Working Paper Number 14

Technology Development in Transition – The Case of Hungarian Industry

Henny Romijn*

The reform of 1989 exposed Hungarian industry to foreign competition and confronted it to the loss of the vast and undemanding COMECON market, the withdrawal of public support and the need for privatisation. Based on twenty-four interviews in pharmaceutical, electronics, automotive and textile companies, this paper gives insight into the efforts made by Hungarian industry to upgrade its technology in response to these pressures. The patterns found reflect the shift away from the old strategy of autarchic imitation of western technology based on own research and development towards catch-up through acquisition of western product and process know-how. The firms' modernisation activities were heavily driven by foreign investment and financial support from public agencies, but there are drawbacks associated with both, especially foreign investment which has in some cases contributed to the erosion of indigenous research capability. Science and technology institutions played an important role in the upgrading of industrial technology before the reform, but linkages with industry have eroded in the 1990s as a result of the drastic decline in state funding for science and technology and the financial crisis in industry. Financial support from the European Union for science and technology in the sample firms is reviewed and a number of suggestions are made for its improvement, so as to better reflect Hungary's current needs in the context of its increasing integration with the European Union.

February 1998

* Queen Elizabeth House, University of Oxford,

and Development Research Institute, Tilburg University

1. INTRODUCTION

Economic integration with the European Union has been high on Hungary's agenda since the reform of 1989 that heralded the end of central planning and exposed the economy to international competition. An Association Agreement with the EU came into force in March 1992, under which all trade barriers will be progressively eliminated and which is expected to pave the way for full membership.[1] The EU accounts for a steadily growing share of the country's imports and exports and it has already become the country's largest trading partner, accounting for 63 per cent of its exports and 60 per cent of its imports in 1996 (Ministry of Finance, 1997).

Clearly, Hungary's future economic well-being will hinge on its ability to tap into western markets. With just over ten million people, its domestic economy is too small to generate substantial economic growth, while its former markets in Eastern Europe have largely fallen away after the collapse of the COMECON in the early 1990s. It is also evident that a drastic technological upgrading of Hungary's industrial capacity will be required if its industries are to be successful in finding niches in the fiercely competitive EU market. The country was among the technically most advanced members of the COMECON, but a combination of protection, lack of competition and soft budget constraints as a result of pervasive state ownership bred inefficiency, lack of quality consciousness and resistance to innovation. In the face of the sudden exposure to competition from western producers, there is now a real danger that its industrial sector will slide back into production of comparatively low value added, labour- and natural resource-intensive items with poor long-term prospects, becoming a manufacturing backyard for foreign investors intent on using a cheap and educated labour force close to their main markets.

Using case study evidence from twenty-four industrial firms collected in 1996, this paper explores the nature and the extent of the technological restructuring efforts that have been taking place in Hungarian industry, and brings out the main constraints that have held it back.[2] Its findings illustrate that there are a number of structural problems emanating from the old economic regime which must be addressed by means of active support for science and technology development during the transition process. The standard recipe of macro-economic liberalisation and privatisation will not by themselves set the economy on the right track for

long-term growth.

Section 2 is a brief introduction to the Hungarian economy before and after 1989, which provides a general context for the rest of the paper. Section 3 introduces the sample industries and the firms chosen for the study. Section 4 briefly outlines the major changes in the incentive climate for technological development after 1989 as the sample firms experienced them. Their perception of those changes has conditioned their technology response during the early years of the transition. The nature of that response is the subject of section 5. Section 6 is concerned with the firms' problems and benefits associated with institutional collaboration and EU support. Section 7, finally, discusses the implications of the study's findings for technology policy and the support received from the EU in the context of Hungary's evolving European integration.

2. THE CONTEXT

Hungary emerged from the communist period as one of the economically and technologically most advanced countries in Eastern Europe. In particular, it had built up considerable expertise in manufacturing, including several branches of engineering, and it conducted much R&D. There were also reasonably intensive trade links with Western Europe in comparison with other socialist countries in the region. Strict Soviet-style central planning was only practised for a relatively brief period (1948–68). In 1968 the New Economic Mechanism was adopted which heralded some degree of decentralisation in decision-making by replacing physical planning by indirect price-based planning.

Yet, that reform left the main tenets of socialist economic management intact and therefore it could not fulfil most of its aims (Swaan and Lissowska, 1996). Just like the other centrally planned countries in Eastern Europe, Hungary began to suffer increasingly from the stifling effects of excessive bureaucracy and lack of market incentives, leading to inefficiencies in production, bad quality of output, lack of innovativeness and technological backwardness in general. Even though much emphasis was placed on formal independence of enterprises, state ownership remained intact and their budgets continued to be negotiable. A complicated system of firm-specific taxes, subsidies and credits, aimed to favour industries of national importance or with clout, greatly distorted the role of prices as guides to efficient resource allocation and reduced profit-making incentives. State regulation of domestic markets and foreign trade

induced excessive specialisation, high degrees of vertical integration and organisation into very large-scale unwieldy production units, in which managers and trade unions retained very influential positions. In addition, monopolistic state-trading corporations prevented firms from obtaining technological information and marketing skills through direct exposure to western markets. Importation of modern engineering technologies was also cumbersome for political and military reasons (due to COCOM restrictions) (Romijn and Taksz, 1997).

The oil price increases of the 1970s exacerbated the effects of these systemic internal problems, resulting in a slow-down in economic growth, increasing inflation and a growing dependence on western credits which led to an ever worsening balance of payments deficit. Piecemeal reforms were introduced from 1982 onwards in response to the deteriorating situation, in an attempt to improve the competitiveness of industry. The scope of activities that state-owned enterprises were allowed to undertake was legally increased. Autonomy was promoted, and the dominating influence of the various branch ministries curtailed, through the introduction of so-called enterprise councils in 1985. Some large enterprises obtained direct foreign trading rights. There was a tax and banking reform and a price liberalisation

programme, and western company forms became legal after 1988 (Swaan and Lissowska, 1996; Romijn and Taksz, 1997). But it was only in 1989 that the country completely abandoned the socialist principles of economic management and central political control. A radical economic, political, and institutional transformation was embarked upon, aimed at establishing a market-based economy with a western-style democratic system of government, to be achieved through economic liberalisation, privatisation, opening up to foreign trade and investment and radical institutional reform.

Even though economic reform in Hungary had a long history and is often referred to as ‘gradualist’ in comparison with other former Eastern European countries, the changeover in 1989 was experienced by many as shock therapy. Many firms were unable to cope with the sudden exposure to western competitors with modern products and effective marketing techniques, the loss of the vast and undemanding COMECON market, the exigencies posed by privatisation and the simultaneous withdrawal of public support. At the same time, effective government policy to manage the restructuring process was severely constrained in the initial transition years by heavy external debt, a high and rising current account deficit and a high fiscal deficit, which deteriorated further due to the economy’s worsening economic performance (see Table 1). Real GDP, which still grew about 2 per cent during the 1980s, was

in decline from 1990 to 1993. In the worst crisis year (1991), it contracted by about 8 per cent. From 1994 onwards GDP has grown, but only modestly. Employment has been declining substantially since 1989. The unemployment rate has now stabilised at around 10 per cent, but this is largely due to falling participation rates. Employment continues to contract in absolute terms, albeit at a slower pace than in the early 1990s. Inflation has hovered between 20 and 25 per cent, contributing significantly to an erosion of real incomes (OECD, 1997). In March 1995 the government found it necessary to adopt a new stabilisation package aimed to bring down the severe external and fiscal imbalances and the inflation rate, involving devaluation, fiscal restraint and reductions in the government's wage bill. As a result, real wages declined by 7 per cent in 1995 and 3 per cent in 1996, contributing to a collapse in domestic demand.

Table 1: Hungary – selected economic performance indicators, 1992–6

(Percentage change from previous year, in constant prices)

	1992	1993	1994	1995	1996 (est.)
GDP	-3.1	-0.6	2.9	1.5	0.8
Private consumption	0.0	1.9	-0.2	-7.1	-3.0
Government consumption	4.9	27.5	-12.7	-4.1	-3.0
Gross fixed investment	-16.4	-5.6	10.9	2.2	N.A.
Exports of goods and services	2.1	-10.1	13.7	13.4	13.0
Imports of goods and services	0.2	20.2	8.8	-0.7	6.5
GDP price deflator	21.5	21.3	19.5	25.6	20.9
Unemployment rate	9.9	12.1	10.8	10.3	10.0

Source: OECD (1997), Tables 1 and 2.

So far, economic growth has come entirely from external sources, namely a combination of strong foreign investment inflows and strong export growth. Hungary has attracted the largest inflow of foreign direct investment among the former communist countries. In the early 1990s, foreign investors interested in establishing new companies could take advantage of favourable tax regulations. In addition, many foreign companies took over going concerns that were undergoing privatisation. The country's favourable export performance is driven primarily by those foreign-owned firms, which are in a good position to

take advantage of the dramatic decline in real unit labour costs, both in forint and US dollar terms. In addition, exporters benefit from a variety of export promotion measures, including export credits, other interest subsidies (for SME specifically), the right to reclaim import duties, preferential tax treatment, and price subsidies on agricultural exports (OECD, 1997).

The country has undoubtedly overcome its worst transition problems. The privatisation process is in an advanced stage, and the banking system is now in a good shape. Considerable progress has also been made in terms of institutional reform. However, as long the country's main source of international competitiveness continues to lie in declining real wage costs resulting from inflation and devaluation (and is primarily conceived of in those terms – see e.g., OECD, 1997), fundamental issues obviously remain to be addressed. In the longer term, economic dynamism must come from 'real' competitiveness – the capability to initiate and manage continuous technological and organisational improvement that will lead to the manufacture of high quality products with modern designs and an increasingly efficient manufacturing base. Foreign investment may give a boost to the development of such competitiveness, but other actors in the national economy must also be involved – these include domestic firms, both large and small; public and private science and technology institutes; and academic institutions. It is only through the establishment of a truly national innovation system with extensive interlinkages that the country will be able to establish a broad-based technological dynamic of its own. The case study in the rest of this paper assesses the recent economic transformation of manufacturing enterprises in Hungary from this perspective. It outlines the major problems they have experienced in the restructuring of their science and technology activities in the first half of the 1990s, and suggests policy measures that could contribute to the improvement of Hungary's national innovation system.

3. THE SAMPLE

The study on which this paper reports consisted of a series of interviews with twenty-four firms in pharmaceuticals, textiles, electronics and automotive production.[3] These industries were chosen because of their importance for the national economy and their different technological and market characteristics and prospects for future growth.

The **pharmaceutical sector** is one of Hungary's technologically strongest sectors (Karsai, 1995). The leading firms were established as private companies in the early years of

this century, and were nationalised at the onset of the socialist period. Production and R&D concentrated in seven companies that each specialised in different fields designated by the government. The sector flourished due to the poor health of Hungary's population and high state subsidies for health care. In addition, the sector became a major supplier to other COMECON countries (Oxford Analytica Daily Brief, 11 July 1996). The impact of the reform has been drastic because of the influx of powerful multinationals and a wholesale reform of the health care system. Yet, the firms have weathered the changes reasonably well because they had considerable reserves and were technologically capable. The sector is expected to continue to play an important role in the post-reform era.

Three pharmaceutical firms are represented in the sample.[4] Two large leading players make final drugs and active ingredients, and one smaller company specialises in laboratory chemicals and medical diagnostics. The two large companies have recently been taken over by French investors, and the smaller firm by a domestic private investor.

The **electronics sector** emerged in the late 1960s. It grew into a sizeable industry during the socialist period, consisting of about 100 state-owned companies at the onset of the reform. Telecoms was the most important subsector with about 30 per cent of total turnover, but a number of other items were also produced, such as measuring instruments, electronic components, data processing equipment, industrial devices, consumer items, medical instruments and office equipment (Pal, 1988). However, technology lagged well behind the international frontier, and the liberalisation led to an output decline of between 40 and 45 per cent in the various subsectors (Brada et al., 1994: 41–2). The industry is unlikely to die, but there is a danger that it will get stuck in the manufacture of relatively simple items such as printed circuit boards, unable to compete with leading western companies in the market for high-complexity and high value-added items.

Seven electronics companies were interviewed for this study, including two telecommunication equipment producers, three producers of various automotive and consumer parts, one producer of medical devices, quality control equipment and industrial automation software and one producer of paint spraying guns, video parts and electromechanical display board systems. One of the telecoms firms was the main domestic state-owned supplier of telecoms equipment which was being privatised at the time of interview, while the other firm transformed itself into a telecoms producer after it was acquired by Siemens in the early 1990s. The two are now direct competitors. The producer of

medical devices was established with Hungarian private capital towards the end of the 1980s, and was subsequently taken over by foreign investors. One of the three automotive and consumer parts producers is a recent foreign investment by a leading German company. Of the three remaining firms, two are now owned by private Hungarian investors, and the third was still undergoing privatisation.

The **automotive sector** has a long history. Cars were produced already since 1903. In the socialist period, passenger car manufacture was discontinued but the country continued to make parts for cars produced in Poland, the USSR and the Czech Republic. In addition it specialised in commercial vehicles, especially buses, for the COMECON market. Production was based on western licences which embodied technology which was at least ten to fifteen years behind that used by western manufacturers (Havas, 1995), and quality and innovation were generally neglected since the COMECON market was vast and undemanding. As a result, the sector was hit very hard by the liberalisation. Imports of second-hand cars from the west, the establishment of two foreign-Hungarian joint ventures (Magyar-Suzuki and Opel Hungary), combined with declining purchasing power and a stagnating vehicle industry in the other COMECON countries led to an output decline of 65 per cent during 1987–91 (Brada et al., 1994: 41–2). The outlook is mixed. There are some companies with highly developed engineering capabilities and a strong research tradition which show signs of successful transformation, but weaker firms are struggling to make ends meet or have already collapsed.

There are seven automotive firms in the sample, including a large bus manufacturer, a large manufacturer of truck and agricultural tyres and a large manufacturer of axles and engines for heavy vehicles. All three were undergoing privatisation. There is also a manufacturer of bearings which had just been bought by a Korean company, a manufacturer of various mechanical, electrical and electronic automotive parts which was undergoing privatisation, a small producer of mainly truck bodies which had been taken over by a domestic investor, and a producer of automotive components. This last-mentioned company is a recent greenfield investment fully owned by Ford.

The **textile sector** played a prominent role in employment and income creation from the late 19th century until the end of the socialist era. It was very badly affected by the reform, mainly because its spinning and weaving technologies were estimated to be about twenty-five years behind best practice (HVG, 1 Feb 1992: 29–30). Three-quarters of the old state-owned companies were compelled to initiate bankruptcy proceedings (Figyelö, 21 July 1994: 21). The

long-term outlook for this sector is not favourable. Competition from East Asia is steadily increasing as tariffs and quota are lowered under WTO agreements. The only feasible strategy for Hungarian producers will be to specialise in niche products.

There are seven textile companies in the sample, including two spinning mills, a net curtain manufacturer, one producer of hemp twine, yarn, rope and packaging materials, and three mills making a variety of industrial textiles, protective clothing, household textiles, upholstery fabrics and so on. One of the spinning mills was recently taken over by a British textile firm, and the net curtain manufacturer has also passed into foreign hands. Four others were handed over to domestic private investors and one was preparing for privatisation.

4. CHANGES IN THE INCENTIVE STRUCTURE FOR TECHNOLOGICAL DEVELOPMENT

Four developments after the reform were found to have had an especially pronounced impact on the incentive climate for technological development in the sample firms. These are: the opening-up of the domestic market to western competition, the collapse of the traditional export market in Eastern Europe, privatisation and the virtual disappearance of state support.

The liberalisation of the domestic market had affected fourteen firms in the sample quite badly, either in the form of emerging import competition from western products or through competition from newly set-up subsidiaries of western companies in Hungary. In addition, they suffered from a decline in domestic demand as a result of reduced purchasing power of consumers in the early years of the transition, and from the disintegration of the state distribution and marketing network. The impact was especially severe in the pharmaceutical companies which cannot match the aggressive sales tactics used by western multinationals. Some bad casualties of the liberalisation of the domestic market were also to be found among the electronics firms, especially the large telecoms producer which lost approximately 75 per cent of its domestic market share to Siemens and Ericsson after direct state procurement changed to a system of competitive tendering in 1990.[5] Among the automotive firms in the sample the effects of import competition have also been severe. Like the telecoms producer, several held domestic monopolies before the reform. Among these are the bearings manufacturer which saw its domestic market share decline to just 30 per cent, and the tyre manufacturer which was badly affected by the large scale import of second-hand retreaded

tyres from western countries which do not meet EU safety specifications but still pass the Hungarian regulations. This company also suffered from the drastic decline in the demand for tyres from the bus manufacturer which was badly affected by the loss of its vast market in other COMECON states. The same fate befell the manufacturer of axles and heavy engines which had also been a major supplier to the bus manufacturer. In the textile firms the effects of import liberalisation have been somewhat muted by the fact that competition in items such as industrial textiles and army clothing from producers in Asia and southern Europe is not severe. However, keen competition from other former COMECON states emerged when direct state procurement gave way to competitive tendering.

If the firms were not hit by a decline in domestic demand, they were affected by the disintegration of the export market in the COMECON. Fourteen firms reported having substantial problems in this area. The COMECON had been the main market for all exporters in the study with the exception of the net curtain manufacturer, which sold mainly to Western Germany even before the reform, and the three recently established foreign-owned companies which were catering to western markets right from the start. As internal markets collapsed and the COMECON trading system was abolished, imports had to be paid for in hard currency instead of transferable roubles. In a situation in which hard currency is scarce and customers are struggling to survive, few continued to prefer Hungarian suppliers which could not match the quality, price and service of western producers. The most dramatic cases of export market collapse are to be found in the electronics and automotive firms in the study, because Hungary was a leading COMECON supplier of engineering products.

The dismal developments in the COMECON area are to some extent offset by newly emerging market opportunities in western markets. Trading with western countries became significantly easier and more attractive after the state ceded control over import-export trade and manifold trade restrictions were eliminated. However, many of the firms in the study complained that they lacked the requisite marketing capability and adequate distribution channels. In addition, many of their traditional products were simply not saleable in western markets. Seventeen firms noted that they were under pressure to upgrade quality, lower their prices, improve service and shorten delivery times. Only six firms in the study reported that expansion opportunities in western markets were actually increasing.

The problems with the loss of markets were exacerbated by privatisation, which had affected twenty-one out of twenty-four companies in this study (the remaining three being

recent investments by foreign private companies). In fifteen firms the process had been completed, while the remaining six were still undergoing the process at the time of interview. It had usually been a complicated process involving major internal changes in the management, financial, organisational and employment structure of the companies, and for the large firms the process had taken a number of years. While it is supposed to make firms more progressive and efficient by introducing a hard budget constraint, in practice there were many obstacles which had prevented the firms from undertaking effective restructuring while the process was underway. Considerable uncertainty prevailed over their future, which had led to a very adverse climate for activities aimed at technological upgrading. Instead, short-term measures to ward off impending bankruptcy, including massive lay-offs to reduce wage costs and sale of equipment and buildings to generate emergency cash have tended to fully absorb the attention of the management. In a situation in which simply staying afloat is a major achievement, there has been little room for strategic investments of any kind.[6]

The seriousness of the brain drain which ensued is illustrated by the figures submitted by sixteen companies which disclosed information about their total number of staff at the onset of the reform and in the year of the survey. The total employment generated by these companies fell from 55,685 just before the start of the reform to just 22,010 in 1995, a dramatic cut by any standard. Especially the old telecoms producer and four leading automotive producers suffered enormous staff reductions. Some of them shrank to about a tenth of their original size. But also the medium-sized companies became considerably leaner. Some of the slimming has undoubtedly been beneficial for boosting labour productivity in the sense that the companies got rid of a lot of excess blue collar workers with limited education and people employed in non-core activities such as administration and transport. However, they also had to let go of very valuable highly educated and experienced people in the middle of their careers, especially engineers, who found better-paid employment in local newly set-up subsidiaries of multinationals or in firms abroad. This happened especially in the electronics sector and to some extent in the automotive sector. One electronics firm reported that the number of university graduates employed by it fell from 300 in 1988 to just 35 in 1996. Another reduced its number of university-educated employees by 100 (down from 200 in 1988). In one of the automotive firms the number fell by 80 (down from 150 in 1988). Others did not give numbers, but stated that the problem was severe and that the best engineers have been the first to leave. Thus, almost all the firms in the sample suffered an erosion of their

technological capabilities at a time when they could ill afford to lose their best technical manpower.

The above problems have been compounded by the virtually complete withdrawal of state support. Aside from an initial debt consolidation operation to save twelve of Hungary's largest and most prominent companies from immediate bankruptcy, government support for industrial restructuring has been quite limited. Seventeen firms in the study complained that public support had deteriorated after the reform. In particular, support for technological upgrading has been piecemeal, and export subsidies had been provided in only two cases in the form of soft loans. Generally, obtaining external finance was a big problem. Fifteen firms reported that the financing environment had deteriorated badly after the onset of the transition due to their bad credit ratings and high interest rates on commercial loans. Only four firms noted an improvement in their financial situation. These were all recent take-overs by foreign firms with ready access to funds from abroad.

In sum, the transition has wrought a profound transformation in the economic environment facing Hungarian industry. We now examine how this has shaped the sample firms' efforts to upgrade their technology.

5. THE FIRMS' TECHNOLOGY RESPONSE

The firms have undertaken a variety of activities to increase their productivity and competitiveness in response to the pressures and incentives generated by the new economic environment. However, only seven firms reported that formal R&D had expanded after the reform, while twelve firms stated that this activity had in fact assumed little or no importance. This is noteworthy because all but a few of the smallest textile firms and the small producer of vehicle bodies did have substantial capacity for conducting R&D before the reform. There are two main reasons for this pattern. First, for companies preoccupied with sheer survival, R&D became an almost unaffordable luxury. Second, R&D in four out of the nine foreign-owned companies was de-emphasised because they relied chiefly on their headquarter firms for this function. Some examples are described below.

Applied incremental activities to improve production processes and products had been of more significance than formal R&D, including the introduction of new procedures to improve product quality. Rationalisation of production equipment had also been important to

some extent. These activities were needed to enter western markets and to be able to compete on the liberalised home markets with new or improved products within a relatively short period, often within a mere one or two years. None of these activities required very substantial R&D except in the pharmaceutical companies.

In sum, the old strategy of autarchic development based on reverse engineering of western technology has clearly been abandoned in favour of a strategy of rapid catch-up through acquisition of modern western product and process know-how. However, this broad pattern manifests itself in many different ways. There are considerable variations between the four industries, and even between individual firms belonging to the same industry. We first look at the firms' internal efforts to upgrade processes and products, followed by new investments in machinery and equipment.

Internal technological efforts to upgrade processes and products

The efforts of the pharmaceutical firms have been mainly geared towards building up their marketing and distribution capabilities and their research capacity. Since they did not make an outdated product range, there were no major efforts to change the product composition, but rather to provide more focus in their research activities and/or to expand research. The smallest of the three companies was, however, still severely constrained in its research efforts because of lack of adequate finance. It had to discontinue its research during the early years of the transition and was only just beginning to restart it to some extent. The two large firms which had recently become foreign subsidiaries were in a much better financial position.

In the electronics companies the response pattern in the four domestically owned firms also differs from that of the three companies under foreign ownership. The latter are fast and successful growers, benefiting from easy access to foreign finance, modern western know-how and access to western markets. All three have been significantly expanding their product range over the last few years. In the case of two of these companies, this has undoubtedly been facilitated by the fact that they were recent starters and were not saddled with a pre-reform legacy in their production, management, market structure and R&D situation. However, in only one of the three foreign companies has there been a significant emphasis on the expansion of research. In the other two, R&D has received but limited attention. One of these was set up

as a pure production plant, and so far it had been relying entirely on its Telefunken headquarters in Germany for its R&D requirements. The other is a formerly Hungarian company with substantial R&D capabilities which were diminished substantially after it became a Siemens subsidiary.

The four domestically owned electronics companies have also cut back on research, for but different reasons. They have had to struggle to make ends meet. Three of them show clear signs of technological downgrading - shifting into the production of items on subcontract for western manufacturers that are technologically less demanding to produce than their old product range, and that require little or no R&D. In two of these companies the R&D department had been completely liquidated. One of these used to undertake research, production and service activities in the area of process regulation systems, traffic control, numerical control equipment for machine tools and test benches for diesel engines. Another made high-precision military equipment. Both were affected very badly by the COMECON collapse. Their financial situation was so dreadful that they had to be bailed out by the state. The only feasible survival strategy was to acquire some basic machinery with which simple mechanical and electronic parts could be produced on contract for car and machinery manufacturers in Germany, Switzerland, Belgium and Austria. The firms compete on the basis of labour costs which are much lower in Hungary than in western countries. Research was discontinued completely after the reform. Recent technological progress takes the form of incremental process improvements that are passed on by their western customers. The fate of the other two domestic firms is similar, except that these have managed to maintain a modest research capacity and continue to undertake some independent product development alongside production of rather simple items such as printed circuit boards and small car parts to order.

The six domestic automotive companies[7] have also been struggling to keep their R&D going to some extent, and two of these exhibit signs of technological downgrading in production as well.[8] All companies had to cut back their R&D activities substantially, especially during the early years of the transition. However, in this sector none of the firms completely closed down their R&D departments, and product development has continued to some extent alongside downsizing and cost-cutting in five of the six firms. In the strongest firms, product diversification and new product development has been very important. They are working actively towards the incorporation of EU environmental standards. However, only in the most capable and resilient company in the group (the axle and engine manufacturer) has

R&D recovered to a level that was considered to be more or less normal before the reform.

The case of the only foreign-owned automotive firm is similar to the two foreign electronics firms described above. The plant has no independent R&D department and there are no plans to establish one either. The main technology supplier is Ford-USA. Only incremental changes are made locally on the shop floor.

On the whole, internal technological efforts in the five domestically owned textile firms have been quite modest. The financial squeeze due to the loss of traditional markets was quite severe for them. Also, the formal R&D capacities of the textile firms were quite limited even before the reform. One firm did not even have a formal R&D department at all, and the others employed just a few people for this purpose. Their recent efforts have mostly taken the form of applied informal shop floor-based incremental improvements to processes and products. Three firms were attempting to develop new products for niche markets, and there has been an emphasis on improving the design function in the two companies which make products that are subject to changing fashions in western markets. The case of the two foreign-owned textile companies in the sample is quite different. The foreign spinning mill is yet again an example of the Siemens and Ford pattern. After the take-over by a British investor, the R&D function shifted to the company's technology centre in the UK and the firm does not possess an independent R&D department any more. Not so in the net curtain firm. This company was quite exceptional in the sample in that the impact of the reform was minimal. Its main markets were in the west even before 1989, and it had built up substantial product design capabilities. It spent 8 per cent of turnover on product development and incremental process improvements in 1995.

There is much more evidence of recent efforts to upgrade quality than of R&D activity in the sample. All except the two smallest firms in the sample (a spinning mill and the producer of truck bodies, which both catered for the domestic market) had recently introduced an internationally approved formal quality assurance system, or were in the process of installing it. Apparently, it has become virtually impossible to capture new export markets without it. Although almost all the firms did operate some form of ex-post quality control and had formal quality control departments before the reform, this was obviously completely inadequate in the open economic climate of the 1990s.

The ISO 9000 series is by far the most popular system among the electronics, automotive and textile companies. For the subcontractors in particular, ISO 9002 is a must

because it is completely impossible to get orders from western companies without it. In addition, some electronics and automotive companies make mention of systems such as EN 29002 and QS 9000 (worked out by the world's leading car producers). For two of the exporting textiles firms, obtaining an ÖKOTEX certificate has been a priority. This shows that their products are manufactured according to environmentally approved specifications. The pharmaceutical firms have achieved adherence to the international norms of good laboratory practice.

The average expenditure on quality assurance among the sample firms in recent years has been considerable, especially during the two to three years preceding the official certification of the system. For example, the net curtain manufacturer reported the need for computerisation and acquisition of quality control machinery, while the manufacturer of axles and heavy engines established its own testing department to save on outside contracts, and also undertook considerable retraining of staff. After the official approval expenditure typically declines considerably since it is much less costly to keep the system running than to install it. During the preparation phase, costs can easily go up to 5–6 per cent of sales, but they tend to drop to about 0.5–1 per cent after certification.

In almost all cases, the research, development and quality upgrading efforts undertaken by the firms have been heavily contingent upon the availability of external finance, either from foreign owners (as in the case of the two big pharmaceutical companies, one electronics firm and one textile firm) or from domestic assistance agencies, notably the National Committee for Science and Technology Development (OMFB) which is the main public policy-making body in this area. Two of the electronics companies and four automotive firms had obtained some research funding for specific projects. Public support for quality upgrading had been obtained by nine firms, all except one from OMFB sources. The OMFB runs a scheme under which companies can apply for reimbursement of maximum 50 per cent of the cost of its introduction after the system has been running successfully for a year. A few companies had also obtained preferential public loans for the same purpose. It would appear that this type of public support for R&D and quality upgrading had been quite useful for several firms in the sample.

However, public finance has its drawbacks. Research funds are usually earmarked for very specific purposes, especially when they come in the form of external (EU) aid which is very often the case. Also, while public support has undoubtedly been beneficial in most cases in helping to develop some products for new markets, the amounts appear to have been too

small to have a large-scale and sustained impact on a firm's long-term R&D capacity. Moreover, in several cases it had been more a firm's R&D profile and fund-raising capacity that has driven its ability to attract finance, rather than the other way around. Funding of industrial R&D in Hungary is not primarily driven by a deliberate strategy on the part of the public sector to develop certain sectors or firms, but rather by the ability of firms to put together proposals that can qualify for funding.

In the present economic situation, ownership by a foreign firm is really the only route towards acquisition of substantial research funds on a more sustained basis. However, it has been shown that the implications of foreign ownership on R&D are not always favourable. It would seem that in specific areas where Hungary is (relatively speaking) technologically strong and where, in addition, foreign owners are motivated to make use of the local capabilities (as in the case of the two large pharmaceutical firms, one electronics company and the net curtain manufacturer), foreign investment can be an important spur to innovative activity by providing the much needed access to scarce funds. However, where these conditions are lacking, the result can be a rapid erosion of local research capacity, especially when the mother companies have strong centrally directed R&D programmes.

Investments in new machinery and equipment

For the majority of the firms in this study investment in new machinery and equipment has been a second important mechanism to modernise technology, although the amounts invested have still been rather modest in relation to their size in the domestically owned companies that were heavily constrained by financial problems.

In the pharmaceutical industry, the two foreign-owned companies have been investing heavily since 1990. The first spent about US$ 12–15 million, and the second more than US$ 80 million. In contrast, the small domestic firm has not been able to undertake any sizeable investments yet due to the tight financial situation. Only now does it have concrete plans in this direction.

In the electronics industry, too, it is in the three foreign-owned companies that we can discern the most comprehensive investment programmes. One of these firms invests about 45–50 per cent of its turnover in new (but also some used) equipment every year, all of which is automated and comes from western suppliers. The Telefunken subsidiary spent about US$ 4

million for the purpose of diversification and expansion. All its technology comes from Telefunken Germany. The Siemens subsidiary spent about US$ 12.5 million. Reportedly it benefited greatly from the take-over in the form of access to finance and technology for equipment modernisation. It invested so drastically that it reported to have overcapacity.

Even in the domestically owned firms in this industry substantial investments in new western machinery were also made (although financial details were not divulged in all cases), especially in NC machines from countries like Germany, Sweden and Japan. Acquisition of modern western-produced computerised technology has been a sine-qua-non for firms which turned to subcontracting for western companies in order to be able to compete with western suppliers in terms of costs and quality. External financing, especially from the OMFB and in a few cases the EBRD and the World Bank, had played an important role in almost all cases. One of the subcontractors also arranged financing from its foreign customers to be able to install production lines for its two new main products – an arrangement which is not unusual in subcontracting. Another firm undertook a sizeable investment in hybrid integrated production just before the reform in 1985–7, which was 100% subsidised by the state. The last major investment by the domestic telecoms producer was a US$ 30 million unit to manufacture printed circuit boards, but this was not planned in response to the reform but rather in response to the government's earlier plans to make the firm a leading supplier of digital switching technology. This, too, was financed externally by loans from the OMFB.

The largest investor in the sample by far is the Ford subsidiary with US$ 150 million since 1990. This is not surprising considering the fact that the plant has been established very recently and some of the production lines are still in the process of being established. Most of the machinery is computer-controlled although some, interestingly, are renovated second-hand machines. Predictably, the sources are all western: the USA, Canada, Germany and Italy.

Among the six domestically owned automotive firms the investment pattern resembles that observed in the electronics industry. Five companies undertook major new investments ranging from US$ 5 million to 32 million, and in each case external finance was behind it, except in the case of the axle and heavy engines manufacturer which has been carrying out a more gradual modernisation programme without assistance. This firm managed to sell off outdated or surplus equipment and production facilities, for example to Audi and Volvo which were in the process of establishing assembly plants locally, and to acquire modern equipment with the funds that were generated in this way. Modernisation has been crucial for this

company because the change-over to western markets meant producing to different specifications to which the existing equipment could not be adapted. The tyres manufacturer also undertook a gradual self-financed modernisation programme in addition to externally financed investments in new equipment.

In the textile industry, too, the two foreign subsidiaries have undergone the most drastic and costly modernisation programme. The spinning mill completely modernised its spinning process in 1990–1 with new Swiss machinery and the installation of an air-conditioning system. The dyeing department was re-equipped with new British machinery and a new lay-out design. New precision winding machines were procured from Germany and Switzerland for the twisting department, and a thread lubrication machine for the finishing department. In addition, information technology and instrumentation for quality control were installed. The total investment outlay was US$ 7.1 million. The net curtain producer spent US$ 3.4 million on the modernisation of its equipment for washing and pressing, and for the construction of a large new building to house it. It received an OMFB loan for part of the investment.

In the other textile companies the efforts at modernisation have been much more modest - the amounts are lower (US$ 1 million or less), there is acquisition of conventional mechanical equipment in addition to automated equipment, and there is frequent mention of acquisition of second-hand equipment, some of it bought from bankrupt ex-competitors.

It can be concluded that equipment financing has been heavily driven by external financial sources, especially foreign investment. It is really in the area of physical investment rather than R&D that the benefits of foreign ownership manifest themselves clearly. On the whole, the investments made by the domestically owned firms have tended to be more modest, and the first and foremost priority of these investments have been the replacement of outdated equipment rather than expansion and diversification as noted in some of the foreign subsidiaries. In most of the domestically owned firms the internal financial constraints were overcome to some extent by loans from agencies such as the World Bank or the OMFB, usually on concessional terms.

6. INSTITUTIONAL COLLABORATION AND THE ROLE OF THE EUROPEAN UNION

In this section we look at the extent to which science and technology institutions and other support agencies, in particular the European Union, have been instrumental in facilitating the upgrading processes undertaken by the sample firms. Some insight into the nature and extent of the firms' external collaboration with institutes and other agents after 1989 can be obtained from Table 2.

Apparently quite a pronounced role has still been played by institutions that were part of the science and technology network before the transition. Nineteen firms in our sample had links with the academia, predominantly with the Technical University of Budapest, which seems to be a very popular contact. Fifteen firms had dealings with sectoral research institutes. Some of these are academic research institutes under the umbrella of the Hungarian Academy of Sciences; others are applied research institutes resorting under the various branch ministries.[9] Eleven firms had also had contacts with the Standards Authority and / or the Office of Measures. For one or two big firms, this included foreign western metrology offices. In comparison, the role of private agencies – consultants and foreign manufacturers – is still comparatively modest, at least if we judge their impact by the number of firms that has been collaborating with them.

Table 2: Collaborations with external actors for technology development since 1989

	No. of firms
Universities / colleges	19
Sectoral research institutes (applied and academic)	15
Standardisation and/or metrology organisations	11
Private consultants	5
Private foreign manufacturers	5
Extension services	2
Design centres	1
Others	2

Source: Fieldwork

There are several likely reasons for the continued dominance of the traditional institutes in the present-day support network. Partly, the firms simply stick with them because the services of private commercial firms – especially consultants – tend to be very expensive and hence do not present a feasible alternative for most of the firms in the present financial situation. Also, the linkages with the institutes were in fact quite well developed before 1989. A need for partial self-financing of the public institutes was introduced after the reform of 1968, to improve the incentives to work together with industry and develop commercially useful innovations. This exposed the universities and research institutes to the need to seek alternative sources of financial support and led to the building-up of many linkages with the business sector which still continue to exist. Further, it has been noted that considerable expertise and professional dedication existed in many of the old institutions. In the old system it was primarily the resistance to innovations by the industrial sector due to the adverse incentive climate, rather than a lack of their potential supply, that held back the technological advancement of industry. As a result of this 'excess supply' situation, research institutions developed considerable expertise in developing fundable projects and seeking out firms which were willing to collaborate (Hare and Oakey, 1993).

However, while the need for technological improvement has risen dramatically after 1989, industry does not have much effective demand for the sort of services that the institutes can offer. We have seen that several of the foreign-owned firms were getting away from

undertaking research themselves. The domestically owned firms in the sample were very dependent on limited project funding for research and quality upgrading, while some other types of services which are urgently required by them in the current situation are not fundable at all, such as trouble-shooting and assistance with incremental productivity upgrading. The institutions, themselves in a precarious financial situation, are not in a position to subsidise companies that do express an interest. Moreover, collaboration with these established institutions has lost some of its traditional attractiveness because the financial squeeze has had deleterious effects on their research capacity. The plight of the applied research institutes is particularly bleak. They were completely cut off from public funding and were essentially left to fend for themselves. Many have in fact gone bankrupt. The ones that still exist have severe difficulties in retaining their professional equipment and their best staff. Some of these institutes have indeed lost many valuable people and have been forced to sell buildings and facilities. The situation in the universities and the academic research institutes is not quite as bad as this, but these bodies too suffered very drastic funding cuts in recent years.[10]

In contrast, the role of science and technology contacts outside Hungary in the form of international research joint ventures, and use of foreign laboratories for quality upgrading activities, product development and testing is growing. This network is especially important for firms that have no history of domestic collaborations such as Siemens and Ford, but also for the older domestic firms that have turned to subcontracting for western companies. These now rely on their foreign customers, such as General Electric, Philips and Bosch. For the other domestic firms the role of foreign technology institutions is still more modest, but it is definitely increasing. In some cases, for services such as certification and testing there is no alternative but to get assistance from a foreign agency. The German TÜV is widely used to certify ISO 9000 systems, and German and Swiss firms examine the fabrics for the purpose of the ÖKOTEX certification because Hungary has no facilities for this purpose. Hungary is also slow to develop EU standards on protective clothing and has no facilities to check whether the materials meet EU quality specifications. There are clear weaknesses in the domestic S&T support structure in this area.

Not surprisingly, according to the companies in the sample the high cost of services of technology support is by far the most pressing problem associated with institutional collaboration (see Table 3). This is especially the case for the companies that are forced to use a foreign agency for certification or testing, but it is also increasingly a problem when one

wants to make use of a domestic institute which now has to charge commercial fees in order to survive. Other problems are of much more limited significance, although lack of understanding of the needs of industry also features to some extent as a complaint. However, the sort of problems that typically figure prominently in less developed countries appear to be rather unimportant, namely the lack of adequately specialised personnel, inflexibility, delays in meeting deadlines and bureaucracy. Lack of confidentiality does not appear to be an issue at all. These ratings suggest that institutional cooperation could be on the whole reasonably satisfactory if the financial constraint is overcome. Indeed, several respondents were of the view that institutions had played a useful or even a very useful role, especially in the area of product development, process innovation or cost decrease.

In view of the importance of the issue of financial support, it is important to briefly review the role of international funding which has been a very major source of the public support received by the companies. Several foreign agencies have been involved to some extent, but the European Union has been by far the most important, with twelve out of twenty-four firms in the sample having received some support from this organisation. Several firms had received EU support more than once.

By far the most common source of funding had been the Phare programme. One firm had also tapped into the INCO-Copernicus programme.[11] The emphasis of the support has tended to be on product development and foreign consultancy assistance with internal restructuring of companies in the form of advice and training. A few companies got support to establish information technology and to attend conferences or major foreign trade fairs. In addition to the amounts actually received, several applications were still pending at the time the companies were interviewed. About two or three applications had been turned down.

Table 3: Importance of problems associated with institutional collaboration

	None	Little	Average	Much	Very much	Missing	Total
High cost of services	6	0	2	3	5	8	24
Lack of confidentiality	16	0	0	0	0	8	24
Inadequately specialised personnel	9	0	4	2	1	8	24
Lack of understanding of problems of	6	1	5	3	0	8	24

industry							
Inflexibility	10	1	2	3	0	8	24
Delays in meeting deadlines	10	4	2	0	0	8	24
Bureaucracy	11	1	1	2	1	8	24

Source: Fieldwork

The companies that had obtained EU support tended to give a positive assessment of its usefulness, although some specific problems emerged. The product development contributions, conference and trade fair budgets and so on were generally found to be useful, although the contributions were found to be too small by several firms, especially for product development. Some companies had experienced problems with respect to the in-plant training carried out by foreign consultancy firms. They found that the foreign companies did not have sufficient knowledge about the Hungarian situation and the specific position of the client firm in it. Also, the accommodation and daily allowance costs of these consultants, which had to be paid for by the client firms, tended to be very high. Some firms felt that they would have been better off if they could have engaged a Hungarian partner company. One firm actually suggested this, but the idea could not be entertained since hiring the services of a foreign western company is a requirement for getting the support.

Several respondents expressed the view that the effectiveness of the support could increase if the role of these western partner firms could be decreased, also because it would release more money for actual assistance to the Hungarian target companies. Even if these complaints may not be 100 per cent objective, they are in fact supported by other sources. For instance, the Financial Times recently reported that as much as 75 per cent of Phare's budget finds its way to consultants in member countries (16–17 Nov 1996). It would certainly seem to be a sensible idea to change the requirements in such a way that domestic technology institutions and consultancy firms could play a more prominent role in the programmes. There is very little evidence that the EU support that was given to the sample firms promoted domestic linkage-building between firms and institutions for science and technology development.

Several other problems were also mentioned by the sample firms. Four firms had found that the programmes tend to have very specific objectives, which had prevented them from applying even though they were interested in receiving support. For five firms, the provided information about the programmes had been insufficient and sometimes it was also issued very

late so that it had been difficult to meet the deadline for handing in the application. For five firms, the bureaucracy involved in going through the application procedure had been quite off-putting. It was found to be very time-consuming to fill out extremely detailed application forms. Some firms had also experienced long delays in getting their applications approved. The fact that screening and implementation are handled by the local OMFB and that funds are disbursed through the local banking system does not help matters. However, it must also be said that in spite of these various problems the majority of the sample firms expressed interest in receiving (additional) support from the EU. It appears to be one of the very few possibilities to get any funding for science and technology activities in the present situation.

7. CONCLUSIONS AND IMPLICATIONS FOR TECHNOLOGY POLICY

The economic reform of 1989 brought about major changes in the industrial incentive climate in Hungary. The combined effect of privatisation, the opening-up of the domestic market to Western competition, the collapse of the traditional export market in Eastern Europe and the withdrawal of the government in the area of industrial policy regulation have been to expose Hungarian industry to the need for drastic restructuring in order to face a future in which its ability to enhance productivity and produce competitively in unprotected markets will be essential to its survival and growth. The degree to which the efforts of Hungarian producers to upgrade productivity will be successful obviously depend crucially on their ability to advance in the area of science and technology.

The twenty-four firms that were interviewed for this study have undertaken considerable technological efforts in recent years, even though the domestically owned firms in the sample have been much constrained by their very precarious financial situation. Most important among their efforts have been applied activities to improve processes and develop products, mainly consisting of restructuring of production facilities, modernisation of production equipment and introduction of officially certified quality assurance systems. Formal R&D has been de-emphasised in most of the firms as a result of the tight financial situation. Alternatively, in the case of four of the nine MNC subsidiaries, R&D was not encouraged by the parent firms. Only in a few firms did R&D continue on a notable scale. On the whole, the patterns found in this study reflect the shift away from the old strategy of autarchic imitation based on own technological efforts towards a strategy of catch-up through acquisition of

western product and process technology.

The outcomes of these efforts have been mixed. In the pharmaceutical companies, some of the textile firms and the strongest automotive firms there is evidence of qualitative upgrading and extension of the established product range. In some of the domestically owned electronics and automotive firms, however, the traditional product range had to be abandoned. In five firms there were signs of a shift towards items that are technologically less demanding to manufacture, and product design has been virtually discontinued. There is also evidence of a substantial erosion of human technological capability as highly qualified and experienced engineers have left for greener pastures.

In contrast, four of the five electronics and automotive firms that were foreign-owned fared much better. These showed signs of fast growth and considerable product diversification into complex areas of engineering, although this process was driven by internal R&D activity in only one of these subsidiaries. In the other foreign-owned engineering firms the role of R&D was found to be very limited or even non-existent and the firms had no contacts whatsoever with other actors in the domestic science and technology system. From the point of view of the need to raise Hungary's long-term competitiveness in technologically complex sectors, the desirability of such investments appears to be somewhat questionable.

Unfortunately, policy makers may feel that they have little choice but to attract whatever investors they can, given the extremely limited availability of domestic finance for industrial modernisation and the urgent need to create employment and incomes. This undoubtedly presents the most pressing problem at the moment. The internal financial resources of the former state-owned firms are exhausted and a properly functioning market for development finance does not yet exist. Support from agencies such as the OMFB, the World Bank, the EBRD and, indirectly, the European Union can help to some extent, but most of the money will have to come from the private sector.

Yet, delivery of effective assistance by public and international institutions is of course very important, especially because the market for innovation is subject to a high degree of market failure during transition. Financial support from the European Union was found to have played a significant role in promoting activities such as product development, quality upgrading and training in the sample firms. However, it is worrying that this does not appear to have contributed in a major way to the strengthening of the domestic institutional science and technology support network, which could be so crucially important for the future health of

Hungarian industry in a liberalised economic environment. Hungary had a well-developed network of universities and public science and technology institutes for academic and applied research before the reform of 1989 which interacted considerably with industry, but in the 1990s the linkages have become subject to erosion. The institutions have been badly hit by the withdrawal of state support and are forced to charge commercial prices for their services, at a time when the effective demand for such services is under severe strain.

One reason why the EU support has not led to significant involvement of domestic institutions is that EU projects require the involvement of foreign partners. In some cases, there is obviously much to be gained from exchange with EU firms and institutes. However, in some cases the disadvantages may outweigh the benefits. Involving western partners is costly and has not always led to good results because western collaborators may lack insight into the problems and requirements of Hungarian firms. In fact, insistence on involving EU partners may actually have contributed indirectly to the erosion of the domestic support infrastructure.

It would appear from the results of this study that the design of EU programmes for technology support could be made more effective in several ways, to better reflect the priorities and requirements posed by the evolving integration of Hungary within the Union. In particular, there is a clear need for strengthening whatever remains of Hungary's traditionally strong support network of institutions. This can be done by encouraging linkage-building of companies with domestic institutions, by building such collaborations into the design of EU research programmes. There is a lot of scope for this kind of collaboration in the case of relatively smaller companies which do not maintain a completely self-sufficient R&D department.

There is also room for more direct support to domestic institutes and universities for staff training, equipment modernisation and projects, to make them more attractive as collaboration partners for science and technology development. In particular, they need support so that they start providing the sort of services for which there is high and growing demand at the moment, such as certain laboratory testing facilities which are carried out according to the western standards required for export production, and consultancy and training for the introduction of ISO 9000, as well as its certification. Alongside this, the speedy adoption of western product norms and standards by Hungary should receive priority.

As far as assistance to industrial firms is concerned, it may be possible to make the application process a bit more efficient, and also to make it easier for companies to meet the

eligibility criteria for financial assistance for technology upgrading. At present, many programmes have very specific objectives. This prevents firms from even making an attempt to apply. Especially, there seems to be a huge unmet demand in the present situation for applied services such as incremental debugging and problem-solving which the existing research institutes are well-equipped to undertake in view of their long and rich experience with reverse engineering and imitation of western technology in the old regime. These can have a dramatic effect on productivity, but they do not meet the usual project funding criteria. There is a very high degree of market failure in this area.

Finally, the results of this study would suggest that in general, funding of domestically owned firms holds out better prospects for domestic linking than assistance to foreign-owned companies, especially when the latter are newly established subsidiaries of multinationals which do not have any past history of collaborating with local institutions. When assistance is given to foreign-owned firms, a careful scrutiny of the nature of their science and technology linkages seems to be warranted.

NOTES

1. The Association Agreement required the immediate removal of all EU quota on industrial commodities except textiles and iron and steel products, while its import tariffs were dismantled over a period ranging from two to five years. Hungary will be required to dismantle its own tariffs and quota after four to nine years. For details see Togan (1997).

2. The paper is based on research funded by the European Union's Targeted Socio-Economic Research Programme, Directorate-General XII, and is part of a project entitled 'Science and Technology Policies in Developing and Transition Countries: Reform and Technological Co-operation with Europe', coordinated by Sanjaya Lall, Queen Elizabeth House, University of Oxford. The author wishes to express thanks to Ildikó Taksz for the efficient organisation of the fieldwork in Hungary and for a fruitful academic exchange. Thanks are also due to Theodosios B. Palaskas and Manos Antoninis for their contributions to the field research.

3. Basic information about sales, employment, ownership, and product range of each of the sample firms is listed in Appendix A.

4. The other four were also approached but declined to provide information. The companies in this sector are much concerned with secrecy.

5. A detailed and interesting account of the drastic changes in the Hungarian telecoms industry after 1989 is given in Tóth (1994).

6. This has also been noted by Inzelt (1996).

7. Including the firm which was very recently taken over by the Korean investor. The take-over was too recent to have had a substantial impact on the firm's performance.

8. The recent history of one of these is detailed in Somai (1995).

9. They are treated as one category in the table because the distinction between the sort of research pursued by the academic and the applied institutes had become rather blurred in the 1980s.

10. The problems of the Hungarian science and technology institutes are discussed in detail in Taksz (1997).

11. Details of the projects are given in Appendix B.

REFERENCES

Brada, J.C., I. Singh and A. Török (1994) Firms Afloat and Firms Adrift: Hungarian Industry and the Economic Transition. New York: Armonk.

Hare, P. and R. Oakey (1993) The Diffusion of New Process Technologies in Hungary. London: Pinter Publishers.

Havas, A. (1995) 'Institutional Support for Re-structuring and Technological Improvement. International Trends and the Re-emergence of Car Parts Industry in Hungary', IKU, Innovation Research Centre, Budapest, mimeo.

Inzelt, A. (1996) 'Institutional Support for Technological Improvement – The Case of Hungary', Technological Forecasting and Social Change, Vol 51, pp 65–93.

Karsai, J.(1995) 'Pharmaceuticals: EGIS Pharmaceutical Works Ltd. No Prescriptions for Healthy Firms?', in: S. Estrin, J.C. Brada, A. Gelb and I. Singh (eds) Restructuring and Privatisation in Central Eastern Europe. New York and London: M.E. Sharpe, pp 241–51.

Ministry of Industry and Trade (1996) 'Hungarian Industrial Policy'. Budapest.

OECD (1997) OECD Economic Surveys. Hungary 1997. Paris.

Pal, R. (1988) 'Technological Change by Central Control: The Case of the Hungarian Electronics Industry', in: C. Freeman and B.A. Lundvall (eds) Small Countries Facing the Technological Revolution. London: Pinter Publishers.

Romijn, H.A. and I. Taksz (1997) 'Science and Technology Development in Countries in Economic Transition: The Case of Hungary', Report prepared for the European Union Project "Science and Technology Policies in Developing and Transition Countries: Reform and Technical Co-operation with Europe", Queen Elizabeth House, University of Oxford, November.

Somai, M. (1995) 'Auto Parts: Bakony Metal and Electrical Appliance Works. Hot Spark Plugs?', in: S. Estrin, J.C. Brada, A. Gelb and I. Singh (eds) Restructuring and Privatisation in Central Eastern Europe. New York and London: M.E. Sharpe, pp 252–63.

Swaan, W. and M. Lissowska (1996) 'Capabilities, Routines, and East European Economic Reform: Hungary and Poland Before and After the 1989 Revolutions', Journal of Economic Issues, Vol XXX, No 4, Dec. 1996.

Taksz, I. (1997) 'Science and Technology Development in Transition: The Case of Hungarian R&D Institutes', Report prepared for the European Union Project "Science and Technology Policies in Developing and Transition Countries: Reform and Technical Co-operation with Europe", Queen Elizabeth House, University of Oxford, draft.

Togan, S. (1997) 'Opening up the Turkish Economy and the Economies in Transition', Seminar paper at the International Economics Study Group Meeting of 28 Feb. 1997, London School of Economics.

Tóth, L.G. (1994) 'Technological Change, Multinational Entry and Restructuring: The Hungarian Telecommunications Equipment Industry', Economic Systems, Vol 18, No 2, pp 179–95.

Appendix A: Sales, employment, location, ownership and main products of the sample firms (1995)

	Sales (1,000 US$)	Appr. no. of workers	Location	Majority ownership	Main products / services
Pharmaceuticals					
P1	141,221[a)]	2,500	Budapest	Foreign	Final drugs and active ingredients for human use (80%) and agrochemicals (20%). Main drugs are anti-Parkinson, anti-spasmodic and anti-osteoporosis.
P2	160,000	2,750	Budapest	Foreign	Final drugs and active ingredients for human use. Main drugs are for cardio-vascular, central nervous system and gastro-intestinal disorders.
P3	8,742	280	Budapest	Domestic private	Laboratory chemicals (80%) and medical diagnostics (20%).
Textiles					
T1	18,000	450	Budapest	Foreign	Staple spun polyester and continuous filament polyester thread (60%), embroidered products (35%) and trading (5%).
T2	25,095	1340	Budapest	Domestic public[b)]	Cotton bedsheets (45%), curtains and furniture fabrics (20%) and fashion fabrics (25%).
T3	N.A.	650	Györ	Foreign	Net curtains.
T4	13,076	605	Györ	Domestic private	Work clothing and protective clothing (60%), table cloths and other kitchen textiles (20%), industrial textiles (18%) and fashion textiles (2%).
T5	2,294	68	Budapest	Domestic private	Cotton thread and polyester thread.
T6	11,235	494	Szeged	Domestic private	Hemp twine, yarn and rope (30%), polyethylene bags (50%) and polypropylene twine and rope (20%).

Electronics					
E1	6,424	600	Budapest	Domestic public[b)]	Mechanical (75%) and electronic (25%) automotive and machine parts.
E2	N.A.	65	Budapest	Foreign	Medical devices, image processing (40–45%), industrial automation (15–20%) and quality control equipment (40%).
E3	D.M. 20,000	410	Budapest	Foreign	Electronic automotive parts (33%), various consumer electronics (33%), membrane keypads and switch systems (33%).
E4	3,585	450	Székes-fehérvár	Domestic private	Paint spraying guns, video parts and electromechanical display board systems.
E5	14,813	335	Budapest	Domestic private	Hybrid integrated circuits, high voltage parts for TVs, automotive and various other electronic parts.
E6	25,000	1,000	Budapest	Domestic public[b)]	Digital switching equipment (70%), printed circuit boards (10%) and boards for electronic equipment (20%).
E7	102,352	560	Budapest	Foreign	Mainly digital switching equipment, transmission equipment, networks, integrated voice and data communications equipment and systems and military electronic and air traffic control equipment.
Automotive production					
A1	54,300	1,049	Székes-fehérvár	Foreign	Automotive components (distributorless ignition coils 25%, fuel pumps 35% and permanent magnet starter motors 40%).

A2	169,734	6,400	Györ	Domestic public	Trucks and truck components, especially axles and bases (65%), heavy duty diesel engines and gas-based engines (25%) and transport and special agricultural vehicles (10%).
A3	24,672	1,940	Debrecen	Foreign	Finished and semi-finished bearing parts.
A4	25,812	1,540	Veszprém	Domestic public	Various electrical and electronic automotive parts (75%) and various parts of industrial and consumer goods (25%).
A5	143,400	4,157	Budapest	Domestic public[b)]	Rubber truck tyres (39%), agricultural tyres (31%), hoses and conveyor belts (17%), air springs and inflatable mattresses (7%) and auto parts (5%).
A6	N.A.	30	Budapest	Domestic private	Truck bodies (80%) and various special purpose and commercial vehicles such as vans and car carriers (20%).
A7	N.A.	4,870[a)]	Budapest	Domestic public[b)]	Buses.

Notes:
a) Pertains to 1993.
b) Privatisation in progress.
Source:
Fieldwork

Appendix B: European Union support for technological development received by the sample firms

	Programme	Amount	Purpose	Results
Pharma-ceuticals				
P1	Phare (1993)	US$ 0.5 million	Development of new agrochemicals.	Still ongoing. Registration of product in process.
P3	Phare (1995)	Ft 1,440,000 (= 90% of total cost of programme)	Organisation of 3 months training for 16 middle managers for reorganisation, by foreign visiting experts.	Found to have been very useful.
Textiles				
P3	Phare (1995)	Appr. Ft 3–4 million	Participation in the national quality competition.	Won first prize.
P7	Phare, two programmes (1996)	N.A.	Operations management consultancy and establishment of an integrated information system.	Still to be implemented.
Electronics				
E1	Phare	N.A.	Training for top management by Hungarian-French consortium.	Not very satisfactory. Foreign consultants were found to have limited expertise relevant to their situation.
E2	Copernicus, 3 programmes (all 1995); Phare, 2 programmes (both 1996); Inco-Copernicus (1996)	Copernicus: ECU 27,000 + ECU 35,000 plus variable budget for conf. visits and training; Phare: ECU 15,500 + ECU 91,000; Inco-Cop: ECU 56,000	Copernicus and Inco-Copernicus budgets all for computing. Phare support for development of medical devices (One for computing, one for equipment purchase), involving cooperation with foreign firm, local firm and local technology institute.	Ongoing.
E6	Phare (1992–3)	N.A.	Foreign consultancy assistance with restructuring of the company.	Not very beneficial. Foreign companies had limited understanding of the local situation.

Automotive production				
A2	Phare (1994–6); Hipe-Phare (199?)	Phare: ECU 1 million (all grant); Hipe-Phare: ECU 3 million (20% grant, 80% pref. credit)	Phare support for restructuring with assistance from a French company. Hipe-Phare money for training, environmental protection (forging), product development, information system and other information technology development.	Essentially a fruitful experience; some activities still ongoing.
A3	Phare (1992–6)	Small budget	Attending big foreign exhibitions.	Very useful for meeting new customers and entering new markets.
A4	Phare (1996)	Ecu 22,000	Consultation and internal training for introducing QS 9000.	Ongoing.
A5	Phare (1994), 2 programmes	First programme N.A.; second ECU 80,000	Audit by a Dutch company; Consultancy by a Dutch consultancy group on environmental protection.	First programme was minor. Second programme ongoing.
A7	Phare (1994–5 and 1991-4), two programmes	N.A.	Foreign consultancy assistance with reorganisation of the company; development of dual bus fuel system.	Reorganisation not very successful yet but this is also due to shareholding structure; dual fuel system development was stopped after 40 buses were produced.

Source:
Fieldwork