4. THE ROLE OF FOREIGN DIRECT INVESTMENTS IN TECHNOLOGY TRANSFER TO ESTONIA

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Theoretical views

Today it is widely recognized that the main factor contributing to real economic growth is technological progress. Through technology transfer it is possible to improve the competitive ability of recipient countries in the long run. There are different ways to transfer technology into the transition countries. In this process of technology transfer foreign direct investments, minority-equity or various non-equity forms of relationships between foreign and domestic partners (alliances[1], contractual arrangements incl. subcontracting, licensing or franchising) all have a certain role to play. Alternatively, firms may learn about technologies by exporting to knowledgeable buyers or

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[1] Alliances or collaborative agreements are normally based on common interests and complementarities between partners; unlike FDIs, they are not connected through majority shareholding (Radošević *et al*., 1997, p. 114). In the transition countries alliances are mainly based on different and not equal interests of partners (typically market interests of foreign, and technological and managerial interests of domestic partners (see Radošević, 1999)).

by importing new varieties of differentiated products or capital goods and equipment (Djankov *et al*., 1998, p. 3). Among other vehicles, foreign direct investments (FDIs) are considered to be a major mechanism for technology transfer.

FDIs differ from other technology transfer channels on the fact that together with investments into the host country, a total transfer of resources, incl. capital-, management-, and marketing-based knowledge and technology, will take place and control over the assets will be retained. The endogenous growth theory suggests that FDIs should result from technological progress (Knell 1999a, p. 3). Foreign investments are accompanied by a transfer of both materialised and immaterialised assets into the local units of the host country. It has been argued that the most crucial channels for dissemination of advanced technology are the external effects or spillovers proceeding from foreign investments (Blomström *et al* 1996, p. 5).

According to Blomström and Kokko, spillovers are said to take place when multinational enterprises (MNEs) are unable to reap all the productivity or efficiency benefits accruing to the host country's local firms as a result of the entry or presence of MNE affiliates. These effects may take place either in the foreign affiliate's own industry or in other industries among the affiliate's suppliers or customers. There are different ways how local firms can improve their productivity: by copying some technology used by MNE affiliates; or by starting to use the existing technology and resources more efficiently; or by searching for new, more efficient technologies under the pressure from increasing competition within the domestic economy.

According to Blomström, technology transfer into foreign investment enterprises (FIEs) is expected to ultimately spread to domestic enterprises (DEs), raising their productivity, and, as a long-term objective, the level of the whole economy. Hence, spillovers appear in DEs by relatively faster factor productivity in comparison with FIEs. As a result, the efficiency of DEs will increase thanks to convergence of productivity between the two enterprise groups. Convergence means a decrease of the gap in efficiency between domestic and foreign investment enterprises.

The motives for the appearance of technological spillovers can be mostly co-operation or competition between foreign-owned and local enterprises (see Blomström *et al*., 2000, p. 103). Technological transfer does not only result from the spread of enterprise-specific resources into local enterprises. The average growth of productivity in local enterprises may likewise be conditioned by intensified competition on the host country's market. Technological spillover can be caused by either horizontal or vertical integration (Knell, 1999c, p. 1). Accordingly, one can distinguish between two main technological spillovers — direct and indirect. Both will be discussed more closely below.

A competition-related spillover arises as a result of horizontal integration between foreign-owned and local enterprises. Spillovers can occur either in the situation where ineffective local enterprises are leaving the market (reallocation effect) or when the competing enterprises are implementing their resources more effectively (see Blomström *et al*., 1996, pp. 6–8; Perez, 1998, pp. 24–25). The latter is the so-called indirect technological spillover, which does not lead to a direct spread of technologies into local units. Instead, the likelihood of technological research in local enterprises will increase in a longer perspective, i.e. the technological ability of local enterprises will grow. Direct spread of technology into local enterprises can be mainly the result of vertical integration of foreign-owned and local enterprises through the appearance of backward and forward linkages (look Blomström *et al*., 1996, pp. 11–14; Perez, 1998, pp. 25–26). Backward and forward linkages develop from relations with local consumers and suppliers. The more intensive is the co-operation with local tenderers, the bigger is the probability that a technological spillover will appear. The technological spillover resulting from co-operation between enterprises favours a direct technological development of local enterprises either by way of developing the existing technologies further or by creating new ones.

A technological spillover resulting from foreign direct investments does not occur spontaneously. Generating spillovers in the host country requires a strong absorptive capacity from the enterprises of that country, which lies in a timely aligning of the incoming technology or in its efficient implementation pursuant to the circumstances (look Cohen *et al*., 1990). The factors determining absorptive capacity are the quality of human assets, the level of research and development (R&D) and innovation in the host country. International technological spillover is an important mechanism of technological development primarily for developing countries. The transferred technologies are more modern, and the more strategically long-term investments will be aggregated into the state, the larger development potential the enterprises of the host country will obtain. The strategy and motives of foreign investors to invest into a particular host country depend on the technological performance of its enterprises. The development potential of the host country will thus determine the probability of occurrence of technological spillovers.

Most research analyzing technological spillovers has taken as a basis the theoretical models of Findlay, Koizumi and Kopecky containing technological spillover (Findlay, 1978; Koizumi *et al*., 1977). The models presume a proportionality of spillover in the host country with foreign penetration. The larger the share of foreign investment enterprises in the host country, the more probable it is that technological spillovers will occur in the local enterprises (see Koizumi *et al*., 1977, p. 36–37).

Findlay's model contains a hypothesis, according to which the occurrence of a technological spillover at a certain level of foreign involvement is the more probable, the bigger the technological gap between the local and foreign investment enterprises (Findlay, 1978, p. 86). There is also Findlay's so-called convergence hypothesis, according to which the local enterprises (as technological followers) have a greater advantage for faster development than the foreign investment enterprises (as technological leaders). The hypothesis comes from the idea of Veblen and Gerschenkon about different stages of development obtaining primarily in the conditions of transition economies. The current chapter will concentrate on evaluating how foreign investments influence the technological development of Estonia as one of the Central and Eastern European (CEE) transition countries by way of generating technological spillovers.

Changes in the technological level and labour of foreign investment enterprises (based on the survey "Foreign Investor" 1996–1999)

Technological development plays an important role, especially in the economies of developing and transition countries. Like in the other CEE countries, R&D and innovation in Estonia are characterized by low intensity and orientation to basic research. At the same time, with intensive foreign capital inflow into Estonia, in the last decade companies with foreign involvement have become the main input to Estonia's technological development. Foreign-owned enterprises have achieved leading positions in technology in the domestic market and have also affected the competitive ability of other local firms.

The present evaluation of the technological development of foreign investment enterprises is based on the survey "Foreign Investor" carried out in 1996–1999 by the Estonian Investment Agency (EIA) in collaboration with Tartu University. Estimating the technological development of foreign investment enterprises in various economic activities in this sub-chapter, the author will mainly rely on the parts of the survey concerned with technology transfer, diffusion and labour force.

Technology transfer from the parent enterprise to the local units. As a rule, the foreign investment enterprises entering the market of the host country are technologically better developed than the domestic enterprises, owing to the transferred enterprise-specific know-how and skills from the parent enterprise to the local units. This manufacturing, marketing, management and R&D know-how has been accumulated by the parent enterprise during many years of its activity. The questionnaire of 1999 showed that foreign investment had mostly transferred marketing and management-related know-how from the parent enterprise to Estonian enterprises since making the investment, respectively in 74% and 77% of cases (per cent of the responding enterprises). Also transfer of other (unpatented) technology (68% of respondents) and of product and process development (62%) to the local units has been remarkable. On a smaller scale, transfer of patented technology occurred, as well as of rights to dispose of brand names relevant from the point of view of technology, and of semi-manufactured products and raw materials.

A big or very extensive transfer of both marketing and management know-how took place in the area of transport equipment and finance (67% of the respondents in both sectors), followed by trade (39%) and food, paper, and furniture Industries (30% in each). While foreign investment enterprises in construction and building materials manufacturing were successful in attracting management-related know-how (45%), enterprises of electrical and optical machinery and equipment attracted marketing know-how (50%). Regarding other technology, Estonian units were active in construction (78%), transport equipment (67%), and chemical industry (60%). Product and process development was transferred as a resource mostly to finance (45%).

As far as evaluating the local units' pre-investment time technological level is concerned, it is notable that the FIEs became more critical during the four years. Figure 4.1 shows that in 1999 the originally owned technology was considered either completely or fairly out of date by 53% of the enterprises as against 38% in 1996.

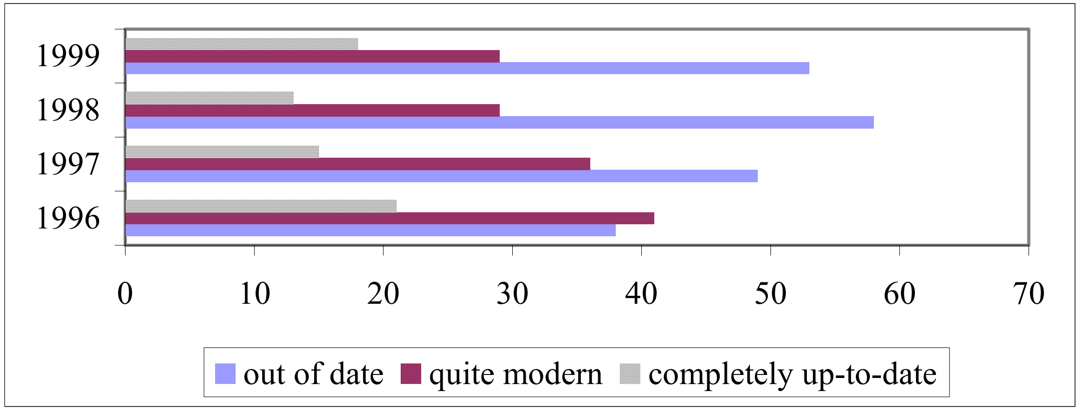

Figure 4.1. Evaluation of the technological state at the pre-investment time, 1996–1999 (%)
(made by the author on the basis of the results of the survey “Foreign Investor”).

In 1999, 29% of the foreign investment enterprises estimated their technology as nearly modern or modern compared to 41% of the respondents in 1996. According to the 1999 questionnaire, only 18% of the enterprises evaluated their technology as completely up-to-date (21% in 1996).

The surveys also inquired to what extent the foreign investors, when transferring technology to the Estonian units and in their later adjustment, had used the peculiarities of the local environment and how they estimated the existing resources. Between 1996 and 1999, adjustment of their production technology to the local conditions had not been necessary for 18% of investors on average. In the last year, however, adjustment of technology had become unnecessary for less — only 6% of the enterprises. This tendency shows that the FIEs had started to consider more seriously the resources available in the host country. According to the 1999 evaluations, 24% of the enterprises had made irrelevant changes. The approximate results of the previous two years were 15% (in 1998) and 8% (in 1997).

The evaluations of the last questionnaire show that most, i.e. 70%, of the FIEs either completely adjusted the transferred or bought production technology or adjusted it to a large degree. Over the years, their number remained the same. The share of enterprises considering adjustment unnecessary has constantly decreased. In 1998, 68% of the enterprises appraised the local conditions and considered technological development of Estonia important, whereas in 1997 the respective percentage was 75. Hence, among the enterprises that do not need technological development, or need it on a small scale, the proportions have changed in favour of the latter as seen from the aspect of local technological development. In the process of adjustment of technology by the FIEs, the proportions of various resources — skilled labour, unskilled labour, materials, capital — changed during the four years (see Figure 4.2.).

It can be seen from the above results that in the period 1996–1998, the use of capital in the manufacturing process increased.

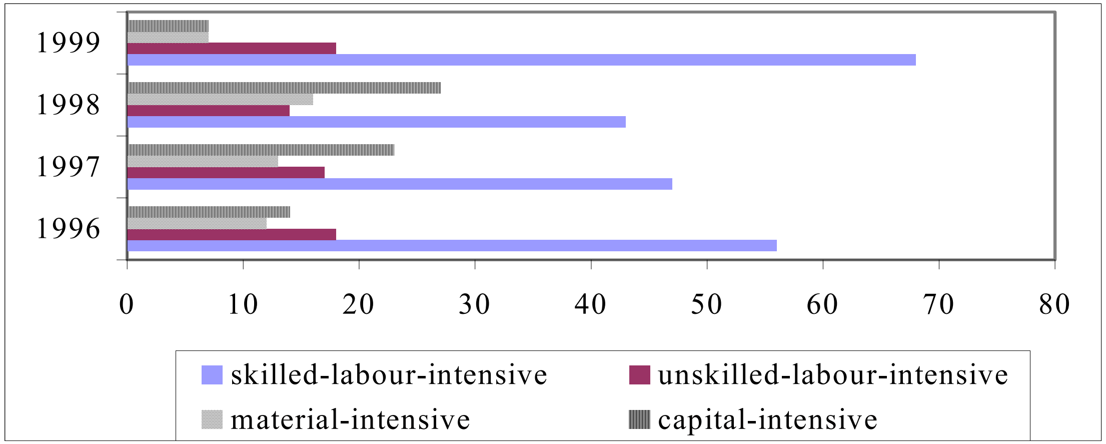

Figure 4.2. Adjustment of production technologies in the Estonian conditions, 1996–1999 (% of respondents) (author's data based on the results of the survey "Foreign Investor").

One of the reasons was a relatively favourable price of the capital for those who entered the Estonian market. While in 1996 only 14% of the enterprises that responded had made their technologies more capital-intensive, then by 1998 their number had already risen to 27%. On the other hand, the existing skilled labour was appreciated less, or there was a lack of this resource. The requirement of skilled labour in technologies decreased from 56% to 43% (13% decrease). At the same time, the requirement of skilled labour in technologies was bigger each year in comparison with other resources (making up on average 54% of all the resources).

In recent years, the demand for skilled labour has constantly increased both in the foreign investment and domestic enterprises. In spite of the increasing shortage of the required labour force, it appears from the last questionnaire that the share of skilled labour force in production has increased drastically and relatively faster than other resources. In comparison with 1998, the growth of skilled labour intensity has been about 60%. The proportions have changed, capital making up only 5%. Material intensity has decreased from 16% to 7%, while unskilled labour intensity has remained the same (17% on average). The cause for such a development has been, on the one hand, the rise in prices of capital. On the other hand, this supports the idea about the favourable price rate and the good quality of labour as advantages for Estonia.

Regarding the period 1996–1998, the enterprises were additionally asked to evaluate the impact of a particular foreign investment on various aspects of their business activities, such as the processes of production, marketing, and management, supporting activities, pricing levels, labour quality, and product and process development (see Figure 4.3). A scale from 1 (impact is irrelevant) to 5 (impact is very strong) was used for this purpose.

It can be seen from Figure 4.3 that during the period under observation no significant changes occurred. The impact of for-

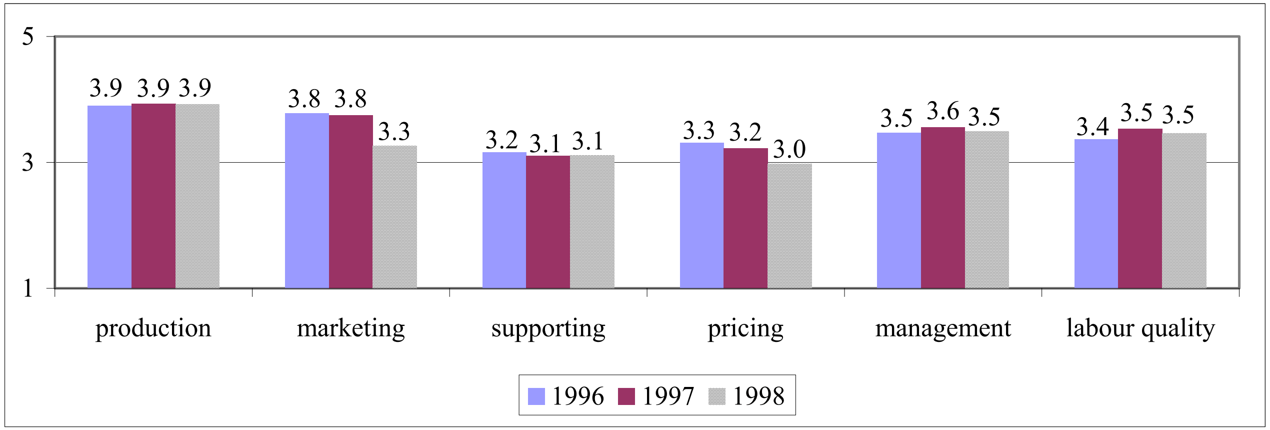

Figure 4.3. Impact of foreign investment on various aspects of business activities in 1996–1998 (1 – no influence at all … 5 – a very strong influence) (author's data on the basis of the results of the survey "Foreign Investor").

eign investment on the processes of production and marketing was thought to be the biggest, followed by the impact on management and labour quality. The result shows that for the enterprises (primarily during the initial years of their activity) the development of production and marketing strategies is primary, helping to raise effectiveness of processes and thus gain a competitive edge. There are several reasons why the impact on support and price policy is less significant, depending on the peculiarities of the enterprises and the country involved. Furthermore, the long-term experience and knowledge of foreign investors in the given fields need not be applicable on the Estonian market.

The results of the survey concerning technology transfer between 1996 and 1999 indicate a rise in the technological level of the local Estonian units in the form of transferred know-how from the parent enterprise and its development. The attitude towards the technology used at the pre-investment time is more critical. The parent enterprises have been active primarily in importing marketing and management-related knowledge both in the servicing and manufacturing sector. Also the rate of product and process development in finance is remarkable. Transfer of patented technology has remained irrelevant. At the same time, from year to year, together with technology transfer to the local units, the number of enterprises has increased who consider the local conditions suitable (primarily the available skilled labour with a favourable price and quality relationship) and the development activities possible.

Co-operation between the foreign investment and domestic enterprises. Evaluating the possible impact of the FIEs on the DEs, this chapter will analyse the distribution of rights between the foreign investors and the local units to participate in the decision-making processes in selected fields; additionally, the extent to which local subcontractors were applied in 1999 will be addressed. The probability of generating technological spillover in the DEs will be evaluated, primarily proceeding from the forward and backward linkages between the foreign investment and domestic enterprises.

Table 4.1 below shows that the Estonian units enjoy a relatively large freedom to select subcontractors (average rate 4.1), as well as to combine their personnel (average rate 4.2). The more freedom of decision-making the local units have, the bigger the probability that more local than external suppliers will be applied in manufacturing, and that local labour will be employed and trained.

Investors observe the whole manufacturing process with a bigger interest, leaving less freedom of activity to the local units (average rate 3.6). As expected, the host enterprises enjoy less freedom of decision-making in the area of R&D (average result 3.0). Decisions in the above-mentioned fields are made by way of co-operation between the foreign investors and the local units, often mostly on the basis of the foreign investor's individual decisions.

In the local units, the right to take decisions is above average in domestic subcontracting in the textile and clothing industry (5.0), financial services (4.8), construction materials (4.4), wood, paper and furniture (4.2), and transport equipment (4.2). Concerning the personnel, also enterprises in the textile industry have more freedom to decide (4.8), followed by those in construction materials (4.7), financing services (4.7) and transport equipment (4.6). The chemical industry has the least right to take decisions in the production process, (3.0), in case of machinery and equipment in R&D activities (2.4).

The questionnaire of 1999 showed that 68% of the respondents, i.e., 72 foreign investment enterprises out of 104 used 1707 enterprises in Estonia as subcontractors in their production process. At the same time, 6015 jobs were guaranteed. By branches, the biggest users of subcontractors were in the manufacturing industry, namely in the wood, paper, and furniture industry enterprises (17% of respondents) followed by office and electrical machinery (14%), and construction mate-

Table 4.1

Division of the decision-making process between the foreign investor and the Estonian local unit in selected fields in 1999

(1 – foreign investor decides completely …, 5 – sub-unit decides completely)

Branch (number of enterprises)	Manufacturing	Sub-contracting	Personnel	R&D
Food products, beverages (10)	3.9	3.8	4.5	3.3
Textiles, clothes (6)	4.3	5.0	4.8	3.3
Wood, paper, furniture (15)	4.2	4.2	3.5	3.0
Chemicals, plastics (5)	3.0	3.3	4.3	2.8
Construction materials (9)	4.0	4.4	4.7	2.8
Machinery and equipment (5)	3.6	4.0	4.0	2.4
Office and electrical machinery (12)	3.7	3.8	4.1	3.3
Transport equipment (6)	3.8	4.2	4.6	2.6
Energy (4)	3.3	3.3	3.3	3.3
Trade (23)	2.7	3.8	3.7	3.3
Financing services (9)	3.2	4.8	4.7	2.8
Total (104)	**3.6**	**4.1**	**4.2**	**3.0**

Source: author's data on the basis of the results of the survey "Foreign Investor".

rials (13%). Trading enterprises were also active users of subcontractors (18%).

As it appears from what was said above, the Estonian local units subcontracting in the given branches of the manufacturing industry enjoy considerable rights of decision-making. This indicates active application of domestic enterprises in manufacturing whenever possible. The results of the questionnaire may presume creation of a possible technological spillover both inside and between the branches. As a result, the technological capacity of the DEs having contacts with FIEs will increase.

Creation of spillover depends on various factors both on the side of the investor and the host country. The bigger the absorptive capacity, incl. the quality of human resources, of local units or the state, the more freedom of activity will foreign subsidiaries enjoy and the larger will be their impact on other enterprises on the market of the host country. Also, the more will the investors be interested in setting long-term objectives with orientation towards developing rather than merely exploiting the local resources.

Development of labour in the foreign investment enterprises. Foreign investors have highly evaluated the importance of labour resource as a motivating factor in investing into Estonia. On the scale 1 (impact is irrelevant) to 5 (impact is very strong), the investors gave it the average mark of 3.8 in 1999. The average result in the manufacturing industry was 4.0. The local labour has hence a significant impact on investing into Estonia.

Change in the quality of labour of the FIEs has been mediocre since pre-investment into Estonia, evaluating the development with 3.02 (change is irrelevant). Despite the average result, there are differences between the branches. Changes in the labour force were evaluated as being more towards the unfavourable in the food industry (average rate 2.6), textile industry (2.8), transportation (2.8) and also office and electronics industry (2.9) enterprises. Among the branches presented herein, there are branches with both large (foodstuffs, textile, electronics) and smaller (transportation) foreign investment involvement. Hence, a more general problem lies in labour, notwithstanding whether it is a domestic or foreign investment enterprise. Problems may be due to lack of qualified labour and its rising prices which may bring about the loss of advantage in prices of manufacturing already in the near future.

The impact of investments on labour in the period 1996–1998 (see Figure 4.3, p. 8 was not considered by the investors to be big. In comparison with other business activities (the processes of manufacturing, marketing, or management), the result was more modest. Despite the investors' modest estimate, the training of personnel and reorganisation of the management system in the FIEs was still considered important, even more so in the conditions of a decrease in qualified labour and its rising prices (see Figure 4.4).

Compared to the initial year of the period, the share of management training and teaching foreign languages in the foreign investment enterprises had increased by 1999. If in 1996, 68% of the enterprises participating in the questionnaire organised management training sessions, then in the following year the figure was considerably bigger, namely, 86%. In 1999, 73% of the enterprises considered it important to train their managers. Importance of language learning had risen from 75% to 83% in 1999. From the questionnaire of 1998 it appears that expenditure on the training of the personnel may be cyclic. A steep decrease in various training levels in 1998 may have been caused by the Russian economic crisis that started in the same autumn, which directed the existing resources mainly into manufacturing or into the marketing process in connection with reorientation to new markets.

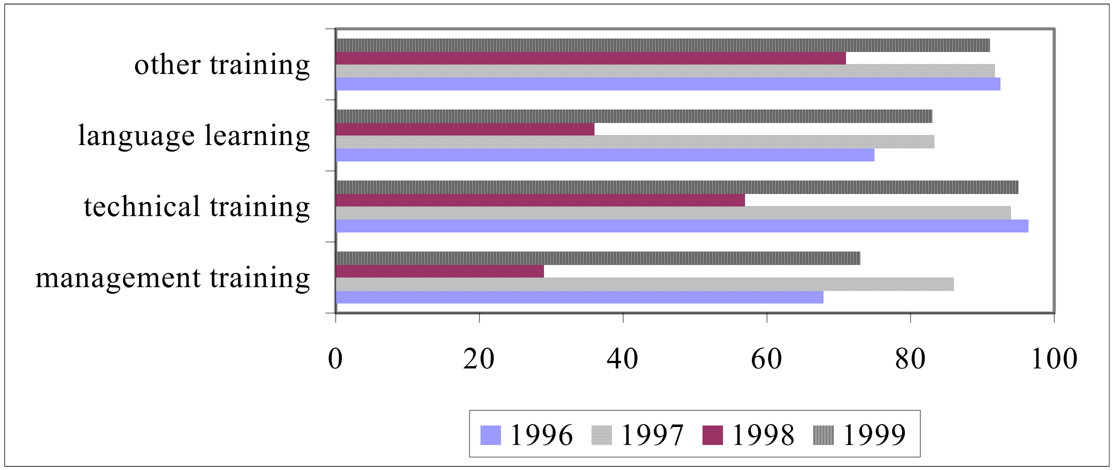

Figure 4.4. Training in the foreign investment enterprises in Estonia, 1996–1999 (%)
(author's calculations on the basis of the results of the survey "Foreign Investor").

Table 4.2

Employees from the foreign investor's home country in 1996–1999 (number of employees)

	1996	**1997**	**1998**	**1999**
Senior management level	38	43	34	66
Middle management level	16	28	26	30
Skilled labour level	4	17	34	38
Total	**58**	**88**	**94**	**134**

Source: author's data on the basis of the results of the survey "Foreign Investor".

Training of the personnel has taken place mainly through dispatching senior and middle management or skilled workers from the parent enterprise or its foreign subsidiaries to the Estonian units. The share of foreign labour from the home country has gradually increased in the FIEs in Estonia (see Table 4.2).

An upward trend can be observed primarily in involving top officials from abroad. The share of foreign labour applied at a higher management level constituted 50% of the total imported labour in 1999. About 50% of the respondents in 1996–1999 had not used foreign labour in any of their fields of activity (i.e. 53% in 1996, 42% in 1997, 47% in 1998, 46% in 1999). On average 35% of the enterprises (40% in 1999) use foreign labour only among their senior-level officials.

The results show that the FIEs use foreign labour mostly among their senior-level officials, which refers to the strategy of the parent enterprise to make the local units aware of the objectives of the corporation and its organizational culture. There has been more possibility to pick and choose the middle management in Estonia and the employees have better met the requirements of the foreign enterprise. Exploitation of skilled labour from the home country remained comparatively modest during the observed period.

The problems that have made the FIEs to employ labour from abroad for a specified term or during an indeterminable time are connected with the quality of the available labour (average rate 3.5) and lack of skilled labour (3.0) (see Annex 1). Lack of skilled labour is in its turn caused by the system of education that does not conform to the actual needs of the economy, its inefficiency and rigidity. Foreign investors have stressed the weakness of both vocational and in-service training systems in Estonia.

The results show that in the conditions of the increasingly growing lack of skilled labour the foreign investment enterprises must be active themselves in training the existing labour both in Estonia and abroad. Labour as a motivating factor in Estonia has been evaluated highly, at the same time not really favouring the changes in labour development, primarily in the light and electronics industries. Dissatisfaction of investors may be caused by the rise in prices of the local labour or its insufficiency.

In addition to the development in the infrastructure (incl. the national innovation system connecting the business, research and government sectors), further binding of the existing investments and attracting new ones to Estonia significantly depend on availability of qualified labour which would meet the investors' requirements. First of all, this would require sizable investments into the development of an education system that would meet the actual needs of the society and economy.

During the last decade, the technology transferred through FDIs into the local units has significantly contributed to Estonia's technological development. The results of the survey "Foreign Investor" 1996–1999 allow us to presume that the technological level of the foreign-owned enterprises in Estonia has risen thanks to the transfer of specific, primarily marketing- and management-based knowledge and skills from the parent enterprise. Adduction of research and development into Estonia has receded into the background. At the same time, the survey shows that the local units enjoy a relatively big freedom to take decisions, primarily in employing subcontractors, and giving preference to local rather than foreign suppliers, in this way stimulating the occurrence of technological spillovers in the local Estonian firms.

When transferring technology to their subsidiaries in Estonia, the enterprises have taken account of the local conditions, adapting the technologies in line with the state's resources. Despite the growing shortage of qualified labour force in Estonia, technology became more skilled-labour-intensive during the examined period. Labour force was evaluated highly as a motivating factor for investing into Estonia, while at the same time the developments within it were not favoured.

Comparison of the changes in the technological level of the foreign investment enterprises and the domestic enterprises in 1996–1998

Foreign penetration into the Estonian manufacturing industry. In the current and next subchapters, the Estonian Statistical Office's database "Manufacturing Industries in Estonia 1996–1998" is used to analyze foreign penetration and its impact on the DEs in the Estonian manufacturing industry. In the database the manufacturing sector has been divided into 16 industries by the type of ownership. The database includes FIEs with at least 50 per cent of foreign ownership and with more than 50 employees.

In the following research the 16 manufacturing industries are further grouped into high- and low-technology sectors according to the modification of Pavitt's classification of industries. After the patterns of technical change and technological learning, four types of industries can be separated: science-based, specialised-supplier, scale-intensive and supplier-dominated industries (Knell, 1999a, p. 7). Based on the works of some other authors (Bellak and Cantwell, Hatzichronoglou), Knell has called those groups of industries respectively high-tech, medium-high, medium-low and low-tech industries (Bellak *et al*., 1998; Hatzichronglou, 1997; Knell, 1999a)[2]. Technological intensity of industries can be measured by the share of R&D expenditures of net sales[3]. As data are available about the aggregate level of 16 industries, we decided to use a simplified classification of industry sectors into high-tech (incl. medium-high) and low-tech (incl. medium-low) in the current analysis of the Estonian manufacturing industry between 1996–1998. It must also be emphasized that in case of the transition countries the OECD-determined technological intensity cannot be directly followed in the high- or low-tech sectors. The bigger technological potential of high-tech industries can be rather arguable.

The foreign penetration in Estonian manufacturing by employment, net sales, value added, tangible and intangible assets in 1998 can be seen from Table 4.3 which sums up the indicators for value added, operating profit, amortisation and labour costs (incl. wages, social tax). The foreign share in manufacturing as a whole is relatively high. It varies from 20–30% in total employment, net sales and value added to between 40–60% in tangible and intangible assets.

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[2] According to the NACE classification the following manufacturing industries can be involved in the high-tech sector: 30, 32, 2423, 353; medium-high sector: 24, 29, 31, 33–35; medium-low sector: 23, 25–28, 36–37, 351; low-tech: 15–22, 361 (Knell, 1999a, p.8).

[3] According to the OECD definition, the R&D expenditures of net sales amount to at least 5% in the high-tech industries, 2–5% in the medium-high and medium-low industries, less than 2% in the low-tech industries (World Investment Report, 1999, p.230).

Higher foreign penetration rates in net sales and value added, and lower rate in employment give reason to believe that the FIEs own higher productivity levels (net sales or value added to employment) than the DEs. High foreign shares achieved in fixed assets, on the other hand, support the idea that the foreign enterprises use more capital-intensive technologies. Foreign penetration is especially strong in case of intangible assets, amounting to over 90% in some industries (paper and paper products; construction, chemicals, coke and petroleum). It can be argued that the foreign-owned enterprises have been more intensive in creating enterprise-specific knowledge or in introducing new industrial property, etc.

Evaluating the extent of foreign penetration in the high- and low-tech sectors of the manufacturing industry, the rate is bigger in the high-tech industries as a total. The chosen indicators (foreign share in employment, net sales, etc.) show better results (on average 40–50% higher) in the high-tech sector than in the low-tech sector. Intangible assets are the special case where the high-tech sector has achieved even twice higher position than its counterpart in Estonian manufacturing.

The industries with the biggest foreign penetration are the textiles, paper, and paper products, followed by the tanning and dressing of leather, and the construction industry in the low-tech manufacturing sector. In the high-tech sector, the foreign investors have mostly concentrated into the chemical and electronics industries. Looking at the structure of foreign penetration in Estonia, the food industry appears to have the biggest foreign share among the low-tech industries (see Table 4.4). On the basis of different indicators (net sales, value added, etc.), it can be concluded that 13% of foreign penetration has been orientated into the food, textile, and construction industries, and 6% and 3%, respectively, into the paper and leather industries.

The high-tech industries of chemical and electronics products have guaranteed themselves 16% and 9% foreign shares, respectively. In the following analysis of how to evaluate the impact of foreign investors on Estonian manufacturing attention will be mainly focused on the development of the seven industries mentioned above.

Changes in labour and capital productivity in 1996–1998. In the current and next subchapter the impact of foreign enterprises on the labour, capital, total factor productivity and capital intensity of the local enterprises will be analyzed. Labour and capital productivity are used as indicators of proxies for technological capability. In the process of analyzing the occurrence of FDIs-induced technological spillovers in the Estonian economy, three hypotheses will be put forward on the example of the manufacturing industry in the period 1996–1998. A comparative analysis will be used. The first two hypotheses will be analyzed in the current chapter.

The first hypothesis follows the proportionality criteria of the technological spillover effect of the foreign share in the industry, based on the theoretical models of Koizumi, Kopecky and Findlay (Findlay, 1978; Koizumi *et al*., 1977).

H1: The probability that technological spillover will occur in the Estonian manufacturing industry is bigger in those branches, where the rate of foreign involvement is relatively higher than in the other branches.

The convergence hypothesis is to be tested by the high-tech and low-tech sectors of the Estonian manufacturing industry. The occurrence of direct or indirect technological spillover effects can be evaluated, depending on whether the development is more rapid in the high-tech or low-tech industry sector. If capital intensity is higher in the high-tech sector, the occurrence of direct spillover effects will be likely there.

H2: The probability that technological spillover will occur in the Estonian manufacturing industry is bigger in those branches, where the technological gap between the local and foreign-owned enterprises is relatively big.

Table 4.3

Foreign share in Estonian manufacturing, 1998 (*per cent*)

ISIC code	**Industry**	**Employ-ment**	**Net sales**	**Value added**	**Tangible assets**	**Intangible assets**
15–16	Food products and tobacco	10	19.3	21.5	31.4	5.9
17	Textiles	56	70.5	55.7	70.2	86.2
18	Wearing apparel, dressing	14	9.8	12.5	8.4	9.0
19	Tanning & dressing of leather	26	45.5	32.6	56.1	86.6
20	Wood and wood products	12	16.3	15.9	22.7	14.7
21	Paper and paper products	65	77.5	77.4	87.6	99.9
22	Publishing, printing	13	20.2	12.3	5.8	4.2
25	Rubber and plastics	14	26.3	32.3	38.6	59.2
26	Construction industry	38	61.0	65.5	78.4	99.3
27–28	Metals and products	14	10.6	14.9	15.7	8.4
36	Furniture	13	19.6	20.7	22.5	17.4
37	Recycling	4	15.1	13.9	10.8	1.5
	Low-technology industry	**19**	**26.5**	**26.8**	**36.3**	**43.7**
23–24	Chemicals, coke, petroleum	27	44.4	48.0	68.5	96.7
29	Other machinery & equipment	8	20.3	21.2	11.2	7.5

ISIC code	Industry	Employ-ment	Net sales	Value added	Tangible assets	Intangible assets
30–33	Office and electrical machinery	50	42.7	50.3	53.1	60.0
34–35	Other transport equipment	20	13.7	16.3	20.4	0.0
	High-technology industry	**29**	**35.4**	**34.6**	**46.3**	**87.1**
D	**Total**	**21**	**28.3**	**28.4**	**38.5**	**57.6**

Source: author's calculations based on the database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000.

Table 4.4

Structure of foreign share in Estonian manufacturing, 1998 (share, *per cent* of 100)

ISIC code	Industry	Employ-ment	Net sales	Value added	Tangible assets	Intangible assets
15–16	Food products and tobacco	10.0	20.7	16.5	20.8	1.4
17	Textiles	20.5	16.5	10.9	9.0	11.4
18	Wearing apparel, dressing	7.4	1.3	3.0	0.5	0.3
19	Tanning & dressing of leather	2.9	1.9	1.9	1.2	7.6
20	Wood and wood products	6.1	5.8	5.5	8.7	0.5
21	Paper and paper products	3.7	4.7	4.5	6.1	17.1
22	Publishing, printing	2.7	3.3	2.7	0.8	1.3
25	Rubber and plastics	1.3	2.2	3.1	2.2	0.8
26	Construction industry	7.6	11.3	17.1	19.0	10.6
27–28	Metals and products	4.5	2.6	3.8	1.7	0.3
36	Furniture	5.6	4.3	5.2	3.1	0.4
37	Recycling	0.3	0.6	0.7	0.2	0.0
	Low-technology industry	**72.6**	**75.2**	**74.9**	**73.2**	**51.7**
23–24	Chemicals, coke, petrol	6.1	12.2	7.1	17.4	46.7
29	Other machinery & equipment	1.8	2.0	3.0	1.1	0.3

ISIC code	Industry	Employ-ment	Net sales	Value added	Tangible assets	Intangible assets
30–33	Office and electrical machinery	15.8	9.1	11.7	5.9	1.3
34–35	Other transport equipment	3.6	1.6	3.4	2.4	0.0
	High-technology industry	**27.4**	**24.8**	**25.1**	**26.8**	**48.6**
D	**Total**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: author's calculations based on the database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000.

In order to explain the differences between the development of foreign investment enterprises and domestic enterprises, the FIE/DE comparison index and change in the indexes of both labour (sales or value added to labour costs) and capital productivity (sales or value added to amortization or tangible assets) are presented for the period 1996–1998. The tables and figures serving as the basis of the analysis are presented in Annexes 2–6. **The FIE/DE comparison index** indicates the relationship between the productivity of foreign investment enterprises and that of domestic enterprises at a certain time. If the value of the index is above one, the productivity of foreign investment enterprises is higher than that of domestic ones. A change in the FIE/DE comparison index expresses the convergence or divergence that has occurred in the productivity (either a decrease or increase in the gap) of foreign investment and domestic enterprises during a certain period of time. Consequently, if the value of the index is below one, the gap between domestic and foreign investment enterprises has decreased.

Measurement both on the basis of the net sales and value added clearly indicates a bigger gap of the domestic enterprises and, on the other hand, the speed of convergence in the high technology branches in comparison with the low technology ones (see Figure 1 in Annexes 4–5). Finding the index on the basis of the value added, the inefficiency of the domestic enterprises will increase more than that of the foreign investment enterprises. On the basis of the net sales, the value of the FIE/DE comparison index in the high-tech branches is 1.45, whereas on the basis of the value added the figure is 1.29. The productivity of labour costs in the foreign investment enterprises is respectively 45% and 29% bigger than that of the domestic enterprises (see Annex 2). While the difference between the productivity of FIEs and DEs in the group of high technology enterprises decreased 31%, the decrease in the low technology group was only 8% (see Annex 3).

In the branches with big foreign penetration (the textile, leather, paper, chemical, electronics and construction materials industries, also the furniture and plastics industries), significant differences can be seen between the FIEs and DEs. At the same time, a relatively faster development occurred in the high technology branches (chemical and electronics industry) in favour of the DEs as compared to the low technology branches, evaluated both on the basis of the net sales and value added. In the chemical industry, the FIE/DE comparison index decreased by 12% (coefficient 0.88), in the electronics industry by 64% (coefficient 0.36) (see Annex 3). Among the branches with a smaller gap (e.g. the clothing, wood, or metal industry), there was no significant development among the DEs.

As far as capital productivity is concerned, there is still a convergence between the FIEs and DEs in the high technology branches despite the initial advantage of the DEs (see Figures 2–3 in Annexes 4–5). On the basis of the rate of net sales and amortisation, the FIE/DE comparison index dropped from 0.83 to 0.59, which indicates an increase in the efficiency of the DEs. In the low technology industries, the FIEs are quickly overtaking the DEs, the index on the basis of turnover and amortization having grown in three years from 0.57 to 0.72. The index has increased by 11%. On the basis of relations between the value added and amortization, net sales and tangible fixed assets, or value added and tangible fixed assets, the growth of the FIE/DE comparison index has been even bigger, respectively 31%, 27% and 50% (see Annex 3). The initial gap has deepened in the textile industry, clothes production, publishing, and other production.

Changes in total factor productivity in 1996–1998. To evaluate the total effect of labour and capital productivity, Figure 4.5 describes the development of total factor productivity in the period 1996–1998 (see also Annex 7). Observations of the development in total factor productivity form the basis for evaluating the previously proposed hypotheses H1 and H2.

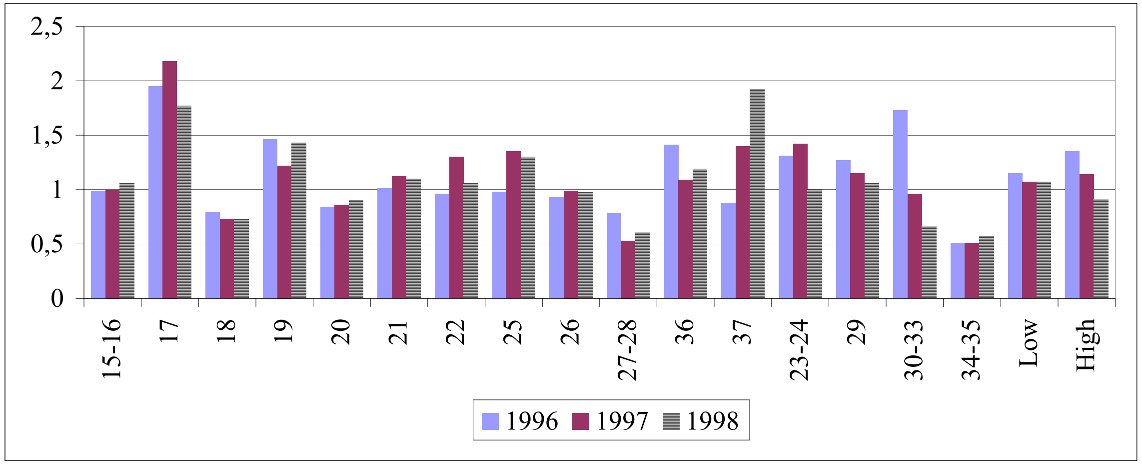

Figure 4.5. Total factor productivity in the Estonian manufacturing industry in 1996–1998, the FIE/DE comparison index (author's figures on the basis of the database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000).

Total factor productivity is found as the ratio between net sales and the sum of labour and capital costs. The coefficient shows how effectively the enterprises have managed to apply both factors — labour and capital — in creating their output. Hence, one unit (kroon) that is spent on labour and capital in an integrated way adds to the net sales a certain number of units (kroons). The index shows the net sales created by one unit spent in an integrated manner on labour and capital. The figure shows that at the beginning of the period, the more effective foreign investment enterprises are concentrated into the high-technology group (coefficient 5.61) and domestic enterprises into the low-technology group (coefficient 4.67).

The advantage of the FIEs over the DEs in the manufacturing industry as a whole had decreased by the end of the period by 14% (0.86 times). The high-technology group had evidently developed faster, i.e., 32% against the 7% of the low-technology sector. If the FIE/DE difference in the textile industry had decreased by 9% in three years, then for example in the chemical industry it had decreased by 24% and in the electronics industry by 62%. Hence, the result based on the total effect of both factors also affirms a more important convergence of productivity between the high-technology FIEs and DEs in comparison with the low-technology enterprises.

In total factor productivity, better initial technological positions are possessed by the FIEs in the textile, leather, chemical, electronics, but also in the furniture, machinery and equipment industries. Five branches out of six mentioned manufacturing industries have big foreign penetration. High factor productivity, however, already prevailed initially in the domestic food and construction materials industry enterprises (see Annex 7). More inefficient enterprises are in the clothes production and transport industries, the more so among the foreign investment enterprises than the domestic ones. Domestic producers of the transport industry were in a more favourable position than the FIEs both at the beginning and at the end of the period, possessing competitive average productivity in the branch.

In 1996, most of the DEs lagging behind the FIEs were in the textile, chemical and electronics industries. In 1998, the FIE/DE indexes had dropped most in the chemical and electronics industries as compared to the first year level. The situation of the DEs as compared to the FIEs had also significantly improved in the textile and furniture industries (convergence 9% and 16%). Hence, after checking the changes in total factor output in 16 manufacturing industry branches, one will see that the DEs developed fastest in the high-technology branches with a big foreign ownership, which possessed a considerably poorer starting position than the DEs in the low-technology sector in 1996.

Annex 6 Figures 1–3 provide a concise comparison of changes in comparison indexes of FIEs and DEs separately in labour, capital and total factor productivity at the levels of technological groups and the whole manufacturing industry in the period 1996–1998. On the basis of the net sales, one can notice a steady growth of DE efficiency in the development of total factor productivity during the period under observation. The high-technology domestic enterprises underwent faster changes (decrease of index 33%), while the domestic low-technology enterprises developed more slowly (decrease of index 20%). The relatively faster growth of total factor productivity in the DEs compared to the FIEs was caused by an increase in DE labour productivity, at the same time exceeding the devolution caused by a decrease in capital productivity.

Capital productivity of the FIEs increased mainly on account of a fast increase in the net sales and a relatively slower development of fixed assets (see Annexes 8, 9). Differences in changes calculated on the basis of tangible fixed assets or amortization with effective use of capital in high technology show that in comparison with fixed assets, amortization increased relatively faster in the FIEs than in the DEs.

Firstly, the results of the analysis confirm the validity of the hypotheses H1 and H2 in the Estonian economic context on the example of the manufacturing industry. The probability of technological spillover is bigger in those manufacturing industries where the involvement of foreign ownership is bigger. Comparing two technological groups within the sector, the generation of spillover is more probable in the high-technology branches (primarily in the chemical and electronics industries), where the convergence of productivity between the foreign investment and domestic enterprises has been more significant.

Convergence between the FIEs and DEs in the low-technology branches with big foreign penetration has occurred in the textile and leather industries, to some extent also in the paper and construction materials industries. The domestic food industry enterprises were already initially more competitive with the FIEs. The small probability of technological spillover in the low-technology branches may result from the passive competition by the domestic enterprises inside the branch. Limitations to the generation of technological spillover primarily in the branches with big foreign ownership, such as the textile, paper or food industries, may be caused by a big concentration of foreign investment enterprises at the branch's level. The average size of enterprises or the market share of several bigger enterprises in the branch may be a decisive factor in the creation of both intra- and inter-branch spillovers. It may be a so-called enclave-type investment, which limits the spread of technology to domestic enterprises. It would be important to evaluate the concentration of foreign direct investments in the Estonian economy in further studies in this field.

Secondly, the analysis confirmed the larger probability of technological spillover in those manufacturing industry branches where the productivity gap between domestic and foreign investment enterprises is relatively bigger. The gap in productivity was initially considerably bigger in the high-technology branches. At the same time, the fastest development also occurred in the high-technology sector, which is expressed in a relatively faster convergence of productivity between the DEs and FIEs as compared to the low-technology branches.

To determine whether the development in the Estonian manufacturing industry was caused by a direct competition-induced spillover or an indirect co-operation-driven spillover, in this study we classified industrial branches as low- and high-technology ones. In case of a faster development in the latter, one may presume occurrence of direct technological spillover caused by the FDI in the Estonian manufacturing industry. The results indicate that in the low-technology branches, the development of the DEs remained remarkably modest in comparison with the high-technology DEs even though they had started from a better technological position (FIE/DE comparison index in productivity) than the high-technology enterprises. In the Estonian manufacturing industry, the probability of inducing a spillover that would directly accompany the intensification of competition is smaller than causing a spillover that would increase direct technological competition. This means a situation where domestic high-technology enterprises have a larger technological capacity and ability to realize it than expected.

At the same time, one shouldn't underestimate the occurrence of indirect spillover ensuing from the growing direct competition in the Estonian manufacturing industry. The competition in the high-technology branches has been relatively more intensive than in the low-technology ones. From Annex 8 it can be seen that the number of high- technology DEs has decreased by 24%, whereas the number of FIEs has increased by 4% (in the low-technology group, the number of both FIEs and DEs has grown). Besides the occurrence of direct technological spillover, the active competition in the high-technology branches also emphasizes the importance of indirect technological spillover in the Estonian manufacturing industry in 1996–1998.

4.4. Impact of the foreign investment enterprises on the structure and intensity of the domestic enterprises' capital in the manufacturing industry in 1996–1998

Faster convergence of factor productivity in DEs compared to FIEs is more likely in capital-intensive manufacturing industries. This sub-chapter serves to evaluate the third hypothesis, which claims that technological spillover is more likely to occur in those manufacturing industry sectors, where capital intensity is higher than in the rest of the branches.

H3: the probability of occurrence of technological spillover in the Estonian manufacturing industry is bigger in the branches with higher capital intensity.

The above hypothesis results from the new growth theory, according to which the intensity of R&D is the main factor determining the economic growth today. In the current study the intensity of capital (the ratio of fixed assets to employment) is viewed as an approximate value for technological development. Firstly, the impact of foreign ownership on the structure and subsequently on the intensity of capital in the domestic enterprises within the period 1996–1998 will be analyzed.

Impact of foreign ownership on the structure of capital in the domestic enterprises. In what follows, both tangible and intangible assets are used as representative factors of capital. At first, the changes in the volume of total tangible assets and the two main components of tangible assets (machinery and equipment, constructions and buildings) will be analyzed at the levels of both the whole sector, branches, and technological groups between 1996 and 1998 (see the Tables in Annexes 9–12, and Figures in Annexes 13–14). In the foreign investment enterprises, the volume of tangible assets increased from 1.4 billion to 2.1 billion Estonian kroons (50% growth), in the domestic enterprises from 2.2 billion to 4.3 billion (95% growth) (see Annex 9). The growth of machinery and equipment in the

FIEs was 50% and in the DEs 128% (see Annex 10). The investments made into constructions and buildings swelled considerably less — only 8% in case of FIEs and 46% in case of DEs (see Annex 11). At the same time, with a significant increase in the volume of investments into machinery and equipment, the DEs also had to acquire appropriate premises and furnish the working conditions necessary for production. Thus their expenditure on constructions and buildings was considerably larger than that of the FIEs who had created their production environment earlier.

Annexes 9–11 and 13–14 present the share of new assets in total investments into tangible fixed assets and separately fixed assets in main components. The share of new assets indicates the preference of enterprises for acquiring more new or older production technologies, which makes it possible to also evaluate the probability to create technological spillover. The newer the technology, the more probable is the occurrence of effects in one or other branch or technological group.

Figure 1 (see Annex 13) shows that the share of new assets in total fixed assets was larger in manufacturing industry enterprises with foreign penetration and concentrated more into high-technology enterprises, reaching 95% of the increase in the volume of total fixed assets in 1998, the respective figure in low-technology FIEs being 86%. In three years, the investments into new fixed assets increased more in low- (on average 50%) than in high-technology (30%) DEs.

Comparing the years 1998 and 1996, it can be said that in the low-technology DEs the sum total of fixed assets increased more — 2.15 times against the 40% of the growth in the high-technology DEs (see Annex 9). At the same time, if we compare 1997 and 1996, the increase was considerably bigger in the high-technology DEs in 1997 — *viz*. about 90%. 1997 was a decisive year for the high-technology DEs in maintaining the market share in the conditions of growing competition. Despite that, the share of new assets in the high-technology DEs remained relatively modest. Regarding the FIEs, the increase in the volume of fixed assets was 56% in low technology and 23% in high technology. Although their growth was smaller, the FIEs maintained a higher position as investors into new assets in comparison with the rest.

Comparing the increase of investments into machinery and equipment, and into constructions and buildings (Figures 2–3 in Annex 13), the share of the former grew proportionally in new assets. The share of new assets in case of constructions and buildings was relatively unimportant, first and foremost, among the DEs. At the same time, the increase in the volume was bigger in the DEs than in the FIEs.

In the high-technology DEs, the increase occurred only in 1997 as compared to 1996. The smaller share of new assets in the high-technology DEs directly refers to the fact that a fast growth of average productivity may, besides the spread of technology, to some degree be caused by competitive pressure on part of the FDIs, which has ousted more inefficient DEs from the market.

While in 1996 mostly the branches with a big foreign partnership (the textile, food, paper, chemical, and electronics industries, the construction materials industry, additionally the transport industry) preferred to invest into new assets, then in 1998, most of the branches could already be characterized by a high proportion of new assets in their total assets (Annex 9). Compared to 1996, by 1998 the share of new assets had remarkably increased also in the DEs. The share of investments into new assets among total fixed assets in the afore-mentioned branches mostly remained between 90% and 100%; that applied to both components of fixed assets. While the branches with big foreign ownership do not differ remarkably from the share of investments made by the DEs into new assets, considering total fixed assets, then in case of machinery and equipment there is a remarkable predominance of low technology (see Annex 10). Investments into new assets have been made rather by low-than by high-technology enterprises. The results provide a basis to presume spillovers in the manufacturing industry both inside and outside the branches. The basis for the creation of technological spillover in high technology is provided by the fact that volumes of investment of DEs with respect to FIEs were more than twice bigger in 1998 compared to 1996 (see Annex 9).

Analyzing the inside structure of new tangible fixed assets, we see that machinery and equipment in the whole manufacturing industry constitute the majority, reaching in both the DEs and FIEs 50% and more of total fixed assets. The results by sectors and technological groups are presented in Annex 12 and shown graphically in Annex 14 (Figures 1–3). The share of new constructions and buildings in new assets constitutes 15–20%. The proportions of the different components of fixed assets have not changed remarkably during the period under observation (see Figure 1).

There are differences between the technological groups (see Figures 2–3 in Annex 14). In the low-technology branches, no significant shifts either in the structure or between the components of fixed assets or in the groups of enterprises were observed. In the high-technology enterprises, however, the proportion of new machinery and equipment, and constructions and buildings changed. In addition, relatively more investments were made into new constructions and buildings as compared to the low-technology enterprises. The share of new constructions and buildings reached 30%, while that of machinery and equipment was 40% of the new assets in the FIEs. In the DEs, the percentages are respectively 19 and 35. Also, evaluating the comparison of the inside structure of the technological groups, it appears that the low-technology enterprises preferred to invest into new machinery and equipment. In the high-technology branches, other components of fixed assets (constructions and buildings, land, inventory, etc.) played more significant roles, which applies to both the FIEs and DEs.

Impact of foreign ownership on capital intensity of the domestic enterprises. Next, the differences in capital intensity between DEs and FIEs, and by the technological groups at the beginning of the period will be evaluated, which is followed by the evaluation of changes in the years 1996–1998 (see the Tables in Annexes 15–17). Capital intensity is measured as the ratio of capital to labour. In this case, the scale of capital as tangible and intangible fixed assets, and the ratio of fixed assets to employment are used as values of capital intensity. The index shows how active investors of capital the domestic or foreign-owned enterprises are, considering the unrecovered costs at the end of the year as fixed assets.

Evaluating on the basis of the differences in capital intensity of tangible assets between the FIEs and DEs (see Annex 15), an increase in the activity of the DEs can be noticed in 1998 in comparison with 1996. While the DEs became 67% more capital-intensive, the increase in the FIEs was only 9%. The average result of the high-technology DEs was significantly bigger than that of the others (incl. the low-technology DEs) (80% increase). In the high-technology FIEs, a decrease occurred (a 13% change). Capital intensity of the high-technology DEs increased in the conditions of a decrease in the number of enterprises and employees, and a simultaneous increase in tangible fixed assets (see Annex 8). In the low-technology DEs, fixed assets grew more, but the number of employees remained almost the same. Despite the suspicion raised in the previous part dealing with the structure of capital, the domestic high-technology enterprises are still more capital-intensive and the result affects the growth of productivity most.

On the basis of intangible fixed assets, the DEs indicate an even faster convergence of the FIEs (see Annex 15). While in the DEs the increase in high technology was 41% and in low technology 108%, then in case of the FIEs, there was a decrease in both technological groups, 40% and 10%, respectively.

Figure 4.6 shows the changes in capital intensity graphically on the basis of the FIE/DE comparison index (see Table in Annex 16). The initial gap of the DEs in capital intensity (on the basis of tangible fixed assets) is bigger in the high-technology branches, where the FIEs rank 3.37 times higher than the DEs, whereas in the low-technology branches the distinction is 2.48. At the same time, the FIE/DE convergence characterizes the high-technology branches, i.e. 51% against the 29% of the low-technology branches. For the sake of comparison, let us say that the convergence in total factor productivity between the figures for 1996 and 1998 in the high-technology group was 32% against the 7% of the low-technology enterprises. Hence, there is some ground to believe that the hypothesis put forward holds: the more intensively one invests into capital relative to labour force, the more probable it is that technological, especially direct spillover will be generated in the branches of the manufacturing industry (at the level of technological groups). This means that the bigger the demand for capital in the branch, the more probable will be the convergence in productivity between DEs and FIEs.

At the branches level, the FIEs exceeded the DEs at the beginning of the period. The most capital-intensive FIEs were in the construction materials industry (9.11 times higher than the DEs), chemical industry (7.64 times), leather industry (6 times), the production of plastics (3.85 times), and the food industry (3.66 times).

The biggest changes, where the FIE/DE index decreased remarkably in favour of the DEs, occurred in the high-technology chemical (FIE/DE convergence 31%), electronics (65%), machinery and equipment (44%), and transport industries (42%) (see Annex 17). In the low-technology branches, the DEs were more active in the metal (convergence 63%), leather (49%), and construction materials industries (42%). In the textile and paper industries, however, a contrary development occurred, the DEs' situation growing worse by 40 and 17%, respectively.

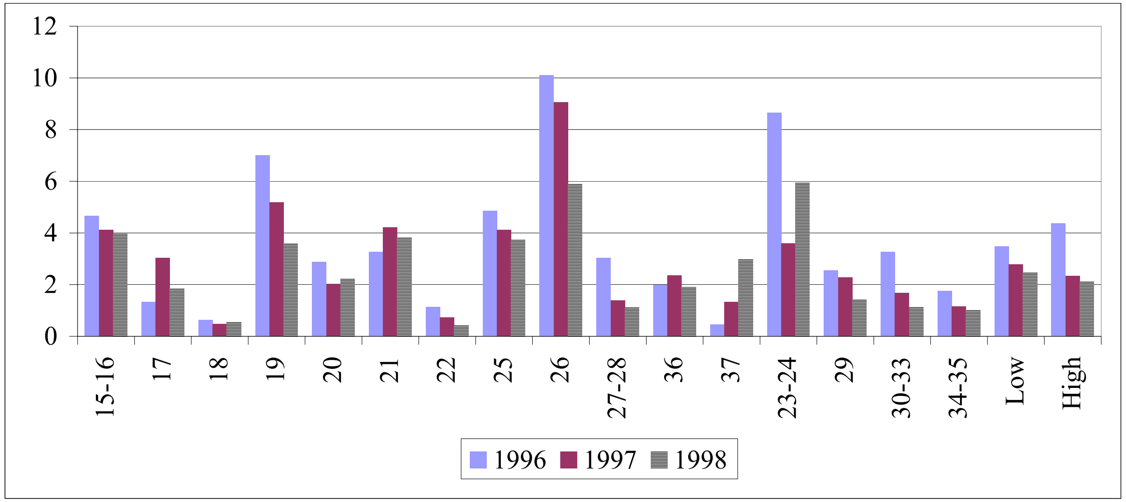

Figure 4.6. Capital intensity (tangible fixed assets per employment) in the Estonian manufacturing industry in 1996–1998, the FIE/DE comparison index (author's figures on the basis of the database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000).

Among intangible fixed assets, the intensity at the beginning of the period was over 13 times in favour of the FIEs (see Annex 16). By the end of the period, the difference between the FIEs and DEs had shrunk fivefold at the level of the whole sector, remaining at the average value 3.4 in the low-technology enterprises, and at 16.6 in the high-technology enterprises in the final year. The FIE/DE convergence was comparatively similar, namely, 59% in high technology and 56% in low technology. Consequently, the convergence at the level of the whole sector was 61%.

At branch level, single bigger variations inside the technological groups can be seen. At the beginning of the period, the DEs had the biggest gap in the leather (251–fold difference with the FIEs), chemical (180–fold) and construction materials industries (139–fold). The development was in favour of the DEs in the leather and chemical industries, and also in the food industry (see Annex 17). In the paper industry, however, in 1996–1998 the FIE/ DE rate multiplied by 673 in favour of the former.

Considering the peculiarity of the branches, a positive connection can be brought forth between the extent of foreign ownership and capital intensity, as well as between capital intensity and generation of technological spillover. The conclusion will sum up the results of both this and the previous subchapter.

Conclusion

The analysis made on the example of the Estonian manufacturing industry confirmed that, unlike the other CEE countries (see Djankov *et al*., 1998; Holland *et al., 1998*; Knell, 1999b), technological spillover occurs in the Estonian economy. Several surveys conducted in the CEE countries have led the authors to conclude that the interest of foreign investors is to exploit rather than develop the local resources. Complications connected with occurrence of technological spillover in the other CEE countries may be caused by a weak absorptive capacity of the technologies; additionally there may be methodological problems (inadequacy of data, etc.) involved.

The probability of occurrence of technological spillover in the Estonian manufacturing industry is bigger in those branches where the foreign share is higher than in the other branches (H1). Occurrence of spillover is more probable in the high-tech manufacturing industry sector where the convergence in total factor productivity has been more significant between the local and foreign-owned enterprises. Limited occurrence of technological spillover in the low-tech sectors may be due, on the one hand, to a passive competition from the local enterprises, and on the other hand, to the concentration of foreign-owned enterprises in certain manufacturing industry sectors, which limits the spread of technology into the local enterprises.

Technological spillover is more likely to occur in those manufacturing industry branches where the technological gap between the local enterprises and the foreign-owned enterprises is potentially big (H2). Initially the gap in productivity between the local enterprises and foreign-owned enterprises was bigger in the high-tech sectors. At the same time, it was in the high-tech sector that a faster development occurred. This leads us to presume that a more direct FDIs-induced technological spillover took place in the Estonian manufacturing industry during the examined period.

A comparatively faster convergence of factor productivity in the local enterprises than in the foreign-owned enterprises is more likely in the capital-intensive manufacturing industry sectors. For the approximated estimation of the intensity of technological or R&D activities, the capital intensity used in the research is based on fixed assets. The growing amount of investments into fixed assets is a presumption for an independent technological development of enterprises.

The analysis confirmed that the more intensively enterprises invest capital relative to labour force, the more likely is the occurrence of technological spillover in the Estonian manufacturing industries (H3). Hence, the more capital-intensive is the manufacturing industry sector, the higher is the ability of its enterprises to absorb relevant technology and the bigger is the probability of technological spillovers.

The appearance of technological spillover in the Estonian economic context may be due to the above-average absorptive capacity of the local enterprises that has helped them resist the competitive pressure from the foreign-owned enterprises. As a result, on the one hand, Findlay's hypothesis about the advantage of the gap of local enterprises can be confirmed. On the other hand, a positive connection between the initial gap of the local enterprises and foreign share at sector level may result from the high development potential of the local enterprises.

According to the results of the analysis, the role played by FDIs in technology transfer to Estonia is increasing. The existence of a strong technological infrastructure with supporting services (science and technology parks, innovation and incubation centres, centres of competence) and a qualified labour resource are becoming more important in ensuring continuous investments and attracting new strategic foreign investors to Estonia. The co-operation between enterprises and R&D institutions in Estonia should be stimulated. The environment-creating factors would provide enterprises with an opportunity to invest R&D activities into Estonia, and also to co-operate with the local R&D institutions. Empirical research so far has shown that foreign-owned enterprises are rather passive in performing R&D in the CEE countries, including Estonia.

The proposals developed from the present study for the elaboration of Estonia's technology and innovation policy are the following:

- support the development of Estonian technological infrastructure, thereby stimulating co-operation between both

foreign-owned and local enterprises, and R&D institutions;
- support the raising of awareness in Estonia about technological development and innovation (incl. the importance of co-operation between enterprises and R&D institutions), and the competence in innovation management.

At the present moment the possibilities for foreign and local enterprises to advance in Estonia largely depend on the investments made by the public sector into technological development. But technological development requires an environment motivating long-term investments whose purpose would be wider than merely enhancing the volume of fixed assets.

The conclusion drawn on the basis of the Estonian R&D strategy "Knowledge-based Estonia" is that the volume of national investments and the applied measures should stimulate enterprises to undertake more active innovation activities. In the long run, the expenditure made by the enterprises themselves on technological development must increase. A knowledge-based economy requires that the state adopt a long-term R&D strategy that would establish its R&D positions until 2006. The Government of Estonia endorsed the relevant document in May 2001, to be approved by the Parliament in autumn 2001.

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Annex 1

Demotivating factors in the development of FIEs in Estonia in 1999
(1 – very big problems … 5 – not problem)

Branch	Difficulties in getting of the employment and residence permit	Quality of the existing labour	Lack of available skilled labour	Weakness of the system of vocational education	Weakness of the system of in-service training	Lan-guage skills	Ineffici-ency of inno-vation system
Food products, beverages (10)	2.8	3.3	3.0	2.4	3.1	3.3	3.3
Textiles, clothes (6)	3.5	3.2	2.0	2.2	3.0	3.6	3.4
Wood, paper, furniture (15)	3.6	3.4	2.4	3.0	3.2	2.8	3.4
Chemicals, plastics (5)	4.2	4.0	3.6	4.0	4.2	4.0	3.2
Construction materials (9)	3.5	3.9	2.7	2.4	2.8	2.8	3.1
Machinery and equipment (5)	3.2	3.0	2.8	2.8	2.6	3.0	2.8

Branch	Difficulties in getting of the employment and residence permit	Quality of the existing labour	Lack of available skilled labour	Weakness of the system of vocational education	Weakness of the system of in-service training	Lan-guage skills	Inefficiency of inno-vation system
Office and electrical machinery (12)	3.1	3.5	2.5	2.4	2.5	3.5	3.0
Transport equipment (6)	3.8	3.6	3.2	2.4	2.6	3.2	3.4
Energy (4)	4.5	3.0	4.0	3.7	3.7	3.0	3.7
Trade (23)	3.5	3.7	3.5	3.0	3.6	3.6	3.6
Financing services (9)	3.9	3.8	3.3	3.3	3.7	3.6	3.6
Total (104)	**3.7**	**3.5**	**3.0**	**2.9**	**3.2**	**3.3**	**3.3**

Source: The materials of the survey "Foreign Investor 1999"; author's calculations.

Annex 2

The productivity of labour and capital in the Estonian manufacturing industry by selected indicators and by branches in 1996–1998 (FIE/DE comparison index)

ISIC code	Branch	Net sales/labour costs			Value added/ labour costs			Net sales/ amortisation		
		1996	**1997**	**1998**	**1996**	**1997**	**1998**	**1996**	**1997**	**1998**
15–16	Food products, beverages	1.24	1.22	1.26	1.24	1.36	1.45	0.48	0.54	0.63
17	Textiles	1.97	2.15	1.70	0.78	1.14	0.90	1.82	2.52	2.35
18	Wearing apparel, dressing	0.77	0.70	0.71	0.99	0.88	0.93	1.05	1.21	1.20
19	Leather and products	1.89	1.43	1.69	1.36	0.97	0.97	0.37	0.44	0.52
20	Wood and products	0.89	0.95	0.91	0.66	0.83	0.88	0.72	0.64	0.88
21	Paper and products	1.36	1.18	1.25	1.51	1.17	1.24	0.36	0.91	0.63
22	Publishing, printing	0.96	1.34	1.00	1.14	0.96	0.56	0.90	1.15	1.35
25	Rubber and plastics	1.15	1.49	1.58	1.82	1.61	2.11	0.60	1.02	0.75
26	Construction industry	1.40	1.48	1.43	1.35	1.67	1.74	0.28	0.38	0.36
27–28	Metals and products	0.81	0.55	0.62	0.84	0.71	0.92	0.56	0.43	0.54
36	Furniture	1.63	1.31	1.28	1.47	0.97	1.37	0.66	0.47	0.79
37	Others	0.84	1.30	1.96	0.75	0.88	1.78	1.38	3.00	1.68
	Low-technology	**1.29**	**1.21**	**1.19**	**1.09**	**1.16**	**1.20**	**0.57**	**0.64**	**0.72**
23–24	Chemicals, coke, petroleum	1.47	1.57	1.29	1.84	1.87	1.49	0.67	0.91	0.51

ISIC code	Branch	Net sales/labour costs			Value added/ labour costs			Net sales/ amortisation		
		1996	**1997**	**1998**	**1996**	**1997**	**1998**	**1996**	**1997**	**1998**
29	Machinery and equipment	1.32	1.29	1.18	1.34	1.29	1.25	0.90	0.53	0.53
30–33	Office, electrical and optical machinery	1.85	1.02	0.67	1.19	1.05	0.91	1.09	0.57	0.59
34–35	Transport equipment	0.52	0.54	0.57	0.62	0.60	0.70	0.45	0.34	0.56
	High-technology	**1.45**	**1.23**	**1.00**	**1.25**	**1.13**	**0.96**	**0.83**	**0.69**	**0.59**
D	**Total**	**1.32**	**1.20**	**1.13**	**1.13**	**1.15**	**1.13**	**0.63**	**0.66**	**0.70**

Source: Database “Estonian Manufacturing Industries 1996–1998”, Tallinn: ESO, 2000; author’s calculations.

Annex 2 continued

ISIC code	Branch	Value added/ amortisation			Net sales/ tangible fixed assets			Value added/ tangible fixed assets		
		1996	**1997**	**1998**	**1996**	**1997**	**1998**	**1996**	**1997**	**1998**
15–16	Food products, beverages	0.48	0.60	0.72	0.45	0.49	0.52	0.45	0.54	0.60
17	Textiles	0.72	1.33	1.24	1.92	0.88	1.02	0.76	0.47	0.53
18	Wearing apparel, dressing	1.36	1.51	1.58	1.21	1.50	1.19	1.56	1.87	1.56
19	Leather and products	0.27	0.30	0.30	0.40	0.45	0.65	0.29	0.31	0.38
20	Wood and products	0.54	0.56	0.85	0.41	0.62	0.67	0.31	0.55	0.64
21	Paper and products	0.40	0.90	0.63	0.43	0.41	0.49	0.47	0.40	0.49
22	Publishing, printing	1.06	0.83	0.75	1.49	3.35	4.09	1.76	2.41	2.27
25	Rubber and plastics	0.95	1.11	1.00	0.41	0.78	0.57	0.65	0.85	0.76
26	Construction industry	0.27	0.43	0.43	0.25	0.28	0.43	0.24	0.32	0.52
27–28	Metals and products	0.58	0.56	0.80	0.29	0.42	0.63	0.30	0.54	0.94
36	Furniture	0.60	0.35	0.85	0.92	0.63	0.84	0.83	0.47	0.90
37	Others	1.23	2.03	1.52	3.36	0.82	1.47	2.99	0.55	1.33
	Low-technology	**0.48**	**0.61**	**0.73**	**0.48**	**0.57**	**0.63**	**0.40**	**0.55**	**0.64**
23–24	Chemicals, coke, petroleum	0.84	1.09	0.58	0.37	0.76	0.37	0.46	0.91	0.42
29	Machinery and equipment	0.92	0.54	0.56	1.01	1.26	2.01	1.03	1.27	2.12
30–33	Office, electrical and optical machinery	0.70	0.59	0.80	0.93	0.78	0.66	0.60	0.80	0.90

ISIC code	Branch	Value added/ amortisation			Net sales/ tangible fixed assets			Value added/ tangible fixed assets		
		1996	**1997**	**1998**	**1996**	**1997**	**1998**	**1996**	**1997**	**1998**
34–35	Transport equipment	0.54	0.38	0.69	0.35	0.49	0.62	0.41	0.54	0.76
	High-technology	**0.71**	**0.64**	**0.57**	**0.55**	**0.75**	**0.64**	**0.47**	**0.69**	**0.61**
D	**Total**	**0.53**	**0.63**	**0.70**	**0.49**	**0.60**	**0.63**	**0.42**	**0.58**	**0.63**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

Annex 3

The productivity of labour and capital in the Estonian manufacturing industry by selected indicators and by branches in 1996–1998 (change in FIE/DE comparison index)

ISIC code	Branch	Net sales/ labour costs	Value added/ labour costs	Net sales/ amorti-sation	Value added/ amorti-sation	Net sales/ fixed assets	Value added/ fixed assets
15–16	Food products, beverages	1.02	1.17	1.31	1.50	1.15	1.32
17	Textiles	0.86	1.15	1.30	1.73	0.53	0.71
18	Wearing apparel, dressing	0.92	0.94	1.14	1.16	0.98	1.00
19	Leather and products	0.89	0.71	1.40	1.12	1.62	1.29
20	Wood and products	1.02	1.32	1.22	1.57	1.60	2.07
21	Paper and products	0.92	0.82	1.76	1.59	1.14	1.02
22	Publishing, printing	1.04	0.49	1.51	0.71	2.75	1.29
25	Rubber and plastics	1.38	1.16	1.25	1.05	1.38	1.16
26	Construction industry	1.02	1.29	1.25	1.57	1.73	2.18
27–28	Metals and products	0.76	1.09	0.96	1.38	2.18	3.12
36	Furniture	0.79	0.93	1.19	1.42	0.91	1.08
37	Others	2.32	2.37	1.21	1.24	0.44	0.45
	Low-technology	**0.92**	**1.11**	**1.26**	**1.52**	**1.32**	**1.59**

ISIC code	Branch	Net sales/ labour costs	Value added/ labour costs	Net sales/ amorti-sation	Value added/ amorti-sation	Net sales/ fixed assets	Value added/ fixed assets
23–24	Chemicals, coke, petroleum	0.88	0.81	0.75	0.69	1.00	0.92
29	Machinery and equipment	0.89	0.93	0.59	0.61	1.98	2.07
30–33	Office, electrical and optical machinery	0.36	0.76	0.54	1.14	0.71	1.50
34–35	Transport equipment	1.09	1.13	1.24	1.28	1.78	1.84
	High-technology	**0.69**	**0.77**	**0.71**	**0.80**	**1.16**	**1.30**
D	**Total**	**0.85**	**1.00**	**1.11**	**1.31**	**1.27**	**1.50**

Source: Database “Estonian Manufacturing Industries 1996–1998”, Tallinn: ESO, 2000; author’s calculations.

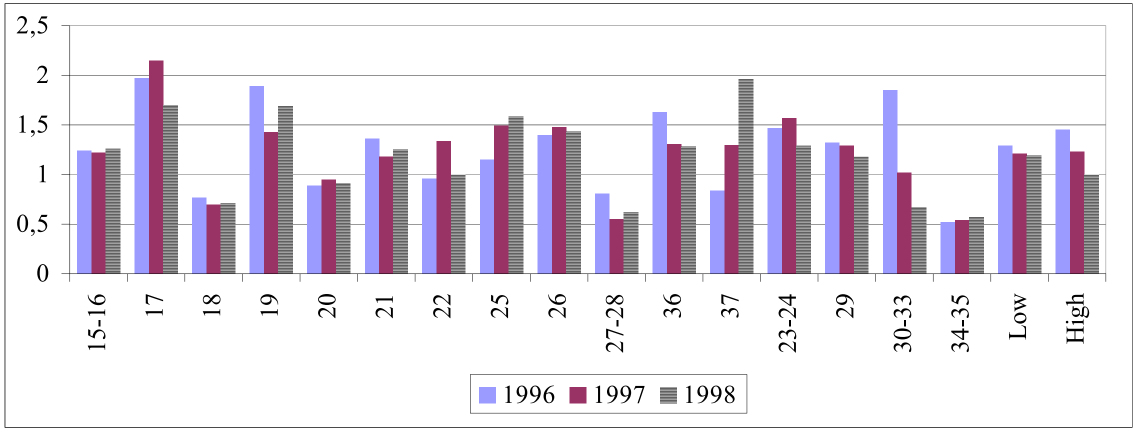

Figure 1. Net sales/employment in the Estonian manufacturing industry in 1996–1998, the FIE/DE comparison index.

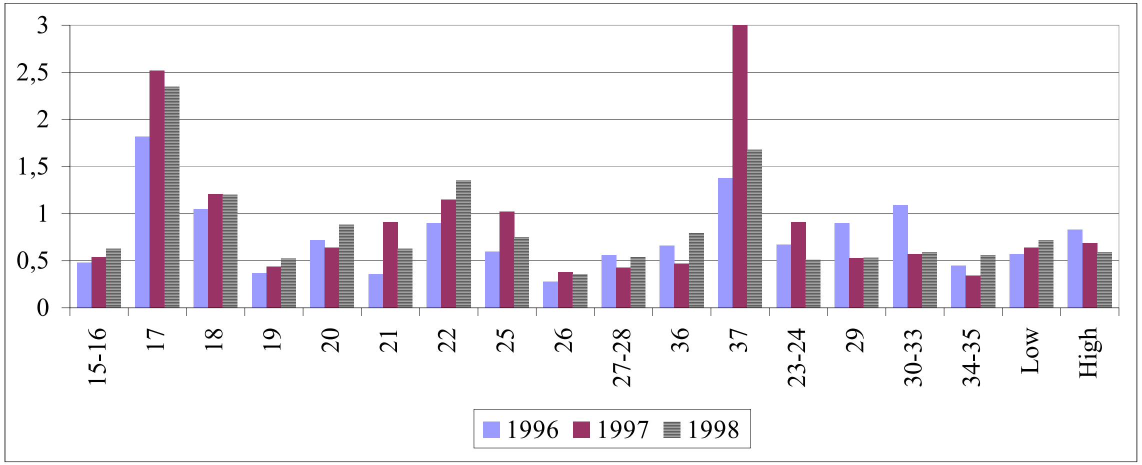

Figure 2. Net sales/amortisation in the Estonian manufacturing industry in 1996–1998, the FIE/DE comparison index.

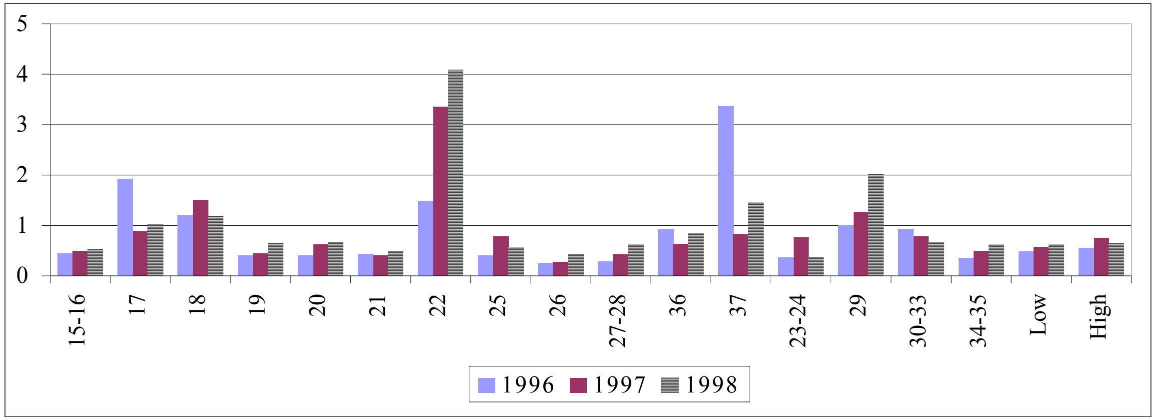

Figure 3. Net sales/tangible assets in the Estonian manufacturing industry in 1996–1998, the FIE/DE comparison index.

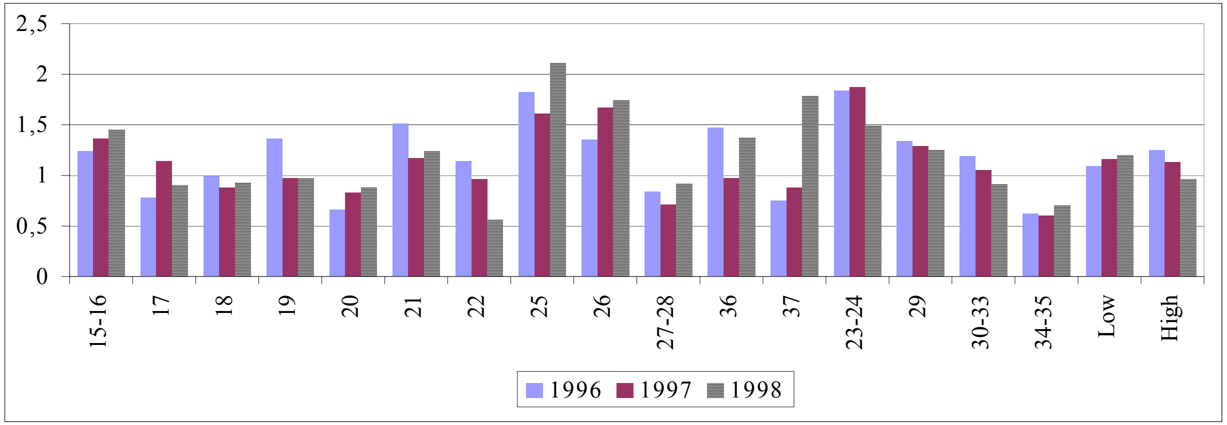

Figure 1. Value added/labour costs in the Estonian manufacturing industry in 1996–1998, the FIE/DE comparison index.

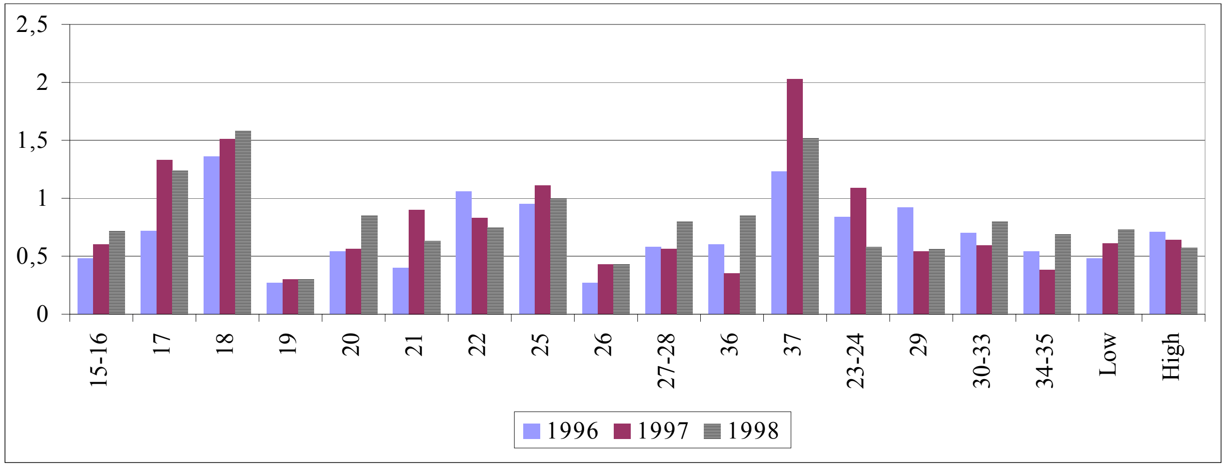

Figure 2. Value added/amortisation in the Estonian manufacturing industry in 1996–1998, the FIE/DE comparison index.

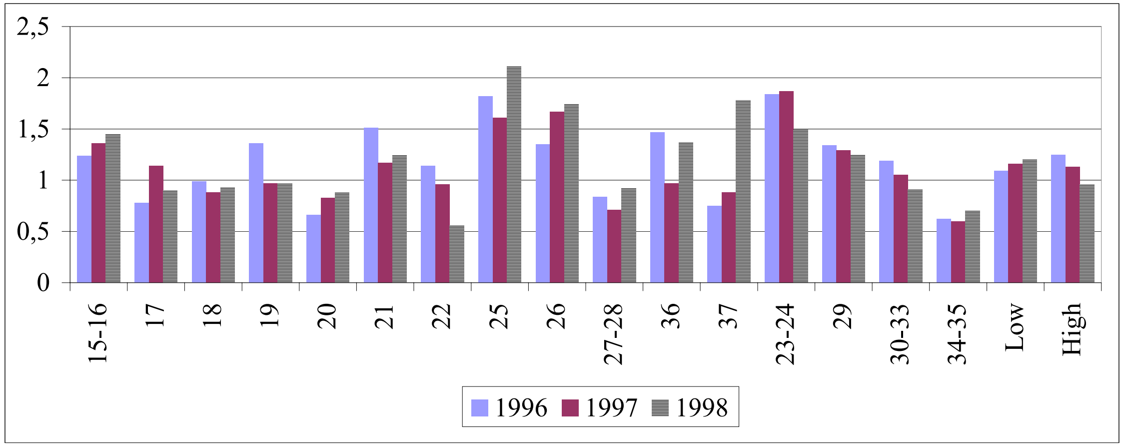

Figure 3. Value added/tangible assets in the Estonian manufacturing industry in 1996–1998, the FIE/DE comparison index.

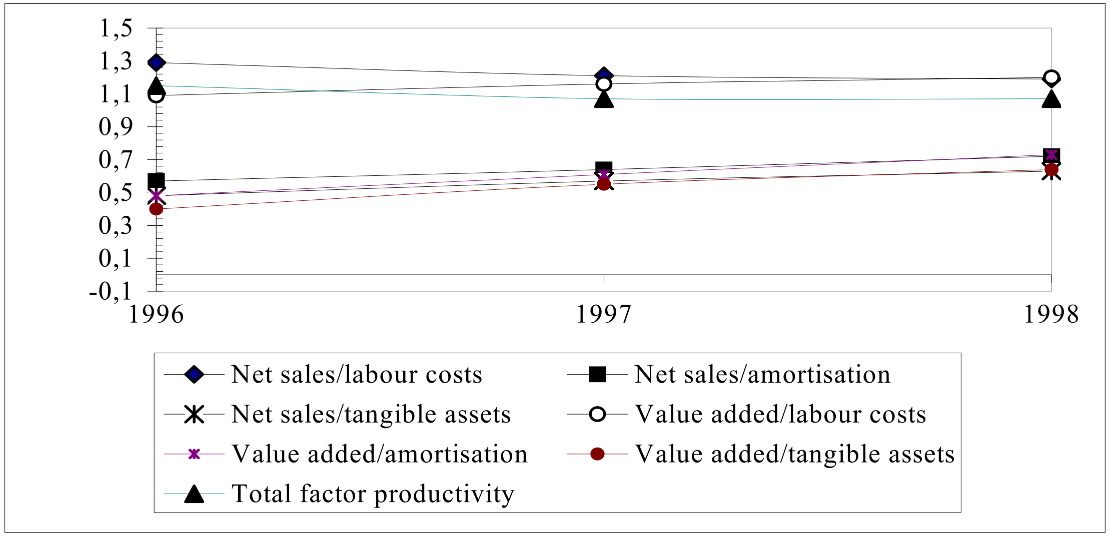

Figure 1. Productivity in the low-technology sector of the Estonian manufacturing industry, 1996–1998, FIE/DE comparison index.

Annex 6 continued

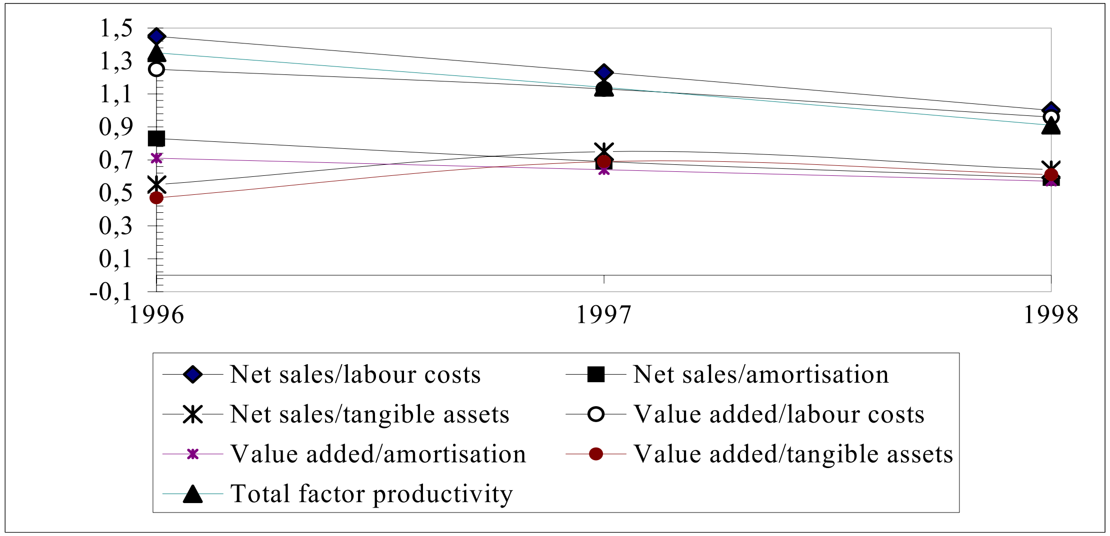

Figure 2. Productivity in the high-technology sector of the Estonian manufacturing industry, 1996–1998, FIE/DE comparison index.

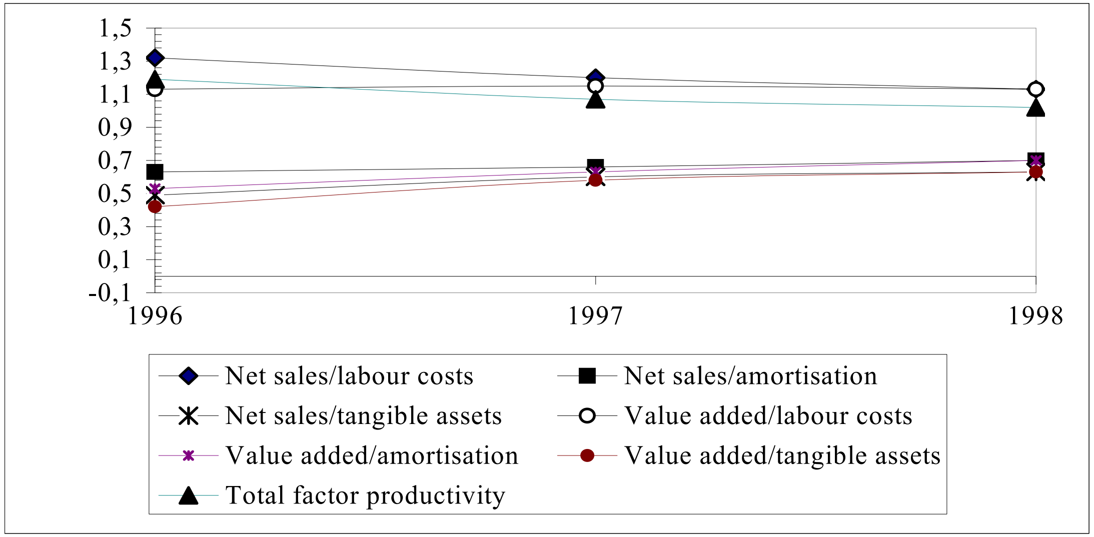

Figure 3. Productivity in the total Estonian manufacturing industry, 1996–1998, FIE/DE comparison index.

Total factor productivity in the Estonian manufacturing industry based on net sales by branches in 1996–1998

ISIC code	Branch	Multiplier 1996, change index				FIE/DE comparison index 98/96			Change in FIE/DE index 98/96
		FIE		DE					
		1996	98/96	1996	98/96	1996	1997	1998	98/96
15–16	Food products, beverages	6.01	1.15	6.08	1.08	0.99	1.00	1.06	1.07
17	Textiles	6.60	1.13	3.38	1.24	1.95	2.18	1.77	0.91
18	Wearing apparel, dressing	1.97	1.01	2.49	1.09	0.79	0.73	0.73	0.93
19	Leather and products	3.80	1.08	2.61	1.10	1.46	1.22	1.43	0.99
20	Wood and products	3.61	1.30	4.29	1.22	0.84	0.86	0.90	1.07
21	Paper and products	4.15	1.35	4.13	1.24	1.01	1.12	1.10	1.09
22	Publishing, printing	3.51	1.05	3.68	0.95	0.96	1.30	1.06	1.10
25	Rubber and plastics	6.35	1.03	6.46	0.78	0.98	1.35	1.30	1.32
26	Construction industry	3.25	1.26	3.50	1.19	0.93	0.99	0.98	1.06
27–28	Metals and products	3.29	1.02	4.23	1.30	0.78	0.53	0.61	0.78
36	Furniture	5.14	0.93	3.65	1.10	1.41	1.09	1.19	0.84

ISIC code	Branch	Multiplier 1996, change index				FIE/DE comparison index 98/96			Change in FIE/DE index 98/96
		FIE		DE		1996	1997	1998	98/96
		1996	98/96	1996	98/96				
37	Others	3.24	2.44	3.69	1.11	0.88	1.40	1.92	2.19
	Low-technology	**5.37**	**0.99**	**4.67**	**1.06**	**1.15**	**1.07**	**1.07**	**0.93**
23–24	Chemicals, coke, petroleum	7.96	0.85	6.08	0.12	1.31	1.42	1.00	0.76
29	Machinery and equipment	3.54	0.98	2.79	1.17	1.27	1.15	1.06	0.83
30–33	Office, electrical and optical machinery	5.15	0.67	2.98	1.76	1.73	0.96	0.66	0.38
34–35	Transport equipment	2.10	1.10	4.11	0.99	0.51	0.51	0.57	1.11
	High-technology	**5.61**	**0.78**	**4.17**	**1.15**	**1.35**	**1.14**	**0.91**	**0.68**
D	**Total**	**5.43**	**0.93**	**4.55**	**1.08**	**1.19**	**1.07**	**1.02**	**0.86**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

Annex 8

General indicators of the Estonian manufacturing industry by branches, 1996–1998 (change index 98/96)

ISIC code	Branch	Number of enterprises			Number of employment			Net sales			Amortisation		
		FIE	DE	Total	FIE	DE	Total	FIE	DE	Total	FIE	DE	Total
15–16	Food products, beverages	1.18	1.41	1.39	0.92	1.03	1.02	1.33	1.52	1.48	1.15	1.73	1.52
17	Textiles	0.94	1.10	1.07	0.96	1.08	1.01	1.27	1.94	1.42	1.08	2.12	1.43
18	Wearing apparel, dressing	1.00	1.10	1.09	1.03	0.96	0.97	1.30	1.41	1.40	1.02	1.27	1.24
19	Leather and products	1.22	1.00	1.03	1.15	0.88	0.94	1.44	1.33	1.38	1.01	1.31	1.11
20	Wood and products	0.85	1.18	1.15	1.32	1.08	1.10	2.74	1.81	1.92	1.92	1.56	1.61
21	Paper and products	1.00	0.76	0.81	1.17	0.76	0.98	2.12	1.03	1.71	1.06	0.91	1.04
22	Publishing, printing	1.04	1.15	1.14	2.23	0.98	1.06	3.10	1.39	1.56	3.35	2.26	2.38
25	Rubber and plastics	1.11	1.10	1.10	1.11	1.29	1.26	1.47	1.60	1.56	1.63	2.21	1.98
26	Construction industry	1.05	1.03	1.03	1.09	0.83	0.91	2.04	1.54	1.81	1.60	1.51	1.59

ISIC code	Branch	Number of enterprises			Number of employment			Net sales			Amortisation		
		FIE	DE	Total	FIE	DE	Total	FIE	DE	Total	FIE	DE	Total
27–28	Metals and products	1.40	1.32	1.33	2.39	0.99	1.08	3.43	1.76	1.86	3.78	1.87	2.06
36	Furniture	1.27	1.41	1.40	1.46	1.12	1.16	1.78	1.57	1.61	1.61	1.69	1.67
37	Others	0.67	0.87	0.86	1.41	0.82	0.83	6.41	1.30	1.47	5.26	1.29	1.39
	Low-technology	**1.05**	**1.18**	**1.17**	**1.12**	**1.01**	**1.03**	**1.62**	**1.57**	**1.58**	**2.13**	**2.61**	**2.43**
23–24	Chemicals, coke, petroleum	1.33	0.93	0.99	1.24	0.63	0.72	1.26	0.93	1.05	2.76	1.53	2.10
29	Machinery and equipm.	0.95	0.78	0.79	1.05	0.93	0.94	1.61	1.28	1.34	2.43	1.13	1.37
30–33	Office, electrical and optical machinery	0.97	0.83	0.85	2.00	0.73	1.07	1.57	2.32	1.93	1.89	1.50	1.70
34–35	Transport equipment	1.17	1.12	1.12	1.08	0.86	0.89	1.62	1.27	1.31	1.79	1.73	1.74
	High-technology	**1.04**	**0.86**	**0.88**	**1.52**	**0.77**	**0.90**	**1.41**	**1.27**	**1.31**	**2.31**	**1.49**	**1.80**
D	**Total**	**1.05**	**1.12**	**1.11**	**1.20**	**0.96**	**1.00**	**1.56**	**1.50**	**1.52**	**2.17**	**2.33**	**2.27**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

Annex 9

Growth in tangible fixed assets in the Estonian manufacturing industry, 1996–1998

ISIC code	Branch	1996				1997			
		Growth, m EEK		Only new, share, %		Growth, m EEK		Only new, share, %	
		FIE	DE	FIE	DE	FIE	DE	FIE	DE
15–16	Food products, beverages	174.5	639.4	75.6	56.1	238.0	801.2	76.0	58.8
17	Textiles	86.5	94.7	94.0	11.1	180.4	54.2	89.3	40.4
18	Wearing apparel, dressing	8.1	88.4	30.1	53.8	8.4	97.6	59.3	59.7
19	Leather and products	11.8	11.7	36.2	44.6	13.0	15.0	44.7	64.0
20	Wood and products	189.2	217.1	44.3	49.4	148.8	588.9	63.9	53.6
21	Paper and products	22.5	55.7	83.5	30.9	58.9	17.8	38.9	60.7
22	Publishing, printing	9.9	127.5	50.7	81.6	14.8	382.4	82.1	74.0
25	Rubber and plastics	95.6	47.6	2.0	29.6	12.9	66.3	76.0	51.2
26	Construction industry	432.9	56.2	63.6	39.1	303.	81.8	64.0	52.3
27–28	Metals and products	21.2	127.3	46.3	53.7	43.0	239.1	44.9	71.2
36	Furniture	36.5	120.5	49.3	41.2	59.0	228.9	81.6	30.5
37	Others	0.5	20.9	66.4	37.0	14.0	22.3	16.4	48.6
	Low-technology	**1089.1**	**1606.8**	**58.1**	**50.6**	**1096.0**	**2595.6**	**69.1**	**57.7**

ISIC code	Branch	1996				1997			
		Growth, m EEK		**Only new, share, %**		**Growth, m EEK**		**Only new, share, %**	
		FIE	**DE**	**FIE**	**DE**	**FIE**	**DE**	**FIE**	**DE**
23–24	Chemicals, coke, petroleum	82.6	228.4	56.4	50.1	106.5	601.4	48.8	76.8
29	Machinery and equipment	0.0	68.9	0.0	34.5	23.8	90.3	36.5	54.3
30–33	Office, electrical and optical machinery	157.1	76.8	75.0	43.0	114.9	146.0	68.3	64.3
34–35	Transport equipment	65.9	194.9	93.9	73.9	16.0	238.5	90.0	36.4
	High-technology	**305.7**	**569.0**	**74.0**	**55.4**	**261.2**	**1076.1**	**58.8**	**64.3**
D	**Total**	**1394.8**	**2175.8**	**61.6**	**51.8**	**1357.7**	**3671.7**	**67.1**	**59.6**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

Annex 9 continued

Growth in tangible fixed assets in the Estonian manufacturing industry, 1996–1998

ISIC code	Branch	1998			
		Growth, m EEK		Only new, share, %	
		FIE	DE	FIE	DE
15–16	Food products, beverages	445.8	1116.9	93.9	72.0
17	Textiles	354.1	135.2	98.2	40.5
18	Wearing apparel, dressing	13.8	117.2	86.1	56.7
19	Leather and products	10.5	21.1	73.6	57.6
20	Wood and products	366.1	920.2	96.6	86.4
21	Paper and products	113.7	14.8	41.1	69.6
22	Publishing, printing	24.4	374.4	96.7	93.1
25	Rubber and plastics	17.5	91.7	82.9	75.7
26	Construction industry	248.5	125.0	64.9	61.1
27–28	Metals and products	25.3	246.6	64.1	60.5
36	Furniture	74.3	259.8	81.7	60.6
37	Others	8.4	32.7	94.7	38.1
	Low-technology	**1702.4**	**3455.5**	**86.4**	**74.0**

ISIC code	Branch	1998			
		Growth, m EEK		Only new, share, %	
		FIE	DE	FIE	DE
23–24	Chemicals, coke, petroleum	181.6	100.4	93.9	57.8
29	Machinery and equipment	10.8	164.1	70.0	48.5
30–33	Office, electrical and optical machinery	130.0	126.5	97.6	48.0
34–35	Transport equipment	55.3	411.9	94.7	74.4
	High-technology	**377.8**	**802.8**	**94.6**	**62.9**
D	**Total**	**2080.1**	**4258.3**	**87.9**	**71.9**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

Growth in machinery and equipment in the Estonian manufacturing industry, 1996–1998

ISIC code	Branch	1996				1997			
		Growth, m EEK		Only new, share, %		Growth, m EEK		Only new, share, %	
		FIE	DE	FIE	DE	FIE	DE	FIE	DE
15–16	Food products, beverages	95.8	320.0	88.6	71.0	117.1	384.2	86.1	72.6
17	Textiles	64.5	8.0	98.9	46.9	58.0	22.0	99.0	47.4
18	Wearing apparel, dressing	2.8	27.6	80.0	81.5	6.4	48.9	50.1	77.7
19	Leather and products	4.6	6.1	6.0	64.9	3.2	9.3	70.8	75.0
20	Wood and products	102.9	120.4	35.4	60.1	81.9	249.4	47.7	49.1
21	Paper and products	9.5	28.9	93.6	50.1	24.9	11.5	47.1	84.7
22	Publishing, printing	5.8	57.0	65.0	73.4	6.1	293.0	99.9	77.5
25	Rubber and plastics	18.3	27.2	7.3	35.5	6.5	36.0	99.7	63.1
26	Construction industry	257.4	24.5	52.7	62.3	178.5	48.4	61.7	64.1
27–28	Metals and products	4.0	63.3	28.3	61.4	33.2	95.7	48.6	76.2
36	Furniture	22.2	63.6	50.6	50.5	36.6	169.8	92.3	25.1
37	Others	0.3	15.0	99.9	33.4	2.6	12.3	57.6	56.5
	Low-technology	**588.1**	**761.7**	**59.5**	**63.9**	**555.2**	**1380.6**	**70.0**	**63.0**

ISIC code	Branch	1996				1997			
		Growth, m EEK		**Only new, share, %**		**Growth, m EEK**		**Only new, share, %**	
		FIE	**DE**	**FIE**	**DE**	**FIE**	**DE**	**FIE**	**DE**
23–24	Chemicals, coke, petroleum	44.0	66.6	50.5	63.7	54.2	199.	59.5	70.6
29	Machinery and equipment	0.0	16.7	0.0	78.5	14.7	34.2	31.6	58.6
30–33	Office, electrical and optical machinery	26.4	36.6	60.4	69.5	26.0	42.2	88.5	62.1
34–35	Transport equipment	26.4	49.0	94.9	87.8	10.4	70.5	94.7	65.7
	High-technology	**96.7**	**169.0**	**65.3**	**73.4**	**105.1**	**346.7**	**66.2**	**67.4**
D	**Total**	**684.8**	**930.7**	**60.3**	**65.7**	**660.3**	**1727.3**	**69.4**	**63.9**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

Growth in machinery and equipment in the Estonian manufacturing industry, 1996–1998

ISIC code	Branch	1998			
		Growth, m EEK		Only new, share, %	
		FIE	DE	FIE	DE
15–16	Food products, beverages	295.7	427.4	97.6	77.3
17	Textiles	164.7	107.9	97.9	36.0
18	Wearing apparel, dressing	5.4	49.3	67.0	74.6
19	Leather and products	5.4	12.4	53.6	86.7
20	Wood and products	121.2	565.3	93.7	87.9
21	Paper and products	83.5	11.3	38.9	81.7
22	Publishing, printing	13.6	287.2	98.6	93.7
25	Rubber and plastics	8.3	65.5	69.5	86.8
26	Construction industry	111.9	66.1	60.1	66.0
27–28	Metals and products	16.0	126.0	78.9	70.2
36	Furniture	31.0	121.8	75.5	64.5
37	Others	8.1	10.9	97.9	73.7
	Low-technology	**864.6**	**1851.2**	**84.7**	**79.3**

ISIC code	Branch	1998			
		Growth, m EEK		Only new, share, %	
		FIE	DE	FIE	DE
23–24	Chemicals, coke, petroleum	90.4	38.2	93.5	51.7
29	Machinery and equipment	6.1	94.6	77.4	34.4
30–33	Office, electrical and optical machinery	528	42.6	96.2	70.9
34–35	Transport equipment	15.2	97.7	89.2	87.1
	High-technology	**164.5**	**273.0**	**93.4**	**61.4**
D	**Total**	**1029.1**	**2124.1**	**86.1**	**77.0**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

Growth in constructions and buildings in the Estonian manufacturing industry, 1996–1998

ISIC code	Branch	1996				1997			
		Growth, m EEK		Only new, share, %		Growth, m EEK		Only new, share, %	
		FIE	DE	FIE	DE	FIE	DE	FIE	DE
15–16	Food products, beverages	20.1	160.7	69.1	40.1	47.0	201.5	53.2	42.1
17	Textiles	8.7	78.1	95.7	0.8	29.6	27.2	97.2	31.4
18	Wearing apparel, dressing	5.1	49.2	2.1	37.5	0.7	26.2	75.8	20.9
19	Leather and products	2.1	3.6	19.2	8.1	3.6	2.2	0.0	70.7
20	Wood and products	52.9	61.8	51.5	34.1	27.6	140.4	73.2	38.0
21	Paper and products	0.8	7.6	99.9	28.1	5.5	2.0	51.7	11.1
22	Publishing, printing	0.4	40.0	99.9	90.4	1.4	35.5	0.0	19.7
25	Rubber and plastics	74.8	5.8	0.0	51.4	3.4	18.5	49.5	21.5
26	Construction industry	101.0	13.0	69.9	7.3	56.3	17.0	56.8	14.8
27–28	Metals and products	10.3	37.8	25.2	33.4	7.3	102.7	12.4	72.1
36	Furniture	9.7	34.1	50.0	17.8	21.4	33.3	64.0	47.7

ISIC code	Branch	1996				1997			
		Growth, m EEK		Only new, share, %		Growth, m EEK		Only new, share, %	
		FIE	DE	FIE	DE	FIE	DE	FIE	DE
37	Others	0.2	3.5	0.0	45.1	10.4	4.6	0.0	22.6
	Low-technology	**286.0**	**495.1**	**45.2**	**33.8**	**214.0**	**611.1**	**58.7**	**42.3**
23–24	Chemicals, coke, petroleum	21.0	71.6	39.0	90.3	31.7	110.4	41.9	47.6
29	Machinery and equipment	0.00	48.3	0.0	18.9	5.6	35.9	29.7	29.5
30–33	Office, electrical and optical machinery	470.6	14.1	75.0	23.2	60.1	36.2	47.2	17.4
34–35	Transport equipment	34.0	54.8	99.9	26.1	3.6	59.2	73.5	9.4
	High-technology	**102.6**	**188.7**	**75.9**	**48.4**	**101.0**	**241.6**	**45.5**	**31.0**
D	**Total**	**388.5**	**683.7**	**53.3**	**37.8**	**315.0**	**852.7**	**54.5**	**39.1**

Source: Database “Estonian Manufacturing Industries 1996–1998”, Tallinn: ESO, 2000; author’s calculations.

Annex 11 continued

Growth in constructions and buildings in the Estonian manufacturing industry, 1996–1998

ISIC code	Branch	1998			
		Growth, m EEK		Only new, share, %	
		FIE	DE	FIE	DE
15–16	Food products, beverages	66.1	212.8	83.7	39.7
17	Textiles	32.9	15.2	98.7	68.2
18	Wearing apparel, dressing	5.2	43.4	98.8	27.2
19	Leather and products	0.2	5.3	0.0	4.6
20	Wood and products	90.0	215.8	96.1	81.8
21	Paper and products	10.9	2.7	76.9	14.7
22	Publishing, printing	1.1	47.6	42.7	89.0
25	Rubber and plastics	5.3	13.1	95.5	57.5
26	Construction industry	70.5	44.5	54.2	58.5
27–28	Metals and products	6.6	74.5	25.5	35.3
36	Furniture	38.3	71.3	88.0	40.6
37	Others	0.1	14.6	0.0	18.4
	Low-technology	**327.2**	**761.0**	**81.6**	**54.9**
23–24	Chemicals, coke, petroleum	41.2	27.8	93.4	29.6

ISIC code	Branch	1998			
		Growth, m EEK		**Only new, share, %**	
		FIE	**DE**	**FIE**	**DE**
29	Machinery and equipment	3.8	40.0	53.6	55.7
30–33	Office, electrical and optical machinery	22.6	69.0	98.9	35.2
34–35	Transport equipment	24.8	106.3	98.7	26.2
	High-technology	**92.4**	**239.0**	**94.5**	**33.6**
D	**Total**	**419.6**	**1000.0**	**84.4**	**49.8**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

Annex 12

The structure of new tangible fixed assets in the Estonian manufacturing industry by branches, 1996–1998

ISIC code	Branch	New machinery and equipment						New constructions and buildings					
		1996		1997		1998		1996		1997		1998	
		FIE	DE	FIE	DE	FIE	DE	FIE	DE	FIE	DE	FIE	DE
15–16	Food products, beverages	64.4	63.3	55.7	59.2	69.0	41.1	10.5	18.0	13.8	18.0	10.5	13.2
17	Textiles	78.4	35.9	35.7	47.7	46.4	70.8	10.2	6.0	17.9	39.0	18.9	9.3
18	Wearing apparel, dressing	93.1	47.3	64.2	65.2	30.3	55.4	4.4	38.8	10.2	9.4	17.8	43.0
19	Leather and products	6.4	76.3	39.3	72.4	37.7	88.4	9.4	5.5	0.0	16.2	2.0	0.0
20	Wood and products	43.5	67.5	41.1	38.8	32.1	62.5	32.5	19.6	21.2	16.9	22.2	24.5
21	Paper and products	47.4	84.1	51.2	90.4	69.4	89.5	4.2	12.4	12.4	2.0	3.9	17.9
22	Publishing, printing	75.7	40.2	49.7	80.3	57.1	77.2	8.1	34.7	0.0	2.5	12.1	2.0
25	Rubber and plastics	69.7	68.7	65.8	66.8	39.6	81.9	0.0	21.1	17.2	11.7	10.8	35.0
26	Construction industry	49.3	69.5	56.7	72.5	41.7	57.1	25.6	4.3	16.4	5.9	34.2	23.7

ISIC code	Branch	New machinery and equipment						New constructions and buildings					
		1996		1997		1998		1996		1997		1998	
		FIE	DE	FIE	DE	FIE	DE	FIE	DE	FIE	DE	FIE	DE
27–28	Metals and products	11.5	56.9	82.1	42.8	77.2	59.3	26.5	18.5	4.6	43.5	17.6	10.4
36	Furniture	62.4	64.7	69.4	61.0	38.4	49.9	27.0	12.2	28.1	22.7	18.4	55.4
37	Others	97.6	64.7	65.4	64.3	99.7	64.6	0.0	20.6	0.0	9.7	21.6	0.0
	Low-technology	**55.3**	**60.0**	**51.3**	**58.1**	**49.8**	**57.4**	**20.4**	**20.6**	**16.6**	**17.3**	**18.1**	**16.3**
23–24	Chemicals, coke, petroleum	47.6	37.1	62.0	30.5	49.6	34.0	17.5	56.6	25.5	11.4	14.2	22.6
29	Machinery and equipment	0.0	55.2	53.4	40.9	62.2	40.9	0.0	38.3	19.0	21.6	25.2	27.1
30–33	Office, electrical and optical machinery	13.5	77.2	29.2	28.0	40.0	49.7	30.3	9.9	36.2	6.7	39.9	17.6
34–35	Transport equipment	40.4	29.9	68.1	53.3	26.0	27.8	54.9	9.9	18.2	6.4	9.1	46.7
	High-technology	**27.9**	**39.4**	**45.3**	**33.8**	**43.0**	**33.2**	**34.4**	**29.0**	**29.9**	**10.8**	**24.4**	**15.9**
D	**Total**	**48.1**	**54.2**	**50.3**	**50.4**	**48.5**	**53.4**	**24.1**	**22.9**	**18.8**	**15.2**	**19.4**	**16.3**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

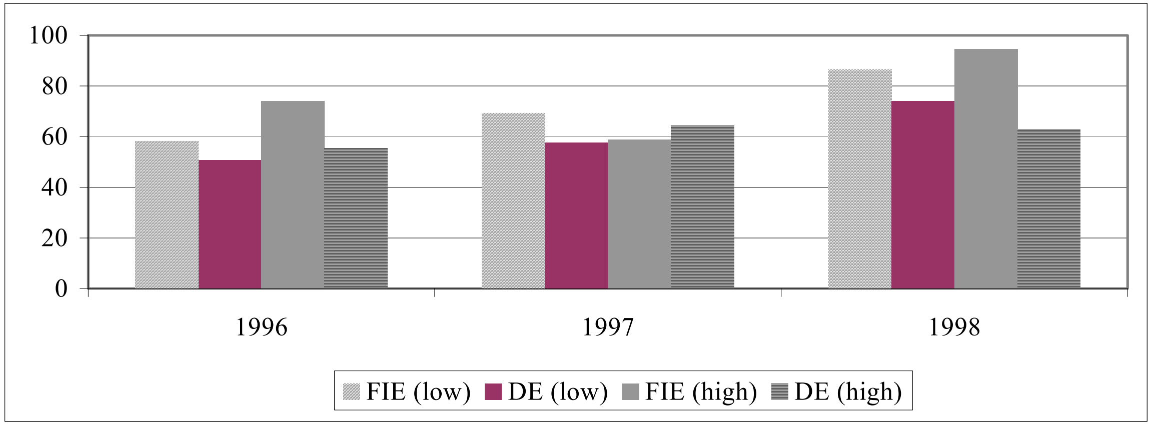

Figure 1. The share of new tangible assets in the total growth of tangible assets in the Estonian manufacturing industry, 1996–1998 (%).

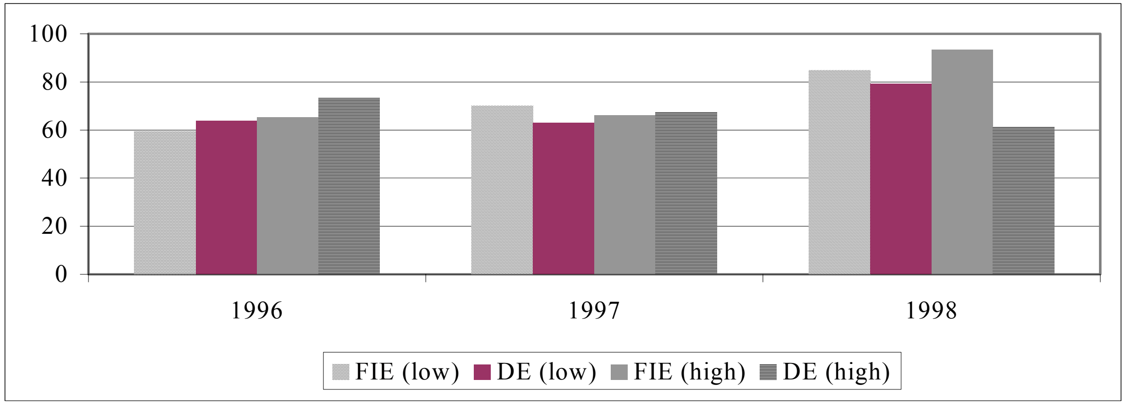

Figure 2. The share of new machinery and equipment in the total growth of machinery and equipment in the Estonian manufacturing industry, 1996–1998 (%).

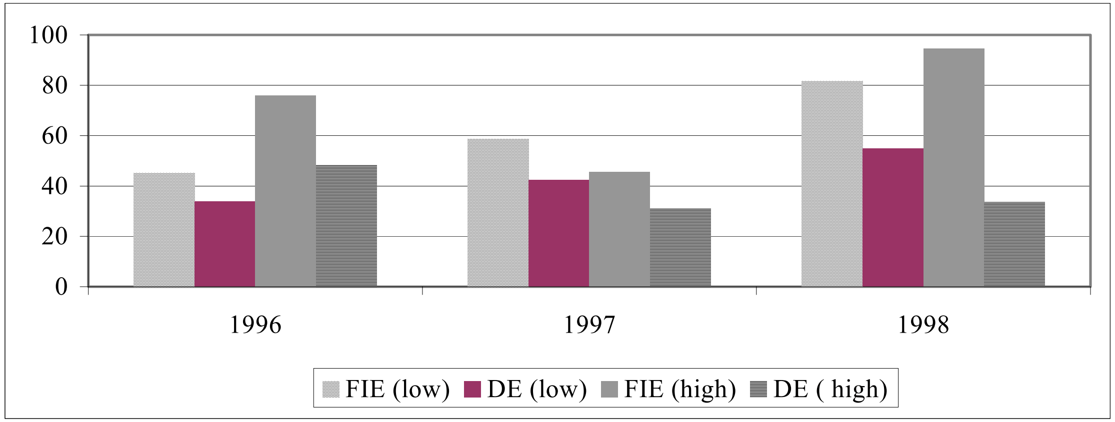

Figure 3. The share of new constructions and buildings in the total growth of constructions and buildings in the Estonian manufacturing industry, 1996–1998 (%).

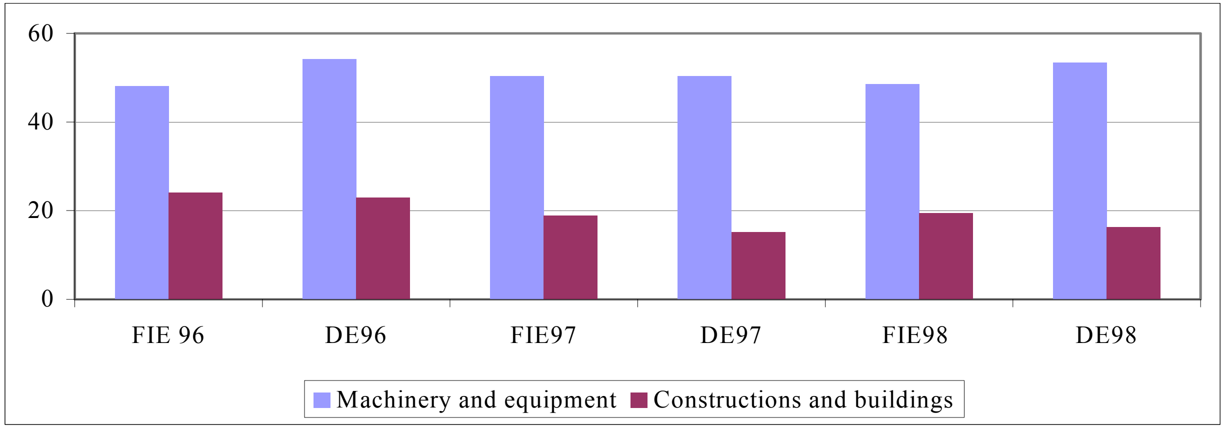

Figure 1. The structure of new tangible assets in the total Estonian manufacturing industry in 1996–1998, (%).

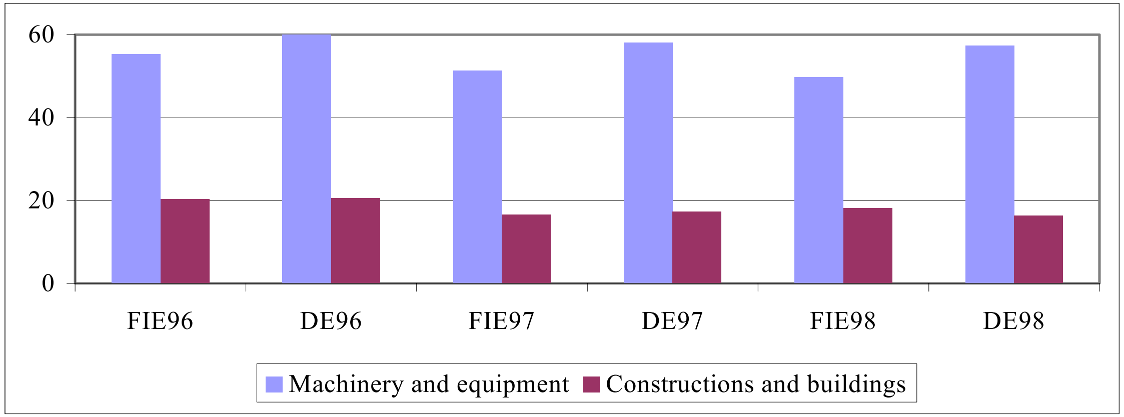

Figure 2. The structure of new tangible assets in the low-technology sector of the Estonian manufacturing industry in 1996–1998, (%).

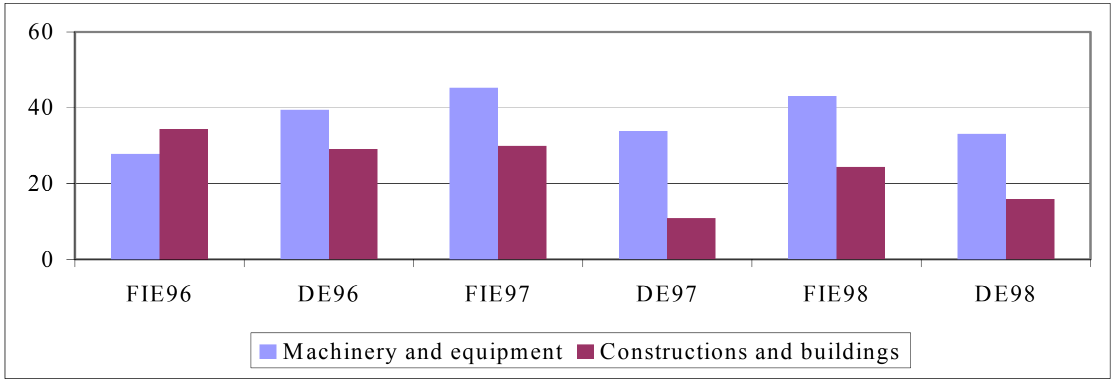

Figure 3. The structure of new tangible assets in the high-technology sector of the Estonian manufacturing industry in 1996–1998, (%).

Annex 15

Capital intensity in the Estonian manufacturing industry by selected indicators and by branches in 1996–1998

ISIC code	Branch	Tangible assets/employment, m EEK 1996, change index 98/96				Intangible assets/employment, m EEK 1996, change index 98/96			
		VE		KE		VE		KE	
		1996	98/96	1996	98/96	1996	98/96	1996	98/96
15–16	Food products, beverages	347	1.37	74	1.61	1.7	0.5	0.4	3.44
17	Textiles	56	1.78	42	1.27	0.8	4.2	1.7	0.40
18	Wearing apparel, dressing	15	0.98	24	1.13	0.5	0.5	0.3	1.14
19	Leather and products	116	0.84	17	1.63	25.0	0.6	0.1	8.54
20	Wood and products	228	1.44	79	1.88	0.6	0.9	1.0	0.38
21	Paper and products	317	1.20	97	1.03	27.9	1.0	1.2	0.03
22	Publishing, printing	59	1.09	52	3.06	0.9	3.2	1.6	5.97
25	Rubber and plastics	413	0.92	85	1.19	2.3	1.6	0.3	1.44
26	Construction industry	598	0.95	59	1.63	8.6	0.9	0.1	0.55
27–28	Metals and products	126	0.71	41	1.91	8.7	0.0	0.5	1.51
36	Furniture	122	1.03	61	1.08	4.4	0.1	0.1	3.00

ISIC code	Branch	Tangible assets/employment, m EEK 1996, change index 98/96				Intangible assets/employment, m EEK 1996, change index 98/96			
		VE		KE		VE		KE	
		1996	98/96	1996	98/96	1996	98/96	1996	98/96
37	Others	15	8.24	33	1.25	24.5	0.0	1.2	0.25
	Low-technology	**198**	**1.17**	**57**	**1.65**	**4.5**	**0.9**	**0.6**	**2.08**
23–24	Chemicals, coke, petroleum	613	1.06	71	1.54	62.7	0.7	0.3	1.61
29	Machinery and equipment	152	0.87	60	1.54	1.9	0.5	0.2	6.46
30–33	Office, electrical and optical machinery	112	0.76	34	2.20	0.8	0.6	0.2	1.67
34–35	Transport equipment	119	1.29	68	2.24	0.0	0.0	1.3	0.34
	High-technology	**256**	**0.87**	**59**	**1.80**	**17.9**	**0.6**	**0.4**	**1.41**
D	**Total**	**210**	**1.09**	**57**	**1.67**	**7.4**	**0.8**	**0.6**	**2.01**

Source: Database “Estonian Manufacturing Industries 1996–1998”, Tallinn: ESO, 2000; author’s calculations.

Capital intensity in the Estonian manufacturing industry by selected indicators and branches in 1996–1998
(FIE/DE comparison index)

ISIC code	Branch	Tangible assets/employment, m EEK 1996, change index 98/96				Intangible assets/employment, m EEK 1996, change index 98/96			
		FIEs		DEs		FIEs		DEs	
		1996	98/96	1996	98/96	1996	98/96	1996	98/96
15–16	Food products, beverages	347	1.37	74	1.61	1.7	0.5	0.4	3.44
17	Textiles	56	1.78	42	1.27	0.8	4.2	1.7	0.40
18	Wearing apparel, dressing	15	0.98	24	1.13	0.5	0.5	0.3	1.14
19	Leather and products	116	0.84	17	1.63	25.0	0.6	0.1	8.54
20	Wood and products	228	1.44	79	1.88	0.6	0.9	1.0	0.38
21	Paper and products	317	1.20	97	1.03	27.9	1.0	1.2	0.03
22	Publishing, printing	59	1.09	52	3.06	0.9	3.2	1.6	5.97
25	Rubber and plastics	413	0.92	85	1.19	2.3	1.6	0.3	1.44
26	Construction industry	598	0.95	59	1.63	8.6	0.9	0.1	0.55
27–28	Metals and products	126	0.71	41	1.91	8.7	0.0	0.5	1.51
36	Furniture	122	1.03	61	1.08	4.4	0.1	0.1	3.00

ISIC code	Branch	Tangible assets/employment, m EEK 1996, change index 98/96				Intangible assets/employment, m EEK 1996, change index 98/96			
		FIEs		DEs		FIEs		DEs	
		1996	98/96	1996	98/96	1996	98/96	1996	98/96
37	Others	15	8.24	33	1.25	24.5	0.0	1.2	0.25
	Low-technology	**198**	**1.17**	**57**	**1.65**	**4.5**	**0.9**	**0.6**	**2.08**
23–24	Chemicals, coke, petroleum	613	1.06	71	1.54	62.7	0.7	0.3	1.61
29	Machinery and equipment	152	0.87	60	1.54	1.9	0.5	0.2	6.46
30–33	Office, electrical and optical machinery	112	0.76	34	2.20	0.8	0.6	0.2	1.67
34–35	Transport equipment	119	1.29	68	2.24	0.0	0.0	1.3	0.34
	High-technology	**256**	**0.87**	**59**	**1.80**	**17.9**	**0.6**	**0.4**	**1.41**
D	**Total**	**210**	**1.09**	**57**	**1.67**	**7.4**	**0.8**	**0.6**	**2.01**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.

Annex 17

Capital intensity in the Estonian manufacturing industry by branches in 1996–1998
(change in the FIE/DE comparison index 98/96)

ISIC code	Branch	Tangible assets/employment	Intangible assets/employment
15–16	Food products, beverages	0.85	0.13
17	Textiles	1.40	10.50
18	Wearing apparel, dressing	0.87	0.40
19	Leather and products	0.51	0.07
20	Wood and products	0.77	2.42
21	Paper and products	1.17	29.09
22	Publishing, printing	0.36	0.53
25	Rubber and plastics	0.77	1.08
26	Construction industry	0.58	1.72
27–28	Metals and products	0.37	0.03
36	Furniture	0.96	0.03
37	Others	6.59	0.02
	Low-technology	**0.71**	**0.44**

ISIC code	Branch	Tangible assets/employment	Intangible assets/employment
23–24	Chemicals, coke, petroleum	0.69	0.44
29	Machinery and equipment	0.56	0.08
30–33	Office, electrical and optical machinery	0.35	0.39
34–35	Transport equipment	0.58	0.00
	High-technology	**0.49**	**0.41**
D	**Total**	**0.65**	**0.39**

Source: Database "Estonian Manufacturing Industries 1996–1998", Tallinn: ESO, 2000; author's calculations.