PILOT

Policy and Innovation in Low-Tech

Low-Tech Industries: Innovativeness and Development Perspectives

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Contribution to the conference

Low-Tech as Misnomer:
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in the Knowledge Economy

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The contribution introduces the PILOT project and its main findings. The starting point – a critique of the widely held focus on high-technology – and the context of research on low-tech industries are summarised. Secondly, the project's objectives and methodology are discussed. Generally, the project aims at deepening the understanding of growing knowledge intensity of the economic and social development in Europe. It is assumed that the process depends not only on industries with frontline technological knowledge but also on low-tech industries. Thirdly, basic findings of the project will be presented. This part aims at an generalised overview of project results which will be elaborated in more detail in the conference papers. Fourthly, the author discusses policy issues derived from the findings. One key policy issue is to start and support activities and measures raising the awareness on low-tech industries and their specific needs and conditions. A fundamental precondition for this is the development of a new, broader understanding of innovation that does not equate innovative ability with excellence in R&D alone. Finally, it is emphasised that in spite of globalisation and growing competition, prospects for low-tech and medium low-tech (LMT) sectors and companies are not necessarily bad in the high-tech countries of the European Union.

1. Challenges and Context of the Research on Low-Tech Industries

The main starting point of research on low-tech industries and likewise of the project entitled "Policy and Innovation in Low Tech. Knowledge Formation, Employment & Growth Contributions of the 'Old Economy' Industries in Europe" (PILOT) is a fundamental criticism of the widely held focus on high technology. What are the underlying causes for the scientific and policy obsession with high tech industries and the reason we have to discuss the relevance of low-tech? To a large extent, this one-sided attention reflects the idea that ongoing societal change in modern societies can be characterised as typical of an emerging "Knowledge Society" (cf. Drucker, 1994; Stehr, 1994; Willke, 1998; David and Foray, 2003) or "Learning Economy" (cf. Lundvall and Borrás, 1997). These writers and others share the idea that modern organisations and societies are undergoing a fundamental change process, based on the enhanced significance of knowledge as a productive force and asset. Continual innovation, accompanied by a restructuring of work processes and organisation, is regarded as a decisive determinant of economic and social development. And the generation, diffusion and utilisation of knowledge is regarded as a core characteristic of firms and economic activity as a whole.

These discourses on the emerging knowledge society – beyond any doubt – describe important tendencies of economic and social development. We share the view that knowledge is an increasingly important resource, but we dispute much of the conventional wisdom about how the knowledge economy is structured and the accompanying implications for economic trends and hence policy measures. On the one hand, the knowledge economy is usually identified with a very small number of research-based or science-based activities, especially information and communications technologies (ICT), and biotechnology. On the other hand, it is often argued that as a consequence of increased knowledge intensity, the economies of industrialised countries in Europe and elsewhere are currently going through at least two great changes (Carson, 1998):

- A significant part of industrial production is relocating from its traditional sites to developing

countries. The classic example is the exodus of textiles from the rich world during the past three decades. This applies particularly to labour-intensive ‘mature’ industries: quite soon, it is argued, many big Western firms in such industries will have more employees and even customers in developing countries than in developed ones.

- The second change is that in many industrialised countries the balance of economic activity is swinging from manufacturing to services. Even in Germany and Japan, which rebuilt so many factories after 1945, manufacturing’s general share of jobs in relation to the whole economy is declining very fast, in favour of high-tech manufacturing and services.

Particularly in Western countries, these alleged trends have caused a debate about an ongoing process of “de-industrialisation”, originating in the 1970s already (cf. Fröbel et al., 1977). By the end of the 1980s, many American and European experts had come to believe that their countries’ industries were being “hollowed out” as many basic activities relocated to other areas.

The political consequence drawn from this development is the well-known objective of making the EU the world’s most competitive knowledge-based economy by 2010. How this objective can be reached has been debated since then, with the policy makers focusing especially on an important target indicator selected to reflect the objective, namely that the EU should achieve a R&D to GDP ratio of three percent. This political and economic objective has been strongly identified with high-tech, high-R&D industries.

The *theoretical* basis of this argument is the linear model of innovation. The quintessence of this model is the assumption that research and development activities are the starting point of any kind of innovation and that scientifically generated knowledge gives impulses for the development of new technologies. Research and development are regarded as fundamental and necessary innovation steps, which functionally and temporally precede the industrial process. It is assumed that there is a clearly structured course of action, during which the knowledge of basic research is transferred, specified and utilised step-by-step via applied research and is finally employed in the form of concrete technologies in a certain implementation context. If one adheres to this model – also referred to as „technology push“ in the economic theory debate – then it is logical and consistent from an innovation policy point of view that an effective promotion policy has to focus on the field of research and development in order to foster industrial innovations. It is then merely necessary to ensure that the new knowledge asserts itself to the point of concrete development projects and fields application by fostering appropriate transfer measures (cf. Gerybadze, 2004).

The *statistical* basis of this argument is the well-known indicator measuring the ratio of the R&D expenditure to the turnover of a company or a business sector (OECD, 2002). According to the OECD categories, the industrial sectors can be classified as follows: High-technology sectors („high-tech“) with a R&D intensity or more than 5%, sectors with complex technology („medium-high-tech“) with a R&D intensity between 3% and 5% and industries which are not research-intensive (“medium-low-tech” and „low-tech“) with a R&D intensity below 3%, in the following subsumed under the term *low-tech and medium-low- tech (LMT).* Pharmaceuticals, the electronic

industry, motor vehicles, the aerospace industry as well as mechanical engineering, for instance, are categorised as high-tech or medium-high-tech. On the other hand, “more mature” industries such as the manufacture of household appliances, the food industry, the paper, publishing and print industry, the wood and furniture industry and the manufacture of metal products – such as the foundry industry – as well as the manufacture of plastic products are generally regarded as low-tech.

In this debate, the fact that all industrialised countries have a large proportion of LMT industries, both in the manufacturing and service sectors, is often simply overlooked. In spite of growing global competition, particularly in the sectors of traditional and mature industries, this continues to hold true for the industrialised countries of Western Europe as well as for the transition economies of Middle and Eastern Europe.

Further evidence for the importance of the LMT sector is provided by a number of empirical findings which emphasise the innovation ability of the low-tech sector precisely in high-tech countries too (e.g. Maskell, 1998; Palmberg, 2001; Tunzelmann/Acha, 2003); thus the Economist, for instance, referred to “the strange life” of low-tech industries in the high-tech state California a few years ago (The Economist, 1998). From the perspective of historical economics, one can assert that low-tech industries were among the pioneers of multi-divisional modes of organising the production and distribution of a continuous flow of branded, package goods. Hence, the thesis can be formulated: “Innovation in low-tech industries should, therefore, not be seen as a contradiction in terms.” (Mendonça, 2004: 15).

The questions which pose themselves are therefore:

- What are the reasons for the remarkable stability of LMT in the industrialised countries?
- Can they be called innovative and is there a specific mode of innovativeness of non-science based companies?
- And what policy recommendation for the promotion of LMT can be derived from the findings?

In the following, I will, firstly, comment on the project objectives and methodology, secondly I will summarise the main answers to the questions the PILOT project posed itself. Finally, I will sum up the central policy-oriented conclusions. For a more detailed outline of arguments, I refer to the papers by the colleagues of the project consortium.

2. Project Objectives and Methodology

Generally, our research on LMT industries aims at deepening the understanding of the growing knowledge intensity characterising the economic and social development in Europe. A central assumption guiding us is that this process does not only depend on industries with frontline technological knowledge but also on low-tech industries. Our hypothesis is that these are not necessarily low-growth industries; many companies and branches within these industries are growing

fast, are interlinked with high-tech and service branches and provide an important basis for future growth and employment.[1] The role and importance of these industries in different European nations and for the economic and social prospects of Europe as a whole are analysed. Mapping and analysing learning processes and innovation patterns, the PILOT project aims at identifying knowledge bases that contribute to innovation and knowledge creation in low-tech industries and particularly in individual companies. This will also make it possible to identify systematic inter-dependencies between low-tech and high-tech sectors in a network perspective.

The main objectives of the project can be summarised as follows:

- To formulate viable concepts of 'knowledge and technological intensity' and 'learning process' with a wider applicability and a deeper analytical basis than those currently available.
- To determine the role and importance of specific LMT sectors for the innovative abilities of regions and/or nations.
- To identify the knowledge bases that enable innovation and knowledge creation in LMT industries.
- To ascertain the relevance of firm-level knowledge from a network perspective in order to gain an understanding of innovative ability along whole value-chains, including high-tech and service companies.
- To contribute to the formulation of policies on industrial restructuring which pay appropriate attention to the significance of LMT industries for the further economic and social development of Europe.

To achieve these project objectives and tasks, we make use of a mix of different statistical and case study-oriented methodologies. On the one hand, conceptual, taxonomic and statistical data issues are tackled. The currently dominating concepts of "technology and knowledge intensity" and of the "learning process" in firms do not contribute very much to an understanding of LMT industries and their relevance for innovation and growth. Hence, it is inevitable to depart from both the high-tech concept and from the industry classification based upon it and to develop a new conceptual framework. On the other hand, low-tech firms are scrutinised empirically. The core of the project is an extensive series of company case studies in eleven countries across Europe; about forty-five case studies have been conducted. More than half of the firms pertain to the metal-working sector (manufacture of fabricated metal products, except machinery and equipment), the rest belongs to selected other industries: food, beverages & tobacco, textiles, apparels & leather, wood products, paper, pulp products & printing or furniture. The selection of companies is not a representative sample nor did we select firms because they show excellence and profitability far above the average. To qualify as a PILOT case, a company had to be innovative (regarding products and/or processes), economically successful and of a critical minimum size (preferably more than 50 employees). And because innovation in the low-tech sector has not been well investigated

[1] For a more detailed elaboration of the project concept cf. Hirsch-Kreinsen/Jacobson/Laestadius/Smith (2005).

so far, the case studies' purpose within the overall project was rather to state problems more precisely than to answer questions.

For the inquiry we used a standardised questionnaire to collect basic data on the respective company, its production process and its relations to suppliers, clients and, if existing, partners. This research instrument was complemented by about half a dozen semi-structured extensive interviews for each case study (based on a master guideline common for all national project teams) with company representatives on different levels and with different functions, furthermore by site inspections and by an analysis of publicly available documents of the firms (catalogues, product specifications, internet presence, self-portrayals etc.).

Special attention was paid to the use of technologies, typical patterns of innovation and to knowledge creation as well as to the importance of skills and qualifications. Other issues were the collaborative behaviour of firms in different regions and the expected future quality of employment and qualification structures in low-tech industries. The empirical analysis focuses on three levels:

- The first level is the individual company;
- the second level concentrates on inter-firm networks and issues of regional embeddedness;
- the third level deals with the impact of innovation and industrial policies on the development of low-tech sectors.

The empirical investigations have been accompanied by macroeconomically oriented statistical analyses, conceptual and theoretical work and discussions which aimed at clarifying and improving concepts and theories of knowledge formation in low-tech industries and related technological activities.

As has already been mentioned, the full title of the project is: "Policy and Innovation in Low Tech. Knowledge Formation, Employment & Growth Contributions of the 'Old Economy' Industries in Europe". The PILOT project is being conducted by a consortium of social scientists from eleven universities and research institutes in nine European countries including two partners from Poland. It started in December 2002 and runs until the end of 2005.

3. The Strange Life of Low-Tech: Project Findings and Theses

One of our theses is that the term low-technology is basically a misleading designation for the industries and enterprises examined here. For this label evokes judgements such as those that these industries are little innovative, that they are of no importance for the future development of the old developed countries and that they relocate to newly industrialised , low-priced countries in the course of growing globalisation and the shift in the international division of labour. The fact that this image is too one-sided shall be substantiated by the following summarised research findings of the PILOT project.

3.1 Figures and Facts

Generally, and not surprisingly, the statistical data shows the well- known picture of economic development in all industrial countries.[2] Taking employment as an indicator, there is an unmistakable trend for the share of industrial employment to decrease rapidly while the corresponding share of the service sector is markedly increasing. However, if one examines the industrial sector more closely, some surprising findings arise with regard to the significance of the LMT sectors. Our statistical data shows that the LMT industries play a very important role in all industrialised countries as far as employment is concerned. The data shows that LMT industries account, roughly speaking, for more than 60% of employment in the whole manufacturing sector whereas the share of high-tech industries is not more than 10%. But going into detail, it appears that in the countries examined here there has been a tendency for the low-tech industries' share of manufacturing to decline during the long period 1980 – 1999, while the share of high-tech industries has increased. A similar trend can be observed regarding the share of value addition of the different sectors in manufacturing. In the long run, starting from a low level, high-tech sectors show a rising share of the value added in manufacturing while the LMT sector' s share is declining. However, these declines are not marked, and the LMT industries still constitute the largest part of the manufacturing sector in OECD economies. Generally speaking, these changes do not appear to be dramatic. It is, moreover, a very moot point whether one can speak about a real structural change in the period examined here. In fact, the low-tech sectors continue to evince a remarkable stability and a high share of employment.

In addition, it can be shown that there is no clear connection between a high technology intensity and the growth rates of a country. The question is, whether countries with a higher share of high-tech sectors than other countries have the economies with the best growth performance. On the basis of the statistical data no positive correlation can be found between a high proportion of high-tech industries and the level of the average GDP per inhabitant, i.e. it cannot be concluded that high-tech countries are also high growth countries. It can even be shown that low-tech countries have a better growth performance than high-tech oriented countries.

Thus the question arises: What are the reasons for this remarkable stability of LMT industries? This leads to the following thesis which will *elaborate* on the mode of innovation in non-science based industries.

3.2 Prerequisites and Mechanisms of Innovation

Without any doubt, a central precondition for the surprising stability of the LMT industries is their strategy and innovation ability which enables them to face up to the pressures of world market competition by developing new products, process technologies as well as organisation concepts. For a better comprehension of this connection, it is essential to come to an understanding of innovation ability with which the narrow focus on the R&D intensity is avoided. With other words, the

[2] For more details cf. Kaloudis/Sandven/Smith (2005).

question is: What are the central Prerequisites and mechanisms of the innovation ability of firms of the LMT sector?

a) Prerequisites

Starting point of an answer to this question is the argument that the dominant concepts developed to describe and analyse industrial and technological change have many shortcomings. The main argument in this respect is criticism of the traditional interpretation of innovation processes that – *as previously mentioned* – can be described as a linear model. As is generally known, this model's concept boils down to the idea that technical change is the result of always new discoveries and inventions and that the apparatuses, machines and equipment generated in this process permeate into social contexts and thus bring about new forms of social action and social systems. The crux of this model is the assumption that research and development activities are the starting point of any kind of innovation and that scientifically generated knowledge gives impulses for the development of new technologies. Research and development are regarded as elementary and necessary innovation steps which functionally and temporally precede the industrial process. It is assumed that there is a clearly structured course according to which knowledge derived from basic research is transferred, specified and utilised step-by-step via applied research before it is finally converted into wholly concrete technologies that are used in a particular implementation context.

It is obvious that this notion of an industrial innovation process cannot be regarded as plausible, especially not in the light of the specific conditions of the low-tech enterprises examined here. To analyse the requirements and preconditions for the innovative capability of low-tech companies more closely, it is first of all necessary to clarify the specific structural conditions of these firms. These can be characterised relatively precisely by taking recourse to the R&D intensity indicator: The companies have limited or no independent R&D capacities at all and their in-house expenditures for, e.g., R&D personnel and costs and investments connected with R&D activities are low. Their outside spending on R&D orders to other companies or organisations is likewise small. One can therefore assume that these firms have other kinds of resources and capacities to act, on which their innovation ability is founded and which (functionally) compensate for their lacking R&D capacities (Palmberg 2001).

A more theoretically based criticism can refer to Joseph Schumpeter's concept of innovation[3]. This concept establishes no compelling connection between innovation and scientific or technological originality at all. All creative activities which contribute to diversity and thus generate profits count as innovations in Schumpeter' s concept. Many of the problems faced by today's innovation researchers, such as classifying the "uniqueness" or "technology height" of innovations, are of little relevance from this perspective. What matters is not the existence of a science base but professional creativity which can score on the market. This allows for a better understanding of the creative processes which take place in so-called low-tech manufacturing sectors as well as in many service sectors, last but not least in those labelled Knowledge Intensive Business Services.

[3] For more detailed outline of arguments cf. Laestadius/Pedersen/Sandven (2005)

Following this basic idea, an analysis of LMT innovation processes may start by asking how successful companies manage to develop or create the capabilities and competencies which make them perform better than their competitors or at least help them to survive on the market. Part of the answer may, of course, be found in R&D activities, or what can be identified as R&D, carried out and financed in-house or acquired from outside sources. Another part may be related to other activities, of which some may be called innovations and others may be a far cry from what innovation researchers normally focus on. A convincing analysis has to identify and capture all these "profit enhancing" activities irrespective of their labelling. It is our thesis that it makes no sense to distinguish between high-tech and low-tech firms, one should rather differentiate between successful and less successful firms. There are "high-end" firms in all sectors, both LMT and high-tech.

A possible starting point for such an analysis could be resource-oriented analysis concepts of innovation and management research (e.g. Penrose, 1959; Foss, 1997) which lend themselves well to attempts to specify the above-mentioned connections. These concepts aim at examining how firms attain competitive and innovative advantages, which resources they have at their disposal in this respect and furthermore how they employ their resources. Putting it simply, the central argument in this case is that companies can be characterised by means of their specific combination of more or less special and rare resources, especially of knowledge in miscellaneous forms and not only of R&D based scientific knowledge. Furthermore they must dispose of a specific competency to be able to make use of these resources for their strategic goals in each case (cf. Laestadius, 2005). The capability approach of Teece et al (Teece/Pisano, 1994; Teece/Pisano/Shuen, 1997) specifies these aspects because this concept does not exclusively link innovativeness to the knowledge field but takes into account a broader variety of factors that all are important for explaining innovations. Design and synthesising capabilities can be regarded as especially significant in this respect. Therefore at least five dimensions should be considered when analysing the innovativeness of LMT firms. These dimensions include the well-known R&D intensity but also refer to aspects such as design intensity and skill intensity. All together, these dimensions could form the base for the development of an alternative to the system of technology indicators currently used within the OECD and the EU.

b) Mechanisms

To be able more exactly to analyse these connections and the acting mechanisms between available resources and innovation results of diverse kinds, a specification of the capability approach is needed.[4] To put the thesis of this contribution in a nutshell, the authors suggest that the term capabilities should not be understood as a pattern of activities but rather as a term to address specific preconditions for specific activities: a particular configuration of enabling cognitive, financial and material (machinery etc.) resources an organization possesses. This concept encompasses two fundamental dimensions, namely transformative and configurational capabilities. The former focuses on the enduring ability of an organisation to transform externally available, codified

[4] For more details cf. Bender and Laestadius (2005)

knowledge into company-specific knowledge, the latter on the enduring ability to synthesise novelty by creating new configurations of knowledge, artefacts and actors. Three specific aspects of configurational capabilities are established, cognitive: configuring distributed knowledge of different kind; organisational: configuring distributed actors and other repositories of knowledge and know-how; and design: configuring functional features and solutions. The distinction between transformative and configurational capabilities is strictly analytical; empirically the two dimensions are tightly interwoven. And innovations require both.

Given the types of companies which were examined , the analysis of the empirical results on the basis of these categories indeed yields no surprising findings. However, the special character of LMT innovations is thus pointed out. Innovation in this sense is to a great extent the result of the transformation and reconfiguration of well-known internal and external knowledge and of components and technologies developed elsewhere. What all the case firms in this sample had in common, was that not a single one of them based their innovativeness on recent scientific findings and knowledge. The conclusion of this analysis is that also within mature industries with unfavourable cost conditions at least some firms may develop capabilities which for a long time make them profitable and competitive. Innovation is here to a great extent the result of processes of transforming and configuring generally well known knowledge, components and technologies developed elsewhere. These may be knowledge formation processes similar to what may be found in other firms labelled as high-tech or medium high-tech too. Generally spoken, this perspective of analysing innovations developed in the context of the PILOT project and which can be termed as the concept of “innovation enabling capabilities” is appropriate not only for the analysis of innovation processes in LMT industries but my be also useful science-based innovations too.

3.3 Practices and Resources

a) Knowledge Management and Personnel Policy

The concept of capabilities refers to the question on which conditions the enterprises’ ability to be innovative depends. This question can be answered by looking at the findings of innovation studies. According to these, one can basically start from the assumption that this ability is strongly embedded in the practices and processes of the company organisation (cf. Henderson/Clark 1990). The internal organisation practises unquestionably have a vital stake in this matter.[5] It discusses the modes of knowledge management and personnel policy as central elements of transformative capabilities of LMT companies. According to the case studies findings, there is neither one common pattern regarding work-force and work organisation nor one shared pattern of knowledge creation and utilisation. The knowledge base of the investigated low- tech companies can be characterised as “accumulated internal knowledge”. Regarding the processes of knowledge creation, two main, opposing, patterns could be identified: The stimulation of collective accumulated knowledge on the shop-floor and the concentration of knowledge creation in the hands of special-

[5] See the paper by Köhler and Schmierl (2005).

ised personnel in the planning departments in terms of a Taylorist tradition of work design. Both patterns are characterised by a systematic combination of dispersed knowledge and an incorporation and assimilation of external knowledge. It can be shown that low-tech firms are not basic innovators but combine existing codified knowledge with practical knowledge in a competitive way. The knowledge management strategies which can be identified are not at all different from other sectors although there is one often expressed position: “We are followers, not trendsetters”. This is reflected by a strategy which can be labelled “intelligent imitation”: Low-medium-tech firms very often improve their capability to incorporate external knowledge which has already been implemented and tried by others. Benchmarking and learning from the best is a very common practice which requires the capability to observe, to obtain information, to analyse and to transform machines, design or organisational structures from other contexts.

As regards work organisation and personnel policy, many low-tech companies are characterised by core competencies in processing technology and logistics which produce uniqueness and competitiveness. The bandwidth in the case study sample ranges from companies using ultra-modern machinery and highly automated processes (especially in the paper industry, but also in parts of the metal-working industry) to companies which are hardly automated and still largely depend on traditional manual labour and standard technology (like in the food, textile or wood processing industries). However, as a general rule, it can be emphasised that the term low- tech as a classification of sectors is not necessarily synonymous with low-tech manufacturing processes.

The same holds true for the patterns of work organization. First of all, the workforce and work organisation vary from company to company. This means that there is definitely no low-tech specific pattern of work organisation and qualification level which is systematically distinct from medium or high- tech sectors. This heterogeneous economic segment is indeed characterised by a variety of different forms of work organisation. The concrete work organisation is thereby determined by an interplay of many factors – such as product complexity, production process characteristics and automation, personnel policy, quality requirements and customer demands. The companies also dispose of a broad variety of qualifications and skills with differences as to where and in which form transformative capabilities are located internally. The bulk of the firms, however, is characterised by the concentration of strategic knowledge in the hands of a rather small group of managers and technical staff while the production workers are more or less skilled executors.

To summarise the PILOT findings with respect to knowledge management and personnel policy in the investigated low-tech companies, it can be stated that the regular workforces of many companies hold a considerable, as yet underdeveloped, potential for the improvement of transformative capabilities which can be tapped by strategic training and improved and appropriate forms of work organisation. As the authors emphasise, most of the investigated low-tech companies seem to follow a policy of “muddling through” instead of a systematic and foresighted personnel policy.

b) Networks and Local Embeddedness

The next thesis is, that, in addition to the outlined internal aspects, network relations between

companies and supportive social networks are of great and growing importance as resources for the companies' capabilities. Network embeddedness in various forms is becoming increasingly important for the LMT industries' capacity to act, given the growing challenges of the world market and globalisation.[6] Following their systematic analysis of the empirical findings, the following must, however, be noted:

- The equation "low-medium- tech industry = locally embedded processes" is not tenable; while some of the businesses studied are highly embedded, others are not.
- Likewise, the equation "low-medium-tech = structural weakness in the face of globalisation" is wrong; some of the study cases provide evidence of strongly embedded processes but nonetheless proved able to attain a global market position.

Many of the cases investigated concur with overall business trends towards increasing internationalisation. They clearly demonstrate though that globalisation does not necessarily imply a decrease in embeddedness. In fact, a number of scenarios are possible, all of which are dynamic. For many firms, an increase in internationalisation has meant a decrease in territorial embeddedness. What is significant though, is that a number of the PILOT firms have successfully increased their level of globalisation while simultaneously maintaining a high degree of local embeddedness. In these cases, the research findings substantiate the connections well-known thanks to regional research: Generally firms, but especially LMT firms are very sensitive to the density of the institutional set-up both on the national and subnational level. "Density" in this case stands for a mix of physically available infrastructures and of educational and vocational knowledge creation, furthermore of diffusion and brokerage facilities. To sum up, there is no typical LMT firm characterised by standard behaviour concerning global or local orientation strategies. On the contrary, there are close interdependencies between both factors.

In this context, the aspect of the integration of LMT firms into value chains is also of importance. Especially in the light of a progressive restructuring process of value chains, the question where LMT firms position themselves is of strategic importance for these. The empirical findings show that LMT firms are distributed at different levels so that there is no single formula for success for all. Basically, the firms in the upper part of the value chain are not very keen on designing new strategies for moving up the value chain. For the others, moving up is a matter of survival; moving up means acquiring the capability (managerial capability, organisational renewal and workforce skills) to handle customised product and service innovation. This presents the problem of attaining a new degree of integration with clients and suppliers. The empirical findings show that both aspects are becoming increasingly important for LMT companies.

In this connection, it must be pointed out that such enterprises often play a strategic role for the smooth functionality of value-chains. In particular, it can be shown that low-tech companies are of strategic significance for the innovativeness of high-tech companies in the context of value chains. This is so in the sense that low-tech companies boost high-tech innovativeness. It is not surprising

[6] This, in a nutshell, is the basic argument of the paper by Garibaldo and Jacobson (2005).

that proximity plays an important role in this regard. However, this need not necessarily mean spatial proximity. More important are cultural and organisational proximity that constitute the precondition for the passing on of knowledge (especially practical, not codified knowledge) between the companies. Again the social context is of critical importance for technological evolution and innovative capacity. In many cases, value chains as well as clusters need strong intermediate institutions and institutional infrastructures to provide resources for the management and organisation of the networks . Such institutions can be created through the combined efforts of public institutions and local stakeholders so that social contexts can be generated that strengthen the innovation process, thereby including LMT companies.

4. The Specific Situation of a Recent EU Member State: Poland

The outlined conditions and patterns of innovations in LMT sectors mostly relate to Western and Northern European countries with their generations-long free market conditions. It is obvious and requires no further substantiation that the economic and industrial situation in the new Central European Member States is structurally different from that of the Western states. In the context of the PILOT project, this was exemplified by the situation of Poland. This means that it must be assumed that the situation of the low-tech sector in Poland is not comparable to that of the corresponding sector in the Western EU countries.

In their analysis, Tadeusz Borkowski & Aleksander Marcinkowski (2005) refer to the agrarian past of the majority of Central and East European societies, poor industrial traditions, the strong impact of the so-called socialist industrialisation , years of communist ruling and finally the transformation process and the new imperatives of the market economy. Their conclusion is that all of this resulted in a lower level of innovativeness of the LMT sectors and of the country's economy as a whole. And they continue: "There is a difference between LMT firms of the East and the West which is a result, first of all, of the backwardness of their social, cultural, legal, capital and institutional environment which is firstly due to differences formed over time (historical determinants), and secondly due to the separation of these countries, with the consent of the Allies, from Western civilisation , and especially from its work ethos , culture, learning and the democratic system of government (political determinants)." As described by them in more detail, these determinants are reflected in the organisational culture of the enterprises as well as in the institutional and economic environment.

The fact that that currently approximately 70% of the banking system in Poland is in Western possession can be regarded as a decisive factor of the specific Polish situation. On the one hand, this takeover lead to the quick modernisation of the financial system and the surprisingly rapid introduction of methods, techniques and financial tools previously unknown in Poland. On the other hand, such a situation holds certain threats. Banks are a tool of the economic policy of the state in which they are based. Therefore, there is a well-founded apprehension, confirmed by many precedents, that firms competing with their counterparts in the countries in which the banks have their head-

quarters, may encounter problems with obtaining loans. This has already taken place in Poland and was also connected with the purchase and later with the closing of competitive plants.

At the same time, however, it is obvious that the economic situation in Poland - contrary to the situation in other new Member States – is characterised by an at least limited tradition of independence and entrepreneurship. Last but not least out of fear of local mutinies, the governments in the Communist era allowed and fostered sectors of small craftsmen's workshops and , to a greater extent, private agriculture. Furthermore there is a long-standing tradition of an informal economic sector. The question is, whether this tradition holds lasting development potentials. Given an adequate framework, it might become the source of economic initiative and development dynamics.

According to the authors, these very diverse and partly contradictory conditions constitute a number of dilemmas for public policy dealing with SME and thus also indirectly with LMT firms. Thus they point out that policy makers are still completely undecided whether to follow a national or a regional approach with regard to support programmes; a further dilemma in their eyes is the unsolved question whether one should follow foreign models or should develop own models with respect to political programmes. From this follows the question that is still unanswered from a Polish perspective, namely whether policy can really shape the LMT situation and - if so - what type of policy can be effective? Concerning the Polish situation and possible policy measures in general, one can therefore formulate the following thesis: The present situation in Poland is very much characterised by policy dilemmas on how to promote low-tech sectors. At the moment, it is almost impossible to say which policy tasks and measures are appropriate and might be successful. Simple concepts are certainly not appropriate in this case.

5. Policy Issues

As already set out at the beginning, one of the main objectives of the PILOT project was to make policy recommendations for the promotion of LMT based on the empirical findings on the situation of LMT companies. Following the research findings a number of problem situations concerning innovation policy in the LMT sector can be identified. Roughly summarising, the following can be highlighted:[7]

a) First Policy Issue: The policy community only has a limited awareness and understanding of the complexity of industrial innovation processes, particularly in LMT industries

Referring to the EU in general, our empirical findings show that there is little if any awareness of innovation-generating policies other than those focusing on R&D. Correspondingly, the low-tech sectors receive little attention from innovation policy makers on different levels, such as the EU, the national state and the regions. Therefore, a key policy task is to support activities and measures raising the awareness on low-tech industries and their specific needs and conditions. A fundamental precondition for this is the development of a new and broad understanding of innovation

[7] Summarising the arguments of Jacobson and Heanue (2005).

and the insight that one should no longer equate innovative ability only with R&D activities. The more recent debate within the Commission and the OECD about the need for new R&D indicators certainly points in the right direction and should be intensified.

A further fundamental prerequisite is a holistic view of industrial innovation processes and the relevant interlocking of different kinds of knowledge as well as of the different elements of the companies' capabilities which enable them to be innovative and profitable. The policy conclusion to be drawn would therefore be that it is necessary to focus on the industrial innovation chain as a whole, to concentrate more strongly on intersectoral connections and to make a point of finding the potentials of low-tech industries.

However, it must also be emphasised that the firms themselves are little aware of innovation policies for LMT industries and that policy measures are perceived very differently by different firms. The policy measures that are regarded as helpful by some firms as a rule concern general aspects such as national policies providing tax incentives and subsidies for various activities and EU policies such as the Framework Programmes and Eureka. On the whole though, one can state that there are great innovation policy shortcomings as far as the specific problem situations of LMT companies are concerned.

b) Second Policy Issue: Apparently the prospects of low-tech companies primarily depend on both the existing knowledge base and the capability to use and recombine the available knowledge in the innovation process.

As for the knowledge base, low-tech innovations presuppose the availability of a specific (practical) in-house knowledge as well as the integration and use of complex knowledge inputs within networks. It is therefore an important policy task to conceive measures and to support activities which aim at improving the knowledge base and the capability of low-tech companies. This task can be realised on different policy levels, both on the level of EU-wide support programs and also on national and regional levels. In practice, such measures should be directed at promoting the different dimensions of and particularly the preconditions for the capabilities of companies; especially the organisational conditions and the management skills regarding a more efficient use of existing knowledge should be further developed.

In this context a key problem relates to training and recruitment needs. The necessary training for the array of skills required by workers in the LMT companies is not readily available from mainstream providers. Additionally, many of the firms are experiencing recruitment difficulties due either to the negative image of the industries or to skills shortages.

c) Third Policy Issue: Local embeddedness and the co-ordination of network relations between companies are of great and growing importance for the companies' innovativeness.

Therefore, policy tasks should focus on the development of the companies' organisational structure so that it is geared to the demands of cross-company co-operation with corresponding channels of communication, gateways and personnel responsibilities. In this respect, the professional-

ism of the respective management, which plays a vital role in this regard, should be supported and further developed. Another important policy task is to concentrate on improving the firms' capabilities for making the right strategic choice as regards the dilemma between globalisation and local embeddedness. The findings of the PILOT project show the overwhelming importance of a balanced dynamic between global and local and regional policies that operate on all sets of "environments" to which a firm belong and aim at creating the supporting infrastructure supporting the innovation process. Clusters and fragmented economies need strong intermediate institutions and institutional infrastructure to provide appropriate local conditions. To set up such institutions, the positive combination of the vision of the public bodies and the interests of the stakeholders (i.e. collective actors) are important factors.

6. Résumé: Development Perspectives of LMT

Finally, the following should be emphasised: In spite of the doubtlessly difficult economic situation of LMT industries and the challenges of globalisation and growing competition on the world market, prospects for low-tech sectors and companies are not at all bad even in high-tech countries. This is true for a number of reasons:

- Firstly, the specific competence which low-tech companies possess cannot easily be used by potential competitors. For this competence is deeply embedded in the social system of a company and its local environment, which makes it hardly transferable and thus fairly inaccessible to competitors (cf. Maskell, 1998). This – paradoxically – applies to standardised products which are usually considered easy to imitate. But such products are often design-intensive and have major potentials for technological upgrading via the use of complex knowledge inputs.
- Secondly, the geographical and social proximity to sales markets and specific customer groups as well as the company's capability to use and influence these advantages in a flexible manner, are a further important reason for the relatively favourable development perspectives of such companies. For cheaper competitors from other countries, on the other hand, it is often a time-consuming and difficult task to establish the needed contacts and to gain the necessary information.
- Thirdly, a considerable number of low-tech companies are quite evidently in a position to employ high-tech process technologies systematically and efficiently. Their specific process skills on the one hand, and probably also their well-established contacts to the manufacturers of such technologies on the other hand, form the basis for this achievement. Quite evidently the high-tech environment is a central requirement for the development perspectives of low-tech enterprises in this case.

These considerations lead to a new understanding of the restructuring of the economic landscape of Europe in the first years of the 21st century. This change does not appear to be a wholesale structural replacement of "old" sectors with "new" ones, or a substitution of "old" technologies

with “new” ones. In fact, this process of change is evolving as a restructuring of sectoral and technological systems, transformed more from within than from without. It is not dominated by industrial activities for which competitive advantage, capability formation and economic change are generated by front line technological knowledge. Rather, it is dominated by what are often wrongly termed low-and medium-tech industries. And it is characterised by a specific combination and continuous re-combination of high and low-tech.

On this note, the irrelevance of the linear model of innovation has to be underlined. Industrial innovations are mostly not based on newly created scientific knowledge. Even if technical change is based on scientific activities, it is not necessarily based on recent ones – innovations stemming from the stock of knowledge and of the solution of practical problem of various natures may be more important than the creation of new knowledge. The relationship may, in addition, be the other way around, i.e. technology creating the foundation for scientific knowledge (cf. Kline and Rosenberg, 1986). Especially LMT industries can play a decisive role for innovations because the involvement of low-tech products and companies is frequently a core precondition both for the innovativeness of value chains – or production systems – and for the design, fabrication and use of a range of high-tech products. As is convincingly shown by Paul Robertson & Pari Patel (2005) on processes of technological change in developed economies, the relationships between high-tech and non-high tech sectors are highly symbiotic and the well-being of high-tech firms and industries depends heavily on their ability to sell their outputs to other sectors in developed economies.

Collaboration and networking between companies of different industries at regional, national, as well as transnational levels, are therefore increasingly becoming important determinants of the innovativeness and competitiveness of individual companies. These value chains, *filières* or clusters include low-tech companies not just as third tier participants in supply chains or as more or less passive receptors of technologically advanced machinery and equipment developed independently of user specifications. On the contrary, the dynamics and efficiency of value chains may crucially depend on the reliability and effectiveness, the capabilities and specific knowledge of their low-tech partners and on their integration into innovation processes in other firms in the cluster, whether low-tech or high-tech.

This focus on the contribution of low-tech industries to the innovativeness of industry as a whole is extremely important in a policy perspective, both at national and regional levels. It is indispensable for developing a proper foundation for the overall growth and performance possibilities of the European economy. The development of the low-tech sectors is of great importance for both ‘old’ industrialised and ‘young’ high-tech countries and regions. Following the above line of argument, the high-tech prospects of many economies are based on the presence of and dynamic interaction with reliable low-tech functions and processes.

The significance of low-tech companies as regards innovation policy must ultimately also be seen against the background of the strong and probably increasing international competition pressure

on complex technologies and products too. Their market position can by no means be regarded as permanently stable and promising. High technologies and the corresponding know-how are potentially ubiquitously available under the terms of the global economic integration. And the crucial point is, they are also quickly utilisable for innovations, so that the window for realising innovation profits is quite small. One instructive example, as experts stress, is that a developing country like China will in some years be one of the largest developers and producers of high-tech products such as mobile phones. Another example is the situation of the high-tech automotive industry in countries like Germany. It is occasionally pointed out that the German industry' s dependency on the auto industry not only holds specialisation advantages but also brings the danger of severe competition with it since highly sophisticated cars are increasingly being produced more cheaply in newly industrialised countries. The policy conclusion to be drawn would therefore be that it is necessary to focus on the industrial innovation chain as a whole, to concentrate more strongly on intersectoral connections and to make a point of finding the potentials of low-tech industries. Most notably, the empirical findings show that there are favourable development potentials for low-tech industries, definitely also in the high-tech-oriented countries of the European Union.

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