

GERMAN DEVELOPMENT INSTITUTE

**The Software Industry in Argentina
Perspectives of a High-Tech Sector in a
Low-Tech Country**

Andreas Stamm
Aida Kasumovic
Frank Krämer
Carmen Langner
Oliver Lenze
Christian Olk

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German Development Institute

Tulpenfeld 4 · D-53113 Bonn

Telephone +(228) 9 49 27-0 · Fax +(228) 9 49 27-130

DIE@die-gdi.de

www.die-gdi.de

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Abbreviations

AGENCIA	Agencia Nacional de Promoción Científica y Tecnológica - National Agency for the Promotion of Science and Technology
ARLOG	Asociación Argentina de Logística Empresaria – Argentine Association for Company-related Logistics
ASP	Application Service Provider
BICE	Banco de Inversión y Comercio Exterior, Bank for Investment and Foreign Trade
BMWi	Bundesministerium für Wirtschaft und Technologie - Federal Ministry for Economics and Technology
BMZ	Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (German Ministry for Economic Cooperation and Development)
BSA	Business Software Alliance
CAD	Computer-aided Design
CASE	Computer-assisted Software Engineering
CEPAL	Comisión Económica para América Latina – UN Economic Commission for Latin America
CESSI	Cámara de Empresas de Software y Servicios Informáticos – Association of Software and Information Services (SIS) companies
CITEFA	Instituto de Investigaciones Científicas y Tecnologías de las Fuerzas Armadas - Research Institute for Military Technology
CNEA	Comision Nacional de Energía Atómica – National Atomic Energy Commission
CONICET	Consejo Nacional de Investigaciones Científicas y Técnicas - National Council on Science and Technology
ECLAC	UN Economic Commission for Latin America
ERP	Enterprise Resource Planning
EU	European Union
FDI	Foreign Direct Investment
FOMECA	Fondo para el Mejoramiento de la Educación Científica, World Bank fund for improving scientific training
FONCYT	Fondo de Ciencia y Tecnología – Fund for Science and Technology
FONTAR	Fondo Tecnológico Argentino – Argentine fund for technology transfer
GACTEC	Gabinete de Ciencia y Tecnología – Cabinet for Science and Technology
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GMD	GMD Research Center for Information Technology
ICT	Information and Communication Technologies
IDC	International Data Corporation
IEC	Instituto de Estudios Sociales de la Ciencia y la Tecnología – Institute for studies in the social sciences on science and technology

IMF	International Monetary Fund
INTA	Instituto Nacional de Tecnología Agropecuario - National Institute for Agricultural Technology
INTI	Instituto Nacional de Tecnología Industrial – National Institute for Industrial Technology
ISO	International Standards Organization
ISP	Internet Service Provider
IT	Information Technology
m	million
MERCOSUR	Mercado Común del Sur - Common market of the countries Argentina, Brazil, Uruguay and Paraguay
NIC	Newly Industrializing Country
OECD	Organization for Economic Co-operation and Development
PC	Personal Computer
R&D	Research and Development
SECYT	Secretaria de Ciencia y Tecnología – Secretariat for Science and Technology
SETCIP	Secretaria para la Tecnología, la Ciencia y la Innovación Productiva – Secretariat for Technology, Science and Productive Innovation
SME	Small and Medium-sized Enterprise
SOFTEX	Brazilian government program for the promotion of software exports
UBA	Universidad de Buenos Aires
UNDP	United Nations Development Programme
UNLP	Universidad de La Plata
WWW	World Wide Web

Summary

The use of information and communication technologies (ICT) entails comprehensive and far-reaching impacts in large areas of economy and society. For developing countries, too, these technologies offer new potentials for accessing stocks of knowledge dispersed throughout the world, overcoming traditional barriers to development, and accelerating catch-up processes. This, however, presupposes that the technical conditions and the infrastructure are in place that are required for any comprehensive use of ICT. Furthermore, the use of ICT as a catalyst of development processes cannot be viewed in isolation from the technological competence available *in situ*. The potentially efficient users of technologies with very short life cycles must be conversant with their specific technological state of the art or at least have recourse to relevant advisory or consulting services. In the field of information technology (IT) the search for internationally available software suited to solving specific problems as well as the implementation, installation, and maintenance of such software call for a high level of technological competence. Many international program packages are not designed to solve local problems, and the necessary adaptations require a high level of technical competence. In the absence of such competence such services must be rendered by international providers or consulting companies, and this can mean prohibitive costs for many potential users in developing countries, leading to restrictions on the spatial and social scope of possible technological innovations. The advanced developing countries would also be well advised not to leave the world market for software entirely to the industrialized countries and instead to seek to actively participate in it by offering products and services in demand there.

The present study, based on the example of Argentina, looks into issues touching on the conditions that must be given in developing countries if they are to develop technological competence in IT and specifically in software development as well as into the policy measures that governments can use to support this development and the contributions that can be provided by international

development cooperation. Between February and April 2000 the authors of the present study conducted comprehensive interviews designed to cast light on these issues. The authors surveyed 58 companies involved chiefly in developing and marketing software in Argentina. In addition, 43 Argentine companies from three selected branches of industry were interviewed to gain an estimate of the extent to which and the form in which software is used in modernizing Argentine businesses. The company surveys were supplemented by interviews with experts from the private sector, the field of science, and public-sector institutions.

The problem's relevance to development

Building technological competence in IT and developing a relevant range of products and services in developing countries are issues that have thus far found little resonance in the discussion on development policy and in the deployment of suitable measures. It would, however, be time to start, in view of the fact that one of the contributions expected of development policy is to help build self-sustaining economic structures than lead, via growth and employment, to a sustainable reduction of poverty. Basing our considerations on this widened concept of development, we can point to the following arguments in favor of promoting the development of technological competence in IT:

- Under the conditions of increasingly open economies, it is only thoroughgoing modernization, including the use of IT, that can ensure the competitiveness of companies in developing countries, in this way sustainably securing jobs in the formal sector.
- Technological competence is only in part a tradable good. The exclusive use of imported products and services leads to costs prohibitive to many small and medium-sized enterprises (SMEs) and other potential users in developing countries and thus diminishes the social and spatial impacts of the use of IT.
- The production and provision of IT services is highly employment-intensive. In developing a range of products of their own, such

companies create valuable jobs in forward-looking service fields that can give rise to extensive multiplier effects.

- The world market for software and IT services has been growing at two-digit rates for many years now, and there are no signs that the market will soon be saturated. For developing countries this can mean possibilities to develop exports, acquire orders, and attract foreign direct investment (FDI), in this way joining in the international division of labor.

The main task facing government would be to use targeted social inputs to offset the possibility of market failure. Without government activity overall investments in education and training tend to fall short of the socially desirable level. The reason for this is that only part of the returns on private investments in qualification measures flow back to investors. Moreover, investment in research and development (R&D) generates externalities that mean positive effects for an economy's competitiveness. The industrialized countries have a broad range of experience in designing and shaping technology institutions and instruments. They can support the efforts developing countries are making to enhance their technological competence by transferring their experience in this field.

The present study's conceptual context

There is at present no theoretically grounded concept indicating how and under what conditions developing countries could close the gap on the industrialized countries in the field of IT. For this reason the study looks back to some thoughts developed by Sanjaya Lall at the beginning of the 1990s. Building on experiences made in the field of latecomer industrialization, Sanjaya Lall identifies some influencing factors crucial to the development of technological competence. He stresses the interplay between competent and learning companies, functioning factor markets, adequate institutional arrangements, and incentives with a stimulative effect on technological development.

The starting point and de facto source of technological innovation processes is the innovative and competent enterprise. The development of company-specific technological competence ("firm-level technological capabilities") rests mainly on three factors, viz. the ability of a company to

- assess investments in technological development ("investment capabilities");
- to master, assimilate, imitate, or improve existing process and product technologies, or to develop them autonomously ("production capabilities");
- to build linkages to other actors such as customers, suppliers, associated service companies, and research institutions ("linkage capabilities").

It is not in isolation but together with other economic, scientific, and governmental actors that companies develop technological competence. While it is true that each individual company operates its own technology and innovation management, this management is subject to a "common element of response of firms to the policy, market and institutional framework." The shape given to a specific framework of this kind brings about different national levels of technological competence, and these in turn entail different rates of productivity and growth. Sanjaya Lall terms this "national-level technological capabilities" (NTC). A broadly effective increase in technological competence will only materialize if a sufficiently large number of companies is prepared to invest in technological progress. And the key to such progress is specific **incentives** designed to act on the business environment; they break down into three groups:

- Macroeconomic incentives, such as growth, inflation, interest and exchange rates as well as the availability of foreign exchange and credit.
- Particularly effective are incentives provided by the internal and external competition to which a company is exposed.
- Factor markets can have positive effects on technological development if they are flexi-

ble, reflect factor prices in line with the market, and lead to an efficient allocation of resources.

A company's **factor endowment** has an influence on the extent to which it will be able to use, adapt, and develop technology for the market. Since the individual company is for the most part unable to generate the factors of production it needs on its own, it has to demand them in the relevant factor markets. According to Lall, there are three types of factor endowment that are relevant in this connection:

- Access to sufficient financial capital is the sine qua non to investment in technological capabilities. And if capital is to be deployed as efficiently as possible, an economy must have a functioning financial system.
- A sufficient number of adequately trained workers must be available. Although qualifications can also be acquired informally and by way of practical experience, a central role has to be played by formal training, for the most part closely associated with public education.
- Access to technological information provides support for company-level innovation efforts. This information is generated through R&D conducted in companies and research institutions and has to be complemented through access to internationally available information.

Institutions define the framework for the interplay between factor endowment and incentives, for instance in the form of intellectual property rights. The development of technological competence can furthermore be encouraged via technological training, publicly funded research, and institutions dedicated to technology transfer and the promotion of business startups.

There are two arguments indicating that, despite increasing **globalization**, the national frame of reference is crucial for the development of technological competence:

- The factor markets important for companies to enhance their technological competence are mainly organized at the national or subnational level, and their functioning often depends on government decisions.
- Close interaction between producers and users plays a key role in developing and disseminating technological innovations. These user-producer relations are encouraged by spatial proximity and linguistic and cultural affinities.

Argentina - a potential location for technologically demanding software production?

Argentina, a newly industrializing country (NIC), is practically unknown as a provider of technologically demanding products and services. Its role in the international division of labor has until now mainly consisted in exporting bulk agricultural and agroindustrial goods and importing the knowledge-intensive products it needs. Proceeding on the basis of Lall's concept, we must assess the conditions for a catch up process in technological competence as unfavorable.

We find some severe deficits at the microlevel. The country's enterprise structure is marked by a dual structure: a core of some 500 highly productive, technologically competent, and export-oriented corporations on the one side and roughly 890 000 SMEs, only a few of which can produce to international quality standards, on the other. The Argentine private sector's propensity for technological innovation is low, user-producer interaction is weak.

While companies that want to boost their competitiveness by means of technological innovation can find qualified personnel in the Argentine labor market, funding poses substantial problems. Access to the relevant information is limited in that public investment in science and technology is relatively low and the relevant institutions are for the most part not properly interlinked with the private sector. The incentives emanating from the business environment are ambiguous: though Argentine companies in some years achieve high

growth rates, the country is far from any stable economic dynamics. In the 1990s the country did succeed in stabilizing prices, but this success was bought at the expense of an overvalued currency and high real interest rates.

Argentina's software sector: its structure and dynamics

When the present study was in preparation, there were hardly any reliable figures available on Argentina's providers of software and IT services. It was estimated for 1995 that some 300 national and international companies were producing and marketing software in Argentina. Since then a good number of suppliers have been forced out of the market. At the same time, quite a few new companies have been started up, and so we may assume that even today the figure of 300 national software companies is close to reality. The empirical data of the present study indicate that in 1999 the sales revenues of national software providers were around US \$ 300 million and that these firms directly and regularly employed some 4500 persons. Our estimate is that the exports of Argentine software companies do not exceed US \$ 25 million.

The industry consists for the most part of relatively new companies. Half of the companies surveyed were started up in the 1990s. The great majority of software companies were founded by university graduates who had majored in IT or related disciplines. The interviews conducted permit us to infer an ideal-typical course for the development of a great deal of new companies. Many company founders started out, themselves or in small teams, providing programming services for individual customers. These are for the most part SMEs that began to introduce IT in the mid-1990s, when hardware prices began to tumble. These programming jobs served to computerize certain functions in company administration and management. Successful provision of a software solution often led to follow-up jobs for other companies. Reuse of individual modules made it more and more possible for developers to go beyond individual contracts and begin to produce

partially or completely standardized products, to lower costs, and to build stocks of customers.

Even today, enterprise-resource planning (ERP) software constitutes the most important segment of the programs offered by Argentine companies. SMEs from the secondary or tertiary sectors are their most important clientele. Public institutions (hospitals, municipal administrations) need software to computerize administrative operations. Some providers have concentrated on computerized solutions for professionals and freelancers (doctors, lawyers, insurance representatives).

In terms of program complexity and price, the ERP software on the market presents a highly differentiated picture. It ranges from simple, fully standardized packages for small enterprises to complex solutions for mid-sized companies, that contain, on top of partially standardized software, comprehensive advisory and implementation services. The business strategies pursued in this connection are correspondingly broad in nature. The suppliers of standard packages often market their product via middlemen or other IT service providers who also take charge of installation as well as the maintenance and service of the programs. The number of customers is high, some 30 000 licenses have already been sold for the best-selling Argentine ERP program. The providers of complex IT solutions, on the other hand, have direct contact to only a limited number of customers, for whom they take on comprehensive jobs.

There are only a few companies active outside the ERP segment, for instance a provider of geographic information systems or a company that offers a complex program for architects. Some companies offer computerized solutions for technical problems. These are provided with customer-specific programming or in the form of partially standardized program packages with high service requirements. Two suppliers from our sample are involved in developing so-called embedded software. This is software that is integrated into technical systems and equipment.

Argentine software providers have until now mainly serviced the domestic market. Fourteen

companies (24 %) also had customers abroad, mainly in MERCOSUR countries. Their volume of exports is relatively small, though. Only eight companies (14 %) export more than 10 % of their sales volume, and only two companies transact over half of their business abroad. Export successes are reported almost exclusively by companies active outside the segment of ERP software.

Most of the companies interviewed are small. At the end of 1999 only eight companies from the sample (14 %) employed more than 50 persons, the largest had 120 employees. The average number of persons employed by the companies surveyed was 24, the median 15. Depending on their volume of orders, many companies hire extra staff, often students or freelancers, on the basis of short-term service contracts. The overall sample shows a close correlation between sales volume and number of employees. This means that very few effects to scale are achieved in the Argentine software industry; the data we collected indicate that Argentine software companies create one new job for every increase in sales of roughly US \$ 40 000. Approximately half of the jobs in the companies interviewed were held by university graduates. Sixty-two percent of these persons held degrees in computer sciences or systems engineering. In addition, many such employees had attended a three-to four-year technical computer-science training program.

Most of the companies concerned had developed positively in the years prior to the survey, i.e. their sales, employment, and numbers of customers had risen. At the same time, however, both the internal and the external competition to which these companies are exposed had intensified. An exact analysis of our data permits the following interpretation:

- The protective "natural niche" from which, thanks to national peculiarities, the Argentine providers of ERP software were long able to benefit, has been penetrated by international providers in subsegments.
- Companies that offer technologically demanding specialized products or software that needs to be tailored specifically from cus-

tomers to customer continue to face very limited international competition.

The role of software in the modernization of Argentine companies

The empirical study included an analysis of the role of software in the modernization of Argentine companies in the auto parts industry, in the wine-making business, and in logistics. Most of the companies interviewed in these branches of industry were comparatively large SMEs; the study was, though, not concerned with presenting a representative picture of the overall industries concerned.

For some time now the Argentine auto parts industry has been faced with tough international competition, specially following the devaluation of the Brazilian Real in 1999. This competition and the pressure exerted by assembly plants are forcing these companies, for the most part medium in size, to accelerate their processes of modernization. This inevitably means the use of software, though investments for software are subordinate to those made for plant and machinery. Most of the programs used in production are purchased from international suppliers and are as a rule software embedded in machinery. As far as ERP is concerned, we found clear-cut differences associated with the origin of companies' majority shareholders. Argentine companies for the most part demand national software that has been adapted to local conditions. Companies dominated by foreign capital, on the other hand, mainly purchase their software in the international market. In many companies the parent corporation determines what software to use, since it is interested in networking its branches using a uniform system. Other international corporations have their own ICT departments that develop dedicated systems for the specific needs of the company.

The companies surveyed are at times unable to find adequate solutions for certain problems in the Argentine market. For instance, they see a lack of software for technical applications (design and metrology) as well as of systems adequate to the

task of integral corporate management, that is, systems that interlink production and administration. The latter programs are available in the international market, though they do not pay for themselves in the narrow domestic market and are thus beyond the financial means of SMEs in particular.

The winemaking industry

Argentina's traditionally domestically oriented winemaking industry is increasingly looking to exports, with simple table wines being replaced by higher-grade quality wines. These processes are bound up with technical modernization. This calls first and foremost for investment in plant and equipment (filter presses, high-grade steel tanks), and the investments needed for software are relatively small.

The advances made in computerizing winemaking companies differ in extent between production on the one hand and administrative and commercial departments on the other. With the exception of embedded software, used for instance to monitor tank temperatures, actual wine production has not found many uses for IT. One exception is a program used to document the receipt of grapes and prepare a mandatory legal declaration required by the national winegrowing institute.

All of the companies interviewed use ERP software. Many winemaking estates have a marketing office in Buenos Aires that makes extensive use of IT, though the software for the most part does not link them with their remote production operations. Some such companies use their own ICT departments to produce the ERP software they need, though most of them purchase from national providers of generic ERP-programs, software that has not been developed specifically with the winemaking industry in mind.

Logistics services

Logistics services are a relatively recent business segment in Argentina; core competences include

the handling of large quantities of information. With the exception of tiny operations, all of the logistics companies interviewed use software for different company functions, and most of them have an ICT department of their own. As far as the company functions radically modernized in recent years are concerned, these companies prefer in-house developments and international programs. Software supplied by Argentine providers is used mainly for accounting, personnel management, as well as for some special applications (programs to optimize route-planning).

It is above all a lack of specific solutions that prevents any closer cooperation between national software providers and logistics companies. Several of the companies surveyed reported that they are unable to find software solutions for their core business (warehousing) in the national market. The companies interviewed stated that the relevant modules of ERP programs are not suited to the purpose, since they lack the required degree of complexity. At the same time international systems are too costly for Argentine logistics operations. Due to these problems on the supply side many companies are forced to program their own software, which they combine with other modules purchased in the market.

The software industry's strengths, weaknesses, and future risks and chances

The Argentine software industry has thus far developed mainly in response to domestic demand. This entails specific strengths vis-à-vis the international competition. At the same time, however, the focus of software developers on the national market and the needs of SMEs constitutes a barrier to the development of higher-grade, exportable products.

In the national market Argentine software providers have a number of comparative advantages over their foreign competitors. The prices of the products and services they offer are graduated in such a way that companies with different needs and levels of financial strength are usually able to find solutions tailored to their problems. In addi-

tion, products they offer are geared to the particular features of the Argentine market. This aspect is especially important in producing ERP software geared to a variety of national rules and regulations. Frequent changes to the latter call for a high level of flexibility. Here national providers have an edge over their foreign competitors. One other advantage enjoyed by Argentine software providers is their geographic proximity, a factor which allows them establish fast and low-priced customer contacts.

The focus of Argentine software companies on ERP software for national SMEs has led to a narrow range of products, mainly geared to the needs of accounting and personnel management. More specific applications, e.g. integrated process control in the agricultural industry or the administration of large warehouses run by logistics companies, are not offered for sale. Obviously the domestic market lacks the critical mass needed to make such developments profitable.

Many software companies mainly work together with SMEs which, for lack of funds and knowledge, do not require much quality. The lack of a lead market consisting of demanding customers is preventing the providers from engaging in learning processes and incremental technological improvements that can, in the medium term, lead to international competitiveness.

The microlevel problems addressed here are exacerbated by deficits in the institutional environment of the companies concerned:

- The software industry has largely developed without any external sources of funding. The funding needed for both startup and growth stemmed almost exclusively from the resources of company owners or from retained profits. These companies have no access to loans at reasonable terms. Thus far they have had to get along without equity capital, indeed many of the persons interviewed were even unfamiliar with the term.
- Most of the companies interviewed indicated their satisfaction with the training levels of Argentine computer professionals, though they

do complain that thanks to manpower scarcity the salaries of highly qualified specialists have risen sharply. This is becoming more and more of a problem for the SMEs in the software industry.

- It is only in recent years that research and development (R&D) in ICT - still insufficient in quantity - has begun to emerge in Argentina, and as yet no independent scientific community has developed in the country. FDI generates hardly any spillover effects, since the activities of IT corporations represented locally are, with very few exceptions, restricted to sales of hard- and software. This means a limited exposure of Argentine software companies to innovation impulses and up-to-date scientific findings.

Conclusions for Argentine policy

In the short term the Argentine government must concentrate on appropriately increasing the social inputs needed for a technology-oriented development as well as for the development of IT competence. Furthermore, the bottleneck factors noted, above all in the field of company financing, must be eliminated. Additional measures should focus on accompanying innovative companies in their startup and growth phases and generally supporting IT firms in their efforts geared to internationalization. It would be particularly important to attract producing branches of foreign direct investors as a means of encouraging spillover effects in the local industry. Finally, another promising flanking measure would be to support the use of software among Argentine SMEs.

- To supply the labor market with a sufficient number of highly qualified IT specialists, it would be necessary to enlarge the relevant course of study at the country's universities. This would have to involve an increase of teaching salaries, since there is presently no financial incentive for qualified IT scientists to teach at universities. Scholarship programs should be developed for students with talents in mathematics and computer science, in this way mobilizing additional human resources.

- Along with training in IT, it would also be important to expand relevant R&D activities. The aim must be to build a productive scientific community that keeps an eye on, and actively participates in, the international development of the relevant disciplines. Commissioned research and transfer of technology from publicly financed research to the private sector should be facilitated. Finally, the public sector can use subsidies and calls for bids on projects geared to computerize public administrations as a means of stimulating R&D activities in the private sector.
- Improved access to capital for software companies and other SMEs can be brought about by enabling banks to condition loan provision not on tangible securities but on the anticipated yields of SMEs. Furthermore, it will be necessary to go on with the most recent approaches aimed at establishing a technology stock exchange as a means of increasing the financial resources available in the venture-capital market. In addition, the public sector could participate directly in venture-capital corporations for technology companies. Finally, it would be feasible to use fairs, competitions, and tax breaks as incentives geared to disseminating venture capital.
- The software industry offers an especially good opportunity to create new companies with growth potential. The government could improve the framework by adjusting the tax laws accordingly. Incubator institutions (technology and startup centers) created specifically for the software industry could enhance its visibility and increase the survival chances and growth potentials of infant companies.
- Apart from classical instruments of export promotion (attendance at fairs, export loans), it would be worthwhile looking into other approaches geared to creating subcontracting relationships or joint ventures with large corporations. The industry associations and the chambers of industry and commerce would have an important role to play here. The willingness of foreign software corporations to cooperate with local companies can be improved by encouraging these local companies to seek certification as per ISO 9000 or the Capability Maturity Model (CMM), in this way enhancing the transparency of their quality standards. As a means of accelerating the certification process, the government could contribute to defraying the costs involved.
- The only competitive advantage that Argentina has in the international competition for software FDI is a highly qualified manpower potential. This advantage must be secured and enlarged by means of social inputs. On account of its wage costs, relatively high in international terms, Argentina would be best advised to increasingly train workers with profiles that enable them to offer high-quality and creative programming services. Tax incentives and elimination of bureaucratic obstacles can be used as flanking measures designed to attract FDI.
- At present only a small percentage of Argentine SMEs use software. A targeted promotion of modernization would increase company competitiveness and at the same time stimulate the market for IT. Points of departure would include subsidized credit lines for company computerization, subsidization of appropriate consulting services, and improved market transparency.

1 Introduction

1.1 The problem addressed by the present study

Today software is a core component of consumer goods and industrial production processes, it is used to control machine tools, measuring and control equipment, and has become a core element of modern automotive technology. A broad variety of services such as those offered by banks and insurance companies are being thoroughly changed by the use of new information and communication technologies (ICTs), and here, too, software plays a key role. Apart from industry and economy, the "information revolution" is increasingly changing other areas of social life as well, e.g. medicine, leisure activities, and culture.

The question as to what impacts these processes will have on the developing countries is a controversial one. Great expectations are, for instance placed, in the fact that the classical barriers to access to the stocks of knowledge dispersed throughout the world are shrinking:

*„New communication technologies and plummeting computing costs are shrinking distance and eroding borders and time. The remotest village has the possibility of tapping a global store of knowledge beyond the dreams of anyone living a century ago, and more quickly and cheaply than anyone imagined only a few decades ago“.*¹

The counterhypothesis argues with reference to the "digital divide," the fact that the resources and infrastructure needed to exploit these new technological potentials are extremely unequally distributed.² This is seen as implying that the development gap between industrialized and developing countries will continue to grow. The 1999 Human Development Report notes a growing gap between

the "knows" and the "know-nots",³ i.e. between countries, regions, or individuals that have key technological competence and those that do not.⁴

The pessimistic prognosis of a technology-driven decoupling of the developing countries appears in a more grave light when we look not only at the use of ICT but at the same time also at the development of these technologies and the generation of innovations. The by far greater share of knowledge-intensive and creative activities is conducted in the industrialized countries of the North, also the location of the lead markets in which new products and processes are first presented for use. The "globalization" of science and innovation has until now been largely restricted to the so-called triad countries, and the synergies attained here threaten to further widen the know-how gap between industrialized and developing countries.

The possible use of ICT as a catalyst of development processes cannot be viewed in isolation from the locations of existing technological competence. The efficient use of technologies with a very short life cycle requires that potential users have a good grasp of the specific technological state of the art or have access to relevant consulting services in their institutional environment.

Applied concretely to software, even the search for internationally available programs suited to solving specific problems, the implementation, installation, and maintenance of such programs require a high level of technological competence. In many cases international software packages are not designed for local problems and the modifications required call for highly qualified programmers. Without such competence services must be purchased from international providers or consulting companies, and this means prohibitively high costs for many potential users in developing countries, a factor which restricts the spatial and social scope of technological innovations.

1 World Bank (1999), Foreword, p. III.

2 E.g. Seibel / Müller-Francke / Bertolini (1999).

3 The 1998/99 World Development Report speaks in this connection of a knowledge gap. Weltbank (1999), p. 1.

4 UNDP (1999), p. 57.

At least the advanced developing countries are also well advised not wholly to abandon the world software market to the industrialized countries and instead to seek to participate in it by offering such products and services with an eye to improving current accounts and creating high-grade jobs. As opposed to other high-tech industries, the entry barriers for software are relatively low, and there are a number of countries that have managed, in part without any marked tradition of knowledge-intensive and technology-oriented production, to become relevant suppliers in the world market (India, Ireland, more recently Costa Rica and Uruguay).

The present study picks up on this international discussion on the chances and risks of ICT for developing countries. The intention is above all to look into the questions what conditions have to be given in developing countries if they are to generate technological competence in IT and which policy measures governments can use to support this development.

The field of ICT is a broad and heterogeneous one. The present study focuses on information technology (IT), and specifically software, for three reasons. First, the market for software is especially dynamic, even compared with other segments of the fast-growing ICT markets. Second, the software industry offers providers in developing countries the advantages of low entry barriers in national markets and great development potentials, including high-end and technologically demanding products. Third, restriction of the problem under consideration to a subsegment of the ICT industry seems reasonable in view of the complexity of the issue.

The following section presents the methodology used to gather the empirical information needed to answer the above-mentioned questions.

1.2 Methodology of the empirical study

The present study is the result of empirical surveys conducted in Argentina between February and April 2000. The aim of the surveys was to

come up with propositions, first, on Argentine software providers, second, on the use of modern information technologies in selected sectors of the commercial economy, and, third, on the relations between national suppliers and demanders.

In the period specified 58 Argentine software providers were interviewed, most of whom were based in Buenos Aires. The subject of the study was delineated in terms of the functional criterion of whether the company in question provides programming services domestically as part of its core business. This means excluding on the one hand those companies which supply imported software in Argentina and on the other hand big corporations from other industries (banking, health care, petrochemicals) that often develop software for their own use.

1.3 Structure of the study and main results

The following, **second chapter** looks into the development relevance of the problem addressed. This is done against the background of the fact that the study is concerned with modern branches of Argentina's industry, a factor that could be seen as clashing with the traditional approaches pursued by development cooperation. The study emphasizes on this point that it is only the targeted use of IT that can guarantee the competitiveness of SMEs, in this way safeguarding sustainable jobs in the formal sector. Development of an Argentine IT industry furthermore creates high-grade jobs in promising services sectors. Finally, technological competence can raise the capacity of Argentine society on the whole to solve complex problems.

The **third chapter** provides the study's theoretical underpinning. The central concept here is Sanjaya Lall's *technological capability building*. The building of technological capability in a society presupposes on the one hand that there is a sufficient number of competent and learning companies. These companies must on the other hand have functioning factor markets and adequate institutions available to them and be able to take advan-

tage of macroeconomic incentives to invest in their own technological development. As far as factor endowments are concerned, the sector mainly needs access to qualified manpower, capital, and a telecommunications infrastructure. Direct investments of international software corporations can convey important technological information if they develop relevant linkages to national actors. Despite the formation of international and global relationship systems, the spatial proximity of software users to software developers continues to play an important role.

Chapter four, based on the matrix presented by Lall, asks whether Argentina is a potential site for technologically demanding software production. One basic drawback at the microlevel is the phenomenon of dual business structures: on the one hand a few large, highly productive corporations, on the other a large number of underfunded and not particularly innovation-oriented small and medium-sized enterprises (SMEs). The starting points for technological modernization are those SMEs that are basically able to compete under open market conditions. The factor markets present a mixed picture: while there is still a good potential supply of qualified labor, there are grave shortcomings when it comes to financing investments and technological innovations.

Following a brief presentation of the secondary statistics available on the IT market in Argentina, the **fifth chapter** presents and summarizes the results of the survey. The Argentine software industry consists of a total of some 300 formal enterprises that offer permanent employment to around 4500 mainly highly qualified workers and earn a total of roughly US \$ 300 million p.a. Their economic activities are concentrated mainly in the field of programming business software for SMEs.

Chapter six deals with the role of software in three selected branches of industry which, for different reasons, are engaged in modernization processes. In the case of the auto part suppliers hard international competition and the pressure exerted by big customers is forcing companies to optimize their operational processes. Argentina's traditionally inward-looking winemaking industry

has recently been looking more and more to exports, which also forces the companies concerned to undertake technical innovations. Logistics is a relatively new service industry whose core business calls for the administration and processing of large quantities of data, and this in turn induces them to use modern IT. Above all, innovation-oriented SMEs display linkages to national software producers, since for the former international software packages and related services are too complex and too expensive.

Chapter seven, based on the survey, looks into the strengths and weaknesses of Argentina's software industry at the microeconomic level as well as the complex factor endowments and institutional environment. The close relationships between national suppliers and demanders of software are due above all to the fact that the supply is tailored to the specific needs and the purchasing power of local SMEs. This imparts to the market a certain stability as well as still some – limited – growth potentials. If they are in the long run to achieve dynamic development with accordingly high value added and employment, though, software companies will have to diversify their products and services and become active beyond the narrow confines of the Argentine market. This would mean removing development barriers in the business environment, providing for adequate possibilities of funding, and training enough qualified IT specialists.

Academic and nonacademic IT research must be expanded considerably in order to make Argentina more attractive for international scientific cooperation and heighten the industry's innovativeness. The process of starting up formal companies should be given flanking support and the existing companies should be assisted in their efforts to gear their operations to the international market.

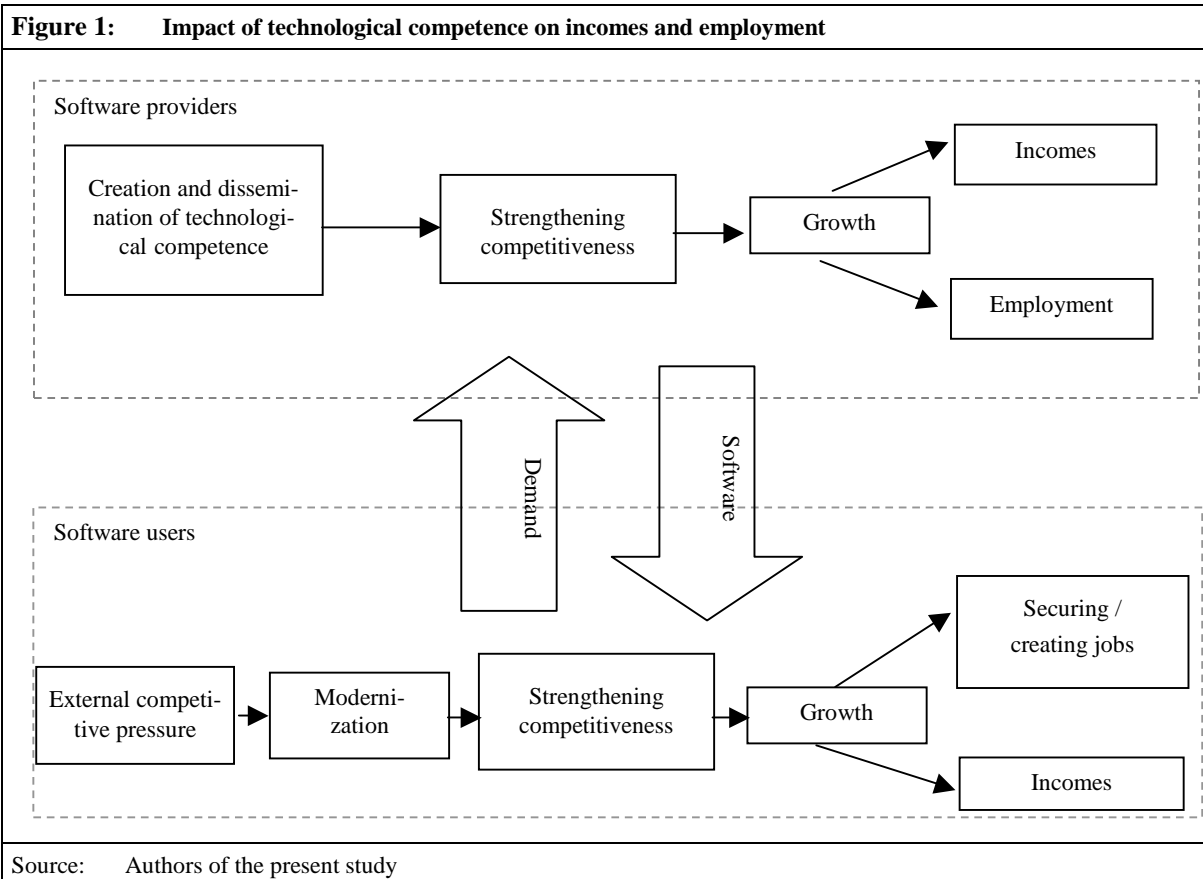
2 Information technology as a means of social and economic development

The following section discusses the significance of developing technological competence in the field of IT, asking what options are open to the public sector. These issues are discussed mainly because the present study is concerned with modern branches of Argentine industry, a circumstance that might appear to be in contradiction to traditional concerns related to the developing countries.

2.1 Information technologies, company modernization, and employment

For some years now there has been an extensive international discussion underway on the chances and risks of IT for developing countries. The main

issue is the risk of a growing "digital divide."⁵ The use of new IT-based media leads to a situation in which spatial barriers to economic, social, and cultural interaction lose much of their meaning, a circumstance which in turn stimulates development processes of a new type and accelerates those already in progress. This gives rise to innovative forms of education and training, the potentials offered by telemedicine improve the health-care system, computerized public administration makes it possible to radically cut travelling and waiting times. The fact that the elementary conditions needed to take advantage of these possibilities (access to a telephone connection and the Internet) are extremely unevenly distributed both nationally and internationally, will, the fear goes, cumulatively intensify existing inequalities. To prevent any further deepening of the digital divide, international organizations have prepared a number of programs that for the most part aim to



5 E.g. Seibel / Bertolini / Müller-Falcke (1999).

increase, in spatial and social terms, the use of IT in developing countries.⁶ Whether the effects of the use of IT in business firms will prove desirable or undesirable is a controversial question. The most widespread thesis is that the increasing IT-based automation of production and administration is killing jobs, a fact in plain contradiction to the aim of development policy to create and safeguard jobs. But others counter here that under the conditions of increasingly open economies there is no alternative to company modernization to the extent that only permanently competitive firms are in a position to sustainably safeguard jobs and harness growth processes to create additional employment.

Moreover, the production and provision of software and other IT services is highly employment-intensive, and in view of its global dynamics there is in this field a worldwide labor market marked by constant growth and increasing differentiation. With an eye to employment, the aims should thus be to produce and provide as many of the services needed in the process of company modernization at the local level. In the ideal case this would result in close mutually reinforcing interactions between the providers of IT services and their users (see Figure 1).

The need for the **public sector** to intervene to ensure and accelerate the development of technological competence is bound up with the fact that purely market-mediated processes in the fields of education and training as well as research and development are known not to lead to socially desirable results.

Without any public-sector activity overall social investments in education and training tend to miss their mark. The reason for this is that only part of the returns on private investments in qualification and knowledge creation flow back to investors in the form of additional profit. Although competence in computer science is often acquired by self-teaching and learning by doing, the discussion over the issue of the international migration

of IT specialists clearly shows how important it is to sufficiently train an adequate number of IT specialists in formal, for the most part publicly funded training institutions.

Investments in research and development also generate externalities that have positive effects on the competitiveness of an economy. The technological competence due to them is not tied to the individuals and organizations in which it emerges or is acquired; it can instead be transferred to other economic agents via learning processes and personnel fluctuation. ECLAC speaks in this context of a society's "knowledge capital."⁷ But this also means that investments in R&D will not reach desirable levels if they are made exclusively on the basis of private utility rationales. In other words, social inputs are needed here too to ensure innovativeness.

2.2 The world market for software and IT services

The following section aims to provide an overview of various product categories as a means of providing the reader with a more differentiated view of the software market. The aim is, first, to present a qualitative description of individual market segments and ongoing or anticipated development trends and, second, to arrive at a quantitative assessment of the volumes involved. The section looks into the software market in the narrower sense (standardized software products) and customized programming services. The latter are usually categorized as computer services.

Software market segments

The software market breaks down roughly into three segments: **embedded software** includes programs integrated into physical products and sold along with them. An example would be the control software for electronic weighing scales.

6 For example, the "Information for Development," InfoDev, program introduced by the World Bank.

7 Ocampo (1998), p. 18.

For the most part the literature does not give separate treatment to embedded software, and so there are no market data available on this segment and it will not be considered here. Standardized, or **packaged, software** consists of standardized articles sold in large quantities. This includes both operating systems⁸ and standardized applications programs.⁹ The **individual programming** is used to refer to customized programming jobs created specifically for a customer's needs; the intellectual property rights to it are transferred to the customer when the job is completed. In statistics, individual programming, as opposed to packaged software, is generally regarded as a service, and for this reason the following look at the market also includes computer services. Many software packages are in need of comprehensive adaptation to the needs of the companies using them, and this as a rule means external consulting and programming services geared to customizing such software. In what follows, this type is referred to as "partially standardized software."

Software can be further subdivided with an eye to function. The International Data Corporation (IDC)¹⁰ distinguishes three categories: 1. system software and utilities, 2. applications tools, and 3. applications systems.

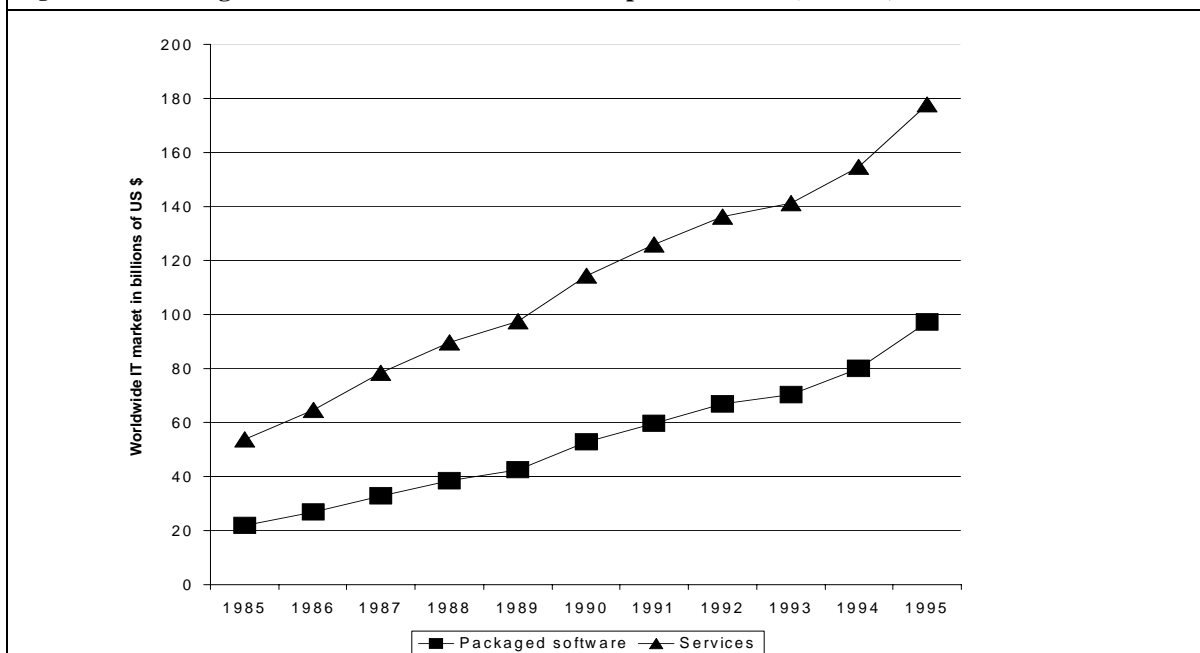
System software and utilities are programs used

- to control hardware (e.g. operating systems and programming languages), improve the efficiency of system administrators, and control the flow of data between different hardware units;
- to safeguard the functioning of programs (e.g. antivirus programs) or to convert data from one format into another.

Applications tools include

- programs used to search, organize, and alter data and databases;
- programs used as decision aids;
- spreadsheet programs;

Figure 2: The global market for software and computer services (1985-95)



Source: Authors of the present study, based on OECD (1997).

8 E.g. DOS, Windows, INIX, Linux, OS/2, etc.

9 For instance, applications such as word-processing, spreadsheet programs, and the like, and business software such as "Enterprise Resources Planning" (ERP).

- computer-assisted software engineering (CASE).

Applications systems include customized solutions for problems specific to an industry or company function. Such solutions can include specific functions such as personnel management, payroll accounting, project management, word-processing, and other office activities. But this category also includes vertical solutions for specific industries (e.g. banking, health care, etc.).

Quantitative development of the market

It is difficult to prepare a detailed description of the software market and the development trends in it, since the literature is marked by different approaches to subdividing the material. The rapid pace of technological development makes it impossible to delineate any clear-cut and quasi-static market segments, and some segments tend to merge while others are marked by growing differentiation. The comparability of data from different sources is problematic in that the boundaries between segments are often difficult to define unambiguously. It is even more difficult to assess prognoses on the future development of these markets. The data presented here should thus be regarded as more or less tentative; their main purpose is to identify significant trends.

The *Information Technology Outlook*¹¹ of 1997 estimates the world software market in 1995 to be worth US \$ 97 billion; IDC assumes a value of US \$ 154 billion for the year 1999 and the Business Software Alliance a value of US \$ of 231,8 Billion for 2001¹² The market for IT services was US \$ 178 billion in 1995.¹³ In the 1990s these

markets were marked by extraordinary dynamics, with average annual growth rates reaching 15.9 % (software) and 12.5 % (computer services).¹⁴ One general trend is that the market volume of packaged software is rising in relation to individual programming. This is explained by the great costs, time, and effort involved in individual programming and the growing complexity, power, and flexibility of standardized applications programs.

The growing use of packaged software is accompanied by increasing work involved in adapting software to individual company and industry needs, i.e. by a growing need for services in implementing these programs. A *Strategy Partners*¹⁵ study, for instance, finds that the license fees for ERP software SAP r/3 account for no more than 8 % of the costs that accrue during the first five years. Apart from end-user efforts and the hardware required, the implementation costs, 14 %, are considerable higher than the costs for the software itself. The suppliers of business software are developing more and more industry-specific solutions with an eye to reducing the high customization costs.

The competitive conditions faced by software suppliers differ depending on whether latter are involved with packaged software or individual programming. Providers of packaged software are forced to meet high quality standards, and the marketing of these products involves large and risky capital outlays. The market for packaged software is relatively heavily concentrated for this reason. For instance, 60 % of the market for PC software is controlled by ten companies. On the other hand, the entry barriers for customer-specific programming are relatively low and the number of providers is high. Most Latin American software companies are also active in this field.¹⁶

10 The IDC is a market-research organization specialized in the ICT industry.

11 OECD (1997), p. 13.

12 Cf. BSA (2001), S. 8.

13 The category "software" includes all packaged computer programs available in the market. Apart from customized software (individual programming), the category "services" includes the design, installation, and integration of systems as well as related training, IT-related consulting

services, and the management of IT systems. The category also includes the maintenance and repair of hard- and software systems (so-called support services) and the outsourcing of IT-intensive company functions.

14 OECD (1998), p. 34. By comparison, world GDP grew by an annual 5.7 %.

15 Computerwoche 32/99.

16 Correa (1996), p. 192.

3 Conditions for latecomer development of technological competence in the field of software: the study's conceptual framework

The last chapter discussed the significance of IT in the development process, explaining why developing countries should aim to build technological competence of their own. Based on the literature available on latecomer development of technological competence, the present chapter looks into the crucial influencing factors involved in the process. This conceptual framework is needed to examine what deficits are hampering technological dynamics in Argentina and what approaches are available for targeted promotion policies and measures in the context of international development cooperation. Our point of departure here is a concept that was developed by Sanjaya Lall at the beginning of the 1990s and is used to identify central influencing factors involved in latecomer development of technological competence.¹⁷ In essence, Lall is concerned with the interplay between competent and learning firms, functioning factors markets, adequate institutions, and incentives with a stimulative effect on technology development. In a manner similar to that involved in the concepts national innovation system¹⁸ and systemic competitiveness,¹⁹ Lall proceeds mainly from causal complexes at the *national* level. In view of increasingly global patterns of interaction, it must be asked whether an approach of this type still adequately mirrors ongoing processes. Without claiming to present a final answer to this question, we cite two important reasons that indicate that the key conditions for technological competence must be sought at the national level, at least when the aim is to achieve broad effects above and beyond individual success stories:

- The factor markets central to enhancing technological competence continue to be shaped by political decisions made at the national level

(investment in education and training, deregulation of the telecommunications market, etc.).

- The development of new technologies involves close interplay between suppliers and users. Personal interactions continue to be of great importance in this regard, and spatial proximity is in turn an important precondition for this.

3.1 Points of departure for a policy of latecomer technological development

In Lall's complex approach, the point of departure and actual source of technological innovation processes is the innovative and competent business enterprise. Development of company-specific technological competence, or "firm-level technological capabilities" (FTC), rests mainly on three factors, namely a company's ability

- to estimate its capacity to invest in technology development ("investment capabilities");
- to master, to assimilate, to imitate, to improve or independently develop existing process and product technologies ("production capabilities");
- to build linkages to and to exchange information with other actors such as customers, suppliers, upstream service providers and research institutions ("linkage capabilities").²⁰

Whether companies will want and be able to build such skills is dependent on the one hand on internal and external incentives, on the other hand on their own specific factor endowments. For Lall, one essential incentive to acquire competence is the need to assimilate information and skills when a given company decides to introduce new production technologies. Like general investment behavior, acquisition of technological competence is governed by signals that are sent out at the economic macrolevel and shape expectations as regards possible future earnings (growth rates, competition, foreign-trade regime). Lall sees interna-

17 Lall (1992).

18 Lundvall (1988).

19 Esser / Hillebrand / Messner / Meyer-Stamer (1994).

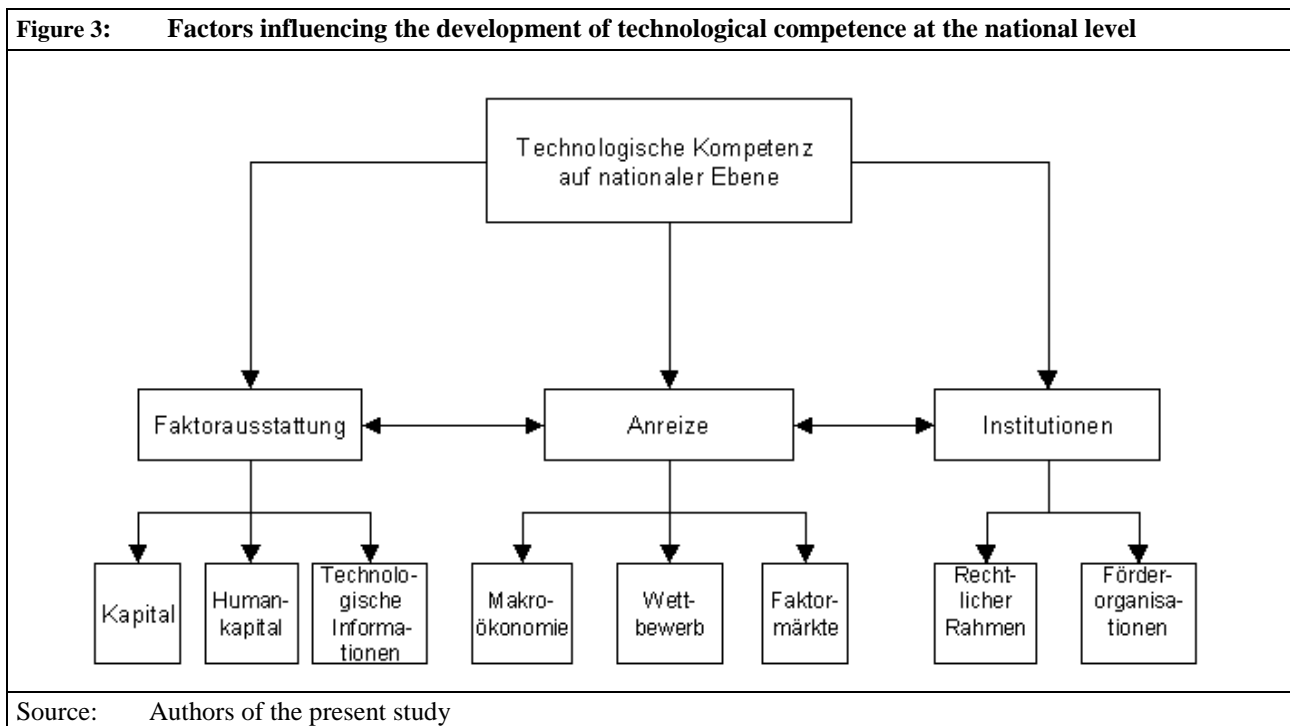
20 Lall (1992), p. 169.

tional competitive pressure as one of the most powerful catalysts involved in the development of technological competence in developing countries, barring market failure, which leads to prohibitively high learning costs for new participants in the market. Finally, technological change constitutes an external incentive for companies in developing countries to invest in their technological competence as a means of closing the gap on the processes and products typically used by the industrialized countries.

The extent to which a company is not only willing but also able to raise its technological competence depends on the one hand on company-specific givens such as size and organizational and mana-

effects emerge, and, accordingly, that competence is built across a broad national level. While every company engages in individual innovation and technology management of its own, this management is subject to a "common element of response of firms to the policy, market and institutional framework."²¹ The shape given to a specific framework of this sort leads to nationally different levels of technological competence, and this in turn entails different rates of productivity and growth.

According to Lall, three independent factors influence the development of national technological competence: 1. **incentives**; 2. **factor endowments**; and 3. **institutions** (see Fig. 3).



gerial skills. But one key factor is always the extent to which the business environment makes possible access to factors that are not available internally.

For Lall, this idea constitutes the transition to the concept of "national technological capability". Companies develop technological competence not in isolation but together with other economic, scientific, and governmental actors. It is crucial for the formation of specialization advantages that technological knowledge diffuses, that synergy

An increase of technological competence entailing broad effects can only come about if a sufficient number of companies are prepared to invest in technological progress. The key to this propensity to invest is the **incentives** effective in the business environment; they may be broken down into three groups:

²¹ Lall (1992), p. 169.

- The macroeconomic incentives include signals defined by GDP growth, inflation, interest, and exchange rates as well as by the availability of foreign exchange and credit.
- Competition provides some especially effective incentives. Domestic competition is influenced mainly by the size of the national industrial sector, the degree of development and diversification, and state regulation such as laws governing competition. External competition comes about through foreign direct investment (FDI), imports, and export-oriented growth patterns.
- Incentives operating via factor markets may have a positive effect on technological development if the latter are flexible and correctly reflect relative factor prices, in this way leading to an efficient allocation of resources.

A company's **factor endowment** influences the extent to which the company is able to use and adapt technology as well as to develop it further for the market on an independent basis. Since the individual production unit cannot generate the factors of production it needs on its own, it must demand them in the factor markets. According to Lall, there are three types of factor endowment that are relevant here:

- First, a company's endowment with capital is a condition that influences its capacity to develop technological competence. Investment in technological equipment hinges mainly on access to financial capital. If this capital is to be used efficiently, an economy must have a functioning financial system.
- Second, an endowment with qualified labor must be ensured. Although qualification can also be acquired informally by means of on-the-job training and practical experience within the production process, formal qualification, as a rule public education and training, plays a central role in determining whether companies are able to foster their technological competence by hiring qualified manpower.
- Third, a company's endowment with technological information influences its innovation efforts. Technological knowledge comes about

through company-level R&D, in research institutions in the company's environment, and by means of the possibility to access internationally available knowledge resources.

Institutions on the one hand define the framework for the interplay between factor endowment and incentives, e.g. in the form of intellectual property rights and other legal conditions defining the framework of economic activity. Lall on the other hand includes specific promotion policies and organizations that help to overcome specific market failure in his list of institutions important to the development of technological competence.²² Development of technological competence is supported, for instance, by technical training institutions (technical colleges, training centers, etc.), publicly funded basic research, technology-transfer institutions, and support for business startups.²³ Building on the heuristic framework outlined above, Lall investigates the experiences made by a number of Asian and Latin American developing countries and NICs in the course of their latecomer industrial development. From this he concludes that a dynamic development can be expected only if correct incentive structures coincide with the development of suitable qualifications. Lall also sees the targeted import of technology in a positive light if such efforts are accompanied by a strategy of capability creation. The success stories also show that selective government interventions aimed at overcoming market failure can play a major role here, though only when certain conditions are given:

„Much depends on the competence, honesty and political strenght of the policy makers: where governments are so weak or corrupt that selective interventions inevitably lead to the ‘hijacking’ of policy by entrenched interests it may be better to suffer market failure than pervasive ‘government failure’. In such cases, however, it is not evident, that

22 This distinction between institution and organization is found in North (1992).

23 For the example of the German innovation system, see Stamm (1999).

*non-intervention would lead to industrial success”.*²⁴

3.2 What relevance does a national frame of reference have for the development of technological competence today?

No promising strategy aimed at creating technological capability can be based on a purely inward-looking development. Under today's conditions of largely open markets, protectionist measures to safeguard technology-oriented activities from foreign competition are practically unworkable, and should not be aimed for either, since such measures imply an intention to attempt to modernize companies and institutions without recourse to international best practice. Instead, the aim must be to consciously utilize the technological knowledge available throughout the world as an essential element within a strategy of technology capability creation. This means, among other things, building international cooperation and attracting branches of big technology corporations as well as research and technology-transfer institutions.

Despite a growing level of international interaction, there are two weighty arguments indicating that, at least for the time being, the national frame of reference will continue to have great significance for the development of technological competence in modern sectors:

- The factor markets essential for the ability of companies to develop their technological capability are still organized chiefly at the national level.
- Close interactions between producers and users play a central role in the development and dissemination of technological innovations. While these user-producer relationships are not necessarily bound to national borders, they are fostered by spatial proximity and linguistic and cultural affinities.

According to Lall the capacity to raise technological capability in the field of **factor endowments** depends on whether qualified human resources, capital, and technology-related information are available. If we look at the market for qualified labor, there is no doubt that the nation state has a central role to play here in that it decides on levels of social inputs and their distribution within national education and training systems. The growing international migration of qualified specialists is only gradually altering this situation. In spite of globalized financial flows for the time being the funding of investments in technology keeps depending on whether a given country has a functioning national credit system and a market for venture capital. Changes in the access to technology-related information are more obvious. Here it is above all the rapid dissemination of the Internet that makes fast worldwide sourcing possible. But in this context as well, international experience indicates that the transfer of technological information between public research institutions and private companies often implies complex interaction and multiple feedback processes. Geographical proximity between the actors is not a necessary precondition, but clearly facilitates this process.²⁵

The discussion over innovation and development of technological capability increasingly refers to the interactive character of these processes as well as to the important relationships between the **producers** and the **users** of technology.

To develop a new product, a company needs information on the needs of the potential user. The latter in turn must know what individual benefits he may derive from the use of new technological possibilities. This is why contact between producer and user is indispensable to developing new technologies.

User-producer relationships imply intensive exchange of information. This calls for longer-term relationships that are marked by a certain level of

²⁴ Lall (1992), p. 183.

²⁵ For the example of technology transfer from large-scale German research institutions, see Fromhold-Eisebith (1995).

mutual trust and respect for certain rules, since cooperation usually entails divulging competition-relevant technical knowledge and other company secrets.²⁶

The necessity of direct and frequently repeated contacts between producers and users implies that the geographic and cultural proximity of the actors involved is of crucial importance during the phase of interactive product development.²⁷ This in turn means that despite the increasing globalization of economy and society the spatial dimension of exchange relations continues to be of great importance.

How important the spatial dimension is depends on the type of product or technology under development. This applies particularly on its degree of standardization. With standardized technologies it is possible to code information and effectively convey it over great distances; here there is practically no need for spatial proximity. If however, the issue at hand is complex technologies that change quickly and radically and are marked by short product cycles, geographic proximity can have a decisive impact on producers and users alike. In these cases personal contact and a common cultural background may be essential to any transfer of uncodable knowledge, so-called tacit knowledge.

The nation state has an important role to play in the use-producer interaction. As e.g. Porter's study on national competitive advantages shows, exacting demand conditions, which may arise due to competent users in the domestic market, may have positive effects on technology development. This in turn can lead to the formation of competitive advantages for the companies in these industries,²⁸ a fact that can be demonstrated quantitatively with the aid of econometric analysis.²⁹ According to Lundvall as well, the interaction between producers and users within national boundaries is, for

several reasons, particularly efficient. Aside from geographic and cultural proximity and a shared language, government action plays a major role here; it can use national standards and regulations to simplify user-producer interaction, or at least to unify it by placing it on a legal footing. Direct government support for certain technologies can also reinforce this process. As a large and especially demanding and competent user of certain products, the public sector can play a crucial role in the development of technological competence.

3.3 Factors influencing technological capability development in the software industry

The set of conditions presented by Lall as necessary for the broad-based development of technological capabilities were worked out on the basis of latecomer technological development in the manufacturing industries. As yet no comparable concept has been developed for business services in general or for the software sector in particular. It is plausible that important influencing factors like access to qualified human resources and funding possibilities are also of great relevance here, though there are some differences at the qualitative level. The following section looks into them in detail.

One factor determining the development of competent companies in the IT industry, and one that has not yet come in for consideration, is physical access to telecommunications infrastructure as well as the conditions under which this access is effected. These issues are discussed in the further course of the study.

Some countries have managed during the last two decades to overcome their development lag and become important suppliers of IT services in the world market (e.g. India, Ireland, Israel). In all such cases the key factor was success in attracting international technology corporations. What follows will for this reason look into the possible role of foreign direct investment for the development of technological competence. Finally, the section discusses the significance and possible

26 Lundvall (1988), p. 352.

27 Goddard / Richardson (1996); Porter / Sölvell (1998).

28 Porter (1993).

29 Fagerberg (1996).

formulation of user-producers relationships, since one might assume that while the latter also play a role in the IT industry, they no longer display any close spatial ties due to the new possibilities of rapidly transferring large quantities of data.

Human resources in the software industry: needs and requirements

In his analytic framework on the development of technological capabilities, Lall pointed out that availability of qualified labor is of crucial importance. In software programming this aspect is becoming all the more urgent as the field's growing complexity places demands on human resources that are not only growing but are also subject to constant change. What this means is a need for national education and training systems in developing countries to generate technological knowledge with special reference to software development and to transfer and constantly update this knowledge.

Software development can be characterized with reference to four features central to it: it is knowledge-intensive, subject to a fast-moving technological progress, complex, and involves a high share of tacit knowledge.

- Software development is **knowledge-intensive**. Access to a sufficient quantity of highly qualified workers is becoming the key factor determining the innovativeness and competitiveness of software companies. There is a special need here for university and college graduates trained in computer science and mathematics as well as engineers and scientists.³⁰ In the medium term it must be anticipated that the demand for simple programming services will decline in favor of more highly qualified expertise in software and information technologies.³¹
- Software development is subject to a **fast-moving process of technological change**

characterized by extremely short innovation and product life cycles.³² To avoid the risk of losing touch with this progress, even the developing countries have to search for ways to give their software companies access to comprehensive and constantly updated knowledge on technological development. R&D and training are growing increasingly important, national training systems have to impart the capacity for lifelong learning.

- Software development is becoming **increasingly complex** and calls for knowledge that goes beyond purely technical know-how. Due to the trend toward object-oriented programming,³³ software is now often produced in different teams that may be located in different countries. Software must meet stringent quality standards³⁴ and is confronted with increasingly specific and exacting customer needs. Firms providing high-grade programming services are therefore dependent on a labor supply that combines IT competence with the ability to implement customer-specific solutions and engage in effective marketing. Accordingly, the ability to work in interdisciplinary teams and on projects as well as management skills and service and consulting capacities are of considerable importance here.³⁵
- Despite its high degree of formalization, software development contains a significant share of **tacit knowledge**. The development process does not proceed along the lines of clearly defined, fixed rules and methods.³⁶ It is for this reason that both specific individual program-

32 Correa (1996), p. 172.

33 In producing object-oriented software, the programs are made up of separately developed modules that run individual program routines. Since the individual modules must interact without any snags, coordination between teams is of crucial importance.

34 Including program stability or data integrity. Adequate quality management is seen as a decisive future competitive factor; it is geared to the ISO 9000 standard.

35 Schware (1992), p. 147; Correa (1996), p. 173.

36 Schware (1992), p. 146.

30 World Bank (1998), pp. 42f.

31 Schware (1992), p. 147.

mer experience and creativity constitute the decisive components that on the one hand qualify the programmer to tackle complex tasks in design and development and on the other hand give rise to software innovations. Both the software companies and public institutions should therefore have a real interest in training their workers on a continuous and permanent basis.

What challenges can we identify on the basis of the above-named features of software development for national education and training systems in developing countries?

- One focus of education and training systems should be IT, engineering, and sciences. Such education and training should also impart cross-cutting skills, including knowledge of business matters.
- IT curricula should be constantly adapted to the state of the art of technology.
- Training should be practice-oriented and should also be conducted at vocational schools and technical colleges. What is called for here is close cooperation between the public and private sectors as a means of ensuring that training is in line with actual needs.
- Training capacities in software development should be available at the company level as well.
- Care should be taken to ensure a large measure of autonomy and competition between private and public training centers.
- An introduction to the new media should be part of the curriculum at schools providing general education.

Access to capital

The software industry is marked by a high share of infant companies. These companies need capital for their startup and often to finance rapid growth. Internal funding from profits, reserves and writeoffs is often impossible. There are usually two external sources available for external

funding: loans and equity capital. In developing countries there are barriers to access to both sources of funding.

Even today the access of small businesses to the **credit market** is sharply restricted.³⁷ The main reason for this is that banks and lending institutions demand conventional tangible security (e.g. mortgages) or bonds that small business are unable to come up with. In the software industry the problem is exacerbated by the fact that it invests more in personnel than in tangible assets.

Venture capital is a means of business financing that makes use of risk-bearing equity capital or similar forms of investment capital, with the investor in this way becoming actively involved in the company's interests for the period of his investment. This may be a time-limited investment with disinvestment in three to eight years. The advantages offered by venture capital include the following:

- Unlike in the case of credits, there are no fixed limits on the availability of venture capital to a company.
- Venture capital is liable in the event of a company crisis.
- Venture capital does not burden a company in the same way as loans with periodical payments (interests, amortization).
- Venture capital improves a company's capital structure, distinctly enhancing later chances of obtaining credit for financing purposes.

The disadvantages of venture capital include restrictions on autonomous decision-making of the entrepreneurs as well as investor participation in the appreciation of the company's value.

The developing countries are marked by an extremely limited supply of venture capital. Technology-oriented startups are at an additional disadvantage as far as access is concerned. This is

³⁷ Lepp (1996), p. 77.

mainly due to the high risk associated with financing technology companies via venture capital.³⁸

The problems facing any financing of software companies in developing countries by means of risk capital are encountered in all three phases of financing (see Box 1). As a rule, in raising funds with investors such as banks, insurance companies, the government, or well-off private persons, joint ventures fail to secure the capital they need. They are for this reason unable to come up with any sufficient risk diversification of their portfolios. It

software and associated services, which are increasingly based on the Internet or related to other types of electronic data transmission. Access is determined by the network infrastructure (telephone network, cell-phone network, etc.) and user fees.

The supply structure in most telecommunications markets has diversified since the 1980s. The end of government monopolies has made it possible for many developing countries to lower their telephone costs and improve services.

Box 1: Phases and functioning of venture-capital financing

Financing via venture capital consists of three phases:^a investment decision, involvement in the joint venture, and disinvestment.^b

The investment-decision phase includes, first, the acquisition of the capital needed (fund-raising) and the potential portfolio companies (deal flow). It, second, includes an appraisal of the company in search of capital. An examination process (due diligence) entails comparing the investment profile with the demands of the associated company, quantifying possible risks. This is followed, third, by the investment negotiations aimed at concluding an association contract.

Depending on company development and the exit strategy selected, the involvement phase may extend anywhere from three to eight years. This active involvement entails a number of tasks. These include support for the company's management, aid in selecting a management team, mediation of all sorts of contacts, tracking down possible promotion programs and aids available to manage short-term crises. The disinvestment phase ensures the pay-back of the capital invested and the anticipated returns. The exit point depends on the one hand on the company's economic development, on the other hand on the possible exit strategies. Possible exit strategies include sales to another company (trade sales), sale to another associated company (secondary purchase), a buyback of these shares by the company concerned and the process of going public.

a This applies only for the formal venture-capital market, in which joint ventures act in the capacity of capital intermediaries

b Betsch / Gloh / Lohmann (1998), p. 232; Zemke (1998), p. 212

is particularly difficult to appraise newly founded software companies since theirs are often wholly new business segments for which there are no past reference data and whose market tendencies are unclear. Moreover, in the developing countries that are without any functioning stock market there can be no *disinvestment* via an initial issue of shares. The danger here is that capital investors will be unable to realize profits that accrue when companies appreciate in value.

Access to the telecommunications market

Access to the telecommunications market is a necessary condition for the production and use of

In the past the network infrastructure was seen as having the characteristics of a **natural monopoly**, i.e. efficient operation was assumed to be possible only by one supplier in the market.³⁹ This assumption was based on two arguments. First, when the number of participants rises, economies of scale lead to declining costs per subscriber connection. Second, market access is associated with high initial investments that cannot be used for other purposes in the case of market exit, and are thus irreversible (sunk costs). The existence of a natural monopoly was advanced as a justification for provision of services by government or an enterprise supervised by government. But as experience with government-owned telecommunications monopolies shows, these failed to lead to optimal solutions, particularly in the developing countries.

38 On the risks faced by technology companies, see BMWi (1999), p. 2.

39 Arnold (1999), p. 4f.

Inefficiency and a lack of maintenance and expansion investments led to a poor supply of services, and a low coverage of rural regions.

Liberalization of the telecommunications markets in the industrialized and developing countries has shown that **competition** in this industry is technologically possible and can bring with it a number of advantages for both private and business subscribers:

- Telecommunications costs for the most part decline drastically in the wake of liberalization and privatization.
- New connections are provided far faster.
- Suppliers operate with an eye to customer wishes, e.g. as regards additional services.

If these advantages of a liberalized telecommunications market are to be fully realized, this market must be regulated.⁴⁰ The regulatory authority must on the one hand ensure that new providers are given access to existing networks at reasonable terms and on the other hand guarantee provision of full services on a broad basis.⁴¹

The role of foreign direct investment in the software industry

Foreign direct investment can play an important role in noticeably accelerating technological dynamics in countries and regions without any marked tradition of knowledge-intensive production. This is proved by recent IT success stories such as India and Ireland. Broad dissemination effects can be reached mainly in cases in which the FDI entails linkages with national companies.⁴² The most important spillover effects that result from these linkages include:

- development and improvement of products and processes;

- expansion of technical management skills on the part of national actors;
- new business startups (spinoffs), in particular in the software industry, by former employees of foreign firms.

It is customary to distinguish between cross-industry and industry-specific linkages as well as between upstream and downstream linkages.

Cross-industry technological spillover effects result from linkages of foreign software investors with upstream or downstream national actors within the value-added chain. The outsourcing potentials available to software corporations include on the one hand procurement of media (diskettes, CD-ROMs). Since these are standardized products they give no reason to expect any far-reaching spillover effects. But such corporations may also outsource demanding programming services, e.g. external development of individual software modules.

The variety of downstream linkages is greater; it includes

- joint further development of software by foreign corporations and local customers with an eye to customizing software to user needs;
- customer support in process optimization once a particular software has been introduced;
- cooperation with consulting firms specialized in implementing software;
- schooling for software users;
- cooperation with retailers and wholesalers (e.g. with specialized dealers);
- cooperation with providers of after-sales services (e.g. schooling and technical support);
- cooperation with companies that develop software building on the platforms of foreign investors.

The more foreign corporations concentrate on their own core activity, outsourcing other activities, the greater the chances are that linkages will materialize with national suppliers. A high degree

40 World Bank (1999), p. 83.

41 Arnold (1999), p. 6.

42 For further spillover effects between multinational corporations and SMEs, see Altenburg (2000).

of linkage in turn increases the likelihood of technological spillover effects. The type and dimensions of such linkages are the result of make-or-buy decisions influenced by cost and quality criteria. The foreign corporation compares its own production costs with the costs (market price and transaction costs) that would result from purchasing from outside producers domestically or abroad. Foreign direct investors in the software industry will furthermore only be willing to purchase their intermediate products and services from national suppliers if the latter are able to provide the required quality of products and services.

Industry-specific technological spillover effects are those effects on national competitors that are sparked by the corporate activities of foreign direct investors. The market entry of foreign investors can entail both positive and negative effects on the competitiveness of national software suppliers. The type of influence that emerges will depend on the absorptive capacity and the innovativeness of national competitors, the market-entry strategy, and the level of the competitive advantage enjoyed by the foreign investor.⁴³

- Absorptive capacity and innovativeness determine the speed at which national competitors will be able to adjust to the competitive domestic situation. National suppliers can strengthen their competitiveness by recognizing the importance of R&D activities and the necessity of quality assurance and by seeking, by imitation or innovation, to come closer to meeting the quality standards of such foreign corporations. It is in this way that foreign investors can contribute to an upgrading of the technological competence of their national competitors.
- Furthermore, the market-entry strategy of foreign software suppliers also has effects on the competitiveness of national providers. If market entry is effected by acquiring national companies or company shares, the result can be a concentration of R&D activities on the side of the foreign corporations, which would

entail negative impacts on the competitiveness of national suppliers.

- Pronounced competitive advantages of foreign direct investors (e.g. new technologies, marketing budget) can create high barriers to market entry, in this way diminishing the competitiveness of national competitors.

The increased domestic competitive pressure due to the market entry of foreign investors in the software industry forces national suppliers to improve their products and processes. Moreover, positive spillover effects can result from a drift of specialists from foreign investors to national competitors, since these specialists have accumulated specific expert knowledge through training on the job and targeted advanced training measures.

3.4 The user-producer interaction in the software industry

In the field of customized software in particular, producers work closely together with the later users of programs.⁴⁴ But the providers of packaged software also seek contact with end users in developing new products by providing their programs to users per Internet as a means of innovatively harnessing feedback responses.

The development process of software products begins with the definition of product requirement profiles on the basis of which, in a second step, the product is then designed. In a third phase this design is operationalized by specialists into modules and submodules prior, finally, to being implemented, i.e. transformed into a source code in a given programming language. The especially knowledge-intensive and time-consuming stages include the preparation of a requirement profile and the actual design of the software.

43 Dunning (1993), p. 446f.

44 Weltz / Ortmann (1992), pp. 75ff.; the following discussion on the development of software are further based on talks with a programmer with the German research centre "GMD - Forschungszentrum für Informationstechnik."

During the entire process there is continuous contact and exchange of information between the producer and the user of the software in question. The most intensive period of user-producer interaction is in the initial phase involving the joint developer-user definition of requirements. Trust-based exchange of information and personal contact play an important role in software development, as is shown by the following quotation on the sequence of a software project:

"One essential quality of this approach and its particular effectiveness were, not least, its informal character and the personal familiarity between developers and users. This provided the conditions under which the development task to be solved could be handled flexibly and without strain, and this in turn made it possible to come up with a compromise between the technical and specialist requirements without unduly wasting time and effort. This, though, absolutely presupposed continuity in terms of the personnel active here."⁴⁵

It may be noted by way of summary that the user-producer interaction in software development is of great significance. While with packaged software these contacts are conducted informally per Internet, customized software again and again calls for personal contacts, and this means that the advantages involved in close spatial relationships continue in effect.

4 Argentina - a potential location for technologically demanding software production?

Argentina, an NIC, is practically unknown as a provider of technologically demanding products and services in international markets. Its role in the international division of labor has until now mainly consisted in exporting bulk agricultural

and agroindustrial goods and importing the knowledge-intensive products it needs.

Based on Lall's framework, the following chapter looks into the conditions required for a broadly effective development of technological capabilities that exist in Argentina. At the microlevel we find here severe deficits stemming from a dual enterprise structure and a low propensity to innovate. Companies aiming to raise their competitiveness through innovation have access to qualified workers in the Argentine labor market; but the current situation is marked by a severe lack of financing capabilities, and also access to the information required is limited. The incentives in the business environment are ambiguous. Though the country reaches high growth rates in some years, Argentina is far from any stable economic dynamics. While in 1990 it managed to achieve price stability, this development was bought at the expense of an excessively high exchange rate and high real interests rates. The country's scientific and technology-related institutional structure is underdeveloped and underfunded, which means that innovation-minded companies will find little encouragement here.

4.1 The conditions for the development of technological capabilities at the company level

According to Lall, the development of technological capability proceeds from **firms** that are both willing and able to innovate. Seen in these terms, the initial conditions in Argentina are extremely unfavorable in that the country is marked by a sharply dualistic enterprise structure: a core of no more than 500 highly productive, technologically competent, and export-oriented corporations as opposed to roughly 890 000 SMEs. The big corporations account for some 40 % of GDP, in 1997 their share of export earnings was even 65 %.⁴⁶ The great majority of the country's SMEs is oriented to the domestic market and is marked by low productivity figures. Kosacoff and López

45 Weltz / Ortmann (1992), p. 76, our translation.

46 Kosacoff / López (1998).

break down Argentine SMEs into three groups reflecting their competitiveness:

- The first group is competitive and technologically competent enough to produce to international standards. The group includes only around 5 % of all Argentine companies.
- The second group is far away from international competitiveness. Thanks not least to their lack of technological capabilities, the companies in it - they account for roughly 30 % of all Argentine SMEs - have to fear for their survival.
- The third group is only conditionally competitive. Its members are going to be faced with great challenges if they are to survive in the future. The group includes some 65 %, the majority, of all Argentine SMEs.⁴⁷

The propensity to technological innovation is low in Argentina's private sector. Seen in terms of company R&D expenditures and its share in GDP, Argentina is about average as compared with other Latin American NICs and lags far behind the industrialized countries (see Table 1).

technological capabilities.⁴⁸ As suppliers of goods and services for large corporations, SMEs play no more than a subordinate role in Argentina.⁴⁹

Compared with Latin America as a whole, Argentina's workers have **above-average qualifications**, in particular as far as general education is concerned. Illiteracy, which affected some 4 % of the adult population in 1998, is no longer considered a significant factor; in regional terms, secondary school attendance is above average. Tertiary training shows an uneven picture: the figures for the most important indicators (share of college graduates and researchers as a percentage of the overall population, share of technology-related courses in tertiary training as a whole) are quite high compared with other Latin American countries, though the gap separating Argentina from the OECD countries is considerable (see Table 2). One alarming fact is that the number of students in sciences and engineering has declined by 7 % in the past ten years.⁵⁰

For the great majority of Argentine companies access to **capital** constitutes a real problem. In the

	Investments in R&D in million US \$	Percentage of GDP	Company share of R&D expenditures
Argentina	371	0.12 %	29 %
Brazil	2495	0.35 %	46 %
Chile	15	0.02 %	3 %
Mexico	184	0.06 %	21 %
Spain	2703	0.44 %	49 %
US	136116	1.73 %	75 %
Germany	24529	1.50 %	66 %
Source: GACTEC (1999)			

The user-producer interactions between suppliers, purchasers, and final customers are very weak in Argentina; this is generally seen as one reason why the country is making little headway in developing

1990s the Argentine capital market was reformed, raising its efficiency. While this improved the possibilities of financing open to large corpora-

47 Kosacoff / López (1998), p. 23.

48 Chudnovsky (1999), p. 160.

49 Pastor / Wise (1999), pp. 486f.

50 Chudnovsky (1999), p. 161.

	Enrolment rate Secondary school (1995)	College graduates per 1000 residents (1995)	Percentage of scien- tists and engineers	Researchers per 1000 employees
Argentina	59 %	1.08	24.50 %	1.84
Brazil	19 %	1.49	17.10 %	0.67
Chile	55 %	1.15	33.00 %	1.32
Spain	94 %	4.40	21.80 %	3.25
Canada	92 %	4.20	12.80 %	5.50
US	89 %	1.90	39.50 %	7.40

Source: RICYT (1999); World Bank (1998)

tions, it did little to improve the situation of SMEs. Up to the present those SMEs that have access to official or unofficial credit markets were forced to pay interest rates two or three times as high as those paid by large companies.⁵¹

The economy's pronounced inward orientation and an inadequately developed innovation system are responsible for the fact that access to **technology-related information** is difficult. Empirical studies show that it is mainly SMEs that have trouble obtaining or processing the information they need for purposes of modernization or reor-

4.2 Incentives from the business environment

The 1990s present an uneven picture for the macroeconomic incentives that motivate companies to invest in the development of technological competence: the first years of the decade were marked by very high growth rates, which were interrupted toward the end of the decade by a sharp recession. By 1996 the country had managed to bring down inflation rates to zero. Loan costs were also lowered, though they stabilized at a rather high level (see Table 3).

	1991	1992	1993	1994	1995	1996	1997	1998	1999
GDP	10.6 %	9.6 %	5.7 %	8 %	-4 %	4.8 %	8.6 %	4.2 %	-3.5 %
Inflation	84 %	17.5 %	7.4 %	2.7 %	1.6 %	0.1 %	0 %	0 %	-1.8 %
Interest rate (interbank)	71 %	15.1 %	6.3 %	7.7 %	9.5 %	6.2 %	6.6 %	6.8 %	7 %

Source: IMF (1998, 1999a)

ganization.⁵² Due to such information deficits it is very difficult for these companies to derive any benefits from the access to foreign technologies facilitated by trade liberalization.

For Lall, the incentives provided by **competition** are of particular significance in stimulating investment in technology. In Argentina the 1990s were marked by a rapid increase of competition leaving many companies without the possibility to respond adequately. Domestic competition was raised by the privatization of government-owned companies (airlines, railroads, the postal service, telecommunications). But in fact for two reasons the dynamics stimulated in this way lagged behind expectations:

51 Pastor / Wise (1999), p. 487.

52 Kosacoff / López (1998). pp. 20-22.

- The former publicly owned companies went for the most part to foreign corporations which, beyond purchasing and modernizing existing plant and equipment, made very few expansion investments.
- Due to insufficient regulation and market supervision many companies were sold on unfavorable terms.⁵³ Costly private monopolies emerged in the telecommunications sector, leading to high charges for services.⁵⁴

Liberalization of external trade increased **external competition** more than internal competition. Up to 1995 the liberalization process was driven by Argentina's participation in two trade agreements. On the one hand, the government managed, in connection with the "Uruguay Round" of the General Agreement on Tariffs and Trade (GATT), to abolish most nontariff trade barriers as well as to substantially lower average import tariffs. The import tariff on capital goods and raw materials was even eliminated altogether. On the other hand, in 1994 the Argentine government entered into a customs union with Brazil, Paraguay and Uruguay, the MERCOSUR agreement (*Mercado Comun del Sur*).⁵⁵ Since January of 1995 there has been a common external tariff of between 0 % and 20 % covering 90 % of customs items. Many Argentine SMEs were unable to respond appropriately to the drastically rising external competition, the number of company closures increased rapidly.

The **incentives provided by factor markets** in Argentina were shaped by a more efficient capital market, a still inflexible labor market, and a liberalized technology market.

- The capital market was made more efficient by a reform of the Argentine financial system. Above all, the central bank's autonomy

was strengthened and a number of provincial banks were privatized.⁵⁶

- Thoroughgoing reforms of the labor market were undertaken only in 1998 and 2000, and their scope is as yet unclear. Until very recently excessive regulations, collective wage agreements reflecting the interests of parties and unions, and high mandatory employer contributions to union health-insurance schemes (that offer few services) unnecessarily increased the price of the factor labor, reinforcing a tendency to shed workers into the informal labor markets.⁵⁷
- The technology market benefited from Argentina's trade liberalization. Practically every type of technology is available today via FDI, imports of capital goods, and franchising/ licensing.

4.3 Institutions and technology policy

Since the 1950s the Argentine government has for the most part pursued its technology objectives via a number of publicly sponsored research institutions. But the linkages between these institutions and the country's businesses are weak and the institutional structure has not yet succeeded in promoting an efficient diffusion of technological knowledge into the private sector. The end of the 1990s saw the launch of a number of institutional reforms, but their impacts have yet to materialize. What follows is a brief sketch of the country's most important research institutions:

- The National Council on Science and Technology (CONICET) was founded in the 1950s and today is still the country's leading research institution. CONICET has 198 associated scientific institutions, eleven regional research centers, and roughly 7500 employees.⁵⁸ Since 1984 attempts have been underway to use technology-transfer offices as a means of strengthening linkages with the business sector.

53 For a general presentation, see Pastor / Wise (1999), pp. 487-490. For a specific presentation of the situation of insufficient regulation in the processes of liberalizing the telecommunications market, see Arnold (1999).

54 IMF (1998), pp. 5-6; Pastor / Wise (1999), pp. 487-489.

55 Pastor / Wise (1999), pp. 486-487, 498.

56 IMF (1998), p. 6.

57 The Economist, Oct. 23, 1999.

58 Katz / Bercovich (1993), p. 467.

- The National Institute for Agricultural Technology (INTA) employs roughly 5000 persons, some 1900 of them engineers and scientists. INTA is relatively closely connected with agriculture, and the R&D efforts undertaken by the institute achieve quite broad effects.⁵⁹
- By contrast, the effectiveness of the national Institute for Industrial Technology (INTI) tends to be assessed as relatively low.⁶⁰ INTI has the task of carrying out research and development programs with the private sector. The institute is further in charge of elaborating industrial standards.
- At the end of the 1980s the National Atomic Energy Commission (CNEA) employed some 6000 persons and absorbed roughly 17 % of total public expenditure on R&D. This indicates a high priority given to military and civilian nuclear research for some decades. In addition, since the 1950s the army has operated a research institute for military technology (CITEFA) of its own.

Though Argentina maintains a number of in part personnel-intensive research institutions, as far as public investment in science and technology is concerned, the country lags far behind the industrialized countries, but also behind the other Latin American NICs (see Table 4).

In 1996 the Argentine government set out to reform its research and technology policy. Its stated aim was to raise the percentage of funds spent on science and technology by both the public and the private sector to 1 % of GDP.

A special institution, the National Agency for the Promotion of Science and Technology (AGENCIA), was set up to more efficiently channel the funds provided to support public and private research. AGENCIA is equipped with two financial-support instruments: the Fund for Science and technology (FONCYT) and the Argentine Technology Fund (FONTAR).

- **FONCYT** uses publicly announced competitions to subsidize research projects, the results of which are published in scientific publications or which are assumed to have the character of a public good, even if they are initially available only to a company for use and exploitation.
- **FONTAR** uses subsidies and subsidized loans to fund innovations and measures aimed at technological modernization in private companies. Until 1990 50 % of the funds stemmed from the Argentine budget and 50 % from the Interamerican Development Bank (IDB).⁶¹

	Investment in science and technology (in million US \$)	Percentage of GDP
Argentina	984	0.33 %
Brazil	4 107	0.61 %
Chile	310	0.60 %
Mexico	1 039	0.31 %
Spain	2 464	0.52 %
US	66 822	0.87 %
Germany	14 785	0.99 %

Source: GACTEC (1997) p. 78

59 Katz / Bercovich (1993), p. 469.

60 Chudnovsky (1999), p. 161.

61 AGENCIA (1999); conversation with Jorge Fontanals of the *Secretaria de Ciencia y Tecnología (SECYT)* on Jan. 20, 2000, in Berlin.

On the whole, Argentina's institutional system designed to promote technological innovations is underdeveloped and chronically underfinanced. There are hardly any linkages between universities and private companies in the field of R&D, there is practically no support for business startups in technology-relevant areas. In their concrete formulation, the promotion programs operated by FONCYT and FONTAR are largely in line with international best practice in technology promotion. But their financial endowment is wholly inadequate to deal with the massive problems with which the better part of Argentine firms are faced in funding technological innovations.⁶²

5.1 Volume and structure of the Argentine software market

In 1999 around US \$ 15 billion was spent in Argentina for products and services in the field of information and communications technology. Over 70 % of this went to telecommunications (some US \$ 11 billion),⁶³ a field whose dynamics profited from a partial liberalization of the market. Over US \$ 3.8 billion went into IT in the narrower sense, the area of interest to us here.

The time series represented in Table 5 show that all subsectors of IT have developed positively in

	1995	1996	1997	1998	1999
IT market					
- Overall spending (in m US \$)	1.950	2.400	2.900	3.470	3.840
- Growth rates	--	23.1 %	20.8 %	19.7 %	10.7 %
GDP					
- (in m US \$)	258.032	272.150	292.859	298.131	--
- Growth rates (nominal)	--	5.5 %	7.6 %	1.8 %	--
GDP share of IT market	0.76 %	0.88 %	0.99 %	1.16 %	--

Source: Authors' presentation, based on Prince & Cooke (1998) and IHF (1999a)

5 The Argentine software sector: structure and dynamics

Thus far no comprehensive studies have been published on the Argentine software industry. The industrial federations and chambers of commerce have no comprehensive and reliable data that could be used to describe the sector's structure and dynamics. In the literature available internationally there are, beyond the well-known success stories à la Bangalore, hardly any studies on the providers of high-grade IT services in developing countries and NICs. The present study thus has pilot character. The following chapter starts out with a brief analysis of the most important secondary data on the Argentine IT market (5.1.) and then presents the information gleaned from the survey of software suppliers (5.2 to 5.5).

recent years, though software and services invariably showed higher growth rates than hardware. It must be added here that the actual demand for software is distinctly higher than the official figures seem to indicate. With packaged software for the mass market, the situation is still such that only some applications and uses are covered by licenses, though recent years have experienced increased efforts against software piracy.

Between 1995 and 1999 total expenditures for IT in Argentina grew at two-digit annual rates, accounting for a rise in percentage shares of GDP from 0.76 % to 1.16 % 1995 and 1998 (see Table 6). It should be noted, though, that as early as 1995 this figure was, on average, roughly 2 % for the OECD countries.⁶⁴

62 Interview with Fernando Porta of the *Instituto de Estudios Sociales de la Ciencia y la Tecnología (IEC)*, Dec. 14, 1999, Berlin.

63 See www.cicomra.org.ar.

64 OECD (1997), p. 13.

Segment	1995	1996	1997	1998	1999
Hardware					
- Expenditures (in m US \$)	829	995	1.165	1.330	1.382
- Market share (in %)	42.5	41.5	40.1	38.3	36.0
- Growth rates (in %)	-	20.0	17.1	14.2	12.8
Software					
- Expenditures (in m US \$)	273	340	417	530	614
- Market share (in %)	14.0	14.2	14.4	15.3	16.0
- Growth rates (in %)	-	24.5	22.6	27.1	18.9
IT services					
- Expenditures (in m US \$)	730	910	1.118	1.370	1.574
- Market share (in %)	37.4	37.9	38.6	39.5	41.0
- Growth rates (in %)	-	24.7	22.9	22.5	14.8
Other					
- Expenditures (in m US \$)	118	155	200	240	270
- Market share (in %)	6.1	6.4	6.9	6.9	7
- Growth rates (in %)	-	31.4	29.0	20.0	12.5
All segments					
- Expenditures (in m US \$)	1.950	2.400	2.900	3.470	3.840
- Market share (in %)	100.0	100.0	100.0	100.0	100.0
- Growth rates (in %)	-	23.1	20.8	19.7	10.7

Source: Authors' presentation, based on Prince & Cooke (1998) and <http://www.cicomra.org.ar>

Table 7 shows which sectors generate demand for IT. Firms are clearly dominant here over private households and the public sector. One surprising aspect is the strong position of the large corporations that were rapidly modernized in the 1990s as a consequence of takeovers by foreign interests. In view of the problems with access to credit discussed in Chapter 4, on the other hand, it is surprising that one quarter of the overall demand for IT is generated by SMEs. The reason for this is in part that from the mid-1990s on world-market prices for

hardware had declined to such an extent that a larger number of SMEs were able to acquire personal computers and appropriate software in connection with the process of their modernization.

The distribution of earnings from sales reveals a high degree of concentration. In 1999 the 50 largest producers accounted for 66 % of overall IT expenditures. Most of these are large international corporations like IBM, Microsoft, or Oracle, which have sales organizations in Argentina.

Demand types	in m US \$	in %
Business sector, incl.:	2.715	78.2
- Large corporations	1.270	36.6
- Banks	555	16.0
- SMEs	890	25.7
Public sector	185	5.3
Households	570	16.4
Total	3.470	100.0

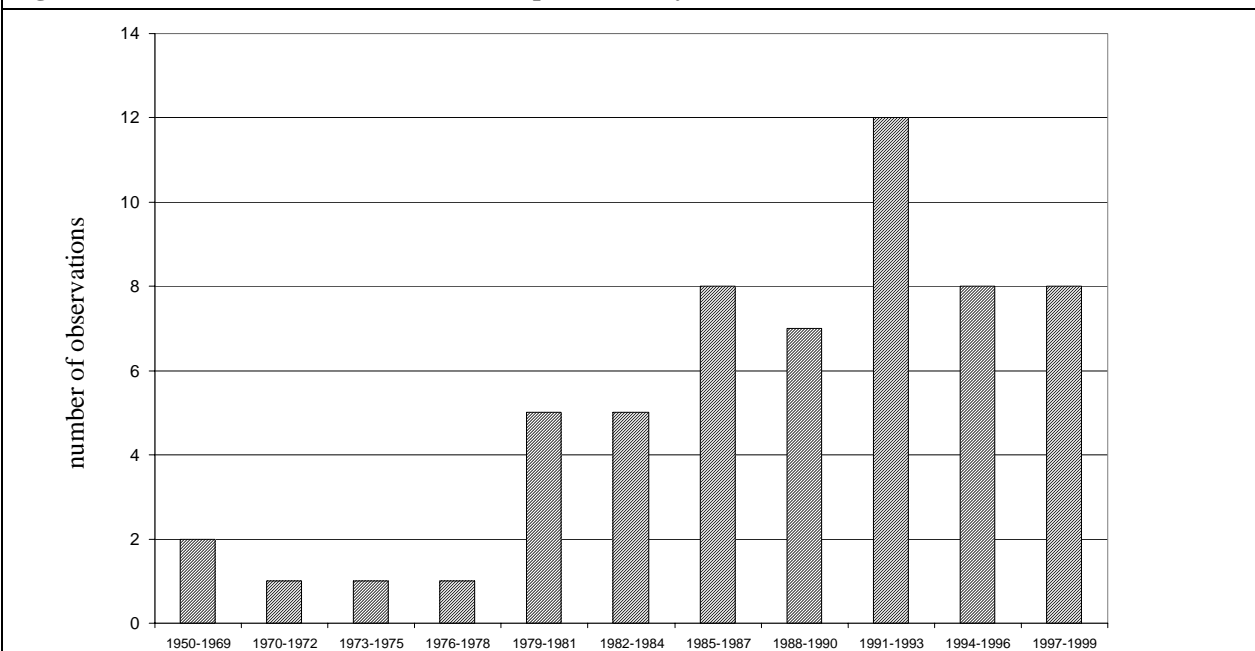
Source: Authors' presentation, based on Prince & Cooke (1998).

When the present study was conducted, there was hardly any reliable information available on Argentine providers of software and IT services. It was estimated for 1995 that some 300 national and international companies were producing and selling software in Argentina.⁶⁵ The entry to the market of foreign companies crowded out many national suppliers. The same period, however, saw the startup of a good number of new software companies, which indicates that even today a number of 300 national software companies constitutes a realistic approximation to reality. Estimates based on the empirical data that went into the present study indicate that in 1999 national software companies turned over US \$ 300 million⁶⁶ and employed some 4500 persons. The share of domestic software thus accounts for only 13.7 % of the overall earnings of the industry. It is assumed that the export earnings of Argentine software companies do not exceed a figure of US \$ 25 m.

The survey, conducted between the middle of February and the end of March 2000, covered 58 companies active in software development in Argentina. Most of these companies (50) were located in Buenos Aires, four were in Córdoba, three in Mendoza, and one in the state of Misiones. This geographic distribution is bound up with the study's methodological approach and does not constitute a representative sample of the industry. But Buenos Aires is clearly the center of Argentina's software industry.

The companies surveyed are for the most part relatively new organizations, as shown in Figure 4. Thirty of these companies were established in the 1990s, 22 in the 1980s, and only six in previous decades. The companies established prior to 1980 were for the most part initially active in fields outside software development (e.g. business consulting) and only later added IT solutions to their line of products and services.

Figure 4: Years in which the software companies surveyed were founded



Source: Authors' survey

65 Correa (1996), p. 175.

66 This figure was calculated multiplying the estimated number of national software suppliers (300) by the median of the earnings of the companies surveyed (US \$ 1 m).

Seen in terms of sales and employment figures, the industry is made up mainly of relatively small companies. In the 1999 business year the 45 companies that provided data here varied in annual sales between US \$ 25 000 and US \$ 12 million, the median being US \$ 1 million.

5.2 Quantitative and qualitative aspects of employment in software companies

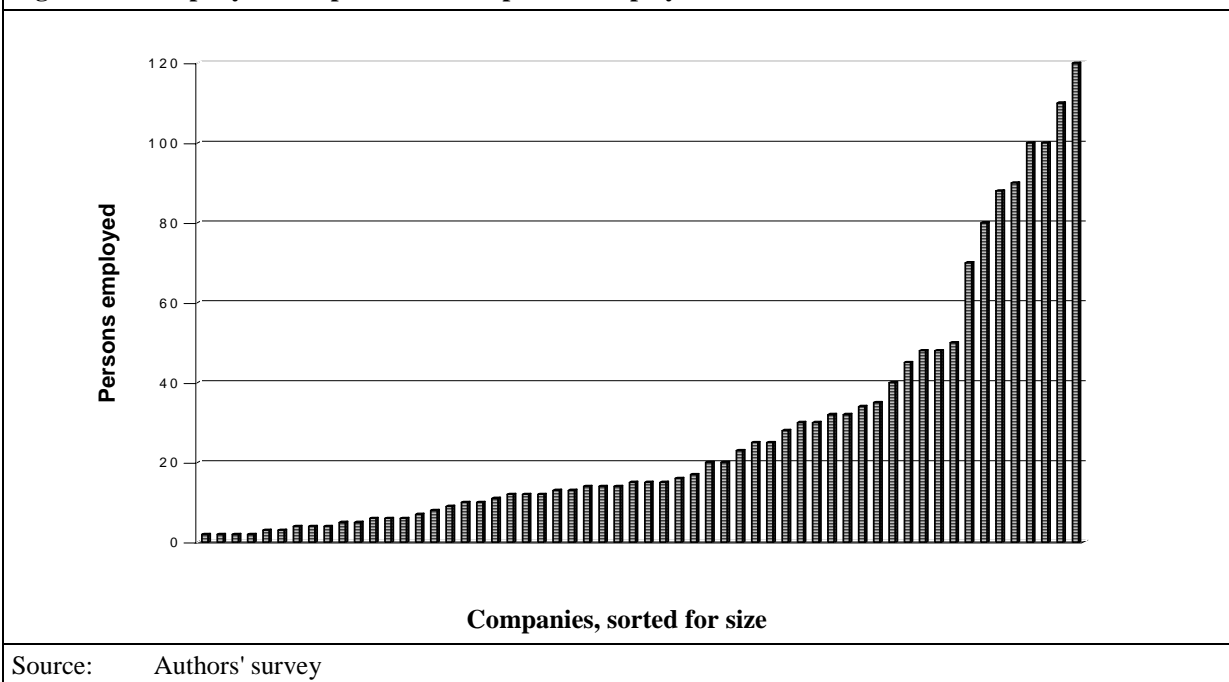
In the past year the software companies surveyed provided regular employment to a total of 1614 persons. The companies interviewed employed an additional 248 persons on a part-time or temporary basis. It is important to note here that the production and use of software involves a number of additional services, e.g. installation and maintenance of programs and training for the personnel of customer companies. Since these services are often provided by external companies, the supplier survey did not assess these indirect employment effects. The largest company in the sample employed 120 persons on a regular basis, while the smallest one consisted only of the two company founders. The distribution of employment across the companies surveyed is depicted in Figure 5. The average

number of persons employed by the companies surveyed was 28, the median 15. All of the larger companies were located in Buenos Aires. Outside the capital we found only one company, in Mendoza, that employed over 30 persons, while the other seven had fewer than 15 employees.

Twenty-six of the 58 companies interviewed employed temporary personnel and freelancers. A large percentage of the part-time workers are computer-science students engaged in practical training with these firms or are already planned in as part of their regular staff. On the whole, temporary employment accounted for 13 % of all of the employment covered in the sample, though there are some smaller companies that employ more temporary than regular personnel.

A number of companies employ no part-time or other nonregular staff with an eye to avoiding any possible negative impact on quality standards. Other companies indicated that they employ students because of the relatively low wage costs they entail and their experience with the most recent object-oriented programming languages and tools. In addition, in periods marked by peak order volumes or when certain time-limited proj-

Figure 5: Company size as per number of persons employed



ects are involved, these companies frequently employ freelance programmers and temporary personnel, often without any regular contractual arrangements.

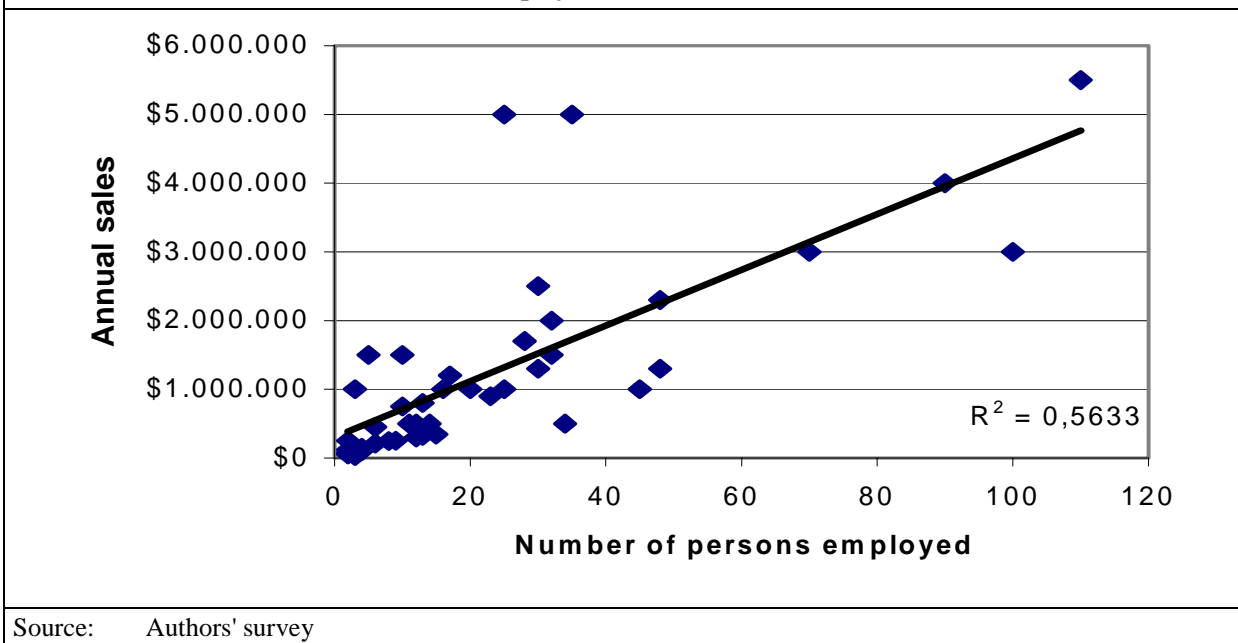
Roughly half of the jobs in the companies interviewed were in the hands of college or university graduates. Sixty-two percent of the latter hold degrees in computer sciences or systems engineering. Among employees without any academic training we find a large number of workers who have attended three-to-four-year training courses in computer science. This shows that this is an extremely knowledge-intensive sector with a high need for scientifically and technically qualified workers. A more exact analysis of the results of the study indicates that companies marketing packaged software are in need of more sales and marketing people with economic training, while companies that produce customized software for certain niches are more in need of software engineers.

given social sector, e.g. for the chemical industry, the winemaking industry, or the health-care system, were founded or co-founded by university graduates in disciplines relevant to these sectors, e.g. chemistry, oenology or medicine.

Thirty-five of 52 companies reporting indicated that their personnel figures had risen between 1997 and 1999, while eleven companies reported no change and only six companies had cut their staff in the past three years. These companies also indicated that part-time employment had increased with them over the past three years. The rise in employment, strong on the whole, goes hand in hand with a dynamic period of increasing sales and growing clientele.

The empirical results support the thesis that the software sector can give rise to significant employment effects without demanding large investments.

Figure 6: Ratio of turnover to number of employees



Furthermore, the survey data also contain information on the **founders of companies** in the software industry: 74 % of them graduated from technical colleges or universities, 19 % of cases involved a business partner with training in business administration. Some companies that develop software for a specific branch of industry or a

As Figure 6 demonstrates, company labor intensity, determined as a quotient from sales and employment figures, shows no major deviations between medium-sized and small companies. Aside from two outliers, whose above-average produc-

tivity can be explained,⁶⁷ there is a practically linear relation between number of workers and sales figures. This indicates that there are hardly any economies of scale in the Argentine software industry. This empirical context also permits us to infer that Argentine software companies create one new job (at different levels of qualification) per increase in sales of roughly US \$ 40 000.

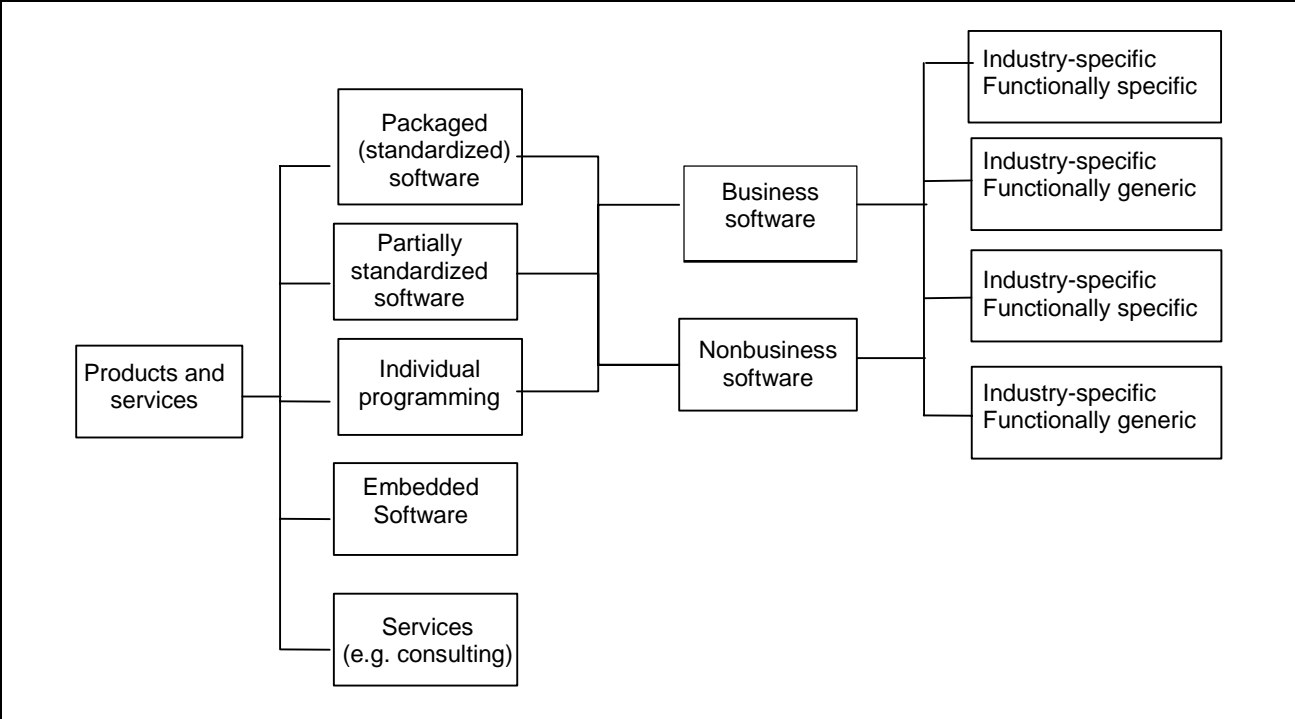
5.3 Products and services offered by Argentine software companies

For purposes of analysis, we broke down the products and services offered by the companies covered here into five categories. Figure 7 presents them in schematic form. Over 57 % of these

companies made the better part of their sales with packaged and partially standardized products, and only 17.2 % of the companies surveyed devoted their activities mainly to individual programming. Only two companies of the survey (3.4 %) produce embedded software. In many cases companies are active mainly in developing packaged or partially standardized software, supplemented by individual programming customized for specific customer problems.

The greatest share of the packaged or partially standardized software solutions offered by the companies interviewed (83 %) is business software. Table 8 shows how this segment breaks down in terms of industries and company functions.

Figure 7: Categories of products and services found in the survey



Source: Authors' survey

67 In one case a company that reaches substantial sales figures abroad, but with relatively few workers in Argentina; the other case one of the market leaders in packaged software for SMEs with outside sales channels. In both cases we necessarily find a far above-average turnover per regularly employed national worker.

Function	specific	generic
Industry specific	12 %	21 %
Industry generic	16 %	51 %

Source: Authors' survey

5.4 Customer structure of the software companies surveyed

The number of customers per software supplier in the 1999 business year ranged between a minimum figure of four and a maximum figure of 30 000, the median being 60 customers. The breadth of a company's customer portfolio does not necessarily reflect its success in the marketplace; it is instead a result mainly of the business segment in which the company is active. Companies that offer comprehensive programming services for specific problem areas are as a rule marked by low customer figures and high order volumes. By contrast, packaged software is as a rule sold in large volumes at low cost.

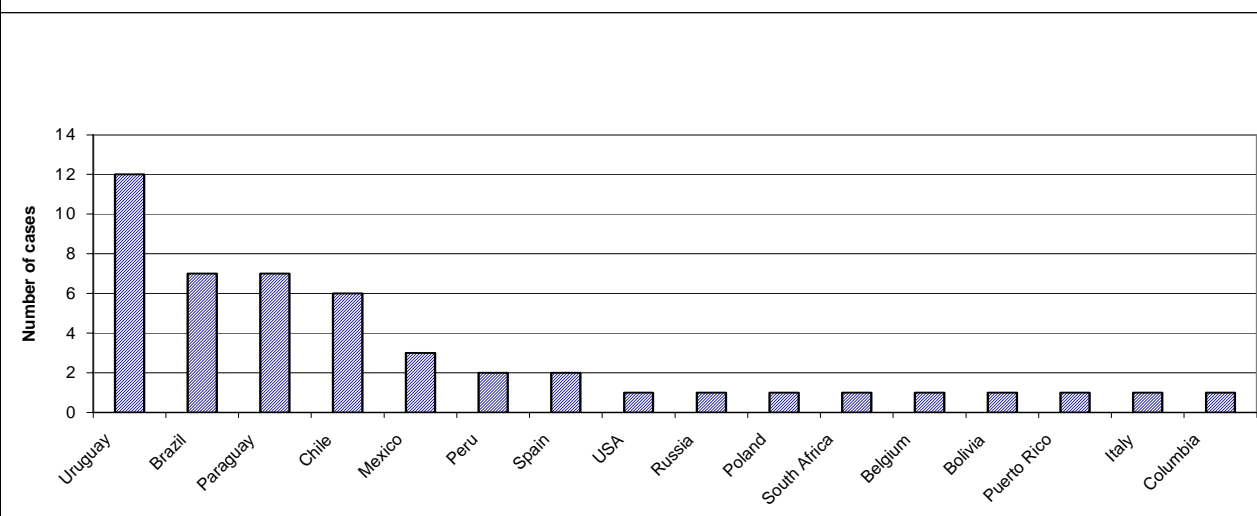
The software industry mainly works "business to business", which means that most customers are themselves businesses and not private consumers. The cases in which software companies work directly together with private customers concern for the most part not software development but provision of access to the Internet (Internet service providers, ISP). Our sample included not one single company active in the field of so-called edutainment software, though this is a market segment for which high growth rates are predicted.

A large share of the software developed in Argentina is sold in the service sector, in which 43 % of overall sales are made. This figure includes mainly the retail trade, telecommunications, and banks, hotels, and private clinics. Some providers also develop software for freelancers such as lawyers, architects, and insurance representatives. Thirty percent of the overall sales of the sample were made with manufacturing companies, mainly in the petrochemical, automotive, and agricultural industries. Finally, the public sector plays a key role as a buyer of national software. Fourteen companies (24 % of the sample's overall sales) mainly work together with publicly owned hospitals and municipal administrations.

The great majority of software demanders are small and medium-sized enterprises (SMEs), which are, for the purpose of the present study, defined as companies with fewer than 300 employees. Fifty-seven percent of the companies interviewed work together exclusively with SMEs, 13 % make at least 75 % of their sales with customers in this size segment. Then there are the 25 % of software companies that work chiefly or exclusively with large companies, including agroindustrial corporations, large banks, or daily newspapers. Table 9 further breaks down the sales volumes achieved with different company sizes.

Percentage of sales	Small companies (< 50 employees)			Medium-sized companies (50-300 employees)			Large companies (> 300 employees)		
	No.	%	Cum. %	No.	%	Cum. %	No.	%	Cum. %
75 % - 100 %	10	20.8	20.8	6	12.5	12.5	12	25.0	25.0
50 % - 75 %	7	14.6	35.4	9	18.8	31.3	7	14.6	39.6
25 % - 50 %	5	10.4	45.8	11	22.9	54.2	3	6.3	45.9
1 % - 25 %	9	18.8	64.6	11	22.9	77.1	7	14.6	60.5
0 %	17	35.4	100	11	22.9	100	19	39.6	100
Number of valid responses	48			48			48		

Source: Authors' survey

Figure 8: Target countries for Argentine software exports

Source: Authors' survey

As regards the spatial distribution of clientele, we can note that our software companies make three quarters of their sales in the province in which they are located and only 20 % in other provinces. These narrow geographic ties to customers are not surprising for suppliers headquartered in Buenos Aires in that this urban conglomeration also contains the largest number of potential customers. But the companies outside the capital also mainly work together with users in their immediate spatial vicinity. This observation indicates that, despite globalization and the expanded options offered by the Internet to penetrate new markets, geographic proximity to customers continues to be a highly important factor.

Fourteen of the companies surveyed (24 %) also had customers abroad and exported some of their software to MERCOSUR countries (eight companies, mainly to Uruguay), to other regions of Latin America, and, in individual cases, to countries

outside the subcontinent (four companies). The volume of exports is, however, relatively low. Only eight companies (14 %) make more than 10 % of their sales abroad and only two of the companies surveyed have made more than half of their earnings abroad.

Figure 8 shows the target countries for the software exports of the companies interviewed. The figure represents all projects carried out in recent years, including small and one-off programming services. This again points to the great significance of their neighboring countries in their sales figures.

5.5 Development of software companies in the three years prior to the study

As a means of coming up with propositions on the competitive conditions to which Argentine soft-

Table 10: Change of competition – Domestic or foreign suppliers

Change	National products	Imported products
Increase	55,2 %	46,6 %
No change	25,9 %	15,5 %
Decrease	8,9 %	5,2 %
No competition	5,2 %	29,3 %
No response	5,2 %	3,4 %

Source: Authors' survey, based on 58 responding companies

ware companies are exposed, they were asked about trends in important business indicators in the three years prior to the survey. They were furthermore asked for an assessment of how the national and international competition in their specific market segments had developed. Most of the companies have very positive growth dynamics, although, according to the information provided by them, outside competition and internal competition are at the same time on the rise. The greater part of the companies interviewed indicated that annual sales, number of employees, and number of customers had risen in the past three years (see Table 10).

The positive perception of the companies surveyed as regards their own development is surprising in view of the weak development of the Argentine economy as a whole in recent years and the heightened competitive situation in many segments of the software market (see Table 11).

As is indicated by the data presented here, half of the companies interviewed perceive the competition with other national software providers as having intensified. As far as competition from foreign suppliers is concerned, we can distinguish two groups of companies in our sample: while for some of the companies interviewed the international competition has risen *substantially*, another, large part of the companies interviewed are *not* in direct competition with foreign suppliers. A closer analysis of the data material suggests the following interpretation:

- Evidently the protection afforded by a "natural niche," from which Argentine providers of business software long benefited thanks to national peculiarities, has been penetrated by international suppliers, at least in some sub-segments of the market, intensifying the competitive situation in the Argentine market.

Table 11: Development of software companies in the past three years

	Sharp rise	Rise	Unchanged	Decline	Sharp decline	No response
Sales	47.4 %	21.1 %	15.8 %	7.0 %	7.0 %	3.5 %
Employees (regular)	24.6 %	36.8 %	19.3 %	5.3 %	5.3 %	8.8 %
Employees (temporary)	18.2 %	14.5 %	18.2 %	3.6 %	0.0 %	45.5 %
No. of customers	35.1 %	38.6 %	15.8 %	8.8 %	0.0 %	1.8 %
No. of products	29.8 %	35.1 %	33.3 %	0.0 %	0.0 %	1.8 %

Source: Authors' survey

The companies' self-assessment was, though, in line with the results of a study conducted by the International Data Corporation (IDC) on the development of the software market in Argentina, Brazil, and Mexico at the end of the 1990s.⁶⁸ This study notes that on the one hand the market for generic Enterprise Resource Planning (ERP-) software has grown sharply since 1994/95 and on the other hand that competition within the market segment has intensified and a gradual saturation can be observed.

- For companies specialized in a relatively narrow, technologically demanding market niche or producing customized software in need of substantial adaptation to specific customer needs, the international competition is far less sharp. In these cases degree of specialization and geographic proximity entail competitive advantages for national suppliers over existing and potential foreign competitors.

68 See <http://www.idc.com/Data/Latinamerica/Content/LA020900PR.htm>.

Box 2: The Software Technology Parks of India

Soteica – technology- and export-oriented development path

Soteica is a company that is distinguished from the general trend in the Argentine software industry by its dynamic technology- and export-oriented development path.

The company develops software for the chemical industry as well as for oil refineries. Unlike the greater part of Argentine software companies, it offers not only business software but technology-specific integral solutions such as programs designed to simulate chemical processes in real time as well as information systems for entire production plants and laboratories.

With its export share of 60 %, measured in terms of number of customers and its branches in Brazil, Mexico, and Venezuela, this small company, which employs 25 persons in Argentina, is the firm with the highest degree of internationalization covered by the study. Aside from its presence in the Latin American Market, this niche supplier has also managed to gain a foothold in the US market. For the future the company aims to sell its products worldwide. One pillar of its international presence is the strategic alliance it has forged with the US company OSI software in the field of information systems. Seen in terms of the low number of persons it employs, the company achieves far above-average sales figures.

As an R&D-intensive company, Soteica seeks cooperation with Argentine universities. It is already cooperating with the chemistry department of the University of Santa Fé in applications-related fields, and it works together with a university's programming team in developing software.

Synergywave – free software for architects

As a company, Synergywave / CAD 32 is particularly interesting in that it in 1999 opted for a radical change of strategy made possible by the new potentials offered by the Internet.

When the base of the company's product - a computer-aided design (CAD) program for the field of building and architecture - was established in the Argentine market, it was faced with an important foreign competitor. The program cost US \$ 1000 plus an annual fee of US \$ 400. Beginning in 1999, the program was given away free of charge together with an architecture journal. Beforehand, however, it had been expanded to include a number of options that enabled users to order directly, via the Internet and from various building-materials companies, the materials they needed for a given building project. This entailed setting up a website listing the most recent offers of different producers and enabling the customer to place direct e-mail orders for the quantities of materials calculated by the program. The company is now funded via fees paid by the building-materials firms for the service of being listed on the website. The offer of the program free of charge has led to a growing number of users, even abroad, and the interest of foreign companies in this project is on the rise. A Portuguese version is already available for the Brazilian market, and the next planned step is to develop the markets in Europe and North America, where the company sees its future.

InterSoft – subsidiary in the US market

InterSoft was founded in 1983 by three computer-science engineers. In 1998 InterSoft reported record sales of US \$ 4.5 million and employed a staff of 90. In the past years the company has been engaged in diversifying its products and markets. Its most important products include system solutions for personnel administration, horizontal solutions used to model business processes, and vertical solutions for hospitals and banks.

Furthermore, InterSoft has established three new subsidiaries in the past three years. With an eye to developing the US market, InterSoft in 1998 founded Fuego Technology, a subsidiary headquartered in the US. While the products it offers are marketed under a US label, Fuego Technology's product development continues to be centered in Buenos Aires. In pursuing this marketing strategy InterSoft's intention is to get around the poor image of Argentine software, which constitutes a real obstacle to exports. Last year the company also founded eTopware, which is specialized in developing solutions for e-commerce.

6 The role of software in the modernization process facing Argentine business

The empirical study also looked into the role of software in the modernization process of Argentine companies active in the auto parts industry, the winemaking industry, and the logistics industry. This chapter describes the competitive situation, the modernization efforts, and the role of software in this process. The chapter finally analyzes why, in a potentially globalized technology, there are still close national relationships between producers and users.

The empirical study does not raise a claim to be representative in any one of the industries looked into. The authors instead selected, with the aid of institutions and experts, a number of companies assumed to be in the process of modernization and in need of a minimum quantity of software. For this reason we mainly interviewed relatively successful and relatively large SMEs in all three industries.

6.1 Auto parts industry

With its sales revenues of over US \$ 1.3 billion, the auto parts industry has an important place in the Argentine economy. It is marked by a triangular structure in its supply chain, each tip of which contains an assembly plant. The second tier is occupied by system suppliers, who supply complete brake systems, cable trees, etc. Each of these system suppliers has a number of subsystem suppliers, which in turn obtain their intermediate products from component suppliers. The suppliers of spare parts for the used-car market are a special case. They are not integrated into the supply chain and instead sell their products directly to wholesalers or garages and repair shops.

The number of auto parts suppliers has declined sharply in recent years, a process accompanied by a growing internationalization of the industry's capital. Many companies have closed or relocated abroad, in particular in Brazil. In 1998 Argentina's auto parts industry consisted of 400 companies. Most of these are SMEs operating with national capital, on the third or fourth tier of the supplier

chain, and with fewer than 100 workers. The limited number of larger, often international suppliers for the most part occupy the first or second tier and supply the assembly plants directly or indirectly. Both the companies integrated into the supply chain and the producers of spare parts are under incessant pressure to modernize, and the pressure has even increased due to the 1999 Brazilian crisis.

The **empirical study** surveyed 13 auto parts suppliers located in Córdoba; their products included transmissions, exhaust systems, loudspeakers, or heaters. In 1999 these companies reported sales revenues between US \$ 1.1 million and US \$ 550 million, the median being US \$ 8 million. In the same year employment varied between 20 and 1220 workers, the median being 90. Eleven of the companies surveyed directly supply the assembly plants of the major automakers, i.e. they belong to the first tier of the supply chain, while the remaining two companies produce spare parts. Even though the greater part of their sales revenues is made in the Argentine markets, nine of the companies surveyed also supply international markets. Six of these companies are Argentine-owned, while seven others operate with a majority share of foreign capital.

The companies surveyed are currently faced with growing **competition** from both national and international products (especially from Brazil), though they have, in their own estimate, for the most part managed to improve their market position. It is in particular price competition that has intensified, since, thanks to the devaluation of the Real in 1999, Brazilian products currently enjoy comparative cost advantages. On the other hand, quality aspects are of less significance for competition in that the assembly plants demand consistently high quality of their suppliers. It is therefore not surprising that all of the companies interviewed are certified as per ISO 9000.

The most important supplier response to increased competition was, in the eyes of the suppliers, **technological modernization**, followed by internal restructuring and modified product lines. Mergers and cooperative ventures were accorded

less significance here. This is not surprising in that many of the companies interviewed already belong to international consortia.

In discussing modernization, the companies interviewed particularly emphasized the fields of production and quality control. Twelve companies indicated having markedly modernized company functions. The companies interviewed have mainly modernized the areas procurement, logistics, sales, and management. They regarded marketing and customer service as less important. This is a reflection of the fact that these companies work closely and continuously together with a limited number of assembly plants.

Compared with investments in machinery and restructuring of internal company processes, **software** plays only a subordinate role in the modernization of the companies surveyed. This is proven by the low budget entries earmarked by these companies for software projects. These items are for the most part less than US \$ 100 000.

As a rule these companies use international software in their production processes; this software is usually embedded into their machinery. In the fields of administration and management, the international corporations prefer international systems, while the national companies are usually interested in national software.

Companies dominated by foreign capital for the most part procure their software in the international market. The parent corporations of many such companies decide on which software is to be used by networking their subsidiaries with their own system. Other international corporations have an ICT department of their own that develops systems to company specifications. One company of the sample spun off its ICT department and since the software company created in this way has a high level of technological competence, it offers its services to other (in part international) auto parts suppliers as well. Apart from this case, linkages between international auto parts suppliers and national software suppliers are limited to some specific IT services (implementation, main-

tenance) and software modules adapted to national laws (e.g. in personnel administration).

The linkages between national auto parts suppliers and the Argentine software industry are significantly stronger. The most important barrier to even closer relations is the lack of specific solutions on the national market, e.g. systems adequate to the demands of integral management, i.e. systems that link production with administration. While such systems are available in the international market, they are usually beyond the financial means of Argentine SMEs. A second problem reported by various companies is to find software for technical applications (design and measuring). One consequence of these weaknesses in the national supply is that many companies have individual solutions programmed for themselves, be it by their own software departments, be it by external persons or companies contracted for specific projects. Despite all of the problems noted, two of the companies interviewed use standardized or partially standardized national systems in all of their departments. The most frequently mentioned benefit offered by national software is its cost, which is low by international comparison. Service is also better thanks to supplier proximity.

The companies surveyed use the **Internet** mainly for communication per email as well as to obtain technical information on products and processes. During the survey one of the companies was in the midst of a project on the use of e-commerce in procurement. It is likely that the demand of auto parts suppliers for specific services in the field of e-commerce will rise in the short to medium term since business-to-business relationships between assembly plants and suppliers via the Internet are gaining significance. Five of the 13 companies interviewed had already installed an intranet with the assembly plant.

6.2 Winemaking industry

With an output of 12.8 million hectoliters and a world-market share of 6 % in 1998, Argentina is the world's fourth largest wine producer after France, Italy, and Spain. In 1998 the industry re-

ported sales revenues amounting to US \$ 2 billion. There are roughly 750 vineyards in Argentina, and 70 % of them are located in the province of Mendoza.

Even though Argentina's winemaking industry continues to produce mainly for the domestic market, for some years now export earnings have been on the rise, as has the industry's degree of internationalization. Between 1994 and 1999 the value of exports more than trebled. In 1999 exports amounted to some US \$ 117 million. The main importers are the US, the UK, and Japan. The dynamics of exports was set in motion not least by foreign investors, who are making inroads into foreign markets. Foreign capital is involved in eight of the country's twelve largest exporters. The framework for the Argentine winemaking industry has been marked in recent years by declining mass consumption and rising quality standards. Both in Argentina and worldwide the consumption of wine, and here chiefly simple table wines, has declined sharply. The demand for quality wines has risen at the same time.

In Argentina there are two groups of vineyards, each of which is forced by different givens to approach the new market conditions differently. The first group of vineyards can meet the increased demands at home and abroad. These have sufficient capital to produce high-grade quality wines with well-known labels. The second group of vineyards (the majority) lack investment capital and therefore continue to produce no-name table wines, which are less and less marketable.

The vineyards in possession of sufficient capital have responded in recent years to the higher demands placed on the quality of wines. They have modernized technologically, raising the efficiency of procurement and warehousing. Software has played a secondary role in modernization, as is shown by the following results of the empirical study.

The **empirical study** surveyed 19 vineyards located in the vicinity of the town of Mendoza as well as in San Rafael de Mendoza. The median of sales revenues in 1999 was US \$ 8 million. All

vineyards interviewed produce quality wines, five also produce table wine or must. Three of the vineyards surveyed are cooperatives. At the end of 1999 eight of the companies employed fewer than 50 workers, nine between 50 and 300, and two over 300. All of the vineyards interviewed exported at least small quantities of their wines. Their export earnings accounted for an average of 15 % of their 1999 sales revenues. Fifteen companies are family-owned or belong to national capital interests, three are jointly owned by national and international capital, and one is owned solely by international capital interests.

The economic situation of the vineyards surveyed in the domestic and foreign markets has improved over the past five years despite stepped-up **competition**. The survey indicates that competition in the national market has increased sharply as regards both price and quality. Nevertheless, in their own perception, the position of the vineyards interviewed has improved. Positive developments in the domestic market reflect the altered consumption patterns described above. All of the vineyards interviewed have profited from the fact that they produce quality wines. Since these wines are also in increasing demand abroad, new markets can be developed. Wine exports are thus a relatively new business area for the majority of the vineyards interviewed.

All of the vineyards interviewed have used **technological modernization** to respond to intensified competition, and most of them have at the same time improved their quality. They have invested in particular in plant and equipment, including stainless-steel tanks, presses, and other machinery. The growing awareness of the significance of the ISO 9000ff. quality standard among the vineyards interviewed is a sign of their increasing orientation to the growing demands of their national and international clientele for high and reliable quality. One vineyard is already certified as per ISO 9000, five were involved in the certification process when the survey was conducted, and seven regard the certificate as important to their future business development.

In the technological modernization of these businesses **software** plays only a secondary role and does not constitute a major cost factor. Even though the annual costs for externally produced software differ from vineyard to vineyard, representatives of the businesses interviewed estimate them as "low" or "moderate." Only one company was introducing a new software worth more than US \$ 100 000 when the survey was underway.

The level of vineyard computerization attained thus far differs between administrative and commercial departments on the one hand and production on the other. All of the businesses surveyed use software for their administrative activities. Many vineyards have a sales office in Buenos Aires which uses highly advanced software, though the latter is often not linked with production in Mendoza, some 1000 km away. In one case the reason why there was no link between administration and production was that the providers of telecommunications services had not yet installed permanent telephone lines.

Some companies develop their own software in special IT-departments, while the majority uses generic products offered by domestic suppliers. The vineyards interviewed have different assessments of the importance of software. This even goes for companies of similar size competing in the same segment: two vineyards, producers of high-quality and relatively expensive wines with highly renowned labels, were asked about this. While software played a practically insignificant role in one of them, the other had its own ICT department with three software engineers.

In all of the vineyards interviewed in Mendoza production is supervised by wine engineers (oenologists). Except for embedded software to monitor e.g. the temperature in tanks, little use is made of IT here. Among the few specific developments for the winemaking business, produced for the most part by small companies or individual programmers from Mendoza, there is one that is in particularly widespread use among the vineyards interviewed, independently of their size. The primary function of this relatively inexpensive system is to document the receipt of grapes, in this way facili-

tating the mandatory declaration winegrowers are required by law to submit to the *Instituto Nacional de Vitivinicultura* (National Viticulture Institute). This packaged software was developed by a small software company from Mendoza, that has since then gradually added additional features to it.

Since 1997 the **Internet** has found its way into the vineyards. Eighteen of the businesses interviewed had access to the Internet and to email when the study was conducted. Seven vineyards had a homepage of their own for presentation purposes; nine had an internal network of their own.

In the form of e-commerce, the Internet offers vineyards new areas of business activity for the future. Nine vineyards are examining the possibility of using e-commerce as a new sales channel. In two cases this is a business-to-business application, the international sale of must between vineyards and contacts between the producers and sellers of quality wines. The possibility of business-to-consumer sales is seen especially by smaller vineyards as a means of increasing their share of direct sales to end customers, which is already high. When the survey was underway, one group of national entrepreneurs who also own three vineyards was just about to open up a virtual wineshop.

The businessmen interviewed see payment by credit card as a problem that is yet to be solved. One business presents its wines, prices, and sales modalities on its homepage. Only when a potential buyer has transferred the price of his purchase to the account indicated is the wine delivered. This form of e-commerce gives rise to additional transaction costs (e.g. the need to constantly monitor email and bank account) that are passed on to the end customer. The current fees demanded by banks for such transactions imply that international e-commerce is unlikely to gain a solid footing in the immediate future.

Wine is well suited as a product for sale via e-commerce. More use of this new marketing and sales channel could engender positive impulses for the software industry. A growing use of e-commerce would also lead to an increase in the

use of software in vineyard operations. But as long as this stops at homepage design, there will be no major impulses for Argentina's software industry. If, on the other hand, the issue is e-commerce, including international financial transactions, the share of technology-intensive services would be far higher, and the push effects on the domestic IT sector would be more pronounced.

6.3 Logistics

Logistics services are a relatively new business segment in the Argentine economy. In 1999 the industry made sales amounting to US \$ 0.6 billion. Traditionally, the only, or at least the main, function of the companies active in this industry has been the shipping of freight. The services associated with the flow of goods inside a factory, including warehousing, materials management, and end products have remained the responsibility of the producing firm. Due to growing competition, however, more and more company functions were gradually outsourced in the 1990s as a means of boosting company efficiency and productivity. This development opened up new business segments for providers of special services and traditional shipping companies. Today, logistics services may include up to six activities:⁶⁹

- shipping,
- warehousing,
- handling,
- stock management (raw materials, intermediate products, end products),
- production planning, and
- order-processing.

The empirical study covers eleven providers of logistics services, most of them headquartered in Buenos Aires. Almost all of these companies offer integral variants of all six components of logistic services. Some of these companies are also active

internationally. The sample includes some of the most important companies in the industry, but also medium-sized and very small companies. This made it possible, despite the limited size of the sample, to investigate quite different economic units and their strategies in the use of technology.

In order to offer logistics services, companies need not necessarily be in possession of a truck fleet or warehouse of their own. Many companies contract external carriers for all or part of their transports. Half of the companies surveyed had no fleet of vehicles at all. It is far less frequent for such companies not to have a warehouse of their own. This was the case with only two companies from the sample.

Logistics services are increasingly linked with the handling of large quantities of information in that they

- integrate and restructure various company functions (shipping, warehousing, order-processing);
- are as a rule offered by complex and relatively large companies with several warehouses, a fleet of vehicles either of their own or leased, and a good number of workers;
- require an exchange of information with at least two different economic agents (first, the customer, second, the customer's customer); and
- involve dealing with and handling a growing diversity of products.

We can observe two contrary tendencies in the market for logistics services:

- On the one hand, the market has been growing since the beginning of the 1990s, since an increasing number of industrial corporations in Argentina now outsource not only shipping but a number of other functions of the logistics chain (warehousing, order-processing). Furthermore, due to the liberalization of foreign trade and the sharply increasing imports of consumer goods it entails, the market has grown. Deregulation of postal services has

⁶⁹ Interview with Pablo Doregger, ARLOG, in Buenos Aires, on February 22, 2000.

opened up an important field of business for private providers.

- On the other hand, competition inside the industry has increased because new suppliers, including some big international corporations, have entered the Argentine market. In addition, some transnational corporations from other industries (food, automobiles) have begun operations in Argentina and have logistics department of their own or work together with Argentine subsidiaries.

The **empirical study** shows that the second of the tendencies named is predominant, i.e. the supply of logistics services is growing faster than the demand for them. Even though the majority of the companies interviewed indicated that their market position has not changed, or indeed has improved, in the past five years, there were complaints about the declining prices for services. The quality of the service offered (predictable, on time) is not all that important since this is a relatively new service, and most customers lack experience with it. It is only the quality demands of international customers that are seen as very high.

When the study was conducted, only one such company had been certified as per ISO 9002. This is a company that has close links to the automobile sector and mainly works for a limited number of large assembly plants. Three other companies were in the process of being certified.

The majority of the companies interviewed regard **technological modernization** as the measure best suited to responding to the growing competition in the industry. The few cases in which this is not seen as strategically relevant are very new companies or companies that have only recently become active in Argentina and are already using up-to-date technologies.

Technological modernization varies in type from company to company: while some of the companies surveyed were making low but constant improvements, two others indicated that they had in recent years made substantial investments in new high-tech warehouses. In general, warehousing

and stock management were seen as the functions most affected by technological modernization.

All of the logistics companies interviewed use **software** in all of their functions. This reflects the large quantities of data handled in this industry and shows that all company processes can and must be optimized on the basis of software as a means of encountering the growing pressure generated by price.

We can summarize our findings on the use of software in logistics companies as follows:

- All of the large companies interviewed and nearly all of the companies in the sample have IT-departments of their own.⁷⁰
- As far as functions are concerned that have been especially modernized in recent years, including e.g. warehousing and stock management, the companies interviewed tend to place their trust in in-house developments and/or international programs.
- Software provided by Argentine suppliers is mainly used in accounting, payroll and human resources, and some special applications (e.g. route optimization).

The linkages between the supply of domestic software and the demand of logistics companies are limited mainly by a lack on the supply side. Several of the companies surveyed stated that they are unable to find any solutions in the national market for their core business activity (warehousing). The relevant modules of generic ERP-programs are, in the opinion expressed by the companies interviewed, subcomplex. But at the same time the international systems are too expensive for Argentine logistics companies in that they do not pay for itself in the narrow market. Thanks to these supply restrictions, the companies interviewed are forced to look to international solutions and to combine these with other software modules either bought in the market or developed for the purpose.

70 In one case employing 20 persons.

One example for the lacking linkage between national supply and demand is a logistics company in the sample, an Argentine subsidiary of a transnational corporation that mainly works for a French automaker. This company sees for itself a comparative advantage in using software compatible with that used by its most important customer. This is a strong argument against the use of national software. A stronger linkage between national supply and demand is in this case prevented by another factor: if every subsidiary of a transnational corporation worked with local software, the costs for the corporation would rise since every update of a specific software item would require a reprogramming of the interfaces in question. In the case under review the parent company not only bans the use of local software, it is also gradually replacing the Argentine programs used thus far (administration and management) with an integrated ERP system supplied by SAP, which the automaker uses in the parent plant.

6.4 User-producer interaction in the Argentine software industry

The survey showed that it is mainly in the field of ERP-software for SMEs that there are close linkages between national suppliers and demanders. The following section analyzes what reasons there are for Argentine companies to avail themselves of the national supply and why suppliers have thus far concentrated largely on the Argentine market. The section also looks into the factors that limit or prevent local user-producer interactions.

Incentives for the use of national software

For many Argentine SMEs price is the most important argument influencing the decision on what systems to purchase. This is linked on the one hand with financial constraints and on the other with a lack of information on the possible utility to be derived from different software. The national supply, with its relatively low and graduated prices, adjusts to SMEs of different sizes. The prices for local services like software imple-

mentation, maintenance, and updates are also lower than those of the large international suppliers. The reason for this is, first, the distinctly lower wages commanded by skilled labor in the domestic labor market and, second, geographic proximity, which means shorter travel times and lower travel costs.

For Argentine demanders, Argentine software offers four advantages:

- The national systems are attuned to the national legal system (accounting) as well as national business practices (e.g. modes of payment). National suppliers guarantee quick adjustments to frequent changes in laws, in this way ensuring that their software is always functional.
- Geographic proximity and close relations between supplier and user permit a flexible technical service, in particular when the support is needed on the customer's premises.
- The variety of different management programs available make it possible for SMEs to select their systems in terms of their specific level of complexity and process computerization.
- Only for few branches of industry there are industry-specific systems available. Where this is not the case, the companies concerned are forced to have their own software departments program individual systems or have external (local) programmers work out customized solutions for them.

Obstacles to the use of national software

Companies dominated by foreign capital as a rule use little Argentine software. International corporations are interested in unifying their various national subsidiaries. They in this way elude the pitfalls of incompatible systems, which entail high costs for updating interfaces. Something similar can be observed in companies that work closely together with international customers. Suppliers tend to start using the systems employed by their major customers. They in this way comply with

customer demands or see system compatibility as one of their comparative advantages.

National software has less of a reputation than international programs. Accordingly, domestic demanders see the use of world-standard software as a strategic advantage in linking up with international markets. Furthermore, many demanders are sceptical about the survival chances of smaller national suppliers and for that reason put their money on the services offered by big international providers.

Moments of "inertia" in the software market

- Once a piece of software, of national or international origin, has been installed in a company, the user tends to avoid changing providers in order not to lose his "sunk costs". The latter are especially high when the systems concerned have been individually programmed or call for costly implementation or staff schooling.
- User information on the supply of software available is as a rule incomplete. Decisions on the use of software are often made on the basis of personal contacts, seldom on the basis of a cost-benefit analysis of all systems available.

We explained earlier that there are a number of incentives for domestic SMEs to acquire their

software locally and not from international suppliers. Conversely, however, this does not explain why it is that Argentine software suppliers sell their products and services almost exclusively in the national market and have not made a mark in the international market. Based on interviews with suppliers, we have drawn up an ideal-typical model of the development of software companies in Argentina; its aim is to explain the limited scopes of action open to them thus far (see Box 3).

This path dependency of companies entails an accumulation of comparative advantages in connection with interaction with customers of a specific type. Departure from the path once embarked upon to develop new markets and offer new products implies the eventuality of greater risks and need for greater investments. Even today the majority of Argentine software companies are unwilling to depart from the path once taken, the macroeconomic signals and the institutional environment providing neither adequate incentives to do so nor the framework required.

7 Analysis and assessment of the empirical results and conclusions

The Argentine industry's development perspectives are influenced by factors on the one hand associated with the skills and strategies of the

Box 3: Ideal-typical development of an Argentine software provider

1. Phase 1: Individual programming
Many software companies have started out by offering individual programming services for isolated customers. In some cases these are customers with whom these companies were previously in contact (e.g. in connection with business consulting activities).
2. Phase 2: Repeating and enlarging the scope of individual programming services
A company repeats individual programming jobs thanks to recommendations made by its original customer. In one or more branches of industry the company gains specific experience with the legal system and business practices typical of Argentina.
3. Phase 3: Increasing the number of employable modules
The repeated programming of solutions for comparable problems enables a company to reuse certain program modules, in this way lowering costs and increasing its number of customers.
4. Phase 4: Packaged or partially standardized products
Gradually, a company interconnects a number of reusable modules and develops standardized or partially standardized products that can be offered for sale in the market. These are products designed to address the problems of a given group of customers.

companies concerned and bound up on the other with institutional environment. We can here note both chances and challenges for future development.

Chapter 7.1 discusses influencing factors at the company level. They are mainly due to the present strategy of Argentine software suppliers, which involved gearing products primarily to the demands of domestic SMEs, in this way moving into national market niches. Even though this strategy may at first have meant competitive advantages, the narrowness of the Argentine market and the intensifying competitive situation are at the same limiting the future expansion potentials open to software companies. The challenge is therefore to diversify products and markets. As far as the institutional and technology-related company environment (Chapter 7.2) is concerned, the survey data indicate clear-cut deficits that are hampering the sector's dynamics. These include above all lack of access to adequate financing and the necessary know-how as well as the continuing unfavorable conditions involved in making reasonable use of telecommunications. Chapter 7.3, based on an analysis of these deficits, draws conclusions regarding Argentina's economic and technology policy.

7.1 Strengths, weaknesses, opportunities and threats for the Argentine software industry

Until now the Argentine software industry has mainly developed on the basis of close relationships between national software developers and users. These close links have given rise to many of the strengths of the national software industry. At the same time, though, the concentration of software developers on the domestic market and, above all, on the needs of SMEs constitute an obstacle to the development of high-grade, exportable products.

The domestic market offers Argentine providers of software a series of comparative advantages over their foreign competition. The prices of products and services are graduated in such a way

that companies with different needs and different levels of financial strength are able to procure systems here that address their individual problems. Furthermore, the supply is tailored to specific features of the Argentine market. This aspect is especially important in ERP-software that has to take account of, for instance, national tax laws, and special modes of payment. Flexibility is called for in that the country's tax laws are frequently altered. National suppliers are far better able to offer this feature than their foreign competitors.

Another element of "natural protection" is geographic proximity, which continues to be a great advantage for Argentine software providers. Though the last few years have seen the rise of online customer service, provided in the form of call centers and thus no longer dependent on spatial proximity, personal contacts are still essential in addressing customer problems where they occur. Here Argentine suppliers are faster and less expensive than their foreign competitors that do not maintain a support network of their own in the country. The essential strengths of the Argentine software industry can thus be summed up as including a high degree of adaptation to local needs in connection with high qualification levels on the part of their workers. The study also identified some specific weaknesses of the industry. These include in particular too little diversification of products and services, insufficient marketing, high wages, and a lack of spillover effects from FDI.

The fact that Argentine software companies are mainly geared to producing ERP-software has led to narrow product lines, mainly in the fields of accounting and personnel management. More specific applications, designed e.g. for process control in the agricultural industry or for managing large warehouses in the logistics industry, are not supplied by these companies.

Many companies work mainly or exclusively for SMEs for which price constitutes the crucial argument for purchasing a product or service and which, thanks to their limited access to funding and insufficient knowledge, demand little in terms of quality. The lack of a lead market of exacting customers runs counter to both supplier-side

learning processes and technological improvements, that might lead to international competitiveness. Due to the relatively high wage levels of skilled Argentine workers, the software industry will be able to penetrate international markets only on the basis of high quality and a high degree of innovativeness on the part of products and services alike.

The growing competitive pressure also makes professional marketing a *sine qua non* for successfully developing and defending markets. This fact has been neglected by Argentine companies, and at present only a limited number of such companies have a thought-through marketing strategy of their own. The consequence is that many potential customers are not adequately informed about the national supply of software.

facts only when their products need to be adapted to the needs of Argentine demanders and this work is done by domestic companies (e.g. implementation of SAP). Between the suppliers of program platform (e.g. Unix, Informix, Windows) and local companies that produce applications used in this context we can observe cooperation-based international relations that involve flows of technology-relevant knowledge.

Thus far Siemens is the only international IT provider that programs software in Argentine on a large scale. For 2001 Motorola plans to build a software laboratory in the town of Córdoba and the Japanese company NEC will settle in the province of Buenos Aires.⁷¹ In 1999 Siemens Argentina S.A. began establishing some subcontracting relationships for high-grade programming ser-

Box 4: Subcontracting relationships between Siemens Argentina S.A. and Argentine software companies

Siemens Argentina S.A. is a subsidiary of the German Siemens AG and is headquartered in the province of Buenos Aires. In 1998/99 ICT accounted for 50 % of the corporation's sales of US \$ 693 million. The company's R&D department presently employs 156 persons. This means that Siemens operates Argentina's largest software laboratory.

Ten years ago Siemens Argentina S.A. developed a so-called small digital exchange (SDE). The development work associated with this products, which was sold worldwide, accounted in 1997/98 for over 50 % of Siemens S.A.'s overall R&D.

When the SDE became increasingly standardized, Siemens looked for new business segments in the area of computerized solutions for telecommunications. In this context the Argentine subsidy is forced to compete for contacts within the Siemens corporation. The company's main competitive disadvantage is its development costs, which are high in international terms: the company's costs for a man-year in programming are roughly 100 % above those in India.

In order to be able to reduce development costs and respond more flexibly to smaller contracts, Siemens Argentina S.A. in 1999 began building subcontracting relationships with Argentine software developers. The advantages offered by these small companies consisted in their low overhead costs, their lean structure, and their high level of motivation in working together with Siemens. Problems do arise when unforeseen peak workloads occur that may go beyond the capacities of a small business.

Two pilot projects have been conducted thus far, and Siemens at present plans to build cooperative relationships with eight Argentine companies and two university departments. Siemens' future partners have experience in IT for telecommunications. For Siemens this means the ability to utilize specific skills and enter into a facilitated dialogue on technical problems. This presents these national companies with the opportunity to participate in worldwide contracts in developing telecommunications software as well as to use the learning processes involved to further build their own technological competence.

Thus far there have hardly been any spillover effects from major international suppliers to the Argentine industry. While the majority of the global players are represented in the country, they are, with few exceptions, merely represented by sales offices; and these give rise to learning ef-

fects, and this may lead to some important spillover effects (see Box 4).

⁷¹ La Nación, June 26, 2000.

Despite a number of weaknesses, the Argentine software sector has good chances for the future. On the one hand, a growing number of national SMEs recognize the importance of IT for their modernization processes. It may therefore be assumed that the domestic demand for business software will grow in scope. Second, Argentine software producers could profit from the new technologies and develop new business segments (e.g. Internet, ASP, customer-relation management, etc.). Furthermore, the expansive growth of the world market provides software producers with opportunities to build international alliances and subcontracting relationships.

Argentina will be able to make use of these potential chances only if it eliminates existing weaknesses and is not too slow to recognize the important risks in the international and national markets. Though there are a great number of comparable solutions in the world market, competition in Argentina is at present largely restricted to the national suppliers. This situation is changing, though, since the national market is coming under pressure from various quarters:

- Large international systems (e.g. J.D. Edwards, SAP), nowadays working with nearly all larger Argentine companies, are now gearing their activities to the segment made up of medium-sized companies.
- The same period is experiencing the beginning import of foreign products (e.g. from Spain) that are using low prices to compete in the small-business segment.
- New technologies are diminishing the advantage offered by geographic proximity of software providers to software demanders; what is meant here is, for instance, the possibility to update software via the Internet or for customers to obtain technical support via call centers.
- When national companies are purchased by foreign capital, they largely cease to be potential customers of Argentine suppliers, since the former are then under pressure to use internationally compatible systems.

Looking at the institutional environment, one of the strengths of Argentine industry is the country's supply of highly qualified workers. A scarcity of skilled labor, already taking on visible shape, threatens to be exacerbated by a brain-drain to the industrialized countries, where the demand for IT specialists is high. The wage increases induced in this way will have negative impacts on the industry's competitiveness. Table 12 provides an overview of the strengths, weaknesses, opportunities, and threats with which the Argentine software industry is faced.

7.2 Deficits in the institutional environment

With an eye to working out recommendations on how the Argentine public sector, possibly in cooperation with bilateral and multilateral development organizations, can maintain and further develop the existing technological competence in software, the study group interviewed companies on their assessment of the support they receive via sectoral policies and institutions. We can sum up our findings in the following picture:

In the past the software industry developed without any external sources of funding. Funding for both startup and growth was financed from the resources of partners or shareholders or from retained earnings.

- Most such companies are satisfied with the training levels of Argentine software engineers, though rising wages are increasingly leading to problems for the industry's SMEs. The latter are often unable to pay the wages demanded, and they thus have difficulties retaining their staff or recruiting new specialists.
- Although the situation has recently shown signs of improvement, the high costs for telecommunications services continue to be named as a central obstacle to development.

Table 12: Strengths, weaknesses, opportunities, and threats with which the Argentine software industry is faced	
Strengths	Weaknesses
Business software adapted to the needs of national SMEs.	Argentina's software supply is underdiversified, there is a lack of specific solutions; what is lacking to come up with such solutions is the required critical mass of major customers.
The graduated prices involved are attuned to the financial strengths of different companies.	Adaptation to a non-exacting demand impedes learning processes and limits competitiveness.
Geographic proximity is important for customer service.	Many companies in the sector lack marketing competence.
Software adapted to the national legal framework as well as to local business practices, quick updates available when laws are changed.	In international terms, wage costs for IT specialists are very high in Argentina.
Qualification levels of Argentine IT specialists are high in international terms.	Thus far FDI has not given rise to any palpable spillover effects.
Future chances	Risks
There is still room for domestic demand to grow, a rising number of SMEs recognize the importance of software for modernization processes.	The domestic market for business software has natural limits.
The growing demand for software in the international market offers Argentine software developers the possibility to export their products and services.	International suppliers are increasingly competing for the business of Argentine SMEs.
There exists an international trend toward building alliances and subcontracting relationships.	The advantage of geographic proximity is losing its significance due to technological developments.
New technologies create new business segments and facilitate access to external markets.	Takeovers of Argentine companies by foreign capital diminish domestic linkages.
	Brain-drain is reducing the supply of qualified IT specialists.

Access to financial resources

Independently of industry, location and life-cycle phase, access to the credit market and to venture capital continues to be a general problem with which Argentine SMEs are confronted.⁷² Own capital, stemming in particular from retained earnings or funds provided by partners, continues to be the main source of funding for SMEs. In addition, customer payments and bills of exchange play an important role in procuring liquidity. But these funding options are very limited, a fact which makes it impossible for such companies to make all of the investments required. The software industry, marked as it is by a high percentage of small businesses, is strongly affected by this problematic. The empirical study shows that most of the companies interviewed were in a position to finance neither their startup phase nor their growth phase with the aid of external capital. In 92 % of cases startups were funded with funds provided by partners or family members. 56 % of

all companies see funding as the most important bottleneck in the startup phase. Others in turn regard startup funding as no major obstacle in that the startup phase of a software company does not as a rule call for large investments. The growth phase is for the most part financed via retained earnings. Due to the strong links between a software company's investment options and its current earnings situation, resources are often lacking for important investments in product innovation, marketing, and sales.

The inadequate access of many software companies to medium- and long-term loans is due to two causes. First, high interest rates on loans, stemming from relatively high bank refinancing costs and a high risk premium, mean high payment schedules for software companies. Second, small and medium-sized software companies are unable to provide the tangible security required. Non-physical assets such as knowledge and established clientele are not accepted as security. In some cases entrepreneurs have obtained loans as private persons, using their personal assets as a mortgage.

72 Yoguel / Moori-Koenig (1999), p. 69.

The majority of our companies (54 %) see the inadequate supply of credit as an important obstacle to development. Many companies that regard access to the credit market as problematic indicate that their development would be substantially more dynamic if they were able to fund their activities via external financial resources. Some companies even stated that, due to the lack of financial resources, they have been unable to take on certain customer orders.

At the same time, 26 % of the companies interviewed stated that the lack of access to the credit market posed no problem for them. Many of these companies have never applied for a loan. The low level of willingness to take out loans is above all due to the risk of indebtedness as well as a lack of confidence in the country's economic stability.

The Argentine market for venture capital so continues to be underdeveloped in spite of first signs of improvement. The most important developments in the venture-capital market include:

- the entry to the market of international capital funds like Chase Capital Partners and Lat-Cap;
- an expansion of the informal capital market due to new private investors (business angels);
- the development by the de la Rúa government of new programs designed to promote funding via equity capital

Despite these new developments, access to venture capital continues to be problematic for SMEs and thus at the same time for most software companies. There are institutional deficits that present additional obstacles to the access of software companies to venture capital:

- The local financial sector has no experience in appraising software companies and projects and is therefore unable to assess these companies' potential risks and anticipated earnings.
- Argentina still lacks a stock exchange at which shares of technology-based start-up companies could be traded. The lack of exit options via issues of stock lowers the willingness of capital-holders to invest.

More than 40 % of these companies regarded the inadequate access to the venture-capital market as a crucial development handicap. We furthermore noted that a number of these companies were unfamiliar with the concept of and the benefits associated with funding via venture capital. Only one of the 58 companies interviewed had financed its growth with the aid of a North American venture-capital fund.

The Argentine government and international organizations are attempting to use various instruments to remedy these funding problems encumbering SMEs, and in particular technology companies (see 4.3). It should, however, be noted that only two of the companies interviewed indicated having received any form of public-sector subsidies.

Access to technological know-how

The access of Argentine software providers to know-how is determined by two factors: first, the education and training system that supplies such companies with qualified manpower; second, universities and other public research institutions and the cooperative relations they maintain with the private sector.

As regards the labor supply, the interviews with software companies indicate that training quality is on the whole satisfactory, though there are more and more problems involved in obtaining highly qualified IT specialists. There are three reasons for this:

- First, while Argentine universities offer 139 courses of studies in IT with various major fields, only a limited number of these courses have sufficiently qualified teaching staff.⁷³

⁷³ Argentina's universities offer 57 courses of study that take five years and are concluded with a degree or engineering diploma. Another 82 courses of study take three or four years and train technicians and programmers.

- Second, a large number of IT students drop out without a degree.⁷⁴ This is attributed to inadequate school training in mathematics, for which reason a large percentage of students fail their intermediate examinations. On the other hand, there is great demand for IT students in the labor market. The high salaries offered in the private sector attract many students to take a job before concluding their course of studies.
- Third, the high demand stemming from firms leads to a lack of researchers and teaching staff at universities, and this in turn makes it more difficult to offer sufficient courses of study with exacting curricula. The earnings possible for IT specialists vary extremely between universities and the private sector. To generate a scientific community in Argentina that engages in R&D, imparts exacting curricula, and trains a greater number of highly qualified IT specialists, the country would need a critical mass of some 300 IT specialists with PhDs.⁷⁵ At the end of 1999, however, only 38 IT specialists with PhDs taught at Argentine universities.

In substantive terms, the majority of software companies interviewed expressed their satisfaction with the training of the staff they recruit, criticizing only in isolated cases a lack of practice-mindedness or a marked academic orientation on the part of their new recruits. At the same time, many companies criticized the fact that the low number of IT graduates makes it increasingly difficult for them to cover their demand for qualified personnel. We can differentiate here in terms of company size and company location. Large companies that have high sales figures and are located in Buenos Aires presently have good prospects of recruiting qualified new personnel. Difficulties in recruiting qualified manpower are reported by smaller companies, in particular those

located in the interior of the country. It is these companies that are, in view of a growing scarcity of specialists, unable to offer attractive working conditions and the salaries to go along with them.

The Internet boom of recent years is exacerbating the problem by raising the demand for software engineers with knowledge of the newest programming languages. This is leading to a pronounced rise of salary levels in this field. It is precisely at this qualification level that the lack of manpower is evident. Multinational corporations and international headhunters recruit the year's best IT graduates directly at their universities. Argentine SMEs are largely unable to compete with the conditions they offer.

Argentina's universities lack experience in scientific cooperation, in particular at the international level. One reason for this is that IT research was relatively late to get underway in Argentina.⁷⁶ Many universities have recognized the relevance of an international orientation and are launching cooperative projects with universities abroad. Two initiatives will be presented as examples here.

The University of Buenos Aires (UBA) has built up contacts with researchers from other countries in connection with its PhD program in computer sciences, which is partially funded via the FOMEC.⁷⁷ This program includes joint research projects, invitations to foreign guest professors, and support for PhD students by universities abroad. The National University of La Plata (UNLP) is also intensifying its international cooperative ventures in applied research; its partners include some EU countries.

The Argentine side has a twofold benefit from such cooperative ventures. On the one hand, these make it possible to prove specialist training for the

74 One university interviewed indicated that no more than 7 % of new student actually go on to get a degree.

75 This is the assessment of an interviewee from the Universidad de La Plata, one of Argentina's most renowned IT training centers.

76 It was only in March of 2000 (!) that Conicet, the national research council, first recognized informatics as an independent discipline.

77 *Fondo para el Mejoramiento de la Educación Científica*, a World Bank fund designed to improve the level of scientific training in Argentina.

persons involved, especially PhD computer scientists active in research. At the same time this cooperation is instrumental in transferring knowledge on up-to-date technological standards and innovations in IT. The main quantitative restriction on these cooperative ventures is the lack in Argentina of enough highly qualified scientists and researchers to make up a critical mass.

Thus far cooperative relationships between national universities and the private sector are extremely weakly developed. There are three main reasons for this:

- First, university research is not sufficiently geared to the needs of the private sector.
- Second, many universities are plagued by bureaucratic obstacles and procedural intransparency.
- Third, thus far the private sector has also been somewhat remiss in demanding R&D services from the universities.

Some first initiatives are conserved to more strongly integrate universities and the private sector. These efforts include internships, scholarships involving theses written in cooperation with the private sector, and attempts to attract teaching staff from the private sector.

Thus far, however, these initiatives have been more or less patchy, there is no strategic approach to strengthening the cooperative relations between universities and the private sector. Hardly any cooperative international ventures in R&D that include private firms have emerged thus far.

Telecommunications costs

One consequence of the privatization of state-owned companies has been intensified domestic competition in the telecommunications market. But since regulation was neglected, the outcome was a costly private monopoly which meant, initially, sharp price rises for services previously

provided by the public sector.⁷⁸ Toward the end of 1999, though, work was begun on further deregulation of the telecommunications industry. Subsequently the rates for telecommunications services have already noticeably declined. The prices for long-distance national calls have declined by up to 56 %, international calls by up to 50 %.⁷⁹ In 2003 local calls are also set to be offered by new competitors as well.⁸⁰

A high percentage of the companies interviewed continued to regard the telecommunications costs as too high. These costs represent a burden to those companies in particular that also offer after-sales and consulting services. One company interviewed indicated that its telecommunications costs account for 30 % of its sales revenues. In individual cases companies also referred to technical problems with the service caused by insufficient connections to networks in remote areas or inadequate access to broad-band lines, which is essential for use of the Internet.

Additional obstacles stemming from the institutional environment

In the survey the software companies pointed to further institutional obstacles that restrict the possibilities of any dynamic business development.

As noted above, the Argentine software industry is primarily oriented toward the domestic market and accordingly neglects **exports**. On the one hand, there are product-specific reasons for this: for instance, customized software has to be adapted to country needs. While this means a "home advantage," or a kind of "natural protection," in the domestic market, it on the other hand constitutes an obstacle to exports. If a program is to be exported to a non-Spanish-speaking country, this means costs for translation. Deficits in the

78 IMF (1998), pp. 5-6; Pastor / Wise (1999), pp. 487-489.

79 La Nación, April 21, 2000, p. 2.

80 Interview with Jorge Fontanals, Secretaria de Ciencia y Tecnología (SECYT), Jan. 18, 2000, Berlin.

institutional business environment also contribute to impeding exports:

- There are no special programs designed to finance export projects.
- The lack of specific incentives, promotion, and consulting services put Argentine companies at a disadvantage. Competitors e.g. from Chile and Brazil benefit strongly from their countries' export-promotion programs.
- There are bureaucratic problems, e.g. there are considerable delays in obtaining refunds of the value-added tax. There is a lack of special arrangements for the export of services.
- It is still difficult and expensive to make international money transfers.
- There is a lack of specific information on demand, markets, specific regulations, and quality standards in other countries.
- It is difficult both to build contacts with potential sales partners and to advertise abroad.

Software piracy

Argentina is marked by a high rate of pirated software. Estimates proceed on the assumption that 62 % of all programs installed are illegal. This figure is far above the world average, which was reduced to 32 % in recent years. Pirated copies caused the software companies active in Argentina total losses of US \$ 123.8 million in 1998.⁸¹ The Chamber of the ICT sector (*Cámara de Empresas de Software y Servicios Informáticos*, CESSI) recently managed to get the intellectual property rights to software recognized in Argentina. Since then software piracy can be prosecuted as fraud and punished by up to six years of imprisonment.

The survey of software companies indicates that software piracy is indeed perceived as a problem in Argentina. This is true above all in connection with the bad reputation the country is earning

abroad, a factor that could discourage international investors from developing software in Argentina. Despite the evidence, the majority of the companies interviewed are not confronted with the piracy problem as far their own programs are concerned. Only 24 % stated that their software had been illegally copied. The reason for this is on the one hand that many companies work with practically unbreakable security systems and on the other hand that the problem is relevant only for some suppliers. The programs most prone to piracy are packaged programs, not so much software that needs extensive adaptations to specific customer needs, must be updated on a continuous basis, or that calls for a high level of customer support.

7.3 Conclusions for Argentine policy

We can use the strengths, weaknesses, opportunities, and risks identified here to derive recommendations for Argentine policy. The underlying assumption is that the aim pursued is to safeguard, enlarge, and further develop existing competence, firms, and jobs in the field of software development.

Financial system

The empirical study shows that the Argentine financial system does not provide sufficient financial resources for SMEs in general and for software companies in particular. Government can encounter this problem by measures in the credit and the venture-capital market.

Two measures could be used to increase the volume of financial resources in the credit market.

- First, banks should be encouraged and advised not to make the loans they grant contingent solely on tangible security and guarantees but to seek their point of orientation in the anticipated earnings of SMEs (downsizing). This reorientation should apply both to SMEs in general, whose productivity would be raised by the credit-financed procurement

⁸¹ see www.legalsoftware.org.

of hard- and software, and to software companies in particular, whose "securities" rest in their intellectual abilities.

- Second, government guarantees could increase the willingness of banks to include software companies in their credit portfolios.

Political decision-makers have three possible fields of action open to them to increase the financial resources available in the venture-capital market.

- First, it would be essential to further pursue the most recent approaches to building a technology stock exchange modeled, e.g. on the US Nasdaq. It would be necessary to set up a secondary market, i.e. a stock-market segment to trade the stock of infant technology companies as a means of ensuring the reflux of invested capital.
- Second, the public sector can assume a direct role in allocating venture capital. One possibility that should be looked into is allotment of funds to venture-capital organizations that accompany the startup phase of software companies. One particularly important aspect of government action would be support for seed and startup funding, because in these phases private investors are often unwilling to take the high risks involved in placing their capital at the disposal of newly founded companies.
- Third, the public sector could use fairs, competitions, and tax breaks as incentives to broaden the base of venture capital. Startup fairs would be a good way to better familiarize software companies with the benefits and possible uses of venture capital. Competitions calling on software companies to present their business ideas could award the winners startup capital as prizes. Tax breaks for investments in relevant funds could contribute to bolstering the supply of venture capital.

Supply of qualified labor

In spite of training of good quality, Argentina even today lacks the highly qualified, college-trained IT specialists needed to cover the demand of software companies. This bottleneck could be aggravated in the future if the national and international demand for IT specialists grew more rapidly than the national supply due to dynamic growth of the international software market. If a sufficient number of IT specialists are to be available in Argentine in the future, it will be necessary to invest heavily in IT training at public universities. Three measures could increase both the quantity and the quality of training.

- First, the number of teaching staff and PhD candidates should be increased as a means of raising the personnel strength of public universities and, accordingly, the number of graduates.
- Second, in view of the relevance of training and knowledge as resources essential to Argentina's future development, it would be advisable to raise the salaries of teaching staff to levels ensuring at least a reasonable living standard and making a career in teaching and research more attractive to qualified graduates and PhD.s.
- Third, scholarship programs could be used to make academic training accessible to more young people. Socially less well-off population groups are at present clearly underrepresented at universities in Argentina. This disparity is at odds with the ideal of equal opportunity for members of different social strata. On the other hand, Argentina's education/training system is losing important human resources. One possibility would be specific scholarships for IT-relevant disciplines, e.g. computer science, electronics, or mathematics. The issue of funding could be addressed by the public sector as well as via full or partial contributions provided by the private sector. This might also include international software corporations that would at the same time benefit from graduates of the Argentine education/training system.

Research and development

Both the private and the public sector of the Argentine system of innovation are marked by grave deficits, including in particular a low propensity to innovate on the part of firms and an inadequate public research system.⁸² Since 1996 Argentina has developed or reformed and focused a number of modern instruments of technology policy (see 4.3). These are in principle suited to strengthening the country's innovation system, though these instruments should be more consistently geared to the specific givens encountered in knowledge-intensive services and would have to be endowed with greater financial resources. The public sector could become active here in four specific areas:

- First, it could stimulate R&D in the private sector. International experience shows that tax incentives and some subsidies can be used to increase the willingness of companies to engage in R&D as well as to innovate. FON-TAR's "*Crédito Fiscal*" could be used to stimulate development projects in the IT sector, indeed it has already done so in individual cases in connection with three initial competitions.
- Second, government can improve the public sector's IT research capacities. This would require on the one hand increased investment in computer-science faculties on the one hand and possibly concentration on faculties with a comparatively good record. On the other hand, the possibility of developing a public institute for applications-related IT research should be looked into as soon as the human resources available are sufficient for the purpose. The starting point here could be the microelectronics department of the *Instituto Nacional de Tecnología Industrial* (INTI). In addition, contracted university research should also be facilitated. This could be done by setting up university-level R&D institutes.

- Third, political decision-makers can encourage cooperation between public and private actors within the national system of innovation. In FONCyT's *Programa de Investigación y Desarrollo*, Argentina's technology policy is already in possession of a relevant instrument. It would, however, be important to determine why it has until now been mainly outside institutions, and rarely private firms, that have contracted for R&D projects at universities and research institutes.
- Fourth, in view of a very underdeveloped R&D tradition, the Argentine public sector could harness its demand power to induce innovative projects. In a manner more targeted than in the past, it could identify areas in which there is a need for R&D to modernize administrations and public services, e.g. in the health sector or in traffic-guidance systems. The R&D projects decided on could be advertised through a system of transparent and public competitions. The offers received could then be reviewed to find the most suitable proposals and to publicly fund the R&D projects selected. The propensity of public and private actors to cooperate can be boosted by making such cooperation an element of project evaluation in competitions. In the case of complex solutions it would also be possible to seek the participation of international partners.

Promotion of business startups

Aside from the provision of venture capital to start up technology companies (see above), the public sector has four further possible approaches to accelerating the rejuvenation of company structures:

- First, the government could adapt its tax legislation to the needs of infant technology companies. It could, for instance, grant one or more years of tax exemption for the early phase of a company's development.
- Second, the public sector could initiate start-up fairs for technology companies that bring software companies together with financial institutions, business consulting firms, and potential customers.

⁸² Worldwide, all Latin American countries have poor values on innovation-relevant indicators. See Stamm (1999).

- Third, the public sector could participate in private startup parks for technology companies, or indeed initiate them itself. Universities should be involved in giving concrete shape to such startup parks. Startups could be facilitated and the survival chances of infant technology firms improved by means of rent subsidies, provision of technical infrastructure (e.g. permanent, dedicated lines) and consulting services (e.g. assistance in preparing businesses plans).
- Fourth, Argentine universities could look into possibilities to participate themselves in startups. Stanford University in California is presently operating a model of this kind. Both government and universities would have to develop incentive systems that make commitments of this kind financially and/or scientifically rewarding and at the same time avoid any moral hazards.

Internationalization

One means of supporting the internationalization of the software industry would be to give careful consideration to five support instruments. Aside from the "classical" instruments of export promotion, the software industry's specific features also call for new instruments geared to promoting in particular linkages with demanding international corporations.

- First, classical instruments could be used to enable market-oriented institutions to coordinate and support visits to fairs.
- Second, the classical means of export-financing could be used to pave the way for larger investments. The latter are necessary to develop external markets, to adapt software to specific national conditions, and to engage in the necessary marketing activities. Specific credit lines are needed to make this first step into external markets possible for software SMEs. Together with the *Banco de Inversión y Comercio Exterior (BICE)* and the *Banco de la Nación*, the Argentine export-promotion

organization *Export Ar* is seeking to improve the supply of export loans.⁸³

- Third, one new instrument might be seen in the possibility of promoting alliances, joint ventures, and subcontracting relationships with leading corporations active in the sector. In many cases a successful export strategy calls for partner companies on the ground as a means of tackling the required adjustments to the national conditions of the target country concerned and to organize marketing. Competitive advantages can also be attained via a functionally specialized programming of different modules. Since the transaction costs involved in building up international cooperative efforts of this kind are prohibitively expensive for Argentine software suppliers, institutional support, e.g. by the chambers of trade and commerce, would constitute an appropriate approach to promoting the export orientation of software companies.
- Fourth, it would be possible to create intermediary institutions that are close to the market and could explore the chances of exports and cooperative ventures in the major markets. In view of the continuing lack of a sufficient critical mass, such agencies would have to mediate generally technology-related cooperative ventures between companies and not only in the field of ICT. The demand for these services would, as is shown by international experience, have to be subsidized for a certain period of time.
- Fifth, it would be possible to increase the willingness of foreign software companies to cooperate with local companies if the latter were certified as per ISO 9000 or the Capability Maturity Model (CMM), in this way enabling outsiders to clearly assess their quality standards. Here, too, the possibility of a partial subsidization of certification should be looked into.

83 La Nación, April 18, 2000, pp. 10f.

Promotion of foreign direct investment

Desirable technological spillover effects from foreign direct investors, e.g. in connection with the outsourcing of programming jobs by multinational corporations, have thus far been very limited in the Argentine software industry. The greater part of foreign direct investors in Argentina's software industry are pure marketing organizations. Most of the software sold in the Argentine market is developed abroad. While the Siemens software lab in the province of Buenos Aires and Motorola's investment in Córdoba are noteworthy, they can not obscure the fact that in international terms Argentina offers few locational advantages (training levels, membership in MERCOSUR) and that the country's high cost levels constitute a crucial disadvantage for FDI.

Thus far Argentine policy has not sent out clear-cut signals indicating that the long-term significance of information technology has been recognized and that the country is set to expend more effort in seeking its place in the international division of labor in the field of software development. While the de la Rúa Government set up a subsecretariat on the information society, its activity is largely restricted to accelerating the pace and widening the scope of Internet use in Argentina. An improved position in the international competition for FDI would, however, presuppose that the corporations courted could assume that locational conditions will improve in Argentina over the long term and that the government is prepared to use more and more social inputs geared to fostering competence in this key technology.

Due to its wage costs, high in international terms, Argentina must work to build a manpower base in IT that is capable of offering high-grade and creative programming services if the country is to become interesting as a potential location for multinational corporations. At present Argentina still assumes a medium position, bordering on the lower end on countries like India, but without yet reaching the level of the industrialized countries at the upper end. The core of a highly qualified, FDI-oriented strategy must consist in a targeted increase in specific inputs, i.e. Argentina must invest more in training and R&D in the field of

information technologies. In view of the scarcity of public resources this would mean a conflict-laden reallocation of resources, e.g. within public universities. In addition, the telecommunications market would have to be consistently further developed in order to ensure that multinational corporations will find an adequate infrastructure here.

Support of SME demand for software

At present only a small percentage of Argentine SMEs are using modern technologies and software. To promote their modernization entails a twofold benefit. On the one hand, it would increase the competitiveness of SMEs, making their survival more likely in an atmosphere of growing competitiveness; and it would on the other hand stimulate the IT market. In view of the market-mediated orientation of SMEs toward national software providers, this would above all mean boosting the demand for products produced nationally. Proceeding from existing programs and institutions, we can specify three measures that could be used to promote the modernization of SMEs and the use of IT:

- First, government could promote the procurement of hardware as a base on which the use of software in SMEs could build. The subsidized credit lines provided by the *Banco de la Nación* for this purpose as well as the "100 000 PCs" program recently launched by SETCIP in 2000 point in the right direction.⁸⁴
- Second, financial support could be provided for counseling on the use of software provided by consulting firms. Promotion of this sort could, for instance, be carried out in the framework of the Sepyme's *Programa de Apoyo a la Reestructuración Empresarial* (PRE). It provides a 50 % subsidy for consulting services used in connection with company modernization processes.

⁸⁴ The program grants private persons and firms PCs and access to the Internet at particularly favorable conditions.

- Third, efforts could be undertaken to improve the transparency of the software market. The chambers of commerce could play an important role in the task of matching between supply and demand.

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