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Mechanisms for Dissemination of Innovations: A Case Study of four Portuguese Technology Centres

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Innovation Strategies to Catch-Up
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Øystein Luktvasslimo (sign.)

Valencia, Spain, 28th of September 2006

Abstract

This paper looks at the feasibility of different mechanisms for disseminating innovations; understood in this paper to mean the planned and directed transfer effort by an agent. The agent is in this case illustrated by four different Portuguese Technology Centres working for the interests of their member companies within four distinct sectors. The Technology Centres (TCs) represent in the researcher's opinion an appealing case in that they offer an angle on this topic closer to the industrial sector than is often found in other studies of the same kind, which are often focused at dissemination from public R&D laboratories.

A case study approach is applied using interviews as the key instrument of data gathering. Furthermore, this paper views technology, knowledge, and innovation as socially constructed in a National System of Innovation where the TCs being one of many actors.

It is suggested in the background of the findings in this study that dissemination activities should focus on two things: 1) Creating arenas where the parties can meet, thus enabling the stakeholders to negotiate and eliminate gaps stemming from tacit knowledge. These arenas should allow for relationships between actors to last in time since the adoption process is lengthy. 2) Focus on *what* is being disseminated; not only *how* since the 'what' may vary greatly from case to case.

The results if sought applied can be seen as transferable to other practitioners apart from technology centres, in the field. They should however be applied with care as examining their ramifications have not been done in this study; they should merely be seen as guidelines.

Key words: Technology Centres, Portugal, Dissemination, NSI, Knowledge

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Chapter 1: Introduction

1.1 Background

The spread of new techniques or the dissemination of innovations as it is labelled in this paper, is by many institutions regarded a tool for increasing the economic growth of regions. Other tools can include investment in the education of the workforce, infrastructure, public R&D et cetera. Publicly funded technology development projects which is another common tool used, often enforces obligations to spread the result widely thus for the benefit of whole sectors. These obligations do not however necessarily, state how the dissemination activities should ideally be performed to maximise their ripple effects. Additionally, previous studies within the field of dissemination of innovations often seem to focus on public R&D laboratories and transfer offices. These two elements leaves in the author's opinion a room for further studies on the feasibility of such activities seen from the viewpoint of a profit seeking actor, exemplified in this study by four Portuguese Technology Centres.

The Technology Centres dealt with in this study work both with dissemination on an institutional level; that is day-to-day activities to pass on new developments to their members, and on a project level; that is fulfilling the obligations for dissemination of results given by the funding institutions in case of technology development projects. In that respect they may represent in the investigator's opinion, an interesting case given their closeness to the industry and duality in dissemination activities. Finally, this paper can hopefully provide a complementary angle to dissemination from public R&D laboratories, a field which there exist abundant literature on[1].

[1] See for instance: Bozeman (2000), Brown et al (1991) and Eto (1995).

1.2 Structure of the Paper

The structure of this paper is based on Eisenhardt's (1989) model for building theories from case study research. Figure 1 shows how this corresponds with the different chapters of this paper.

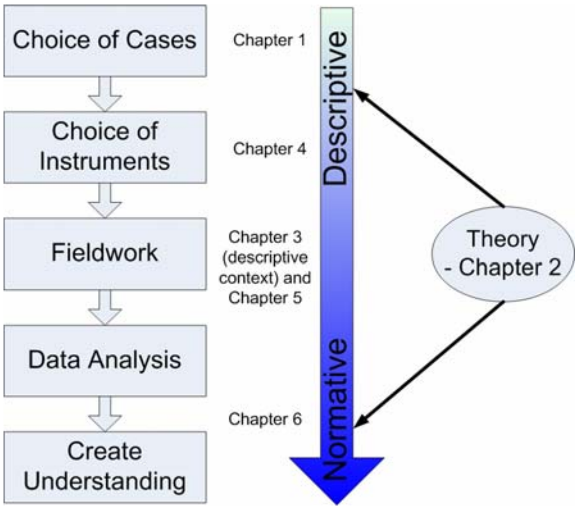

Figure 1 A model for building theories from case studies (Eisenhardt, 1989).

Moreover, the paper can be said to consist of three parts as illustrated in Figure 1: a descriptive part; this includes both the findings from the applied methods and a descriptive context, a normative part; where recommendations are being made based on the descriptive part, and a theoretical part. Methodological issues are discussed in Chapter 4.

1.3 Objectives

The objective of this study is threefold:

1. Understand the diffusion of innovations as a social process involving different actors, players and institutions negotiating within a system.
2. Present the dissemination of innovations in a broad systemic context.
3. Be able to suggest based on the theoretical framework and the relevant findings in this study, well-designed and efficient methods of disseminating innovations.

1.4 Research Question(s)

The research question suggested for this paper is the following:

How do the dissemination practices of the Technology Centres analysed in this study relate to the models and theories of innovation diffusion? Which of those models might be more effective in terms of suggesting normative guidelines for the action of those Technology Centres?

1.5 Scope and Limitations

This paper examines aspects of the dissemination process and tries to assess their relative efficiency, where the ultimate goal of this process being implementation of innovations with SMEs. Two key arguments are developed. Firstly, that *what* is being a disseminated matter as technology, knowledge and science is often 'black boxed' by transfer agencies. Secondly, assessing the efficiency of different dissemination mechanisms is difficult given the nature of the technology adoption process; its length in time, multiple sources and involvement of many actors. To illustrate this, the case of four different Portuguese Technology Centres is studied. Given the space available one will be unable to follow the case over a length in time and study the dissemination process from the perspective of the SME, so this paper will simply use literature on the field to provide recommendations. The aim of this study is not to go into technical details about the innovations being transferred; it is rather to use broad principles from the theory to explain what aspects of the innovation one should take into consideration in a dissemination process.

Chapter 2: Theoretical Foundations

This part of the paper seeks to identify a theoretical framework for this study to be performed within. One also wishes to establish a vocabulary to work with this field securing the transferability and interpretability of potential results of the study.

2.1 Constructivism and Evolutionary Economics

This paper will try to argue that to innovate; thus presupposing the spread or dissemination of new knowledge as a vital part of this activity, is a collective process involving many actors, players and institutions within a system. To build up this argument one will departure from *social constructivism*.

The construction of Science and Technology is a social process. This thought is often accredited the School of Social Constructivism[2], or to quote one of the central contributions to this field the book "The Social Construction of Technological Systems. New Directions in Sociology and History of Technology" from 1987 by Bijker et al: "Science and technology are socially constructed cultures and that the boundary between them is a matter for social negotiation and represents no underlying distinction"(p. 11). Different actors on a stage negotiate influenced by cultural variations. Maybe the most fundamental aspect of this line of thought is that it can be said to contradict technological determinism[3]: humans shape technology through social processes; technology does not shape human action. It tries to open up the 'black boxes' in which science and technology are constructed, taking into account the

[2] In many cases labelled SCOT (Social Construction of Technology). See for instance: http://en.wikipedia.org/wiki/Social_construction_of_technology for a very brief introduction and suggestions for further reading.
[3] Technological determinism is for instance accused of an account of technology as something beyond the realms of policies, politics and culture; where technology is predetermined to follow a certain path.

cultural dimension, but maybe even more important it gives hope that technology and science can be shaped through social processes and policies. Following this logic, understanding these social processes happening inside the black boxes are crucial for modelling successful policies.

Social constructivism might be called an important input to how the concept of innovation is viewed by scholars today. To find the root of today's (academic) view on innovation it would be only natural to turn to the works of Austrian economist Joseph Alois Schumpeter (1883-1950), seen by many as the 'father' of innovation studies. Another fundamental pillar in which contemporary innovation studies build on, is *evolutionary economics*. These two pillars together with the idea of science and technology being negotiable can have formed the basis for viewing innovation as *systemic of nature* (Fagerberg, 2004): organisations innovate in collaborations with other organisations and there are widespread feedback loops in the innovation process. The innovation-concept will be discussed more thoroughly at a later point in this paper, but it could prove valuable to catch a glance at evolutionary economics before moving on.

As already mentioned Joseph Schumpeter is by many considered the founding father of modern innovation studies, but he is also widely recognised for introducing the *evolutionary perspective* in economics in his book "the Theory of Economic Development" from 1949. Labelled evolutionary in that it bares many resemblances with Charles Darwin theory of evolution: selection, variation, radical inventions (new species) etc. Schumpeter argues in his works that there exists an equilibrium; a normality of economical life; that is put out of balance by entrepreneurs introducing innovations altering the relative position of already existing technologies and means of production, thus shifting the scale. Central in today's view to evolutionary economy are concepts such as *variety* (: “the processes which determine the range of actual innovations (variety) introduced into the economy” (Metcalfe, 1994, p. 934)), *selection* (the processes which alter the relative economic importance of the competing alternatives (selection)” (pp. 933), and *moderation* as the one that allows dynamic entities. These notions of selection and variation can be said to have been introduced by ‘new’ evolutionary economists. One of the most important of these later contributions to evolutionary economy was a book published by Nelson & Winter in 1982: “An Evolutionary Theory of Economic Change”, where the authors use terms as selection and variation. Even though these terms can said to have been first put to use in this book they can also be viewed as a continuance of Schumpeter’s notion of *creative destruction;* the process describing the industrial transformation after the introduction of a radical innovation (Metcalfe, 1994).

2.2 Innovation and Models of Innovation

A single definition of innovation, if it should ever exist, will not be applied in this paper. If one should attempt to search for such a definition it would be only natural to once again start with Joseph Schumpeter, as this paper previously labelled the father of contemporary innovation studies:

> […] The setting up of a new production function. This covers the case of a new commodity as well as those of a new form of organisation such as a merger, of the opening up of new markets, and so on […] innovation combines factors in a new way, or that it consists in the carrying out of New Combinations (Schumpeter, 1939, pp. 87-8).

Seen in connection with the main topic of this paper, the dissemination of innovations, one immediate critic of this definition arises: it does not encompass the diffusion of the innovation. Furthermore, it does not necessarily include process innovations as it seems to focus on product (“commodity”) and organisational innovations. Another definition including the diffusion of the innovation is suggested by Everett M.Rogers in his book “Diffusion of Innovations”: “An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12). Here Rogers include the *unit of adoption* because of his focus on the diffusion of innovations *in lieu* of their coming into being. For this paper it might be an important perspective to consider, as much of the same perspective as Rogers will be maintained through this study. Focusing on the units of adoption and diffusion in the study of innovations does not automatically exclude a perspective on their arrival on the market; on the contrary, as adoption of innovations is in itself combining new ideas and knowledge they can be said to be interwoven. This study will not debate over various definitions of innovation to find one that is appropriate in this case, but instead confine itself to make the same important distinction between invention and innovation as Fagerberg (2004): "Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice" (Fagerberg, 2004, p. 4). In other words: an invention is not an innovation until it is any way put into use or practice, and what is normally perceived as innovation might indeed be a combination of several inventions, or other innovations . This definition encompasses in the author's opinion the diffusion of the innovations as a successful adoption means combining already existing knowledge: thus to innovate.

Moving on from defining innovation to how the actual process is viewed, the long prevailing Linear Model of Innovation commonly accredited Vannevar Bush's letter from 1945 to the President of USA at that time; "Science the Endless Frontier", has long been adapted as the model for policy making, promoting that increase R&D investment will give economical growth (Lundvall & Borrás, 2004). It preaches a linear relationship between basic research and economic and technological growth. A visualisation of this perception of the innovation process is shown in Figure 2. It That is not to say there exists empirical evidence directly contradicting such a connection between investment in R&D and economic growth, but in more recent years there has been a wide appreciation of this process as far more complex. One has gradually starting to see the innovation process as involving many actors, players and institutions working together often combining already pre-existing knowledge in new ways, thus diminishing the importance of R&D and augmenting the importance of network interactions.

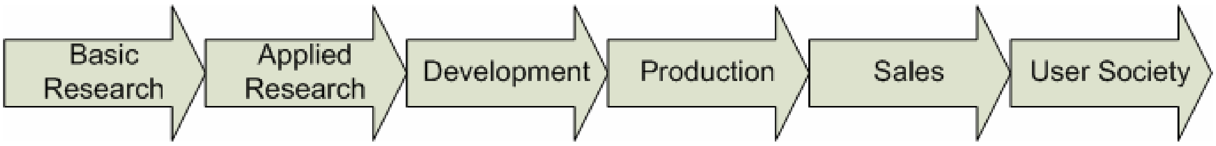

Figure 2 The linear model of innovation (adapted from Bush, 1945).

Today's academic prevailing view of the innovation process might in many ways have been sparked by Kline & Rosenberg in 1986. They proposed at that time a Chain-Linked view between research and innovation criticising the traditional linear model, suggesting that the relation was of a more interactive kind and did not originate solely in R&D, but rather in a variety of activities (Kline & Rosenberg, 1986). This model is shown in Figure 3 with extensive feedback loops. In this model a firms networking and interaction processes are crucial to how innovations occur on the market. This importance of a firm's network with respect to innovativeness has been the focal point in many studies by for instance Pittaway et al. (2004); how networking affects innovativeness, and Rothwell (1991); how external networking is crucial for SMEs innovativeness due to small in-house capacity. However Tödtling & Kaufmann (2002) discusses in an article from 2002 how the external networking of SMEs is to a large extent limited to other SMEs in the same region (Upper-Austria) (Tödtling & Kaufmann, 2002, p. 15). This may indicate that as external networking is widespread and crucial for SMEs innovative capacity, the role public agencies play in the innovation process might or not be important.

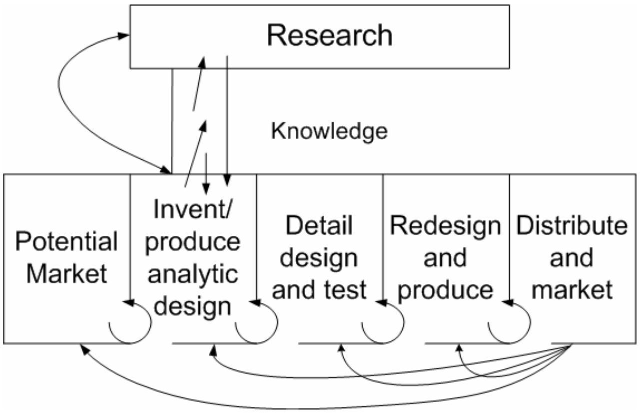

Figure 3 The Chain-Linked Model of Innovation (Kline & Rosenberg, 1986).

The criticism of the linear model of innovation could also be seen as a denunciation of the four pillars in neo-classical economic thinking: a single profit maximising company, economic agents act on rationality alone and have perfect information, technology and science are seen as a publicly available exogenous variable, and the relation between science, technology and market is seen as linear, thus constituting Bush's linear model of innovation shown in Figure 2.

The reason for presenting these models of the innovation process was twofold. Firstly it's important to notice that innovation is now, as opposed to Bush's linear model, viewed by at least scholars as an interactive process, being far more complex than only a strict linear relationship between science, technology, and market. Secondly, it's important to shed light on how academics see the process of innovation today and the 'rediscovery' of evolutionary economics, and furthermore the recognition of science and technology as being socially constructed and systemic of nature.

2.3 Knowledge as a Resource

The somewhat denunciation of neo-classical economic thinking might have ignited the wide appreciation of knowledge as a factor of production. This, because labour and capital traditionally have been considered the original first two in classic economics. Knowledge can nowadays readily be transferred regardless of nation-state borders or topographic obstacles: people are living in what Peter Drucker referred to in his book from 1968 “The Age of Discontinuity” as a *knowledge economy.* Knowledge is seen as an asset, a possible competitive advantage for firms or nation-states, where investment in for instance education yields direct profits. Drucker talks 22 years later in a book from 1990, about how changes in the view of knowledge, could relate to the fact that knowledge now is being applied to *doing* instead of *being* and thus has become a resource (Drucker, 1998)

Logically, concepts such as *technology transfer*, *diffusion of innovations*, and *knowledge transfer* are viewed as crucial assigning knowledge such a high relative value as a resource: if knowledge is a key resource then controlling the channels where knowledge flows, optimising the flow, and maximising the output is of course *as* fundamental as dealing with pipelines of oil. The importance of the channels is also underlined by the shift to an interactive view of the innovation process. The transferral concepts will be discussed more in detail in a moment, but one should first try to remove any potential confusion regarding the terms knowledge and technology and if possible, attempt to provide some precise definitions.

The concept innovation has already been touched upon earlier in this paper. As proposed, *to innovate* is to combine knowledge to present something perceived as new. But what does this knowledge comprise, and what is technology? In many cases the concepts of technology and knowledge overlap, and are maybe for that reason often treated as black boxes. On the other hand, many scholars working within the field of *technology transfer* spend a great deal of effort on clarifying potential confusion in relation to these terms before moving on to talk about the actual process of technology transfer (Autio & Laamanen, 1995). Daniel Bell proposes in his book “The Coming of a Post-Industrial Society: a Venture in Social

Forecasting" from 1976 where he predicts a shift in how our society is made up; from goods to services, a definition for knowledge drawn upon what Robert Lane defines as the knowledge society:

> "Knowledge is that which is objectively known, an intellectual property, attached to name or a group of names and certified by copyright or some other form of social recognition (e.g. publication). This knowledge is paid for-in the time spent in writing and research; in the monetary compensation by the communication and educational media" (Bell, 1976, p. 176).

Bell's focus is on the objectivity of knowledge and that it can be traded and its value estimated on the marked for it to be knowledge. This definition might be criticised for missing a crucial aspect of knowledge: the divide between *tacit* and *explicit* originally made by Polyani (1966). Burton-Jones (1999) elaborates on this when he makes a distinction between these two kinds of knowledge. This divides whether the knowledge can be; "codified and readily transmitted" (Burton-Jones, 1999, p. 7), thus being explicit; or if it remains "tacit (literally 'silent')" (p. 7), thus difficult or maybe even impossible to transfer. Another important distinction Burton-Jones makes, is the difference between data, information and knowledge where data being "any signals that can be sent by an originator to a recipient-human or otherwise", "information is defined as the data that is intelligible to the recipient" and "knowledge is defined as the cumulative stock of information and skills derived from use of information by the recipient" (p. 7). Learning is labelled as "knowledge acquisition" (p. 6). The concept of learning is central to the National System of Innovation perspective described more in detail later in this chapter.

Gorman (2002) details further on the distinction between tacit and explicit knowledge in respect to technology transfer, proposing four different subcategories summarised in Table 1:

	Declarative (explicit)	**Tacit (implicit)**
Information (what)	Accretion, memorization, External memory aids	Restructuring
Skills (how)	Algorithms	Heuristics, tuning, Hands-on, kinaesthetic
Judgement (when)	Rules	Case-based expertise, *mental models*, trans-active memory technological frames *Italics indicate knowledge shared in groups
Wisdom (why)	Codes	Moral imagination

Table 1 Types of Knowledge (adapted from Gorman, 2002, p. 228).

This paper has now proposed that knowledge is generally viewed as comprising two elements: tacit and explicit. In transferring it, one usually seeks to codify the tacit element to make it explicit. But in transferring one should ideally know what is being transferred calling for a distinction between technology and knowledge. Eto et al (1995) uses this definition of *technology transfer* including a statement on what is technology: "Technology is information that is put to use in order to accomplish some task" (Eto et al., 1995, pp. 672). This definition could point to a perception of knowledge not being applicable unless it is put into use as a technology. Autio & Laamanen (1995) working within the academic field of technology transfer applies on the other hand quite a broad definition of technology:

> Technology comprises the ability to recognize technical problems, the ability to develop new concepts and tangible solutions to technical, and the ability to exploit the concepts and tangibles in an effective way. (Autio & Laamanen, 1995, p. 647).

Using such a broad view on the technology concept could in this paper's opinion miss the important difference between knowledge and technology in that the latter comprises a physical artefact as well, or as Rogers (2003) puts it:

> A technology usually has two components: (1) a hardware aspect, consisting of the tool that embodies the technology as a material or physical object, and a (2) software aspect, consisting of the information base for the tool (Rogers, 2003, p. 13).

Another way of looking it would be to say that what many perceive as being a technology is merely the hardware aspect of it forgetting that it also includes a software, or knowledge, aspect being tacit or explicit. In working with the dissemination of research results or the dissemination of innovations in general, it is important to keep this in mind as it can work as a barrier for efficient technology transfer. Transferring technology as the pure hardware aspect of it exemplified by for instance a machine should not prove too hard as machines are everyday being made available to more and more people; the problem is that it always carries this “software aspect” (Rogers, 2003, p. 13) making the transfer process far more complex. Nonaka and Takeuch (1995) also points to tacit knowledge being created in companies by them redefining problems and re-creating their environment, and that this knowledge is not easily transferable. This contradicts a popular perception that companies simply process external information in order to resolve their challenges and should be an important aspect to remember when trying to disseminate new techniques.

2.4 Systems of Innovation

Earlier in this paper it was suggested that innovation is systemic in nature. Firms interact in networks and share knowledge, which is seen as a factor of productivity and a key asset in the new knowledge economy; easily tradable and transferable. All of these thoughts can have be said to have contributed to the rise of the *System of Innovation* (SI) approach. For this study such an approach with boundaries of the nation state will be applied in order to frame the analysis.

This paper will suggest that a system can in general said to, among others, possess the following three characteristics:

1. A system has boundaries which can be open or closed, thus constituting an open or closed system.
2. A system serves a function.
3. A system contains various objects/entities being in some way connected; if not they are not part of the system.

The SI approach presupposes a non-linear view of innovation as indicated in Figure 3 and abundant networking and cross-linking between firms and institutions involved in the innovation process, or as Noteboom puts it: “A central feature of innovation systems is that innovation arises from interaction between organisational units” (Noteboom, 2003, p. 105). The Chain-Linked model discussed earlier in this paper is just one of many theoretical perspectives within the Systems of Innovation approach with *distributed process model, interactive learning theory, network analysis*, and *development block theory* being among the other approaches (Edquist & Hommen, 1999, pp. 70-5).

The main function of a SI is according to Edquist (2006, p. 182) is:” To pursue innovation processes, i.e. to develop, diffuse and use innovations” (cf. 2nd characteristic of a system). And it is per definition: “All important economic, social, political, organizational, institutional, and other factors that influence the development, diffusion, and use of innovations” It comprises *organisations*; “Formal structures that are consciously created and have an explicit purpose. They are players or actors” (p. 182), and *institutions*; “Sets of common habits, norms, routines, established practices, rules, or laws that regulate the relations and interactions between individuals, groups, and organizations. They are the rule of the game” (p. 182).Together the organisations and institutions are the components in the SI (cf. 3rd characteristic of a system).

This paper will suggest a National System of Innovation (NSI) as a framework of analysis. This is another theoretical approach within the system view and perhaps most viable in this connection: it sets a nation’s border as the boundaries of the system (cf. 1st characteristic of a system). Furthermore, adopting a NSI view gives the opportunity to talk about potential findings in a transferable and accepted terminology. The NSI approach was first introduced by Freeman (1987) and followed and elaborated by many others such as Lundvall (1992) and Nelson (1993). The NSI approach builds upon two basic assumptions: the importance of knowledge and learning to the modern economy and the institutional context of learning (Gu, 1999, p. 2). A definition of a NSI is difficult to provide as there exist many without one prevailing; Freeman suggested: “The network of institutions in the public- and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies” (Freeman, 1987, p.1), Niosi: “The elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge […] and are either located within or rooted inside the borders of a nation state” (Niosi, 2002, p. 292).

The notion of a NSI is relatively young and that might be why there exists both several definitions and it is in its nature perhaps vague, intangible and difficult to grasp. A figure; as shown in Figure 4, presented by Arnold & Kuhlman (2001) could help perhaps prove more useful in order to envision what comprises a NSI.

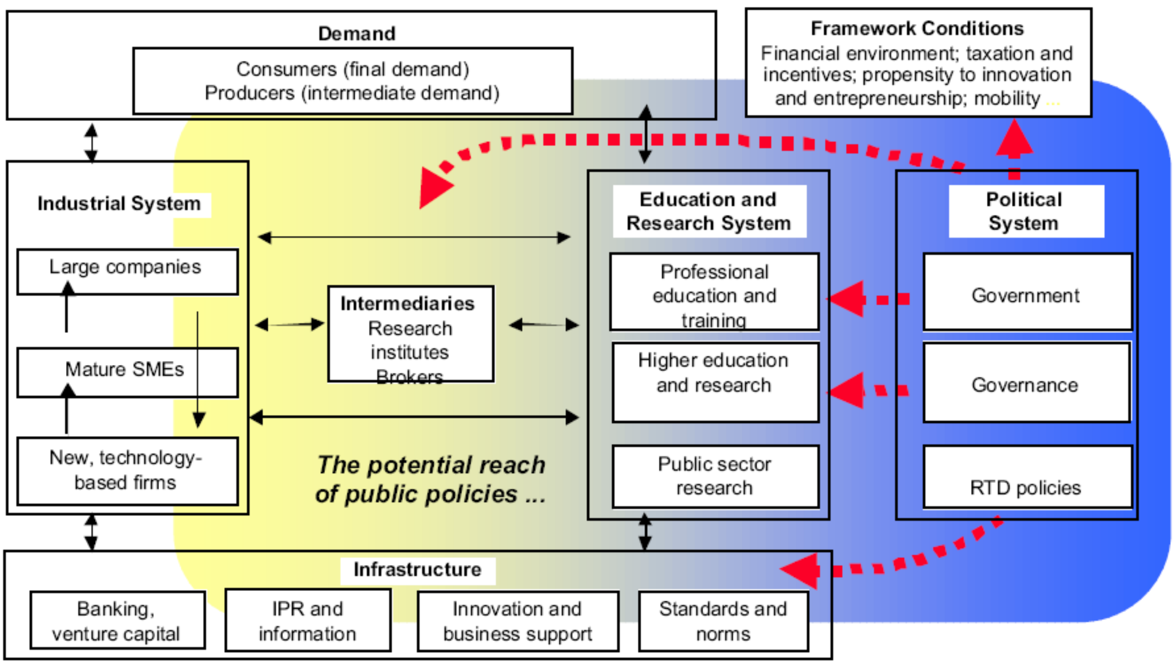

Figure 4 A National Innovation System Model (adapted from Arnold & Kuhlman, 2001).

In Figure 4 one see how a possible NSI is made up of actors, how they interact under certain conditions and in what way intermediating actors can influence the flow of knowledge. The example shown in Figure 4 is of course an imaginary one, but could also serve as an illustration of the complexity and often intricate network interactions that exist in a region or nation. It is exactly these interactions that are focused upon in the studies of NSI, or as OECD[4] puts it: "The study of national innovation systems directs attention to the linkages or web of interaction within the overall innovation system." (OECD, 1997, p. 4).

NSI should not be seen as competitive to other approaches such as Regional Systems of Innovation (Cooke, 1996), Technological Systems (Carlson & Jacobson, 1997) or Sectoral Systems of Innovation (Malerba, 2004). It is this paper's opinion that it should rather be considered complementary giving a different angle where nation borders constitutes the boundary conditions.

The increased interest in Systems of Innovation can also be seen in relation to the growing awareness of existing within a *knowledge society* briefly mentioned earlier in this paper, defined by the free online dictionary Wikipedia as:

> "Knowledge societies have the characteristic that knowledge forms major component of any activity, particularly economic activities. Economic, social, cultural, and all other human activities become dependent on a huge volume of knowledge and information. A knowledge society/economy is one in which knowledge becomes major product and raw material."

Or as the European Commision state on their Knowledge Society page:

> "Our society is now defined as the 'Information Society', a society in which low-cost information and ICT are in general use, or as the 'Knowledge (-based) Society', to stress the fact that the most valuable

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[4] The Organisation for Economic Co-Operation and Development

> asset is investment in intangible, human and social capital and that the key factors are knowledge and creativity". [5]

In other words: a knowledge society is fuelled by a functioning knowledge economy, and knowledge is the key resource in such an economy.

To know which the key channels of knowledge are and how to maximise their efficiency is thus crucial presupposing human and social capital as such important assets in the society, as also pointed out previously. Putting in the society within a System of Innovation framework can help identify and analyse through which channels knowledge flows. (OECD, 1997, p. 12) provides four different examples of channels where knowledge could flow among actors in a national innovation system:

1. Interactions among enterprises.
2. Interactions among enterprises, universities and public research laboratories.
3. Diffusion of knowledge and technology to firms.
4. Movement of personnel.

In this paper the main focus is on the second channel, but it is obvious that such channels do not arise independent of each other; they are rather a categorisation to help pin the analysis. The diffusion of knowledge and technology to firms can for instance include all of the four. OECD's characteristics can therefore be said to somewhat confusing, and actors working with creating knowledge flows should not limit themselves to only one kind of activity.

2.5 Dissemination of Innovations

A theoretical framework and a terminology have now been suggested so that it is possible to move more specifically into the field of which this paper chooses to label *the dissemination of innovations*; a rationale for such a label will be given in this chapter. Claiming that

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[5] Source: EC- Knowledge Society Homepage: http://ec.europa.eu/employment_social/knowledge_society/index_en.htm

incorporating new techniques, processes and knowledge into the production have traditionally been viewed as a key factor to economic growth would be fairly uncontroversial; problems may however occur when one want to find out what the influencing factors are and how they differ in magnitude. Approaches to this area of research have been made from many different fields: historical, sociological, economic, and network theoretical (Hall, 2006, p. 461). The diffusion of new techniques has also been viewed as an important strategy to *catch-up,* defined as: "the ability of a single country to narrow the gap in productivity and income vis-à-vis a leader country" (Fagerberg & Godinho, 2004, p. 515), and is as suggested earlier in this document one of the functions of a National System of Innovation.

According to the economical historian Rosenberg the "serious study of the diffusion of new techniques" (Rosenberg, 1972, p. 3) did not appear until the mid 1960's. Some of the early contributors to the field include Nathan Rosenberg and Edwin Mansfield. What Rosenberg tries to do in his article "Factors Affecting the Diffusion of Technology" from 1972 is an attempt to link the events of technological change to economical consequences and the factors affecting the spread of new technology. Edwin Mansfield explores on the other hand in his article from 1961, factors that might determine the rate at which new techniques spread from one firm to another. Some of his findings were: there are inter-industry differences in the rate of imitation; rate of imitations was slower for less profitable and higher degree-of-investment techniques, and the general tendency was that the rate of imitation was higher in more competitive industries (Mansfield, 1961, p. 763). Even though Mansfield's study is both limiting in time and scope and one should not necessarily put to much emphasize on the findings, one important point noted by both Mansfield and Rosenberg is: two important characteristics of the diffusion process are: "its apparent overall slowness and the wide variations in the rates of acceptance of different inventions, on the other" (Rosenberg, 1972,

p. 6). So what is possible to conclude from this is that finding the factors that determine the rate of imitation might be difficult given that one accept that it varies greatly depending on the characteristics of the innovation[6].

The process of dissemination may have many names depending on which kind of process one emphasise: *technology transfer, diffusion of innovations, dissemination of results*, and so forth. Autio & Laamanen (1995) suggests the following definition for *technology transfer*:

> Technology transfer is intentional, goal oriented interaction between two or more social entities, during which the pool of technological knowledge remains stable or increases through the transfer of one or more components of technology." (Autio & Laamanen, 1995, pp 648).

Rogers (2003, p. 152) furthermore suggests three levels of technology transfer:

> *Knowledge*: Here the receptor knows about the technological innovation.
> *Use*: Here the receptor has put the technology into use in his or her organization. This level of technology transfer is much more complex than just knowing about the technology. The difference is equivalent to the knowledge stage in the innovation-decision process versus the implementation stage.
> *Commercialisation*: Here the receptor has commercialised the technology into a product that is sold in the marketplace. For such commercialisation to occur, a great deal of time and resources must be invested by the technology receptor. Commercialisation requires interpersonal communication exchanges about the technology over an extended period of time.

It is implied in this paper than a transfer organisation is working towards the goal of commercialisation. As one might see, Rogers says that this requires a platform where actors can communicate over time.

So what is then the difference between technology transfer and diffusion of innovations? Hall (2006) states that: "In the study of, the word diffusion is commonly used to describe the process by which individuals and firms in a society/economy adopt a new technology, or replace an older technology with a newer" (Hall, 2006, p. 461). Rogers says the following "Diffusion is the process by which (1) an *innovation* (2) is *communicated* through certain

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[6] This paper chooses to use innovation even though Rosenberg in the citation included talks about inventions.

channels (3) over *time* (4) among the members of a social system" (Rogers, 2003, p. 11), but also: "Some authors restrict the term 'diffusion' to the spontaneous, unplanned spread of new ideas and use the concept of 'dissemination' for diffusion that is directed and managed" (Rogers, 2003, p. 6). In line with Rogers, Hall, and the concepts discussed previously in this sector this paper choose to label the concept: *dissemination of innovations* since it talks about a directed and managed effort (dissemination) to introduce something new (innovation). Additionally, avoiding the term technology should circumvent critics of this must necessarily include a hardware aspect. The term diffusion will label the general process of adoption.

2.5.1 Models of Technology Diffusion

Roughly this paper will seek to divide models for dissemination of innovations into two categories: m*odels for technology adoption or imitation* and models for how to *perform dissemination of innovations*. The first category can be said to view the diffusion process from the adapting entity, while the latter through the eyes of the disseminator. In line with the objective of this paper one will try to focus on the second category, but start off by briefly discussing the first category hopefully providing a holistic view of the diffusion process.

Models for Technology Adoption

The literature on field of technology transfer is vast. Subsequently there also exists a popular perception of how technology is adopted over time and models to account for this perception. That the adoption follows an S-curve; the diffusion rate curve having an area of rapid rise in the middle culminating with one infliction point and converging towards a value as time passes, is the prevailing model among both policy makers and academics (Geroski, 2000, p. 603).

An example of this S-curve is shown in Figure 5. Curve B represents the perception that there is a time lag before firms start to adapt the new technology, then a rapid phase of adoption, before the rate of imitation will decrease and number of users converges towards the limit of maximum possible users. This time lag (the period from 0 to λ in Figure 5), or slowness, being one of the fundamental characteristics of technology adoption has been observed by many scientists in relatively large studies including already mentioned Mansfield (1963) and Rosenberg (1972, p. 6). According to Rogers (2003) the diffusion process is characterised by the three phases shown in Figure 5: phase I where the early adopters are prevalent, phase II which is labelled 'take-off', and phase III where the late adopters enter.

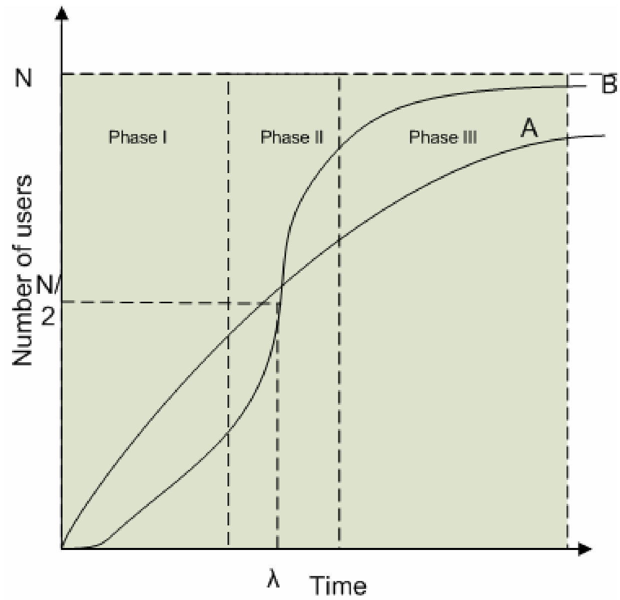

Figure 5 Exponential (A) and logistic (B) diffusion function (adapted from Geroski, 2000, p. 605).

The view of an S-curve shown in Figure 5 might be said to follow an evolutionary economic approach described briefly earlier in this paper because of two features: 1) Continuous (small) change leads to big changes over a long time span. 2) Periods of small and no change follow short periods of rapid change (Mokyr, 1990). Such a view uses the theory of evolution as a model; competition between technologies (species) on the market creates specialisation, the difference being that technology is created through learning (the central process in a NSI) and is therefore cultural and can be imitated and be disseminated. This leaves the room for actors that want to work with intentionally spreading innovations.

But to return to the S-curve for a moment: If this is how one perceives how an innovation is introduced, the next step, as often in science, is to construct a plausible model that will fit the empirical observations. Geroski (2000) has analysed these models quite thoroughly and states that there are different kinds of models that will (and wont) plot a curve resembling the one marked 'B' in Figure 5 and they chiefly fit four different categories: *epidemic, probit, legimitation & competition*, and *information cascades* (Geroski, 2000, p. 603).This paper will not venture into this field being beyond the scope; however it could be useful to give some brief examples to perhaps create further insight.

An *epidemic* model could be the one given in equation (1):

$$y(t) = N\{1 - e^{[-\alpha t]}\} \quad [7] (1)$$

Where N is the potential users of a new technology, y (t) is the amount of firms that have adopted the technology at a time t, α is the share of potential users informed by a central source (e.g. a Centre of Technology). Even though this might be a popular view on how a 3rd party might assist in disseminate new technologies it will not give a curve such as the one marked 'B' in Figure 5, but instead the one marked 'A' giving the name epidemic resembling the rise and stagnation of an epidemic. In other words; this is a model of how information might spread in a population and not technology, because technology also includes an element of tacit knowledge (Geroski, 2000, p. 605); firms will not automatically adopt a new technology just by being informed about it. This can be supported by the theses that

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[7] This simplified model builds on one core assumption: all firms that are informed will adopt the technology. This is of course not a reasonable assumption.

knowledge is culturally created through learning and Rogers (2003) hardware-software definition of technology quoted earlier in this document. Epidemic models might be adjusted with a component of firms already adapted to the new technology helping to spread it further in order for such a model to fit an S-curve.

The other models mentioned earlier might also be used to fit to an S-curve of adoption depending on what one wants to look at: probit models include firm specific characteristics[8] as the rationale for choice (Geroski, 2000, p. 610), legimitation & competition models includes the factor of density (in firms already adopted) dependence (p.616), and information cascade models including the factor of lock-in an lower learning costs for latecomers (p. 619). Together they may provide a valuable insight in the diffusion process and where and how the effort from a third party disseminator should be put, but they still remain only models with the limitations that implies.

Models for the Dissemination of Innovations

Despite of increasing knowledge on how new technology is absorbed, and innovation being systemic of nature, third party disseminators and policy makers in many cases continue to work on the basis of what Brychan (2000) labels the Centre-Periphery model (see Figure 6).

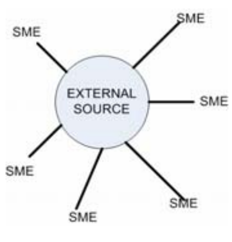

Figure 6 Centre - Periphery Model (Brychan, 2000).

Here the mediator is viewed as the one which knowledge passes through, a passive loudspeaker, in the line of an epidemic information model as shown in equation (1). As

[8] Transfer costs, risk aversion, size etc.

already stated, this is not necessarily a viable approach; ignoring inter-firm interaction, tacit knowledge elements, and to a large extent differences in firms characteristics. Or in the words of Everett M. Rogers: "Most change agents concentrate their efforts in creating awareness-knowledge (although this goal could often be achieved more efficiently by mass media channels)" (Rogers, 2003, p. 173).

To move on more specifically to the dissemination process, Everett M. Rogers (2003) autored a well known book called "Diffusion of Innovations" where he presents a model for how to perform the diffusion of innovations. A general overview of this model is presented in Figure 7.

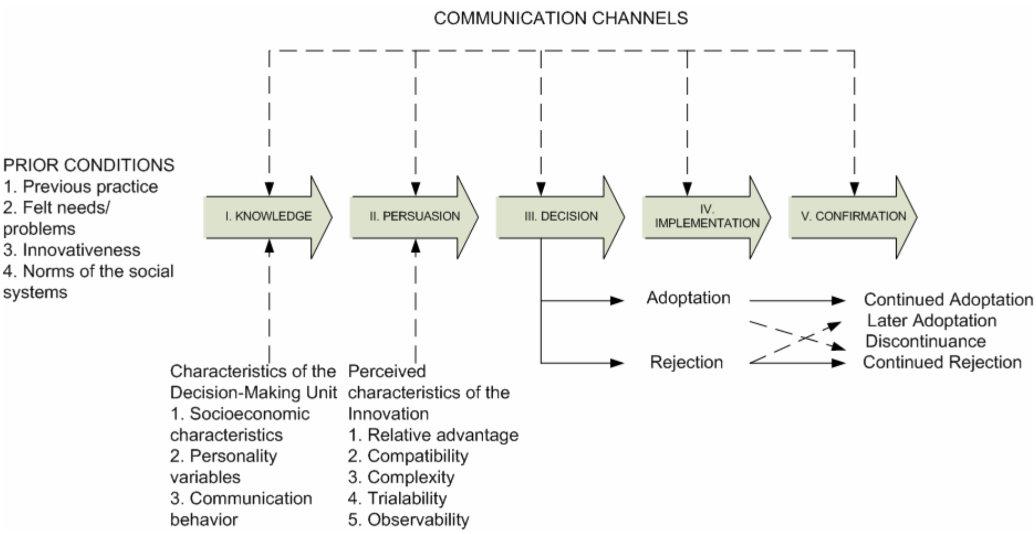

Figure 7 Innovation - Decision model (Rogers, 2003)

In Rogers (2003) opinion the most important part of the diffusion process is the innovation-decision process when a decision making unit decides to adopt the innovation, or in his own words:

> The *innovation-decision* process is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to the formation of an attitude toward the innovation, to a decision to adopt or to reject, to implementation and use of the new idea, and to confirmation of this decision. We conceptualise five main steps in the innovation decision-decision process: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation (Rogers, 2003, p. 20).

Rogers' model might be criticised for not encompassing the crucial element of time. Combining this element with the knowledge of how innovations are adopted and its different phases shown in Figure 5, one might arrive at the following model incorporating the component of time:

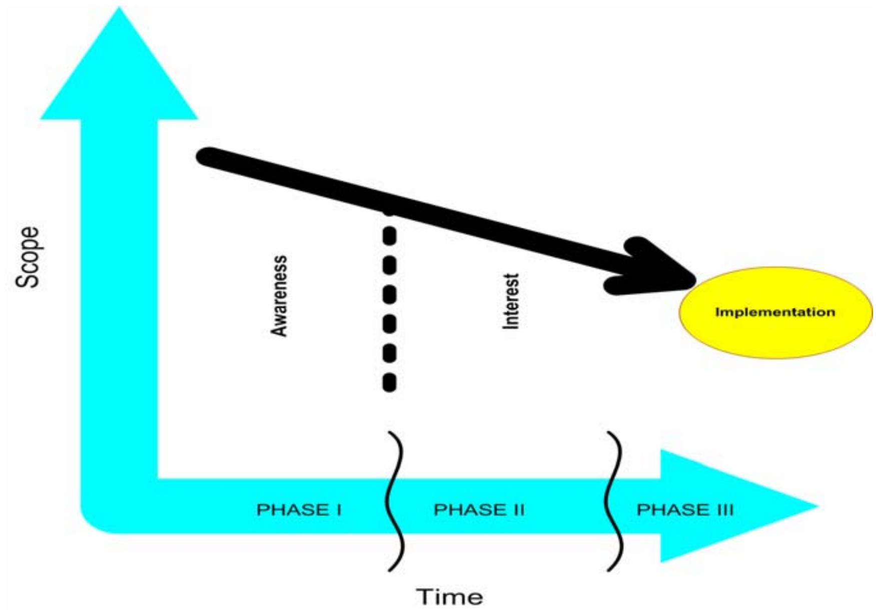

Figure 8 Innovation-Decision model combined with a component of time

Rogers advices where change agents should focus their efforts in such a model:

> Change agents could perhaps play their most distinctive and important role in the innovation-decision process if they concentrated on how-to knowledge, which is probably most essential to clients in their trial of an innovation at the decision stage in the innovation-decision process (Rogers, 2003, p. 173).

This paper choose to interpret this citation along the thoughts of the social constructivists: science and technology is a social process that involves the negation between relevant social groups. It is in this process the efforts to disseminate innovations are most efficient.

2.5.2 Measuring Diffusion of Innovations

Some methods have been applied to measure the rate of adoption of an innovation. The methods can be said to have a general goal of assessing the efficiency of the different dissemination mechanisms, in measuring how a certain technology was adopted. Probably the most common is using firm surveys or submitting questionnaires. Given a lengthy bit of time surveys like this can tell something about the rate of diffusion. Empirical evidence show that such a method in most cases will produce a diffusion curve resembling the S-curve discussed previously in this paper. But as noted by OECD (1997, p. 15): “Such surveys do not generally reveal the source of the equipment or the technology, which limits their usefulness in tracking technology flows among actors within an innovation system”. They therefore also may fail to assess the feasibility of different dissemination mechanisms.

Another approach explored by for instance OECD trying to compensate for this lack in traceability of firm surveys, is how one may track inter-industry R&D flows through purchases of machinery and equipment; labelled “embodied technology diffusion” (OECD, 1997, p. 16). This method allows for the distinction regarding dependency on the acquirement of technology; it distinguishes between technologies acquired, or as a result of own R&D efforts. An example of how this approach is able to identify dependency on technology acquirement is shown in Figure 9. The different types of technologies are categorised.

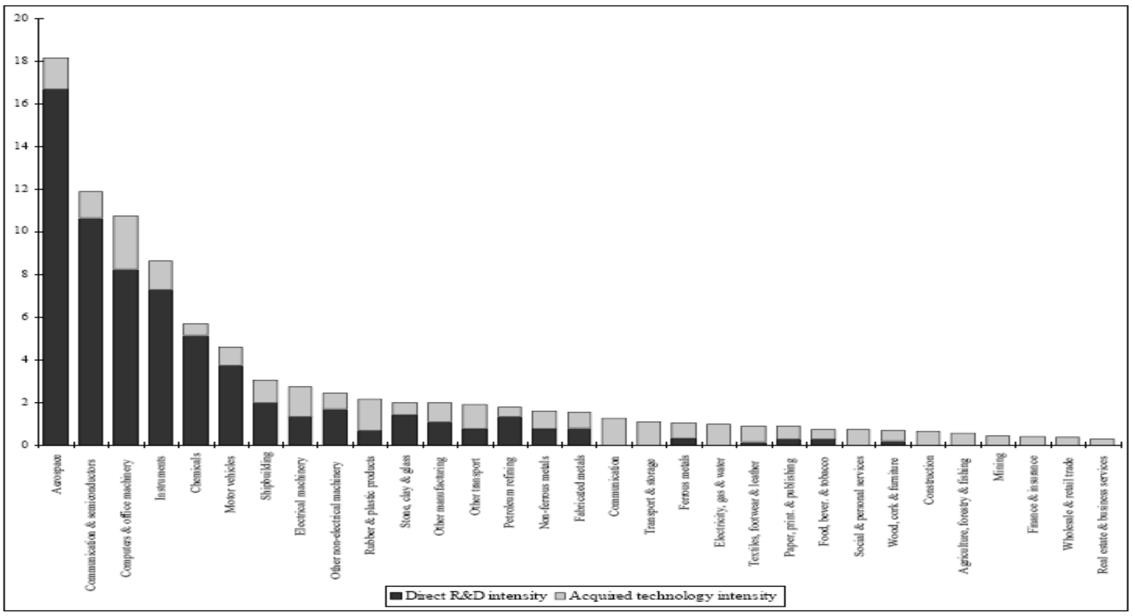

Figure 9 Embodied Technology Flows in the United States 1993 (example taken from OECD (1997))

The method approaches briefly discussed here both have its fortes and failings. Firm surveys can as mentioned fail to identify how the technology was acquired, but can help to identify leverage or take-off points. Studies focusing on embodied technology flows can be used to compare on a cross-national level the dependency on external technology attainment, however this approach may fail in pointing to the efficiency of an intermediating institution facilitating the transfer of knowledge. In that respect firm surveys targeting client firms seem like a more viable approach.

2.6 Summary of the Chapter

This chapter has demonstrated that it is common to label the world most Europeans live in a *knowledge society*. In such a society, knowledge is seen as the key resource and as a history exhibits countless examples of: controlling the key resources of our society can determine the success or failure of a nation. Therefore great efforts are being made to understand the process of how knowledge is being created and how to make it available to as many as possible.

In this paper the creation of both new technology and knowledge are viewed as social processes involving actors, institutions and players, all operating within the frame of a National System of Innovation. The central process in this system is knowledge acquisition, or learning. This is an interactive process involving many players acting in networks. They combine knowledge and inventions in new ways to create innovation, and new techniques are adapted. In the links between actors in these networks operate intermediating players working with the dissemination of innovations, knowledge and new techniques; dissemination meaning in this connection a targeted and managed effort to diffuse. Such an intermediating player can be the Portuguese Technology Centres dealt with in this study.

The adoption of innovations are generally characterised as being a lengthy process; thus existing a time lag from when the innovation is introduced on the market to it is accepted, and the acceptance phase being in comparison very rapid. While diffusion models based on S-curves might be good to account for the dissemination of embodied technology through a given population of business firms, the Roger's innovation-decision might be more interesting to understand how knowledge about a given innovation is absorbed by each individual organisation. Based on the theoretical assumptions this paper suggests that intermediating players focus their efforts in the phase were the decision of adoption is being made. These efforts should embrace the dissemination process as an interactive one, allowing for elements of tacit knowledge to be removed.

The next chapter will seek to take a brief look at the Portuguese System of Innovation.

Chapter 3: A brief look at the Portuguese System of Innovation

This part of the paper seeks to give a brief overview to the Portuguese SI and perhaps point to some key characteristics for the country. Such a short introduction is necessary for the reader without pre-existing knowledge of Portugal, but even more important: to frame the empirical findings and discussion to be found later in this paper. That said, it is not the aim of this thesis to give a full account of every aspect of the country. One will rather try to focus on three issues relevant to this thesis: 1) Education and Research, 2) Innovation Indicators and 3) Innovation Infrastructure. For further background on Portugal and rather large amounts of statistics the reader is referred to the sources cited in the footnotes and Chapter 8: Works Cited.

3.1 Growth and Stagnation

Portugal is a country that has seen *labour productivity*[9] come to a near halt following a rapid increase since the mid 1970's. This trend began to surface in the mid 1990's and even though it might be found in other EU15 economies, Portugal's average Gross Domestic Product[10] (GDP) per capita is still around two-thirds of that in the Euro area. That means in the words of the International Monetary Fund (IMF): "[…] Even with a growth differential of 1 percentage it will take 35 years for Portugal to catch-up to the euro area average". This trend is indicated in Figure 10. Using the term 'catch-up' as in the quote by IMF, is not necessarily as transparent as it may seem. As defined by Fagerberg & Godinho (2004) and quoted in

[9] Labour productivity is general considered to be: "average output per worker" or "per worker-hour".
[10] Wikipedia, the free online dictionary, defines GDP as "The GDP of a country is defined as the market value of all final goods and services produced within a country in a given period of time".

Chapter 2, this concept deals with the ability of a country to reach the level of a leader. This could be said to be based on an assumption that the leader is developed and the laggard should strive to reach this level of development. Furthermore, it is of course relative and (regional) context dependent, leaving the identification of what factors one should focus on to catch-up difficult. Dividing the world economies in groups in respect to how developed they are is however still widely acknowledged[11]. The 'developed versus not developed' polemic will by this paper be left to others as it is beyond the scope of the study; an assumption that Portugal should attempt to reach the level of the leading economies is thus applied.

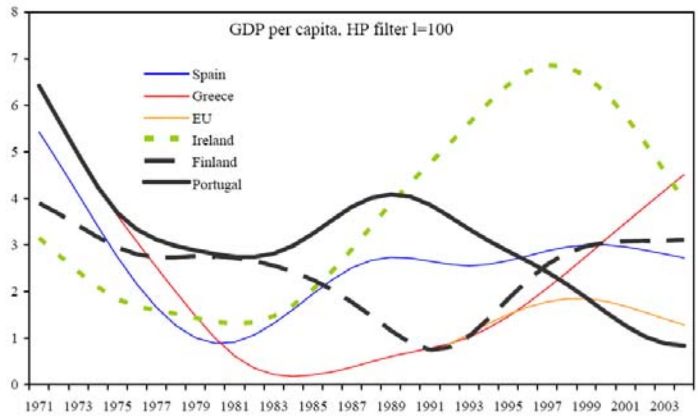

Figure 10 GDP per capita trend growth (adopted from IMF, 2005)

Following the recognition that Portugal possesses an economy in need of catching-up with respect to the leading nations of the European Union, this relatively recent stagnation shown in Figure 10 has of course been investigated from many different angles. IMF (2005) suggests some of following causes:

- Weak technological progress resulting from low investment in human capital
- The poor performance of ICT producing and using industries
- Inefficiencies in labour and product markets that led to the poor utilisation of resources

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[11] See for instance the Worldbank pages: http://publications.worldbank.org/subscriptions/WDI/

For the purpose of this paper especially the first point of IMF indicating the importance of human capital investment for the technological progress is interesting. Even more so seen in relation to the issues discussed in the theoretical foundations of this paper, regarding the emphasis put on a knowledge society and the importance of investment in human capital. IMF's view does however in the causes suggested not take into account how technology adoption can be an efficient strategy for catching-up, underlining instead the need for investment in R&D forming the basis for knowledge creation. This could be said to ignore that knowledge already exist in other parts of the world ready to be adopted.

3.2 Education and Research

OECD tries to explain the previously mentioned productivity gap versus the EU25 average by the following:

> Portugal's productivity gap can be explained to some extent by the structure of the economy with its relatively high share of relatively low-skilled labour intensive sectors. The relatively low educational level of the population at large is the main factor explaining why many firms remain stuck in low-productivity activities and do not adopt more widely ICT and other modern techniques (OECD, 2006, p. 5).

In other words: there might be a lack of highly educated skilled workers in order to exhibit a competitive knowledge economy according to the OECD. This view is in many ways shared by Social Watch's, an agency aimed at surveying agreed targets on poverty eradication an equality, annual country report on Portugal:

> "Social restructuring is hampered by low-skill levels, in an economy based on labour- intensive, low-paid work together with low participation in further training (2,9% in 2002), which also explains why productivity growth is so low (0,3% in 2002, unchanged since 2001)" (Social Watch, 2005).

The rate of early school leavers[12] in Portugal is as a matter of fact one of the highest in the EU25 area and also ranks high including all the OECD countries (OECD, 2006, p. 8). More specifically: in 2002, only 20,6% of 25 to 64 year-olds had completed upper secondary

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[12] Share of 20-24 year olds who have not completed upper secondary and are no longer in education.

education, and the early school-leaving rate of 45,5% contrasts enormously with the EU average of 18,8%. This should be able to explain some of the scarcity of skilled workers and an economy based on low-skilled and labour-intensive industries could have provoked such a trend. But it should be noted that public spending per student is close to the European average pointing to that there may exist efficiency issues or investments not yet yielding results (OECD, 2006, p. 14).

A possible explanation why this lack in human capital became even more evident and caused a halt in the productivity growth from the mid 1990's can be found in another citation in the same document previously quoted by the OECD:

> During the 1990s, this shortage of human capital did not prevent strong growth because the economy benefited from large infrastructure investment, often co-financed by EU funds, and large private investment […] The need to strengthen Portugal's knowledge base is also reinforced by the increasing competition from emerging countries in both low-skill and more skill intensive activities. (OECD, 2006, p. 6)

These are of course just speculations merely touching the surface and it is not the aim of this paper to explore possible explanations in detail, but some of the same causes pointed to by OECD were opinions shared by many of the respondents in this study.

Investment in human capital and R&D is seen as an important instrument to increase the knowledge creation in a country; thus perhaps augmenting the innovativeness, but as well as an indicator to compare countries. Many governments for instance the ruling Norwegian one, use the measure 'investment in R&D as a percentage of GDP' as a political goal[13] and it

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[13] Interested readers are referred to *Regjeringserklæringen*, stating the political platform for the ruling Norwegian coalition government saying that it is a goal to increase the investment in R&D of GDP to 3% by 2010. Can be found here (in Norwegian) :
http://odin.dep.no/filarkiv/260512/regjeringsplatform.pdf

seems to be a common trend that (European) countries seeks to increase this percentage[14]. In Figure 11 an example of a cross-country comparison using such an indicator is demonstrated. This figure shows the total gross domestic expenditure on R&D as a percentage of GDP for OECD countries compared to the EU25 average and the OECD average.

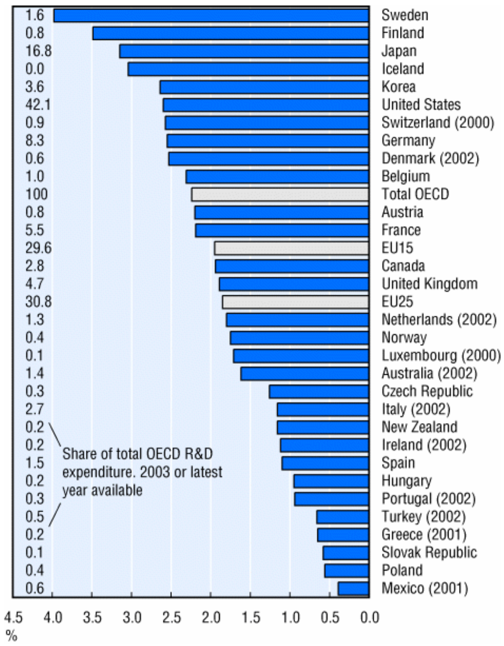

Figure 11 Gross domestic expenditure on R&D as a percentage of GDP (includes both private and public expenditure)[15]

As one might observe Portugal places itself far down on the list of the countries and even more concerning is the decrease in *public* expenditure: 0,58% in 2001 to 0,52% in 2003 (OECD, 2005b, p. 113).

There are however steps being made to narrow this gap versus other countries as for instance citied in the National Action Plan for Employment 2000[16]. Another initiative is *Novas Opurtunidades*[17] (New Opportunities) aimed exactly at overcoming the low level of education

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[14] See figure *Forskningspolitiske ambisjoner i utvalgte land* in: http://odin.dep.no/kd/norsk/tema/forskning/p30003706/bn.html
[15] Source: STI Scoreboard (OECD): http://thesius.sourceoecd.org/vl=46970993/cl=11/nw=1/rpsv/scoreboard/
[16] See: http://ec.europa.eu/employment_social/news/2001/may/nap2001pt_en.pdf
[17] See 'New Oppurtunities': http://www.novasoportunidades.gov.pt/ (In Portuguese)

in the workforce. Some of the main lines of action include increasing the quality of the education system, make professional courses more readily available and increase efficiency of spending.

3.3 Poverty and Gender Gap

Two key characteristics of Portugal often discussed when comparing with other European countries may be the poverty and gender gap. According to the annual country report for Portugal produced by Social Watch, Portugal is the country with the highest risk of poverty rate[18] among the EU 15[19]. Around one out of every five, or more than two million people, live below the poverty line[20] defined by Eurostat: the statistical office of the European communities. The poverty problem may be further escalated by something labelled a "structural problem" (Social Watch, 2005) in the social protection system: it has the lowest per capita expenditure in the EU 15(Social Watch, 2005).

One interesting aspect about Portugal is that it has the highest percentage of women workers in the EU. This I followed by the fact that Portugal also has a lower wage gap[21] than the average EU 15 (Social Watch, 2005). But this does not necessarily mean that women are occupying influential position in the private and public sector: In 2005, two ministers out of a total of sixteen were female in the Portuguese goverment (European Commision, 2005a). The

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[18] According to Eurostat, the risk-of-poverty rate is the share of the population with an equivalised disposable income below the risk-of-poverty threshold, set at 60% of the national median equivalised disposable income (after social transfers).
[19] EU 15 stands for the original 15 member states of the European Union.
[20] A common perception of poverty line is: a level of income below limit sufficient to purchase all resources required to live. There is an on-going debate on where the poverty line should be drawn for different countries. The poverty line usually varies from country to country, but it may be fixed at one level in cross-country comparisons.
[21] Calculated by dividing the median annual earnings for women by the median annual earnings for men.

relatively low wage gap could be also be explained by, as suggested by Social Watch (2005), the fact that women mostly occupy low-income jobs where differences in salaries are smaller.

3.3 Innovation Indicators

The European Trendchart on Innovation[22] developed on a yearly basis, provides some indicators on innovation performance. In this trendchart the countries in question are studied and ranked with respect to some different statistical indicators. Figure 12 gives an overview of what is labelled 'Innovation Performance' by the European Trendchart on Innovation.

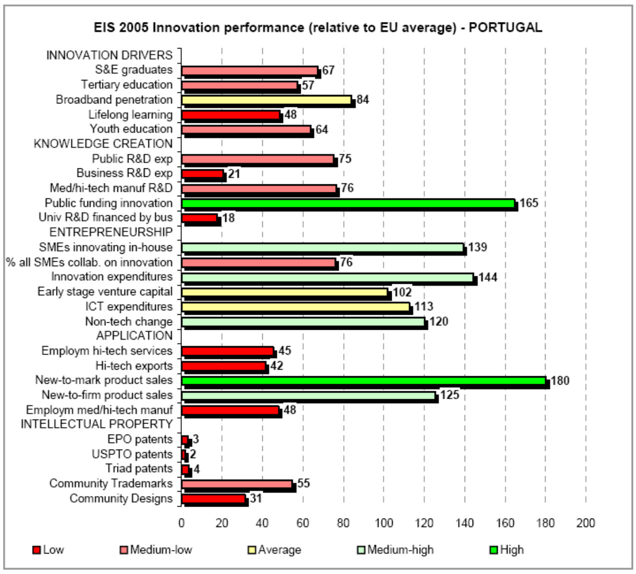

Figure 12 Innovation performance relative to EU (25) average for Portugal[23]

As one might observe from Figure 12 the performance relative to the EU average provides an opportunity to categorise the country on a scale from low to high relative to its score. Portugal's main weaknesses seem to be found primarily within three indicators: innovation drivers, knowledge creation, and intellectual property (OECD, 2005b, p. 114). It was pointed out earlier in this paper[24] that even though the indicator 'public funding innovation' is high, there might exists efficiency issues.

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[22] Available with supporting papers here: www.trendchart.org
[23] Source: http://www.trendchart.org/scoreboards/scoreboard2005/pdf/Annex_F_PT.pdf
[24] See: OECD (2006, p. 13).

Other important innovation performance indicators used to compare and measure innovativeness include ‘S&E graduates’ and ‘patenting’, where Portugal falls in the category of medium-low to low. One indicator where Portugal performs above average is ‘SME in-house innovation’. This relationship is further illustrated in Figure 13.

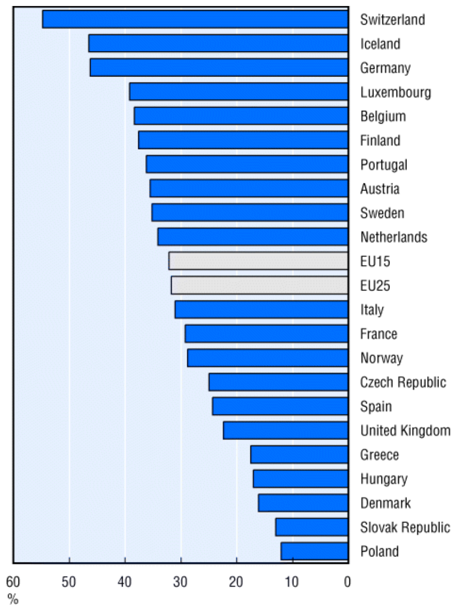

Figure 13[25] SME In-house Innovation (as a percentage of all SMEs[26])

This can be an especially important indicator for Portugal as it is as stated by the European Commission (2005a): “The Portuguese economic fabric is characterised by a very high share of SMEs” (EC, 2005a, p. 1).

The European Commission (2005c, p. 21) names the following three sectors as being the most innovative in Portugal: Computer services and related activities (& Renting and Business activities), Chemicals and chemical products and Electrical and optical equipment. None of the technology centres more thoroughly described later in this paper falls directly into any of

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[25] OECDs definition of innovation includes: "advanced management techniques", "new or significantly changed organisational structures", or "significant changes in the aesthetic appearance or design in at least one product".
[26] Source: http://oberon.sourceoecd.org/vl=3075563/cl=13/nw=1/rpsv/scoreboard/

these categories, even though they may all touch upon these areas in some form as they serve many kinds of clients.

To fight the relatively low performance on many of the innovation indicators, Portugal has defined some national objectives for innovation stated in among other documents, the Regional Development Plan from 1999 to 2006, and quoted by the National Trend Chart of Innovation for Portugal (2005 , p. 4) as being the following four:

- Improving the environmental conditions for innovation processes
- Strengthening the diffusion of already known solutions (that is, newly developed technologies)
- Promoting cluster relationships
- Stimulating specific innovative projects carried out by firms

Steps, thus, are being taken to increase Portugal's innovative performance, focusing on the diffusion of already known solutions as one the measures to achieve this goal.

3.4 Innovation Infrastructure

This part tries to briefly describe actors and institutions that make up the Portuguese system of innovation.

The author was immediately in first dealing with the Portuguese NSI struck by the complexity and multitude in the infrastructure of institutions. If the author's bewilderment stems from cultural or lingual issues, or just lack of experience in dealing with SI, will be left without further pondering, but it is interesting to see that the European Commission(2005a, p. 8) also notes that the Portuguese NSI quote: "encompasses a significant number of players". One interesting question to look at could be if the large amount of actors affects the efficiency of the NSI. It was mentioned earlier in this paper that other sources point to efficiency problems in the SI.

This thesis will not venture far in to describing all of the players, but rather limit it self to giving a brief background; a context for the rest of this study. Table 2 adapted from the European Commission (2005a, p. 2) gives a general categorisation of actors and institutions in the Portuguese NSI.

Type of organisation	Name of organisation (in English)	Website (where available)
Government and legislative bodies	IAPMEI – Institute for Small and Medium Sized Firms and Investment	www.iapmei.pt
	ICEP - Portuguese Institute for Foreign Trade	www.icep.pt
	FCT – Science and Technology Foundation	www.fct.mces.pt
	INPI – Institute for Industrial Property	www.inpi.pt
	IPQ – Portuguese Institute for Quality	www.ipq.pt
	UMIC – Agency for Innovation and Knowledge	www.umic.gov.pt/UMIC
	API – Portuguese Investment Agency	http://www.investinportugal.pt/
	AdI – Innovation Agency	www.adi.pt
	CSCTI – Higher Council for Science, Technology and Innovation	
Private sector organisations and entrepreneurship promotion	AIP – Portuguese Industrialists' Association	www.aip.pt
	AEP – Portugal's Entrepreneurs Association	www.**aep**portugal.pt
Knowledge institutes (R&D and education bodies)	CRUP – Council of University Rectors	www.crup.pt
	CLA – Council of Associated Laboratories	http://draft.isr.ist.utl.pt/cla/index.shtml
Industrial research centres and innovation intermediaries	Technology Centres (sector oriented)	
	INETI – National Institute for Engineering and Innovation	www.ineti.pt
	LNEC – National Laboratory for Civil Engineering	http://www-ext.lnec.pt/index.phtml
	INIAP – National Institute for Agriculture and Fishing Research	www.iniap.min-agricultura.pt
	TAGUSPARK – Science and Technology Park (Oeiras)	www.taguspark.pt
Financial system	APB – Portuguese Banking Association	
	APCRI – Portuguese Venture Capital Association	www.apcri.pt
	SPGM – Credit Enhancement Securitisation Society	www.garantiamuatua.com
	Venture Capital Syndication Funds	

Table 2 Institutions and players in the Portuguese NSI (adapted from EC, 2005a, p. 2)

An organisational chart adapted from the country report for Portugal (European Commision, 2005a) is shown in Appendix III. Figure 14 gives a timeline for the creation for some of the institutions quoted in Table 2 (and technology centres).

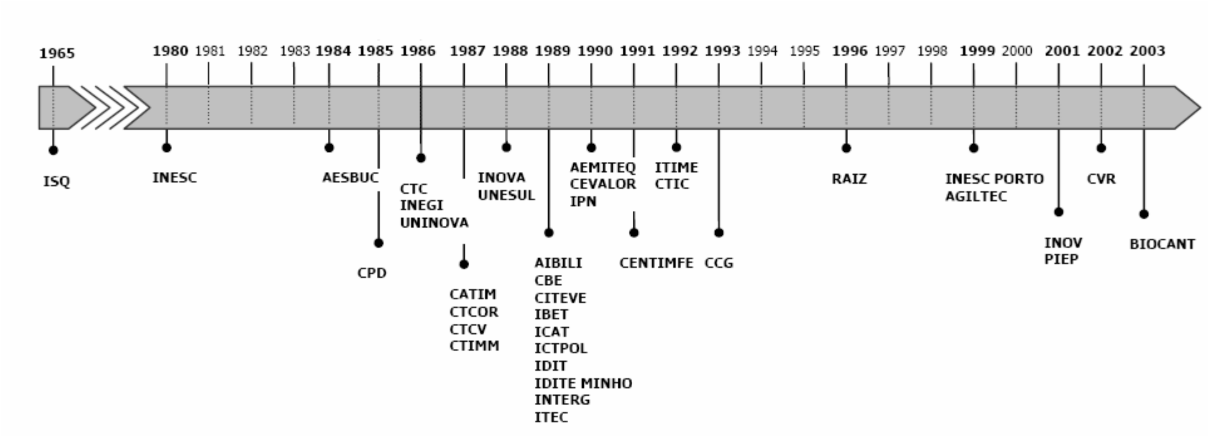

Figure 14 Timeline for creation of actors in NSI (Source: ADI, 2006, p. 25)

Table 3 gives a brief description of the function and mission of the different categories of players mentioned in Table 2. As one might observe from Table 3 redundancy might be experienced in mission of the different players.

Type of Infrastructure	Description and Mission
Technological Centres	Infrastructures connected to specific sectors of industrial production and the main activity of which is to give technical and technological support to companies in the sector, namely by introducing and perfecting already tested technologies, in certifying and controlling quality in raw materials and products, specialised training for technical staff and industrialists and promoting information pertinent to the respective industrial area.
Institutes for New Technologies	Private institutions of public utility with the fundamental aim of speeding up the transfer of modern scientific and technological know-how to industrial fabric as well as the results of research done by their associates or results creatively adapted to the national situation.
Transfer Centres	Infrastructures that should work in close collaboration with research institutions and the Institutes for New Technologies so that university-industry interaction can be promoted, speeding up technological transfer from the universities and research centres to industrial companies.
Technological Parks	Infrastructures which aim to promote industry, improving the competitive position by innovating companies and spreading scientific and technological capacities associated with already existing cultural approaches to clearly define fields for economic activity.
Incubation Centres	Infrastructures that aims essentially to encourage the appearance of new, small companies with modern production processes and noted for the youth and high level of technical training of their protagonist industrialists.

Table 3[27] the Mission of the Technological Infrastructure Supported by PEDIP[28]

Of course, in addition to those mentioned in Table 2 there also exist educational establishments on various levels, but more importantly to this paper are the so called

27 Source: European Commision (2005a).
28 Specific Programme for the Development of Portuguese Industry (1989-92)

Technology Centres (TCs); institutions working within industrial sectors. A list of those centres is provided in Table 4.

Name of Centre (in english)	Website	Location[29]
CATIM – TECHNOLOGICAL CENTER FOR METAL INDUSTRY	www.catim.pt	PORTO and LISBON
CENTIMFE – TECHNOLOGICAL CENTER FOR THE MOULDMAKING, SPECIAL TOOLING AND PLASTIC INDUSTRIES	www.centimfe.com	MARINHA GRANDE and OLIVEIRA de AZEMÉIS
CEVALOR- TECHNOLOGICAL CENTRE FOR THE USE AND PROMOTION OF ORNAMENTAL AND INDUSTRIAL STONES	www.cevalor.pt	BORBA
CITEVE- TECHNOLOGICAL CENTRE FOR THE TEXTILE AND CLOTHING INDUSTRIES OF PORTUGAL	www.citeve.pt	VILA NOVA de FAMALICÃO
CTC-TECHNOLOGICAL FOOTWEAR CENTRE	www.ctc.pt	SÃO JOÃO da MADEIRA
CTCOR-TECHNOLOGICAL CENTRE FOR THE CORK INDUSTRY	www.ctcor.pt	MARIA de LAMAS
CTCV- TECHNOLOGICAL CENTRE FOR THE GLASS AND CERAMIC INDUSTRIES	www.ctcv.pt	COIMBRA
CTIC- PORTUGUESE LEATHER RESEARCH CENTRE	www.ctic.pt	ALCANENA

Table 4 Technology centres and their location[30]

The TCs could be a particularly interesting case to study owing to their detachment to policy enforcements and closeness to the industrial sector[31]. It is noted by the European commission (2005a) that the Portuguese innovation governance system has traditionally been characterised by a divide between science policy on one hand and industrial and enterprise policy on the other hand. Furthermore, that the distance between the academic and the industrial world is large. Choosing a case that could be said to pertain somewhere in between those two worlds could open up new insights.

3.5 Summary of the Chapter

Summing up this chapter could perhaps best be done with a quote from one of the respondents. Asked about how they tried to promote new technological developments to their

[29] See also Appendix II for a map of their location.
[30] The centres dealt with in this paper are highlighted in yellow.
[31] This is not to say they are unaffected by changes in the political and economical climate. On the contrary: since they operate without direct public financial support they are forced to follow the demand of their clients and members; their market.

clients the TC in question mentioned mass media as being one of the channels: "It seems to be very easy to get a journalist to make a case on some of the technological development projects we have had. All we have to do is mention the word *innovation.*" Portugal is trying to deal with underachievement of the knowledge economy, and a general political focus on innovation seems to be one of its consequences.

Statistics show that Portugal is still lagging behind the EU15 and have a long way to go in order to catch-up: she scores average, or under average on the lion's share of the innovation indicators measured by the European Trend Chart on Innovation. There especially seems to be a need to increase the level of education of the workforce, transforming from an economy traditionally based on low-skilled labour intensive sectors to an efficient knowledge economy. Increasing innovative activities, transferring already known solutions and funding technology development projects are steps being identified on this path. The technology centres in this study are important instruments to achieve the goal of a more innovative Portugal in that they transfer knowledge to their members, undertake technology development projects and they orientate themselves towards the SMEs, thus being able to bridge a potential science/industry divide.

Chapter 4: Methodology

This chapter describes the method proposed to give answers to the questions more thoroughly discussed in the introduction to this document. A description of the method will give the reader an opportunity to validate the solution to the problem and gives the researcher an opportunity to argue for his or hers chosen angle of approach. For this study a case study approach is chosen. In the following it will be argued why that is an adequate method for the stated problem in the introduction of this document.

A case study may be defined as an empirical investigation that (Yin, 1989, p. 23):

> Examines a temporary phenomenon within its given context; the limits between phenomenon and context are not obvious; and where a composite of sources are used to illuminate the phenomenon.

Few units of observation and many variables characterise a case study, where the aim is to describe the phenomenon in its context or a complex social phenomenon (Yin, 1989). A phenomenon is described by the use of numerous sources of information, a variety of viewpoints, and in its given context. A qualitative case study is characterised by the researcher spending time on providing background for the case(s) studied in addition to the data collected. The researcher has the opportunity of reflecting on what is going on (Stake, 1994). A case study gives the opportunity of giving a broad characteristic of real life by means of collecting data, performing interviews and through observation. The proof can be both qualitative and quantitative (Eisenhardt, 1989). One of the benefits of using this type of method is that can create a basis for a deeper understanding of the dynamics of the phenomenon in question, and at the same time get an understanding for the phenomenon in comparison with the environment (Andersen, 1990). It is this deeper understanding of the research question and the link to the environment that one seek to find in this case study. This study uses a questionnaire as the key instrument of investigation, but along the thoughts of

Stake (1994) just mentioned, it is important to use additional sources to broaden the perspective on the case and avoiding the trap of observing the picture from only one viewpoint. To provide this broader perspective the researcher has used traditional sources such as books, articles, and previous studies performed within the same area in Portugal, but also informal talks with academics in Portugal, actors in the Portuguese System of Innovation and even functionaries working within the field of dissemination of innovations on an European level.

One can have various intentions for embarking on a case study, and these intentions form given categories of case studies (Stake, 1994). This case study in particular falls into two main categories. One of them is a so-called collective case study, where a group of cases are studied (Stake, 1994). In addition the case study falls into the category of an instrumental case study, where the case study is used as a tool to get insight in a theory (Stake, 1994). These two categories will frequently overlap, as there are often numerous interests behind a case study

Attempting to have minimal preordained theoretical perspectives or propositions is important because these may limit or bias the findings (Eisenhardt, 1989). In a case study it is important not to be too focused on generalising and finding links to theory that one forgets to focus on those characteristics that are important to understand the given case per se (Stake, 1994).
An important element in the analysis of the case study is to relate it to existing hypotheses and theories. To what extent are there similarities or differences, and what are the reasons for the empirical evidence differing from theory? In order to make this comparison a considerable literature study will be performed. The literature study is important for several reasons. If one compares empirical evidence with existing theories it gives more comprehensive insight into

both ones own studies and the theories in the field of study. Concurrent or non-concurrent results can sharpen the limits for generalisation within the research field (Eisenhardt, 1989). One can also strengthen the confidence in the validity of the results by seeing that other researchers get the same results in other contexts.

A brief argumentation has now been presented for applying a case study approach in this thesis. The following three sections will describe how the study was designed and an introduction to the case at hand.

4.1 Research Design

As already mentioned the main instrument of data gathering in this study is a questionnaire: the whole study is built up around and support the questions dealt with in the questionnaire. Chiefly, one might divide the questionnaire in two parts: a quantitative and a qualitative part; the former putting a strict frame for the respondents to move within, the latter opening up a larger space for the respondents. The majority of the questions in the qualitative part were open and relatively general in order to give the informants the opportunity to speak freely and communicate their understanding of the situation (Andersen, 1990). Furthermore, even though opening up the questions and allow the respondents freedom to ponder up on different subjects may create difficulties in comparing the answers given, it is crucial in such a study to allow feedback for the respondent to understand the question relative to his or her cultural context. Even more so with respect to the interviews being performed in a second language for both the interviewer and respondents; therefore it is important create a dialog to avoid getting ‘lost in translation’.

The interviews based on the questionnaire should ideally be performed in the same setting for all of the respondents ensuring transferability of the data gathered. This was however in the case of this study not possible. The interview situation varied from formal; the interviewer was given a set time frame alone with a key person, to (very) informal; lunch with various personnel. Facing such a multitude of settings the quality of the interviews varied greatly which also should be reflected in the results.

There has been a limited use of observation (Eisenhardt, 1989) in this study. After or before the interviews, the investigator was in all cases given a short tour of the premises and equipment. However, ideally one should have been able to spend more time within the TC conversing with key staff, making sure more viewpoints were heard, and creating a deeper understanding of the case. But as any actor in a system of innovation the Portuguese TCs are working under constraints of resources. These constraints make it difficult to prioritise a young student's work.

4.2 Questionnaire

The questionnaire used in this study is given in Appendix I. It may be said to circle around three core topics: 1) Networking activities 2) Dissemination activities on an institutional level 3) Dissemination activities on a project level. These three mains lines of investigation are meant to follow the research question defined in Chapter 1 of this paper.

All the respondents were given the opportunity to have a look at the questionnaire at least one week ahead of the interview. This gave them the opportunity to get familiar with the topics in question, and in one case it actually resulted in the answers being already prepared prior to arrival. The interviews lasted from between 30-120 minutes, and in some cases involving several respondents. The goal from the researcher was to keep the interviews further towards structured than reflexive (Kvale, 1994), but because of great variations in the environment it should be said that the four interviews ended up in total midway between the two.

4.3 Description of Case

The object at hand as already touched upon earlier in this paper, deals with four Portuguese Centres of Technology. The Portuguese technology centres are according to the European Commission (2005a, p. 2) performing four core tasks*: 1) Technology diffusion towards SMEs 2) quality standards and certification 3) training 4) technology information services*. They are furthermore by mission industry-specialised, thus it was found by investigation that this is a fact with some modifications: The TCs can as a matter of fact perform services for a variety of industries. In many cases it was also quoted to be a necessity of survival.

The TCs were chosen first and foremost according to one criterion: where a contact could be made and there existed a willingness to participate in the survey. Ideally one should be able to select a representative selection based in the requisites of the study for instance that they vary in size, business area, location and so forth, if not there could exist a risk of creating an area where only the 'loudest voice' is heard. In a case study it is also in many cases desirable to study deviants or special cases to 'find the black swan'. This was unfortunately not an option for this study. However, the author believes that potential weaknesses in the data selection are more likely to occur regarding issues such as misinterpretations, scope, and insufficient background than problems connected to such a bias.

Table 5 gives a brief summary of the four different technology centres studied in this case with respect to size, core areas of business and number of associates.

CATIM – Technological Center for the Metal Industry[32]	**CITEVE – Technological Centre for Clothing and Textile Industry**[33]
Employees: 87 (2005); stabilizing after increase. Revenue; 3.8 M EUR. Core Areas: Certification & Calibration, Technical Support (HSE), Education, Dissemination of Knowledge. Around 550 members (2005) halting increase, 2000 clients (stagnating), around 150 clients abroad (Spain).	Employees: 200 (2005) 6500 textile companies (average size 30-40, 90% SMEs), 200 000 employed in this sector 700 associated members Core areas: problem solving, certification, education, technical support
CTIC – Portuguese Leather Research Center[34]	**CENTIMFE Technological Center for the Mouldmaking, Special Tooling and Plastic Industries**[35]
Employees: 19 (2005); increasing. Revenue; 1.5 M EUR. Core areas: Education, certification, consulting, R&D. Water treatment, waste management. Dissemination of knowledge. Around 100 members (increasing), 75% of clients from tanning industry, 25% from other sectors.	Employees: 80 (2005); increasing. Core areas: Education, certification, consulting, R&D. Water treatment, waste management. Dissemination of knowledge. Around 500 members

Table 5 Fact Sheet TCs

This table is only meant to give an indication of the relative difference of the TCs and should be read with care since the numbers stated are based on annual reports where provided and in some cases presentations, but also on direct questions from the researcher. In Appendix II there is included a map showing the location of the TCs along with further information. It is important to note that in the case of a TC having several branches, it is the main office that has been studied labelled I: for instance CATIM I. As one might observe from Table 5 the TCs vary considerably in size, CTIC being by far the smallest one studied. This variety in size of course affected how the interviews were performed and how it was possible to obtain the desired information. All interviews were done with the general director of the TC with support from other employees when possible. With the larger TCs the general director did not have the sufficient background to answer questions on the practice level of dissemination, but

[32] Source: CATIM (2006)
[33] Source: PowerPoint Presentation provided by CITEVE July 2006. Available upon request.
[34] Source: CTIC (2006)
[35] Source: PowerPoint Presentation provided July 2006. Available upon request.

proved more valuable on a strategy level of dissemination and how they interact with other institutions. For a small institution such as CTIC the general director could provide both perspectives given the size of the TC.

4.4 Summary of the Chapter

One have in this chapter proposed to investigate four Portuguese technological centres as a case study on how they disseminate knowledge. A questionnaire trying to identify networking and dissemination activities will be applied as the main data-gathering instrument. Conversations and relevant literature on the topic will support the findings from the questionnaire.

The four TCs chosen; CTIC, CATIM, CENTIMFE and CITEVE vary considerably in both size of member mass, industrial sector and employees.

Chapter 5: Empirical Findings

This part of the paper presents the main findings along the lines of the questionnaire and other relevant issues. Viewpoints quoted or referred to will be labelled with the TC centre name even though they may originate from various members of the staff working within the TC. A list of respondents is given in Appendix IV.

5.1 Industrial Sector

Chapter 3 sought to give a brief introduction to the Portuguese System of Innovation. One of the key characteristics of the country identified in that chapter was that Portugal is struggling to convert from an economy traditionally focused on low-skilled labour intensive sector to a more knowledge intensive economy. Increasing competition from emerging low labour-cost markets may to a certain degree be pushing this conversion. In the meeting with the four different technological centres this transformation is especially noted with regards to CTIC; operating within the leather & tanning business, and CITEVE; working within the clothing & textile industry. These are both functioning within sectors that might be especially vulnerable to the issues just mentioned. CITEVE say that the change in the business sector opens up new opportunities for them: “companies are more willing to approach us in order to find new ways of surviving, diversifying, or changing the end product”. In other words: they might be experiencing a shift towards ‘market-pull’ instead of ‘market-push’ where their market is the present and prospective clients, thus being companies. But an important point is also noted by CTIC; the popular perception is often that Europe is losing ground in low-skilled labour intensive sectors because of high level of wages, buy this may only be a part of the whole picture: the European Commission also enforces stricter policies on environmental issues making *social costs*[36] higher than in other parts of the world. Remarks such as noted by CTIC could indicate that these labour intensive sectors may well still be competitive despite high level wages; it is the total costs that influence to a larger degree.

5.2 Networking Activities

The networks which the different TCs participate in will roughly be divided in three categories in this paper: *down-stream, cross-stream and up-stream*.

Down-stream

All TCs define their down-stream network as being their associated companies, members and clients. These are the one they provide services for and participate in various projects with. The network relations occur and disappear depending on the tasks performed, but there always exists a 'core-network' through which information is distributed for instance in the form of magazines. Furthermore, following the fact that the TCs operate in sectors and the country as a whole is relatively small, gives the opportunity to maintain long lasting relations within their core-network and monitor activities and changes. Such tight relations and close monitoring is especially important in the question of dissemination activities; maintaining an overview of the sector at all time simplifies the identification of the target audience for dissemination.

Cross-Stream

The cross-stream network might be said to consist of actors on the same hierarchic level. Such networks exist both on a national and international level. CATIM for example pertains to an international network of laboratories called *LabNET*. Figure 15 shows the relative distribution with respect to country in such networks.

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[36] The percentage of a companies total expenses going to the society in which they operate.

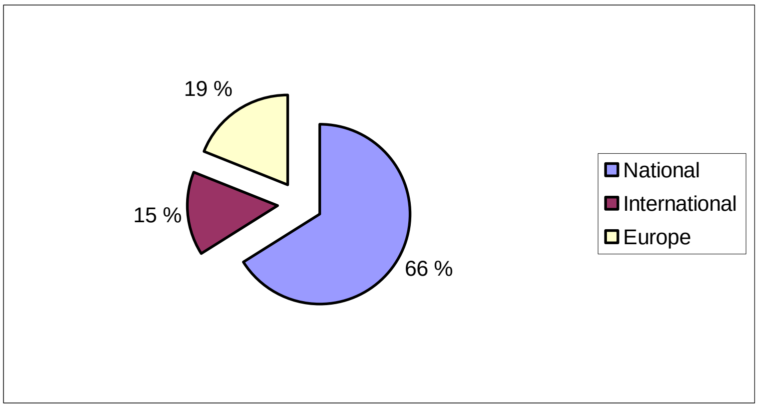

Figure 15 Type of Network; European, International, or National (Source: ADI, 2006, p. 55)

CATIM's example is just one of many of formal networks that exist allowing for cross-cultural knowledge sharing; all TCs reported to belong to such networks in one form of another. There also exists networks on a European level for institutions operating in the same way as the Portuguese technology centres studied here. It however seem to vary greatly how important those networks are to obtain new knowledge which in turn can be furthered disseminated down-stream. In that respect informal networks consisting of acquaintances from conferences and projects were deemed equally, or even more important. This could owe to the fact that many of those networks, as for instance LabNET, are not aimed at sharing knowledge: they have different objectives. In Figure 16 it is illustrated how many networks each TC participate relative to the others.

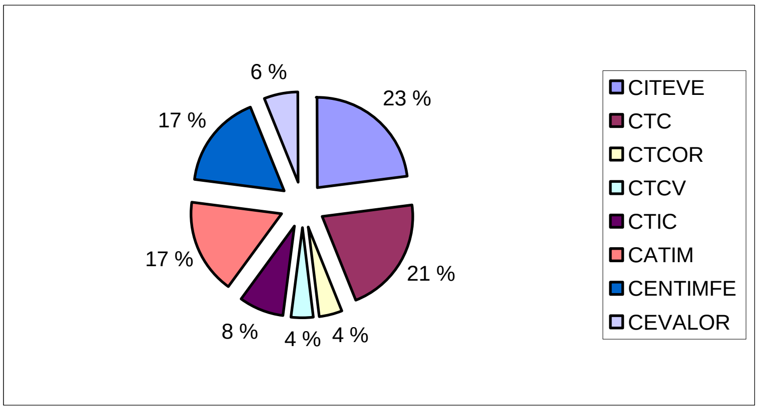

Figure 16 Relative participation in co-operative networks, CITEVE=11, CTCV=2 (Source: ADI, 2006, p. 55)

As one might observe from Figure 16, it gives only an indication of the number of co-operative networks the TCs participate in. It gives no account of how these networks function, and what are their main objectives. Furthermore, it should only be expected that institutions of greater size participate in more networks as seen in the relative difference between CITEVE and CTIC.

On a national level *Associação dos Centros Tecnológicos de Portugal* (RECET), acts as the co-ordinating institution for the technology centres in Portugal. Ideally this institution could work as a co-ordinator and facilitator of knowledge flows, encouraging collaboration between the different TCs. The interviewers impression was however that RECETs primary function is to represent the TCs as one group; an organisation working to promote the interest of its members (the technology centres), and this network is not used actively to let knowledge flow. This should however be seen as a personal viewpoint of the author. This study did not investigate this relation in depth, it also being beyond the scope of this paper.

Up-stream

It was mentioned previously that the European Commission (2005a) pointed to a long prevailing science-technology divide in Portugal. That is to say, the distance between the industry and the academia and policy makers has traditionally been perceived as very significant. Firstly, it is important to note that the TCs might be seen as 'un-coupled' from the Portuguese political decision making apparatus as sketched in Appendix III. This is not to say that they are unaffected by ruling governments and 'political winds'; ministries may even be stakeholders in the TCs as is the case for all the TCs in question. The Ministry of Economy is the ministry quoted to the one they direct their attention towards. But in principle a technology centre works for the interest of its industrial sector and survives by providing services. That is their primer agenda. Secondly, presupposing that the TCs orientate themselves towards an industrial sector, signs of the academia-industry divide were found during the interviews. One TC for instance quoted that “universities hold too much theoretical knowledge not applicable in the ‘real world’”. Another one said “we have problems co-operating with INETI[37] and the universities because they are not ‘business minded’”. Nothing was said on how this relation could be improved, or how knowledge universities potentially hold could be exploited by the industrial sector.

5.3 Dissemination Activities

This part describes the ways of disseminating knowledge or innovations applied by the TCs found in this study. The questionnaire used in this study made a distinction between dissemination on a project level and on an institutional level. That was to be able to distinguish between activities performed as an element of their daily agenda; magazines, newsletter, posting on websites etc, and extraordinary activities; related to development projects resulting in innovations. The TCs run R&D projects in co-operation with SMEs and other contributing institutions, partially funded by national and communal authorities. Outputs of such projects can be innovations and new knowledge. Publicly funded research can be seen as an attempt by policy makers to avoid dependency on technological trajectories created by profit maximising companies (Callon, 1993). A project governmentally funded in most cases, require that the results are widely disseminated along with the thoughts of controlling the trajectories[38].

[37] The National Institute of Industrial Engineering Technology: a public research laboratory located in Lisbon.

[38] In many ways this requirement for dissemination could resemble a classical assumption that knowledge should be a public good, freely available to all. Dissemination of the results however remains an important criterion in assessing whether funding should be granted by the institution.

If required by the funding agency, a plan for dissemination is integrated by the TC within the overall project plan. Of course there exist restrictions related to Intellectual Property Rights (IPR): before spreading one must define *what kind* of knowledge can be exploited and in *what way*. But presupposing that IPR issues are clarified, the outputs of the project should ideally be widely disseminated. This is the distinction made in this paper between activities on an institutional level; day-to-day activities, and project specific activities.

Institutional Level

The findings related to dissemination activities might be divided in three distinct categories: *passive, active* and *pro-active.*

Typical, traditional ways of conducting dissemination found were: *journals, folders/flyers, newsletters*, *posting at internal websites* and so forth. These might be said to fall into the category of *passive* means of dissemination. This category includes channels of communicating knowledge that only allows for a one-way flow. The technology centre acts as a passive player, passing on knowledge without allowing for a stage were the actors may interact, helping perhaps to decode elements of tacit knowledge. Such a stage may only arise if a company actively seeks more information. Dissemination activities in this category were by far the most common found; therefore labelled traditional.

The second category of dissemination channels is labelled *active.* Activities here include: participating at *conferences* and *fairs*, *demonstrations*, and to a certain degree *workshops*. This category allows for a setting for which the actors can negotiate on the material presented. However, they do not necessarily target a specific pre-defined audience and the communication between the transmitter and recipient of knowledge is left to the recipient to be two-ways. In that respect activities in this category may not differ greatly from those found in the first category mentioned even though they may include involvement of personnel holding key knowledge.

Finally, the last category is labelled *Pro-active* means of dissemination. Here one can find activities of a more unconventional form and are the less used. It includes: *directly contacting companies*, *workshops*, and linking actors in *networks.* Activities in this category are less frequent than in the first category mentioned and are more often connected to specific projects that resulted in an innovation. Nevertheless, some of the TCs as for instance CITEVE, use workshops on a regular basis where they gather a targeted audience in a room to present something new. The common denominator for this category seems to be that the audience is predetermined.

Some interesting practices besides those mentioned above were however found at various TCs: CTIC for example stated that they tried to "get together people" in a room regularly to talk about new developments within the sector along the same lines as CITEVE. This could hopefully spark a reaction to start the process of adopting an innovation. The importance of including key personnel with sufficient knowledge of the innovation was also stressed. CENTIVE tries to dedicate human resources to 'survey' recent new developments that could be transferred to their members.

The dissemination activities found on an institutional level have now briefly been summarised. In the following activities found on the project level will be described.

Project Level

In general dissemination mechanics found on the project level do not differ much from the ones found at the institutional level. The main distinction can be made in the way that these activities often are 'mandatory': they are outlined in a project plan and should be performed along with the rest of the task specified. Therefore they might be said not only to rest on the TC's interest of working for the good of its members when it comes to dissemination on the project level, but as well to comply with guidelines and enforced policies. That is not to say that this study discovered any reluctance towards activities on a project level.

Another deviation from activities on the institutional level could be found in the way the audience is in many cases predetermined, given that an own plan for dissemination is submitted accompanying the overall project plan. Additionally to the more conventional dissemination activities mentioned under the first category in the preceding subchapter, workshops and seminars appear to be popular instruments. CATIM for instance seeks to arrange seminars after the completion of a project with at least one reference person from one of the participating SMEs. This can help to eliminate potential difficulties in communicating knowledge in that beholders of knowledge participate in the process.

Barriers to Dissemination

The Technology Centres were also asked about which they saw as barriers to effective dissemination. A few of the findings include:

- SMEs are small; they do not necessarily have the sufficient resources to able to adopt knowledge. Adopting innovations, and maybe in particular process innovations, is a lengthy and resource-draining procedure that needs to be given priority within the company

- R&D projects are often large and complex in nature. That makes it difficult for 'outsiders' to penetrate and grasp what can be useful for them, what innovation they can benefit from and in what way
- Personnel involved in the actual R&D process does not participate in the dissemination process, often because of lack of allocated resources, leaving knowledge they might hold outside the transfer process.
- Technological innovations; e.g. machinery, seem to diffuse more readily than organisational innovations. CTIC also note that this could vary according to which sector one is dealing with: "The leather industry in Portugal is conservative and traditional where it is difficult to introduce changes". This might further complicate the matter of introducing organisational innovations.
- Companies that are 'doing well' are more reluctant to adopt new innovations. In such situations the TC is often given the role of the passive mediator of knowledge with an unreceptive audience

Measures of Efficiency

Finally, the Technology Centres were asked about measures of their efficiency as a disseminator. On this subject little was found. Some TCs suggested using questionnaires to measure the satisfaction of their clients, others surveyed participation in workshops or seminars. On a project level, actual activities performed could be compared to those specified in the project plan to give an indication of performance. However, this investigation was not able to identify any mechanisms to measure to the adoption of innovations disseminated in the sequence of the TCs activities.

5.4 Summary of the Chapter

This chapter has given an account for the most relevant findings in the interviews with the four Technology Centres dealt with in this paper. The findings are categorised along two branches: networking and dissemination activities.

All of the TCs operate within sectors usually seen as labour and low-skilled intensive, working for the survival of their members in a changing world. They function in the business area of the industry-policy-academia divide in the sense that they are not directly governmentally funded, but rather need to generate their revenue as a service provider for their members and other clients.

Networking activities are widespread in informal, formal, national and international networks, but they are not necessarily used for the flow of new knowledge: a network can serve many purposes.

The most common dissemination activities found in use were; posting at websites, publications, newsletters, and newspaper articles, by the TCs do not allow for a dialog between the messenger and the recipient. Other activities found seek to target the right audience before starting the dissemination process. It can be done by inviting certain companies that ideally could benefit from a change-over, to a workshop on new developments in the sector. There were found no significant differences in the activities performed on an institutional level and a project; the deviations rather relating to planning and obligations from funding agencies.

Barriers to efficient diffusion of innovations include issues regarding knowledge; elements of tacit knowledge can not be eliminated in the transfer process, resources; the SMEs do not hold sufficient resources to be able to adopt, and demand; a ‘pull’ in the market simplifies the TCs role as a disseminator.

This concludes the main findings in this paper. In the following chapter the results will be discussed.

Chapter 6: Discussion

This chapter will discuss the findings referred to in Chapter 5, within the theoretical framework sketched in Chapter 2 and the objectives and research question defined in Chapter 1 of this paper.

The Technology Centres dealt with in this study might be labelled organisations (Edquist, 2006) in the Portuguese National System of Innovation: they have a specific purpose and mission within the system. Their mission should be to work for their sector of SMEs, a crucial task in Portugal with a relative high share of SMEs (European Commision, 2005a, p.1). In that respect the SMEs might be called a driving force in the Portuguese Economy, it should be in everyone’s interest that they are as competitive as possible. Furthermore, the TCs alongside other actors in the NSI constitute important channels for the flow of knowledge and new techniques to the SMEs. This knowledge acquisition, or learning (Burton-Jones, 1999, p. 7), is central within a NSI.

The TCs appear to be aware of their existence within a larger system and their mutual dependence on the other actors operating within the same boundaries. Networking activities can be said to be widespread, but formal networks are not necessarily effectively used for dissemination purposes; here informal networks that rise (and eventually fall) independent of pre-existing ones seem to be more important. A reason for this could be found in the fact that there are no networks deliberately constructed, as far as the scope of this study could reveal, for the communication of knowledge; communication meaning in this context an opportunity for dialog. Most of the formal networks that the TCs form a part of have objectives such as promoting the interest of a certain area. Another reason for relying on informal networks could be the ‘inflexibility’ of the existing networks to be able to adapt to the variety in what is being transferred and to different social contexts: as noted by Rosenberg (1972, p.2) the rate of acceptance of different inventions vary greatly, given differences in those innovations and in the environments in which they diffuse. The combination of the two factors just mentioned could help explain why informal networks are used to a larger extent in dissemination activities than established, formal ones.

The research question proposed in Chapter 1 of this paper sought to look at how the Portuguese Technology Centres taken as the research object, perform their dissemination activities, and how this could correspond with a model for the diffusion of innovations. More specifically: where in such a model does the Technology Centres focus their attention. This paper chose to use Rogers (2003) Innovation-Decision Model for the Diffusion of Innovations (shown in Figure 7) as a basis and combined with an element of time one drew Figure 8; giving a reference for comparison with findings. The findings summarised in Chapter 5 indicate that the TCs focus their effort in the first phases of the model suggested, creating “awareness-knowledge” (Rogers, 2003, p.173). Moreover, the findings point towards the TCs following a strategy which is related to the way information is spread in the epidemic model shown in Equation (1): they try to disseminate innovations by focusing on spreading information about them to potential users. This as stated in Figure 5 might not produce the typical S-curve for the adoption of innovations, but is rather an illustration of how to spread information done by for instance mass media channels. Such means of dissemination presupposes that companies will adopt a technology after being made aware of it, neglecting the soft aspect of a technology which often can be tacit. Dissemination activities of this sort, is in the author’s opinion in many cases a waste of effort since they do not take into consideration the elements of tacit knowledge in what is being transferred. The TCs should rather seek to open up arenas where the tacit elements can be made explicit: where the actors can negotiate and understand the issues on science and technology which are being dealt with in the transfer process.

In general one could have reason to suggest in the basis of the findings that there should be a greater emphasize on *what* is being transferred. This study might have failed to investigate the relation between what and how, and therefore the criticism of the TCs overemphasising 'information-spread' activities may not necessarily be valid. One could for instance have reason to believe that dissemination activities on an institutional level focus on passing on information since that is the prime function of the TC in this mode. What is transferred could also have the nature of information instead of technology: the TC can point to where further knowledge can be found. On the other hand; on a project level, what is being transferred can for example be new machinery. This may indicate that the there should be made a distinction between dissemination activities on a project level and on an institutional level, and the distinction should be based on what is being transferred. The TCs may also in many cases have participated in the project, holding knowledge themselves. Even though this study did not look specifically into the relationship between what and how, none of the TCs seemed to give this any concern. Dissemination is performed in various ways and the audience seems to be more of a deciding factor than what is sought disseminated.

Saying that the TCs focus their attention on activities aiming at creating awareness-knowledge does not mean that they do not perform other actions, as seen in the findings summarised in Chapter 5. There are as stated in that chapter, arenas being created to allow for actors to meet and communicate. However, these arenas seem to arise and fade away without continuance in time. One of the key characteristics of the adoption process seems to be that it is lengthy, or with a time lag (e.g. Figure 5). One could believe that creating arenas that sustain over time could be a more viable approach, since for a company to adopt often will take years. Even though Rogers (2003) advices to focus on the stage where the company makes a decision, being a short phase with rapid change, it should also in the author's opinion be followed by a lengthy and lasting relationship. This supports findings on how innovations are adopted by for instance Rosenberg (1972) and Mansfield (1961): the adoption process being slow and varying from one innovation to another.

The other part of this paper's research question, where the first being to look at how the TCs disseminate and this fitted with theoretical models, was to try to make an assessment of the variance of efficiency in dissemination mechanisms. But a problem arises when attempting to connect different dissemination mechanism with measures of its efficiency: innovations origin or source can be difficult to trace as to innovate itself, is to combine different knowledge and inventions to create something new. Ultimately the goal of a dissemination process should be the successful implementation of an innovation in a company. Measures such as firm surveys on service satisfaction and for instance the European Trend Chart on Innovations indicator on 'SME In-house Innovation' as shown in Figure 13, can give a basis for assessing the work of the TCs, but it does not give a possibility to trace knowledge flow back to a certain TC. Such considerations would require a different kind of study with length in time. Therefore this paper can not provide an unambiguous answer to the question of efficiency of dissemination mechanisms.

Critics of Results

This part will briefly discuss potential flaws of the findings and results discussed in this chapter with regards to the methodological approach and pre-bias issues of the researcher.

Analysing the Findings

Eisenhardt (1989) points to several common pitfalls researchers might encounter in analysing his or hers findings; they might “Leap to conclusions based on limited data”, […]”They are overly influenced by vividness or by more elite respondents”, “Ignore basic statistical properties” and “Sometimes inadvertently drop disconfirming evidence” (Eisenhardt, 1989, p. 540). And of course an un-experienced researcher as is the case in this study, will be more likely to walk into these snares. In relation to this study the first of Eisenhardt’s pitfalls can be particularly likely to influence the results. Restrictions on time, resources, and language barriers have certainly put its boundaries on the findings from this study. It is in such cases likely that one will tend to jump to conclusions, or ‘invent’ theories with no base in reality. Hopefully this can have been counteracted by shifting the weight in the discussion from the empirical findings to the theoretical part.

Finally, it is important to mention that the researcher always will enter the field with a bias. This was especially felt when dealing with issues regarding Portugal as a country: many of the sources used point to what is wrong with Portugal or in what way her performances deviates from the rest of the Europe. Such an approach presupposes that the top performers are doing something ‘right’ and Portugal something ‘wrong’. Ideally a larger amount of Portuguese sources should have been utilised to balance this as one could suppose that they are written with a different bias, but once again the language barrier arises. The probability of running into any of the traps mentioned here can in short be said to be smaller if one looks at data from more angles (Eisenhardt, 1989).

Methodological issues

According to the three main methods Yin (1989) gives as options when working when case studies; observation, experiment and interview, this study chose to focus on interview.

Performing experiments was not feasible for this case, and observation was impossible due to restraints in time and in the respondents' resources. That leaves the study heavily relying on the data obtained from the interviews, which is especially unsatisfactory when one is working with case studies seeking to illuminate from several angles. Ideally a larger degree of observation should have been used both with respect to the theoretical framework of this paper, but also to eliminate potential misinterpretations. Language barriers as mentioned earlier can create misunderstandings, maybe even more common in qualitative studies. Using observation as a method and perhaps putting a stricter 'frame' on the questions, could have cleared away some of these potential errors.

Chapter 7: Future Research Issues

As mentioned in the discussion, this study does not provide an answer to what dissemination activities yields most effective. To investigate this question more thourougly it would be possible to connect studies of adoption of innovations with studies on how they were disseminated: follow it over time. That could gain further insight to the efficiency of the transfer process.

A possible way to perform such a study could be to identify cases where technology was sought disseminated: What mechanisms were utilised? How did it diffuse? To whom did it diffuse? To whom did it not diffuse? The result of this study could hopefully be some deciding factors for dissemination mechanisms related to what is being disseminated.

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Appendix I: Questionnaire

	Questionnaire on dissemination practise
	Interviewer: Mr. Øystein Luktvasslimo, MsC, luktvass@gmail.com
	Purpose of the questionnaire:
	The main objectives of the questionnaire are: to enquire about the main activities of the organization and how they are **funded**, how the organization relates to different **networks**, and finally how it performs **dissemination activities***. It should be noted that the questionnaire differentiate between dissemination activities on a day-to-day basis and on a project basis. All data gathered will be treated anonymously. Personal data are merely used for the researcher to be able to contact the respondent for additional information.
	Details:
1.	Name of the person filling out the questionnaire:
2.	Phone:
3.	E-mail:
4.	Region:
5.	Position (please, describe briefly the main responsibilites and tasks of your position)
6.	Name of institution/agency:
7.	Are you an research and technology organisation (RTO)**?
8.	Please, describe briefly the main objectives and activities of your organization
9.	How is your organization funded?
	Networking:
10.	What kind of ***networks*** does your organization belong to:
	a) *Downstream*; does your organization act as an umbrella or coordinating institution for other institutions? If yes; describe what the limits of this network are and what is the role of your organization.
	b) *Upstream*; does your organization act as a member of a network with other similiar organizations and a coordinating institution (i.e. ministries, departments)? If yes; try to describe how this connection is and what its boundaries are.
	c) *Crosstream*; does your organization have informal or formal networks with other similar organizations regionally, nationally, and internationally? If yes; what is the main purpose of those networks?
	Dissemination practise on the institutional level:
11.	What kinds of ***activities*** does your organization initiate, arrange or perform to spread ***knowledge*** within your network? (Examples: "*codified*"(publications, patents, blueprints, etc.;"*tacit*"('know-how',organizational routines etc.),"*scientific*"(basic or applied research), "*production and engineering knowledge*"(experience from production processes, testing and experimenting).
12.	What kinds of ***activities*** does your organization initiate, arrange or perform to secure wide dissemination of the ***results produced in projects performed by your members***? (Examples: dissemination events, mobility program, set up of networks, web-sites, ...)
13.	Please provide some examples of ***good dissemination practise*** in your organization.

	Dissemination practise on the project level:
14.	What kind of ***dissemination obligations*** exist when funding is granted to a project? (Please provide example text - in your own language, if not available in English.)
15.	How the dissemination of the results from the projects you participate in is ***financed:*** As part of the funding from your own programme or from other sources?
16.	What ***dissemination measures*** (passive - proactive) are used in the funded projects?
17.	How is the ***audience*** or target group for the dissemination activities defined?
18.	Please describe the flow of the research results to the SMEs not members of the organisations involved in the projects. To what extent do these SMEs (the outsiders) have to pay to get the results?
19.	Do you require ***exploitation plans*** (or similar) for technologies developed?
20.	How do you ***monitor*** the dissemination activities in the funded projects?
21.	How do you ***measure the effect*** (e.g. economic) of the dissemination activities?
22.	Please provide some examples of ***good dissemination practise*** from projects funded by your programme. (In your own language, if not available in English.)
23.	Please give details of any ***scientific or governmental reports on dissemination*** of R&D results from collective research (or other) projects that you are aware of.
	* Dissemination activities refers in this context to the activities used to spread new knowledge and/or technology.
	** EARTO (The European Association of Research and Technology Organisations) defines RTOs as organisations "which as their predominant activity provide research and development, technology and innovation services to enterprises, governments and other clients..."

Appendix II: Technology Centres: Background Information

Figure 17 Map of Technology Centres (Source: www.recet.pt)

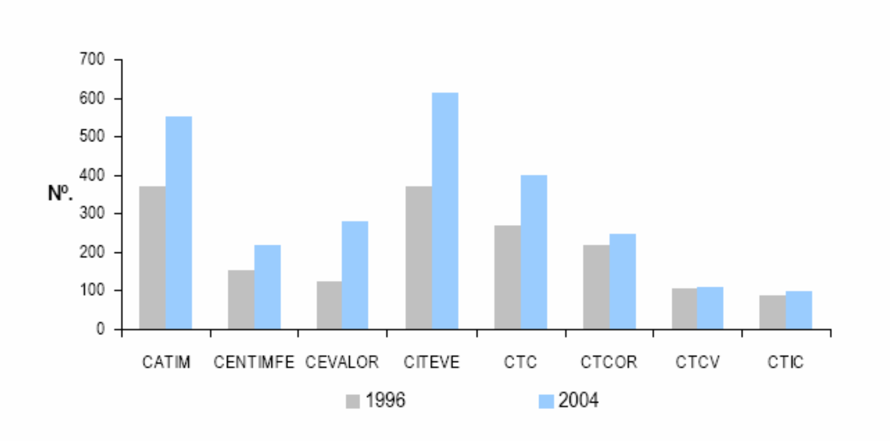


Figure 18 Number of members, TCS (Source: ADI, 2006, p. 29).

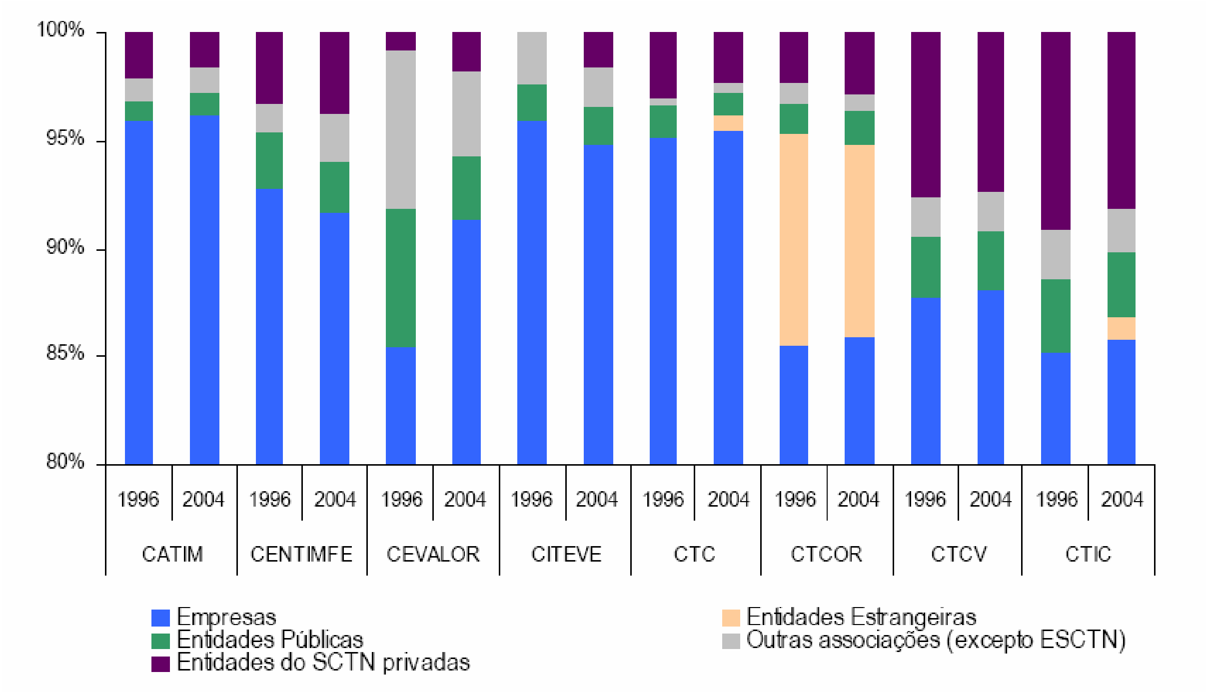
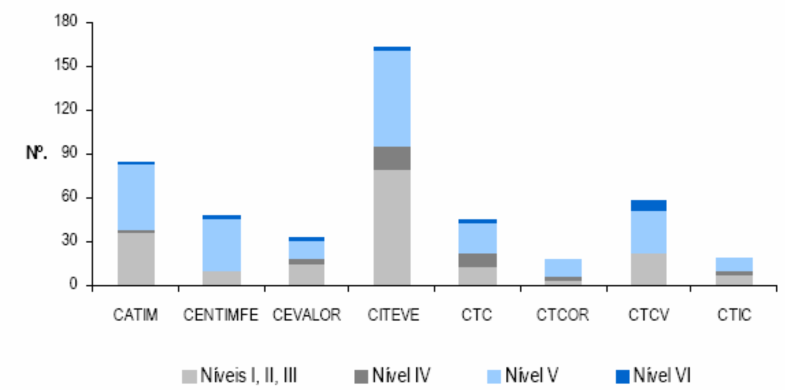


Figure 19 Structure of members per type, 1996 and 2004 (Source: ADI, 2006, p. 30).



[15] Foram considerados os seguintes níveis de qualificação:

Nível I - Escolaridade obrigatória e iniciação profissional
Nível II - Escolaridade Obrigatória e formação profissional (inclui aprendizagem)
Nível III - Escolaridade obrigatória e/ou formação profissional e formação técnica, complementar ou formação técnica escolar
Nível IV - Formação técnica pós-secundária
Nível V - Formação superior completa
Nível VI - Formação pós-graduada

Figure 20 Employees sorted per level of education (Source: ADI, 2006, p. 35).

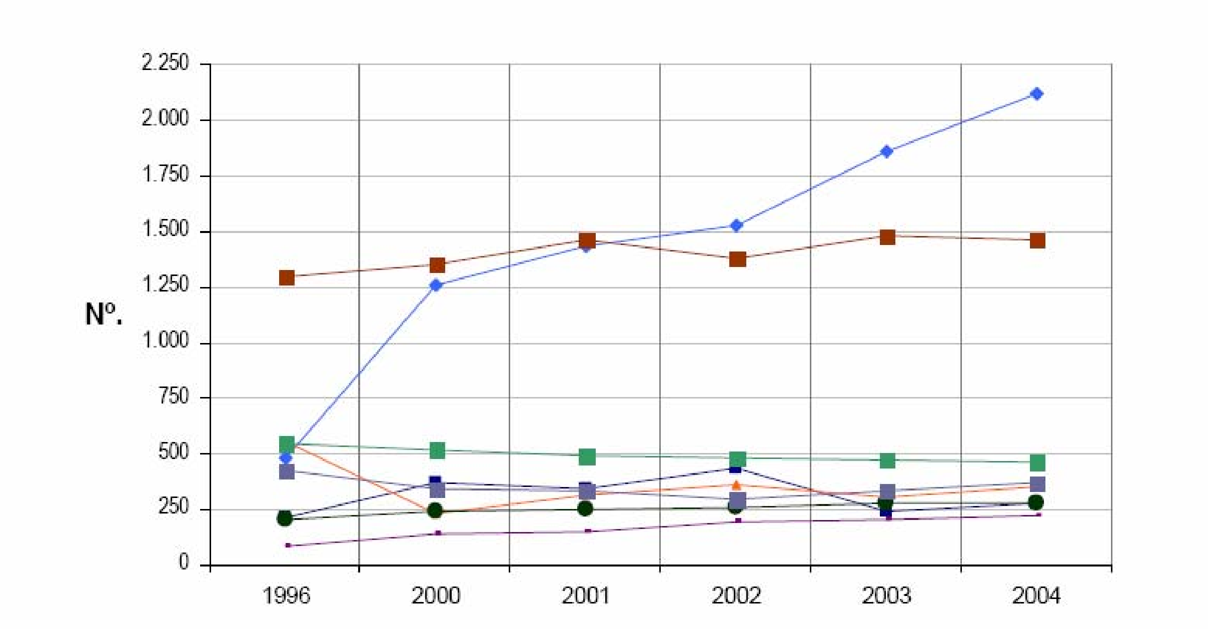
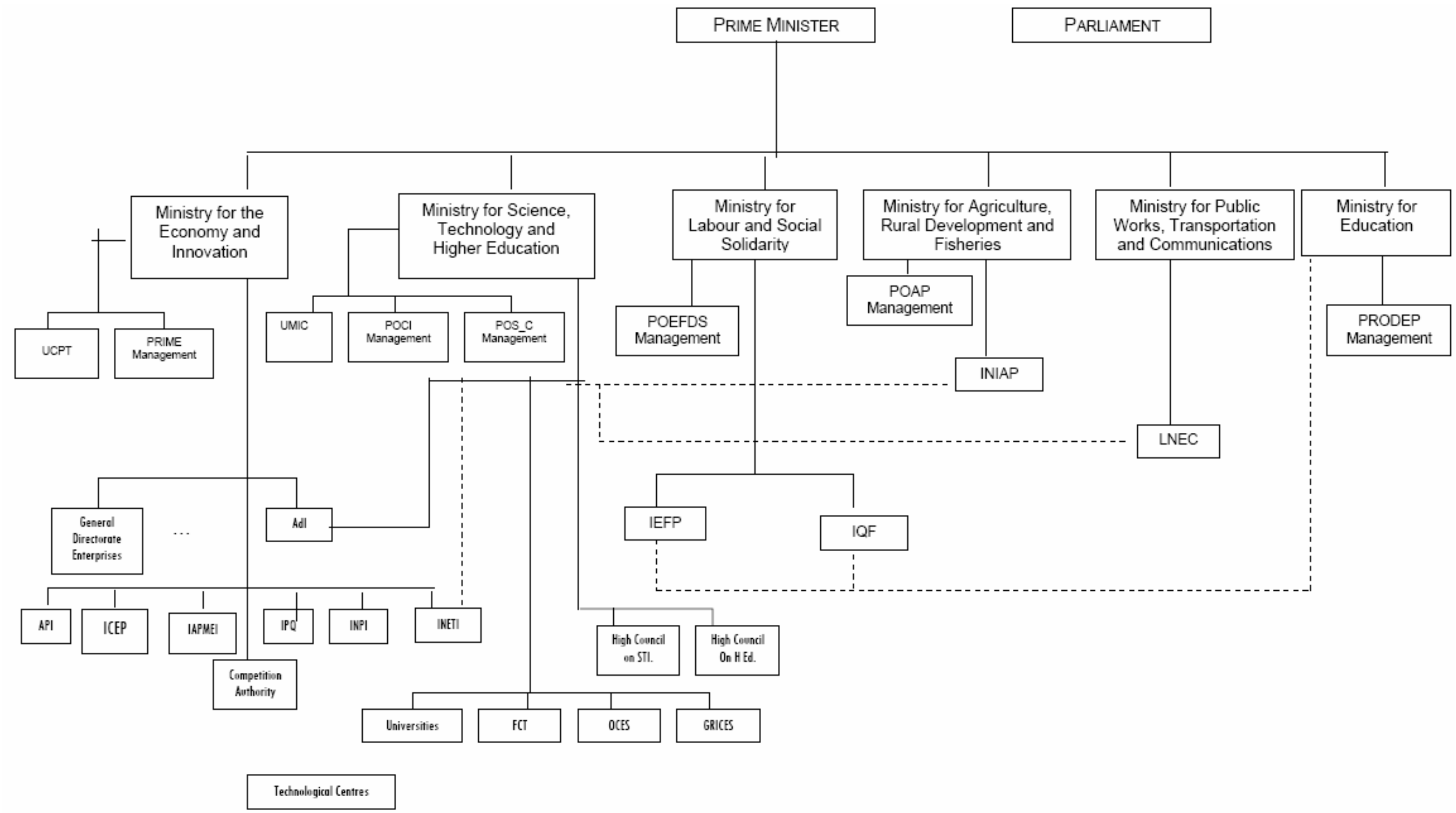


Figure 21 Development in number of clients (Source: ADI, 2006, p. 41).

Appendix III: Organisational Chart of the Innovation Governance System



Appendix IV: List of Respondents

CATIM: Hildebrando Vasconcelos (General Manager)

CTIC: Alcino Martinho (General Manager)

CENTIMFE: Rui Tocha (General Manager) and Pedro Rocha

CITEVE: Helder Rosendo (General Manager)

RECET: Gonçalo Xavier (General Manager)

ADI: Carlos Lajas