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## **Connecting Systems of Innovation**

**An analysis of innovation in the Estonian telecommunications sector and  
its reorientation towards Sweden and Finland**

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### *Abstract*

The purpose of the project is to analyse the influence of the Swedish and Finnish telecommunications sector on innovation in the Estonian telecommunications sector. I discern two (not mutually excluding) potential Nordic influences. The first implies a process of convergence, i.e. that Estonia has come to *resemble* the Nordic SSIs. The second refers to the possibility that Sweden and Finland have affected the Estonian SSI by creating and exploiting *complementarities* between the Nordic and the Estonian telecommunications sectors, leading to a specialisation (which may be based on ‘creative’ or ‘imitative’ innovation) of the Estonian telecommunications sectoral system of innovation. I propose to study the transformation of Estonian telecommunications as a process of ‘co-evolution’ of technologies; organisations, and institutions, and to investigate to what extent and in which ways elements of the Swedish and Finnish telecommunications sectoral systems of innovation are determinants of this co-evolutionary process.

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## 1. Purpose and relevance

During the past decade or so, it has been widely argued that the Baltic Sea region is gradually taking the shape of a dynamic growth region in the North European periphery (e.g. ISA, 2000; NUTEK, 2000). High rates of economic growth especially in several of the Eastern countries of the region and increasing flows of trade and foreign investments have been observed and there has been a growing awareness of a potential for increased prosperity of the whole region by deepening the political, economic, social and cultural integration among the countries around the Baltic Sea.

In socio-economic perspective, the problem with indicators related to economic growth, productivity increases, foreign investments, trade flows, etc., is that they do not tell much about the underlying mechanisms that account for long-term development of integration. In particular, they do not tell much about the role of *innovation*, an issue that, however, since long (see e.g. Schumpeter, 1934) has been recognised to be of paramount importance for the long-term development of any modern national or regional economy. From the perspective of the Eastern Baltic Sea countries, it is in this connection certainly worrying that their often impressive growth rates are not paralleled by any corresponding increase in innovative activities; these have been at a very low level throughout the 1990s, as indicated by much lower expenditures (as a percentage of GDP) on research and development as well as a much lower patenting activity than in the Western Baltic Sea countries (OECD, 2001). Similarly, more qualitative studies indicate that technological change in the Eastern countries is still very much an issue of *imitation* of Western products and processes rather than genuine, creative innovation (Sandberg, 1999; Geenhuizen, 2001).<sup>1</sup> A comprehensive account on the issue of creative versus imitative innovation in Eastern Europe has not yet been made, however.

I propose to investigate whether in the Baltic Sea region the *telecommunications sector* forms an exception from this overall negative pattern, i.e. whether innovation in this sector is creative also in the Eastern countries, and if so, what the factors are that have enabled this. Telecommunications has been pointed out as a sector with particularly strong *interactions* between East and West in the Baltic Sea region in terms of foreign investment, subcontracting relationships etc., and in which advanced competencies exist also on a large scale in the East (e.g. NUTEK, 2000). However, it is not clear from earlier studies whether these competencies are actually reflected in any genuine, creative innovation in the Eastern countries, nor to what extent the far-reaching linkages to the Nordic countries have *fostered* or *obstructed* such creative innovation. Focusing specifically on the case of Estonia and the emergence of its connections to Sweden and Finland, the **purpose** of the project is therefore to ***analyse the influence of the Swedish and Finnish telecommunications sectors on Estonian innovation in telecommunications.***

Supported by recent theorising on so-called *sectoral systems of innovation* (see further below), I argue that important insights into innovation in the Baltic Sea region can be gained by studying innovation at the *sectoral* level as proposed here. In line with the classical argument in innovation studies that sectors differ widely in their rates and directions of development, I suggest that sectoral systems of innovation based on creative innovation may be emerging in some sectors in the Eastern Baltic Sea countries, although at a national level systems of inno-

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<sup>1</sup> The distinction between creative and imitative innovation goes back to Deutsch (1944), who used the terms 'initiative' and 'imitative' innovation, and Schumpeter (1947), who suggested the distinction between 'creative' and 'adaptive response', whereby he associated the latter with the imitation of an already existing innovation, while the former is seen as a 'new combination'. We here define creative innovation as the first application of a new combination and imitative innovation as its subsequent application.

vation may still be very weak.<sup>2</sup> I will investigate whether Estonian telecommunications forms such an exceptional sector. If so, the results of the project may provide useful hints with regard to the factors that at a sectoral level enable creative innovation to emerge as a driving force in the Eastern countries of the Baltic Sea region, and the role that the Nordic countries play in this process.

The proposed project will address the following empirical research questions:

- Is innovation in Estonian telecommunications *creative* or *imitative*, and how and why (if at all) has this changed over time?
- In particular, is there any evidence that Estonia's strong relationships to Sweden and Finland *enabled* or *hindered* the emergence of a 'creative' Estonian sectoral system of innovation?
- To what extent has Estonia's strong relationships to Sweden and Finland led to a *convergence* of Estonian telecommunications with Sweden and Finland in terms of innovation, i.e. is there any evidence of 'typical Nordic' features in the Estonian system?
- To what extent has Estonia's strong relationships to Sweden and Finland led to the emergence of a joint Swedish-Finnish-Estonian sectoral system of innovation in telecommunications?

### 3. Earlier research

The Cold War produced a vast number of studies with a focus on innovation in the Eastern bloc. For example, Hanson and Pavitt (1987) investigated the differences between systems of innovation in the Western market economies and those of the centrally-planned economies of the former Soviet bloc. In line with modern innovation theory, they suggested a systemic perspective to understanding the differences between innovation in East and West, showing that the weak performance of Eastern innovation systems was closely linked to the central planning of innovative activities. They pointed at the fragmentation of the innovation system as inhibiting vital learning processes, especially inter-organisational learning – both horizontally and vertically. They identified strongly *linear* characteristics of the East European model of innovation, with virtually no role for the demand side. Further, referring to evolutionary insights into the economics of innovation, they pointed at the critical lack of variety and redundancy and of appropriate selection environments.

With regard to the *influence* of Western on Eastern systems of innovation, an important research area in the Cold War period was the study of technology transfer in an East-West perspective. For example, Sandberg (1990) here studied how and to what extent Soviet-style innovation systems were capable of 'learning from capitalists' through technology transfer projects. The major results of these investigations were that imported technologies never acquired a dynamics of their own, but worked as static enclaves in the centralised economy. For example, modernisations were made only with new support package deals, and diffusion to other sectors than the military or space industries were minimal.

In the transition context of the 1990s, studies on systems of innovation in the transition countries in Eastern Europe usually include an interest in relationships to foreign firms and other organisations, but there is a critical lack of detailed empirical studies on how and why East

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<sup>2</sup> A system of innovation can be defined as 'all important economic, social, political, organizational and other factors that influence the development, the diffusion, and use of innovations' (Edquist, 1997). With this definition, we do not deal with the question of whether a system of innovation exists or not, but rather focus upon what type of actors we find in it, which functions they perform, and which evolutionary mechanisms may produce creative versus imitative innovation.

European countries are able to restructure and reorient their systems of innovation in the post-socialist context. The main reason for this is probably the very fact that innovation activities have been at a very low level in Eastern Europe, as indicated by much lower expenditures (as a percentage of GDP) on R&D and by a much lower patenting activity than in most Western countries (OECD, 2001).

Radosevic (1999) has used secondary literature to estimate to what extent the East-West differences as identified by Hanson and Pavitt (see above) have disappeared through Eastern Europe's transition to a more market-oriented innovation system. Not surprisingly, Radosevic finds elements of convergence with Western-style innovation systems as well as a number of remaining differences. For example, most formal institutions have quickly been brought in line with Western standards, and the old homogeneity of organisations have started to give way for a more heterogeneous structure, with the emergence of new kinds of firms such as 'specialised suppliers' as important agents in the innovation system. On the other hand, the innovative process in Eastern Europe seems to largely retain its strongly linear character, and the interaction among organisations in general remains weak. In particular, the role of universities in Eastern systems of innovation remains problematic.

However, this is a very broad picture, and it does not explain how and why partial convergence and new linkages with Western innovation systems actually do or do not emerge and what their impacts have been. In particular, it does not tell us anything about the extent to which the restructuring and reorientation processes have led to any creative (Schumpeterian) innovation in the Eastern countries, as opposed to adaptive, imitative innovation (as defined above). Sandberg (1999), stressing the importance of this difference between creative and imitative innovation, shows that for the case of environmental innovation in Poland, it is not yet possible to speak about creative innovation, despite many radical changes. This may be seen in relation to Radosevic's (1999) argument that the most interesting issue is in fact not the process of systems convergence (which he studied) as such, but rather the emergence of specific features of the East European systems of innovation, i.e. how and in what dimensions they have started to develop their own long-term systemic characteristics. However, such studies on the emergence of creative innovation and of specific features of innovation systems have not yet been carried out for most of the East European countries.

Bell (1997) pointed at the possibility for Eastern Europe to draw on experiences from developing countries and their integration with the world economy. For the already industrialised East European countries, however, restructuring of systems of innovation and their potential integration with Western systems involves, in contrast to these newly industrialising countries, not only the creation of new linkages to the West, but also a radical destruction of existing systems of innovation from an earlier industrial regime. On the one hand, Hirschhausen and Bitzer (2000) have in this context suggested that the heritage from these Soviet-style systems are more or less completely destroyed through the transition from central planning to a decentralised market economy. On the other hand, evolutionary theorising suggests that inherited institutions and patterns of innovation may constitute a considerable bottle-neck in the new, market-oriented economic system (Brezinski *et al.*, 1998). This question of the role of Soviet-era history in shaping post-socialist systems of innovation suffers from a lack of deeper empirical evidence.

In studies on Western countries, research on systems of innovation has during the past decade or so produced a wide array of new insights into innovation and its role in modern society (see Edquist & McKelvey, 2000, for an overview). Above all, the systemness of innovative activities have been addressed explicitly, with interactive learning through market as well as non-market interactions as a key process. However, there has so far been a strong focus

thereby on specific *national* systems of innovation or comparisons between different national systems, while there has been a very limited focus on how and why connections *between* systems develop and how these connections affect innovation.

An interesting variant of the systems of innovation conceptual framework is in this connection the so-called 'sectoral systems' approach. In line with the general idea of systems of innovation, it opens up for the explicit incorporation of factors such as institutions and non-firm organisations into the analysis of innovation, and it recognises learning as an interactive process involving both firms and non-firm organisations as well as market and non-market interactions (Malerba, 2002). As indicated by the concept, studies on sectoral systems aim at the analysis of innovation in a *systemic* perspective while, in contrast to the more common national and regional systems approaches, it proposes to focus on specific *sectors*. The obvious advantage is here that the geographical boundaries of the innovation system are not postulated *ex ante*. As indicated by Breschi and Malerba (1997) in their original formulation of the sectoral systems approach, this opens up the possibility of *transnational* systems of innovation in specific sectors. In view of increasing internationalisation of innovative activities, this is of great interest not least for small and internationally strongly dependent countries such as the Nordic countries and the Baltic states.

#### 4. Theoretical framework

In view of what has been said above, I argue that the sectoral systems approach may constitute the adequate starting point for the analysis of innovation in Estonian telecommunications and its connections to Sweden and Finland. In contrast to traditional studies on sectors (notably in industrial economics), the sectoral systems approach does not only take into account variables such as entry and exit, concentration, vertical and horizontal integration etc., but also the role of learning; of non-firm organisations in the innovative process; of the relationships among firms as well as between firms and other organisations; and of the role of institutions. Above all, the sectoral systems approach explicitly recognises sectoral innovation as a *systemic* and *historical* process. I argue that these factors are of key importance for understanding the emergence of transnational linkages in innovation and that they should therefore be dealt with explicitly. Moreover, these factors imply clear similarities with the overall systems of innovation approach, but by focusing on a specific sector, as I will indicate below, a clearer operationalisation and analytical clarity is made possible than with the *national* systems approach.

I here define a sectoral system of innovation broadly as the network of individuals, firms and other organisations that are involved in the generation, diffusion and utilisation of technology within a specific sector under the conditions of the sectoral institutional environment in which these activities take place. The institutional environment is defined by laws and other formal or informal rules (including firm- and sector-specific routines and codes). Institutions in this sense are thus not organisations, although the word institution is often used to denote certain organisations (e.g. universities and government agencies) in everyday language. We thus follow the definition by North (1990).

With regard to the purpose of the proposed project as formulated above, it is possible to discern two basic influences that the Swedish and Finnish sectoral systems of innovation could have on innovation in the Estonian telecommunications sector. The **first** potential influence implies that the telecommunications sector in Estonia has come to *resemble* the Nordic SSIs, in the sense that a similar sectoral structure (in terms of organisations and their linkages) has emerged; that a similar institutional environment has been established; and that technologies, knowledge and learning processes have come to resemble those observed in the Nordic SSIs.

(I will label this first potential influence ‘convergence’ – see further below). The **second** potential influence implies that the Swedish and Finnish SSIs have affected the Estonian SSI without necessarily making it *similar* to the Nordic system, but rather by creating and exploiting *complementarities* between the Nordic and the Estonian telecommunications sectors. Interpreting systems of innovation as ecologies of technologies and organisations subject to institutional selection, this is equivalent to the creation of a niche, i.e. a specialisation, which in this case may be based on creative or imitative innovation. It may then also be hypothesised that the Estonian telecommunications sector has actually become *part* of the Nordic systems of innovation in telecommunications.

In order to determine the extent to which these influences have actually occurred, I propose to operationalise the concept of sectoral system by seeing it as being composed by three main building blocks: **technologies**, **organisations** and **institutions** (cf. Malerba, 2002). Under these labels I include elements of the sectoral system in the following way:

‘Technologies’:

- Products, processes;
- Competencies (knowledge-base);
- Forms of learning;

‘Organisations’:

- Firms (and individuals);
- Non-firm organisations;
- Relationships and linkages;

‘Institutions’:

- Formal institutions;
- Informal institutions.

With respect to the first potential Nordic influence, these building blocks define the process of sectoral systems evolution in such a way that convergence (divergence) is said to occur when one or more of the dimensions technologies, organisations and institutions evolve towards increasing (dis)similarities. Convergence (divergence) is thus treated as a multi-dimensional process, i.e. it may occur in one dimension and in another not. For example, certain technologies might be developing towards increasing similarities in Estonia and the Nordic countries, while at the same time the characteristics of organisations might be developing towards increasing dissimilarities.

Breschi and Malerba (1997) have shown that under market economy conditions, the features of a sector’s technologies and the corresponding knowledge-base are likely to produce certain similarities across countries in all three building blocks. This is so also among the leading countries.<sup>3</sup> In this sense, elements of convergence does not exclude the occurrence of creative innovation. But on the other hand, creative innovation, by definition, presupposes *some* element(s) of divergence, be it within ‘knowledge and technological domain’ (technological product or process innovation); within ‘actors and networks’ (organisational innovation); or within ‘institutions’ (institutional innovation).

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<sup>3</sup> For example, the technological characteristics of the internet have brought about a radical change in the organisational landscape of telecommunications service providers. It has become possible for new kinds of organisations to enter the telecommunications services market, new processes of competition and collaboration have appeared, and new regulatory structures have had to be created. This is true for any telecommunications sector in which the internet has been adopted. See Corrocher (forthcoming).

However, the occurrence of elements of divergence is not in itself a sufficient condition for creative innovation. There is an obvious risk that divergence may be associated with disadvantageous specialisation of Estonian telecommunications which, for example, may lock it into a 'second-tier' supplier role based on low-wage labour. I therefore argue that the occurrence of creative innovation can only be determined empirically for each specific case.

Moreover, the extent to which convergence and divergence occurs does not tell us anything about how the above elements are *related* to each other and how they with these relations account for the evolution of the system. I discern two basic ways in which the elements are related to each other:

1) They are *embedded* in each other:

It is a classical evolutionary argument that institutions in the form of routines are embedded in organisations (Nelson & Winter, 1982). On the other hand, organisations are also embedded in institutions, in the sense that firms and other organisations are actually largely defined by firm-specific institutions; these account for the heterogeneity and idiosyncracies of firms and other organisations (cf. Edquist & Johnson, 1997). Moreover, from an evolutionary point of view organisations can be seen as *hosts of technologies* (just as organisms are hosts of genes). Conversely, technologies embody organisational features (for example, a Volvo car embodies characteristics of the firm Volvo, such as its well-known priority to security-thinking).

2) They are *determinants* of each other:

Technologies, organisations and institutions strongly influence each other and can thus be seen as important determinants of each other:

- *Features of technologies and of the knowledge-base tell a lot about how innovation is likely to be organised.* It is a well-known argument in the economics of innovation that the differences in technological characteristics across industrial sectors tend to produce sector-specific patterns of innovation (Pavitt, 1984; Breschi & Malerba, 1997). This also means that radical technological change may alter the sectoral structure; notably a Schumpeter Mark II pattern may change into a Schumpeter Mark I pattern.

- Similarly, *technological change also tends to enforce institutional change.* For example, innovation in biotechnology and in the internet sector have produced an intense search for new appropriate institutional structures.

- Organisations, on the other hand, are the agents of technological change. *The way innovation is organised therefore determine to a great extent what kind of technological change is possible and likely.* This is basically an argument from sociology ('social constructivism'), where technology is argued to be 'socially shaped' (e.g. Bijker, Hughes & Pinch, 1987). In a sectoral systems perspective, an example could be that in an economy where universities are very isolated from industry, it may be impossible to manage innovation in science-based industries; if there is a technological discontinuity that suddenly makes academic research crucial for industrial innovation, it is likely that some countries will quickly fall behind if there is no tradition of university-industry collaboration. (Maybe possible to see in some countries for the case of biotechnology?)

- Further, *institutions constrain the behaviour of actors and technologies.* In Sweden, it is forbidden by law to do research on applied nuclear physics! But institutions also *enable* inno-

vation: for example, the liberalisation of telecommunications has shown to be a crucial condition for launching innovation in internet services (Corrocher, 2002).

- But how are institutions created? I mentioned that new technologies may make institutional change necessary. But also *organisations exert great influence on institutional change*. It can be an issue of lobbying, but organisations are often involved in institutional change because their expertise is needed, i.e. they take part as advisors in the creation of institutions. In Estonia, for example, Swedish organisations and individuals took part as influential advisors in creating a new institutional structure for the telecommunications sector. This issue should be taken explicitly into account, rather than be abstracted from as an exceptional phenomenon.

These processes define the transformation of sectoral systems as a *co-evolutionary* process. This concept goes back to authors such as Nelson (1994), McKelvey (1997), Teubal & Andersen (2000), and is also emphasised by Malerba (2002) in recent work on sectoral systems.

If the co-evolution of technologies, organisations and institutions is strong, it is likely to produce *path-dependencies* in the sectoral system, since technologies, organisations and institutions develop in relation to each other (co-evolve) in a mutually reinforcing way. This may have advantageous or disadvantageous consequences. In the case of Eastern Europe, path-dependencies from the Soviet-era are usually seen as problematic. A key question is therefore under what circumstances path-dependencies in the SSI can be broken, so that the Eastern countries can either catch-up by converging with the West, or by developing a diverging SSI (a 'niche' SSI) building on a combination of Western influences and own accumulated innovative capability.

It seems plausible to assume that a necessary but not sufficient condition for such a breaking of path-dependencies requires some radical *discontinuity* in one or more of the dimensions of the SSI (technologies, organisations, institutions). In the case of Estonian telecommunications, there are interesting examples of such discontinuities with regard both to technology and to organisations and institutions. Institutionally, the break-down of the Soviet Union is definitely such a discontinuity, whereas technologically, the rise of the internet represents a paradigmatic rupture (Kavassalis *et al.*, 1996).

The key question is here which kind of discontinuities (technological, organisational or institutional?) may stimulate the emergence of a *creative* sectoral system of innovation? For the Estonian case, my hypothesis is that the break-down of the Soviet Union (i.e. a radical institutional discontinuity) was not enough to enable catch-up in innovation, but that the internet rupture (i.e. the technological discontinuity) has made it possible for a 'creative' sectoral system of innovation to emerge (key is here in addition that this rupture radically reduces cumulativeness). An interpretation of this would be that although Soviet break-up was pervasive, it was not enough to cut off the path-dependent co-evolution of technologies, organisations and institutions. The technological discontinuity, on the other hand, could do this.

If this hypothesis holds, the implication would be that **catch-up countries may build their innovative strength primarily on sectors that are subject to strong technological discontinuities**. This would explain why in most sectors the political revolutions of 1989-91 have produced major changes in the Eastern economies but without stimulating the emergence of 'creative' innovation systems. In sectors that are characterised by high cumulativeness and the absence of technological discontinuities, the radical institutional ruptures merely seem to result in the integration of the Eastern economies as 'second-tier' suppliers into the global economy. Foreign investors here often take advantage of already existing competencies in the

Eastern countries and do thereby not necessarily break the Soviet-era co-evolution radically enough. Catch-up is then characterised by imitative innovation.

For the purpose of the proposed project, a key issue is also to what extent co-evolution is a *domestic* or rather a *transnational* process. For example, NUTEK (2000) discussed the possibilities of transferring ‘successful Swedish concepts’ to the Eastern Baltic Sea countries; this would, if realised, be an element of transnational co-evolution. (In our case, it could take place, for example, through direct Swedish participation in designing Estonian institutions in telecommunications.) But the features of the institutional environment in the Estonian telecommunications sector could also develop as a response to *domestic* sectoral characteristics and needs. Another example is whether it are domestic or foreign markets that determine the structure of demand in the Estonian telecommunications sector. These are empirical questions. The ways in which Sweden and Finland, by being involved in the co-evolutionary process, affect the evolution of the Estonian telecommunications sector (an example was given above), are here seen to determine the second potential influence of these countries as formulated above. Further, the extent to which the process of co-evolution is transnational as opposed to domestic will be used in this project as a criterion for whether a *transnational* (joint Nordic-Baltic) *sectoral system of innovation* can be said to exist or not.

For the purpose of the proposed project, I see two main advantages of the sectoral systems model suggested here, as opposed to the national systems approach. First, there is overwhelming evidence from earlier research that the main systemic features of innovation that I are here interested in vary dramatically across sectors (e.g. Pavitt, 1984; Breschi & Malerba, 1997). A focus on the national level would make it difficult to say anything about key system characteristics such as the forms of learning that dominate the innovation process, the main channels of knowledge diffusion throughout the sector, the type of key relationships between actors, and the role of sector-specific institutions, since all these features vary strongly from sector to sector. Second, the sectoral model proposed here does not *ex ante* exclude the possibility that systems evolution takes place largely at a transnational level. A largely transnational evolution implies that the key determinants of innovation lie outside the national borders. Delimiting the system of innovation nationally would therefore make it impossible to study the key determinants of innovation. This is particularly important in ‘catch-up’ countries such as the transition economies in Eastern Europe, since ‘catching-up’ is likely to be particularly strongly associated with learning from leading countries’ experiences (see e.g. Fagerberg, 1988).

#### **4. Methodology and empirical sources**

The principal units of analysis in this project are of three kinds:

- technologies;
- organisations;
- institutions.

The method of analysis is based on the interactions between these. I will thus analyse how they influence each other, which defines the process of co-evolution as elaborated in the theoretical model above.

Further, in order to study the process of convergence (divergence), the project takes the form of a three-case study. The cases consist of the three telecommunications sectors in Estonia, Sweden and Finland. However, the approach is asymmetric to the extent that the Nordic sectors will be treated as *reference cases*, while the main focus will be on the Estonian telecom-

munications sector. A comparative approach is applied as far as the issue of convergence is concerned, whereby the Estonian sector is compared to the corresponding Swedish and Finnish sectors. I am thus interested in Estonia's possible convergence specifically with Sweden and Finland, i.e. I do not address the issue of whether convergence with *other* countries occur.

However, as the issue of convergence is only one part of the study, the project goes beyond this comparative approach to a considerable extent, since it also takes into account the issue of Nordic influences on Estonia and of the potential emergence of a joint Nordic-Baltic sectoral system, as discussed above. The three cases are thus not only compared, but above all the development of connections *between* them is studied. Here, too, the approach is asymmetric, as I focus on Nordic influences on the Estonian system, but not on Estonia's influence on Sweden and Finland. The influence is studied through the same units of analysis as specified above.

With regard to the delimitation of the specific sector to be studied, it should be noted that in a sector such as telecommunications, which is subject to high turbulence and undergoes complex processes of convergence with related sectors (computers, media), it is important to use a high level of aggregation (Malerba, 2002). This is because innovation in the sector is likely to be concentrated to a considerable extent exactly on these convergence processes. The project will therefore take into account not only traditional fixed and mobile telephony, but also internet access and content provision. Similarly, it will take into account not only manufacturing of traditional equipment such as exchanges and terminals, but also innovation in software.<sup>4</sup>

The units of analysis chosen above require that I take into account not mainly the traditional empirical data of sector- and industry-level studies such as entry and exit, concentration, vertical and horizontal integration, etc.; the empirical material will rather have to address in an explicit way the issue of formal and informal institutions and take into account the role of non-firm organisations, inter-organisational relationships, forms of learning and the character of the knowledge-base. These issues are all key for understanding the transformation of sectoral systems as a co-evolutionary process. In addition, the data must incorporate a period of time that stretches back to the origins of Nordic influence, which I will here roughly regard be the last few years of the Soviet era.<sup>5</sup>

The corresponding data are thereby both qualitative and quantitative. Semi-structured, qualitative interviews will be used to a considerable extent in the project, in order to collect data on the characteristics of technologies, organisations (and their history), informal institutions, and the inter-organisational relationships in which organisations (including firms) are involved. These interviews will be carried out with senior managers of firms and other organisations in Estonia, Sweden and Finland, representing organisations currently as well as in earlier periods.

On the other hand, data on the diffusion of telecommunications technologies, the changing population of firms in the sector, firms' expenditures on innovation, etc. will largely be subject to quantitative analysis.

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<sup>4</sup> The constituent organisations of the sector as defined here are thus: 1) manufacturers, i.e. producers of telecommunications equipment, components, etc.; 2) network operators; 3) access and content providers; 4) specialised software suppliers; 5) maintenance, installation and consultancy firms; 6) research organisations (including universities); and 7) regulatory and governmental bodies related to telecommunications. The telecommunications sector in this sense includes the *internet services sector*, and it also takes account of *non-firm organisations*.

<sup>5</sup> While being aware of the possibility of a Nordic influence already in the inter-war period, we will for simplicity concentrate on the more recent developments.

In addition, whenever possible, firm-specific material in written form, e.g. annual reports, company histories, etc., will be used, as well as background material covering changes in the formal institutional environment and the historical setting in which organisations act. The relevant material is here secondary literature, but also public policy documents and governmental and ministerial reports (e.g. master plans for the modernisation of the telecommunications infrastructure) and legislation (e.g. concerning regulatory reform and property rights).

Data on the Swedish and Finnish telecommunications sector in their domestic contexts will be collected mainly through secondary sources.

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