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## **Keskusteluaiheita - Discussion papers**

No. 569

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### **THE INHERITED AND EMERGING ABSORPTIVE CAPACITIES OF FIRMS**

- Results of a firms survey in the  
Estonian electronics industry

**Paasi, Marianne, THE INHERITED AND EMERGING ABSORPTIVE CAPACITIES OF FIRMS - Results of a firms survey in the Estonian electronics industry.** Helsinki: ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 1996, 26 p. (Keskustelualoitteita, Discussion Papers, ISSN 0781-6847; No. 569)

**ABSTRACT:** The diffusion of Western technologies into the transition countries requires adequate absorptive capacities. However, there is very few knowledge on the present state and dynamics of the absorptive capacities in the transition countries. Furthermore, the transition countries' specific problem is the lack of knowledge of the absorptive capacities in the firms, which after all plays the major role in a market economy diffusion process. This study modifies the concept of the absorptive capacities by Cohen/Levinthal for the transition period; the inherited absorptive capacities of the firms from the socialistic period are analytically separated from those emerging presently under the market economy conditions. Finally, the results of a firms survey measuring the absorptive capacities in the Estonian electronics industry are presented. The results of the questionnaire inform about the state and dynamics of the absorptive capacities in the Estonian firms, which is required for the evaluation of the growth prospects and for targeting the economic policy.

**KEYWORDS:** Absorptive capacities of firms, national innovation system, international diffusion, Estonia, electronics industry, transition countries.

**Paasi, Marianne, YRITYSTEN PERITYT JA UUDET ABSORPTIIVISET KYVYT - Yrityskyselyn tulokset Viron elektroniikkateollisuudessa.** Helsinki: ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 1996, 26 s. (Keskustelualoitteita, Discussion Papers, ISSN 0781-6847; No. 569)

**TIIVISTELMÄ:** Ulkomaalaisen teknologian hyväksikäyttö siirtymätalouden maissa edellyttää riittävää absorptiivisten kykyjen olemassaoloa. Tietämys siirtymätalouden tämänhetkisten absorptiivisten kykyjen laadusta ja soveltuvuudesta läntisen teknologian hyväksikäyttöön on kuitenkin puutteellista. Erityisesti kaivataan tietoa yritysten absorptiivisista kyvyistä, ovathan juuri yritykset avainasemassa markkinatalousjärjestelmän diffuusioprosessissa.

Tämä tutkimus modifioi Cohen/Levinthalin absorptiivisten kapasiteettien käsitettä, jotta se soveltuisi siirtymäaikaikauden tutkimiseen; yritysten perimät kyvyt sosialistiselta aikakaudelta erotetaan analyttisesti uusista kyvyistä, jotka kehittyvät markkinatalouden olosuhteissa. Tutkimuksessa esitellään myös Viron elektroniikkateollisuudessa tehdyn yrityskyselyn tulokset, jotka selventävät tämänhetkisten absorptiivisten kykyjen dynamiikkaa. Tulokset auttavat Viron talouden kasvunäkymien ennustamisessa ja maan talouspolitiikan suunnittelussa.

**AVAINSANAT:** Yritysten absorptiiviset kyvyt, kansallinen innovaatiojärjestelmä, kansainvälinen diffuusio, Viro, elektroniikkateollisuus, siirtymätaloukmaat.

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*This paper has been presented at the Fifth Freiberg Symposium on Economics "Innovation and Transformation", August 29 - 31, 1996, Freiberg, Germany. The present version has gained from the comments of the participants at the conference.*

## 1. Introduction

The transition economies have the opportunity to benefit largely from exploiting foreign sources of technology in their growth strategies. The ability to exploit this diffusion potential requires, however, the presence of absorptive capacities in that particular technology. Yet, there is little knowledge on the present state and dynamics of the absorptive capacities in the transition countries. Furthermore, for the transition countries a specific problem is the lack of knowledge on the absorptive capacities in the firms which after all play the major role in a market economy diffusion process. In addition to this, there is no information about the development of the absorptive capacities during the transition period; i.e. how the dynamics of the inherited absorptive capacities from the socialist time and the emerging (new) absorptive capacities develop, and in which way interactions between them are taking place.

The purpose of this study is to gain information about the above questions. Firstly, the concept of the absorptive capacities within the national innovation system is reflected. Secondly, the concept of absorptive capacities by Cohen/Levinthal is modified for the present situation in the transition countries: it is divided into that part which represents the inherited absorptive capacities from the socialist period and that part which is emerging under market economy conditions. Finally, using this modified concept, the study analyses empirically the level and dynamics of the inherited and emerging absorptive capacities of the firms in the Estonian economy. The measurement of the absorptive capacities in Estonian firms is carried out through a firms questionnaire.<sup>1)</sup> In order to separate the inherited absorptive capacities from the socialist period and those emerging under the market economy conditions, the firms are divided into old (state-owned and privatized) and into new firms. Further, the firms with foreign ownership were analysed separately to find out their specific contributions. The questionnaire is limited to a selection of branches (electronics industry, food stuff industry and R&D intensive service sector) which resulted from a preliminary study on the absorptive capacities in Estonian economy.<sup>2)</sup> This paper presents the results for the electronics industry which plays an important role in the Estonian technological dynamism.

The results of the questionnaire give information about the dynamics of the absorptive capacities in the Estonian firms. This information is required for the evaluation of the growth prospects resulting from the international diffusion and for targeting the economic policy.

<sup>1)</sup> The planning and the organization of the firms questionnaire was carried out by Julianna Borsos-Torstila at ETLA, Helsinki and Marianne Paasi at IWH, Halle. J. Borsos-Torstila was responsible for the sample in the food stuff industry and M. Paasi for the samples in the electronics industry and service sector. The difficult task of interviewing the firms was done by Külli Viks and Tiina Vares. Many thanks to them. And finally, many thanks to Dirk Ziegenhausen in Halle and Sari Sirviö in Helsinki for coding the results of the questionnaires into a valuable data base. The results of the whole project will be published soon in the series of IWH and ETLA. An last, but not least, this paper has gained a lot from the discussions with my colleagues at IWH, especially with Kimberly Crow and Thomas Meißner.

<sup>2)</sup> See Paasi 1996.

## 2. The concept of national innovation system, international diffusion and absorptive capacities of the firms

### *The concept of national innovation systems*

In a market economy, the innovations and their diffusion result mainly from the R&D investment of the profit-orientated firms (see for example Nelson/Winter 1982). Simultaneously, however, research and development activities take place in universities, public institutes and in the research department of public firms. The innovations and diffusion in the economy as a whole are the result of interactions between the participants mentioned above. The most important interactions take place between the producers of components and systems, between vertically integrated (upstream and downstream) firms, between universities and the industry, and the government agencies (Nelson/Rosenberg, p. 15 in: Nelson 1993). Such complex relations between firms, universities, or institutes can be described by the concept of a national innovation system (see for example Nelson/Rosenberg, p. 4-5 in Nelson 1993 and Lundvall (Ed.) 1992, p. 2).<sup>3)</sup>

The concept of the national innovation system focuses therefore on all those factors, which determine the national technological capabilities - regardless of their innovative or imitative character (Nelson/ Rosenberg 1993, p. 4). Opposite to the traditional linear models of technical change, no clear distinction is made between innovations and diffusion processes (for example Mowery 1994, Bell/Pavitt 1993, p. 160ff). The innovation and diffusion activities are rather interactive processes, where the diffusion activity (in sophisticated technologies, or in early phases) does not differ very much from the original innovation activity. Both the innovations and their diffusion require technological capabilities and R&D investment; both the producers and the users of a technology play a creative role.

### *International diffusion during the transition period*

During the period of transition the post-socialist countries are faced with the modernizing of their economies by importing Western technologies as fast as possible. The diffusion of foreign technologies takes place for example by purchasing foreign products, and/or by imitating and learning activities of the economic actors. According to the evolutionary concept of technical change the use of external sources of technology also represents an innovative event (see above).

<sup>3)</sup> Lundvall defines the national innovation system in the following way: "a system of innovation is constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge and that a national system encompasses elements and relationships, either located within or rooted inside the borders of a nation state" (Lundvall, B-A. (ed) 1992, Introduction, p. 2).

However, in analysing countries with a large international diffusion potential (such as the transition countries, or also the developing countries), the conditions for fast diffusion are what counts. First of all, the necessary condition for exploiting foreign technologies is the existence of absorptive capacities in the receiving country. The absorptive capacities of a country is that part of the national innovation system which determines the speed of international diffusion. The absorptive capacity includes factors such as entrepreneurial capabilities, scientific and technological skills, the level of general education and the available infrastructure (see for example Gomulka 1990, p. 160). Also the present praxis in many countries to provide the own researcher and engineers with international education, improves the capabilities to exploit all types of foreign technologies. Similar effect arises due to global free trade (Nelson/ Rosenberg 1993, p. 17).

### *The concept of absorptive capacity of a firm*

Furthermore, this paper focuses on the role of profit-oriented firms in producing new technologies, in exploiting external sources of knowledge and in converting that knowledge into profitable innovations. Basic sources of technological knowledge in a firm is therefore the firm's own R&D, competitors' R&D spillovers, and the knowledge outside of the industry. The in-house research of firms is not only aimed at the production of innovations but also at the imitation of competitors and the exploitation of external sources such as basic research or foreign technology. The cumulative in-house research of a firm simultaneously builds up its ability to identify, assimilate and exploit new technologies. Consequently, Cohen/Levinthal 1989 themselves speak about the dual role of R&D investment which it plays in the innovative activity and in accumulating absorptive capacity of a firm (Cohen/Levinthal 1989, p. 569-571).

The absorptive capacity of a firm does not only result from past in-house research (cumulative R&D investment in a particular technology), but also from the cumulative production process and from the investment in the education of the staff. The absorptive capacity of a firm arises therefore partly as a by-product of the firm's activities, and partly by incentives to invest in a particular absorptive capacity. The incentives for in-house R&D investment in a particular technology depends on the expected demand, appropriability and technological opportunities (Cohen/ Levinthal 1990, p. 135 - 138).

This concept of the absorptive capacities of a firm means firstly, that the assimilation of a new technology does not take place passively, but as a result of entrepreneurial investment. Secondly, it implies that the technical change is cumulative and local. Therefore, if a firm plans to exploit a new technology, which is not similar to its present technology, it must invest in the corresponding absorptive capacity (Cohen/Levinthal 1990, p. 150).

The (by in-house research) accumulated absorptive capacity of a firm reduces the transfer costs for an external technology which may be quite high in the long run. These costs mainly arise because technology is not a public good. The higher the accumulated absorptive capacity in the relevant field of technology, the lower the respective transfer

costs and the faster the exploitation of external sources of technology (Cohen/Levinthal 1989, p.570).

### *International Transfer Costs of Technology*

There are various possible channels and mechanisms how the international diffusion both by domestic and foreign firms can take place. Such possibilities are for example the purchase of a foreign capital good, direct foreign investment, licences, or sub-contracting. The determinants for example for the diffusion of foreign production capabilities can be illustrated more precisely by the concept of transfer costs of a firm which was developed by Teece (1977). The purchase price for a technology is not the only cost factor for a firm. Rather, the transfer costs of foreign technology include all the costs that arise in the process of diffusion and adaptation. The speed, or ease of international diffusion depends on different types of transfer costs. Such costs include for example the information costs that arise during the preparation of the diffusion, construction costs, the costs of R&D personnel during the technology transfer and the training costs for using the technology (p. 243-245).

The level of such transfer costs is determined by many factors like the information level of the innovator, or by the current phase of the technology. Among the important factors for the level of transfer costs are the technological and entrepreneurial capacities of the imitating company, its size and R&D activity (Teece 1977 p. 247 - 251). These factors are in accordance with the above concept of the absorptive capacity of a firm.

### *Diffusion and the accumulation of absorptive capacities (Networks, Technological spillovers)*

The technological level/knowledge of a firm can also be increased by other means than the own in-house investment. The accumulation of absorptive capacities of a firm can take place by the diffusion of knowledge and learning effects. Therefore, the relationships and interactions between the industrial firms and their partners such as the suppliers, customers, public and private consults and the competitors constitute various channels of knowledge dissemination. Following types of channels of internal and international dissemination may occur: as a process of interactive learning due to embodied technical knowledge in traded products, as a result of the mobility of highly skilled personnel, or a result of the collaboration between the competitors and/or with a public research institute.

These kind of relationships can be analysed by the concept of industrial networks which also makes the useful distinction between the trade networks and knowledge networks (Gelsing 1992, p. 117). In the more neoclassically based new growth theories the dissemination of a new technology which takes place without a price are labelled as technological spillovers. Such spillovers can be generated by the industrial R&D activities, mobility of skilled production factors, or by foreign buyers who buy local products (Grossman/Helpman 1992, p. 17; p. 336 - 338).

### 3. Inherited and emerging absorptive capacities of the firms during the transition period

Considering the growth prospects of the transition countries, there are very different opinions about the present usefulness of the socialist science and technology sector. There are the ones who expect very high growth rates due to the large knowledge and technology stock in the transition countries. And there the others who deny any value of this stock under market economy conditions. The problem is, however, more complex. Much more than the examination of the levels of technological inputs alone are necessary. Not only was the technological output (for example number of patents registered abroad) meager which indicates a low efficiency of the socialist science and technology sector (Paasi 1995, p. 12). Furthermore, the main problem of transition countries under market conditions is the low share of the profit-oriented research of the total R&D activities (for example OECD 1993 for Hungary; Paasi 1996 for Estonia).<sup>4)</sup> Therefore, the main problem is the restructuring of the R&D activities from the public sector to profit-oriented firms.

The point in this study is that the diffusion of Western technologies into the transition countries can only take place, if adequate absorptive capacities of profit-oriented firms exist. As already shown, the absorptive capacity of a firm results from the cumulative in-house R&D in a particular technology, cumulative training investment, and the cumulative production process. However, when analysing the presently existing absorptive capacities of the firms in the transition countries one should modify the Cohen/Levinthal concept. In analysing the transition countries, it should consist of two parts. This distinction is necessary because of the specific relationship between technological knowledge and its environment (Antonelli, C. 1995, p. 3). The one part represents the absorptive capacities of the firms which was accumulated during the socialist period. Their present value and size is not a priori known. The other represents absorptive capacities which are emerging under market economy conditions. The separation of the absorptive capacity allows to analyse the present usefulness of the inherited absorptive capacities of the firms explicitly. The prospects for successful international diffusion depends on both parts and on their interaction. In the following these two parts and their interaction will be analysed.

#### *The Inherited Absorptive Capacities of Firms in the Transition Countries*<sup>5)</sup>

The transition countries accumulated a large stock of own scientific and technological knowledge when measured by the technological input indicators (like the R&D expenditure, the number of researchers, see for example OECD 1996). Such high input indicators also suggest large past accumulation of absorptive capacities in these

<sup>4)</sup> The presently available statistics about the business sector research in transition countries show, however, much too high levels and are misleading as they include for example the R&D activities of the industrial ministries and expenditures of the large research units which have nothing to do with profit-oriented research.

<sup>5)</sup> There are some important differences between the transition countries, but the science and technology sector was similarly organised as in the former Soviet Union which this analysis refers to.



countries. However, the technological output indicators like number of patents abroad or international competitiveness in technologically sophisticated exports show that the science and technology sector was very inefficient. Therefore, the present restructuring and reduction of the science and technology sector is likely to have induced large productivity effects (for example Schneider 1995 for Russia, Martenson 1995, p. 10 for Estonia).

There are important qualitative features which may even lead to the total obsolescence of the inherited absorptive capacities in the transition countries under market economy conditions. First of all, the existence of market-oriented firms with in-house research is necessary, since it is the firms which react to market incentives, invest in uncertain R&D and produce a diversity of technologies. Second, the market forces select the most profitable innovations.<sup>6)</sup> The production and diffusion of technology in the former socialist countries, however, was organised quite in the reverse manner: the in-house research of firms was determined and financed by the central planning authority without much reference to market incentives such as expected demand or returns to investment. In-house research took place in the research departments of the large state-owned firms, which cooperated mainly with the research institutes of industries (subordinated to ministries and therefore, to the central plan). The research results both of the research departments and the research institutes were not exploited very much in production, because research and production were largely isolated from one another (Schneider 1994). As a result, the large state-owned firms may, therefore, have not inherited absorptive capacities, which are efficient in the new market-oriented innovation system (Paasi 1996, p. 9). This problem is even more serious if not only the inherited absorptive capacities of the firms but the inherited stock of human capital bound to the obsolete capital stock turns out to be obsolete as well (for example Albach/ Schwarz 1994 for Eastern Germany). However, the human capital contains mixes of tacit localised knowledge which was accumulated in the socialist firms and of formal explicit knowledge which was accumulated in the high quality educational system. Therefore, one can expect that the human capital stock is not totally obsolete and can be modified through learning.

An additional problem is that the present external sources of information for the transition countries exists mainly in the advanced capitalist countries. The inherited absorptive capacities of firms in the transition countries may be inadequate to exploit modern Western technologies, if the inherited technological capabilities and information differ largely from those in the West. Large R&D investments may be necessary to enable firms to exploit new kinds of technologies such as input-saving technologies or communication technology.

### *Emerging absorptive capacities under market economy conditions*

The accumulation of new absorptive capacities of the firms in transition countries depends on the present in-house R&D investment, investment in production and training

<sup>6)</sup> In a market economy too, the public research and the interactions between public and private research play a very important role, but this is not the focus of this paper.

by firms profitable under market economy conditions. This means that only the activities of presently profitable and profit-oriented firms are assumed to account for the emerging absorptive capacities in the business sector. Therefore, the new absorptive capacities are assumed to emerge only since the transition to market economy. The emergence of the absorptive capacities in firms is supported by the reforms like the patent legislation, the privatization policy (institutional set-up), legislation for foreign investment, functioning financial markets and market competition among others.

The point is that new absorptive capacities are emerging in all profitable and profit-oriented firms since the transition to market economy, containing old, privatized firms, new firms and foreign firms. The enterprises differ of course from one another according to their (production and technology) history and ownership conditions, differences which cause different types of entrepreneurial behaviours and imply differences in the inherited technological knowledge. Therefore also the state-owned and privatized firms may, if they are profitable, utilize the inherited absorptive capacities and build up new absorptive capacities.<sup>7)</sup> On the other hand, the newly founded and profitable firms accumulate new absorptive capacities by their production, in-house R&D investment, training investment and export activities among others. These firms behave market orientated, improve the product quality and production methods. They also exploit the inherited absorptive capacities if for example the management comes from the former research staff or socialist firm.

In addition, the presently emerging absorptive capacities are not only induced by domestic firms, but also result from foreign direct investment. It contributes directly to the emerging absorptive capacities of a country, and may be treated as international technological diffusion. Foreign companies and joint-ventures may import new management and technologies, which in turn build up the absorptive capacities. The total size of such technological spillovers, however, depends additionally on the connections to the other firms and research facilities in the country (indirect contributions). Investigations concerning the actual extent of the technological diffusion is necessary, since they do not arise automatically. Interfirm relations should be studied as well (between the domestic firms and mother firm; See Lovio 1992, p.1).

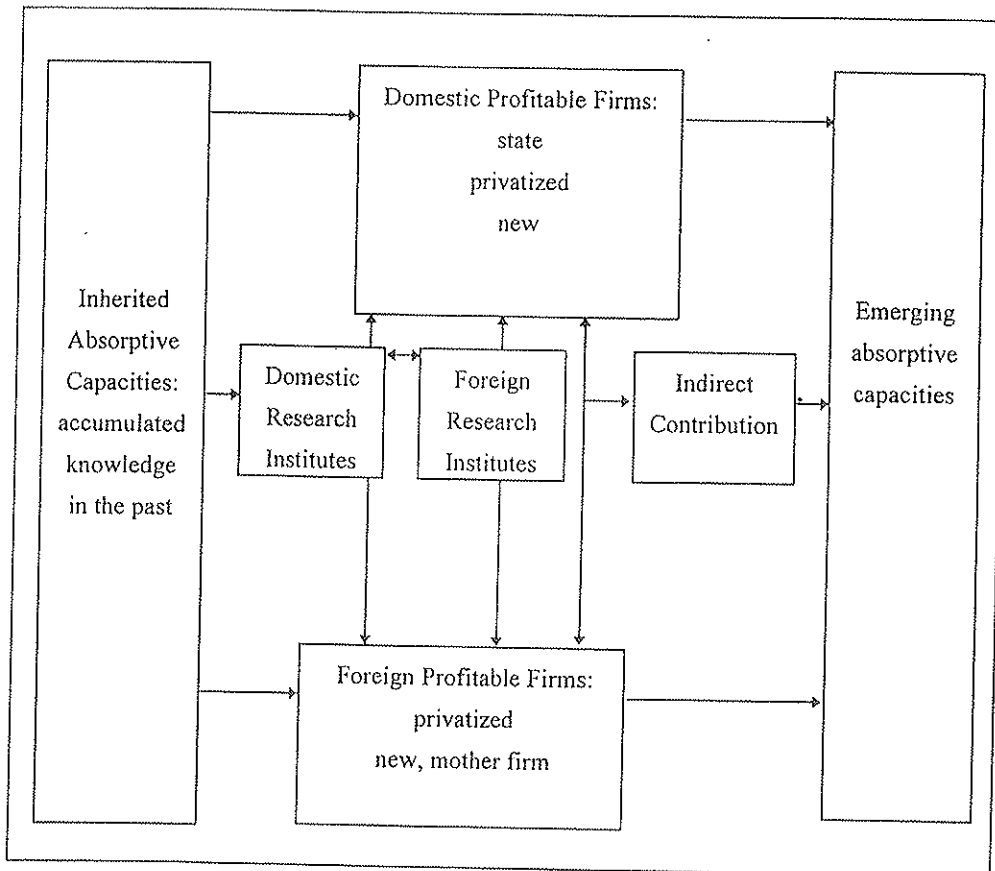
Simultaneously, however, the foreign direct investment itself is induced by the existence of inherited absorptive capacities in that particular industry or technology. Foreign investment therefore also means the exploitation of the inherited absorptive capacities by purchasing a firm (with technological asset), founding a joint venture or employing domestic human resource (either within the firm or by sub-contracting). The foreign investment itself therefore reflects that the inherited absorptive capacities today have an economic value.

The following figure shows various domestic and foreign channels for emerging absorptive capacities under market economy conditions. On the one hand, the present absorptive capacities are accumulated by investing in R&D, in production and in training within the various types of the firms. On the other hand, some parts of the accumulated knowledge during the socialist period is utilized in the firms. The

<sup>7)</sup> For example, if they have a new management and have been reorganised.

exploitation of the past knowledge includes variables such as the accumulated human capital stock, which facilitates the ability to exploit external sources of technology. Therefore, only those parts which are utilized in the firms count as presently relevant inherited absorptive capacities. As the present discussion about the national innovation systems and results of the new growth theories show (see page 3) there are many additional factors and links which build up the learning capabilities of a firm. The analysis of the accumulation of absorptive capacities will therefore include the export activities which reflect the learning effects due to competition on the international market and the connections to other research institutes which support the diffusion of knowledge. These links are also presented in the following figure. It should not be interpreted as a closed system, because the channels abroad are connected by the foreign research institutes, the foreign investment itself and the inter-firm connections in the foreign company.

**Figure 1: Inherited and Emerging absorptive capacities during the transition period**



However, all these channels only mark theoretically possible channels, and each link should therefore be seen with a question mark. In order to find out, if and through which channels the absorptive capacities presently emerge, it is necessary to interview the firms. The results of such questionnaire therefore enables the location of "weak channels" in the system of emerging absorptive capacities and therefore offer targets the economic policy.

#### 4. The role of the electronics industry in the Estonian technological dynamism

The Estonian electronics industry is included into the present study on the absorptive capacities of firms<sup>8)</sup> because it contained many R&D intensive activities during the socialist period, and because it shows presently - even if at a small absolute level - positive growth rates after a strong restructuring process.

First of all, the Estonian electronic and electromechanical industry played a very important role in the Soviet industrial system. Much of the R&D intensive activities of the Soviet electronic and electromechanical industry was located in Estonia and mainly produced for the other republics. The raw materials were imported from the other republics and the distribution and marketing of the products was organised by the all-union authorities. Since the independence the industry has experienced major adjustment processes, and in 1993 the share of electronics and electromechanical industry amounted to 1,5 % in the total industrial output (Estonian Investment Agency 1.1.1995, Overview of the Electronics and electromechanical Industry in Estonia).

Today the Estonian electronics and electromechanical industry is made up of 236 enterprises (according to the Estonian Enterprises register). It produces a broad spectrum of electronic and electromechanical products including components, PCBs, telecommunication equipment, process and security electronics, computers and a long range of instruments (Ministry of Economic Affairs/EU Phare 1995, p.2).

In spite of the small quantitative size of this industry, it still could play an important role for the technological dynamics in Estonia since it includes many R&D intensive activities and because it holds important connections to other industries and sectors. The connections of the electronics industry arise as a supplier for other industries and as a demander for the products of the other industries (industrial cluster). In addition to these features, the Estonian electronics and electromechanical industry employs a large part of the accumulated stock of human capital which has been educated by the universities. The importance of past educational investment and research activities in this industry is indicated by the high share of the engineering (37 %) out of the whole researcher stock in Estonia in 1990 (Centre of Science, Research and Statistics 1993, p. 335 in: Paasi 1996, p. 8 ff).

However, it is possible that there is no demand for this human capital under market condition, i.e. it is obsolete. Therefore, only the actual employment of this human capital in the profitable production shows the inherited absorptive capacities embodied in it. For example, such researchers from the engineering industry who have founded consulting firms combine inherited absorptive capacities (embodied in the researcher) with emerging new capabilities. The number of such consulting firms is, however, very small (Estonian Economy 94/95, p. 55). On the other hand, their importance can be

<sup>8)</sup> The selection of the electronics industry, food stuff industry and R&D intensive services for the firms questionnaire took place according to their past and present role in the technological dynamism in Estonia. For this see the preliminary study about the absorptive capacities in Estonia Paasi 1996.

large during the transition period, when the in-house research activities of all firms are almost negligible and R&D services are rather bought outside of the industry. In this context the role of the engineering industry is also very important as it demands the bulk for external R&D services (63 %) (Statistical Office of Estonia 1994, Science 1993, p. 34, in: Paasi 1996).

Considering the unfavourable characteristics of the socialist firms in producing new technologies, the inherited absorptive capacities which are suitable to exploit the external sources of technology may be embodied in the educated labour force rather than in (privatized or still state-owned) Estonian firms. Therefore, it is important to include aspects of the utilization of the Estonian human capital in the firms' questionnaire.

## **5. The Absorptive Capacities in the Estonian Electronics Industry: Results of the Questionnaire**

### **5.1 Measuring the inherited and emerging absorptive capacities: the questionnaires**

In order to measure separately the inherited and emerging absorptive capacities, the enterprises are divided into those which already existed during the socialist period and into those which have been established during the transition to market economy. In Estonian this means the year 1991. The enterprises are, however, further classified into five analytical categories of firms: state owned firms, privatised Estonian firms, newly founded Estonian firms, privatized foreign firms and new foreign firms.<sup>9)</sup> Due to this detailed classification more information can be gathered. On the one hand, the separate analysis of the state-owned and privatized Estonian firms gives insight to the question whether there really are differences in the entrepreneurial and technological dynamism. On the other hand, the separate analysis of the foreign firms allow to investigate if the expected technological spillovers by foreign direct investment indeed have taken place.

These five categories are the basis for the four different types of questionnaires (state-owned and Estonian privatized firms have the same type of questionnaire), in which the questions are adjusted to the relevant firm type.

### **5.2 The Sample**

All enterprises located in Tallinn and without missing data concerning the employment were taken to the sample, which amounts to 113 enterprises.<sup>10)</sup> The Estonian Enterprises Register divides the enterprises into 3 different ownership categories: state owned, private and foreign property.

<sup>9)</sup> The Estonian Enterprises Register had only three types of enterprises so that it was not possible to determine the number in each five categories in the sample in advance.

<sup>10)</sup> Only if the population of firms inside and outside of Tallinn do not differ strongly from each other, the results of the sample are valid for the whole industry. However, important differences can be expected between the firms in cities and on the country side.

The sample includes all ownership types so that both the inherited and emerging absorptive capacities are represented. Furthermore, both small and large enterprises are taken to the sample. The reason for this consideration is firstly, that the correlation between the size and the R&D activities of a firm is expected to be positive. Therefore, if only large firms are included, the sample will possess a positive bias towards R&D activities. Secondly, many small enterprises in the transition countries embody inherited absorptive capacities, for example if they were founded by former researchers or managers. Exclusion of these firms would introduce a negative bias towards the inherited absorptive capacities to the sample. The following table shows the distribution of the enterprises according to the ownership and the size. The size is measured by the number of employment.<sup>11)</sup>

**Table 1: Distribution of the enterprises according to the employment and type of ownership**

Employment	Total	state	of which domestic	foreign
1-10	78		72	6
11-50	25		16	9
over 50	10	2	5	3
total	113	2	93	18

The initial sample included 20 enterprises in Tallinn.<sup>12)</sup> The number of the answered questionnaires may limit the generality of the results for the Estonian electronics industry. However, the accuracy of a sample is more important than its size (Oppenheim, p. 43). Accuracy of the present sample was improved by accounting for the population characteristics „size and ownership“ which are important determinants for the inherited and emerging absorptive capacities in the firms. Therefore, the sample was taken with the help of a quota sample according to the firms ownership type and size. The sample for the 20 firms in the Estonian electronics industry reflects the relative shares of the different types and of the various sizes of the firms (quota sample).<sup>13)</sup>

<sup>11)</sup> The choice of this indicator - instead of the turnover - for measuring the size of a firm results from the database characteristics which includes more enterprises without turnover figures (32) than enterprises with unknown employment (8).

<sup>12)</sup> Considering the accuracy of a sample, its information depends on the variance of the measured variable: if the variance is very large, sample results of any size will not be very reliable. This is the case for the firms' population in the Estonian electronics industry. Therefore, even a very large sample would not be representative for the heterogenous population of the firms.

<sup>13)</sup> The quotas in the sample and the final distribution and number of the investigated firms are shown in the appendix 1.

However, many of the firms (eleven) in the sample did not exist at all, nowadays produced other than electronics products or refused to answer the questionnaire. These firms were replaced (16 replacements), so that finally 15 firms were interviewed personally by two Estonian students.

### 5.3 The absorptive capacities in the Estonian electronics industry

#### 5.3.1 Main characteristics of the firms in the sample

The following table shows the main characteristics of the firms in the sample. There are one state-owned, two privatized Estonian firms, eight new Estonian firms and four new foreign firms. The missing privatized foreign firms in the sample and their low number of privatized foreign firms in the Estonian electronics industry altogether may imply that the existing assets are not very interesting for foreign enterprises.<sup>14)</sup> New firms - both domestic and foreign - therefore constitute the majority of the sample (with 80%).

The size of the domestic new firms is very small in comparison to the state-owned, the privatized and the foreign firms. It seems that even if the number (4) of the foreign firms is not very high, the extent of foreign investment in the Estonian electronics industry can be important because of their size. Two of the foreign firms came from Sweden and two from Finland.

Most of the firms explain that they were profitable in 1995, except one privatized, two domestic new firms and two foreign firms. This information is important as the profitability of firms is the pre-condition for the inherited absorptive capacities having an economic value under market economy conditions and that new absorptive capacities are emerging. However, the present lack of profitability may be the result of present high investment for rising future competitiveness. Therefore a more long term analysis of each firm would be required. Because such an analysis is not possible, all firms are included in the evaluation of the questionnaires.

In the following the inherited and emerging absorptive capacities of the 15 firms in the Estonian electronics industry will be studied. Because of the differences in the backgrounds for the use of inherited capacities and for emerging new absorptive capacities the firms of the sample are studied in two classes. First, the state-owned and privatized firms will be studied. Following this, the new domestic and foreign firms will be analysed together, while some additional contributions of the new foreign firms to the emerging absorptive capacities will be shown separately.

<sup>14)</sup> This may also result from high adjustment costs, unclear property rights, unclear book-keeping systems etc.

**Table 2: Main Characteristics of the electronics firms in the sample - 1995 -**

Type of Firm	Year of establishment	Year of privatization	Produced products	Profitable since	Employment	Turnover, in Mio EEK 1995
state-owned	1957	-	service, electric devices, metal constructions	1957	1 708	144
privatized	1958	1994	behind-the ear-hearings, integrated circuits	1993	1 100	42
privatized	1959	1995	Manufacturing lighting, installations, illuminations	1996 prognosis	172	14,6
New Estonian	1993	-	uniterm, unimail, unifa, direc	1994	7	1,71
New Estonian	1990	-	electronic measures & instruments	not yet	8	0,5
New Estonian	1992	-	electrical products, metal constructions	1992	20	5
New Estonian	1993	-	traffic signs	not yet	4	1,5
New Estonian	1993	-	semiconductive devices	1994	1	0,3
New Estonian	1991	-	electronics and automatics installation	1995	4	0,08
New Estonian	1994	-	electronic devices; guaranty repair, supply powers	missing value	7	2
New Estonian	1992	-	radiocommunicational instruments & mediation	1992	6	2,8
New Foreign	1993	-	subcontract work	1994	35	2,6
New Foreign	1994	-	personal computer	1996 or 1997	12	15
New Foreign	1992	-	electronic manufacture	1992	828	755,6
New Foreign	1991	-	unknown	1993, but not now	27	4,2

### 5.3.2 Inherited and emerging absorptive capacities of the state-owned and privatized firms

Both the state-owned and the two privatized firms are very large in terms of employment and turnover. They all declare that they are profitable and that they do not receive any public support. However, one of the firms has only recently been privatized, and obviously has problems in restructuring its activities as the following analysis will show. For these firms distinction between the inherited and emerging capacities is made by assuming that the new absorptive capacities only have been emerging since the transition to market economy in year 1991. Therefore, the following analysis is organized by this principle.



*Past accumulation of the inherited absorptive capacities*

Table 3 shows the past R&D activities and training investment of the firms which measures the accumulation of the absorptive capacities during the socialist period before 1991. Cumulative figures for these variables are not available, but the long existence of all three firms indicate a large accumulation in that particular technology and production.

**Table 3: Past accumulation of absorptive capacities during the socialist period**

Type of firm	Type of R&D department before 1991	R&D costs as share of the firm's production costs	Share of R&D personnel to the total in 1989	Investment in training and education
state-owned	department of technology, laboratory of metal and weld	1 - 5 %	1,3 %	average
privatized	Special construction bureau	more than 10 %	20 %	higher than average
privatized	R&D activities were the main function of the company as it was an experimental factory	more than 10 %	5 %	higher than average

Table 3 shows that one of the privatized firms was even an experimental factory which had more freedom than usual in changing production methods or developing new technologies.<sup>15)</sup> But all three firms show considerable R&D activities and training investment in the past. Firstly, they all had in-house research activities and development departments of various types. Secondly, two of the firms with the R&D share over 10 % even belong to the R&D intensive industries when measured by the OECD definition for R&D intensive industries.<sup>16)</sup> The comparison is, however, difficult because the method of calculation may differ considerably. In particular, it could be that the large research units of the firms above contained many types of costs which not at all related to the R&D activities (cleaning costs, kindergarten etc.). The share of R&D personnel in the (normal) privatized firm is much higher than in the experimental one which is unexpected. Finally, the interpretation of figures for the training investment are, however, simpler: all three firms seem to have been quite training intensive in comparison the other Estonian firms.

<sup>15)</sup> In the „normal“ enterprises the R&D and other development work was determined rather by the central plan, and not by the enterprise itself.

<sup>16)</sup> See OECD classification for R&D intensive production for example in: OECD 1992, Industrial Policy in OECD Countries, Annual Review, Paris, p.125: Industries with a share of R&D to production more than 10 % are classified as high R&D intensive. In this classification the medium-high R&D intensive industries own a R&D intensity between 3,2 % - 4,8%.

It has been claimed that the diffusion was weak and the in-house research of the firms played only a subordinate role in the socialistic innovation system (see above pages 5-6). In order to find out, if this claim is valid for the firms in the sample the connections of the firms to the all-union and domestic research institutes (Academy of sciences, research institutes of the ministries) and to the more practice orientated institutes (KTB, SKP) are analysed in the following table. Such connections are assumed to indicate the diffusion of technology from all types of research institutes and from other firms.

**Table 4. Connections to the research units before 1991: Past internal diffusion of technology**

Type of Partner	state-owned	privatized	privatized (experimental)
SKB, KTB of other SU research institutes	yes	yes; Institutes of the USSR Ministry of Electronics	yes
the research institutes of the military sector of the SU	yes; belonged to the USSR	yes, with lots of them	no
domestic R&D institutes	Technological University, most of them Estonian projects	no	no
domestic SKB, KTB	Eesti Projekt, Toostu-project, Energie	no	yes
Foreign R&D institutes	Germany, Finland, CIA, USA	no	no
R&D departments or personnel of other firms	no	no	no

SKB: Special construction bureau, KTB: Construction technology bureau

Striking - and expected - feature are the missing research connections of all three firms to other firms. Non-expected is, however, the small number of cooperation partners of the experimental factory. However, a concentration of the cooperation with the more practice oriented institutes can be observed. International research cooperation existed only for one of the firms. In the pattern of cooperation there is a certain continuity as in 1995 two of the (state owned and privatized) firms still made use of the former research connections.

According to the theoretical considerations many additional factors influence the learning capabilities of a firm (see page 4). Therefore, the international trade and cooperation with the West also represents an important source of technological and organizational learning for the firms. However, there was almost no trade with the West which could have induced learning effects, and no diffusion embodied in capital goods from the West took place in these firms. International cooperation only took place in one firm by sub-contracting, the others did not have any international cooperation at all.

Summarizing these findings, all three firms show quite high technological inputs (like training investment, R&D personnel). However, as already pointed out (page 15), the figures on the R&D intensity in table 3 can be misleading in measuring the accumulated absorptive capacities, but the figures for training are more reliable. In addition, only one of the firms (2) had registered patents (50) in the socialist period. They were so-called certificates of authorship which were all registered in the SU. Finally, the missing diffusion between the domestic firms and low international diffusion were characteristic in the past. The isolation of the innovation system in the former SU means that the international R&D results could not be utilized, and that there was no pressure on the firms by international competition. This resulted often in the development of already existing mature technologies, or such which were remarkably lagging behind the international technological frontier.

However, it is not the total past accumulated knowledge and technology which counts today for the Estonian growth prospects. Rather, only those parts of the capital stock, human capital and technology count which remained in the firms after the transition period. Table 5 shows the large extent of the adjustment processes in the three firms during the transition period. One can see that only a fraction remains in the firms, which therefore suggest quite a narrow basis of inherited absorptive capacities in these firms.

**Table 5: Inherited absorptive capacities after the adjustment processes**

Type of Firm	Decline of the total personnel: 1995 to 1989		R&D personnel: share 1989 to 1995	Capital stock: share 80s to 1995	Restructuring: New Products New Production methods		New management
state-owned	- 534	75,9 %	89,7 %	25%	no	no	partly
privatized	- 2400	31,4 %	31,4 %	50 %	yes (integrated circuits)	no	totally, since 1995
privatized (experimental)	- 828	17,2 %	10 %	50 %	no	no	totally, since 1996

Since 1995 the two privatized firms have reduced their number of both total and R&D personnel much faster than the state-owned firm. Such sharp decline in production factors, the new management and the restructuring of the production should induce rising labour productivity in the privatized firms which is analysed in the following table. The result is however quite surprising, because only the state-owned firm has improved its productivity.

Especially the firm privatized in 1995 (decline - 105) seems to have many problems. The firm has not been profitable yet.<sup>17)</sup> Since this enterprise was an experimental factory it is obviously very difficult to restructure it for the present market conditions.

<sup>17)</sup> The present management is very negative about their prececeders since it was difficult to get a right picture about the enterprise before the privatization (unclear book-keeping).

Ironically, this type of factory should have accumulated lots of experience in research and development.

**Table 6: Development of the labour productivity 1993 - 1995**

Type of firm	labour productivity in 1993	labour productivity in 1995	Change
state-owned	248	281	+ 33
privatized 1994	145	127	- 18
privatized 1995	388	283	- 105

The labour productivity in a firm is calculated by dividing the turnover by the number of employees. The turnover is deflated by producer price index (PPI, 1992 = 100; Monthly Bulletin 12/1995, 6/1996)

All these firms have gone through major restructuring processes. Even most of the personnel and capital stock has been dismissed. The dismissed human capital is now available outside of the firms either for the foundation of new firms, or to be used in other Estonian or foreign firms and in other sectors like the service sector. The employment of this dismissed labour force without a long time lag is important for Estonian growth prospects.<sup>18)</sup>

### *The emerging absorptive capacities*

Present profitable production, investment and research activities in these firms contribute to the emerging absorptive capacities which is taking place on a much narrower basis than before the adjustment. The figures in the following table look quite promising in terms of accumulating new absorptive capacities. First of all, the share of R&D expenditure on the turnover is quite high, even if this figure overestimates the R&D intensity when compared to the OECD definition of R&D intensity.<sup>19)</sup> In addition to this, also the investment in improving technology and products is almost as high as the R&D expenditure.

Surprisingly, both privatized firms state that the R&D activities have remained the same as in the past, only in the state-owned firm there have been changes. Also the share of the R&D personnel to total personnel has remained the same or almost the same, although the number is much lower today (see above table 6).

All firms invest in training of its personnel, which is in all cases financed by the firm itself. The training however is not only organized by the firm, but also by domestic and international organizations.

<sup>18)</sup> In order to investigate such processes the firms in the R&D intensive service sector have also been interviewed in the present project. The results will be soon presented in the publication series of IWH, Halle and ETLA, Helsinki.

<sup>19)</sup> OECD definition: the share of R&D in the production, not in turnover.

**Table 7: Present R&D expenditure, investment in technology and product improvement and R&D personnel - 1993 and 1995 -**

Type of firm	R&D Expenditure in Mio EEK		Investment in technology and product improvement, in Mio EEK		R&D Expenditure % of turnover		% of R&D Personnel in total	
	1993	1995	1993	1995	1993	1995	1993	1995
state-owned	5,5	9,5	3,5	5	6	6,5	1,2	1,4
privatized	4	9	4	8	13	20	20	20
privatized	unknown	0,03	unknown	0,03	unknown	unknown	4	2,9

Only the state-owned firm uses external R&D services which come from foreign (Nordic) firms standing for the diffusion of foreign knowledge. The same firm also cooperates with a large multinational firm and it is the one which is preparing to register a patent; the more established privatized firm cooperates in the field of developing new products with other firms. The state-owned and the profitable privatized firm both have been restructuring their exports and imports increasingly towards the Western market. In both cases the Eastern market - both exports and especially imports - still plays a very important role, which is an expression of the past relationships.

### 5.3.3 Inherited and emerging absorptive capacities in the new firms

This chapter analyzes those activities of the new firms from the sample which build up new absorptive capacities. Although the new firms have not directly accumulated capabilities during the socialist period, they may still exploit and demand such capabilities from outside the firm. The analysis of inherited absorptive capabilities in the new firms therefore concerns the employment of Estonian human capital either embodied in the owner of the firm or by employing skilled Estonian labour. In addition, the domestic and foreign firms are separated, as the latter may have additional contributions to the emerging absorptive capabilities which domestic do not have.<sup>20)</sup>

#### *Inherited absorptive capacities*

Considering the sharp decline in the stock of personnel in large Estonian firms during the transition period,<sup>21)</sup> lots of human capital is assumed to be available for all firms which are active in Estonia. The newly founded firms (domestic and foreign) exploit

<sup>20)</sup> Much more detailed results about the foreign firms in the questionnaire for electronics industry, food stuff industry and service sector will be soon published by J. Borsos-Torstila in the series of ETLA.

<sup>21)</sup> For example, see the adjustment processes of the state-owned and privatized firms above.

inherited Estonian capabilities/absorptive capacities when employing skilled and educated personnel which comes from former socialistic Estonian firms or from the research institutes.

Therefore, the educational and professional background of the founders is one indicator for the use of inherited human capital in the newly founded firms. In all firms (except the one with missing value) the founder has a higher educational background, mostly a higher technical education (in 7 cases out of 11). In 6 out of 11 cases the founder came from another Estonian firm or research institutes listed below. From these six cases three are foreign companies which indicate the relative importance of foreign firms in demanding Estonian human capital.

- "Signaal" director of production
- leading researcher at Tallinn Elektrotechnics Institute
- KTB (Construction technology bureau)
- Production engineer and marketing specialist
- Küberneetika Institute
- Tallinn technical university

The number of Estonian R&D personnel and other skilled persons (experts) is another indicator for the present use of the domestic human capital. Only one of the firms (domestic) employed Estonian R&D personnel and also the number of other skilled persons (experts) was low (1 to 3 experts in three firms). One of the foreign firms stated that they employed Estonian R&D personnel in 1995, which originally came from the university. Although the other foreign firms did not explicitly state the existence of R&D personnel in their firms, two of them explained that the R&D personnel came from other firms (Estonian and Finnish). The fourth one explained that the R&D personnel came from an Estonian research institute. Therefore, in comparison to the domestic new firms, the new foreign firm employ Estonian human capital more often.

The purchase of external Estonian R&D services also indicates the use of human capital stock which was accumulated in the past. However, only four of the 12 firms stated the use of such services. The R&D services were bought twice from an Estonian firm, in one case from a foreign firm and in the case of a foreign firm from the mother firm. No difference between the behaviour of the domestic and foreign firms in this respect was found.

### *Emerging absorptive capacities*

The present absorptive capacities emerge as a result of the activities in all profitable new firms with either domestic or foreign origin.<sup>22)</sup> The research activities, product and production improvements and investment in training in these firms represent a direct

<sup>22)</sup> The foreign direct investments, however, may facilitate the emerging absorptive capacities of the Estonian business sector even further as they are expected to have a large positive effect due to their better access to technology, know-how (including marketing and management skills), to capital as well as access to the markets. However, these types of contributions were not tested with this questionnaire.

contribution to the emerging absorptive capacities. However, as many as four domestic firms (50 % of the domestic firms) and one foreign firm (25% of the foreign firms) did not invest into in R&D, development and training in 1995 and the years before at all. Therefore, only the remaining firms (8) are worthwhile analysing and the results are represented in the following table 8. All the years in which investment in R&D took place are presented in order show their cumulative effect.

In 1995 only one of the domestic firms had a separate R&D department, and the share of R&D expenditure in its turnover amounted as high as to 17 % in 1994 and to 14 % 1995. Another domestic firm explained that it received R&D support from its Finnish partner. None of the foreign firms had R&D departments although two of them explained to have invested in R&D activities in the past. Except for one of the firms (0,4%) the R&D shares on the turnover show quite high levels when compared to the OECD definition of the R&D intensive production.

**Table 8: R&D investment in the new firms of the sample, in 1995**

Type of firm	R&D expenditure in EEK		R&D share in turnover, in %	
	1994	1995	1994	1995
New Estonian 6	35.000	70.000	17	14
New Estonian 9	200.000	70.000	*	
New Estonian 41	50.000	200.000	3,6	10
New Foreign 21	46.000-460.000	15.000-1.500.000	1-10	1-10
New Foreign 41	0	15.000	0	0,4

\* R&D is financed by the Finnish partner

One should not however conclude that there were no creative research and development in the other firms since research also can take place without having an extra R&D department. As the development costs and the training investment also are important sources of the technical development in a firm, their level will be shown in the following table. As expected, in comparison to the above R&D expenditure the level of the development costs is not to be neglected in analyzing the emerging absorptive capacities.

Also only few firms (six out of 15) stated to have invested in training (in Estonian Kronas), the level there being quite low as table 9 shows. However, 5 of 8 domestic firms declared to train their own personnel and to finance their programmes themselves. The organisation of the training took place only partly in the firms; in many cases also foreign organisations were involved. On the other hand, all foreign firms in the sample

explained to train their personnel. The training was usually financed and organized by themselves or by the mother firms. Obviously, the foreign firms took a greater effort to train their personnel which probably results from the need to mediate the differences in the firms' systems and from the availability of already existing training system in the mother company.

**Table 9: Development costs and training investment**

Type of firm	Development costs in EEK		Training investment in EEK		
	1994	1995	1993	1994	1995
New Estonian 1	139.000	79.000		5.000	
New Estonian 6*	41.000	76.000		6.000	
New Estonian 8	35.000	130.000		0	
New Estonian 11	0	60.000		-	
New Estonian 41*	-	-		0	5.000
New Foreign 3	50.000			3.000	5.000
New Foreign 21*	0				20.000-30.000
New Foreign 42	400.000		2	5.000	10.000

The firm with \* invest also in R&D activities (see above)

As the transition countries usually lack entrepreneurial and managerial skills, the employment of foreign management is an important source for such (foreign) knowledge. Both the domestic and foreign firms did not employ any foreign management or other foreign personnel. Therefore, there was no diffusion from abroad by this channel. Even if the foreign firms do not differ in this respect it does not exclude the possibility of other types of knowledge transfer from the mother firm. The existence of actual contacts to the mother company which could serve as an additional channel of foreign knowledge requires, however, further empirical analysis.

The following table shows other important channels for the diffusion of knowledge like foreign capital goods, domestic and foreign external R&D services and international cooperation. All firms purchased their capital goods from abroad. However, only some domestic firms used capital goods from Russia. The foreign firms on the other hand obtain their capital goods from the country of their origin. These firms do not, however, show any distinctive differences between the domestic and foreign firms concerning these channels of diffusion.



**Table 10: Channels for the diffusion of foreign knowledge in the new firms**

Type of firm	Origin of the capital goods	External R&D services	International cooperation
New Estonian	Japan,USA,Estonia	no	no
New Estonian	Russia, Germany	Foreign firm	representatives in Russia, partnerships in Latvia
New Estonian	USSR, Finland	no	cooperation contract with a Danish firm
New Estonian	EU, USA	no	yes
New Estonian	Russia, Estonia	no	cooperation contracts
New Estonian	Russia	no	yes; cooperation contract with a Finnish firm
New Estonian	Central Europe	no	no
New Estonian	many countries	Domestic private firm	no
New Foreign	Sweden	Domestic private firm	no
New Foreign	mainly Finland	Mother firm	seminars, exhibitions
New Foreign	Finland	no	mother firm
New Foreign	Sweden, USA	no	no

Further, important indirect contributions to the emerging absorptive capacities occur when there are contacts to the other firms and/or research institutes. These interactions may cause additional positive effects to the emerging absorptive capacities. However, the external relationships of the firms in terms of R&D services or international cooperation were not very intensive both for the domestic and foreign firms. The diffusion of knowledge in the foreign firms in this sample due to the interactions with the mother firms does not seem not to be very intensive either.

The present trading partners inform about the possibility of learning effects because the firms must face the international quality considerations. However, only one of the Estonian firms exported to the West and two of them to the East. These firms are, however, not strongly export oriented. The import-orientation is not either very intensive as only two of them imported from the West. However, this is in conflict with table 10, according to which all firms import their capital goods. The foreign firms are - as expected - very strongly mother company oriented. One of them produces only for the mother company, and the others are also heavily mother company oriented in their sales. In one case the imports from the mother company was even higher than the exports which is generally a very common picture.

## 6. Conclusions

The present dynamism of the emerging absorptive capacities in the Estonian electronics industry can be summarized by recalling the channels shown in the figure 1 on page 8. Referring first to the inherited absorptive capacities, the strong adjustment processes in the state-owned and privatized firms suggests that only a small size of the accumulated absorptive capacities is relevant today. On the other hand however, the dismissed human capital from large Estonian firms can be demanded by the newly founded domestic and

foreign firms in the electronics industry. This seems to be a very important link to the usage of inherited capabilities, since all founders - or domestic partners in case of the foreign firms - have a higher education and in many cases come from Estonian research institutes. In the sample the foreign firms used the Estonian human capital more intensively than the domestic ones. The accumulated Estonian human capital can also be utilized by demanding external R&D services outside of the industry. This activity was, however, very limited in the interviewed firms.

The investment for emerging capacities measured by in-house R&D activities or educational investment has not been present in many of the interviewed firms since the transition. However, the state-owned and one of the privatized firms invested in these activities at a remarkably high level. In the group of the new firms only few firms invested in R&D, some of them even at a high level. In this group the foreign firms were more active investors than the domestic firms; their importance might also be greater for emerging absorptive capacities as their size is also much larger. The in-house research activities of the newly founded firms lies rather in development than in research. Many potential contributions of the foreign firms to emerging absorptive capacities could not be observed, like the employment of foreign management or R&D personnel. However, the in-house training of the foreign firms was much more intensive than in the domestic firms. Probably the main part of the indirect contribution cannot be observed because inter-firm information is not available. The international diffusion embodied in capital goods was important in all firms, but international cooperation played no role at all.

The development of the Estonian electronics industry to an important industrial cluster requires more in-house R&D activities and educational investment in the firms. The industry could also benefit largely from a more intensive diffusion of technology which can be supported by the construction of internal networks in Estonia and by the participation in international networks.

**Appendix 1.**

The sampling frame and the suggested and realized number of random samples.

Type of enterprise	share in %	suggested number firms in random sample	The actual number of the firms
State	1,7	1	1
Private: domestic	83,4	15	10
Foreign	14,9	4	3
Total	100	20	14

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