PILOT
NEWSLETTER

- 6 -

The PILOT project is funded within the European Commission's Key Action Improving the Socio-economic Knowledge Base.

Editorial

Dear readers,

The Pilot-Project is finished and this is presumably the last PILOT NEWSletter. It introduces some results of the project.

In the first part Gerd Bender briefly summarises topics of the discussions at the PILOT-Conference in Brussels this June for those of you who were not able to attend.

How to strengthen economic growth is one of the most important questions and aims of European and national policies to improve employment and welfare. Trond Einar Pedersen sums up the PILOT-Argument on Policy and Innovation in Low-Tech Sectors in a macro-economic perspective. He stresses the relevance LMT industries have for economic growth.

This is finding is part of the general backdrop and starting point of David Jacobson and Kevin Heanue's reasoning. In their paper they elaborate policy implications of the project findings.

The issue concludes with an announcement of a special issue of the Polish journal Perspectives on Economic Political and Social Integration which comprises overworked versions of the papers given at the PILOT conference in June.

On the project website www.pilot-project.org you can find more results of the project work including a 30 p. summary "Low-tech industries: innovativeness and development perspectives".

Thank you for your interest during the last three years and enjoy reading the Newsletter No. 6.

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Content

Low-Tech as Misnomer: The Role of Non-Research-Intensive Industries in the Knowledge Economy. PILOT Conference in Brussels, 29-30 June, 2005

Gerd Bender

Do low-tech industries have a future in high-tech countries? What do non-research-intensive companies offer to enhance growth and welfare? Are high-tech firms the main drivers of innovation and growth? How much low-tech does a nation need to be able to survive as high-tech economy? Questions like these were discussed at a workshop the PILOT consortium organised in Brussels on 29th and 30th of June (cf. PILOT NEWSletter No 5, pp. 25-26). The meeting was attended by about forty academics, representatives of industry associations and trades unions, members of the European Parliament and officers of the Commission services.

The consortium had invited external discussants to comment on the papers presented at the conference and was very happy that the following well known experts responded positively: Stan Metcalfe, Stanley Jevons Professor of Political Economy and Cobden Lecturer at the University of Manchester; Dr.-Ing. Giuseppe Strina, senior consultant of OSTO Systemsconsulting, Aachen; Nick Von Tunzelmann, Professor of the Economics of Science and Technology and R.M. Phillips Professor of Science and Technology Policy at SPRU, University of Sussex; and James Wickham, Director of the Employment Research Centre and Jean Monnet Professor of European Labour Market Studies in the Department of Sociology at Trinity College Dublin.

The critical feedback from these distinguished colleagues did not only incite fruitful debate, together with the statements of all other discussants at the conference it was also a very important input for the work the PILOT team undertook in the final months of the project.

Heiko Prange Gstöhl of the European Commission's Directorate General Research and responsible scientific officer for the PILOT project opened the conference with a welcome address. An introduction of basic ideas of the project and the eight papers presented was given by Hartmut Hirsch-Kreinsen. The six papers presented at the first day of the meeting focused on four main topics:

(a) *The relevance of low-tech and medium low-tech industries (LMT) in the economy*. Papers on this issue were given by Kaloudis, Sandven & Smith and by Robertson & Patel.

(b) *Innovation in LMT industries,* with one paper by Laestadius, Pedersen & Sandven which was commented by Nick von Tunzelmann. Commentator of the second paper on this topic, by Bender & Laestadius, was Stan Metcalfe.

(c) *The relevance of networks in LMT*. The paper by Garibaldo & Jacobson was commented by Giuseppe Strina.

(d) The topic *Learning and training in LMT companies* was introduced with a paper by Schmierl & Köhler and the comment by James Wickham.

The second day was opened with a paper on the specific situation of LMT companies in transforming countries, particularly in Poland. The paper on this was presented by Borkowski & Marcinkowski.

The concluding paper by Jacobson & Heanue summarised policy related conclusions drawn from the overall project results and suggested some policy recommendations.

At the final session of the conference the discussions based on presentations from within the PILOT consortium were complemented by comments from stakeholders. Giles Chichester, chairman of the European Parliament's Committee on Industry, Research and Energy opened this part. His input was followed by a statement of Gerhard Huemer, Director Economic Policy of the European craft and SME association UEAPME. Hardy Koch of the European Metalworkers' Federation was the final speaker.

The conference ended with a discussion of conclusions for policies that may be drawn from the project. There was a general understanding that non-research-intensive industries deserve more attention in both structural and innovation policy. Though we will witness further "hollowing out" in some sectors others indeed have a future in the knowledge-based economy, not least as clients of research-intensive firms.

What policy makers should also take into consideration is that migration to low-cost regions is not a faith of LMT industries but of much of high-tech production too. That is to say, the distinction between high-tech and low-tech is not a useful criterion to distinguish promising industries and firms from others. The Lisbon process will not bear success if policy makers reckon only on high-tech.

Overworked versions of the papers presented at the conference will be published in a special issue of *Perspectives on Economic Political and Social Integration* edited by Gerd Bender, David Jacobson & Paul Robertson (cf. p. 22 below). Earlier versions are already available on the project web site www.pilot-project.org.

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Macro-level Analysis of the Impact LMT Industries Have on Economic Growth. Report on the PILOT Work Package 2

Trond Einar Pedersen

In this Newsletter article we make an effort to assemble the main components of work package 2 into a finished whole. We sum up the findings, and we discuss some of the policy implications that emerge.

The work activity of work package 2 has been accomplished according to the following guiding themes:

1. Identify and analyse growth patterns in modern developed economies.
2. Evaluate and improve existing indicators to measure innovation and growth in low-tech industries.
3. Europe-wide analysis of innovation in low-tech sectors.
4. Elaboration of a viable growth theory.
5. Survey of formal qualification structures in low-tech industries.

Rationale and reasoning

The background and rationale for the PILOT project includes assumptions about how our modern developed economies grow. While the established wisdom – in PILOT terminology called "the high-tech argument" – prescribes that the main engine of growth and innovation in Europe is high-tech industries – i.e. industries that maintain a relatively high degree of R&D – we have been working with the hypothesis that the significance of high-tech industries in growth is overestimated, or, the significance of low-tech industries in growth is underestimated. In the documentation work we started off with concepts such as industrial structure and change in this structure.

As part of analysing structural change there was need for establishing an overview of the industrial structure of our economies. The PILOT project includes a thorough basic documentation of the industrial structure of Europe's economies. In line with the limitation that was imposed on the project, we have limited the analysis to manufacturing industries. We have not explored the services sectors in detail beyond some very basic statistics. The dynamics between the manufacturing industries and the service industries are however of crucial importance for the reasoning we are doing. We will come back to that shortly.

The quantitative data that are used in the basic documentation and the investigation of the main argument can roughly be split into three categories:

1. Basic statistics on economic performance, employment, value added and other basic variables (typically OECD Structural Analysis database: STAN)
2. Survey based data on R&D, innovation, and other innovation relevant variables (typically the Community Innovation Survey: CIS)

3. Register data on formal knowledge and competence (typically individualised records of persons' formal education and current occupation, mainly available in the Scandinavian countries)

It turns out to be impossible to neglect the significance and growth of the service sectors in relation to the manufacturing sectors, if we want to scrutinise the high-tech argument. The high-tech argument is a special case of a more general argument to the effect that economic growth is characterised by the creation of new and the replacement of old industries. ICT sectors are often suggested to be the most important examples of this enhanced role of high-tech. By contrast, it is argued that low-tech industries have declining shares of output for two reasons: their growth is lower (or they are declining absolutely) and they are relocating to low-wage economies. That is, they exhibit trade-driven 'hollowing out'.

If true, these claims would imply that *shares of high-tech output are rising* in growing economies, while low-tech shares are falling, and that countries with larger high-tech sectors would exhibit higher growth rates.

Turning to the question of structural change an important question here is: What is structural change? When is structural change substantial or significant, and when is it rather not so substantial? There is need for some criterion or frame of reference for evaluating the magnitude of growth and structural change. What does a significant change in structure mean?

The answer is far from straight forward and it is certainly dependent on the perspective one takes. Anyhow, there is need for considering the whole economy, i.e. including service industries, before we can say anything substantial about growth and structural change. Table 1 gives a picture of the sectoral distribution of total economy employment development from 1981 to 1998. 15 OECD countries are included.

The table shows that taking the rising share of service industries in the whole economy into consideration brings nuance to the argument. While total manufacturing employment over the last 20 years has experienced a 5 percent decline in share of the total economy employment, services industries experienced a 9 percent increase in the share of total employment. In other words, the doubling of high-tech manufacturing industries as share of total manufacturing is occurring in a context where total manufacturing is loosing shares to services industries and the economy as a whole.

The story is of course then, critics would argue, that it is the low-tech industries that contribute to the decline in manufacturing industries' share. It is evidently true, in isolated terms, high-tech manufacturing industries grow and low-tech manufacturing industries decline. But since we have to include services industries in the calculation, the relevant question is rather whether it is in high-tech services we see the strongest increase at the expense of low-tech industries? The answer is no. The strongest increase within services industries is in what we would call low-tech business services (wholesale and retail trade) and in public services.

Table 1: Share of total employment in the economy by nine sectors. 1981 and 1998. Average (unweighted) for fifteen OECD countries.

	1981	1998	Change
Agriculture, hunting, forestry and fishing	8.7	5.0	-3.7
Mining and quarrying	0.7	0.4	-0.3
Total manufacturing	21.8	16.7	-5.1
Electricity, gas and water supply	0.9	0.7	-0.2
Construction	7.3	6.6	-0.7
Wholesale and retail trade; restaurants and hotels	18.7	19.8	1.1
Transport, storage and communication	6.6	6.3	-0.3
Finance, insurance, real estate and business services	8.5	13.0	4.5
Community social and personal services	26.9	31.4	4.5
Sum all sectors	100	100	0

Having presented the rationale and a few of the crucial concepts and arguments in our analysis of whether the high-tech argument can put up with scrutiny, we now turn to a presentation of the main results from the work package in abbreviated form. Let us now go back to the themes/tasks that have been our guiding principles for work activity in PILOT's work package 2.

Identify and analyse growth patterns in modern developed economies

This theme represents the core task of documentation in the PILOT project. It goes straight into the main argument as elaborated above. Our identification and analysis of growth patterns has been made on basis of a thorough consideration of the relative strength between manufacturing sectors and service sectors, i.e. the whole economy has been under investigation. Basic descriptions of manufacturing industries in the triad (European Economic Area, US and Japan) belong to the statistical basis of this work. We have focused on *shares of total value added and employment in manufacturing, labour productivity, distribution of R&D expenditures, invest-*

ment shares in manufacturing, export specialisation.

Manufacturing is in general a more important sector in the EU economy (particularly in Germany and France) compared to US and Japan both in terms of employment and added value as well as in investment and exports.

The statistics reveal the overall feature that high-tech industries can refer to the highest growth rates, in terms of value added, employment and most of the other variables we have applied. However, the stronger growth occurs from a much smaller base than is the case with low-tech industries. The growth of the high-tech industries is significant, but the low-tech industries' decrease in significance is not severe, employment and value added is relatively stable. In the context of strongly increasing shares of the low-tech service industries, this does not threaten the strength of low-tech economic activities.

Evaluate and improve existing indicators to measure innovation and growth in low-tech industries

The task of evaluating and improving existing indicators that measure innovation and growth has in particular been characterised by interaction between WP2 and other work packages in the PILOT project, in particular WP3, the case study work package that has detailed information about innovation in the low-tech companies. Repeating the specific task of work package 2, we supplied quantitative empirical data to this task, but we also contributed to conceptual work.

One of the important starting points of the conceptual reflections about innovation within this context has materialised in a criticism of the Oslo manual and its relatively strict focus on and bias towards product and process innovation. A number of research contributions within PILOT point to problems with the currently dominating innovation perspective and the corresponding family of science and technology indicators and taxonomies. Do we measure the right thing, is the question. The work has been concretely aimed at suggesting a framework for development of a new taxonomy. In order to survive, a new taxonomy need to fulfil five criteria simplicity, reliability, relevance, adaptability and, finally community creation; furthermore it needs to be able to adapt to new circumstances and accommodate new kinds of information.

The message from this conceptual and theoretical reasoning is that other factors than R&D should receive focus when studying innovation in firms. In condensed form it is the message from the PILOT project that central determinants of change at the firm level include the acknowledgement of economic competencies as multi-dimensional multi-faceted phenomena, with a focus on how competence is defined as the ability to generate, identify, expand and exploit business opportunities.

The observations in the case studies confirm this. Market conditions, organisational capabilities and activities related to product design (i.e. controlling, interpreting and implementing product design in the organisation) represent crucial dimensions of a firm's innovative capabilities.

The core deliverable that signs for this task includes a suggestion of the implementation of a new family of indicators. The new indicators shall have the property of giving credit to the innovation activities that are common in low-tech contexts. Five types of indicators are suggested:

- R&D intensity
- Design intensity
- Technological intensity
- Human capital orientation (skill intensity)
- Innovation intensity

R&D intensity is easy to measure – that has been done for decades. Design intensity is easy to capture in surveys. The difference here is not to divide design activities into innovative ones and "fashion" like ones but accepting the design category as an independent category of importance for the profitability in certain firms. As regards technological intensity we may here include a set of competencies as regards acquisition, using or doing; "imported technology" and "technology transfer" will fall under this category. The skill intensity can be constructed to capture the way professional skills are utilised and/or constructed in firms. Innovation intensity can now, liberated from the fetters of including a variety of different modes of knowledge formation, be focused on non R&D-based innovations in products and/or processes.

This leaves us with a knowledge taxonomy based on five classes and independent from the old industrial classification (if it can be based on disaggregated firm data). It is not as simple as the high-tech/low-tech taxonomy used hitherto. But potentially it may live up to the criteria of reliability, relevance, adaptability and – hopefully – also to a common platform for understanding.

Europe-wide analysis of innovation in low-tech sectors

The quantitative analysis of innovation in low-tech sectors across Europe complements PILOT's case study work packages. The concrete documentation is split into two main components. The first part gives an overview of the industry in Europe, its output and employment trends, R&D performance, and comparisons with Japan and the USA, and an overview of previous approaches to analysing innovation in these sectors. The second part is the analysis of the innovation performance of the industries, using the Community Innovation Survey (CIS) data for 1997. We are thereby forced to exploit a survey and a dataset that we are criticising in an other context of the project. It is however unavoidable because CIS represents the only dataset by which a Europe-wide analysis of innovation can be accomplished.

Our analysis is built on an existing study of the machinery industry, hence it has an explicit focus on the machinery industry. It thereby complements the PILOT project's case studies very well (the majority of the case study companies belong to the machinery and mechanical engineering industries).

The clearest conclusion to be drawn from this study concerns the machinery and equipment industries. European machinery industry is characterised by frequent innovation, with a dominant orientation towards *product* innovations, important to the level of revenues. However, two characteristics of innovation in these industries are striking. Firstly, innovation seems to be dominated substantially more by rather incremental innovations than in most other industries. Secondly, collaboration and interaction in user-producer relations appears as being substantially less important than what we expect from their characterisation as specialised suppliers to other sectors and enterprises. However, there seem to be substantial national differences in this respect. Analysis of the character and dynamics behind these differences needs exploration beyond what this study allows.

R&D intensity is about the same in the machinery industry as in manufacturing as a whole. The analysis presented here shows that the industries are highly innovative. In terms of the proportion of innovating firms within an industry, four industries stand out as having a higher proportion of innovative enterprises than the rest, and the two industries studied here are both among these four. Machinery and equipment is second, with innovating enterprises accounting for 68.2 percent of all the enterprises in the industry. The proportion of innovative enterprises within the engineering Industries varies across countries. Perhaps surprisingly, Ireland lies at the top with 73.5 percent, but also Germany lies far above the rest, with almost 70 percent. Spain and Portugal are far below the others at the other end of the scale, both with less than 30 percent. Sweden, Italy, Norway and France are in between, with from 54 to 43 percent.

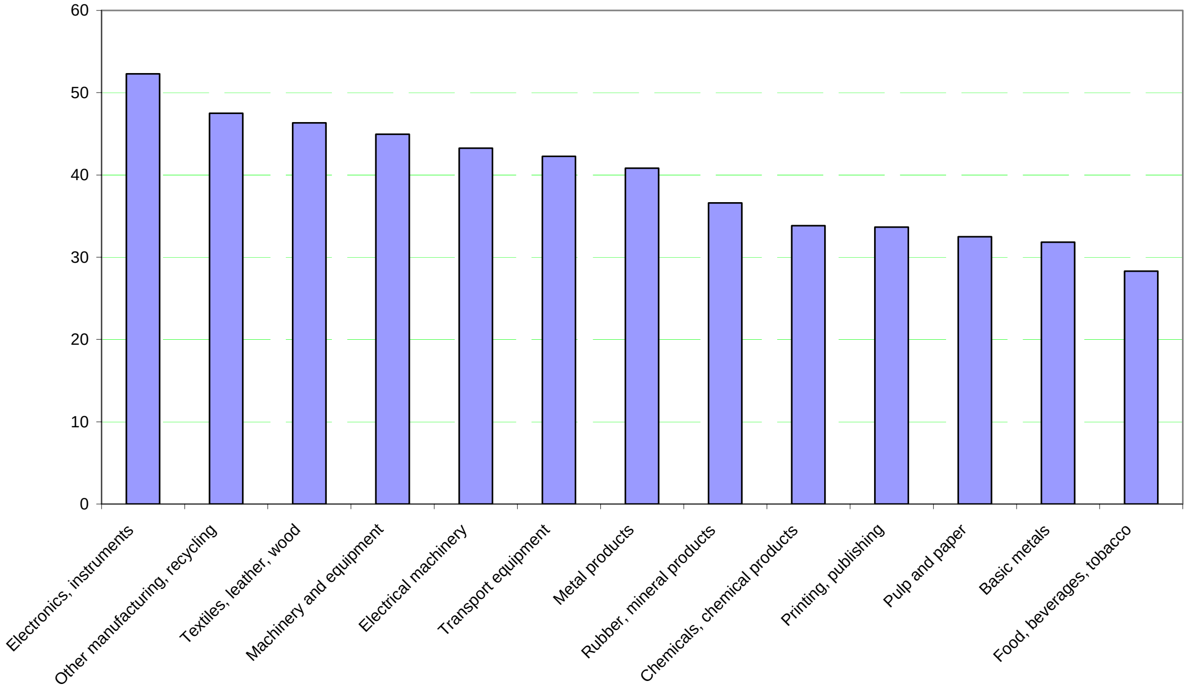
In terms of technological collaboration, Machinery has the highest proportion of internally developed innovations of all the industries, and is very low in terms of both externally developed and collaboratively developed innovations. That the proportion developed collaboratively should be low is perhaps surprising. We might rather expect that firms in the machinery industry develop their products in close collaboration with customers. But it is possible that customers often do not participate actively, but simply supply the information which the manufacturers of machinery ask for.

If this is so, we might expect that especially for Machinery customers and clients would be important as sources of information, and this turns out to be the case. Machinery has the highest score of all the industries on this factor. The difference from the rest of manufacturing as a whole is highly significant.

We also noted that there is a quite clear contrast between product innovations as opposed to process innovations on this matter. For enterprises with only product innovations, customers, clients and competitors tend to be relatively important as sources of information, while the opposite is true for enterprises with only process innovations, and enterprises with both types of innovation are placed in between. In terms of innovation costs, there is not very much variation across the so-called low-tech industries.

We have explored the degree of innovativeness of the industries in terms of the proportion of sales accounted for by new product innovations. An important measure of innovation output in the CIS Survey is the pro-portion of turnover in 1996 accounted for by product innovations as defined earlier in the survey, referring to innovations introduced during the three year period 1994-1996. Among enter-prises with product innovations we find that the mean proportion of sales accounted for by product innovations is 40.9 percent. Figure 2 shows how this mean proportion varies by industry.

Figure 2: Mean product innovations (broad definition) in sales, per cent, among enterprises with product innovations, by industry.



Machinery and equipment is an innovative industry, ranked fourth. As with other factors, Electronics is ranked highest. Machinery and equipment lies significantly above the rest of manufacturing as a whole. The industries grouped under our heading 'Electronics' (NACE 30, 32 and 33) are perhaps in general more focused on in public policy and debate, but the across-the-board innovativeness of the Engineering sector, combined with its large size, might lead us to question whether it receives enough policy attention.

Elaboration of a viable growth theory

The task of elaborating a viable growth theory gathers work done on industrial structure, structural change, innovation and growth.

Starting point is the basic argument that what we might call 'high-technology models of growth' misrepresent the nature of the growth process in advanced economies, especially in smaller economies. The logic of an alternative model builds on the rationale already mentioned in previous parts of this article.

It is often argued that economic growth depends on the creation of new industries, involving major new technologies, and that the latter are in some sense clustered together. At the present time these are often held to be a group of allegedly knowledge intensive high-technology industries, such as ICT, biotechnology and so on. However from a conceptual point of view, in a multi-sectoral economy, the growth rate is a weighted average of the growth of the sectors which comprise the economy (where the weights are shares in output). An empirical examination of the sectoral structure of growth for Europe suggests that growth has a widely-distributed sectoral basis, and that many of the significant sectors are in what are often referred to as low-tech industries. These sectors are typically also large, and thus contribute strongly to overall growth.

How does this square with the idea that growth depends on innovation? We exploit *Community Innovation Survey* data to show that innovation also is a sectorally distributed process. How, then, does this pervasive innovation in 'low-tech' sectors relate to the creation and use of knowledge? Here we use material from empirical studies of industry-level knowledge bases in the Norwegian economy to suggest that the knowledge bases of apparently low and medium technology industries such as food processing, chemicals, oil and gas, publishing and so on, are in fact deep, complex, science-based and above all systemic (in the sense of involving complex and sustained institutional interactions). The policy point of this is that policy makers ought to be aware of the industrial structures – and the associated technological knowledge bases – on which growth actually rests, and that this requires a deeper understanding of the specificity of innovation systems.

How does innovation relate to economic growth? We turn to a critical discussion of an approach which is perhaps dominant within modern studies of innovation, namely a disequilibrium growth model based on 'creative destruction'. The approach can be formulated in different ways, but within it growth is shaped by the irruption of radically new technologies into the economic system. These create new industries which displace existing activities, opening new investment opportunities, and changing the industrial structure. Thus radical technical change, structural change, and growth are part of the same process. One version of this approach permeates economic historiography in the literature on the Industrial Revolution, which is held to derive from steam power, textiles, and so on. In an approach even more influential in innovation theory, deriving from the work of Kondratiev as mediated by Schumpeter, growth tends to be cyclical and epochal. Growth accelerates as new technologies open up investment opportunities, and declines as they are exhausted. In the Kondratiev-Schumpeter framework, radical innovations cluster together, and define eras of accumulation: a steam & textiles era, a vehicles & mass production era, etc.

The most recent systematic formulation of this approach is that of Christopher Freeman and Carlotta Perez, who characterise growth epochs in terms of a dominant 'techno-economic paradigm', and of shifts between these paradigms. It should be noted immediately that a policy argument emerges from these approaches, which is that policy makers should support and reinforce (and if necessary initiate) structural change, investing public resources (or providing incentives for private investment) in the technological capabilities which define the new epoch of growth. The emerging era of our time tends to be defined as the 'knowledge-based economy' or the 'information society', requiring major new capabilities in IT, telecommunications, and software. More generally the argument is that high-tech industries, which in practice means industries investing a relatively high proportion of output in internal R&D, are the growth industries of our age, and should be in the focus of innovation policy.

Now it cannot be denied that discontinuous technological change does occur, is associated with structural change, and is associated with the growth process. We can all think of new industries which have emerged, and old ones which have disappeared. What ought to be at issue, however, is whether such processes can explain growth in any general sense, and therefore whether they offer any reliable guide to useable policy concepts.

There can be no doubt that the cyclical approaches are open to a number of quite basic objections. Firstly, these approaches tend to conflate innovation and diffusion – they tend to assume that radical innovations generate rapid impacts. But this assumption is simply not supported in the various historical studies which have been made of some of the allegedly breakthrough technologies. These technologies, when examined closely, take a long time to diffuse and even longer to have an economic impact. (The same point can be argued of IT at the present time – there is simply no body of literature which supports the idea that IT is driving growth at present). Secondly, these new sectors – even when fully diffused and established – do not necessarily contribute to output in a significant way. Obviously the automobile complex of industries grew to be a large element in output, but something like the hardware IT sector (ISIC 3825) does not make up more than about 4 percent of manufacturing output in any OECD economy. So although new technologies and new industries may exhibit rapid growth rates, they are invariably growing from very low levels, and the overall impact may be small. Thirdly, such theories obviously cannot account for growth in countries which do not possess the industries in question. This applies in particular to small economies. It is clear that these epochal shifts cannot account for growth in the Nordic area, in Switzerland, in Australia and New Zealand, in the

Benelux countries – and these are among the richest economies in the world. These economies are characterised by high growth and high incomes, and are not significantly involved in these allegedly central technologies or industries.

What kind of conclusion can be drawn from this? One conclusion must be that innovation, in the sense of new product introduction, is widely distributed across all industrial sectors; it is pervasive, and by no means confined to the so-called high-tech sectors of the economy. This leads to the suggestion that the reason why low-tech sectors play such a prominent role in the sectoral distribution of economic growth is not because innovation is unimportant to growth, but rather because these sectors are on the contrary highly innovative. This raises a wider question. Innovation involves learning and the creation of knowledge; it involves the creation of novelty in the various aspects of competence related to product and process development and implementation. If many innovative and growing sectors are relatively low performers of R&D, then how do they innovate: how is knowledge created and used within them?

We reflect on the nature of economic growth, exploring the implications of a systems approach for the analysis of growth. Our argument is that growth analyses based on the dynamics of high-tech sectors can be misleading; in fact growth has a complex sectoral distribution, which in turn is based on a wide spread of innovation across sectors. Low-tech sectors are often highly innovative, and this is because they are knowledge intensive from a systemic perspective, as the rest of the PILOT project has managed to show.

Survey of formal qualification structures in low-tech industries.

This theme complements theme number 2, which is the Evaluation and improvement of existing indicators to measure innovation and growth in low-tech industries. The aim of the engagement in this theme is to explore to what extent data on the educational attainment of employees can be used as indicators of the innovation capacities of enterprises. In addition to the value of good indicators for policy making, a maintained knowledge base about the structures of formal qualification in low-tech industries represents important input to an understanding of these industries' innovation and learning capabilities. The contribution is purely statistical: we investigate the statistical relationship between variables expressing the educational attainment of employees (employees holding degrees in engineering subjects; in other natural science subjects: in business administration, accounting, economics, etc; or in other higher education such as social science, law, medicine, etc) and some of the established indicators of innovation capacity and activity.

A clear contrast is found between the natural science education variables, on the one hand, and the other education variables, on the other. The natural science education variables in general correlate more strongly with the innovation variables than the other education variables. They may thus clearly function as indicators of innovative capability, as also their substantial correlation with R&D intensity indicates. However, their effects also almost invariably become non significant when we control for R&D. In a couple of cases they even become non significant when we control for the background variables enterprise size and industry. The natural science education variables thus only express the R&D dimension of innovative capability. They belong to the R&D dimension. For instance, they are instrumental in bringing about R&D: to perform R&D you tend to need engineers, chemists, etc.

Several of the other education variables also correlate with the innovation variables, although less strongly so than the natural science education variables. Thus, they also function as indicators of the innovative capability of enterprises. Furthermore, being not or only weakly correlated with R&D intensity, the effects of these education variables tend to remain even when we control for R&D. To the extent that they do express innovative capabilities, we thus have indication that they express other dimensions of innovative capability than the R&D dimension.

In conclusion, the adding of the data on the educational attainment of employees to the R&D and other innovation data would seem worthwhile and promising. We get reasonably strong and meaningful correlations with the innovation variables, which also serves as partial validation of the latter: it strengthens our confidence that they do reflect important aspects of innovative capability and activity. The education variables seem partly to reflect the R&D dimension of innovative capability, partly other dimensions, and in a pattern that makes sense. Moreover we should not forget that there are aspects of competence important for economic performance which may have little or nothing to do with the capability for innovation. Thus, the education data may be of importance also in investigations where we not focus primarily on innovation, but for instance more broadly on the role of innovation in economic performance, where other kinds of competence may be equally important.

Conclusions and policy implications

Having presented a condensed version of the findings of PILOT's work package 2, it is evident that we cast doubt on the perspective we have called the high-tech argument. We document that the European economy is dominated by low-tech industrial activities. Our findings indicate that we are not facing structural change in the direction towards a society influenced radically by high-tech industrial activities. The most distinct observation is the increased size of the service sector – i.e. what we would call low-tech services, including whole sale and retailing and public services. The theoretical work on growth extends the argument and connects innovation to the reasoning. Innovation is a sectorally distributed phenomenon that exist in all industries, hence there is need for studying the heterogeneity by which innovation occurs. We took as starting point research that document the deep, complex and systemic knowledge bases of low-tech industries, and developed the criticism of the prevailing perspective to innovation into a concrete suggestion for a new family of indicators that can help us measure innovation and growth performance more adequately, in turn enabling policy makers to develop more customised policy instruments.

An important conclusion of this work is that there is substantial variation across the countries when it comes to the shares of output and employment accounted for by high-tech industries – there are quite different sectoral mixes that persist over time. In this context we found no evidence of any simple relationship between technological intensity of the industrial structure and economic growth at the total economy level. There is no simple relationship to the effect that the high-tech economies are also the high growth economies. This suggests that different economies can follow different routes to economic growth. Countries play different roles in an economic system which is differentiated at the international level, and in which there is a division of labour among the highly developed economies.

The policy implications are as important as they are simple. Non-research-intensive, low-tech, industries need to be taken seriously as actors that are responsible for the lion's share of the economic prosperity that European countries experience. This message goes above all to politicians and policy makers. Across Europe it is the policy instruments' bias towards high-tech economic activities and the dilatoriness of innovation policy change that is most striking.

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Policy Guidelines Deduced from PILOT Results[1]

David Jacobson and Kevin Heanue

The Problem

The PILOT project rests on the idea that there has in general been something of a "policy obsession" with science-based innovation and high-tech industries in general. The dominant view is that there is a strong relationship between scientific and advanced technology research on one hand, and industrial competitiveness on the other. From this it follows that science, technology and innovation policies should focus on scientific and advanced technological research. This kind of research is what is generally measured, on the basis of the OECD

[1] The details of any of the references in this paper can be obtained from the authors. They will also appear in the extended version of this paper to be published in the forthcoming issue of PEPSI (Perspectives on Economic, Political and Social Integration); cf. pp. 22 below.

definitions, by R&D expenditure. At the micro level, this was shown to be inappropriate for a number of reasons, including:

- Science does not always lead to innovation
- Learning and innovation can take place without R&D, for example through acquisition of tacit and practical knowledge, and through formal and informal diffusion between firms.
- Non-research-based innovation sometimes leads to scientific discovery
- There is learning and innovation in low-tech and medium-low-tech (LMT) industries like furniture, clothing and engineering
- Some LMT industries, like furniture, remain significant and even continue to grow in Western European economies

At the more macro level, there are also serious reservations about the relationships between R&D and innovations. Expenditure, as a percentage of GDP, is shown in Table 1 below.

It is clear from this data that the relationship between R&D and economic success is at best tentative. Having consistently had the highest rates of R&D expenditure – and expenditure growth in the 1980s – Japan was below only Sweden and Finland in the 1990s. Yet, the Japanese economy has been performing well below average OECD growth rates since at least the mid-1990s.

PILOT Findings

Among many other results, the PILOT project provided ample evidence of the existence, and in many cases crucial importance of non-research based innovation. Many of the forty-three case study firms that were an important empirical focus of the project had survived, and in many cases grown, because of their innovativeness, whether expressed in product, process or organisational change.

In relation to policy, PILOT found that there was a combination of low level of knowledge about policy among LMT firms and a disproportionate attention on the part of policy makers to science and research-based innovation and especially R&D. Moreover, despite some improvements in the sense of cross-fertilisation between academics and policy makers, at the level of policy the difficulty in measuring the type of innovation most prevalent in LMT firms tends to result in less attention being focused on it.

The continuing weight put on such indicators as the 3 percent Lisbon target is evidence of the problem. This is not to say that R&D is not important, but that other important factors seem frequently to be ignored or dismissed. The separation within the echelons of the European Commission between research and innovation is further evidence of the bias. There is a Commissioner for Research and a Directorate General (DG) for Research with its own building, a huge staff and, among other things key responsibility for disbursement of the Framework Programme funds. Innovation, on the other hand, is the responsibility of one of the nine sections within DG Enterprise. It has a relatively small section within DG Enterprise, and a relatively small part of the EU budget. This illustrates the backdrop for the following policy recommendations and conclusions of the PILOT project.

Table 1: GERD[a] as a percentage of GDP[b], 1991-2002[c]
(Source: OECD, 2004, Table 2[d])

	1991	1998	1999	2000	2001	2002
France	2.37	2.17	2.18	2.18	2.23	2.20
Germany	2.52	2.31	2.44	2.49	2.51	2.52
UK	2.07	1.80	1.87	1.84	1.86	1.88
Austria	1.47	1.78	1.86	1.86	1.92	1.93
Finland	2.04	2.88	3.23	3.40	3.41	3.46
Ireland	0.93	1.25	1.19	1.15	1.15	----
Italy	1.23	1.07	1.04	1.07	1.11	----
Norway	1.64	----	1.65	----	1.60	1.67
Poland	----	0.68	0.70	0.66	0.64	0.59
Spain	0.84	0.89	0.88	0.94	0.95	1.03
Sweden	2.72	----	3.65	----	4.27	----
EU-25	----	1.73	1.77	1.80	1.83	1.83
Japan	2.94	2.95	2.96	2.99	3.07	3.12
USA	2.72	2.60	2.65	2.72	2.74	2.67

[a] Gross Domestic Expenditure on Research and Development
[b] Gross Domestic Product
[c] or closest year
[d] see OECD source table for detailed notes

Policy Recommendations and Conclusions

This section is based on two main sources of information. In places, it draws on responses from the PILOT case studies to outline particular policy measures that they identified as being required. Elsewhere, it is based on other PILOT-generated or more general, PILOT-related literature.

Labour force policy

In many LMT companies, the bundle of skills needed by workers is changing; craft based competences and skills are becoming less important or obsolete while at the same time the ability to operate computer controlled machines is becoming more important. Currently, however, there is an absence of the provision of this type of "hybrid" qualification, a lacuna that contributes to recruitment problems. The lack of tailor-made curricula by education and training providers to address the gap in "hybrid" qualifications exacerbates this problem.

Exploring the complexity of this issue, the PILOT project found that in terms of work organisation and skill levels, LMT companies do not automatically use low skills (Schmierl and Köhler, 2005); instead, a broad variety of qualifications and skills are used in LMT firms. In principle, however, two generic types were identified: those firms with generally high skill levels and those characterised by polarised hierarchical layers with a concentration of supervisory tasks within foremen or white-collar staff grades. Similarly, in terms of work organisation, a variety of different forms of work organisation (e.g. strictly taylorist-hierarchical; more participative forms of work organisation like semi-autonomous group work or polarised work-organisation) can be identified in LMT firms. In some cases different forms of work organisation exist within a single company. Thus, simplistic pictures, which consider the LMT sector as being dominated by unskilled labour, a certain type of work organisation with an extremely high division of labour and strict hierarchies etc, is incorrect and misleading from a policy formulation perspective.

All in all, the PILOT case study firms show that in terms of the "progressiveness" of new forms of work organisation, LMT firms seem to be followers (compared to what is known about high-tech sectors) rather than trendsetters. In other words, they incorporate new technologies, organisation concepts, designs and so on only after they have been proven successful elsewhere.

Training in LMT Industries[2]

Any assessment of training in LMT industries should differentiate between companies, which have changed their personnel strategy due to far-reaching organisational or technological innovations, and those that follow a standard personnel policy regarding their work force and its qualifications. The PILOT project, in fact, identified five partially differentiated types of personnel policy in its selection of LMT firms.

1. An advanced personnel policy including an integrated work organisation, technology and workforce related strategy
2. A non-systematic personnel policy and "muddling through"
3. Incremental, internal on-the-job training and informal further vocational training
4. Recruitment activities on the external labour market
5. Vocational training networks and learning alliances.

Most LMT firms apply a personnel policy that relies heavily on the use of internal training, usually unsystematically provided during daily work time and at the workplace. In most cases there is a large variety and difference in intensity of the further vocational training that is provided.[3] A high level of training is often an

[2] This section is also based on (Schmierl and Köhler, 2005)

[3] This trend is not exclusive to LMT firms. For example, a representative survey on the vocational further training situation in Germany for the Federal Ministry or Education and Research resumes that in 2003 26 percent of the total workforce took part in further education as well as in advanced vocational training measures (BMBF 2005, p. 15). However, there are noticeable differences in the take-up of such training with more people with higher education, people aged between 35 and 49 years and more managers participating in such further training.

indicator that there are inadequate regional or national educational systems, which cannot provide enough adequately skilled workers. As a result, internal vocational training – in terms of training on-the-job – is most common. Apart from characteristic differences (e.g. between the sectors or certain types of enterprises) three predominant basic modes of vocational education and training were found in the sample, ranked in order of importance:

- Internal training on the job and learning-by-doing
- External recruitment of key workers on the external labour market followed by an internal phase of training on the job
- Cooperative further training with other institutions and companies.

In terms of policy, there is a need to examine ways to assist in providing access to the delivery of appropriate curricula either in-house or through some other mechanism to LMT firms. Those employees currently not usually participating in such further vocational training should be targeted. Perhaps especially in the first years of employment – as training in-house might represent a significant drain on the company – financial aid from the state or public agencies would facilitate the hiring and integration of more workers, especially young people.

Need for new innovation indicators

The composite indicators that are currently used to describe innovative activity lead to a high-tech bias in data acquisition and policy documents. Although recognised at EU level, the PILOT project has complemented this body of work and addressed the issue of the appropriateness of currently used innovation indicators and the conceptualisation of innovation on which they are based by developing a system of innovation indicators. It was argued that such a family of indicators rather than the currently used composite indicators should be adopted, and incorporated into future Community Innovation Surveys.

Innovation policy

R&D focused innovation policy instruments fail to address the deeper concerns and needs of LMT companies' innovation activities. This is obviously of concern for the firms themselves that do not find support in the innovation policy system, but it is equally serious for policy makers in their attempts to increase the overall level of innovation activity in the economy. From the point of view of the PILOT project this is a flaw of the national innovation system.

Some companies viewed innovation policy with a strong focus on sustainability as a fundamental requirement for both corporate success and economic growth as a whole. Acknowledging that innovation as a competitive strategy was increasingly important, other companies suggested that grants were needed for companies introducing innovations to compensate for any possible losses incurred if the innovations were unsuccessful.

It was suggested by some companies that initiatives to support the investigation of technological problems relevant to companies by final year students at universities and technical colleges would be useful. Such initiatives would be a relatively cheap way of facilitating access by firms to scientific expertise, who otherwise do not have the internal resources to do this work.

R&D targets such as those outlined in the Lisbon Strategy are admirable and desirable policy objectives for those industries where such knowledge is directly needed. It should, however, be acknowledged that they are only among a range of possible necessary targets to help firms embrace the knowledge society and provide employment growth. Other knowledge inputs that are critical to firms' innovativeness and competitiveness require alternative support mechanisms and although not as easily identified or neatly categorised, are just as – if not more – important in the drive to ensure industrial competitiveness and need to be recognised as such.

The concept of "innovation enabling capabilities" developed within the PILOT project poses searching questions for innovation policy makers. At the most basic level, the greater the creativity and design capabilities of firms, the more innovative they will be, whether they be in LMT or high-tech industries. How can firms be encouraged to build up these capabilities? What roles could different actors play? How and at what level can the development of transformative and configurational capabilities be supported?

Funding Policy

Funding policy is defined here as direct funding and subsidies including taxation-based instruments towards any activity carried out by firms. The retention of such financial instruments where they already existed, or their instigation where they were absent, was considered important by many case study firms. This included funding for the recruitment of new staff (especially young people), innovation, new machinery and subsidies to help attend trade fairs. Another example was funding towards investment in continuous technological and equipment innovation, and in areas such as pre-competitive R&D. On a more general level, it was also argued that enterprise support agencies needed to help companies take a more strategic view of their business environment.

Public support policy

If we define public support policy as the broad array of policy initiatives directed at firms, there is a need for consistency, predictability and coordination in these policies. For example, the uncertainty about the availability of funds is seen as a substantial hardship in planning corporate innovation and R&D projects. In addition, specific policies such as environmental policy are sometimes seen as arbitrary and selective in the manner in which they impact certain companies.

In contrast to calls for additional or continued public support policies, some companies favoured less intervention by the state in industrial activity. Moreover, it was suggested that the influence of policy should be limited to the smallest possible scale, except possibly for financial assistance from the EU and that business should stand on its own without public support.

The need for a public policy designed to help low-tech companies deal better with the trauma of generational changes in the work force emerged from the Italian case studies. Such a policy should be aimed at helping companies create effective knowledge management systems so that when one generation retires, all of that generation's knowledge is not lost.

Cooperation Policy

A need for policies to encourage the creation of new, and the reinforcement of existing networks between companies in the same sector, and between companies and other institutions such as universities, emerged from some case studies. In contrast, although other companies considered such policies potentially advantageous they were not considered crucial. For other cases, there was no knowledge about policy programmes that support cooperation between firms or between firms and other organisations or it was stated that there were no policies aimed at facilitating such cooperation. What is certain from PILOT results, is that firms have to have both the capability of cooperating with other firms, and the ability to determine when to cooperate and when to interact on the basis of market criteria.

Conclusions

This paper drew on PILOT project output to examine the ways in which of firms in the LMT industries, across Europe, experienced policy. We were interested, in particular, in whether evidence would emerge of support for innovation in these firms. What policies, at what levels, would they find to have been supportive of their efforts to remain competitive, and in what ways? Were there policies, on the other hand, that the owners or managers in these firms perceived to impede their efforts to remain competitive? Finally if there were gaps, what policies were suggested as appropriate for supporting innovation in LMT industries?

The most important result in the context of this paper is that there is little awareness of policies aimed specifically at innovation that is not R&D based. There is one possible – though minor – exception to this in that one Irish company had participated in an EU Adapt programme. The impression, that the firms in the PILOT project perceived themselves as in some sense excluded from R&D policies, was reinforced by explicit responses from some of the firms: that there was a lack of interest in their industry, or that tax incentives and export subsidies were aimed at high-tech in particular, at the expense of other industries, or that R&D policies were focused on large companies rather than SMEs.

Some (a small minority) of our LMT firms were, on the other hand, successful in obtaining R&D funding. It may be tempting to explain the difference through the fact that these firms are more medium-tech than low-tech. However, this is true by OECD definition in terms of percentage of turnover that goes to R&D. This explanation therefore does not cast much light on what differentiates firms, sometimes in the same industry and in the same country, where one does and the other does not obtain R&D funding. Size may matter in that the application processes are time consuming and where all personnel are fully occupied with existing business, in the short term the opportunity costs of devoting time to R&D applications may be too high. There may be other factors relating to differences in the products and processes that the two firms are involved in, or skill and knowledge issues like differences in dynamic capability. Such issues are discussed in more detail in other PILOT papers. The issue of main relevance in this, the policy paper, is the starkly different ways in which the same policies are perceived by different companies.

Despite these differences, key common issues emerge to provide the list of policy conclusions and policy recommendations. These broadly underline the importance of non-research-based innovation and suggest ways of supporting this innovation. To further underline this importance, the PILOT project recommends that the European Research Council include a unit the specific function of which is to focus on this type of non-research-based innovation.

To conclude, what emerges from the case studies is that there are combinations of real policy lacunae and lack of knowledge about existing policies. In relation to the former, the co-evolutionary process described by Mytelka and Smith (2003)[4] will not by itself lead to the plugging of the policy gaps; research, results, and the feeding of these results into the policy process are an essential contribution to the process. In relation to the latter, improved publicity and information distribution, particularly among firms in the new member countries, will ameliorate the problem.

The overriding conclusion from the PILOT project is that industrial and innovation policies in the European Union and its member states should focus on all innovative companies in the economy – not only on that science-based, or R&D-intensive, small segment we tend to label high-tech.

[4] Mytelka and Smith (2002) have shown that the innovation systems approaches developed by academics, and policy and policy institutions, have interactively co-evolved over the period since the 1980s.

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New book:

G. Bender, D. Jacobson & P.L. Robertson (eds.), Non-Research-Intensive Industries in the Knowledge Economy. Perspectives on Economic Political and Social Integration. Special Issue

This special issue of “Perspectives on Economic Political and Social Integration”, a journal published at the Catholic University of Lublin, Poland, comprises revised versions of papers presented at the PILOT conference “Low-Tech as Misnomer” (cf. p. 1 above).

The issue starts with two introductory articles. **Heiko Prange Gstöhl** of the Commission services discusses the relevance of “PILOT issues” within the EU policy agenda. And **Hartmut Hirsch-Kreinsen** contributes a survey of major project findings.

The paper by **Aris Kaloudis, Tore Sandven & Keith Smith** examines the argument that high-tech industries are the drivers of economic development and *the* relevant sources of growth in output, employment and productivity in the knowledge based economy. Drawing on the OECD’s STAN data base the authors’ analysis does not provide evidence that the high-tech economies are also the high growth economies. They conclude that different economies can follow different paths of economic growth. Countries play different roles in the differentiated international economic system with clear patterns of division of labour among the highly developed economies.

Staffan Laestadius & Trond Einar Pedersen intent to contribute to a new start of measuring innovativeness and creativity within the business sector and thus to widen perspectives in analysing and promoting capabilities and processes that contribute to profitable firms and growth. The core section of their paper is devoted to a discussion of an alternative to the system of innovation indicators used within the OECD and the EU The authors introduce a family of five indicators, not a composite indicator, which they test on Norwegian data.

Starting point of the paper by **Gerd Bender & Staffan Laestadius** is the assumption that the ability to generate and market innovations is one major precondition to maintain competitiveness of European based units. The authors argue that R&D is only one important asset for an organisation’s innovativeness and not necessarily the most important one. Drawing on literature on dynamic capabilities the concept of “innovation enabling capabilities” is introduced which is composed of two dimensions: transformative and configurational capabilities. The different dimensions are illustrated drawing on examples from a selection of company case studies conducted during the PILOT project.

The paper by **Klaus Schmierl & Holm-Detlev Köhler** analyses characteristics of knowledge generation, use and management and of different patterns of personnel policy in successful LMT companies. The authors state that such firms are characterised by a predominance of incremental knowledge accumulation and informal training on the job. Their conclusion is that though this does strengthen the firms' capabilities it may in the long run be an obstacle to the creative reproduction of capabilities.

James Wickham takes the paper by Schmierl & Köhler as starting point but adds some critical remarks on the PILOT project's research design in general. Going a step further he argues that innovation in LMT enterprises often depends on precisely those features of European economic organisation which have recently being challenged by reforms of labour market policy and corporate governance. He concludes that such reforms may destroy structures that are fundamental for European economic advantage.

Francesco Garibaldo & David Jacobson examine regional embeddedness of firms and the importance of the social context for innovation and competitiveness in LMT industries. They argue that appropriate policies in support of building the innovative capacity of LMT firms should focus on strengthening the firms' social environments through the creation of strong intermediate institutions and institutional infrastructure for the provision of regional and local collective goods.

In their paper **Paul Robertson & Parimal Patel** first develop a theoretical model to demonstrate the reciprocal connections between "high-technology" and "non-high-tech" industries. Through the use of patent data, they then show that the latter often employ cutting-edge knowledge in their own R&D and other activities. Finally, they use sectoral case studies to show how so-called high-tech knowledge is used in specific mature industries. The authors conclude that relationships between high-tech and non-high-tech sectors are highly symbiotic and that the health of high-tech firms and industries depends heavily on their ability to sell their outputs to other, less high-tech sectors in developed economies.

Tadeusz Borkowski & Aleksander Marcinkowski highlight the specific situation of LMT firms in transforming countries. They argue that differences in performance of the economy in general and of LMT sectors in particular between old and many of the newer members of the EU cannot be grasped without taking into account historical conditions, and especially without understanding the trauma of war destruction and the nearly 50-year reign of communist policy, economy, culture and morality.

David Jacobson & Kevin Heanue summarise, from a policy perspective, the findings of the PILOT project collated in a variety of ways, in terms of: governance level; type of policy; whether seen by firms as positive of negative; and proposals by companies. Furthermore the paper presents some considerations of recent literature. Finally, the authors specify requirements for efficient innovation policies. A key recommendation is that a specialist unit be set up in the European Research Council, the function of which is to focus on non-research-based innovation.

The paper by **Zbigniew Zaleski & Krzysztof Markowski** discusses determinants of development of SMEs in a border district of the European Union. Based on a case study in the food sector in the Lublin region, Eastern Poland, the focus is on possibilities for the expansion of SMEs. As the region is relatively poor, its future economic and social progress will depend more on a rise of small and medium enterprises than on an expansion of large firms. The paper also argues that a change in mentality from state to private ownership can be a stimulating factor for economic development.

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