

Division 41 Economy and Employment

Section Economic Policy and Private Sector Development



INTERNAL WORKING PAPER

Promotion of Technology and Innovation in the Context of “Sustainable Economic Development”

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1 Technology and innovation in the context of economic promotion activities

Everybody knows what technology and innovation is about. Technology is in the gadgets that we use in our everyday lives, and innovation is when new gadgets appear on the market. However, while this common sense definition of technology and innovation is not wrong, it covers only a small part of the picture. Technology is not only gadgets and machines. It is much more adequate to define it as the combination of hardware, knowledge and organisation. And technology and innovation not only manifest themselves in new products, but also in new processes – and, not to forget, in new business models.

There is widespread agreement that innovation is a crucial ingredient in economic development. There is a causal link with productivity increases, which are the foundation of increases in prosperity. The term innovation usually comes with a positive connotation. However, there is more than one way of looking at it.

- **The heroic view at innovation:** Innovation is the source of growth and prosperity. Innovation is the object of the continuous effort of entrepreneurs and corporations. Ongoing incremental innovation is the source of productivity increases. Radical innovation gives rise to completely new industries that create new growth and employment opportunities.
- **The sober view at innovation:** Innovation is a nuisance. Innovation means to do something differently. Adopting an innovation means that you have to unlearn something that you have learnt using time and effort in the past, and that you have to learn something new, again with time and effort, part of which will be wasted since there will be some other innovation in the future which will induce more unlearning. Often, an innovation means that you have to abandon a process or device that works reasonably well and, most importantly, predictably, and replace it with a process or device that initially will work less well, and may indeed never work as well as the old process or device.
- **The analytic view at innovation:** Innovation is the outcome of competition. In competitive markets, companies are constantly looking for ways of doing things better or doing better things in order to distinguish themselves from their competitors. Doing things better means, for instance, to look for more efficient ways of producing a given product. Doing better things means, for instance, for a different way of addressing customers' needs. Any innovation creates a temporary advantage for the company that creates it. The advantage results in a higher profit, or an "innovation rent". At the same time, innovation is costly. It involves a significant effort in ongoing training of staff, in R&D, in investment in new equipment, and other expenditure. Companies take this effort because they know that otherwise they may be left in the dust of their competitors. Companies that are under no competitive pressure undertake only a very limited innovation effort, especially if they operate in a market that cannot be contested – be it for political reasons, like in the former communist

countries, be it for economic reasons, like in industries with very high capital investment requirements and thus high barriers to entry.

The purpose of this paper is to briefly review the conceptual understanding of technology and innovation, and to discuss how technology and innovation can be addressed in the context of the “Sustainable Economic Development” focus of German development cooperation.

2 Experiences with technology and innovation in technical assistance

Invention is when something is discovered for the first time. Innovation is when something is done for the first time by a person, a company or an organisation. When a given company introduces an innovation, this machine, process or management tools may have been first introduced by another company decades before. For instance, for a carpenter in a small town in rural Ghana the introduction of electric power tools can be a significant innovation. From this angle, in the context of technical cooperation with developing countries it is useful to distinguish three types of innovation:

- **Catch up innovation.** The carpenter in Ghana would be a typical example for this. With catch-up innovation, producers and companies close the efficiency and quality gap that separates them from the state of the art.
- **Running to stand still innovation.** Any company in that is involved in competitive markets needs to innovate all the time in order to match its competitors' innovations. However, even a steady innovation process does not necessarily mean that a company's competitive position changes. Think, for instance, of a company that supplies Ikea with one type of furniture. Ikea expects that the price drops every year. Thus, the producer has to constantly increase its productivity in order to be able to produce cheaper. It is upgrading all the time, yet its position in the value chain does not change (Meyer-Stamer 2004).
- **Innovation for competitive advantage.** Ongoing process and product innovation is a minimum requirement for any company. But a company that operates in a competitive market and does not come up with unique innovation will suffer from serious profit squeeze (Porter 1996). Leading companies try to establish a competitive advantage by doing things differently from their competitors, i.e. by being the first to introduce a given process or product innovation. Yet innovation is not only about process and product. Some business start-ups, and occasionally incumbents, come up with highly innovative business models, where the innovation may have little or nothing to do with technology (think, for instance, of the Aldi business model).

Technical assistance has different track records with respect to these different types of innovation:

- In the context of *catch up innovation*, technical cooperation has been highly effective. Vocational training has had a major impact in this respect, as have many interventions that directly addressed producers and companies, in particular MSMEs.
- It has also supported the creation of structures that underlie the "*running to stand still*" pattern. In this regard, technical assistance has often promoted the creation of an effective quality management, accreditation, metrology and calibration system. Also, the creation of engineering and management faculties in universities has contributed by providing the type of skilled professionals needed by companies that want to compete in the world market.

- Technical assistance has less experience with respect to *innovation for competitive advantage*. This is mostly because partner countries have few companies, never mind sectors, that have reached a level of sophistication that would allow them to build a competitive advantage based on unique innovation. In those partner countries where such companies exist (see Annex 1), they are rarely the object of technical assistance. In this regards, technical assistance is systematically limited by its predominant focus at MSMEs, which in latecomers' countries are usually not the type of company that generates highly innovative products, processes and business models (Khanna and Palepu 2006).

Moreover, technical assistance has not always been informed by an economic concept of innovation. The big technology transfer projects of the early days, the Rourkelas of this world, were just as much driven by engineers' thinking as were the appropriate technology projects of the 1980s. The latter worked well in those cases where for whatever coincidence the newly developed "small is beautiful" artifacts were spotted by entrepreneurs who saw a business opportunity, and they failed in most of the other cases. In an evaluation of German technical assistance projects with a strong focus on technology, we found that they were mostly supply-driven, not articulated with the demands of the productive sector in the respective country (which in some cases were hard to determine in the first place, since technology was not high on the agenda of companies), and had little success in terms of building innovation networks (Hillebrand, Messner and Meyer-Stamer 1994).

Technology and innovation in different types of countries

Has technology and innovation the same kind of relevance for all developing countries? Not necessarily. One can make a rough distinction between countries that are well endowed with resources and that can build their economic development model on the exploitation of resources, and countries that due to a dearth of natural resources need to build their economic development model on knowledge and creativity. Admittedly, resource-rich countries can still pursue a knowledgebased development model, as cases like Malaysia and Chile have shown. However, as the discussion on the "resource curse" has highlighted, the majority of resource-rich developing countries pursue a development model that is based on extraction, generates below average growth, and benefits only a small part of the population (Auty 1994, Rosser 2006).

This observation has important implications for any consideration of the relevance of technology and innovation, and ways of addressing this subject, in the context of technical cooperation. A statement like "knowledge is an increasingly important factor of production" does not apply to all countries in the same way. It obviously applies to countries like India and China. However, in a country like Saudi Arabia, growth and prosperity is not increasingly dependent on knowledge. The same, unfortunately, applies to Angola. In those countries that appear to suffer from the "resource curse", one should not just assume that technology and innovation are generally important for economic development. Technology is obviously important in the resource sector that is the main pillar of the national economy. Yet other sectors may effectively given up hope even to reach the "running to stand still" level – from the government's perspec-

tive, they have little strategic importance; their export competitiveness is compromised by the Dutch disease effect of natural resource exports; and their domestic competitiveness is threatened by cheap imports from China.

3 The evolution of the understanding of technology and innovation since the early 1990s

The 1980s were a period that brought a lot of breakthroughs in the understanding of technology and innovation. Traditionally it had been assumed that knowledge was fully codifiable and could be transferred easily. Also there was the assumption that invention was the source of innovation. Then, systematic research on technology and innovation showed the following:

- It is essential to distinguish between codified and tacit knowledge. Not all knowledge can be codified. Therefore knowledge can not easily be transferred. This is one of the reasons why international technology transfer is a challenging task.
- Innovations become efficient because they are chosen, not the other way around. Decisions on innovation, in particular radical innovation¹ occur under extreme uncertainty. They are often the result of coincidences or specific interests. Innovation is used usually not driven by invention. Frequently it is only after the successful application of an innovation that its underlying scientific principles are understood.
- Innovation is a process, not an event. It is driven by learning-by-doing, learning-by-using and learning-by-interacting. Innovation processes are path dependent. The full potential of an innovation can only be realised over time.
- Innovation is the result of systemic interaction. This happens directly between different types of actors involved in innovation processes (engineers in firms, researchers in laboratories and universities, etc.). For instance, innovation influences science just as much as vice versa. Many innovations have been commercially exploited long before they were scientifically understood. In terms of systemic interaction, there is also a more indirect mechanism in the way the overall economic system shapes the innovation process. Economic systems that do emphasise the creation of competitive markets generate a highly idiosyncratic innovation pattern (as, for instance, anybody who has driven a Trabant can confirm)

Research on technology and innovation in the 1980s culminated in a major OECD research programme and series of conferences that led to the seminal volume “Technology and the Economy – The Key Relationships” (OECD 1992). A concurrent research programme investigated “National Innovation Systems”, and it found that the pattern of innovation in different industrialised and newly industrialising countries was in particular shaped by the overall economic system and the incentives it created. In countries like Brazil and Argentina, despite the best efforts of governments to create the institutions

¹ An important distinction is between “incremental innovation” and “radical innovation”. An incremental innovation is somewhat different, yet not fundamentally different, from its predecessor. A radical innovation is defined as a process or product that solves a problem in a way that is fundamentally different from earlier approaches. For example, an electrical light bulb is not an evolution of the candle.

that usually are part of innovation systems in developed countries, the innovation performance was retarded by economic systems that, behind high tariff and non-tariff barriers, put little performance pressure on companies.

Since the early 1990s, research on technology and innovation has uncovered further important facts:

1. The idea that certain sectors are critical for the national prosperity of a country, perhaps even for its survival as a high-income country, has been dismissed. In the early 1990s, we still had discussions like “Do we need a national basis in microelectronics in Germany?” Such discussions appear somewhat silly today. What has become obvious that each and every sector offers opportunities for upgrading and for building a competitive advantage through innovation.
2. The academic discussion has developed a clearer understanding of why innovation happens, and also why not. Authors like Clayton Christensen (2003) have analysed the rationality of innovation resistance, and the dilemma this creates for companies. Innovation has been demystified, and the fact that innovation often is a nuisance has been acknowledged.
3. Innovation systems have become more internationalised. The notion of a “national innovation system” makes sense to the extent that different countries have different institutional frameworks that create different incentives for innovation; for instance, the U.S. institutional system creates incentives to start biotech firms that specialise in pharmaceuticals, while the German institutional system creates incentives to start biotech firms that specialise in diagnostic kits (Casper 1999). Real world innovation processes, though, increasingly occur in international networks. The key controversy in recent years has been around the relevance of territorial innovation systems, where some authors argue that they become even more important, and build a causal link to globalisation, while other authors argue that “social proximity” is much more important than “spatial proximity” (Malmberg and Maskell 2002).
4. The discussion on the relevance of territorial innovation systems is being energised by the recent performance of Italy, which has turned into the “sick man of Europe”. Lagging desperately in terms of productivity and growth performance, the lag in innovation has been pinpointed as one of the causes, and this in turn has been linked to the strong presence of SMEs and SME-based industrial districts in Italy. While the industrial district model appeared as a viable alternative to a development model that is based on big business 15 years ago, today it is presented as a model of the past that will survive for high-value niche products in mature markets yet fundamentally is incompatible with a globalised world economy (Carabelli et al. 2007).
5. The governance of innovation policy in OECD countries is, by and large, dysfunctional. It suffers from fragmentation, duplication, conflicting policy objectives and lack of strategic thinking. Even those countries that so far had an exceptional performance regarding innovation need to adapt their governance model to the challenges created by increasing integration between traditional disciplines and sectors (OECD 2005).

6. Innovative discussions on technology and innovation policy address the issue of leveraging global factors for national and local development. This discussion is driven by countries like New Zealand, Canada or Scotland that in one way or another are still catching up or under pressure. For instance, Scottish Enterprise teamed up with the OECD to produce a volume on “Global Knowledge Flows and Economic Development” (OECD 2004) which in recent years was one of the most fascinating publications on the issue of innovation policy.

4 Addressing technology and innovation in private sector development

Innovation is a cross-cutting issue. Building and strengthening innovation systems cannot be an activity in its own regard. Innovation is not a sector. It is important to investigate the relevance of technology and innovation for other areas of private sector development as well. When investigating the options for various types of approaches to address the issue of technology and innovation, it is also crucial to move away from traditional concepts. We have moved beyond discussions on the relative merits of the transfer of packaged technology, the transfer of blueprints, and the transfer of technology through foreign direct investment. Today, we understand that the issue of technology and innovation is primarily an issue of incentives – not in the sense of tax incentives, but rather in the sense of the overall incentive framework that is created by a country’s institutional framework, its economic policy, its science policy, and its education policy.

4.1 Core areas of PSD

The following table gives an overview of the relationship between core areas of private sector development and the issue of technology and innovation.

Table 1: Relationships between core PSD approaches and technology & innovation

	<i>Contribution to technology and innovation</i>	<i>Benefit from technology and innovation</i>
Business and investment climate	Defines critical incentives for companies, forcing them to upgrade	An “innovative milieu” is a crucial element of the business climate
Business development services	Provide critical elements for technological upgrading (e.g. training, testing services, calibration, technology consultancy)	Upgrading of service providers is essential for competitiveness. Highly specialised and sophisticated BDS providers are crucial for competitive advantage (Porter: advanced and specialised factors, related and supporting industries). Innovation policy typically battles with effective promotion of service innova-

		tion
Sectoral development	Sector promotion is a typical starting point in the creation of innovation systems	Innovation is a main driver in sectoral upgrading
Local and regional economic development	Local clusters can be highly effective in (a) strong competition and (b) learning-by-interacting	Strengthening local or regional innovation systems is a particularly relevant approach within LRED
Value chain promotion	Lead firms in VCs are a strong incentive to innovation, and often also a major source of knowledge on relevant technologies	Technological upgrading is usually a critical precondition for local producers to appear on the radar screen of national and global buyers

In the following subsections, we will have a closer look at both types of relationships.

4.1.1 Business and investment climate

Contribution to technology and innovation: The business and investment climate is usually defined as an outcome of the regulatory framework and the efficiency of government in delivering it. The same regulatory framework is a decisive element in shaping the innovation behaviour of companies. The framework influences innovation in two distinctive ways. First, effectively functioning markets stimulate innovation-based competition between companies. Second, specific regulations can have a strong and positive impact on innovation behaviour. For instance, in the recent past environmental regulations forced companies to revisit their production processes and explore new innovation trajectories. In other words, it is not necessarily deregulation, and certainly not only regulatory minimalism, but also creative regulation that stimulates innovation. At the level of national policy, regulatory policy can have an impact on innovation that is stronger than that of innovation policy. Environmental regulation (see below) is a typical case in point.

Benefit from technology and innovation: One of the elements of the business and investment climate is the innovative milieu. This is a factor that is related to local or regional economies. The innovative milieu is not only a function of the existence of research and development institutions and an innovation related infrastructure. It is also an outcome of specific relationships between companies which are at the same time competitors and collaborators (“co-opetition”). Innovative milieus are also sustained through dense professional networks. Reinforcing the evolution of an innovative milieu is an important element of an effort to create a favourable business and investment climate at the territorial level. We will come back to this point in the context of local and regional economic development. In a different perspective, technological innovation

can contribute to the creation of a favourable business and investment climate. For instance, running registration and other services via the Internet has in recent years helped governments to make its interaction with business more efficient. Introducing such innovation is a standard approach in the context of public sector modernisation.

Opportunities for Technical Assistance. The tendency of technical assistance to pursue a “more is better” approach regarding deregulation has recently been questioned (Rodrik 2004, Altenburg und Drachenfels 2006). It is crucial for technical assistance to understand that a fully deregulated framework can create a disabling rather than an enabling environment for economic growth in a latecomer country. In this respect, it is crucial to develop a better understanding regarding the approach to creating an enabling environment that stimulates technological learning processes and the creation of effective innovation systems. The “enabling environment” discussion is based on mainstream neoclassical economics. What we need is an understanding of an “enabling environment” in latecomer countries that is informed by evolutionary economics, which is the branch of economics that has addressed the issues of technology and innovation in the most consistent way (Nelson and Winter 2002).

4.1.2 Business development services

Contribution to technology and innovation: Business development services are an important element of the technological infrastructure. Typical examples are testing and certification, calibration, technical training, technological consultancy, and specialised IT services.

Benefit from technology and innovation: Research on technology and innovation and innovation policy tend to primarily focus on business sectors that produce tangible products. This has a lot to do with the fact that this is easier to understand and to conceptualise than innovation in intangibles. Nevertheless, it is crucial that innovation policy also addresses services, and here not just obvious candidates such as Internet related services. Services, and in particular producer services, are the main creators of jobs. Thus, promoting innovation not only in terms of technology but also in terms of business models it is a key challenge for economic promotion. It is an open question whether established entrepreneurship promotion tools are effective in this respect. In fact, innovation in the service sector and promising approaches to promote it are probably the least understood issue around innovation.

Opportunities for Technical Assistance. There is a huge gap between the understanding of innovation in agriculture and industry, and the understanding of innovation in services. Accordingly, interventions to build business service markets are not informed by a robust understanding of innovation, and may indeed be misguided, as Caniels and Romijn (2005) have pointed out. This is another issue where technical assistance needs to develop a better conceptual understanding.

4.1.3 Sectoral development

Contribution to technology and innovation: In the context of sector promotion, technology and innovation, and the creation of a technological infrastructure, are key elements. Sectoral interventions are often a main driver in the creation of a technology infrastructure.

Benefit from technology and innovation: The promotion of innovation is a typical entry point for sector upgrading. In the context of technical assistance, the standard procedure is to involve technical experts that introduce technical innovation that has worked elsewhere. It is much less common to facilitate processes where companies and technology institutions explore and develop customised innovation. Pulling in sector experts is a promising approach in the context of catchup innovation and “running to stand still” innovation, but less promising in the context of innovation for competitive advantage. Here, the key skill of an advisor is not to understand the underlying technology of a sector, and the good practice in applying it. The critical skill is rather to be able to facilitate search processes for strategic innovation, using tools such as foresight and scenarios.

Opportunities for Technical Assistance. The conceptual understanding of sectoral innovation systems is quite robust. Technical assistance can make an important contribution to build sectoral innovation systems at regional, national or supranational level. Building a sectoral innovation system may require the creation of new organisations, such as specialised research institutes. However, the more important approach in the majority of countries will be an effort to better connect existing organisations and companies. This may be done at a territorial level (see next point). Often, it will be useful to have interventions at national level – not only in sectors like health, but also in specific subsectors that are scattered across a number of locations in a given country.

4.1.4 Local and regional economic development

Contribution to technology and innovation: Local clusters of producers and supporting institutions that are marked both by strong competition and by strong learning by interacting can be hothouses of constant innovation processes. However, there appear to have been only few technical assistance projects in such settings, and those that were are hardly captured in documents on innovation (e.g. gtz’s INATEL project in Brazil).

Benefit from technology and innovation: In the context of LRED, strengthening local or regional innovation systems is one of the common approaches. The question is to what extent of this is done in a systematic and consistent way. There may be an opportunity to further develop and deploy systematic tools for the diagnosis of local and regional innovation systems (e.g. RALIS, c.f. Meyer-Stamer and Schoen 2005) and for the identification of strategic interventions (e.g. a refined version of GENESIS). Regarding the strategic interventions, it is particularly important to introduce approaches such as regional foresight, both to define ways to strengthen the competitive advantage and to identify possible disruptive innovation. Regional foresight is a methodology that has

been employed in industrialised countries for a couple of years yet has so far made little inroads in emerging countries.

Opportunities for Technical Assistance. The territorial development approaches in technical assistance have so far had a tendency to address relatively marginal and peripheral regions with an only limited potential to develop an innovationbased competitive advantage. Thus, while there is ample evidence on how to structure and implement territorial development projects, there is only limited experience with innovation oriented territorial development projects. At the same time, there is a huge market for advisory work and facilitation in territorial innovation systems. This includes issues such as: identifying the assets and bottlenecks in the territorial innovation system; formulating a local or regional technology strategy; implementing specific local technology-related interventions, such as technology incubators.

4.1.5 Value chain promotion

Contribution to technology and innovation: Knowledge transfer inside value chains is often the single most important mechanism of technology transfer for companies in developing countries. Moreover, the constant pressure by national or foreign buyers to improve quality and reduce the price creates a strong incentive for ongoing innovation. At the same time, research has pointed out that integration into global value chains limits the innovation options for producers in developing countries, in particular with respect to functional upgrading (Humphrey and Schmitz 2002).

Benefit from technology and innovation: In an effort to connect local producers to national and global value chains, technological upgrading is invariably one of the main activities. This refers not only to the technological upgrading of producers, but also to the technical infrastructure, particularly regarding testing and certification. Once local producers have been connected to a value chain, the innovation pattern is defined by the buyer who tends to become the main source of information on technology and innovation. The necessity to maintain and upgrade the local technology infrastructure, particularly regarding testing and certification, persists. However, in this situation it may be difficult to organise collective action among producers for further upgrading with a strategic intent, as producers will resist any initiative that even remotely implies the risk of upsetting the buyer. In this respect, it is important to understand the structure of the value chain local producers are a part of; Annex 2 presents a typology that is relevant in this respect.

Opportunities for Technical Assistance. Technical assistance can play an important role regarding innovation and value chains. While working with producers, the focus is normally at technological and managerial upgrading so that they fulfil the minimum requirements for integration into domestic or global value chains. Once producers have been integrated into a value chain, they face the challenge to constantly upgrade skills as well as the technological infrastructure in areas like quality, certification and metrology, which are standard intervention fields for technical assistance.

4.2 Neighbouring fields

The following table gives an overview of the relationship between areas that are closely related to private sector development and the issue of technology and innovation.

Table 2: Relationship between neighbouring fields and technology and innovation

	<i>Contribution to technology and innovation</i>	<i>Benefit from technology and innovation</i>
Vocational training	Vocational training is essential in enabling producers and micro and small companies to use available technologies effectively.	Involving training institutions in advisory work in companies improves their understanding of customer needs and can lead to more relevant curricula
Development of financial systems	Financial systems need to operate in a way that supports innovation, in particular in cases where innovation has a long lead time before it becomes commercially viable	Introducing not only technical innovation in financial institutions, but also stimulating the development of innovative financial products is often a weak spot, or even a dark hole, in innovation policy
Rural development	Agricultural development has a long experience in promoting and disseminating technical and organisational innovation in settings where market failure is pervasive	Agriculture is an object of innovation policy, just as industry and services are. Technology fusion can be a challenge
Environmental development	Environmental requirements often have often created new technological trajectories	The need to use materials more efficiently is a key driver of current innovation policy

In the following subsections, we will have a closer look at both types of relationships.

4.2.1 Vocational training

Contribution to technology and innovation: Vocational training is a key precondition for an effective technology absorption. Particularly in the context of catch-up innovation, vocational training and related activities tend to be much more relevant than technology development and transfer.

Benefit from technology and innovation: Technological progress affects vocational training in two ways. First, it creates the necessity to update curricula and to introduce new training courses. Second, it provides new options in terms of delivering training, for instance through virtual reality environments.

Vocational training institutions can be an important part of a technology diffusion structure, whereby their involvement in advisory work improves their understanding of customer needs and may lead to more relevant and updated curricula.

Opportunities for Technical Assistance. Technical assistance can play an important facilitating role with respect to improved integration of vocational training institutions into territorial and sectoral innovation systems. This will often involve a change in focus from capacity building to change management.

4.2.2 Development of financial systems

Contribution to technology and innovation: The high relevance of financial assistance for innovation is not always appreciated. Financial systems need to operate in a way that supports innovation, in particular in cases where innovation has a long lead time before it becomes commercially viable. While highly innovative regions tend to have a thick structure of venture capitalists and business angels, less dynamic regions are hampered in their upgrading effort by the absence of such factors.

Benefit from technology and innovation: Innovation promotion tends to have a bias in terms of developing hardware and tangible products. Efforts to strengthen innovation systems often focus primarily at technology development and transfer, while neglecting financial services. However, the absence of adequate financial services can be the main bottleneck in technological upgrading. Innovation promotion therefore needs to have a strong focus at upgrading the financial system and stimulating the provision of innovative financial products that support technological development and innovation in agriculture, industry and services.

Opportunities for Technical Assistance. Technical assistance can play an important role in informing decision makers in partner countries on possible approaches to promote an innovation focus in their finance system, and it can pursue capacity building activities with training institutions and other service providers that support financial institutions.

4.2.3 Rural development

Contribution to technology and innovation: Agricultural development has a long experience in promoting and disseminating technical and organisational innovation in settings where market failure is pervasive. Other sectors can actually learn from these experiences.

Benefit from technology and innovation: Agriculture is an object of innovation policy, just like industry and services. Similar to industry, agriculture is facing the challenge of technology fusion, where innovations from very different fields need to be combined to create new products; linking biology, biochemistry and chemistry with materials science to introduce nanotechnology into agroprocessing would be a typical example. Disciplinary borders, which are typically reflected in the set-up of technology institutions and in their internal organisation, need to be overcome, something that typically requires a major change management effort.

Opportunities for Technical Assistance. Agriculture is one of the most important sectors where technical assistance can support the creation or strengthening of a sectoral innovation system. This can be complemented with a strategic approach to agricultural technology development that takes megatrends such as the shift in the world economy and climate change into account.

4.2.4 Environmental development

Contribution to technology and innovation: The implementation of environmental policy has often driven technological innovation, in particular in situations where industries moved from end of pipe technologies to fundamentally redesigned processes. It is ironic that industries which initially complain about environmental regulations may ultimately improve their efficiency and become more competitive because of them.

Benefit from technology and innovation: Environmental policy that aims at reducing the emission of greenhouse gases and more generally using materials more efficiently will be one of the main drivers of innovation in the foreseeable future. In fact, it would make perfect sense to conceptualise innovation policy from this angle, rather than primarily from a competitiveness and growth angle.

Opportunities for Technical Assistance. There has already been a significant drive to promote the introduction of environmental technologies and the creation of institutions that specialise in this field. The logical next step would be to move from a sectoral perspective to a cross-cutting perspective. For instance, environmental issues invariably come up in territorial development activities, usually in the form of problems that foreign experts, yet not necessarily local stakeholders, see as opportunities; the question “how can we get rid of sawdust” is a typical example. Territorial development (LRED) can benefit from an approach that is informed by concepts that have been developed under the umbrella of environmental development, such as mapping materials flows and seeking for ways to use materials more efficiently.

5 How to support governments in taking strategic innovation policy decisions

For governments in latecomer countries, innovation policy can not only be about catching up. Catching up means running behind. The strategic challenge for such countries is to leapfrog, i.e. to establish a leading position in specific technology fields. For a latecomer country, it is not an adequate vision to create a complete set of industries with an accompanying technology infrastructure. Instead, they will have to specialise in specific areas. The selection of such areas needs to be driven by criteria such as

- the factor endowment of the country and the existing specialisation profile,
- the major challenges the country has to face, for instance as a result of climate change,
- the global pattern of technological innovation, in particular evolving disruptive innovations which create windows of opportunity for newcomers.

Governments in developing countries that want to approach innovation policy from this angle are in all likelihood looking for support from donors who have shown a credible performance in this regard. So far, however, it seems that this type of advisory work is primarily offered by multilateral organisations such as UNCTAD or UNIDO. There is an opportunity for an organisation like GTZ to assess the German and European experiences regarding strategic innovation and make them available for decision makers in emerging countries. Support to a developing country government would then address two issues:

- Organising a search process that identifies possible strategic innovation policy priorities for a given country. This would involve a number of mutually reinforcing exercises, including scenario writing, technology foresight, a survey of global trends, and an assessment of potential disruptive technologies.
- Involving the relevant stakeholders. Developing country governments tend to suffer from the same fragmentation issues as OECD country governments. For instance, who is in charge of research and development regarding tropical diseases: The Ministry of Health or the Ministry of Science and Technology?

Who addresses research and development on new plant varieties that are adjusted to radical changes in climate: The Ministry of Agriculture, the Ministry of the Environment, or the Ministry of Science and Technology? An external facilitator, who has no stakes in the power play between national ministries, can offer its services as a neutral arbiter.

6 Conclusions

Technical assistance has a tendency to address technology and innovation in an implicit way, as something that is elementary in creating or strengthening productive sectors and services in latecomer countries. Technology is often addressed in an intuitive way. For sector specialists, it goes without question that technology is an integral element of any catch-up or upgrading effort. Also, it is undisputed that the creation of technology-related organisations, from vocational schools to engineering faculties in universities to sectoral research and development institutes to metrology and quality institutes, is an important element of technical assistance, even though the creation of such organisations is not always plausibly justified in terms of specific needs.

There is both a necessity and an opportunity for technical assistance to address technology and innovation in terms of two issues:

1. Strengthening innovation systems in order to create a competitive advantage. This will usually refer to sectoral innovation systems or to territorial innovation systems (in either case with a possible value chain angle). It will consist in efforts both to facilitate internal change in organisations such as technology institutes or vocational and higher education institutions, and in an effort to strengthen interaction between companies and technology-related organisations.
2. Advising governments in addressing innovation policy from a strategic angle. Governments in latecomer countries need to be selective in their innovation promotion effort, and they need to take an informed decision in terms of where to put their bets.

The first approach is the more practical one. It is a natural evolution from existing activities, and it can build to some extent on existing skills and methods. It is something where tangible results can be expected in a relatively short period of time. The second approach is the more strategic one, where tangible results will only emerge in the long term. It is also an approach that involves some effort in developing concepts and methodologies.

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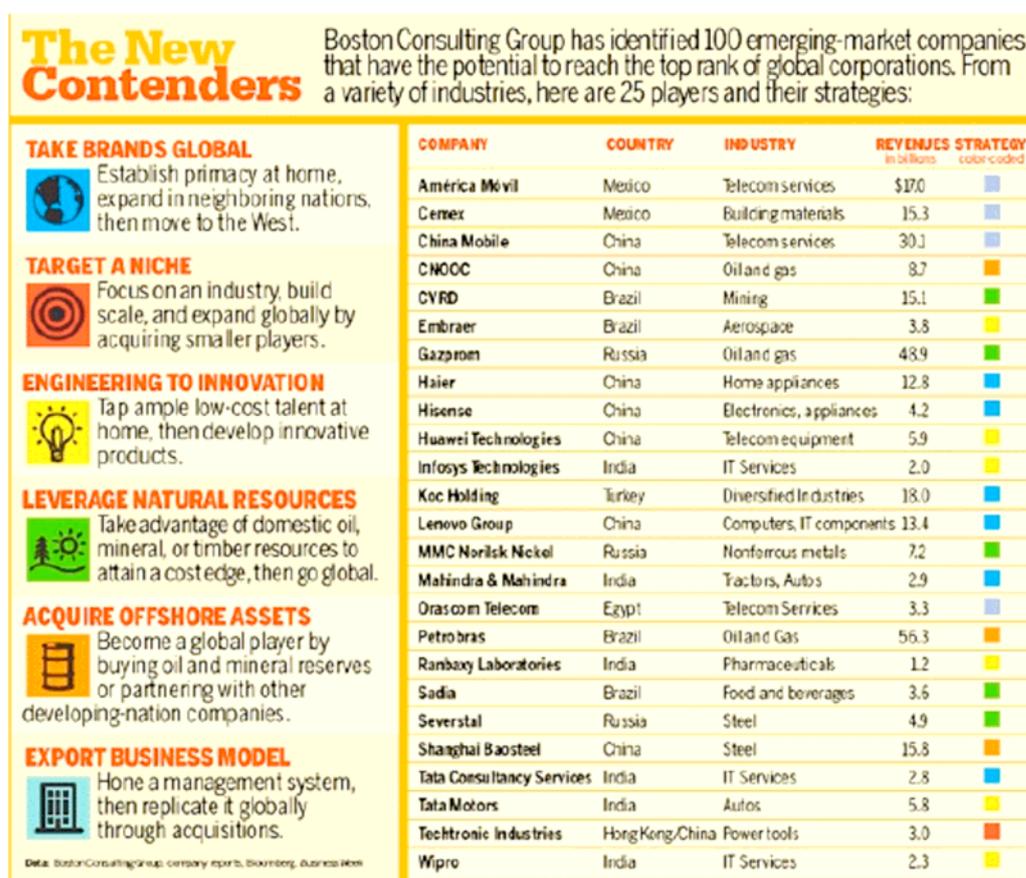
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Annex 1: World Class Companies from Emerging Countries

The following figure gives an overview of some companies from emerging countries that have established themselves as relevant competitors for corporations in advanced countries. Their competitive advantage is based on innovation, more specifically unique first mover innovation, sometimes in terms of products, sometimes in terms of processes, sometimes in terms of their business model.



Source: Business Week, July 31, 2006

For more research on this type of company see Khanna and Palepu (2006).

Annex 2: A typology of global value chains

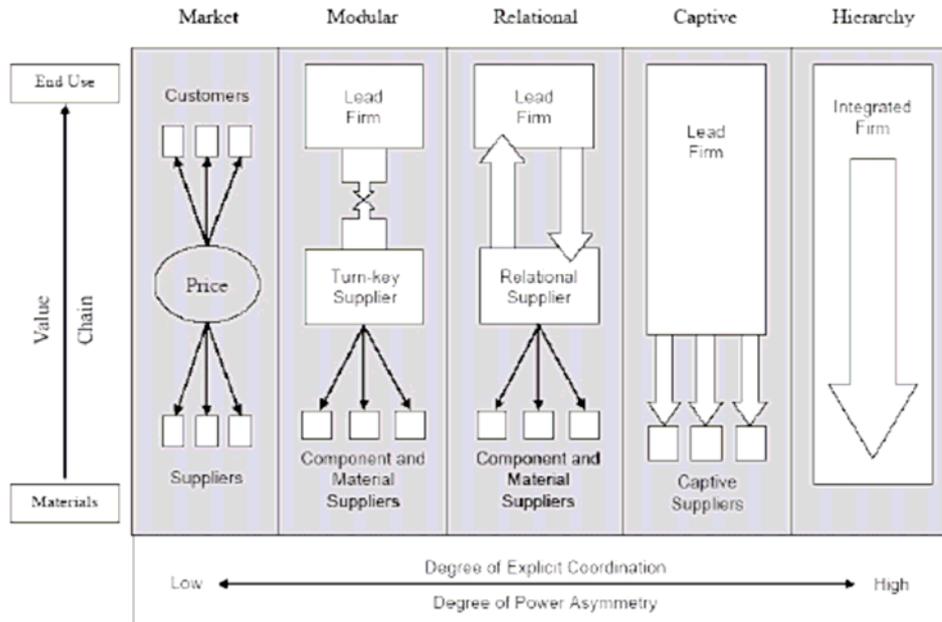
Table 3: Key determinants of global value chain governance

Governance Type	Complexity of transactions	Ability to codify transactions	Capabilities in the supply-base	Degree of explicit coordination and power asymmetry
Market	Low	High	High	Low
Modular	High	High	High	↑
Relational	High	Low	High	↓
Captive	High	High	Low	↓
Hierarchy	High	Low	Low	High

Source: Gereffi, Humphrey & Sturgeon (2005)

Annex 3: Governance within Global Value Chains

Figure 1: Five global value chain governance types



Source: Gereffi, Humphrey & Sturgeon (2005)