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STUDYING THE DIFFUSION OF MODERN TECHNOLOGIES IN HUNGARY

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Abstract

Nowadays, technological progress of national economies that fiercely compete with each other seems to be more important than before, therefore, it is often focused in the great number of today's economic researches on innovation. However, the economic environment and process of technology transfer are not yet paid enough attention in Hungary. In the article the current ways of investigating the diffusion of modern technologies are discussed. First, the relevant references and available statistics, then the methodology of two Hungarian innovation researches are presented briefly. Finally, some conclusions are drawn with respect to the collection of innovation data.

Keywords: (diffusion of) innovation, technology transfer, knowledge flow, empirical research on innovation.

1. Introduction and Concepts

When one would like to study the diffusion of innovation or the transfer of technology for a specific country, the concept and the relationship of innovation and technology transfer should be made clear first. According to the OECD, 'innovation is the transformation of a concept into either an introduced, new or modernised product, or into a new or improved operation in trade or industry, or a new approach to a social service' [6, p 9]. If this definition is interpreted simply and with the purpose of generalisation, we may say that innovation is R&D and/or technology transfer, of which R&D is easier to describe: 'scientific research, experimental development (R&D) is every activity, which aims at the enrichment of scientific knowledge and seeks new utilisation possibilities of scientific results including the knowledge gained about the humans, culture and society. R&D includes basic research, applied research and experimental development.' [6, p 29]. Nevertheless, the latest generally distributed manual on the collection of technology transfer data [8],[1] gives a long way to discussion on what technology is. The term is difficult to define, and without citing comments of the [8], we accept that technology is the knowledge used in production whatever form it may take. According to the

[1] The TBP Manual has been under revision for some time. The latest version was written in 1990, and a revised edition is expected to be published in 2001.

manual, technology transfer takes place in three ways: via equipment and products (capital embodied technologies), people (human-embodied technologies) or written documents and other media (disembodied technology).

As we interpret, technology transfer is an innovation activity that results in economic benefit. In the course of technology transfer, the economic actors make use of new technology (knowledge) created outside their competence. The economic actors are operating in an economic environment, which is a National Innovation System (NIS),[2] if innovation is put in the centre. According to the NIS approach, the main actors in the process of innovation diffusion (or technology transfer) are the research institutions, which create the knowledge/technology (e.g. universities and specialised/professional research institutions), companies that make use of the knowledge/technology and the government organs that help innovation. Nature, direction and intensity of knowledge or technology flow between the actors of the system are of key importance. When the nowadays fashionable knowledge-based economy or new economy[3] is discussed for Hungary's case, the above mentioned three types of technology transfer between the actors of the innovation system should be paid more attention (*Fig. 1*).

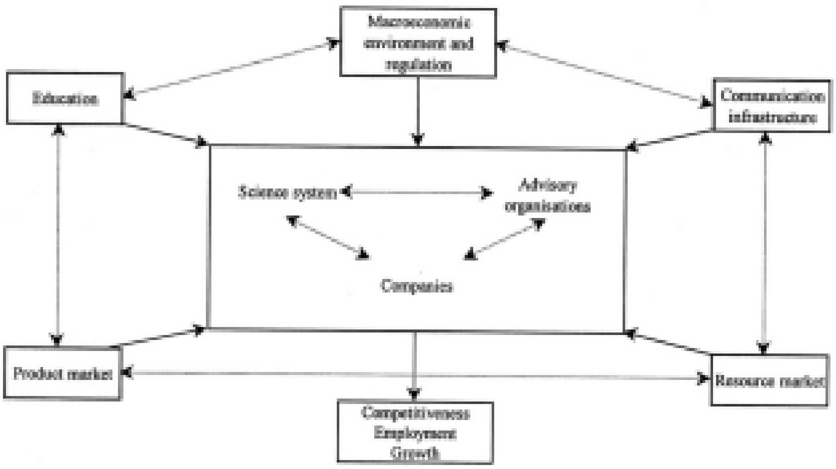

Fig. 1. Relationships in the National Innovation System

Source: simplified figure from [11]

The later presented empirical researches made use of the above depicted NIS approach and important relationships in the subsystems of the Hungarian innovation system were investigated.

[2] Lunwall gave birth to the concept of NIS [12] . Many large scale international researches were made using the NIS concept. For the most complete Hungarian discussion, see [1].

[3] For international reference see: Is there a new economy? [9].

2. The Available Hungarian Statistics and Researches in the Topic

The technology or knowledge flow between actors of the Hungarian innovation system has been rarely studied to this date. Most of the Hungarian Central Statistical Office's innovation statistics refer exclusively to the R&D and related statistics, and there is barely any information on technology flows. The Hungarian technology balance of payments (TBP) data – commercial transactions related to cross-border technology transfers – are missing from the OECD databases. Nevertheless, other more or less reliable statistics in [MSTI] give a picture on how Hungary performs with respect to the diffusion of patented innovations (*Table 1*) and the statistics of the Hungarian Patent Office can also be used.[4]

Table 1. Selected figures of disclosed technology in Hungary

	1992	1993	1994	1995	1996	1997
National patent applications [1 = 2 + 3]	10 925	12 772	17 025	20 882	24 962	30 079
Resident patent applications [2]	1 500	1 144	1 164	1 112	815	748
Non-resident patent applications [3]	9 425	11 628	15 861	19 770	24 147	29 331
External patent applications [4]	2 006	3 364	3 668	3 953	5 069	6 750
Dependency ratio [3/2]	6.28	10.16	13.63	17.78	29.63	39.21
Autosufficiency ratio [2/1]	0.14	0.09	0.07	0.05	0.03	0.02
Inventiveness coefficient [2/10000 inhabitants]	1.5	1.1	1.1	1.1	0.8	0.7
Rate of diffusion [4/2]	–	2.24	3.21	3.40	4.56	8.28

2: patent applications made by the residents of Hungary
3: patent applications made by non-Hungarian residents
4: patent applications made abroad by the residents of Hungary
Source: [MSTI]

Without analysing the details, *Table 1* shows that with respect to patents, the Hungarian innovation system (NIS) is being more and more integrated in the global economy. Nonetheless, at aggregate level, we still do not have sufficient information on the innovative performance of Hungary let the flow of technology/knowledge and the maximisation of innovation results be our primary concern.

The insufficient nature of technology transfer and knowledge flow statistics may also explain why the Hungarian researchers of innovation turn to empirical investigation – to case studies first of all. [13], reviewed innovation processes in Hungarian firms based on 30 case studies, [5] processed 25 interviews with special attention focused on technology transfer, [4] edited 5 case studies in the first Hungarian textbook on innovation for Hungarian graduate and postgraduate students, etc.[5] However, when the terms 'technology transfer' and 'diffusion of innovations' are used, most of the Hungarian authors put certain segments of institutional or corporate behaviour – such as FDI, competitiveness, legal environment, etc. – in

[4]For details see www.hpo.hu

[5]The elaboration of case studies is a traditional way of studying innovations. The case-study method for innovation was first applied by Griliches. In Hungary, the number of available case studies is inadequate, and apart from occasional researches, yet there is no innovation research published on a frequent basis.

the focus of their analysis, and usually the process of 'flowing' and 'being transferred' are only touched. The NIS concept is slowly making its way in Hungary. The author could participate in two recent researches, which relied heavily on this concept, and which – partly – focused on the flow of technology and the diffusion of innovation.

As far as I know, the very first empirical research that tried to map the flow of technology and knowledge between the actors of the Hungarian innovation system was a GKI Co. research, early December, 1999. The investigation was carried out for OMFB,[6] a government organ for promoting innovations, and its main purpose was to show perspectives of growth from other than a macroeconomic point of view. In the GKI Co. study, two basic sources of information were used: questions on innovation were involved in GKI Co.'s traditional enterprise surveys, and 17 detailed case studies were elaborated.

Methods for the GKI Co. enterprise surveys were adopted from the Munich-based IFO at the end of the 1960s (a special case of technology transfer!). Later, the EU recommendations were also included in the methodology. The semi-annually surveyed 8000 companies are sampled randomly from 50–60 thousand legal entities that employ more than 20 people. The sectoral breakdown of the national economy is well represented. The usual response ratio of posted questionnaires, in which the companies provide information on their 1–2 year expectations, is around 10%. The survey results are summarised in the regularly published [2] booklets.

As far as the representative company sample is concerned, the innovation – R&D and technology transfer – and development efforts were asked in a separate questionnaire of the large scale enterprise surveys. The below given figures of innovation are mostly favourable as far as the future development can be projected. Nonetheless, the transfer of knowledge and technology seems to be hampered by the seemingly low weight of R&D results purchased from 'over the fence'.

Table 2. Proportion of Hungarian companies that plan significant development (%)

	Companies introducing			
	world-wide new product	new product (for the company)	new technology	*Sample total*
R&D	56.3	45.2	46.6	*34.2*
Purchase of patent, license, know-how	18.2	12.2	12.2	*8.4*
Transfer of technology	16.7	13.6	17.1	*11.3*
Larger investment	52.3	50.5	56.4	*46.0*

Source: GKI Co. Autumn survey, 1999. See: [15, p 57]

With the help of case studies, the above general information can obviously be shown in a more shaded picture. The analysis is easier because now we do not only have GKI Co.'s cases but further 42 case studies are available, which

[6]National Committee for Technological Development, abbreviated in Hungarian as OMFB. Though this organisation contracted the Budapest University of Technology and Economics for the other research as well, in the meantime it became a department of the Ministry of Education.

were elaborated at the Budapest University of Technology and Economics (BME or BUTE in English).[7] The most important difference between the mentioned researches was that different actors of the innovation system were focused.

3. Methods for Case Study Elaboration

The 17 case studies elaborated for the GKI Co. research represented the most important Hungarian sectors and there were small, medium-sized and large companies included. Obviously, the sampling could not be statistically representative; the representative results that were suitable for control and comparison came from the traditional GKI Co. survey (see the above table).

In the first stage of the TUB research, every university faculty recommended R&D projects for analysis. 42 case studies could be processed by the set deadline, and the innovations described very well the University's R&D relationships, close to representative. Distribution of innovation number was relatively close to the faculties' weight in R&D. Thus there were many cases pertaining to large companies and the service sector was underrepresented.

Table 3. Significance and sector of the 42 innovations at the University

Sector	The innovation was important: globally	for Hungary	for a sector	for a company	other	Total	%
Construction				2		2	*5*
Energy		1	2	3		6	*14*
Manufacture of bulb				2		2	*5*
Universal use		1	2			3	*7*
Instruments		2		1		3	*7*
Machinery				2		2	*5*
Vehicles	1	1	5	2		9	*21*
Chemical industry	1	1	1	2		5	*12*
Telecommunication	2		3			5	*12*
Other	1		2		2	5	*12*
Total	**5**	**6**	**15**	**14**	**2**	**42**	**100**
%	*12*	*14*	*36*	*33*	*5*	*42*	*100*

Source: [14, p 30]

3.1. Questions and Topics for Case Studies

In both researches, the case studies were worked out on the basis of interviews with the innovation project leaders or university professors. The following issues of innovation were expected to be covered by the case studies:

[7] Abbreviated and always referred to in Hungary as BME (Budapesti Műszaki Egyetem was the 'old' name).

- Identification and brief description of the project. Field of science, originality and significance of the innovation in Hungary and in the world. Estimation of the possible technological gap. Related fields in education and industry.
- Nature of research, surrounding environment at the beginning. Scientific and research advances in the field before. Motives influencing the direction of research and innovation.
- Organisational issues of the innovation. Organisations and personnel with direct participation in the project.
- Financing the innovation: grants, contracts from industry, foreign partner, university relations, estimated research expenditures (or facts if could be provided), breakdown of the expenditures, return on innovation investments, prospects of profitability.
- Cooperating institutions, enterprises, organisations. Assessment on the co-operation. Ways of protecting intellectual property in the relationships.
- Practical use of the innovation: new product or service, book and/or publication, patent, new technology, license, use in education, etc.
- Assessment on the general performance of the Hungarian R&D sphere. International comparison.

In an ideal case, the case studies should provide details for all the above topics. Certainly, it will never come true. However, when the responses show some patterns of laying emphasis – and thus providing more details – on given issues (such as the technical/technological content), whereas others are not discussed in detail (e.g. profitability of the innovation), it will map important features of the Hungarian innovation system. The above used interview structure was also useful to draw the technology transfer channels and the flows of knowledge.

3.2. Processing the Case Studies

In order to proceed effectively with comparing the cases, the authors of the case studies were asked to complete some worksheets and tables. In both investigations the research teams tried to operationalise the most important information that the case studies were supposed to contain. In fact the technique of requesting the case study authors to sum up the conclusions of their own case in tables, is a reasonable way of receiving comparable data at a more aggregated level.

As far as the transfer of knowledge is concerned, the case study authors had to judge in a separate table what sources of information helped the birth of 'their' innovation (see *Fig. 2* below)

Accordingly, in another table the case study writers had to provide the information if the R&D result had been sold abroad/in Hungary, or if there was a new product/technology born. In addition, the research teams were also interested if the R&D result had been published and/or introduced in higher education.

As *Fig. 2* shows, the NIS approach has been applied with success in both of the mentioned researches. From the case studies knowledge flow could be described

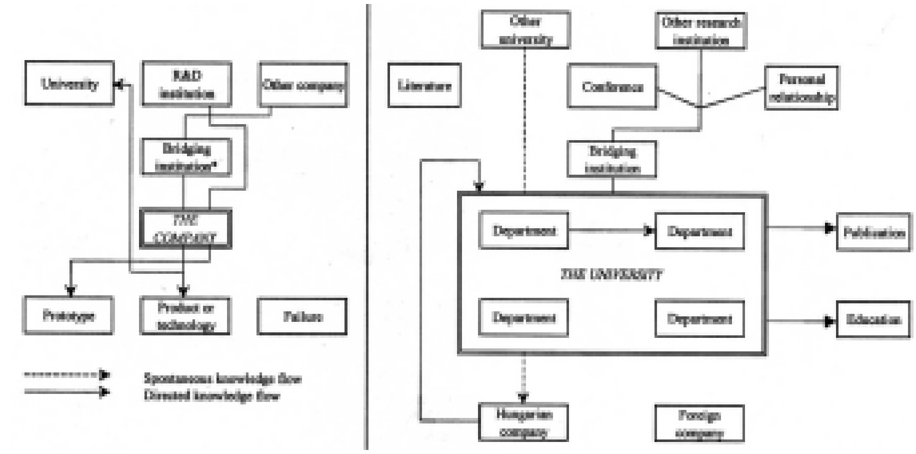

Fig. 2. Examples of mapping the technology transfer investigated by case studies

*Bridging institution is the term for organisations that undertake mostly technology transfer between the 'creator' and the 'recipient' of knowledge. Source: simplified figure. For the original full figures see the [Knowledge flow between...] article in this volume and [3, p 24]

more or less precisely; the case-specific knowledge flow patterns could be simplified and drawn as channels of 'technology' flow. Though the samples were far from being representative, the conclusions on the poor Hungarian knowledge flow and the often lacking cooperation between the R&D sphere and the companies (the users) will probably not be debated.

4. Conclusions and Suggestions for Future Investigations

As we could see, it is not easy to study the issue of technology transfer in Hungary. Aggregated or sectoral statistics are not available, empirical investigations are few in number. Very few publications and researches have been done with the latest internationally accepted concept and approach.

Using the framework provided within the NIS concept, the presented empirical investigation techniques are among the first in Hungary that tried to approach the issue of technology transfer. Nonetheless, we must not forget that knowledge flow or the transfer of technology has not been the primary focus in either of the mentioned innovation researches. Even if the presented conclusions on the subsystems of knowledge flow are the most important results so far, the level of aggregation and representativity are both insufficient.

Consequently, there are three kinds of work to be done, which are equally urgent:

(i) The sectoral patterns of technology transfer within industry should be precisely measured in order to have figures that are comparable with other OECD member countries. In this respect recommendations in the current and the coming [TBP Manual] will be essential for the statisticians.[8]
(ii) Empirical investigations of innovation should gain in number. It would also be welcome if similar methodology to the hereby presented could be used so that the results are comparable.
(iii) The human-embodied technology flows must also be paid attention. Researches in this field are exceptional, the researchers of innovation and the Central Statistical Office of Hungary should make steps to introduce survey systems that measure the mobility of human resources devoted to R&D.

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[8] In fact, overall reform of the complete innovation statistic system (R&D expenditures, researcher mobility, patents, etc.) will be unavoidable in Hungary.