories and depreciation make it difficult to construct capital input data.

### 2.3.3 Explanations of productivity differences in manufacturing industries

This is a quite extensive manufacturing labor productivity study made by the University of Basel and the McKinsey Global Institute. The sources of this presentation are the reports of the same study, from various sources (McKinsey 1993, MET 1995, Gersbach and Baily 1995).

*Objectives of the study*

The objectives of the study were:

- Analyze labor productivity differences in selected manufacturing industries in Japan, US and Germany
- Find the reasons for productivity differences (external factors vs. production process)
- Give a recommendation to policy makers and corporate managers based on these findings

A similar study analysing Sweden's economic performance was done after this study (McKinsey 1995).

*The approach*

The starting point of the study was the industry-of-origin approach (see e.g. van Ark, Pilat 1993). This approach is based on data from the Census of Manufacturers of various countries. The case study method was used for the testing hypothesis on productivity. Nine selected industries - automotive cars, automotive parts, computer, consumer electronics, metalworking, steel, processed food, beer and soap and detergent - comprise between 15 and 20 per cent of the employment and between 17 and 22 per cent of the added value of the manufacturing sector in the three countries Germany, Japan and the USA. The intention was to include both assembly and process industries from a broad range of the manufacturing sector.

The focus is exclusively on the productivity of labor. In the cases where capital productivity is important, discussion on capital intensity and productivity is included. The testing hypothesis was done by assessing the relative importance of different causal factors through data analysis of publicly available data and by benchmarking studies. The phases of the benchmarking studies were:

1) Identifying the manufacturing and managerial process that needed to be analyzed
2) Selecting facilities for comparison
3) Observing and measuring these processes and specific tasks
4) Interpreting the results

In addition to that, the results were scrutinized through meetings and discussions. Hence the approach is certainly non-standard from the economist's point of view.

*Main results*

The summarized main results were:

- Large productivity differences exist at the industry-level
- The differences in industry productivity are caused primarily by differences in the technology used, the design of products for manufacturing and the way functions and tasks are organized (table 2.3.3-1)
- Achieving and maintaining high relative productivity requires that companies compete directly against the best practice production in the global economy (figure 2.3.3-1)

Design for manufacturing is an important source of better productivity. Modular product structures with simplified standard parts and automated processes offer the basis for good product design. Uncontrolled expansion of the product range weakens the productivity. With modern modular product design, large companies can offer tailor-made solutions to customers, meaning that even specialized companies are no longer in safe position. The modern efficient organization of functions and tasks includes continuous small development steps, whole personnel participation and flexible workers capable of doing various jobs. An important productivity aspect is to establish a long-term relationship with subsuppliers meaning:

- cost targets and related benefits are shared with suppliers
- co-operation to quarantee punctuality and quality
- open flow of information
- suppliers' participation at an early stage in the process and product development

Making supplier relations work effectively requires concentration on carefully selected suppliers.

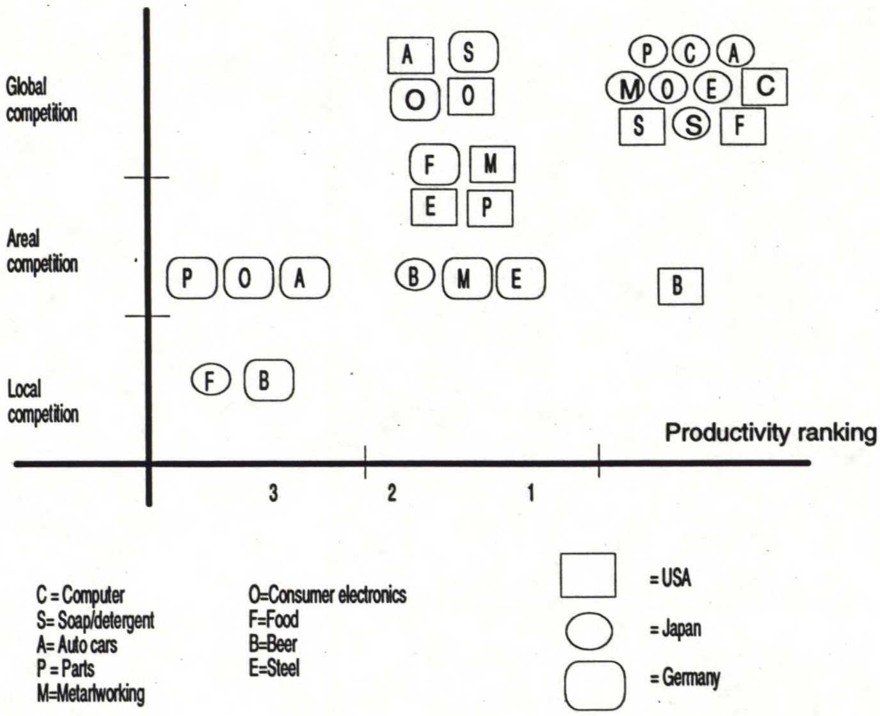
**TABLE 2.3.3-1 Studied external and internal factors and their importance in explaining labor productivity differences in selected industries**

| EXTERNAL FACTORS | Metal working | Cars | Car parts | Consumer electronics |
|---|---|---|---|---|
| Market conditions | | | | |
| • demand factors | • | • | x | o |
| • relative input prices/factor availability | x | x | x | x |
| • other industries | x | x | • | x |
| Policy and regulation | | | | |
| • macroeconomic conditions | x | o | o | o |
| • competition rules and concentration rules | x | o | x | |
| • corporate governance rules | x | • | x | o |
| • labor rules and unionism | o | • | o | o |
| • other regulations (tariffs, nontariffs) | • | o | x | • |
| **INTERNAL FACTORS (PRODUCTION PROCESS)** | **Metal working** | **Cars** | **Car parts** | **Consumer electronics** |
| Output | | | | |
| • mix, variety, quality | o | x | x | x |
| Factor of production | | | | |
| • machinery, equipment, buildings (technology, intensity, age) | • | o | o | o |
| • scale economies | • | x | x | x |
| • product design | • | • | • | • |
| • basic labor skills and intrinsic motivation | x | o | x | x |
| • raw materials, parts | x | o | x | x |
| Operations | | | | |
| • capacity utilization | x | x | x | o |
| • organization of functions and tasks | • | • | • | • |

• = high importance o = low importance x = no importance

*Source: McKinsey Global Institute 1993.*

**FIGURE 2.3.3-1 Differences in labor productivity and nature of competition in selected industries.**




*Source: McKinsey Global Institute 1993.*

*Recommendations to policy makers*

Open competition must be promoted because competition against world leaders enforces corporate managers to utilize the most productive methods in order to stay alive. Different restrictions slow down productivity development. Usually a higher productivity level doesn't lead to a higher level of unemployment because the total output can be raised. Foreign investments mean a positive technology diffusion to the object country. This means that foreign investments must be encouraged. To make markets work effectively, politicians must ensure that consumers get open and reliable information on different products.

*Recommendations to corporate managers*

For corporate managers the most important result of the study is that the most productive technology and know-how can be transferred from country to country. These possibilities must be utilized. Benchmarking and continuous searching for better practices is a sign of a good company. In the search for the best practices, companies should not limit themselves only to the boundaries of their own industry but openly look for the possibilities from all possible sectors. Manufacturing companies can learn a lot from the service sector and vice versa.

Local productivity leadership doesn't quarantee the company position any longer even in a protected market. The global world leaders can enter the market by acquiring local companies, establishing plants, selling licences or making joint venture deals.

## *2.4 Conclusions on the state of the art*

Productivity is a measure of a real process. The productivity level tells how efficiently physical inputs are converted into physical outputs. The best measure of productivity is the total factor productivity (TFP) where all the inputs and outputs are considered. By adding input and output prices to a productivity analyzing system, profitability can be analyzed as a product of productivity and the output/input price relationship.

Conventionally applied financial measures in company management, like profitability, only deal with monetary values. They don't tell anything about real business process productivity. The major motivation for company management to develop productivity measurement is the realization of the importance of levels and changes in productivity to profit rates and the need to track productivity explicitly as an aspect of cost control. It is good to understand how much company profit levels and trends are based on fluctuating market prices and exchange rates, and how much on real process productivity. This is especially important if one wants to build incentive and compensation systems based on certain measures, otherwise rewards on indicators that have nothing to do with personnel performance might be established.

Economic theory offers different approaches to productivity measurement. Approaches based on index numbers are commonly used at the company-level. In practice, theoretically accurate productivity measurement is difficult and, in some cases, even impossible to carry out. Theoretical accuracy on the company-level is not the most important target, however. The objective should be to get useful and sufficiently accurate information to support the company management. A company must customize suitable measures for its information systems and industry type. Today, good examples are beginning to emerge for that purpose. By themselves, the productivity indexes are somewhat vague. They must be analyzed and interpreted to be of use in sparking action. This involves comparisons over time within firms, distinguishing the movements of various partial productivity ratios; comparisons among the components of a firm; and comparisons with competing firms or plants, or with averages for the industry or industries within which the firm and/or its establishments are classified.

Measurement is important but not enough. Companies must select and implement the right improvement actions all the time. One of the most essential results of recent productivity studies is that the company management can transfer best business practices from a company or a country to another. This means that it is possible to catch up all the best organisations in different fields, if one is just able to measure and understand how they are doing it. Opening world markets mean that no company is any more in a safe position because there are many way to penetrate even closed markets.

Thinking about the application part of this study, it should be mentioned that methods and applications found from literature offer plenty of interesting approaches analyzing companies in the elevator industry.

# 3. APPLICATION IN THE ELEVATOR INDUSTRY

The objectives of this chapter are

- To apply company-level methods for comparison in the elevator industry, based on public data
- To develop a suitable system for the internal analysis in an elevator company

## *3.1 Elevator industry*

### 3.1.1 Elevator world markets

Elevator world market can be divided into new elevator markets, modernization and maintenance. The new elevator and maintenance markets total about 90 000 million FIM (table 3.3.3-1). Modernization is a growing business segment in Europe, where buildings are getting old. The new elevator market has become steady in Europe, while there is still expected growth in Asia.

**TABLE 3.1.1-1 Elevator world market in 1995.**

| Region | New elevator market | Elevator service market |
|---|---|---|
| Europe including former Soviet Union | 86 000 units | 3 200 000 units |
| Americas | 25 000 units | 950 000 units |
| Asia | 89 000 units | 900 000 units |
| Africa | 5 000 units | 50 000 units |
| World markets together<br>(money value) | 205 000 units<br>(40 000 Million FIM) | 5 100 000 units<br>(50 000 Million FIM) |

*Source: Kone Elevators research center*

### 3.1.2 Major players

The five biggest elevator suppliers cover 62% of the world market (table 3.1.2-1). Due to the large market share of the five biggest suppliers, it is obvious that they have monopolistic power, in at least some markets. In low-range residential segments, products are standard where a lot of local suppliers exist, and thus competition is tougher. In more demanding segments only bigger suppliers are able to offer good products, reliable project management, aftersales service and product maintenance, meaning that sales margins are there higher.

**TABLE 3.1.2-1 Major players in the elevator industry[1]**

| Company | Origin | Global/regional player | | | | Market share |
|---|---|---|---|---|---|---|
| | | | Europe | Asia | America | |
| 1. Otis Elevators | USA | Global | x | x | x | 22% |
| 2. Schindler Elevators | Switzerland | Global | x | o | x | 15% |
| 3. Kone Elevators | Finland | Global | x | o | x | 10% |
| 4. Mitsubishi Elevators | Japan | Regional | o | x | - | 8% |
| 5. Thyssen Aufzuege | Germany | Global | x | o | o | 7% |
| - Five biggest together | | | | | | 62 % |

x = strong, o = weak, - = not present
[1] according to market share in new elevators business in the world in 1995.

*Source: Kone Elevators Research Center*

### *3.1.3* Specific features in elevator industry

*Vertical integration and business process*

A succesful new elevator delivery process and installation on the customer's premises is a complicated process including many phases, where different actors are participating (table 3.1.3-1). Sales people communicate with customers and the elevator system delivery center, which takes care of the component sourcing and correct timing of component deliveries to the site. In more demanding cases, a lot of communication is needed to carry out the process succesfully.

**TABLE 3.1.3-1 Typical elevator manufacturing process.**

| Process | Material production | Subsystem production | System delivery | System installation/ sales | System maintenance |
|---|---|---|---|---|---|
| Unit in the process | Global/local material markets | Elevator subsystem manufacturer | Elevator delivery Centre | Installation/ sales unit | Maintenance unit |
| • duties | • ropes<br>• guide rails<br>• raw material<br>• other standard components | • cars and car frames<br>• control and signalization<br>• hoisting machinery<br>• safety equipment | • subsystem sourcing<br>• product mgnt<br>• elevator engineering<br>• logistics | • sales<br>• ordering according to specification<br>• installation<br>• site mgnt | • system maintenance<br>• system upgrading/ modernization |
| Owner | Subcontractor | OEM [1]/ subcontractor | OEM | OEM/agent or subcontractor for installation | New game |
| Labor content | - | medium | high | high | high |
| Cost share[2] | 25% | 25% | 20% | 30% | - |

[1] OEM = Original Equipment Manufacturer
[2] approximate cost structure of installed basic elevator

*Source: Kone Elevators Research Center.*

Big elevator companies are still mainly manufacturing the elevator subsystems in their own factories and doing system installations with their own installation personnel. In the future, the industry structure might be developing closer to that of the auto industry, meaning that OEMs concentrate on system-level knowledge and are buying subsystems from subsystem specialists. Subcontracting of elevator installation work can be forecast to be increasing as well.

*Product differentiation*

Requirements vary according to segments. The reliability of an elevator is the most important feature to all customers. In demanding segments, service and product flexibility and quality issues, like elevator performance and ride comfort, become important. In standard elevator segments a low purchasing price and clear site process are appreciated. In addition to load and speed, segmentation can be done e.g. in the following way:

- according to building end-use: office, residential, housing, hotel
- according to actors and their importance in the decision-making process: main contractor, developer, architect, engineering firms

*Barriers to entry industry*

Customers are demanding more reliable and safer elevators all the time. Big elevator companies are able to arrange 24-hours service centers to which elevators in their service are connected. In addition, they can build their products so that maintenance is easier to carry out by their own personnel and equipment. This makes the life of newcomers more difficult. One problem for new players in the elevator industry is that in order to quarantee elevator safety, many country-specific regulations and guidelines have been created by the local authorities. These regulations are in the process being harmonized, however.

## 3.2 Application selection

### 3.2.1 Case selection

Three out of the five biggest elevator companies in the world are part of larger company groups (table 3.2.1-1). Financial information for a detailed analysis is available only on that level.

**TABLE 3.2.1-1 Owner groups of the five biggest companies in elevator industry.**

| Elevator company | Owner group [1] | Share of elevator business [2] |
|---|---|---|
| 1. Otis Elevators | UTC (United Technologies) | 22% , 1994 (21%. 1993) |
| 2. Schindler Elevators | Schindler Group | 86% , 1994 (87%, 1993) |
| 3. Kone Elevators | Kone Group | 97% , 1994 (76%, 1993) |
| 4. Mitsubishi Elevators | Mitsubishi Electric | - |
| 5. Thyssen Aufzuege | Thyssen Industries | 25% ,1993 (20% , 1992) |

[1] related group publishing public annual reports
[2] according to turnover share in the group

*Source: Company annual reports.*

However, the second and the third largest elevator companies, Kone and Schindler, are mainly elevator companies. This makes the comparison of Kone and Schindler groups, based on annual reports, interesting. The objective was set in the following way:

***"To compare company productivity levels and trends of Kone and Schindler groups over past 20 years"***

Earlier public studies in the elevator industry were not found.

### 3.2.2 Method selection

The labor and capital productivity was calculated as a relation of output and capital or labor input. The total factor productivity is calculated by using the index number approach by using labor's share of income as a weight for labor and the residual as a weight for capital (see chapter 2.1.3).

### 3.2.3 Data construction and sources

Company data was extracted from company annual reports. The comparison was made by using the following data sources:

TABLE 3.2.3-1 Annual reports used as data source

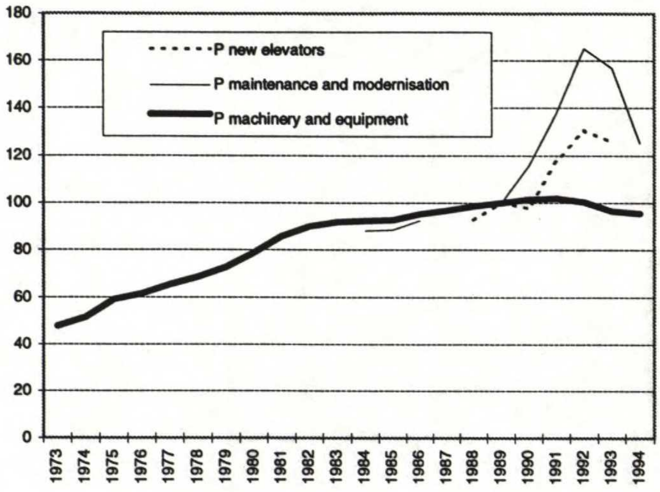
| Annual report | Years | Corresponding elevator company |
|---|---|---|
| Kone group | 1975-1986, 1988-1994 | Kone Elevators |
| Schindler group | 1973-1994 | Schindler Elevators |

Price deflators and data on labor hours are from government sources. Constructed company data, currency exchange rates used and price deflators are listed in the appendix.

*Output*

The output measure used in the productivity calculations is the total value added by the firm during its fiscal year in constant prices. Added value was calculated by subtracting material expences from turnover. Added value was deflated with an implicit price deflator for machinery and equipment. The price deflator was calculated from OECD national accounts (OECD 1988, 1995a). The exchange rates were from OECD sources as well (OECD 1995b, 1995c). A specific price index for the elevator industry wasn't found. Kone reported units delivered and maintenance base in some reports. Based on that, some indicators on elevator prices were constructed (figure 3.2.3-1). However, due to the scarce information, it was decided to use a price deflator for machinery and equipment in comparisons. This might overestimate the physical output during the boom in the beginning of the 90's (figure 3.2.3-1). However, this is not dangerous in comparisons.

**FIGURE 3.2.3-2 Some information on price (P) trends in the elevator industry and price deflator used, the OECD price for machinery and equipment. Index 1989=100.**



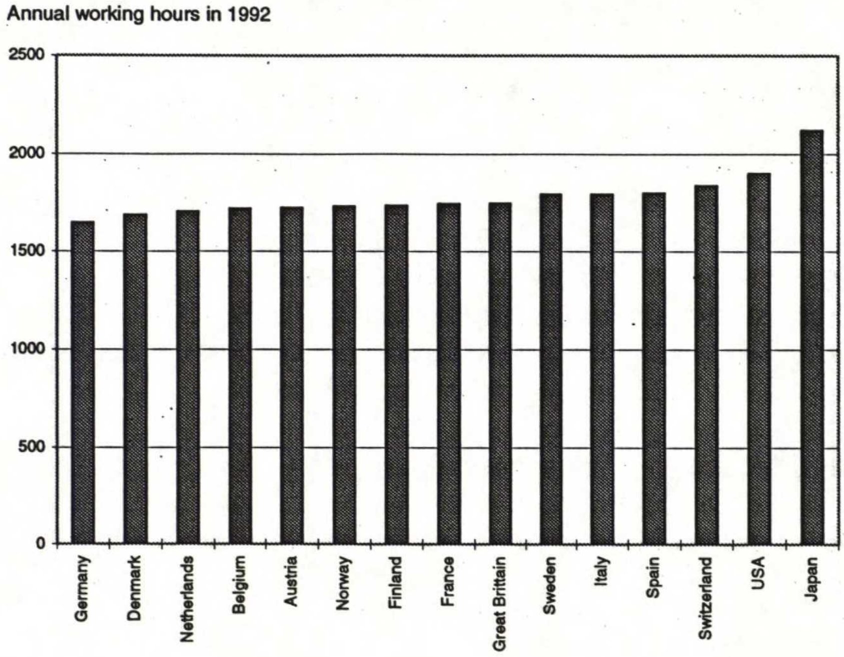

*Sources: Prices on elevator industry products are constructed from Kone annual reports. The deflator used in the study, the price for machinery and equipment in the USA, is constructed from OECD national accounts (OECD 1988, 1995a).*

It would have been nice to use turnover as the output measure and analyze material productivity as well. This would have required information on the material consumption divided into different material categories (e.g. guide rails, ropes, steel, electronics). This information was unfortunately not available. However, added value as a share of turnover seems to be similar and stable for both companies during the observation period, so it might be quite a good measure in this comparison. One data problem was that "other operating expenses" had to be included into the added value because its detailed content wasn't reported. In practice this includes e.g. subcontracting, which should have been excluded to get the correct added value. This means that the correct added value is slightly smaller than thet calculated in this study.

*Labor input*

Labor input was taken as the average number of employees for the firm during the observation year. Both companies have similar personnel portfolios all over the world (appendix). It can be assumed that the working hours are well in line with the number of personnel as well, meaning that the calculation of working hours, based on country data, would have given similar labor input series. Average working hours are close to each other in European countries (figure 3.2.3-2). Working days are longer in Japan and in the USA.

**FIGURE 3.2.3-3 Working hours in the metal industry in different countries in 1992**




*Source: MET 1993, p. 27.*

*Capital input*

Real capital stock series, K(t), for both firms were constructed using a perpetual inventory capital adjustment equation:

( 3.2.3-1) $$K(t) = (1-\delta)K(t-1) + I(t)/P(t)$$

where

- δ = the rete of economic depreciation
- P(t) = deflator for investments
- I(t) = investments in the year t

This was done by using the gross values of machinery and equipment from the fixed assets in the balance sheet:

- K(0) = gross asset value of machinery and equipment in year 0. K(0) = K(1974)
- I(t) = gross asset value of machinery and equipment (t) - gross asset value of machinery and equipment (t-1). t = (1975...1994)

The economic depreciation was estimated to equal 15% for average machinery and equipment in the elevator industry. For the investment deflator, the implicit price deflator for machinery and equipment of the USA was used. This was calculated from OECD national accounts (OECD 1995a, 1988). The deflator for the investments and for the output is therefore the same in this application.

The reason to use machinery and equipment as capital measure instead of e.g. all fixed capital, including land and buildings, was that machinery and equipment reflects well real capital input. In reality, companies substitute work especially with machines, and in addition to that, machines include the important technology for the specific company. A practical problem in measuring the value of land and buildings from the annual reports are devaluations which are poorly reported to clear them from measures. The asset values of machinery and equipment don't include such problems. In productivity calculations the arithmetic average of the capital stock at the end of consecutive years was used. The capital stock series based on the fire insurance value of all the fixed assets, was also constructed, it describes the repurchasing value of the capital stock. The capital stock series based on the machinery and equipment turned out, however, to be more reliable capital stock measure.

*Factor shares for total factor productivity calculations*

Data on income shares of labor and capital are required for the index number estimates of total factor productivity growth. Labor's share of income was taken as total labor compensation divided by added value; capital's share of income was computed as residual.

Schindler reported total labor costs including indirect personnel costs over the whole observation period. Kone reported total labor costs only in 1992-1994. Based on the data it looked that labor's share of income (added value) equals to 2/3 for both firms during to whole period. 2/3 was used as a weight for labor and the residual 1/3 as a weight for capital factor share in TFP calculations during the whole observation period. Formula:

*( 3.2.3-2)* $$TFP(t) = e^{\{1/3xLn[(Q(t)/K(t)]+2/3xLn[(Q(t)/L(t)]\}}$$

The theory behind this formula is introduced in the chapter 2.1.3 (equation 2.1.3-9).

*Profitability*

A profitability measure for analyzing the factors behind profitability was needed as well. Net profit as a share of turnover served for that purpose. Formula:

*( 3.2.3-3)* *Profitability (π) = net profit/turnover*

Other measures, like operating profit as a share of turnover, and operating profit as a share of average balance sheet, describing the return on invested capital, were constructed as well. These measures seemed to give results similar to net profit/turnover.

## 3.3 Results on case application

### 3.3.1 Company growth

Let's start by reviewing the constructed data over the past 20 years (output Q, labor input L and capital input K). These figures actually describe the growth history of the companies. Some completing information behind the figures collected from the annual reports is reported as well, e.g. major acquisitions.

*Company structure and main markets*

Both companies, Kone and Schindler, are publicly listed companies but still strongly controlled by one family. The Finnish company Kone was 14 years old when Harald Herlin purchased the majority of the company in 1924. The family has held the majority ever since (Kone News and Views 1991). The Swiss company Schindler started its operations in 1848 and is still well under the control of the Schindler family. Today Kone's market value is 3265 millions FIM, and market value of Schindler is 2182 millions CHF, both figures are according to 1994 annual reports.

The elevator business usually represented about 2/3 of the Kone-Group turnover during the observation period (table 3.3.1-1). However, at some time in the mid-80's the elevator business accounted for less than half of the company's revenues. The biggest other business has been Kone Cranes, but in the 90's, Kone Group gave up all other businesses and today it is almost purely an elevator company. With Schindler Group, the share of elevator business has been quite stable representing 80%-90% of the group turnover. The turnover share of maintenance and modernization business has been increasing in Kone, being now over 50% of the total elevator business sales. Schindler Group doesn't report maintenance and modernization turnover but sometimes it has reported its maintenance base in elevator units, which reveals that maintenance is as important source of revenue to Schindler as to Kone. The main market for both Kone and Schindler is still the home market Europe. However, the turnover share coming from America and especially Asia, is increasing with both companies.

**TABLE 3.3.1-1 Company structure and main markets**

| KONE GROUP | 1974 | 1979 | 1984 | 1989 | 1994 |
|---|---|---|---|---|---|
| Turnover by business sector: | | | | | |
| • New elevators and escalators | 40% | 33% | 18% | 26% | 37% |
| • Maintenance and modernization | 21% | 34% | 30% | 40% | 60% |
| • Others | 39% | 33% | 52% | 34% | 3% |
| Turnover by market area: | | | | | |
| • Europe including former Soviet Union | 98% | 91% | 69% | 74% | 61% |
| • Northern America | - | - | 23% | 17% | 24% |
| • Asia and Australia | - | - | - | 6% | 10% |
| • The rest | 2% | 9% | 8% | 3% | 5% |
| SCHINDLER GROUP | 1974 | 1979 | 1984 | 1989 | 1994 |
| Turnover by business sector: | | | | | |
| • New elevator business and maintenance and modernization | 87% | 83% | 88% | 90% | 86% |
| • Others | 13% | 17% | 12% | 10% | 14% |
| Turnover by market area: | | | | | |
| • Europe | 84% | 73% | 64% | 61% | 63% |
| • America | na | na | 27% | 35% | 24% |
| • Asia, Africa, Australia | na | na | 9% | 6% | 13% |

*Source: Company annual reports*

*Labor input growth*

Kone's strategy has been that of aggressive growth by acquiring other companies. Kone started its internationalization in 1968 by acquiring Asea-Graham in Sweden. In addition, in the beginning of the observation period 1974, the company had already taken over the Austrian elevator company Sowitch (1970) and the German elevator company Hävemeier und Sander (1973) (Kone News and Views 1991). Smaller and bigger acquisitions have taken place quite regularly after that as well (table 3.3.1-2).

**TABLE 3.3.1-2 Kone major acquisitions during the observation period.**

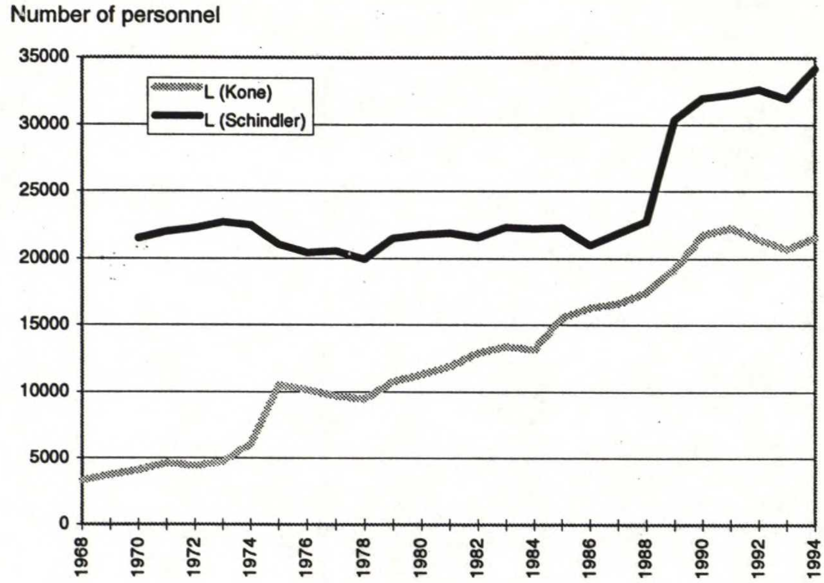
| Year | Acquired company | Industry | Personnel[1] | Turnover[1] |
|---|---|---|---|---|
| 1975 | Westinghouse Europe, Belgium & France | Elevator | 3263 | 300,2 |
| 1975 | Eguren-Kone, Spain (ownership was reduced under 50% during 1977) | Elevator | 858 | 47,8 |
| 1976 | Elevadores Induco Ltd, Brazil | Elevator | 425 | 15,2 |
| 1979 | Marryat & Scott Ltd. U.K & S/E Asia | Elevator | 1275 | 116,6 |
| 1982 | Armor Elevator Company, USA | Elevator | 764 | 265,2 |
| 1985 | Montgomery Elevator, Canada | Elevator | 400 | 190 |
| 1985 | Bauer, Germany | Elevator | 600 | 180 |
| 1985 | Sabiem, Italy, Mexico, Venezuela | Elevator | 1300 | 300 |
| 1986 | Bennie Lifts Ltd. U.K. | Elevator | 450 | 100 |
| 1987 | Fiam, Italy & exports | Elevator | 900 | 350 |
| 1989 | Satlift, Netherlands | Elevator | 700 | 250 |
| 1990 | EPL. Kone Pty. Australia, New Zealand | Elevator | 1250 | 500 |
| 1993 | Lloyds British Testing Company Limited, U.K. | Cranes | 640 | 175 |
| 1994 | Montgomery Elevator Co. USA | Elevator | 3700 | 2000 |
| Year | Sold companies: | Industry | Personnel[1] | Turnover[1] |
| 1994 | Kone Cranes | Cranes | -2900 | -1900 |
| 1994 | Kone Wood and others | Other | -950 | -500 |

[1] Figures were current at the acquisition.Turnover is in millions of FIM.

*Source: Kone annual reports.*

Schindler doesn't report acquisitions as well as Kone but it hasn't been as active as Kone in this field. However, in 1989 Schindler acquired the large elevator company Westinghouse in USA, which is reported as well. At that time the company personnel increased almost by 6000 in the USA. During the years 1992-1994 Schindler's personnel has grown by 2000 in the Far-East, which might be at least partly due to acquisitions (appendix). The sizeable acquisitions can easily be seen in the labor input curves of the companies, e.g. Kone 1975 and Schindler 1989 (figure 3.3.1-1).

FIGURE 3.3.1-1 Company labor input (L). Figures here are at the end of the year.

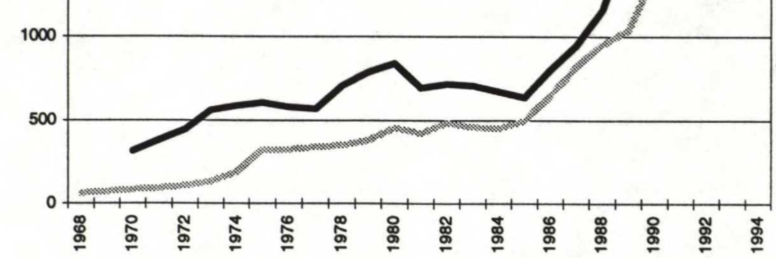



*Source: Author's calculations based on company annual reports.*

### *Output growth*

As a general trend, output growth follows more or less the labor input growth curve (figure 3.3.1-2). However, the business cycles cause some variations to the figures. It can be seen that, measured by output, Kone was almost as large as Schindler before the notable acquisition by Schindler in 1989.

FIGURE 3.3.1-2 Company output (Q). Output measure is the added value in constant 1987 US$ prices.

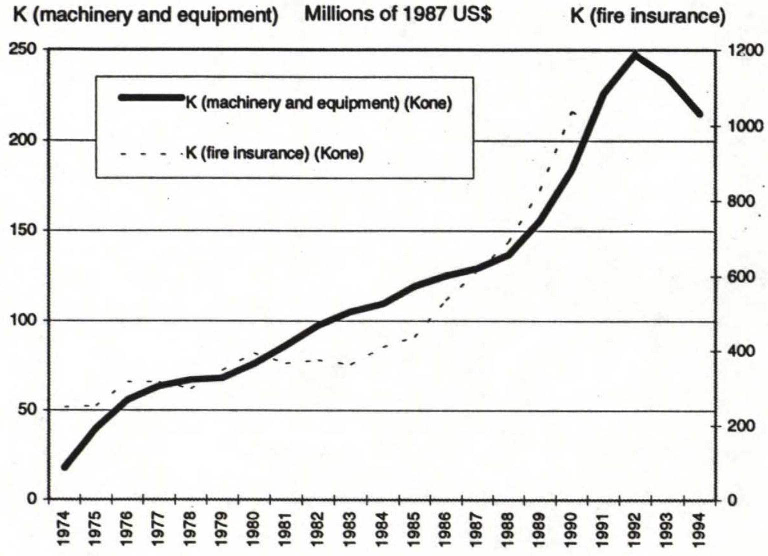



*Source: Author's calculations based on company annual reports.*

### *Capital input growth*

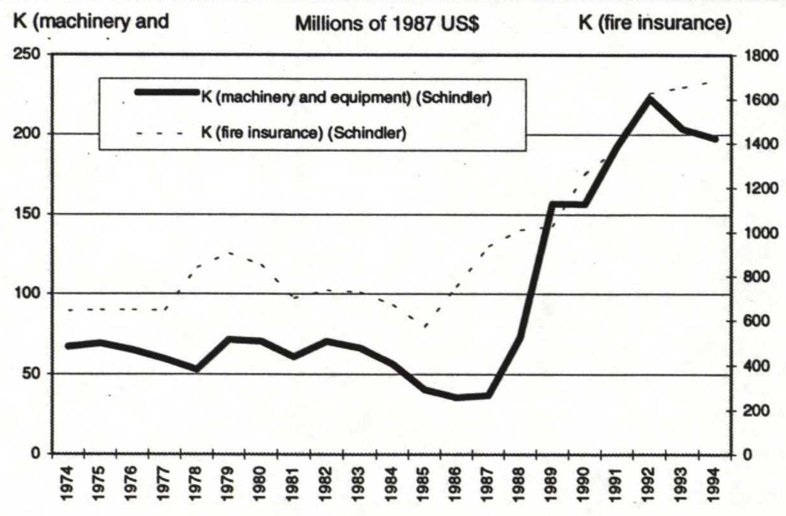
In constructed capital input series, the effect of acquisitions can be seen as well (figures 3.3.1-3 and 3.3.1-4). By looking at the series based on machinery and equipment, investments by Schindler were on a very low level before the large acquisition in 1989. Kone capital stock has grown quite smoothly, except in the last years, when both companies have cut their investments. The fire insurance value seems to sometimes behave unlogically. The capital stock series based on machinery and equipment will be used as capital input measure later on.

**FIGURE 3.3.1-3 Two measures of Kone capital input (K) in constant 1987 US$ prices.**




*Source: Author's calculations based on company annual reports.*

**FIGURE 3.3.1-4 Two measures of Schindler capital input (K) in constant 1987 US$ prices.**




*Source: Author's calculations based on company annual reports.*

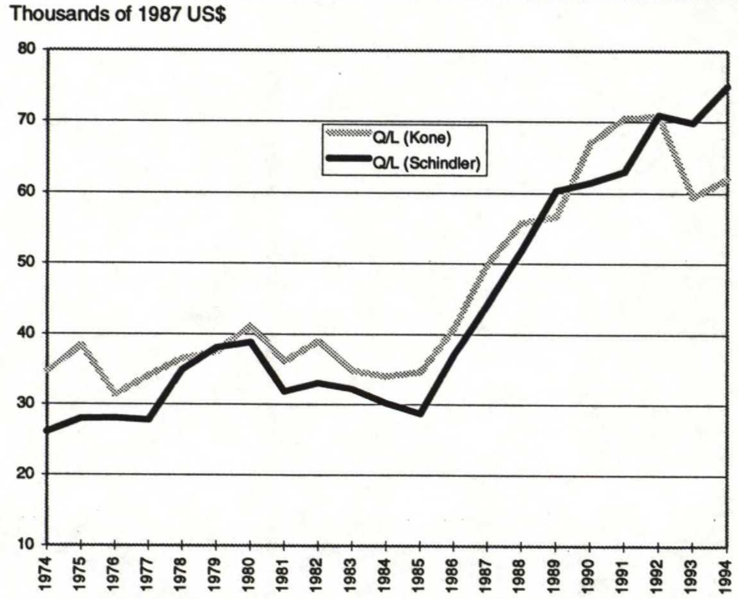
### 3.3.2 Trend and level comparisons

After constructing the K, L and Q series, various productivity ratios can be calculated. Here both the trends and levels are reported in the same figure. From the company management's point of view, the levels are especially interesting because the trend can be good if the starting level is low. The interesting question is, how good is the company's performance compared to its competitors?

*Labor productivity*

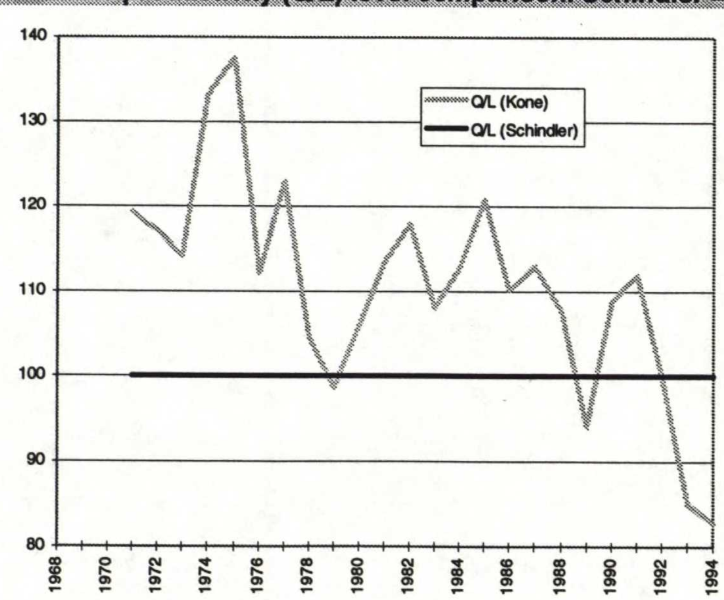
The calculated labor productivity trends and levels are presented in figure 3.3.2-1. The labor productivity level of Kone has been higher than that of Schindler except in the last years. The current annual added value per person seems to be in the region of 60-70 000 US$ for both companies, in 1987 prices. This is equal e.g. to the figures from the Finnish machinery and equipment metal industry, 299 000 FIM 1994 (ETLA 1995).

**FIGURE 3.3.2-1 Labor productivity (Q/L). The labor productivity measure is added value/number of workers in 1987 US$ 1974-1994**




*Source: Author's calculations based on company annual reports.*

**FIGURE 3.3.2-2 Labor productivity (Q/L) level comparison. Schindler = 100.**

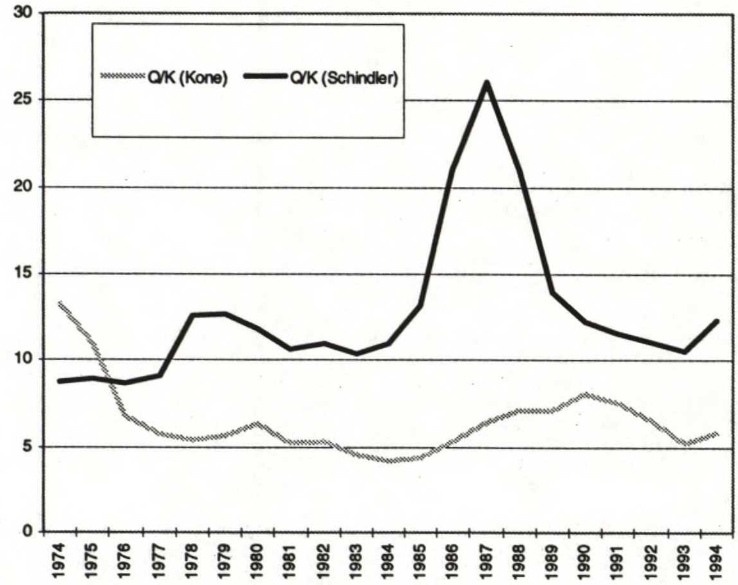



*Source: Author's calculations based on company annual reports.*

*Capital productivity*

The calculated capital productivity trends and levels are presented in figure 3.3.2-3. The capital productivity of Schindler seemed to have gone up rapidly before the Westinghouse acquisition in 1989, due to the low investment rate before that. However, this might overestimate the capital productivity of Schindler just before 1989. After that peak, Schindler capital productivity has returned to the old trend.

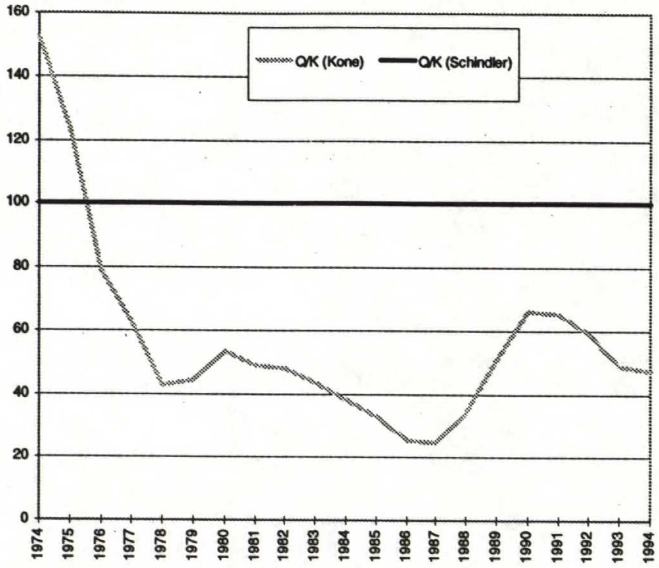
**FIGURE 3.3.2-3 Company capital productivity (Q/K). Capital stock is constructed based on information of machinery and equipment.**




*Source: Author's calculations based on company annual reports.*

Kone's capital productivity was on a higher level than Schindler's before its big acquisition in 1975, at the beginning of the observation period (figure 3.3.2-4). After that, the capital productivity of Kone has clearly been on a lower level compared to that of Schindler.

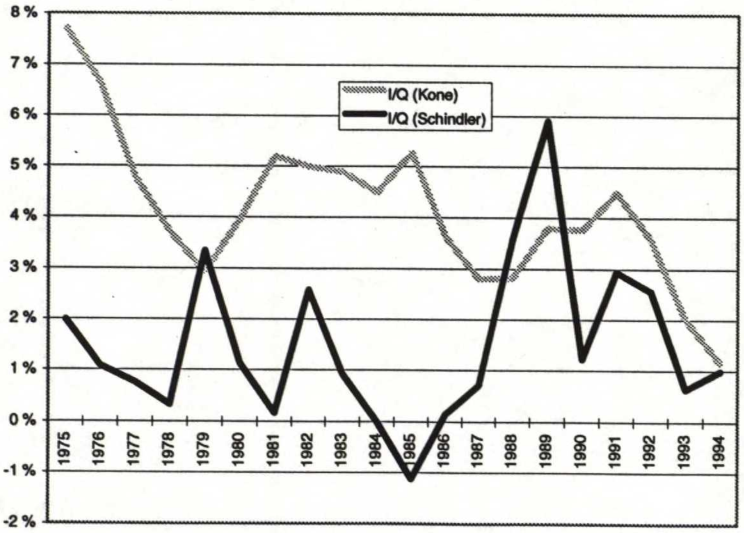
**FIGURE 3.3.2-4 Capital productivity (Q/K) level comparison. Schindler = 100.**




*Source: Author's calculations based on company annual reports.*

Investments in machinery and equipment as a share of added value is presented in figure 3.3.2-5. These figures are not directly comparable with investment ratios from other sources, because only investents in machinery and equipment are considered. Usually such figures are presented based on investments in all fixed asset categories in relation to added value.

**FIGURE 3.3.2-5 Investment level comparison (I/Q). The measure is investments in machinery and equipment in relation to added value.**



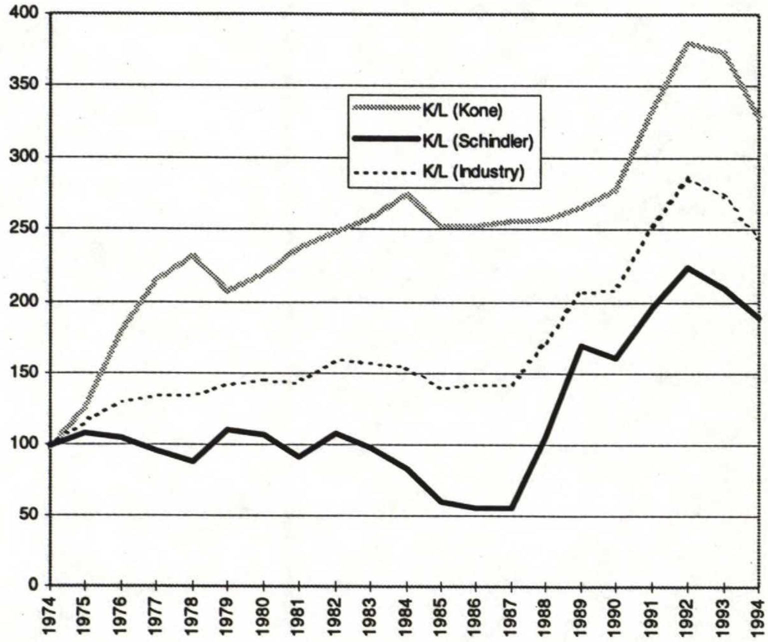

*Source: Author's calculations based on company annual reports.*

*Capital intensity*

The capital intensity describes how much capital input is used in relation to labor input. An increase in the capital intensity increases labor productivity. Capital intensity has grown during the observation period for both companies (figure 3.3.2-6).

Incidentally the capital intensity was almost on the same level for both companies in the beginning of the observation period in 1974.

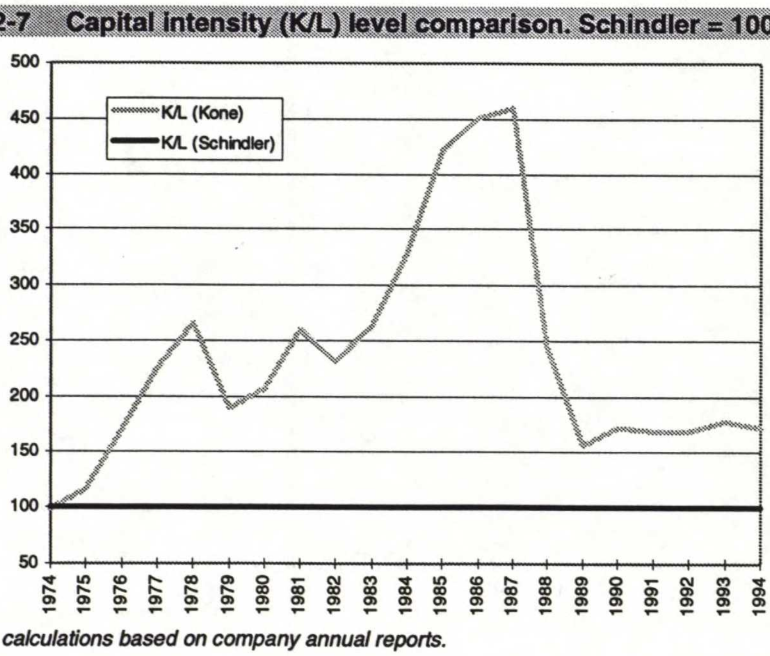
**FIGURE 3.3.2-6 Company capital intensity (K/L). The capital intensity measure is the capital input in relation to labor input. Index 1974 =100 for the industry. Industry is the weighted average of Kone and Schindler.**




*Source: Author's calculations based on company annual reports.*

Kone seems to be clearly a more capital intensive company than Schindler (figure 3.3.2-7). This again explains, at least partly, the good labor productivity of Kone.

**FIGURE 3.3.2-7 Capital intensity (K/L) level comparison. Schindler = 100.**

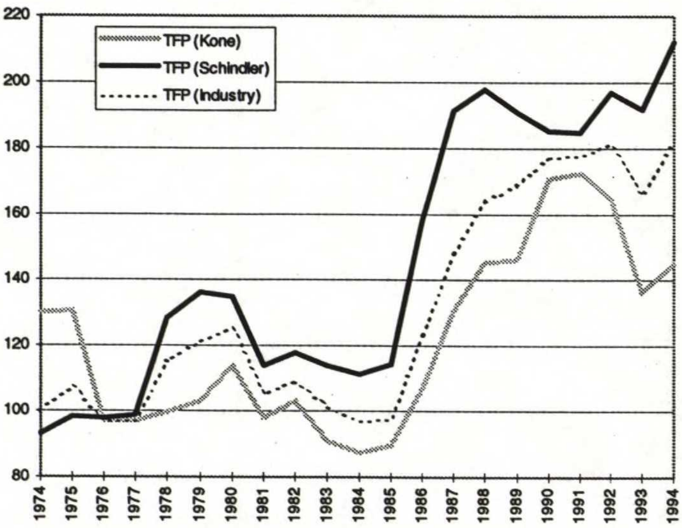



*Source: Author's calculations based on company annual reports.*

*Total factor productivity*

In the total factor productivity calculations, labor and capital productivity were weighted to get the total factor productivity (see chapter 3.2.3, especially equation 3.2.3-2). The constructed trends and levels are in figures 3.3.2-8 and 3.3.2-9. In the Finnish metal engineering industry the trends in total factor productivity growth have been the following: 1960-84: 3,3 %, 1984-89: 6,0 %, 1989-94: 5,7 % (ETLA 1995). The trends before the 90's are quite similar here as well.

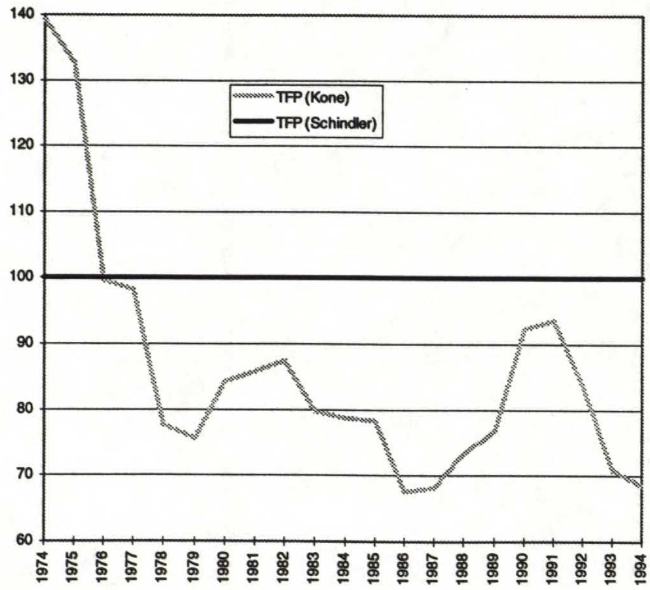
**FIGURE 3.3.2-8 Company total factor productivity (TFP). Index 1974 =100 for the industry. Industry is the weighted average of Kone and Schindler.**




*Source: Author's calculations based on company annual reports.*

After 1975 the total factor productivity level of Kone has been weaker than that of Schindler. This is mainly because of a clearly lower capital productivity level.

**FIGURE 3.3.2-9 Total factor productivity (TFP) level comparison. Schindler = 100.**




*Source: Author's calculations based on company annual reports.*

### 3.3.3 Linking productivity to profitability

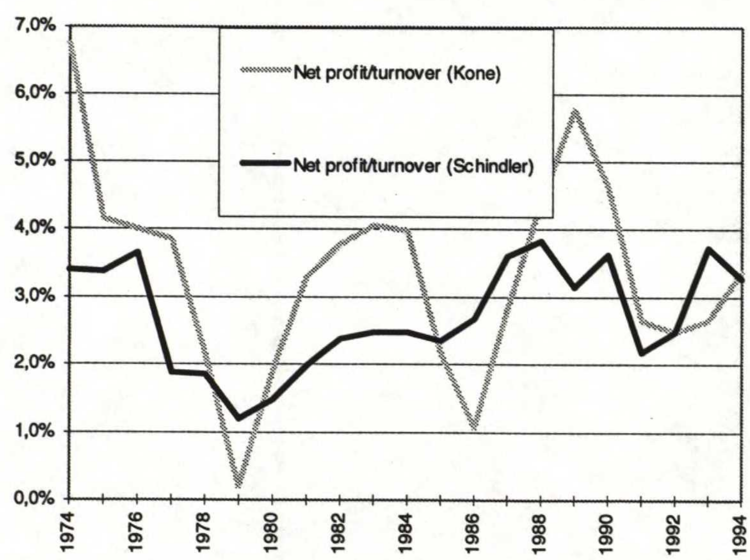
The objective of company management is to maximize company profitability by maximizing revenue and minimizing costs. It was said earlier that productivity is one important factor in the formula of profitability, the price relationship between output and input being another. The objective of this chapter is to try to explain company profitability, based on the constructed TFP level and additional profitability and price information available from the annual reports.

*Company profitability*

On the level of an economy the most interesting output of single companies is the added value. This is because the output of an economy is the sum of the added value of different industries whose output in turn is the added value of the companies in that specific industry. From the company owner's point of view, high added value doesn't offer benefit if it is spent on high salaries, compensations to capital or to government taxes.

The measure used for company profitability here is net profit/turnover. Measures like operating profit/turnover and operating profit/average balance sheet were also constructed. They gave similar results. The average profitablity level has been quite similar with both companies, Kone's average profitability has been 3,3% and Schindler's 2,7% (figure 3.3.3-1). Kone's profitability has varied more, according to business cycles.

FIGURE 3.3.3-1 Company profitability ($\pi$.). The measure of profitability is net profit in relation to turnover.



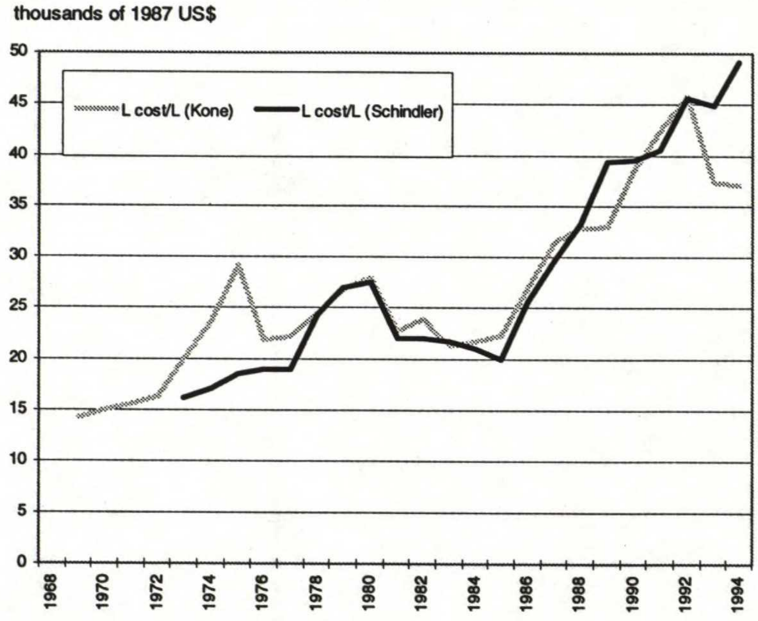

*Source: Author's calculations based on company annual reports.*

*Labor input prices*

Labor input prices can be analyzed on the basis of the information on labor costs and the number of personnel. Labor costs are the most important input price factor, forming about 2/3 of the added value of the companies. Labor costs include here all expenses related to labor. Average ancillary personnel expenses and payments to social benefit instruments have been reported only last years by both companies and they seem to be higher at Kone (36%) than at Schindler (27%). Kone's 36% is close to the personnel overheads in the Finnish metal industry (MET 1993). It is not known exactly what is included here and thus how comparable these personnel overhead percentages are.

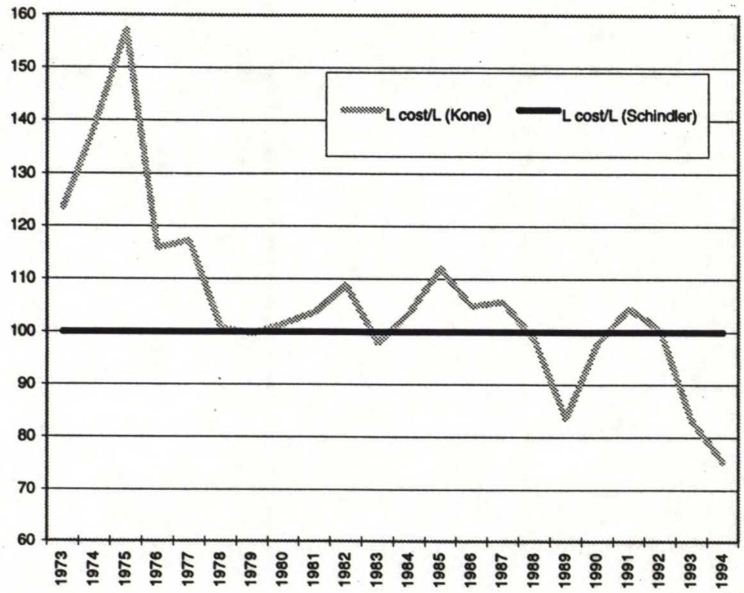
In 1975 Kone's labor costs seem to be extraordinarily high (figure 3.3.3-2). At that point Kone made its biggest acquisition. Either Kone bought expensive labor or the measurement overestimates Kone's labor costs in 1975. Generally the labor costs seem to be roughly on the same level for both companies (figure 3.3.3-3). A labor cost analysis according to different countries would be interesting but must be left out of this study.

**FIGURE 3.3.3-2 Company labor cost ($L_{cost}$ /L). The measure is the annual labor cost per number of workers in 1987 US$.**




*Source: Author's calculations based on company annual reports.*

**FIGURE 3.3.3-3 Labor cost ($L_{cost}$ /L) level comparison. Schindler = 100.**




*Source: Author's calculations based on company annual reports.*

*Unit labor cost*

Unit labor costs serve as an important indicator of competitive performance (van Ark 1995). Unit labor costs are based on the ratio of labor costs per worker to the added value of the worker. Formula:

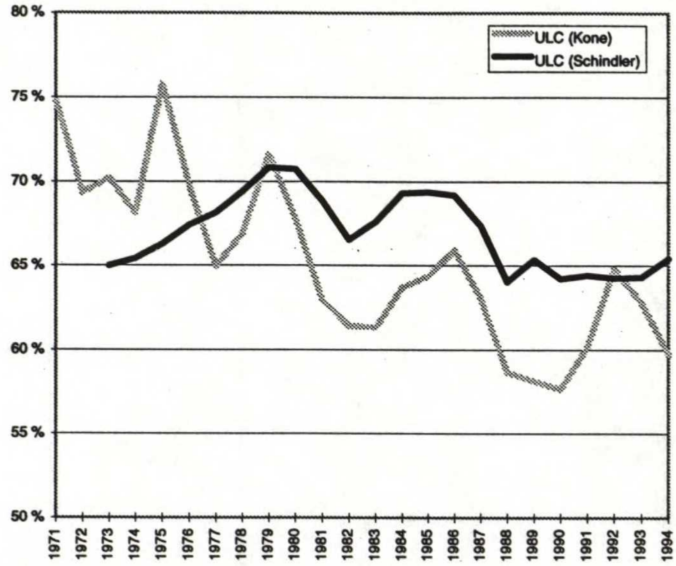
$$ULC = \frac{L_{\cos t} / L}{Q / L} \qquad (3.3.3\text{-}1)$$

where

ULC= unit labor costs
Q/L = added value per worker (labor productivity)
$L_{cost}$ /L= labor costs per worker

Unit labor costs have represented 60% to 70% of the total added value for both companies, Kone being slightly better measured by this indicator (figure 3.3.3-4). The general trend of unit labor costs seems to be moderately decreasing, at least for Kone. However, speaking about competitiveness, in addtion to unit labor costs, we must keep in mind the earlier measured weaker capital productivity and therefore the weaker total factor productivity of Kone when compared to Schindler.

**FIGURE 3.3.3-4 Company unit labor costs (ULC). Unit labor cost is the ratio of labor costs per worker to the added value per worker.**




*Source: Author's calculations based on company annual reports.*

*Capital cost*

What the real cost of capital stock is for both companies can not be estimated on the basis of the data from annual reports. The basic assumption is that capital costs should be at the same level in global capital markets. However, in some cases, e.g. government subsidies might make capital investments more attractive than they are in the free market. In that case investing in extra capital, even at the cost of capital productivity, might be reasonable from the point of view of the company management maximizing the profit.

*Some simple estimations*

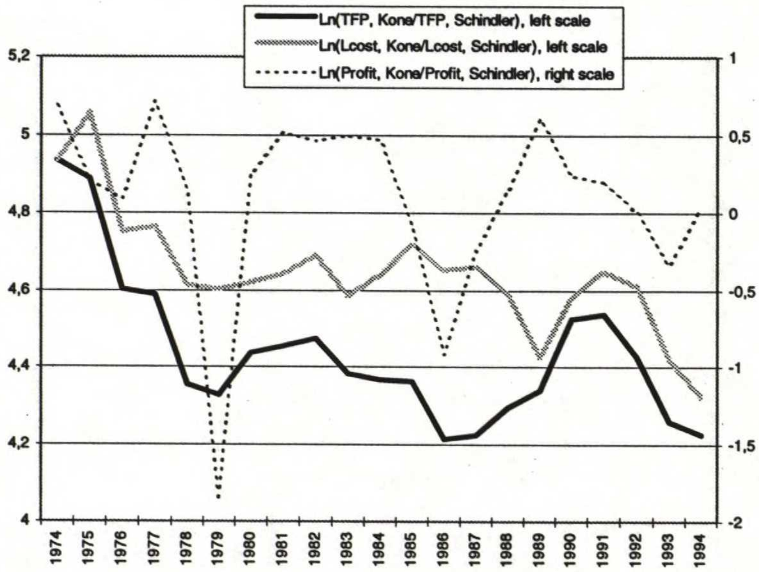
Data on total factor productivity levels, labor costs and profitability for both companies is now available. In theory, higher productivity and lower labor costs should lead to better profitability if all other factors remain the same. To test this, some simple regressions using the following models were done:

$$(3.3.3\text{-}1) \qquad Ln\left(\frac{\pi_t^{Kone}}{\pi_t^{Schindler}}\right) = a + bLn\left(\frac{TFP_t^{Kone}}{TFP_t^{Schindler}}\right)$$

$$(3.3.3\text{-}2) \qquad Ln\left(\frac{\pi_t^{Kone}}{\pi_t^{Schindler}}\right) = a + bLn\left(\frac{TFP_t^{Kone}}{TFP_t^{Schindler}}\right) + cLn\left(\frac{(L_{cost} / L)_t^{Kone}}{(L_{cost} / L)_t^{Schindler}}\right)$$

In practice, how well a company is making profit depends on many factors, e.g. on the phase of the business cycle, and on how well the company is doing compared to its competitors. This means that with data on one company's productivity level alone, it is not possible to predict the company profitability level, if the productivity and profitability levels of its competitors in the same industry are not known. To clear these disturbing effects, annual differences of the variables in the natural logarithms between companies were used. In the first model only the difference in the TFP level works as a predictor of difference for the profitability level. In the second model both the TFP level and labor costs were used as predictor of profitability level (equations 3.3.3-1, 3.3.3-2 and figure 3.3.3-5).

**FIGURE 3.3.3-5 Logarithmic difference in profitability, $Ln(\pi^{Kone}/\pi^{Schindler})$, and tested predictors: 1. Logarithmic difference in the total factor productivity level, $Ln(TFP^{Kone}/TFP^{Schindler})$ 2. Logarithmic difference in labor costs, $Ln\{(L_{cost}/L)^{Kone}/(L_{cost}/L)^{Schindler}\}$**




*Source: Author's calculations based on company annual reports.*

The results of the first estimation are presented in table 3.3.3-1 and, as a scatter diagram, in figure 3.3.3-6. The sign of the relative total factor productivity estimate is positive according to the theory and it seems to be a statistically significant predictor of relative profitability (p-value of t-test is 0,047).

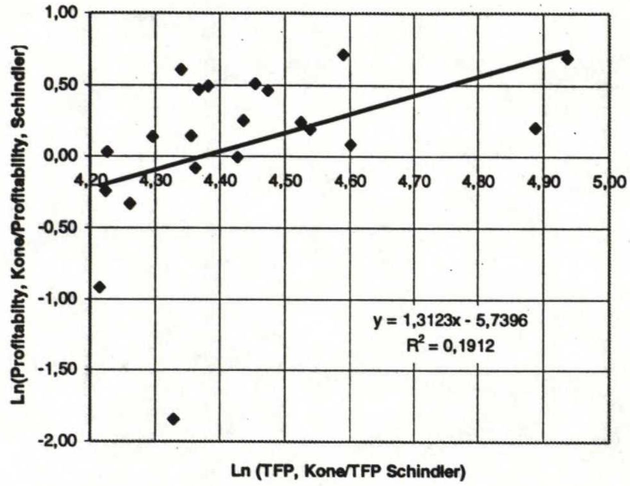
**TABLE 3.3.3-1 Logarithmic difference in the total factor productivity level, $Ln(TFP^{Kone}/TFP^{Schindler})$, as a predictor of logarithmic difference in profitability, $Ln(\pi^{Kone} - \pi^{Schindler})$. The regression summary results.**

| Variable | Estimate | Standard error | t-value | p-value |
|---|---|---|---|---|
| Intercept | -5,74 | 2,75 | -2,09 | 0,0507 |
| $Ln\left(\frac{TFP_t^{Kone}}{TFP_t^{Schindler}}\right)$ | 1,31 | 0,619 | 2,12 | 0,047 |

N=21, $R^2$ = 0,191

*Source: Author's calculations based on company annual reports.*

**FIGURE 3.3.3-6 Logarithmic difference in the total factor productivity level ($TFP^{Kone}/TFP^{Schindler}$) as a predictor of logarithmic difference in profitability level ($\pi^{Kone} - \pi^{Schindler}$).**




*Source: Author's calculations based on company annual reports.*

In the second model both the TFP level and labor costs were used as predictors of profitability (table 3.3.3-2). Adjusted $R^2$ increased in this multiple regression and the signs of predictor estimates are according to theory, TFP level positive and labor costs negative. The TFP level became a statistically more significant predicor in this regression compared to the earlier model (p-value of t-test is 0,0224). The labor costs turned out to be a statistically non-significant predictor of profitability in the model.

**TABLE 3.3.3-2 Logarithmic difference in the total factor productivity level, $Ln(TFP^{Kone}/TFP^{Schindler})$, and logarithmic difference in labor costs, $Ln\{(L_{cost}/L)^{Kone}/(L_{cost}/L)^{Schindler.}\}$, as a predictor of logarithmic difference in profitability, $Ln(\pi^{Kone}/\pi^{Schindler})$. The regression summary results.**

| Variable | Estimate | Standard error | t-value | p-value |
|---|---|---|---|---|
| Intercept | -2,53 | 3,42 | -0,740 | 0,469 |
| $Ln\left(\frac{TFP_t^{Kone}}{TFP_t^{Schindler}}\right)$ | 2,56 | 1,02 | 2,50 | 0,0224 |
| $Ln\left(\frac{(L_{cost}/L)_t^{Kone}}{(L_{cost}/L)_t^{Schindler}}\right)$ | -1,88 | 1,25 | -1,50 | 0,151 |

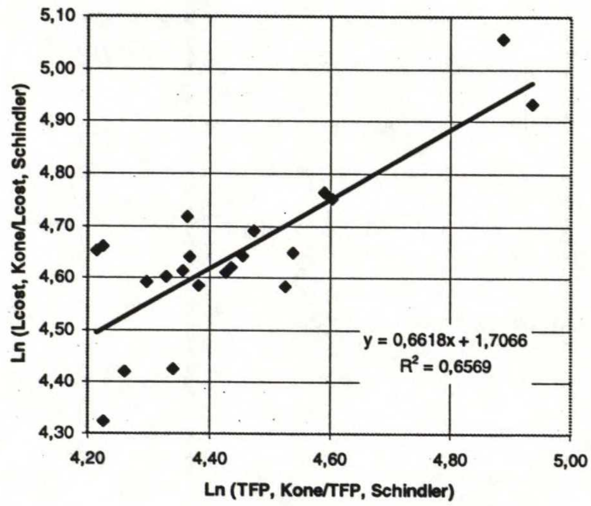
N=21, $R^2$ = 0,281

*Source: Author's calculations based on company annual reports.*

It is interesting in the previous data that Kone's profitability level has usually been slightly higher, although the company total factor productivity level has usually been lower. Differences in the labor costs don't seem to explain it. It is not known wheather Kone has had cheaper capital or higher monopoly power in some ouput market. However, it must be mentioned that the total factor productivity constructed here is

not a perfect measure because the productivity of intermediate goods and services is not measured. More accurate price deflators for outputs should be used as well.
In addition to the above models, the TFP level was used to predict labor costs. A higher total factor productivity level seems to result in a higher labor cost level (figure 3.3.3-7). This regression had the strongest statistical evidence (p-value of t-test is 0,00000841). Based on that and assyming that higher labor costs mean higher real income to the labor force, it can be said that improving productivity should be in the interest of employees as well.

**FIGURE 3.3.3-7 Logarithmic difference in the total factor productivity level, $Ln(TFP^{Kone}/TFP^{Schindler})$, as a predictor of logarithmic diffrence in labor costs, $Ln\{(L_{cost}/L)^{Kone}/(L_{cost}/L)^{Schindler}\}$.**




*Source: Author's calculations based on company annual reports.*

### 3.3.4 Conclusions on the case

The productivity trends and levels of the second and the third largest elevator supplier in the world, Schindler and Kone, were compared over the last twenty years, 1974-1994. During the observation period Kone has gone international and grown aggressively by acquiring new companies on all continents. Schindler was already in the beginning of the observation period larger and its growth has been less aggressive.

The total factor productivity of both companies has grown mainly because of the increased productivity of labor. The productivity growth of capital has been close to zero, even negative with Kone. Zero productivity growth of capital is a common result from other studies as well. Kone has been a more capital-intensive company than Schindler, and its labor productivity level has usually been higher. However, a worse productivity level of capital resulted in a lower level of total factor productivity for Kone. Kone has been on the average slightly more profitable than Schindler. In statistical estimations, a better total factor productivity seem to predict better profitability, and, even more clearly, better total factor productivity resulted in higher labor costs. Factors like output and capital input prices were not possible to analyze. Generally all the figures for both companies are very similar. This is quite understandable because both companies are working in the same industry, have been in global competition in the same market areas and their product offering is very alike.

By looking at the figures one can get an impression that sizeble acquistions weaken the capital productivity, at least temporarily (e.g. Schindler 1989, Kone 1975). This could be tested statistically as well, however, this would require a more extensive data. The reason might be that, in a large acquisitions, companies have to consolidate extra fixed assets which are not needed after reorganisation. The rapidly grown Kone, which had acquired dozens of companies, announced recently that it will concentrate production into bigger units in Europe, and at least six of its current ten European manufacturing plants will be closed (Iivonen 1996). Based on the findings of the weakening capital productivity level of Kone, this is no surprise. However, Kone's profitability has been good, so its aggressive growth strategy can be considered very successful. Now, after aggressive growth, it might be time to harmonize its European operations. We however, do not know what the real costs of these investments have been. If capital is cheap, e.g. because of government subsidies, rational company management increases capital input. Sometimes it has been provocatively stated that Finnish managers manage machines rather than people.

In doing the study, data problems similar to other studies where annual reports have been used as data source were faced (scarce and sometimes not directly comparable information). However, it can be believed that on this level the comparison is quite reliable. Of course it would have been nice to include more companies into the analysis and to have more data available, e.g. on material inputs and output categories and prices. This would have given more accurate information on the real performance levels of the companies in the elevator industry. This kind of study, based on annual reports, is more like a history review and it doesn't serve the company management in its daily operations. There a system with more accurate operational data is needed.

## 3.4 Developing internal measures

A company can not be run by analyzing the annual reports of competitors. The objective of this chapter is to develop a productivity analyzing system for the elevator manufacturing and delivery process, when figures from internal reporting system are available. To make the system useful and easy to implement, the requirements are:

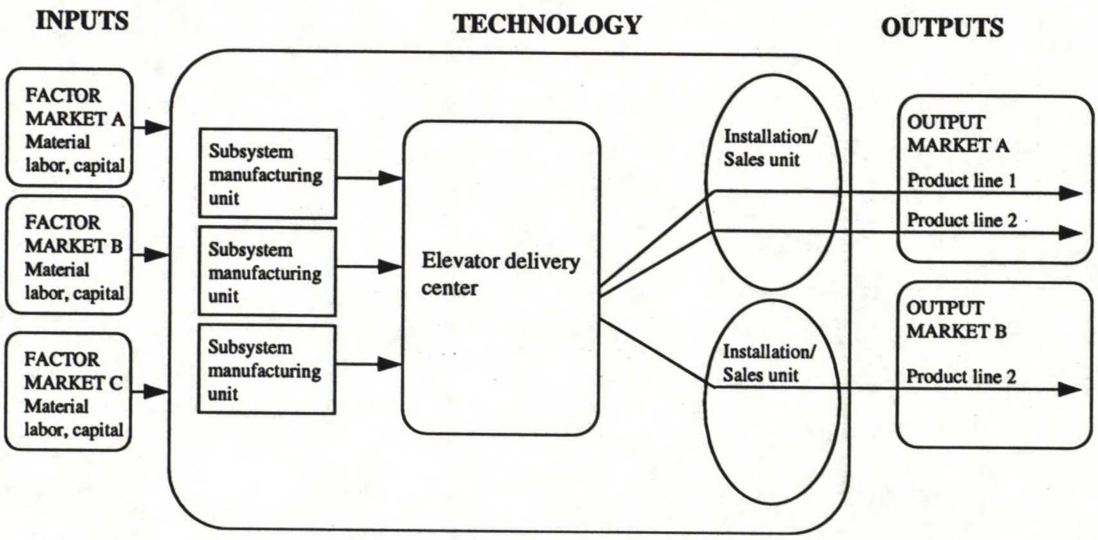
- All inputs (material, labor and capital) and outputs must be taken into account
- A link between productivity and profitability must be built into the system
- The system must be simple and easy to use, e.g., the system uses data already provided by existing reporting systems

*Elevator manufacturing process as an input/output system*

Elevators are typically delivered by elevator delivery centers which take care of the communication with the sales units, possible system-level engineering, sourcing the components and phasing the deliveries according to an agreed schedule. To make the whole chain working, the use of different inputs to participating units are required.

Different units might consume inputs in different market areas (e.g. countries) and they might have many product lines as their responsibility (figure 3.4-1). One elevator company might have many elevator delivery centers and some of the delivery centers might be specialized in certain product lines.

**FIGURE 3.3.4-1 Elevator manufacturing process.**




*Required data - inputs and outputs in the production process*

The idea is to build an analyzing system which calculates various productivity and and price indexes, based on the quantities and prices used in the elevator manufacturing process. The basic idea is very similar to the APC system in chapter 2.2.1 and to the productivity analyzing system used in the Finnish forest industry (see chapter 2.3.1.) The required data is presented in table 3.4-1. If only one product line in one market area is considered, there is one installation unit, one elevator delivery center and a couple of subsystem manufacturing units involved. These units might be located in different labor input markets. They are probably using global material and capital sources, or in some closed markets, there might be restrictions on the use of imported material or capital. These input and output categories can be created on a level which is considered to be accurate enough.

| TABLE 3.3.4-1 | Typical inputs and outputs for the elevator manufacturing productivity analysis | | |
|---|---|---|---|
| OUTPUTS | Explanations | Quantity | Price |
| Products of certain product line | A product line is the specific elevator range for a specific market<br><br>A product is a homogeneous product group in the product line<br>• Basic system (e.g. hydro/rope)<br>• Travel category (e.g. 15-20m)<br>• Nominal load (e.g. 630kg)<br>• Quality (e.g. decoration type = standard) | Units | Market price of the product in the selected market |
| LABOR INPUT | Explanations | Quantity | Price |
| Working hours | Working hours according to labor type<br>• e.g. own personnel, subcontractor<br>• wage classes | Hours used by the product | Wage in the input market |
| CAPITAL INPUT | Explanations | Quantity | Price |
| Depreciation (%) according to capital type | Types of capital<br>• Machinery and equipment<br>• Land and buildings<br>• Office space (rented) | <br>Asset value<br>Asset value<br>$m^2$ | <br>Depreciation%<br>Depreciation%<br>actual price |
| MATERIAL INPUT | Explanations | Quantity | Price |
| Used material according to material type | Types of material<br>• ropes<br>• guide rails types<br>• steel types<br>• electronic components | <br>m<br>m<br>kg<br>Quantity index | <br>Actual price<br>Actual price<br>Actual price<br>Price index |

*Practical issues*

The simple basic rule in building the system in order to make it worthwhile is that the effort required to build the system must not be bigger than the advantages of the system. Therefore a flexible step-by-step approach is recommended. Even rough data gives a fast indication where to concentrate. If some units are using more accurate reporting systems e.g. ABC (activity-based costing), and some are not, the information collection can be tailored to the system available. Building the system is much easier if an organization which is clearly responsible for the total costs of certain product line can be identified.

Constructing a reasonable output by selecting product lines and dividing products into homogeneous categories should be quite easy to carry out. Allocating labor resources to products should be also possible in all participating units. In allocating capital inputs, some compromises between theory and practice must certainly be done. It could be enough to allocate the capital input only by dividing it according to the number of products delivered through the participating unit. Finding the most important material categories should be also possible. Labor input prices are in relation to location of the participating units. The most important material items are bought from global markets based on global company contracts. However, in all input and output categories, concentrating on the most important items should be the guideline.

*Possibilities provided by the system*

This kind of system gives plenty of benefits compared to the system measuring only the monetary flows of operations.

Daily operations
- productivity targets and price targets separately
- forecasts based both on price and productivity scenarios
- compensation systems based on productivity targets, not profitability targets

Operations development
- understanding the most important factors and their sensitivity and impact on profits
- benchmarking between similar units, products and other companies
- development plans based on findings

Analyzing productivity effects of strategic options
- technology changes
- market entries/exits
- logistics rearrangements

The immediate effect of doing a productivity analysis is that the most important real process factors and their prices influencing company productivity and profitability can be isolated. Especially in global companies where different input and output markets are used, separating physical productivity and various prices is essential to give a complete understanding on the company's performance.

## 4. Conclusions

Productivity is a direct subfactor of profitability describing the efficiency of a real process. This means that profitability can be divided into productivity and a output/input price relationship. Productivity measures tell how efficiently physical inputs are used to get physical outputs. Conventionally applied measures in company management, like profitability, are dealing only with financial measures and they don't tell anything on the real process productivity. The major motivation for company management to develop productivity measurement is the realization of the importance of levels and changes in productivity to profit rates and the need to track productivity explicitly as an aspect of cost control. It is good to understand how much company profit levels and trends are based on fluctuating market prices and exchange rates and how much on real process productivity. Economic theory offers many approaches to productivity measurement. On a company level, the index number approach seems to be widely used. In practice, theoretically accurate productivity measurement is difficult, and in some cases even impossible. A company must customize suitable measures for its information systems and industry type.

By themselves, the productivity indexes are somewhat vague. They must be analyzed and interpreted to be of use in sparking action. This involves comparisons over time within firms, distinguishing the movements of various partial productivity ratios; comparisons among components of a firm; and comparisons with competing firms or plants, or with averages for the industry or industries within which the firm and/or its establishments are classified. One of the most essential results of recent productivity studies is that the company management can copy and transfer the best business practices from a company or country to another. Opening world markets mean that no company is any more in safe position, because there are many ways to penetrate even closed markets.

In the case application part, various productivity trends and levels of the second and the third biggest elevator suppliers in the world, Schindler and Kone, were compared over the past twenty years, 1974-1994. The total factor productivity for both companies has grown mainly because of increased productivity of labor. The productivity growth of capital has been close to zero, even negative with Kone. In some simple estimations, the total factor productivity seems to lead to better profitability. Generally all the figures for both companies are very similar. Therefore on the basis of this study it is easy to understand that both companies are working in the same industry and in the same markets. To see more results on the case application, see chapter 3.2. Many issues which came up during the study raised a desire to get more companies and more accurate data to the analysis in order to get a more complete picture of the relative performance of the players in the elevator industry, e.g. information on material inputs, output categories and prices.

Making comparisons based on company annual reports is not enough to run a company, however. In the end of the application part a productivity analyzing system for an elevator manufacturing process with internal data was developed. The outlined system could be part of an integral management system of an elevator company. It can be believed that with a reasonable amount of work and by adding quantity data to the current financial reporting system one could build a very informative productivity analyzing system to supplement the financial reporting system. There are already available existing models of such systems and experience from others. This system would provide the management with a much better understanding on the factors behind productivity. Especially in global companies where different input and output markets are used, separating physical productivity and various prices is a very useful method to get a complete understanding on the company's performance.

Productivity or productivity management is not a separate issue, or just another management fad. It is a permanent success factor and an essential part of company operations. Of cource all good things can be spoilt by doing them wrongly. Implementing productivity management systems in companies require sensitivity of people with different backgrounds - simply good management skills. But doing it in the right way, nothing prevents the company from becoming a world leader in its business processes.

# 5. Recommendations

Based on the study, it seems that productivity analysis should be an integral part of modern company management, in addition to a financial analyzing system. Especially in the case of global companies where one is working with different input and output markets, separating physical productivity and various prices is very useful to get a complete understanding on company performance. Therefore, it can be recommended to start the development of such system. Ideas presented in chapter 3.4 and, e.g. the example from the Finnish forest industry, offer a good starting point (chapter 2.3.1).

In practice, it looks that with a reasonable amount of work and by adding quantity data to the existing financial reporting system one could build a very informative productivity analyzing system to supplement financial reporting data. Implementing should be done step by step. The first step would be to select one representative product line and test the preliminary system there, to find good solutions to some practical questions. Even a very preliminary analysis would surely show the most important factors on which to concentrate later on. After getting experience, the system could be implemented further. If new management information systems are implemented, the data requirements coming from the productivity analysis should be taken into account already at an early stage of the project. In any case, to make productivity analyzing a real part of a company's life, strong interest and commitment from the top management is required.

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## Appendix: Constructed company data 1 (2)

**CONSTRUCTED COMPANY DATA**

| | Measure | Explanation | 1994 | 1993 | 1992 | 1991 | 1990 | 1989 | 1988 | 1987 | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 | 1972 | 1971 | 1970 | 1969 | 1968 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L (Kone) | at the end of the year | 21553 | 20710 | 21426 | 22284 | 21763 | 19231 | 17471 | 16618 | 16301 | 15539 | 13145 | 13391 | 12913 | 11930 | 11316 | 10756 | 9469 | 9694 | 10163 | 10511 | 6103 | 4720 | 4402 | 4627 | 4092 | 3748 | 3317 |
| | L (Schindler) | at the end of the year | 34178 | 31969 | 32656 | 32268 | 31989 | 30394 | 22752 | 21867 | 20994 | 22295 | 22220 | 22332 | 21575 | 21900 | 21758 | 21494 | 19950 | 20546 | 20417 | 21035 | 22462 | 22700 | 22250 | 22000 | 21500 | | |
| 1) | Q (Kone) | 1987 US$ (millions) | 1310 | 1253 | 1546 | 1552 | 1374 | 1040 | 952 | 822 | 651 | 497 | 452 | 458 | 485 | 420 | 459 | 383 | 352 | 338 | 324 | 325 | 192 | 133 | 109 | 93 | 85 | 73 | 63 |
| | Q (Schindler) | 1987 US$ (millions) | 2481 | 2256 | 2302 | 2024 | 1918 | 1603 | 1157 | 948 | 804 | 639 | 673 | 707 | 719 | 695 | 849 | 796 | 712 | 567 | 579 | 619 | 601 | 572 | 455 | 389 | 321 | 0 | 0 |
| | Q (%) (Kone) | Q as a share of turnover | 70 % | 66 % | 64 % | 66 % | 68 % | 65 % | 66 % | 65 % | 63 % | 59 % | 62 % | 61 % | 68 % | 73 % | 71 % | 71 % | 71 % | 71 % | 71 % | 71 % | 71 % | 71 % | 71 % | 71 % | 71 % | 71 % | 71 % |
| | Q (%) (Schindler) | Q as a share of turnover | 71 % | 74 % | 75 % | 76 % | 76 % | 77 % | 78 % | 78 % | 78 % | 76 % | 77 % | 79 % | 78 % | 77 % | 77 % | 80 % | 80 % | 79 % | 77 % | 77 % | 75 % | 75 % | 75 % | 75 % | 75 % | | |
| | I (Kone) | 1987 US$ (millions) | 15,1 | 25,0 | 55,3 | 69,6 | 51,7 | 39,4 | 26,9 | 23,0 | 23,6 | 26,2 | 20,3 | 22,4 | 24,2 | 21,9 | 18,2 | 11,2 | 13,1 | 16,1 | 21,5 | 25,1 | | | | | | | |
| | I (Schindler) | 1987 US$ (millions) | 24 | 14 | 59 | 60 | 23 | 95 | 42 | 7 | 1 | -7 | 0 | 7 | 19 | 1 | 10 | 27 | 2 | 4 | 6 | 12 | | | | | | | |
| 2) | K (macinery and equipment, Kone) | 1987 US$ (millions) | 215 | 235 | 248 | 226 | 184 | 156 | 137 | 130 | 125 | 120 | 110 | 106 | 98 | 87 | 76 | 68 | 67 | 64 | 56 | 41 | 18 | 11 | | | | | |
| | K (macinery and equipment, Schindler | 1987 US$ (millions) | 198 | 204 | 223 | 193 | 157 | 157 | 73 | 37 | 36 | 41 | 57 | 67 | 71 | 62 | 71 | 72 | 54 | 61 | 66 | 71 | 69 | 69 | | | | | |
| | K (fire insurance, Kone) | 1987 US$ (millions) | | | 987 | 1038 | 830 | 691 | 613 | 536 | 437 | 410 | 362 | 374 | 366 | 397 | 349 | 298 | 314 | 315 | 256 | 253 | | | | | | | |
| | K (fire insurance, Schindler) | 1987 US$ (millions) | 1685 | 1655 | 1627 | 1376 | 1262 | 1027 | 1011 | 936 | 753 | 571 | 671 | 728 | 736 | 701 | 862 | 913 | 842 | 643 | 645 | 659 | 657 | 565 | | | | | |
| 3) | L cost (Kone) | 1987 US$ (thousands) | 654 | 787 | 1002 | 934 | 792 | 605 | 558 | 518 | 429 | 320 | 288 | 281 | 298 | 265 | 311 | 274 | 236 | 219 | 226 | 246 | 131 | 93 | 75 | 70 | 60 | 52 | 47 |
| | L cost (Schindler) | 1987 US$ (thousands) | 1623 | 1450 | 1479 | 1304 | 1232 | 1047 | 741 | 638 | 556 | 443 | 467 | 478 | 478 | 479 | 600 | 564 | 494 | 386 | 391 | 410 | 393 | 372 | | | | | |
| | Profitability (Kone) | Net profit/turnover | 3,4 % | 2,7 % | 2,5 % | 2,6 % | 4,6 % | 5,8 % | 4,4 % | 2,8 % | 1,1 % | 2,2 % | 4,0 % | 4,1 % | 3,8 % | 3,3 % | 1,9 % | 0,2 % | 2,1 % | 3,8 % | 4,0 % | 4,2 % | 6,8 % | | | | | | |
| | Profitability (Schindler) | Net profit/turnover | 3,3 % | 3,7 % | 2,5 % | 2,2 % | 3,6 % | 3,2 % | 3,8 % | 3,6 % | 2,7 % | 2,4 % | 2,5 % | 2,5 % | 2,4 % | 2,0 % | 1,5 % | 1,2 % | 1,9 % | 1,9 % | 3,7 % | 3,4 % | 3,4 % | | | | | | |

**USED GOVERNMENT DATA**

| Measure | Explanation | 1994 | 1993 | 1992 | 1991 | 1990 | 1989 | 1988 | 1987 | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 | 1972 | 1971 | 1970 | 1969 | 1968 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P (Q) | index 1987 = 100 | 98,66 | 99,73 | 103,7 | 105,4 | 104,9 | 103,4 | 101,8 | 100 | 98,36 | 95,75 | 95,41 | 94,86 | 92,99 | 88,53 | 80,68 | 74,57 | 70,64 | 67,8 | 63,79 | 59,99 | 52,14 | 48,26 | 47,85 | 46,42 | 44,08 | 42,45 | 40,71 |
| P (I) | index 1987 = 100 | 98,66 | 99,73 | 103,7 | 105,4 | 104,9 | 103,4 | 101,8 | 100 | 98,36 | 95,75 | 95,41 | 94,86 | 92,99 | 88,53 | 80,68 | 74,57 | 70,64 | 67,8 | 63,79 | 59,99 | 52,14 | 48,26 | 47,85 | 46,42 | 44,08 | 42,45 | 40,71 |
| US$/FIM | US$/FIM | 5,2 | 5,7 | 4,5 | 4,0 | 3,8 | 4,3 | 4,2 | 4,4 | 5,1 | 6,2 | 6,0 | 5,6 | 4,8 | 4,3 | 3,7 | 3,9 | 4,1 | 4,0 | 3,9 | 3,7 | 3,8 | 3,8 | 4,1 | 4,2 | 4,2 | 4,2 | 4,2 |
| US$/CHF | US$/CHF | 1,4 | 1,5 | 1,4 | 1,4 | 1,4 | 1,6 | 1,5 | 1,5 | 1,8 | 2,5 | 2,4 | 2,1 | 2,0 | 2,0 | 1,7 | 1,7 | 1,8 | 2,4 | 2,5 | 2,6 | 3,0 | 3,2 | 3,8 | 4,1 | 4,4 | | |

**Corrections/commnets on data**

1) According to turnover before 1980. In 1994 the Montgomery added value was estimated by using information on its turnover
2) According fixed assets in summary (1975 report) before 1974
3) According to wages before 1992. In 1994 labor costs have been calculated w/o Montgomery or sold industries.

## Appendix: Constructed company data 2 (2)

**Schindler (personnel at the end of year)**

| Country | 1994 | 1993 | 1992 | 1991 | 1990 | 1989 | 1988 | 1987 | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Switzerland | 5907 | 6040 | 6115 | 6283 | 6265 | 5967 | 5546 | 5238 | 4570 | 4933 | 4919 | 5198 | 5652 | 6028 | 6108 | 6115 | 6364 | 6453 | 6231 | 6379 | 7054 | 7041 |
| EU countries 1994 (EEC countries 1982-1992) | 12912 | 13063 | 13384 | 12734 | 12067 | 11443 | 10675 | 10007 | 9607 | 9870 | 9973 | 10016 | na | na | na | na | na | na | na | na | na | na |
| Rest of Europe 1983-1994 | 2027 | 1792 | 1887 | 1825 | 1836 | 1650 | 1176 | 1132 | 1122 | 1355 | 1435 | 1435 | na | na | na | na | na | na | na | na | na | na |
| America 1983-1994 | 9220 | 9076 | 9389 | 9673 | 10212 | 10034 | 4418 | 4582 | 4639 | 4913 | 4751 | 4522 | na | na | na | na | na | na | na | na | na | na |
| Asia, Africa, Australia 1983-1994 | 4112 | 1998 | 1881 | 1753 | 1609 | 1300 | 937 | 908 | 1056 | 1224 | 1142 | 1161 | na | na | na | na | na | na | na | na | na | na |
| Europe without Switzherland | 14939 | 14855 | 15271 | 14559 | 13903 | 13093 | 11851 | 11139 | 10729 | 11225 | 11408 | 11451 | 9630 | 9801 | 10016 | 10022 | 10047 | 10429 | 10216 | 10220 | 10975 | 11213 |
| Overseas | 13332 | 11074 | 11270 | 11426 | 11821 | 11334 | 5355 | 5490 | 5695 | 6137 | 5893 | 5683 | 6293 | 6071 | 5634 | 5357 | 3539 | 3664 | 3970 | 4436 | 4433 | 4016 |
| Total | 34178 | 31969 | 32656 | 32268 | 31989 | 30394 | 22752 | 21867 | 20994 | 22295 | 22220 | 22332 | 21575 | 21900 | 21758 | 21494 | 19950 | 20546 | 20417 | 21035 | 22462 | 22270 |

**Kone (personnel at the end of year)**

| Country | 1994 | 1993 | 1992 | 1991 | 1990 | 1989 | 1988 | 1987 | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Netherlands | 715 | 853 | 964 | 959 | 845 | 763 | 54 | 54 | 52 | 49 | 57 | 67 | na | na | na | 15 | 15 | 0 | 0 | 0 | 0 | |
| Australia | 674 | 812 | 936 | 1042 | 1367 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Belgium | 778 | 803 | 821 | 878 | 862 | 851 | 800 | 749 | 756 | 747 | 678 | 661 | na | na | na | 696 | 714 | 716 | 863 | 889 | 0 | |
| Brazil | 570 | 601 | 642 | 708 | 704 | 693 | 628 | 600 | 567 | 487 | 457 | 692 | na | na | na | 675 | 475 | 425 | 0 | 0 | 0 | |
| Spain | 276 | 322 | 341 | 342 | 308 | 97 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 853 | 856 | 0 | |
| Hong Kong | 452 | 395 | 315 | 310 | 273 | 257 | 238 | 213 | 201 | 204 | 190 | 127 | na | na | na | 0 | 0 | 0 | 0 | 0 | 0 | |
| India | 648 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Great Britain | 886 | 1652 | 1906 | 2120 | 1679 | 1551 | 1269 | 1219 | 1397 | 892 | 1016 | 1236 | na | na | na | 1319 | 75 | 74 | 93 | 104 | 0 | |
| Italy | 2651 | 2766 | 2719 | 2599 | 2328 | 2062 | 2111 | 2018 | 959 | 928 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Austria | 475 | 522 | 561 | 531 | 531 | 495 | 455 | 438 | 432 | 451 | 473 | 470 | na | na | na | 526 | 530 | 533 | 551 | 478 | 442 | |
| Canada | 466 | 481 | 536 | 605 | 707 | 659 | 559 | 439 | 450 | 476 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Mexico | 316 | 291 | 306 | 297 | 317 | 306 | 295 | 274 | 296 | 295 | 191 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Norway | 204 | 207 | 225 | 227 | 235 | 255 | 254 | 274 | 309 | 274 | 286 | 272 | na | na | na | 167 | 190 | 207 | 199 | 236 | 391 | |
| France | 2449 | 2760 | 3025 | 3138 | 3028 | 2851 | 2699 | 2528 | 2559 | 2101 | 2005 | 2025 | na | na | na | 1956 | 2009 | 2090 | 2303 | 2514 | 187 | |
| Sweden | 890 | 1180 | 1300 | 1401 | 1378 | 1378 | 1324 | 1340 | 1377 | 1212 | 1070 | 1091 | na | na | na | 764 | 743 | 774 | 762 | 784 | 781 | |
| Germany | 1003 | 1013 | 1109 | 1122 | 1051 | 937 | 842 | 856 | 960 | 970 | 461 | 430 | na | na | na | 404 | 447 | 516 | 594 | 563 | 535 | |
| Singapore | 72 | 125 | 104 | 120 | 116 | 98 | 71 | 65 | 58 | 84 | 91 | 42 | na | na | na | 0 | 0 | 0 | 0 | 0 | 0 | |
| Finland | 1942 | 3134 | 3355 | 3603 | 3815 | 3837 | 3791 | 3698 | 4150 | 4479 | 4595 | 4714 | 4776 | 4609 | 4218 | 3956 | 4015 | 4109 | 3693 | 3842 | 3529 | |
| Taiwan | 136 | 138 | 115 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Denmark | 250 | 271 | 340 | 386 | 403 | 419 | 348 | 353 | 374 | 371 | 296 | 290 | na | na | na | 269 | 256 | 250 | 252 | 245 | 238 | |
| Czech Republic | 366 | 435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Turkey | 118 | 131 | 129 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| USA | 4628 | 1406 | 1246 | 1415 | 1541 | 1397 | 1434 | 1238 | 1147 | 1250 | 1209 | 1221 | 771 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Venezuela | 208 | 268 | 259 | 253 | 187 | 181 | 175 | 166 | 173 | 176 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Other countries 1974-1979 & 1983-1994) | 380 | 144 | 172 | 228 | 88 | 74 | 124 | 96 | 84 | 93 | 70 | 53 | na | na | na | 9 | 0 | 0 | 0 | 0 | 0 | |
| Scandinavia except Finland | 1344 | 1658 | 1865 | 2014 | 2016 | 2052 | 1926 | 1967 | 2060 | 1857 | 1652 | 1653 | 1575 | 1469 | 1363 | 1200 | 1189 | 1231 | 1213 | 1265 | 1410 | |
| Europe except Scandinavia | 9599 | 11126 | 11446 | 11689 | 10632 | 9607 | 8230 | 7862 | 7115 | 6138 | 4690 | 4889 | 4637 | 4917 | 4981 | 4916 | 3790 | 3929 | 5257 | 5404 | 1164 | |
| Outside Europe | 8668 | 4792 | 4760 | 4978 | 5300 | 3735 | 3524 | 3091 | 2976 | 3065 | 2208 | 2135 | 1154 | 935 | 754 | 684 | 475 | 425 | 0 | 0 | 0 | |
| Total | 21553 | 20710 | 21426 | 22284 | 21763 | 19231 | 17471 | 16618 | 16301 | 15539 | 13145 | 13391 | 12913 | 11930 | 11316 | 10756 | 9469 | 9694 | 10163 | 10511 | 6103 | 4720 |