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How Do Sales in High-Tech Firms React to Changes in Expenses? Evidence from Finland

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Abstract

The aim is to analyze the functioning of high-tech companies from a new perspective. The framework is based on a multiplicative sales function leading to constant expense elasticities of sales. The objective is to test the hypothesis that the expense elasticities of sales revenue are associated with financial performance, especially with profitability. Elasticities are estimated for four categories of expenses: expenses of goods sold, R&D expenses, other operating expenses, and depreciations. Empirical data are extracted from ORBIS database. The sample is limited and includes only sixteen largest Finnish manufacturing companies in the high-tech sector. Evidence shows that elasticities are associated with performance. The growth of the companies is positively correlated with the elasticity of expenses of goods sold, but negatively correlated with the elasticity of other operating expenses. The results give support to the research hypothesis. EBIT margin and ROE are positively associated with the elasticity of R&D expenses whereas ROA is positively correlated with the elasticity of expenses of goods sold and the sum of the four expense elasticities. It is also negatively associated with other operating expense elasticity of sales.

Keywords

High-Tech Companies, Large Manufacturing Companies, Finnish Firms, Expense Elasticities of Sales, R&D Expenses, Profitability

1. Introduction

This study concentrates on the functioning of high-tech manufacturing companies. The importance of high-tech companies to the economy of every modern country is large. Therefore, the development of the high-tech company sector is one of the major strategies to achieve economic prosperity in any country (Afonina & Chalupsky, 2014). High tech companies are a significant asset in both local and global markets. High-tech manufacturing companies are associated with innovative and technically advanced production technologies and high-value-added production. High-tech companies typically invest a lot to stay competitive and to raise their market share in the global market through innovating and creating new products, services and capabilities. Thus, for high tech companies, competitive business models and flexibility play the central role (Müller & Vorbach, 2015).

Consequently, industrial economists have for a long time recognized the importance of technological innovation and productivity growth to economic welfare (Karahan, 2015) and also to economic happiness (Lordkipanidze & Abralava, 2024). The potential for high technology to improve productivity growth, stimulate high wage employment opportunities, and enhance the competitiveness of industries is widely acknowledged (Amato & Amato, 2000). Thus, governments all over the world encourage corporate investments in innovation or R & D and foster innovative firms (Liu, 2022; Zhang & Lv, 2021). In Finland, the technology industry is the most important export industry constituting 2023 over 50% of all Finnish exports. In addition, technology companies are responsible for 65% of all private sector investment in research and development (R&D) carried out in Finland.[1] Thus, technology companies play a vital role in the future success of Finland.

There is no unambiguous and commonly approved definition of high-tech company. High-tech company is difficult to define because the majority of new technologies cross borders of traditionally divided industrial companies (Zakrzewska-Bielawska, 2010). However, there are key features, which make it possible to differentiate a high-tech company from a less technically advanced company. High-tech companies are characterized by high demand for scientific research and intensity of R&D expenditure, high level of innovativeness, fast diffusion of technological innovations, fast process of obsolescence of the prepared products and technologies, high level of employment of scientific and technical personnel, high capital expenditure and high rotation level of technical equipment, replaced by more modern and innovative devices, and high investment risk and fast process of the investment devaluation (Zakrzewska-Bielawska, 2010).

The special feature of high-tech manufacturing companies is that they are focused on the expenses for research and development (R&D) activities. The results of these activities in the form of technologically advanced products and their application in production of traditional goods largely determine not only the performance of the company but also the performance of the whole economy. High-tech companies are also intensive users of knowledge and human resources as means of production. Because these means are constantly created, high-tech companies have a positive impact on the surrounding economy.

The features of high-tech companies have also been object for keen research. Traditional companies are typically oriented on mass and large series production of

[1] https://teknologiateollisuus.fi/en/technology-finland.

goods for mass consumers, long production batches, few patents, and rare inventions. High-tech companies produce goods involving resources of modern science and technology for an intelligent customer, short production batches, numerous patents and licences, and continuous innovativeness (Zakrzewska-Bielawska, 2010) (**Table 4**). Traditional companies can use high-tech products and procedures, which, however, does not qualify them as high-tech companies (Jurak, 2020). Consequently, Eurostat classifies manufacturing companies according to technological complexity as high, medium-high, medium-low and low technology.[2] Zakrzewska-Bielawska (2010) summarizes the previous studies of the high technology sector as focusing on the issues related to methodology of measuring the research and development activities and its results, the amounts, structure and sources of financing, institutional solutions and the role of the state in stimulating the scientific and technological progress as well as on the issues of technological advancement in a wider context of innovativeness. However, there have been few studies of functioning and management of high-technology companies.

The objective of this study is to look at functioning of the high-tech companies from a new perspective. For a sample of Finnish high-tech companies, the purpose is to estimate the relationship between sales revenues and different types of expenses, in addition to R&D expenses. This kind of analysis is based on the sales (revenue) function where different categories of expenses are used as arguments to explain sales leading to such concepts as expense elasticities of sales revenue. This approach makes use of the annual figures of sales revenue and different categories of expenses published in the same annual closing of accounts. In annual closing of accounts, sales revenues which are earned during the accounting period are first collected to the income statement and then matched with the expenses incurred in order to produce these revenues. Thus, in the matching process, revenues are first recognized and expenses are then matched against these revenues.

Thus, for the accounting period matching brings in the income statement together expenses and resulting revenue enabling to assess the earnings of the firm as the difference between revenue and expenses. If management is able to match revenues and expenses properly, income statements reflect a causal relation from expenses to revenues making it possible to estimate the sales revenue function. This kind of function can be used to get estimate for the expense elasticities but it is also useful in assessing the quality of matching (Laitinen, 2019). The advantage of this approach is that it does not include complicated distributed lag modelling as the typical models on the lagged effects of R&D investments (Griliches, 1967). The weak point of the method is that the reliability of the material used in the estimation (published income statements) is based on the ability and desire of the company management to correctly assess (judge) the connection between sales revenue and expenses.

In summary, the objective of this study is to investigate the functioning the high-

[2] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:High-tech_classification_of_manufacturing_industries.

tech companies from a novel perspective estimating the relationship between sales revenues and different types of expenses (revenue function) in a small sample of Finnish high-tech firms. The objective is to analyse how the expense elasticities of sales revenue are associated with the measures of financial performance. These elasticities can be roughly used to determine the optimum level for different categories of expenses. In this study, elasticities are estimated for four categories of expenses: expenses of goods sold, R&D expenses, other operating expenses, and depreciation (fixed asset expense).

This paper is divided into five sections. In the introductory section, the objective and the motivation of the study are briefly explained. The second section presents the framework of the study which is based on the properties of the sales revenue function. In addition, a research hypothesis is presented. In the third section, empirical data and methods are discussed. The data of the study is composed of nine-year time-series of financial statement information including variables for sales revenue and the four expense categories. The data includes information from sixteen large Finnish public high-tech companies. Many of the companies belong to the group of largest companies in Finland so that in 2022 the sixteen companies in total employ 247,105 people. Because the number of high-tech companies in the data is small, only simple statistical methods are used. The expense elasticities are estimated using the Solver application in Excel. The hypothesis is tested using the Pearson correlation coefficients. In fourth section, empirical results are presented. Finally, the last section presents the conclusions of the study and some outlines for further research.

2. The Framework of the Study

2.1. Previous Studies

The present study is based on the hypothesis that the measures (ratios) of financial performance, especially profitability, are in high-tech companies associated with the expense elasticities of sales revenue. Therefore, the study can identify ways which high-tech companies can use in making their functioning more efficient in terms of financial performance. High-tech companies are not independent of economic cycles, but need methods to make their functioning more efficient to enhance financial performance. Afonina & Chalupsky (2014) analysed financial performance of large high-tech companies in four European countries and argued that the global economic crisis of 2008-2009 had a significant impact on this sector.

They showed that the profitability ratios were influenced by the economic crisis, while the liquidity and solvency ratios increased or stagnated in this period. Afonina & Chalupsky concluded that the high-tech sector consists of companies with a high level of liquidity, rather than companies with high profits. However, high-tech companies need higher profitability to ensure long-term growth and survival. This means that the high-tech sector of the economy needs to change its priorities and rearrange its resources to remain competitive in the global market. In this process, increasing of profitability plays the central role.

From the perspective of this research, studies that have analyzed the impact of R&D investments on the profitability of high-tech companies are important. Empirical studies have found, contrary to a priori expectations, that R&D spending has a negative effect on the profitability of a high-tech company. Berndt & Morrison (1995) found a negative relationship between profitability and investment in computer equipment. Amato & Amato (2000) used a multi-factor productivity model (MFP) to analyse the effect of adoption of flexible manufacturing techniques and also got a negative relationship, when industry dummy variables were excluded from the profitability model. However, the relationship became insignificant once industry dummy variables were added to the model.

Prior findings of a negative relationship between profitability and high technology may thus result from omitting industry effects. Chen & Lee (2018) suggested on the basis of their empirical results that R&D investment has a higher positive effect on company profitability in the high-tech firms rather than in other industries. Their findings imply that the competitiveness of manufacturing firms in the high-tech sector can be enhanced through the application of new technology or advanced equipment developed within the high-tech sector.

Czarnitzki & Thorwarth (2012) investigated the effect of basic research on low-tech and high-tech industries by estimating augmented Cobb-Douglas (CD) production functions. They showed that there exists a premium for basic research on the net output of a firm. The premium effect for high-tech firms was found to be more than twice as high as the effect they found for basic research in the full sample. Dvoulety & Blazkova (2022) empirically assessed the relationship between total factor productivity (TFP) and financial performance in high-tech companies. They found that the performance of a firm is significantly dependent on total factor productivity.

The results also showed that large firms seem to achieve significantly higher performance both in terms of sales and in terms of EBIT when compared with small- and medium-sized enterprises (SME). The authors identified TFP as the critical factor of the performance differences since TFP reflects the possession of resources by the firm and how these resources are combined and transformed. They explored whether firms utilising resources more efficiently in terms of the TFP indicator are performing financially better. Therefore, they tested a hypothesis that there is a positive relationship between company total factor productivity and financial performance. Dvoulety & Blazkova concluded that their study points out the need to expand knowledge on the factors influencing success in high-tech industries. This is also the objective of this study.

2.2. Sales Revenue Function

The objective of this study is to look at functioning of the high-tech companies from a new perspective using a sales revenue function. Mathematically, this function describes the relationship between the sales revenue and different categories of expenses which act as arguments in the function. The sales revenue function describes the contemporaneous economic relation of advancing expenses to obtain sales revenue. This relation is realized in annual closing of accounts where the management first collects the sales revenue earned during the accounting period and then matches this revenue with expenses incurred to produce these revenues. These economically connected revenues and expenses are presented in the income statement of the period to show the difference, earnings.

Thus, the income statement gives a reliable estimate of earnings if the management match revenues with expenses properly. In the same time, the income statement gives a reliable estimate of the relationship between sales revenue and expenses. The sales revenue function can be presented in its general form as follows:

$$S = F\left[E(1), E(2), \cdots, E(m)\right] \tag{1}$$

where S is sales revenue allocated to the accounting period, $E(i)(i = 1, 2, \cdots, m)$ are matched expenses from m categories, and F is a function that describes how revenues and matched expenses are related with each other.

The relationship between sales revenue and expenses (function F) can in practice be very complicated and difficult to describe mathematically. Therefore, this relationship is here simplified assuming that F has a multiplicative form in the following way:

$$S = \prod_{i=1}^{m} E(i)^{e(i)} \tag{2}$$

where $e(i)$ is the expense $E(i)$ elasticity of sales. The function in equation (2) has a similar multiplicative form as the Cobb-Douglas (CD) production function. The CD function has made a very influential contribution to economic theory and may be the best justified and most widely used function in production economics (Jones, 2005; Felipe & Adams, 2005). The CD function has the advantage of algebraic tractability and it provides a fairly good approximation of the production process leading to a good fit with the data. Its main limitation is to impose an arbitrary level for substitution possibilities between production factors, which may not be as serious when describing matching (Laitinen, 2019).

The multiplicative function (2) assumes that the expense elasticities of sales revenue are constant. These constant elasticities for each expense category i can be calculated as follows:

$$\frac{\partial S}{\partial E(i)} \frac{E(i)}{S} = e(i) \tag{3}$$

The assumption of constant elasticities means that a given proportional change in an expense category is responded by a constant proportional change in sales revenue for any amount of expenses in any expense category. This assumption is a simplification which makes the results simple and easy to interpret. In the CD function, the constant elasticities are called the factor elasticities of production referring to the efficiency of production factors. In this context, these elasticities are expense elasticities of sales revenue referring to the sensitivity of sales revenue to different categories of expense. Thus, expense elasticities reflect the efficiency of expenses to impact sales revenues.

The total effect of expense elasticities on sales revenue can be illustrated by analysing the returns to scale. If the expenses in every category are increased by coefficient h, the sales revenue S will change in the following way:

$$\prod_{i=1}^{m}\left[E(i)\cdot h\right]^{e(i)} = S\cdot h^{\sum_{i=1}^{m}e(i)} \tag{4}$$

Thus, the total effect of elasticities depends on the sum of elasticities. If the sum of expense elasticities equals unity, S will change by the coefficient h as the expenses in each category. This means that the profit of the company also increases by the same coefficient h. This kind of situation refers to constant returns to scale (CRS). If the sum of expense elasticities exceeds unity, there are increasing returns to scale (IRS) and the proportionate change of sales is greater than the change in expenses. If the sum of elasticities is less than unity, there are decreasing returns to scale (DRS).

The present simple sales revenue model can also be used to assess the optimal amount of expenses in different categories. Let us assume that the sales function S fulfils the standard assumptions of a neoclassical production function. The profit P (earnings) can be presented as the difference between sales revenues and expenses as:

$$P = \prod_{i=1}^{m} E(i)^{e(i)} - \sum_{i=1}^{m} E(i) = S - E \tag{5}$$

where E is total expense (the sum of expenses from each category).

The profit P in Equation (5) can be differentiated with respect to expense categories i which leads to the following partial derivative set equal to zero:

$$\frac{\partial P}{\partial E(i)} = \frac{e(i)}{E(i)}\cdot S - 1 = 0 \tag{6}$$

This differentiation gives the following solution of the profit-maximizing optimal expense amount in each category i:

$$\frac{E(j)}{E(i)} = \frac{e(j)}{e(i)} \rightarrow E(i) = E\frac{e(i)}{\sum_{i=1}^{m}e(i)} \rightarrow \frac{E(i)}{E} = \frac{e(i)}{\sum_{i=1}^{m}e(i)} \tag{7}$$

Equation (7) shows that the optimal amount of expenses in each expense category is directly related to the expense elasticity of that category. This result also implicates that the lower the amount of expenses in a category, the lower tends the elasticity of sales revenues for this category to be.

Equation (7) implicates that the expense elasticity of sales revenue tends to be low for small expense categories. This is natural since a percentage change in a small category of expenses cannot usually be expected to have a large percentage change in net sales revenue. Therefore, it is useful to estimate the multiple according to which an absolute change in expenses cause an absolute change in net sales revenue. If a certain absolute change in expenses causes an absolute change of the same size in net sales revenue, the value multiple of expenses in this category is unity. The value multiple $M(i)$ of an expense category i can be calculated as follows:

$$M(i) = e(i) \cdot \frac{S}{E(i)} \tag{8}$$

where S and $E(i)$ can be approximated over the time series by the average of net sales revenue and expenses in the category i.

The analysis of the sales revenue function shows that the expense elasticities and especially the sum of elasticities are important for the generation of sales revenue and profit (part of sales revenue that exceeds expenses). Thus, the following research hypothesis is set: The expense elasticities of sales revenue are positively associated with the financial performance measures (ratios) of the high-tech company. Especially, it is expected that the sum of these elasticities is closely associated with the profitability ratios.

The importance of the empirical results largely depends on how the expense categories are selected. These expense categories must be relevant to the functioning of high-tech manufacturing companies. In this study, four categories of expenses will be considered: 1) Expenses of goods sold; 2) R&D expenses; 3) Other operating expenses; 4) Depreciations (fixed asset expense). The results of the theoretical model show that the size of the expense category sets boundaries to the height of elasticity. If the amount of expenses in a category is very small, its percentage change is usually inefficient to make a significant percentage change in sales revenue. In typical large high-tech manufacturing companies, the size order of the expense categories is that the expenses of goods sold form the largest category followed by other operating expenses. The categories of R&D expenses and depreciations (fixed asset expense) tend to be clearly smaller. It can be expected that this expense category size order largely determines the size order of elasticities.

Expenses (cost) of goods sold (COGS) include all expenses that are directly related to the production of goods. These expenses are of importance to manufacturing firms as their production is closely related to sales. Thus, the elasticity of this large expense category can be expected to be high. Expenses of goods sold do not include indirect expenses which are however included in the other operating expenses. Because the expenses in this smaller category are not directly related to production of goods but are largely fixed, their elasticity of sales revenue is expected to be lower than for expenses of goods sold. Depreciations and R&D expenses are important to the high-tech companies as they reflect the long-term effects of investments but the size of these expense categories is not usually large.

However, depreciations cannot be directly linked to specific revenue transactions. They are typically tied to a span of years and allocated as an expense (depreciation) to each of those years which is expected to make the elasticity of sales revenues small. R&D expenses include individual current and capital expense categories for R&D. Thus, they are similar partly with the operating expenses and partly with the depreciations. In income statements, the shares of R&D and depreciations are typically in larger and established companies relatively small in comparison to COGS. Therefore, their elasticities are expected to be lower.

Thus, in this approach a Cobb-Douglas (CD) type function is used to describe of the sales function in a high technology company. This function describes how the expenses from different categories are related to sales. Expenses are accounting concepts and they refer to the understanding of the management about the expenditures which are in the accounting period participated with the generation of the recent sales. Therefore, for the profitability and competitiveness of a high-tech company it is important that the relationship between sales and expenses is identified and used in planning and controlling the activities of the company. The elasticities of sales with respect to expense categories play central role in the competitiveness of the company. In this study, the relationship between the elasticities and key financial figures is demonstrated using data from Finnish high-tech companies. However, the approach is general and can be applied in companies from any country where financial statements with appropriate expense categories are publicly disclosed.

3. Empirical Data and Methods

3.1. Empirical Data of the Study

The empirical data of this study is extracted from Finnish high-tech manufacturing companies as classified by the EU Eurostat Statistics[3]. The target population of the sample is consisted of the high-tech manufacturing industries summarized in Appendix 1. The sample was taken from the ORBIS database of Bureau van Dijk (BvD) (Bureau van Dijk, 2023). ORBIS includes financial and other information on more than 489 million companies across the globe. ORBIS captures and blends data from more than 170 different sources and makes the data standardized and comparable. The selection of the sample was made under the restriction that the selected high-tech company must be Finnish and have successive financial statements available at least for nine years, last year being 2022. Appendix 2 shows that these nine years are a period of stagnated growth in Finland. There is a total of 1,825 companies meeting these conditions in the ORBIS. However, a closer look at the data of the companies showed that there were so many missing values in the data of the relevant variables (mainly in R&D expenses) that the whole sample could not be used as a basis for this study.

In fact, the necessary variables are only available from public companies, of which

[3]https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:High-tech_classification_of_manufacturing_industries.

there were only a total of 35 companies in the sample. However, also this sample of companies suffered from missing information. The missing data was mainly found in the expense time series data, where an uninterrupted time series of nine years was required. Therefore, only sixteen companies remained in the final sample, half of which (50.0%) belonged to industry 28 (manufacture of machinery and equipment not elsewhere classified), six (37.5%) to industry 26 (manufacture of computer, electronic and optical products) and one to industry 20 (manufacture of chemicals and chemical products) and one to industry 21 (manufacture of basic pharmaceutical products and pharmaceutical preparation). The companies in the final sample are on average very large, with an average number of employees of 15444.06 and a median of 4214.50. As measured by the number of employees, the sixteen sample firms employ 68.42% of the number of employees in the ORBIS sample of 1825 high-tech firms.

The variables used in the study can be divided into three groups. The first group includes the background variables concerning the characteristics of the companies, which can affect the results. These variables are the company age (in years) and size measured by total assets (thousands of euro), net sales (thousands of euro) and number of employees. In older and larger companies, operations are usually more established than in younger and smaller companies, which can affect the elasticities estimated from the nine-year time series. The second group of variables includes process variables that are used to estimate the expense elasticities. These elasticities are estimated using net sales as output variable and different types of expenses as input variables. The following expenses were chosen as expense groups: expense of goods sold, R&D expense, other operating expense and depreciation. Since the analysis concerns high-tech companies, the significance of R&D expenses is central to the study. Other cost groups are also significant, as the companies in the sample are industrial companies for which the costs of sold products and depreciations are important.

The third group of variables includes the so-called output variables that are expected to be affected by the expense elasticities. These variables are growth and ratio variables calculated from the financial statements. They have been shown to measure a company's health and ability to avoid financial distress (Altman & Hotchkiss, 2005). The first variables in this group measure the relative annual growth of the size variables net sales, total assets and number of employees in the nine-year period 2014-2022. The following three variables, Gross margin, EBIT margin, ROA and ROE measure the profitability of the company at the end of the period 2022. In addition to profitability, the analysis includes the liquidity measure, Current Ratio, and the solvency measure, Solvency Ratio (Equity Ratio). In addition to these indicators, the data also includes two variables that measure the value of the company, Enterprise value/EBITDA and Market cap / Cash flow from operations. The objective of the empirical analysis is to show how the background variables affect the estimated cost elasticities and how the growth, profitability, liquidity, solvency and market value of the high-tech companies in the sample depend on the expense elasticities.

3.2. Statistical Methods

The central estimation task in this study is to estimate the elasticity of sales revenue (net sales) separately in relation to the four expense groups from the time series data, which covers the years 2014-2022. The basic equation for estimating flexibilities is a simplified equation between net sales and group expenses, which in this case, can be operationally presented in the following form:

$$S = \prod_{i=1}^{4} E(i)^{e(i)} \tag{8}$$

S is in this equation net sales, $E(i)$ is the amount of expenses of expense group i ($i = 1, 2, 3, 4$) and $e(i)$ is the expense group i elasticity of sales. The expense groups i are the following: $i = 1$ expense of goods sold, $i = 2$ R&D expense, $i = 3$ other operating expense, and $i = 4$ depreciation (fixed asset expense). When these expense groups are all deducted from the net sales, the company's earnings before interest and taxes (EBIT) are obtained.

Estimating the elasticities of sales for each expense group can be simplified by taking the (natural) logarithm on both sides of the equation, in which case the equation becomes linear as follows:

$$\ln S = \sum_{i=1}^{4} e(i) \cdot \ln E(i) \tag{9}$$

However, reliable estimation of these elasticities is not easy, as the expenses of different expense groups are highly correlated with each other. This causes serious multicollinearity in the data, both in the original expenses and in their logarithmic values. Because of this multicollinearity, ordinary regression analysis (OLS) is not suitable for estimating elasticities, as the resulting estimates of elasticities are often unreliable and, in many cases, negative which is against the intuition.

It is expected that the relation of (logarithmic) net sales and (logarithmic) expenses does not stay constant over time, as the efficiency of high-tech companies in generating revenue may increase or decrease. Therefore, the factor k describing the (logarithmic) change in this relation is added to the estimated equation as follows:

$$\ln S(t) = (1+k)^{t} \sum_{i=1}^{4} e(i) \cdot \ln E(i,t) \tag{10}$$

In this equation, the index t refers to year (time). If k is zero, the relation of (logarithmic) net sales to (logarithmic) expenses has remained stable. If k is positive, the effectiveness of these expenses to produce net sales has increased over time, while it has correspondingly decreased if k is negative.

The equation between logarithmic net sales and logarithmic expenses is estimated here using a numerical method allowing to use non-negative restrictions to the estimates of elasticities. In this task, the Solver procedure of the Excel program is used, where the goal is to find non-negative elasticities and the value of the unrestricted parameter *k*, which maximize the multiple correlation coefficient of the equation presented above. The solution for the maximization task is searched using the Generalized Reduced Gradient (GRG) method (Lasdon, Fox, & Ratner, 1973). This method looks at the gradient or slope of the objective function as the input values change and determines that it has reached an optimum solution when the partial derivatives equal zero. It can handle equality constraints and also inequality constraints which are converted to equalities by the use of slack variables. The method uses a combination of the gradient of the objective function and a pseudo-gradient derived from the equality constraints. It is an iterative method using a search procedure where the search direction is found in the way that any active constraint remains precisely active for some small move in this direction.

The sample size affects the selection of the statistical methods. The sample contains only a small number of high-tech companies, which makes the cross-sectional results preliminary and therefore only simple statistical methods are used to derive them. The distributions of the variables are examined using descriptive statistics. The goal is to analyse how background (input) variables, estimated model parameters and output variables are distributed in the data. In addition to that, the interdependence of the variables is examined using Pearson linear correlation coefficients to show whether the background variables are associated with the values of the model parameters and whether these further affect the output variables (Crewson, 2006: pp. 85-102). The present hypothesis assumes that the elasticities that describe the productivity of expenses affect especially the profitability of the company, as they directly reflect the ability with which the company generates profit.

4. Empirical Results

The empirical results of the study are presented in this section in eight tables. **Table 2** shows descriptive statistical data on the background variables that describe the company's characteristics, while **Table 3** shows descriptive statistics on the output variables that are potentially affected by the high-tech operations of the enterprises. **Table 4** presents the statistical characteristics of the sales elasticities obtained from the sales (revenue) function estimation. **Table 5** presents statistical data on the average shares of different expense categories while **Table 6** presents statistical data on the ratio of profit-maximizing shares to actual shares. **Table 7** presents the results of the value multiple of cost elasticities. **Table 8** shows the Pearson correlation coefficients between the background variables and the parameters of the estimated models, while **Table 9** shows the correlation coefficients between the parameters of the models and the output variables. In summary, **Tables 1-7** show descriptive statistics of the variables whereas **Tables 8-9** present the relationships between the variables using Pearson correlation coefficients.

Table 1. The variables of the study.

Variables				
I. Background (input) variables				
Age of the firm	**Size**			
1) Age in years	1) Net sales 2) Total assets 3) Number of employees			
II. Process (expense) variables				
	1) Expense of goods sold 2) R&D expense 3) Other operating expense 4) Depreciation			
III. Output variables				
Growth	**Profitability**	**Liquidity**	**Solvency**	**Market value**
1) Total assets 2) Number of employees	1) Gross margin = 100·(Net sales-Cost of goods sold)/Net sales 2) EBIT margin = 100·EBIT/Net sales 3) ROA = 100·EBIT/Total assets 4) ROE = 100·Net profit/Equity	1) Current ratio = Current assets/ Current liabilities	1) Solvency ratio (Equity ratio) = 100·Equity/ Total assets	1) Enterprise multiple = Enterprise value/EBITDA 2) Price-to-cash-flow ratio = P/CF = Market cap/cash flow from operations

4.1. Descriptive Statistics

Table 2 shows the descriptive statistics of the background variables of the sample companies. The average age of the companies is 69.56 years, which exceeds the median (64.00) by only a few years. However, the sample includes companies over 100 years old and companies under 25 years old. The size of the companies as measured by all three size variables is very large. The average number of employees is 15444.06 and the median size is also high, 4214.50. The average number of employees in Finnish high-tech companies in the original sample (1825 companies) from the ORBIS database is 251.50 and the median is only 8.00, so the companies in the study are, on average, very large companies on the scale of Finnish companies. The 25% fractile of the number of employees is 404.25 employees. The sample also includes small companies, as the two smallest companies employ only 39 and 58 employees, while the two companies next in order of size employ 224 and 252 employees. The three largest companies in the sample are Nokia Oyj, Kone Oyj and Wartsila Oyj. They had a total of 167,754 employees in 2022 that makes 46.4% of the employees in the ORBIS original sample of 1825 high-tech firms.

Table 2. Descriptive statistics of the background variables.

Variable	Mean	Std. Dev.	Percentiles 25	50	75	Skewness	Kurtosis
Company age (in years)	69.56	52.09	24.25	64.00	100.00	1.0130	0.5660
Net sales in thousands of euro (2022)	4018066.8	6335778.5	75649.5	1846350.0	5290000.0	2.7090	8.3090
Total assets in thousands of euro (2022)	5242803.1	10496286.3	77566.3	1464150.0	6522750.0	3.4670	12.9170
Number of employees (2022)	15444.06	24716.91	404.25	4214.50	17337.25	2.2670	4.7430

Table 3 shows the descriptive statistics of the output variables. The companies have grown slowly in the period 2014-2022. When measured by all three growth variables, the average annual growth rate in the sample is only about 2-7%. The slowest growth has been in the number of employees, where the average growth rate is only 2.39%. The total assets of the companies have grown fastest with an average of 6.80%. The profitability ratios of the sample firms are reasonably good. However, the Return on assets (ROA) is low, as its average is only 3.56%. High-tech companies in the original sample have an average ROA of 5.47%, which is also relatively low. The return on equity (ROE) ratio of the sample companies is clearly at a better level, as its average is 16.29%.

Table 3. Descriptive statistics of the output variables.

Variable	Mean	Std. Dev.	Percentiles 25	50	75	Skewness	Kurtosis
Growth rate of net sales (%)	3.4930	8.6741	0.3396	5.2674	8.4954	−1.1500	4.2610
Growth rate of total assets (%)	6.8047	5.7018	4.2140	6.0938	13.1080	0.4920	−0.7430
Growth rate of number of employees (%)	2.3871	4.9981	−0.5266	3.7649	4.5198	0.7930	1.4110
Gross margin (%) 2022	50.9314	16.7947	44.0597	57.5275	69.0815	0.5060	−0.0680
EBIT margin (%) 2022	7.5400	8.5689	5.4115	8.6755	12.1160	1.7250	5.0990
Return on assets (%) 2022	3.5592	16.1642	4.3635	7.3670	13.0180	−2.3770	8.6550
Return on equity (%) 2022	16.2869	16.2920	12.5293	21.0340	33.1335	0.0380	0.0310
Current ratio 2022	1.5939	0.7276	1.3143	1.5235	2.2495	0.4850	1.1840
Equity ratio (%) 2022	36.0956	23.5798	32.6438	42.9870	53.4585	−2.4540	7.7650
Enterprise value/EBITDA	11.3101	5.2841	5.5395	9.8060	14.8832	0.5320	−0.6400
Market cap/Cash flow from operations	25.5992	18.7118	8.1158	22.1330	39.7895	0.7750	−0.0890

The companies in the original sample have both the liquidity measure Current Ratio and the solvency measure Solvency Ratio (Equity Ratio), at a clearly higher level than the current (final) sample companies. In the current sample companies, the average Current Ratio is only 1.59 and the average Solvency Ratio is as low as 36.10%, while the corresponding figures for the original sample are 2.27 and 58.54%. The average of the enterprise multiple (Enterprise value/EBITDA), which reflects the value of the company, is 11.31, which is weaker than the average in Europe, for example, for the information technology industry (hardware and equipment) in March 2023 (15.1). The average of the indicator Market cap/Cash flow from operations of 25.6 is at the same level as the average of the somewhat similar indicator P/E of the technology industry (26.8).[4]

Table 4 shows descriptive statistics for the elasticity estimation results. The estimates for the (logarithmic) productivity change rate (*k*) are very small and largely insignificant in the sample. Eight of the sample high-tech companies (50%) have got a positive estimate for the rate and similarly eight companies got a negative estimate (50%). Expense of goods sold has clearly got the highest elasticity estimates when the mean and the median are both about 0.60. This result is natural, as the sampled companies are industrial companies for which the industrial production is of essence. The second highest elasticities are got for other operational expenses, with an average elasticity of 0.33 and a median of 0.31.

Table 4. Descriptive statistics of the estimated model parameters.

			Percentiles				
Variable	Mean	Std. Dev.	25	50	75	Skewness	Kurtosis
Productivity change rate	0.0006	0.0028	−0.0003	−0.0001	0.0002	3.8290	15.0410
Expense of goods sold elasticity of sales	0.5963	0.2032	0.4700	0.6056	0.7731	−0.9840	1.4350
R&D expense elasticity of sales	0.1168	0.1562	0.0000	0.0596	0.1833	1.6100	2.3930
Other operating expense elasticity of sales	0.3298	0.2219	0.1877	0.3096	0.4223	0.6160	0.5340
Depreciation elasticity of sales	0.0423	0.0620	0.0000	0.0064	0.0636	1.6000	1.8300
Sum of elasticities	1.0852	0.0473	1.0584	1.0770	1.1199	−0.1800	1.2270
R squared of estimated function	0.9549	0.0612	0.9334	0.9791	0.9974	−1.6230	1.7650

The third highest elasticities of net sales are got for R&D expenses, which are of importance in high-tech companies. However, the distribution of the elasticity for these expenses is skewed, as the average of the elasticity is 0.12 and the median is only 0.06. The values of the elasticity vary greatly in the data, and six companies have an elasticity of 0, while the two largest companies (Nokia Oyj and Kone Oyj) have high elasticities (0.36 and 0.54). The third largest company (Wartsila Oyj) is one of the companies that has a zero elasticity. The elasticities of sales for depreciation are generally very small, as the median is 0.01 and the average only 0.04.

With the exception of one company, the sum of the four elasticities exceeds 1, so almost all companies have increasing returns to scale, where a change in

[4]https://www.kroll.com/-/media/kroll-images/pdfs/industry-multiples-in-europe-q1-2023.pdf.

expenses causes a larger relative change in net sales. The company Kone Oyj has got the highest sum of elasticities, 1.18. For the smallest company, the sum of the elasticities is below 1, being 0.98. The coefficient of determination of the estimated function is in the sample generally high. It remains lowest in the smallest company (0.80) and in the second smallest company (0.88).

Table 5 shows descriptive statistics of the average relative shares of different expense groups for the high-tech companies in the sample. The expense of goods sold clearly accounts for the largest share of expenses, the average and median of which are about 50%. The second largest share has other operative expenses, making almost 40%. The shares of R&D expense and depreciation are small and the average shares for these expense groups are only 6.4% and 3.1%, respectively. In addition, the median share of both expense groups is only slightly above 2%. It is important to the companies to assess the level of different expense groups. If the expense elasticities are divided by the sum of the elasticities of all four expense groups, we roughly get the expense shares that according to the model potentially maximize profit. This interesting question of profit maximization is considered in the next table.

Table 5. Descriptive statistics of the average share of the four expense groups.

			Percentiles				
Variable	Mean	Std. Dev.	25	50	75	Skewness	Kurtosis
Average share of expense of goods sold	0.5082	0.2020	0.3888	0.5304	0.6192	−0.5450	−0.0320
Average share of R&D expense	0.0636	0.0833	0.0133	0.0269	0.1141	1.7790	2.5370
Average share of other operating expense	0.3978	0.1946	0.2664	0.3628	0.5172	0.8070	0.2550
Average share of depreciation	0.0305	0.0240	0.0151	0.0214	0.0390	2.4030	6.6040

Table 6 shows the ratio of these profit-maximizing shares to the actual shares, which shows how much actual shares should be increased or decreased to maximize profit. The highest ratio is got clearly for R&D expense, with an average ratio of 4.0 and a median of 1.7. This shows that the R&D expenses of the high-tech companies should be significantly increased if one wants to maximize profit. The highest ratio value (25.9) is got for Kone Oyj, while the smallest company has the lowest ratio (0.46). The second smallest company also has a very high ratio, 6.94. The second highest average ratio is got for expenses of goods sold. The median of this ratio (1.00) shows that the share of expenses is at an efficient level in an average company. However, reducing the share of other operating expenses and depreciations could be profitable for most companies in the sample. For other operating expenses, this would be worthwhile for 12 sample companies (75.0%), whereas reduction of depreciations could increase profit for 10 companies (62.5%). However, an exception is a large company (Vaisala Oyj), as its ratio for depreciations is 9.4, which shows that the share of depreciation (2.9%) should be increased in practice almost tenfold potentially to maximize profit.

Table 6. Normalized expense elasticities of net sales as divided by the average share of expense.

			Percentiles				
Variable	Mean	Std. Dev.	25	50	75	Skewness	Kurtosis
Elasticity per average share of expense of goods sold	1.3682	1.5029	0.9228	0.9968	1.2058	3.8550	15.1960
Elasticity per average share of R&D expense	4.0033	6.7692	0.0000	1.6766	5.3352	2.5730	7.1430
Elasticity per average share of other operating expense	0.8198	0.4838	0.6205	0.8514	1.0945	0.2220	1.4480
Elasticity per average share of depreciation	1.4813	2.4540	0.0000	0.2773	2.4404	2.5060	7.3230

Note: In normalization, expense elasticities are divided by the sum of elasticities.

Table 7 presents the value multiples of elasticities for different categories of expenses. These multiples are close to the ratios of the profit-maximizing shares to the actual share presented in Table 6. In fact, the relation of the value multiple and this ratio is simply:

$$\frac{S}{E \cdot \sum_{i=1}^{m} e(i)} \tag{11}$$

where S is sales revenue and E is the sum of expenses. The value multiples are highest for the R&D expenses, whose average multiple is 4.80. The median of the multiples for this expense category is 1.68, which is an indication of the skewness of the distribution. The result shows that increasing R&D expenses by a certain amount causes an average of almost a fivefold increase in net sales revenue. However, this effectiveness of R&D expenses is not evenly distributed, and in at least a quarter of the companies, increasing R&D expenses has no effect on net sales revenue.

Table 7. Value multiples of expense elasticities.

			Percentiles				
Variable	Mean	Std. Dev.	25	50	75	Skewness	Kurtosis
Expense of goods sold	1.3203	0.6363	1.1225	1.1828	1.3573	2.205	7.828
R&D expense	4.8025	8.5081	0.0000	1.6841	6.0829	2.653	7.566
Other operating expense	0.8748	0.5097	0.6455	0.9473	1.1615	−0.331	0.121
Depreciation	1.7028	2.9963	0.0000	0.2523	2.7567	2.663	8.138

Legend: Value multiple of expense elasticity = (Expense elasticity Average net sales)/Average expense.

The second most effective expense category in increasing net sales is expenses of goods sold, for which the average multiple is 1.32. Even in this expense category, the efficiency is not normally distributed and the median multiple is 1.18. In the expense category of other operating expenses, the average and the median of the value multiple are less than one, so an increase in expenses by a certain amount will usually increase net sales less. The lowest efficiency measured by the median of value multiple is depreciation, for which an increase in depreciation in an average company increases turnover by only 25% compared to an increase in expenses. In addition, at least 25% of companies have a zero-value multiple for depreciations.

4.2. Relationships between the Variables

Table 8 shows the Pearson correlation coefficients between the (input) background variables and the parameters of the estimated model. There are statistically significant correlations only between the size of the company and the elasticities of sales for two different expense groups. The results show that all three company size measures are significantly positively correlated with the elasticity of sales estimated for R&D expenses and negatively correlated with the elasticity estimated for other operating expenses. Thus, the larger the high-tech company in question is, the higher R&D expense elasticity of sales and the lower the other operating expense elasticity of sales tend to be.

Table 8. Pearson correlation coefficients between the background variables and the model parameters (significant correlations at p-level 0.1 are shaded).

	Column variable number						
Variable	1	2	3	4	5	6	7
Company age (in years)	−0.216	0.153	−0.076	−0.156	0.026	−0.293	0.268
(p-value)	(0.421)	(0.572)	(0.780)	(0.563)	(0.924)	(0.271)	(0.316)
Net sales in thousands of euro (2022)	−0.174	0.236	0.602	−0.553	−0.317	−0.006	0.304
(p-value)	(0.519)	(0.378)	(0.014)	(0.026)	(0.232)	(0.982)	(0.252)
Total assets in thousands of euro (2022)	−0.119	0.221	0.499	−0.499	−0.273	−0.104	0.258
(p-value)	(0.660)	(0.411)	(0.049)	(0.049)	(0.306)	(0.702)	(0.334)
Number of employees (2022)	−0.194	0.192	0.707	−0.551	−0.350	0.114	0.279
(p-value)	(0.472)	(0.476)	(0.002)	(0.027)	(0.184)	(0.673)	(0.295)

List of column variables: 1) Productivity change rate; 2) Expense of goods sold elasticity of sales; 3) R&D expense elasticity of sales; 4) Other operating expense elasticity of sales; 5) Depreciation elasticity of sales; 6) Sum of elasticities; 7) R squared of estimated function.

Table 9 presents the Pearson correlation coefficients between model parameters and the output variables. Expense of goods sold elasticity of sales has a positive correlation with all three growth measures. Similarly, other operating expense elasticity of sales has a significant but negative relation with all growth variables. In addition, the coefficient of determination of the estimated function is positively associated with the growth rate of net sales. Productivity change rate is positively and expense of goods sold elasticity of sales is negatively related to Gross margin. However, EBIT margin is correlated only with R&D expense elasticity of sales. The key profitability indicator Return on assets (ROA) is positively associated with expense of goods sold elasticity of sales, sum of the four elasticities, and the coefficient of determination of the function. It is also negatively associated with other operating expense elasticity of sales.

Table 9. The pearson correlation coefficients between the model parameters and the output variables (significant correlations at p-level 0.1 are shaded).

	Column variable number:						
Variable	1	2	3	4	5	6	7
Growth rate of net sales (%)	0.422	0.743	0.150	−0.624	−0.295	0.367	0.465
(p-value)	(0.103)	(0.001)	(0.580)	(0.010)	(0.268)	(0.162)	(0.070)
Growth rate of total assets (%)	0.314	0.601	0.023	−0.480	−0.300	0.013	0.429
(p-value)	(0.236)	(0.014)	(0.932)	(0.060)	(0.259)	(0.961)	(0.097)
Growth rate of number of employees (%)	0.054	0.525	0.126	−0.480	−0.416	−0.358	0.298
(p-value)	(0.850)	(0.044)	(0.655)	(0.070)	(0.123)	(0.190)	(0.280)
Gross margin (%) 2022	0.568	−0.452	0.275	0.320	−0.231	0.163	−0.353
(p-value)	(0.022)	(0.079)	(0.302)	(0.227)	(0.389)	(0.547)	(0.180)
EBIT margin (%) 2022	0.224	−0.188	0.471	−0.106	−0.297	0.190	−0.088
(p-value)	(0.422)	(0.502)	(0.076)	(0.707)	(0.283)	(0.498)	(0.755)
Return on assets (%) 2022	0.081	0.517	0.402	−0.554	−0.235	0.641	0.574
(p-value)	(0.766)	(0.040)	(0.123)	(0.026)	(0.382)	(0.007)	(0.020)
Return on equity (%) 2022	0.264	−0.280	0.522	−0.048	−0.335	0.248	0.008
(p-value)	(0.342)	(0.313)	(0.046)	(0.866)	(0.223)	(0.373)	(0.977)
Current ratio 2022	0.142	0.248	0.119	−0.262	0.268	0.579	0.161
(p-value)	(0.601)	(0.354)	(0.662)	(0.328)	(0.316)	(0.019)	(0.552)
Equity ratio (%) 2022	−0.020	0.608	0.271	−0.616	0.007	0.624	0.648
(p-value)	(0.942)	(0.012)	(0.311)	(0.011)	(0.981)	(0.010)	(0.007)
Enterprise value/EBITDA	0.386	0.167	0.109	−0.060	−0.420	0.097	−0.497
(p-value)	(0.172)	(0.569)	(0.710)	(0.839)	(0.135)	(0.742)	(0.070)
Market cap/Cash flow from operations	−0.021	0.545	0.049	−0.313	−0.382	−0.101	0.205
(p-value)	(0.955)	(0.103)	(0.893)	(0.379)	(0.277)	(0.781)	(0.570)

For column variables see Table 7.

In addition, the profitability indicator Return on equity (ROE) depends positively only on the R&D expense elasticity of sales, while the liquidity measure Current Ratio has a positive significant correlation with the sum of elasticities. The solvency measure Solvency Ratio (Equity Ratio) has a positive relationship with the expense of goods sold elasticity of sales, the sum of elasticities and the coefficient of determination. However, it has a negative relationship with the other operating expense elasticity of sales. The enterprise multiple and the coefficient of determination are negatively correlated, while the market cap coefficient depends positively on the expense of goods sold elasticity of sales. Finally, depreciation elasticity of sales has no significant correlation with any output variable.

5. Conclusions of the Study

The objective of this study was to investigate the functioning the high-tech companies from a novel perspective estimating the expense elasticities of sales revenue in a small sample of large Finnish manufacturing high-tech firms. The main purpose of the study was to analyse how the expense elasticities of sales revenue are associated with the measures of financial performance. The research hypothesis assumed that the expense elasticities are associated with the performance ratios of the companies, especially with profitability ratios. If the hypothesis holds, these elasticities can be used to increase the profitability of high-tech companies. In this study, elasticities were estimated for four categories of expenses: expenses of goods sold, R&D expenses, other operating expenses, and depreciations.

It was expected that expenses of goods sold and R&D expenses are the most important expense categories for high-tech manufacturing companies. The category of other operating expenses includes a lot of fixed expenses that makes the dependence between the expenses and sales revenue weak. In the same way, depreciations are directly linked to specific revenue transactions but are typically tied to a span of years. Expense elasticities largely reflect the importance of the expenses to the sales of the high-tech company, but they are also bounded by the size of the expense category.

The empirical part of the study was based sales and expense time-series information from sixteen large Finnish public high-tech companies employing in 2022 in total 247,105 people. The three largest companies in the sample were Nokia Oyj, Kone Oyj and Wartsila Oyj. The category of expense of goods sold had the largest share of expenses (50%) and clearly got the highest elasticity estimates as the mean and the median of the estimates are both about 0.60. The second largest share of expenses (40%) was got by the other operational expenses, with an average elasticity of 0.33 and a median of 0.31. The third highest elasticities of net sales are got for R&D expenses, which are of importance in high-tech companies. However, the distribution of the elasticity for these expenses is skewed, as the average of the elasticity is 0.12 and the median is only 0.06.

For depreciations, the average share of expenses was small and, consequently the resulted elasticity was low. The estimation of the optimal amount of expenses for each category showed that the share of R&D expenses should increase considerably to theoretically maximize profit. The amount of expenses of goods sold is close to the theoretical optimum. However, reducing the share of other operating expenses and depreciations would be profitable for most companies in the sample.

For sales analyses, it is important to assess how much a change in an expense category can change sales revenue in absolute terms. In the study, this analysis was made using the value multiples of elasticities. The value multiples were highest for the R&D expenses, whose average multiple was 4.80. The result implies that increasing R&D expenses by a certain amount causes an average of almost a fivefold increase in net sales revenue. The second most effective expense category in increasing net sales was expenses of goods sold, for which the average multiple is 1.32.

The empirical results showed that the elasticities of expense categories are associated with the performance measures supporting the hypothesis. The growth of the companies was positively correlated with the elasticity of sales for expenses of goods sold, but negatively correlated with the elasticity for other operating expenses. The results give support to the research hypothesis. EBIT margin and ROE were positively associated with the elasticity of R&D expenses whereas ROA was positively correlated with the expense of goods sold elasticity of sales and the sum of the four expense elasticities. ROA was also negatively associated with other operating expense elasticity of sales. These results give implications on how to improve financial performance in high-tech companies.

In conclusion, the study shows that the expense elasticities of sales revenue are useful and important concepts which can be utilized by the management of high-tech companies to improve the efficiency of operations. The expense categories can be increased or decreased following the optimal size of categories. In practice, the contents of the expense categories can also be reformulated to have a closer association with the sales.

The study has a couple of limitations which can be relaxed in future studies on high-tech companies. The sample of the study was small and limited to large public high-tech companies due to the difficulties in getting access to relevant data of variables. In future, larger samples of high-tech companies should be used to generalize the results. Moreover, the limited sample size forced us to use simple statistical methods. In future studies, larger samples should made to allow the use of advanced statistical methods. Finally, this study is based on a multiplicative sales function. In further studies, other types of function should be applied as well.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendixes

Appendix 1. High-Tech Industry Classification Used in the Study

20—Manufacture of chemicals and chemical products

21—Manufacture of basic pharmaceutical products and pharmaceutical preparations

254—Manufacture of weapons and ammunition

26—Manufacture of computer, electronic and optical products

27—Manufacture of electrical equipment

28—Manufacture of machinery and equipment n.e.c.

29—Manufacture of motor vehicles, trailers and semi-trailers

302—Manufacture of railway locomotives and rolling stock

303—Manufacture of air and spacecraft and related machines

304—Manufacture of military fighting vehicles

309—Manufacture of transport equipment n.e.c.

325—Manufacture of medical and dental instruments and supplies

Appendix 2. Volume Index of Industrial Output in Finland (2013 = 100)

Year	Total industry	Forest industry	Chemical industry	Metal industry	Electrical and electronics industry
2013	100.00	100.00	100.00	100.00	100.00
2014	98.15	98.53	101.23	98.64	94.98
2015	97.28	98.04	102.88	97.09	88.11
2016	101.36	98.43	108.64	104.08	92.42
2017	104.57	101.57	111.73	110.49	96.21
2018	108.17	105.69	114.51	114.56	98.68
2019	109.92	101.67	118.72	120.39	111.98
2020	106.61	91.47	117.59	120.19	117.00
2021	110.99	100.78	112.14	126.70	122.29
2022	115.27	98.92	113.58	138.16	134.01
2023	113.52	86.57	110.80	139.32	122.38
Growth*	0.0185	−0.0081	0.0113	0.0425	0.0454

Source: Statistics Finland. volume index of industrial output; *Annual growth rate. Estimated using regression analysis.