# HUNGARIAN STATISTICAL REVIEW

JOURNAL OF THE
HUNGARIAN CENTRAL
STATISTICAL OFFICE



80. VOLUME 2002. SPECIAL NUMBER 7

## CONTENTS

STUDIES OF SOCIAL STATISTICS

Recent history of the nonprofit sector in Hungary. – *Éva Kuti* ........... 3

Social relationships of the poor. – *Judit Monostori* ............................... 18

ANALYSIS OF THE HUNGARIAN ECONOMY

Productive efficiency in the Hungarian industry. – *Ádám Reiff – András Sugár – Éva Surányi* ......................................................... 45

Spatial gravity centres of the dynamics and the crisis in Hungary. – *József Nemes-Nagy* ....................................................................... 75

Analysis of long-term tendencies in the world economy and Hungary. – *Béla Sipos* ......................................................................... 86

METHODOLOGY

Category selection and classification based on correspondence coordinates. – *Ottó Hajdu* ................................................................. 103

Heteroscedasticity and efficient estimates of BETA. – *József Varga – Gábor Rappai* ............................................................................ 127

Stock return distribution and market capitalisation. – *Péter Lukács* .... 138

ISSN 0039 0690

Published by the Central Statistical Office
Editor in charge: dr. Tamás Mellár
Executive editor: dr. László Hunyadi
Printed by the Akadémiai Nyomda
3656 – Martonvásár, 2002
Director in charge: Lajos Reisenleitner



Editorial office: Budapest II., Keleti Károly utca 5–7. Postal address: P.O.B. 51. Budapest, 1525.
Phone: (361)-487-4343, Telefax: (361)-487-4344,
Internet: www.ksh.hu/statszml E-mail: statszemle@ksh.gov.hu
Publishing office: Central Statistical Office, Budapest II., Keleti Károly utca 5–7.
Postal address: P.O.B. 51. Budapest, 1525. Phone: (361)-345-6000
The publication can be purchased at the Statistical Special Bookshop:
Budapest II. Keleti Károly utca 10. Phone: (361)-212-4348

# RECENT HISTORY OF THE NONPROFIT SECTOR IN HUNGARY

ÉVA KUTI[1]

The paper seeks to explore the recent history of the Hungarian nonprofit sector in the context of the political, economic and social challenges that voluntary organizations had to face at the beginning of the 1990s. It identifies five major functions of nonprofit organizations (NPOs), namely democracy building, public policy formation, service provision, redistribution of wealth, and the socio-psychological role. By mapping the different types of NPOs, the paper offers an analysis of the structural changes and their impact on the nonprofit sector's access to financial resources. Finally, the author gives an overview of the major issues and problems (sectoral identity, financial and economic sustainability, effectiveness and legitimacy) that the nonprofit sector has to solve if it wants to stabilize its position and to meet the expectations of its clients and supporters.

KEYWORDS: Nonprofit sector; Civil society; Sustainability.

The recent history of the Hungarian nonprofit sector can only be understood in the context of the political, economic and social challenges that voluntary organizations had to face at the beginning of the 1990s.

The majority of voluntary associations established in the 1980s were tempted to play some role in the political changes of 1989-1990. The opportunity to build a multi-party political system and a real political democracy, to develop a new political society came somewhat unexpectedly. The leaders of voluntary organizations were among the prominent target groups when political parties tried to recruit leaders and activists. Many of the civil society organizations had to face the dilemma of becoming active supporters of the newly emerging political parties or remaining neutral and independent; taking part in the election campaign or withdrawing from politics. Both historical and statistical evidences suggest that Hungarian voluntary organizations were quite active in the democratization process of the early 1990s, especially at a local level.

Similarly, they also contributed to the economic transition. This transition from the 'planned economy' to a modern market economy represented a challenge and offered several opportunities to both the old and the newly created nonprofit organizations The abolishment of the state monopoly of welfare services provided an opportunity for the

[1] Head of Section of the HCSO.

nonprofit service provision in the fields of health, social care, education and culture. The entire system of welfare services was to be changed, voluntary organizations were accepted and sometimes even welcomed and supported as service providers.

The transition process brought fundamental changes in society, as well. A major redistribution of wealth, political power and economic positions started about 1990. Individuals and entire social strata were exposed to economic and psychological dangers and, at the same time, many exceptional opportunities opened up before them. If they wanted to protect themselves or to seize these opportunities, Hungarians had to form alliances, self-help groups and advocacy organizations. Nonprofit organizations (NPOs) were expected to play an important role in the process of social restructuring, in building solidarity, and in promoting the inclusion and participation of socially or economically marginalized persons.

In order to meet these political, economic and social challenges, a wide variety of nonprofit organizations had to be created. Individuals, government bodies, public institutions, and business firms all used the nonprofit forms (private and public foundations, voluntary associations, public benefit companies) as a vehicle for solving problems and enforcing interests. Their behaviour was equally influenced by historical patterns and new constraints, thus the nonprofit organizations they established constitute an extremely heterogeneous sector. This is why there is a standing debate on how we should call and define[2] the sector, whether its organizations can be regarded as institutions of civil society, what is the appropriate interpretation of its spectacular development in the last decade of the twentieth century.

This paper seeks to explore the recent history of the sector through identifying its major functions, mapping the different types of NPOs and analyzing the economic background of their development.

## MAJOR FUNCTIONS OF HUNGARIAN NONPROFIT ORGANIZATIONS IN THE 1990S

In accordance with the various challenges to be met, the functions of nonprofit organizations are also manifold. The major types are as follows:

– democracy building, strengthening pluralism and citizen actions,
– public policy formation,
– service provision, economic restructuring,
– redistribution of wealth,
– socio-psychological role.

*Democracy building, strengthening pluralism and citizen actions.* Voluntary organizations not only mediate between the citizen and the State, the citizen and the economic power, they also establish mechanisms by which government and the market can be held

[2] The present paper applies the internationally accepted definition of the sector. (See *Salamon–Anheier*; 1997.) According to this definition, organizations can be considered as part of the nonprofit sector if they are officially registered, private, non profit-distributing, self-governing and voluntary. Terms like nonprofit organizations (NPOs) voluntary organizations, non-governmental organizations (NGOs) civil society organizations are all used as synonyms. For more details see *Kuti–Sebestény* (1997).

accountable by the public. Membership in voluntary groups encourages individuals to act as citizens in all aspects of society rather than bowing to or depending on state power and beneficence. In addition, NPOs provide means for expressing and actively addressing the varied complex needs of society, they strengthen pluralism and diversity.

One of the crucial roles of Hungarian voluntary organizations has been to fulfil these 'democracy building' functions during the transition period. The motivation of the establishment of the numerous NPOs in the early 1990s (see Table 1) was mainly the citizens' desire to actively influence the development of the new economic and political system, to participate in the decision-making process, to ensure some autonomy, to strengthen the local identity, to control and influence the local authorities, to promote cultural, ethnic, religious and linguistic diversity, to develop local information networks, to educate citizens and to encourage them to behave as citizens.

Table 1

*Number of nonprofit organizations in Hungary, 1990–2000*

| Year | Foundations and public law foundations | Voluntary associations and other nonprofit organizations | *Total* |
|---|---|---|---|
| 1990* | 1 832 | 11 255 | *13 087* |
| 1991** | 6 182 | 17 869 | *24 051* |
| 1992** | 9 703 | 20 660 | *30 363* |
| 1993*** | 11 884 | 22 778 | *34 662* |
| 1994*** | 14 216 | 25 943 | *40 159* |
| 1995*** | 15 650 | 27 133 | *42 783* |
| 1996*** | 17 109 | 28 207 | *45 316* |
| 1997*** | 18 603 | 28 762 | *47 365* |
| 1998*** | 19 225 | 28 159 | *47 384* |
| 1999*** | 19 754 | 28 417 | *48 171* |
| 2000*** | 19 700 | 27 444 | *47 144* |

* Figures from the court register of NPOs updated on the basis of a sample survey.
** Figures from the court register of NPOs – not updated.
*** Figures from the statistical register of NPOs updated on the basis of annual statistical surveys.
*Source*: *Kuti* (1976); *Nonprofit ...* (2002).

*Public policy formation.* Nonprofit organizations have played important roles in introducing, shaping and implementing policies for the last decade. We can differentiate roughly three approaches and methods used by NPOs when they actively participate in the policy dialogue without encroaching on the sphere of political parties. The first of them concentrates on solving problems mainly through alternative or innovative service provision. The second approach is rather responsive. NPOs that adopt it try to shape public policy through providing the government with feedback on its proposals. The third approach is much more dynamic and creative: initiatives come from voluntary organizations that are able and willing to develop their own policy alternatives and to start a dialogue with political decision-makers.

One of the most frequently used methods of the Hungarian NPOs' participation in introducing, shaping and implementing policies is to act as 'alternative policy-makers', without paying much attention to the difficulties to be overcome. An abundance of exam ples (nonprofit psychiatric hospital for children, shelters for homeless and for victims of family abuse, school for drop-out children, 'job-exchange' for unemployed people, etc.) show that the method of first establishing the service providing organization and then attracting government support 'step-by-step' is often workable when direct lobbying proves to be futile. This approach can be quite fruitful, can efficiently influence the decisions of the 'professional policy-makers', and can result in some kind of social control of the changes in the welfare system if NPOs are able to combine lobbying and service provision.

However, nonprofit organizations as alternative policy-makers cannot substitute for voluntary organizations which are trying to control and influence the government policy in a more direct way. This direct civil control of the government action is of crucial importance. NPOs engage in this kind of advocacy quite frequently. There are lots of protests organized by voluntary organizations, trade unions, interest groups, sometimes even by the business community against additional taxes, industrial-technological projects, pollution, discriminative government measures, etc. Despite the numerous examples of this defensive, protective advocacy, there is a general feeling among NPOs that they are neither well-informed, nor organized enough and not prepared to be really successful in controlling governmental actions. If nonprofit organizations want to influence government policy, they must follow the political debates, get access to the different proposals, be knowledgeable about the relationships, keep contact with politicians, government officials and other NPOs, be prepared to analyze the newly emerging issues and start action at any moment when it seems to be necessary.

These kinds of knowledge and skills are even more necessary if nonprofit organizations do not want to wait for government initiatives in the fields where they can develop their own concepts and policy proposals. As the institutions of a developing civil society, voluntary organizations have their right not only to criticize and control government programs, but also to raise questions, suggest solutions and strategies. If they want to be accepted as partners by the government they cannot afford to confine themselves playing a passive, inferior role. They have to take the initiative in many fields where their members and supporters are knowledgeable enough and the citizens are likely to support the NPO proposals.

This approach is only feasible if nonprofit organizations are able to increase the professional level of their activities. Another necessary condition is the more stable and more efficient communication and co-operation within the voluntary sector. Though we have seen some examples of this dynamic, creative approach for the last decade, their number is significantly smaller than that of the problem-solving or defensive actions.

*Service provision, economic restructuring.* When the nonprofit service provision and the establishment of foundations became legal about 1990, neither the quantity, nor the quality of public services were adjusted either to the limited resources or to the consumers' demand. The government was not able to provide specific groups (such as minorities, disabled people, etc.) with the services they would have needed. Public welfare institutions were far from being efficient and flexible. The distribution of the services they delivered was perceived as unequal and unjust. As a response to these problems, several NPOs have been created in order to meet the unsatisfied demand or at least to alleviate the shortage for the last ten years.

The initiators have been mainly the potential clients (e.g. unemployed people, parents of handicapped children, etc.) or enthusiastic professionals (teachers, librarians, social workers, artists, etc.) both lacking the practice of managerial skills and sufficient money to invest. Recently, government authorities have also appeared among the founders. They have created several public benefit companies and public law foundations providing services (e.g. water supply, road maintenance, cultural services, etc.) that had been delivered by state-run institutions before. The future development of the existing service providing NPOs and the establishment of new ones depend mainly on government policy, including regulation, direct and indirect support, and the development of contracting out welfare services. The resources which are available cannot be dramatically increased, but the social control of their use seems to be feasible. The emergence of the nonprofit and for-profit service providers is clearly a step toward the institutionalization of this consumer control.

*Redistribution of wealth.* As an answer to the economic and structural problems of the Hungarian welfare system, a series of NPOs have been created in order to facilitate and institutionalize the voluntary redistribution of wealth. Though one can find several charitable foundations of the 'classical' type (e.g. poverty relief funds, organizations helping the disabled, homeless, refugees, etc.) among these NPOs, the majority of them raise donations for the public welfare institutions. Very few Hungarian consumers have enough capital to start new welfare institutions if they are not satisfied with the quality and quantity of services delivered by the state run organizations. However, most of them are ready to support voluntarily the improvement of these services. The majority of the public hospitals, clinics, universities, colleges, and many schools, kindergartens, libraries, other cultural institutions have set up foundations in order to urge and facilitate this voluntary contribution. Their establishment was practically forced by the circumstances in the early 1990s because there were serious cuts in the budget of public services, public institutions had to look for additional resources if they wanted to survive.

The founders of these grant-seeking foundations are not necessarily the clients of the supported institutions, but representatives of them and other supporters can nearly always be found among the board members. Consequently, the emergence of these 'satellite foundations' not only improves the financial position of the public service providers, but also imposes some consumer's control on their professional activities, which may bridge or at least decrease the gap between the supply of and the demand for welfare services.

Similarly, social control over the redistribution process has been intensified through the creation of large grant-making foundations distributing government money. These (mainly public law) foundations represent the first attempt to introduce the 'arm's length model', thus promote a less centralized and more participatory way of public grant-making in Hungary. Large public law foundations are also supposed to play an important role in the implementation of government policies. In principle, they can be appropriate means of assuring that the main flows of redistribution be consistent with the policy objectives and the actual grant making procedure still remain free from politicization.

*Socio-psychological role.* The political transition has brought about fundamental changes in all parts of the society and economy. Wealth, political power and economic positions have been redistributed. Under these conditions a lot of people have felt endangered and willing to take all opportunities including those offered by the nonprofit or ganizations. NPOs and the additional resources (donations, governmental support, tax advantages) available through them have served as life belt for several individuals and organizations. Whether they wanted to protect themselves or to seize new opportunities, citizens had to form alliances, action groups and advocacy organizations.

Voluntary organizations have also played an important role in the process of social restructuring. People changing their social and economic positions often feel that they have to leave their previous organizations and find (or establish) new ones where they can meet the members of their new class. The membership in voluntary associations, participation and volunteering are essential elements of their status seeking behaviour.

The previous functions of the nonprofit sector are much too various to be fulfilled by a homogeneous set of organizations. Obviously, different roles must be performed by different actors: legal forms and organizational characteristics of NPOs must vary in accordance with their mission and activities. This relationship (see Table 2) is important and stochastic because institutional choice is always influenced by a series of factors (e.g. institutional environment, personal knowledge and preferences of decision-makers, etc.) and considerations (e.g. independence, registration procedures, tax treatment of different types of NPOs etc.).

Table 2

*Relative importance of different types of NPOs in fulfilling different functions of the nonprofit sector*

| Functions and roles | Private | Public law | Voluntary | Public law | Business, professional | Trade union | Public benefit company |
|---|---|---|---|---|---|---|---|
| | foundation | | association | | | | |
| Democracy building | X | | XX | | X | X | |
| Advocacy through pioneering | XX | | XX | | | | X |
| Advocacy through protesting | X | | XX | | XX | XX | |
| Pro-active advocacy | X | | XX | X | XX | XX | |
| Socio-psychological roles | | | XX | | X | X | |
| Service provision | X | X | X | X | X | | XX |
| Raising private donations | XX | | | | | | |
| Distribution of public funds | X | XX | | | | | |

XX – Prominent actor
X – Somewhat important actor

As it is displayed in Table 2, Hungarian nonprofit organizations do not always follow the traditional pattern of specialization. Foundations do not confine themselves to grant-making and grant-seeking, many of them are involved in service provision, as well. A lot of the private foundations are also active in different types of advocacy and in building democracy. However, the prominent actors of advocacy are voluntary associations, trade unions, business and professional associations, while voluntary associations play the most important role in building democracy and meeting the socio-psychological needs of their members. Created by the state and supposed to represent their members' interest, the public law associations are rather schizophrenic; that is why they could not become a prominent actor in any segment of the nonprofit activities. By contrast, the two other more or less state controlled nonprofit forms have been more successful. Since their emergence[3] in 1994, public benefit companies have come into prominence among nonprofit service providers, while public law foundation have gained importance in distributing governmental money.

To be summarized, even this very short overview of the various functions (and the corresponding legal forms) of nonprofit organizations suggests that the sector's rapid growth (see Table 1) in the early 1990s has its roots in actual needs and aspirations of the Hungarian society. Similarly, the structural changes (resulting from survival and ceasing of the old voluntary associations and creation of the new NPOs) also reflect the changing environment in which the nonprofit sector has developed for the last decade.

## STRUCTURAL CHANGES IN THE NONPROFIT SECTOR

Starting from an absolute dominance of membership organizations in 1990, by now, only 58 percent of NPOs are voluntary associations. Although more than half of these associations have been created since 1989, the structure of the sector is still marked by the 'heritage' of the socialist regime. That time, the bulk of NPOs were voluntary fire brigades, professional and research associations, trade unions, and voluntary associations engaged in sports, recreation, and, to some extent, in culture and social care. The fields of education and research, health care, international activities, development and housing were definitely underdeveloped, mainly because the socialist regime monopolized these kinds of welfare services. While voluntary organizations as service providers were tolerated in culture and even promoted in sports, recreation and emergency prevention, they were not allowed to establish schools or hospitals.

Table 3

*Structure of the nonprofit sector in Hungary in 1990, 1995 and 2000*

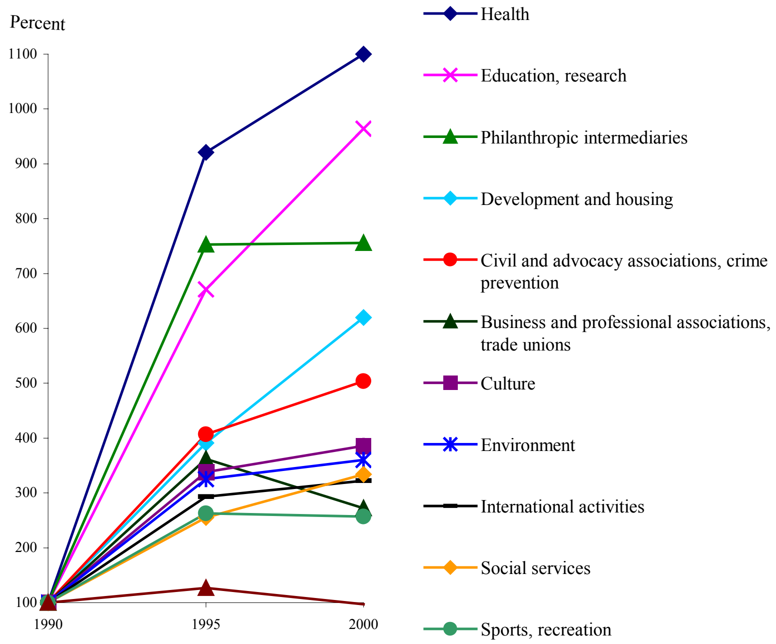
| Fields of activity | 1990 | 1995 | 2000 |
|---|---|---|---|
| Culture | 1 279 | 4 327 | 4 942 |
| Sports, recreation | 5 365 | 14 134 | 13 815 |
| Education, research | 822 | 5 518 | 7 923 |
| Health | 190 | 1 749 | 2 111 |
| Social services | 1 236 | 3 148 | 4 137 |
| Environment | 283 | 919 | 1 019 |
| Development and housing | 529 | 2 067 | 3 279 |
| Civil and advocacy associations, crime prevention | 391 | 1 591 | 1 969 |
| Emergency prevention and relief | 920 | 1 171 | 892 |
| Philanthropic intermediaries | 91 | 685 | 688 |
| International activities | 198 | 580 | 637 |
| Business and professional associations, trade unions | 1 501 | 5 427 | 4 088 |
| Other | 282 | 1 467 | 1 644 |
| *Total* | *13 087* | *42 783* | *47 144* |

*Source*: *Kuti* (1976); *Nonprofit …* (1997, 2002).

[3] An outcome of a bill that changed the Civil Code in 1994 introducing three new types of NPOs, namely the public law associations, public law foundations, and public benefit companies. For more details see *Kuti–Sebestény* (1997).

Though the shortage of capital has been a major impediment to the development of nonprofit welfare institutions in the 1990s, the growth reflected in the statistical indicators (see Table 3 and Figure 1) is still impressive. This growth started to decrease the differences between the Hungarian and the Western European nonprofit sectors. Since the state monopoly of welfare services was broken, voluntary organizations have gained ground considerably in the formerly neglected fields, which also means that they have had direct influence on the welfare mix and on some developmental decisions.

*Figure 1. Growth of the number of nonprofit organizations in different fields of activity between 1990 and 2000*




*Source*: *Kuti* (1976); *Nonprofit …* (1997, 2002).

Figure 1 elucidates that the growth of the number of nonprofit organizations was not even between 1990 and 2000. First, the rate of growth was much higher in the first than in the second half of the decade in the nonprofit sector, as a whole. Secondly, the shape of the curve describing the changes was significantly different in various fields.

At the cost of some simplification, we can identify three types of growth (see Figure 2). They are as follows:

*1. Steady growth* (high growth rate throughout the 1990s):

– education and research,
– health,
– social services,
– development and housing,
– civil and advocacy associations, crime prevention.

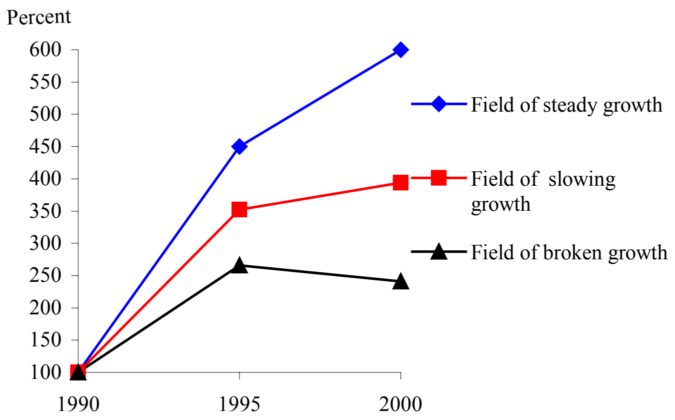
2. *Slowing growth* (the growth rate was significantly lower in the second half of the decade):

– culture,
– environment,
– philanthropic intermediaries,
– international activities.

3. *Broken growth* (the number of nonprofit organizations decreased in the late 1990s)

– sports and recreation,
– emergency prevention and relief,
– business and professional associations, trade unions.

*Figure 2. Types of growth, 1990-2000*




Most fields that had been relatively developed in 1989 stopped growing in the second half of the 1990s. By contrast, steady growth was a characteristic feature of the majority of the formerly less developed or almost non-existent segments of the nonprofit sector. This process obviously resulted in important structural changes and had some impact on the nonprofit sector's access to financial resources.

## ECONOMIC STRENGTH AND REVENUE SOURCES

The financial indicators (see Table 4) show that the economic importance of the Hungarian nonprofit sector is definitely larger than it is generally presumed to be, though its growth has been somewhat slower than that of the number of nonprofit organizations.

The third sector revenues (at constant prices) more than doubled, employment increased by 91 percent between 1990 and 2000, while the number of NPOs more than tripled. The relatively slow employment growth has to do with the fact that the nonprofit sector's share in the GDP is still modest. However, the sector's contribution to the total output is 18 percent in the field of culture and recreation, 5 and 4 percent in education, health and social care, respectively (*Nonprofit*…; 2002. p. 31.). These figures suggest that the service-providing role of NPOs deserves far more attention than it attracted in the first years of the transition period. Its growing importance is also reflected in the changes of the revenue structure (see Table 5 and Figure 3).

Table 4

*Economic indicators of changes in the nonprofit sector between 1990 and 2000*

| Economic indicator | 1990 | 1995 | 2000 | 2000 (Index: 1990 = 100) |
|---|---|---|---|---|
| Revenues at current prices (billion HUF) | 31.4 | 181.9 | 495.6 | 1578.3 |
| Revenues at constant (1990) prices (billion HUF) | 31.4 | 58.7 | 79.2 | 252.2 |
| Full-time equivalent employment | 32 738 | 45 475 | 62 522 | 191.0 |

*Source*: *Kuti* (1976); *Nonprofit* ... (1997, 2002).

The slight increase of the share of direct government support is, at least partly, an outcome of contracting out some of the formerly state delivered services. Nevertheless, this support is still parsimonious in Hungary, its share (28 percent of the total nonprofit income in 2000) is much lower than in Western Europe or in any other developed country of the world (*Salamon–Anheier*; 1998).

Table 5

*Nonprofit sector income by revenue sources, 1990, 1995, 2000*
(Billion HUF)

| Revenue source | 1990 | 1995 | 2000 |
|---|---|---|---|
| Support from the central government | 5 067.3 | 34 431.9 | 112 520.8 |
| Support from local governments | 745.1 | 6 479.5 | 28 396.6 |
| *Government support* | *5 812.4* | *40 911.4* | *140 917.4* |
| Corporate donations | 2 959.9 | 14 046.9 | 25 207.5 |
| Individual donations | 546.9 | 4 309.3 | 11 168.7 |
| Foreign donations | 2 550.2 | 16 406.8 | 31 578.2 |
| Donations from nonprofit organizations | 1 412.6 | 7 729.6 | 12 038.6 |
| *Private donations* | *7 469.6* | *42 492.6* | *79 993.0* |
| Membership fees | 3 672.5 | 17 099.9 | 29 104.8 |
| Service fees, sales and dues related to the basic activities | 4 993.9 | 27 175.4 | 154 000.7 |
| *Revenues from the basic activities* | *8 666.4* | *44 275.3* | *183 105.5* |
| Interest and investment income | 2 510.2 | 21 535.5 | 22 330.1 |
| Unrelated business income | 6 406.1 | 30 562.1 | 65 228.3 |
| *Revenues from for-profit activities* | *8 916.3* | *52 097.6* | *87 558.4* |
| Other | 505.5 | 2 139.4 | 3 933.7 |
| *Total* | *31 370.2* | *181 916.3* | *495 508.0* |

*Note*: Foreign donations were not separately displayed either in the published tables of the Johns Hopkins Comparative Nonprofit Project or in the Hungarian publication of the project. Nonprofit income from abroad was classified according to its actual source (e.g. the PHARE support to Hungarian NPOs was included in government support, the donation from George Soros in individual donations etc.). For the purpose of the present analysis, they had to be separated using the original data base in order to produce comparable figures. This is why the 1990 revenue structure in Table 5 is somewhat different from the one displayed in the cited sources.

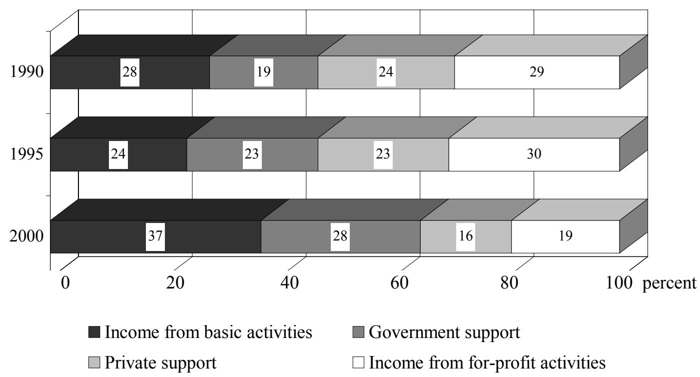
*Source*: *Kuti* (1976); *Nonprofit* … (1997, 2002).

Despite its relatively low amount, the support from municipalities is an important component of nonprofit revenues. As the majority of NPOs work inside one community, their prominent partner is obviously the local government. About one third of them are financially supported by municipalities (*Sebestény*; 2002). In addition, several types of in-kind donations from local governments facilitate voluntary activities. In many cases, these free services (office space, transport, communication, and administrative help) are crucial for the sustainability of nonprofit organizations.

The state support being meagre, Hungarian nonprofit organizations must rely on service income and membership fees. This means that they are probably more dependent on their clients and on private donors than their counterparts in the more developed countries.

The service fees, sales and dues related to the basic activities of nonprofit organizations increased dynamically and became the single most important source of revenues between 1990 and 2000. This extremely quick growth was possible because NPOs significantly increased the scope and variety of their services. They managed to meet formerly unsatisfied consumer demand and offered what their clients needed. This is how they could attract additional fee income in a decade when the market of welfare services was not in a good shape and lots of potential clients struggled with serious financial difficulties. The development of marketable service provision could even counterbalance the much slower growth of membership fees, i.e. the other component of mission related income.

*Figure 3. Structure of nonprofit revenues, 1990, 1995, 2000*



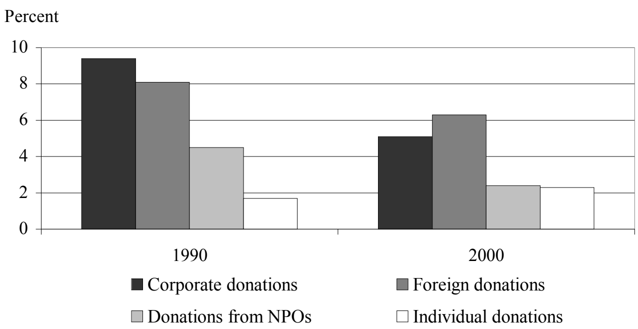

*Source*: *Kuti* (1976); *Nonprofit* … (1997, 2002).

In short, by the end of the 1990s, the nonprofit sector's financial sustainability was more dependent on the income from basic activities than on any other revenue source. In parallel, the dependence on the income from for-profit activities (financial investments and business ventures) decreased. Interest, dividends and unrelated business income were much less important revenue sources in 2000 than they had been in 1990.

To a much smaller extent, the relative importance of private donations also contracted. There was only one element of private contributions that could slightly increase its share within the nonprofit sector income when the proportion of all other components decreased (see Figure 4). Interestingly and unexpectedly enough, this was individual giving.

Since individual giving operates from a much smaller domestic base in Hungary than in the developed countries, the relatively high growth rate of donations must be explained by the close connections and mutual dependence between private individuals and their nonprofit organizations. Under the circumstances of denationalization and shrinking public services, Hungarians can be sure that their problems will not be solved by the government, so they need to create voluntary organizations and must contribute both work and money if they want to increase the consumption of collective goods. Foundations are important satellite institutions of schools, universities, libraries, hospitals, nurseries, research institutes and they can be found quite frequently in the interest sphere of the churches and political parties, as well. Their main role is raising tax deductible donations for either the general activities or the special projects of these institutions. It also happens that voluntary associations (e.g. readers' clubs, scientific societies, youth associations etc.) work in close connection with these institutions. In these cases the associations and their 'mother institutions' mutually support each other. Trade unions, professional associations and employers' organizations also try to solicit individual donations and sometimes establish foundations for fund-raising and grant-giving purposes.

*Figure 4. Kinds of private donations as percentage of the total nonprofit sector income, 1990, 2000*

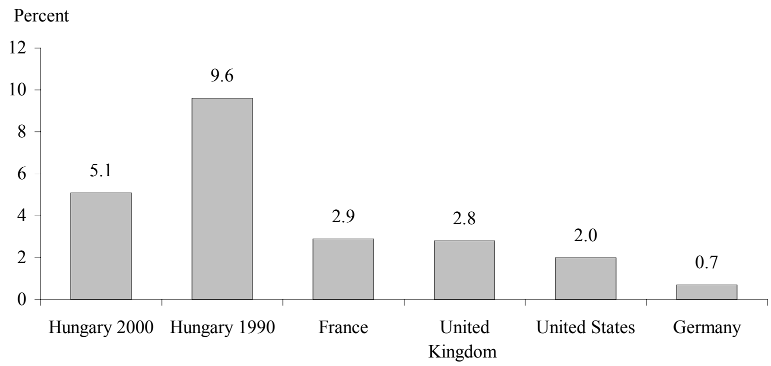



*Source*: *Kuti* (1976); *Nonprofit* … (1997, 2002).

Both the annual surveys of nonprofit organizations and a representative survey of giving and volunteering (*Czakó et al.*; 1995) carried out in 1994 confirm that people are willing to help charitable organizations and to contribute to the solution of social problems. Trust in the supported organization and clarity of the organizational aims to be achieved play an important role in the selection of supportees.

Similarly, private firms are also important donors of nonprofit organizations. Corporate philanthropy has a long tradition in Hungary that was not broken in communist regime. Quite the opposite, for state-run companies it was almost obligatory to develop some corporate welfare policy. They had to put some part of their profit into a 'welfare fund' which was a source of financing corporate welfare services. Several companies had their own nurseries, kindergartens, recreation homes, sports facilities, clubs, libraries and houses of culture, most of them regularly supported their aged pensioners and employees in need. This tradition of the corporate welfare policy did not completely vanish after the privatization. Many firms converted their 'welfare funds' into foundations, several corporate welfare institutions were also donated to these foundations before or during the privatization process. These kinds of donations were extremely beneficial for the early development of foundations and produced an unusually high share or corporate donations in 1990.

*Figure 5. Corporate donations as a percentage of the total nonprofit sector income, 1990*




*Source*: *Salamon–Anheier* (1994), *Nonprofit …* (2002).

The share of the corporate support to the nonprofit sector has somewhat decreased since then, but it is still much higher than in the developed countries (see Figure 5). This suggests, on the one hand, that there are many firms which have not stopped subsidizing welfare services provided by 'their' foundations. Besides the charitable motivations, economic reasoning also accounts for this willingness to support foundations. The tax and social insurance burden of salaries is so high that many employers prefer covering the relatively lower costs of in-kind welfare services which are considered as part of their remuneration by the employees. On the other hand, multinational firms (e.g. Shell, Levi Strauss etc.) have started to work in Hungary for the last couple of years, thus the Western culture of corporate philanthropy has also appeared.

Similar changes can be detected behind the decreasing share of foreign donations, too. The euphoria after the collapse of the Soviet Union in 1989 created an unprecedented flow of grants. Many foreign donors decided to support the democratic transition, several Western NGOs opened offices and established local nonprofit organizations, support centers and even umbrella organizations in order to accelerate the democratization in Eastern Europe.

The slow decline of the share of foreign aid is more or less natural. Donors never intended to take long-term responsibility for financing civil society organizations in Hungary, they only wanted to help the transition process. There is nothing surprising then about their 'marching out', but it still may have a harmful impact on several organizations of the nonprofit sector that attracted large foreign grants in the early 1990s. Though they are seemingly aware of this danger, the diversification of fund-raising activities is not an easy task.

To sum up, Hungarian NPOs must and do try to rely on several different types of donors. Their efforts to exercise some control over social processes, decision-making and the provision of welfare services are actually supported by a wide range of social actors. However, this new sector has to face a series of challenges if it wants to stabilize its position and meets the expectations of its clients and supporters.

## MAJOR ISSUES AND CHALLENGES

*The issue of identity*. As *Leś* (1994, p. 146.) stated, 'despite an enormous upsurge of voluntary organizations after the breakthrough of 1989 and their growing capacity as service provider, formally they are still not conceptualized in terms of a separate and independent sector, similar to the public and private sectors'. Numerous and influential as they are, NPOs can hardly claim that they would really work or identify themselves as a community representing civil society.

An institutional field can gain collective identity if its members tend to act in concert. The lack of these coordinated movements is one of the most difficult problems in the Hungarian voluntary sector. The different roles they play create some 'natural' divisions between the nonprofit organizations. Advocacy groups frequently resent the pragmatism and opportunism of service-providers, while the latter think that their activities are much more important and useful than the ones other NPOs are engaged in. Recreation clubs and membership organizations feel neglected and discriminated. In addition, there is a deep political conflict between the old-fashioned, formerly government-controlled voluntary associations and the new institutions of civil society, and between different political groups. There is also some tension between the heads of grassroots, government-funded and foreign-funded organizations. Very few activists of the small organizations seem to understand that their organizations belong to a sector and their problems could probably be solved only in co-operation with their counterparts. Developing identity and sector-wide co-operation is clearly a challenge which should be met in the very short run because a nonprofit community divided by rivalry will not be able to represent civil society and cope with financial, economic and legitimacy problems.

*Financial, economic and sustainability issues*. The politically motivated renaissance of the voluntary sector can hardly be followed and consolidated by a steady growth without a significant development of the nonprofit service provision. As a consequence of Hungarian norms and values, NPOs confining themselves to criticism and protest and not even trying to solve problems are not really respected and trusted. Most of the nonprofit organizations are aware of this necessity and they make efforts to enlarge their services. The main obstacle to this kind of development is a chronic shortage of resources. Private donors prefer to support spectacular events and highly visible projects. The population is obviously much too poor to buy the services at a market price, or to finance their nonprofit provision through substantial private giving. The government wants to transform the state socialist welfare system into a mixed economy, thus welcomes nonprofit service providers, but is not so eager to support them. There is not a clear agreement concerning financing obligations and techniques; the practice tends to be chaotic and contradictory.

The tax system is under 'reconstruction', rules for tax exemptions and tax deductibility change much too frequently, thus – in the short run – voluntary organizations cannot firmly rely on these forms of governmental support. As far as the direct state support is concerned, the situation is not much clearer or better. Competitive tenders are extremely rare. The arm's length and subsidiarity principles are not rooted in the Hungarian political culture. They are 'imported', they represent an attractive element of the recently developed vocabulary which fits, in best case, in the ideology, but not in the behavioural patterns of the government.

*Effectiveness and legitimacy issues*. As *Kramer* (1992, p. 50) states: 'Using NPOs as service providers offers welfare states ... an acceptable way of dealing with the decline in the legitimacy ascribed to government, and the decreased confidence in its capacity to provide economic, equitable and effective public services'. If this is true in the developed welfare states, then it is even more relevant in a post-socialist country which has more and more serious problems to be solved. We must raise the question, whether the NPOs engaging in service provision will not face the very same decline in legitimacy and confidence which the government as a service provider is suffering from.

The challenges to be met are enormous. After the rather chaotic period of the extensive growth, nonprofit organizations should really organize themselves, develop their own rules of ethical behaviour, establish their umbrella organizations, improve co-operation and information exchange within the sector and significantly increase the professional quality of their activities. The further development of the nonprofit sector depends on its ability to cope with the difficulties of consolidation and professionalization. Voluntary organizations must face these challenges in order to fulfil their service providing functions and still remain important institutions of civil society.

## REFERENCES


CZAKÓ Á. ET AL. (1995): *Individual giving and volunteering in Hungary*, Központi Statisztikai Hivatal and Nonprofit Kutatócsoport, Budapest.

KRAMER, R. M. (1992): The roles of voluntary social service organizations in four European states: policies and trends in England, the Netherlands, Italy and Norway, In: KUHNLE–STEIN–SELLE (ed.) *Government and voluntary organizations. A relational perspective*. Avebury, Aldershot, Brookfield, USA, Hong Kong, Singapore, and Sydney,.

KUTI É. – SEBESTÉNY I. (1997): Nonprofit sector in Hungary in the early 1990s, *Hungarian Statistical Review*,. Special number. p. 97–107.

KUTI É. (1976): *The nonprofit sector in Hungary*. Manchester University Press, Manchester.

LEŚ, E. (1994): *The voluntary sector in post-communist East Central Europe*. CIVICUS, Washington.

*Nonprofit szervezetek Magyarországon, 1995*. (1997) Központi Statisztikai Hivatal, Budapest.

*Nonprofit szervezetek Magyarországon, 2000*. (2002) Központi Statisztikai Hivatal, Budapest.

SALAMON, L. M. – ANHEIER, H. K. (1994): *The emerging sector. The nonprofit sector in comparative perspective.* Institute for Policy Studies, The Johns Hopkins University, Baltimore.

SALAMON, L. M. – ANHEIER, H. K. (1998): *The emerging sector revised. A summary*, Institute for Policy Studies, The Johns Hopkins University, Baltimore.

SALAMON, L. M. – ANHEIER, H. K. (ed.): *Defining the nonprofit sector. A cross-national analysis*. (1997) Manchester University Press, Manchester.

SEBESTÉNY I. (2002): *A nonprofit szervezetek önkormányzati támogatása 2000-ben.* Központi Statisztikai Hivatal, Budapest.

# SOCIAL RELATIONSHIPS OF THE POOR

JUDIT MONOSTORI[1]

This study is concerned with patterns of the social relationships of the poor in the context of the theory of social exclusion. It examines the intensity and the nature of the relationships of the poor with relatives, friends and neighbours. With regard to the latter, we distinguish work activity performed in the framework of social relationships from leisure activity. The source of data used is the 1999/2000 Living Conditions and Time Budget Survey of the Hungarian Central Statistical Office. Thus, we present a new approach to the study of personal relationship networks, as we make deductions regarding relationships based on the amount of time spent together.

The questions of the study are derived from the theory of social exclusion and from the results of earlier Hungarian research concerning the sociography and relationship networks of the poor. These questions are the following. Are the social relationships of the poor truly more confined than those of the non-poor? Do relationships with neighbours truly dominate over others? Does work performed together or for each other truly play a greater role in these relationships than leisure activity does? And finally: do the poor feel more lonely and isolated than the non-poor members of society?

KEYWORDS: Social exclusion; Personal relationship networks; Use of time.

In sociological literature, especially that concerned with poverty, the concept of social exclusion appears with increasing frequency. The study of social exclusion is based on French research traditions. The keystone of these is an image of society as a cultural and political community, a series of ties, rights and obligations rooted in a moral canon. Social exclusion is the process by which a person is excluded from the moral canon that is the foundation of the organisation of society (*Room*; 1997).

The third poverty research program of the European Union (European Community Programme, Poverty 3) recommended that poverty should be interpreted by researchers in four dimensions: *1*. in relation to the system of democratic and legal institutions that ensure the integration of citizens; *2*. in the context of labour market situation, which provides economic integration; *3*. with respect to the welfare system, which assures social integration, and finally *4.* with respect to familial and communal institutions that govern relationships between individuals.

In this approach, the pattern of the social relationships of individuals is one of the dimensions of social exclusion, which may be interpreted on three levels: those of *1.* family

[1] Adviser of the HCSO.

relationships, *2.* social relationships, and, *3.* participation in social organisations. Issues examined in the context of family relationships include whether the respondents live alone or in a family, whether they raise their children alone, whether they have contacts with their family members, siblings or parents living outside their household and how frequently and on what occasions they meet. With regard to social relationships, questions concern relationships with neighbours, friends, acquaintances and colleagues. These areas also allow us to make deductions about the social relationships of respondents from the extensiveness, intensity and nature of the network of relationships. As regards participation in social organisations we can focus on membership in civil organisations, political activity, participation in religious meetings, and any other social relationships that facilitate the integration of the individual into the society (*Non-monetary …*; 1995).

Our study analyses the patterns of the social relationships in the context of the first two levels. Within these, we examine relationships with family and relatives, friends, and neighbours. Theories concerning social exclusion also deal with the possible causes of exclusion. These include prejudices, ethnicity and deviance. Researchers also point out the lack of financial resources, i.e. poverty, as one of these possible causes (*Non-monetary…*, 1995).

This study attempts to provide empirical evidence, based on this idea, for the assumption that the social relationships of the poor differ in both their intensity and their nature from those characteristics of the non-poor society. Basically, causal connections between individual phenomena are frequently questionable. When examining a network of personal relationships, especially in the case of relationships within a family or with relatives, it is hard to identify poverty and the characteristics of the network of relationships as cause or as effect. Is it poverty that leads to the weakening of family and relations ties or in the sphere of close family relationships possibly conduces to divorce, or is it the dissolution of family ties that results in a 'recession' in the possession of material goods? Does poverty weaken contact with relatives living outside the immediate family, or does it lead to poverty if relatives 'let go' of a family in need of support. Such dilemmas conduct the researcher of poverty issues to yet one more problem. Namely: how to differentiate the phenomenon of poverty and the phenomenon of social exclusion. In this respect, there is a wide spectrum of possible approaches. One extreme is represented by approaches that define poverty as having a low income and social exclusion as a multidimensional phenomenon extending to several areas of material and non-material existence. The other extreme is the assumption that these two concepts are identical. According to the social exclusion theory that the present study is based on, poverty means the lack of financial resources and low-level material consumption, while social exclusion is defined as exclusion from those goods that represent the integration of individuals into society.

## QUESTIONS OF THE STUDY

According to the theory of social exclusion, poverty may be one of the causes of the narrowing of the network of personal relationships. However, this assumption needs to be justified, for often its direct opposite is found in sociographical literature, which reveals an abundance of relationships among the poor. This abundance mostly arises from need. That is to say, poor people often need material help, or assistance in the form of work, to substitute for the utilisation of services. This presupposes a more extensive construction of relationships, based on tighter bonds. Of course it must also be noted that such sociographical research was generally focused on the study of closed communities, which may influence survey results significantly and which seriously limits generalisation.

The results from Hungarian network research in this field are also controversial. Studies focused on friendly relationships indicate expressly that the friendly relationship networks of the elder generations, of people with a lower education and of those living in villages are narrower than those of other social groups (*Utasi*; 1990, *Albert–Dávid*; *1998*). Yet a research conducted in the late eighties has revealed that relationships with neighbours are most intensive in the very groups mentioned previously (*Angelusz–Tardos*; 1988). Searching for reasons, researchers conclude that these groups frequently find themselves in situations where they need to borrow money, food or assistance in work, and neighbours can play an effective role in fulfilling such needs. As regards relationships with relatives, research findings assert that in the groups mentioned previously, relationships with relatives are more dominant than in other social groups (*Angelusz–Tardos*; 1988).

Yet all this is not sufficient to conclude that the personal relationship network of the poor is patterned similarly to the previous groups, for the poor include in proportions higher than the national average – apart from the groups listed – divorcees, people raising children alone and widows or widowers. Within these groups, in certain cases, e.g. with regard to relationships with relatives, we can expect findings quite contrary to the previous.

The first part of the study categorises relationships according to the mutual relationship of the parties, and examines the characteristics of the personal relationship networks of the poor.

Social relationships may be grouped not only by the relationship of the parties, but also by the function of the relationship. We can distinguish relationships fulfilling emotional and instrumental functions. Emotional relationships are primarily meant to satisfy such needs of individuals as the need for company to counter solitude, for resolving events that pose a problem or conflict to the individual, and for sharing experiences. On the other hand, satisfaction of instrumental functions may manifest in the form of acquiring material goods, of borrowing and of assistance in the form of work. Naturally, these functions may be present simultaneously in a single human relationship. Given that the poor need support more frequently because of their financial indigence, it can be assumed that their relationships are dominated by those fulfilling instrumental functions. That is to say, the poor give or receive material support or assistance in work more than the non-poor. The second part of our study undertakes to explore this issue.

The characteristics of the network of personal relationships can also be examined in its subjective aspect, rather than only in the objective one: how respondents experience the development of their human relationships, how isolated they feel, and how they perceive the medium that presents them potential opportunities for forming relationships. The last part of our paper presents the patterns of key points in the subjective experience of the network of personal relationships in the poor and non-poor strata.

## SPECIAL FEATURES OF THE APPROACH TO THE RESEARCH PROBLEM

To explore the characteristics of social relationships for our study, we basically processed data regarding the use of time by individuals. This was intended to obtain a picture of the so-called micro-networks, i.e. the network of personal relationships of the respondents. This approach is fundamentally different from the methods applied in Hungarian network research.

The 'three friends' method concentrates on the composition of relationships and the study of heterogeneity (*Utasi*; 1900). The other, the Fischer method allows for a more complex analysis, as it can measure, apart from the former, extensiveness, i.e. the size of the network of relationships, and the density, i.e. whether various members of the network are also interconnected.

The Living Conditions and Time Budget Survey contains three kinds of information with regard to the network of social relationships. On the one hand, it reveals the role of social relationships in the daily time use of individuals, i.e. the amount of time the respondents spend in these relationships. On the other hand, it also shows the proportion of relationships with relatives, friends and neighbours within this. And third, it helps to point out the shared activities that respondents perform in company.

However, an analysis of these factors does not cover the entirety of the network of personal relationships, for relationships become manifest not only in time spent together, but also for example in financial support, issues of which cannot be revealed merely on the basis of time management. Another limiting factor of sorts is that the amount of time spent together is not necessarily equivalent to the intensity or the potential scope of a relationship. That is to say, individuals might have valuable relationships that play a very important role for them even though they cannot devote much time to these relationships. It is also feasible for a relationship to be based on the satisfaction of a certain function that, though it requires little time, is in itself very important. And there are also relationships with a high potential scope, i.e. ones that are not intensive on time use, yet can be mobilised in need. Despite all these limits, the use of time may be regarded as an area of individual resource management within which the amount of time that individuals devote to social relationships does have significance.

## THE CONCEPT OF POVERTY

There is no universal and generally accepted definition of poverty. Researchers use this concept on the basis of quite different approaches. On our part, we do not presume to resolve the debate over definition and measurement techniques that has been going on for over a century, since the beginning of the empirical study of poverty. Any definition of poverty and delineation of the poor can only take place as a series of arbitrary decisions by researchers. Poverty is a relative concept and has different meanings not only in different societies, but also in various social groups. Even the people involved would draw various boundaries between poor and non-poor. Can such boundaries be drawn at all? To what extent do the zones delineated by such boundaries express different situations in life? And perhaps no-one doubts that there are significant differences within the group of the poor as well. The increasingly current use of approaches of 'absolute poverty' does not abate all these difficulties. In the words of *O. Lewis*, 'We all know poverty when we see it, but few know what it is exactly.' (*Lewis*; 1969) However, because of all these dilemmas we present a brief explanation of the concept of poverty used in this study.

This is an objective, relative and multidimensional concept of poverty that covers the material aspects of the conditions of living. We have considered four dimensions of material living conditions: *1.* income, *2.* the value of the home, *3.* the amount of durable consumer goods in the home, and *4.* any movable or immovable property of great value. We would have preferred to formulate the concept of poverty used taking into consideration a wider spectrum of consumption, but unfortunately the data survey did not allow this.

*1. Income*. In our data survey, income status was asked with regard to the preceding month and to the total income of the family. The offered answers consisted of income category, therefore we first had to assign a specific income value to the families. This value was the mean value of the income category. In consideration of the principle of the economies of scale of the family, we then calculated income per consumption unit rather than per capita from the family income, using an elasticity coefficient of 0.73. Based on these income figures, we classified families to five groups of equal size.

*2. Value of home*. Our data survey contained no information concerning the value of the home, therefore we used a regression estimate to count this. The basis of the estimate was the value given by respondents in the survey 'Residence conditions, 1999', projected to one square metre. The procedure of estimation involved creating a model from the data of the 'Residence conditions, 1999' survey, where the dependent variable was the value of the home projected to one square metre. Independent variables were factors of crucial influence to value: the location of the home by region and type of settlement; the type of the building; variables concerning comfort level; and data about the quality of the home. Applying the coefficients of the regression equation to our data survey, we produced the home value variable, which we used to produce quintiles. The lowest quintile comprised people who did not own a home or whose home had very little value.

*3. Durable consumer goods*. To produce this contracted variable, we used the possession of washing machines, refrigerators, televisions, computers, microwave ovens and VCRs. We made a distinction between traditional and automatic washing machines, as well as between black-and-white and colour televisions. In the cases of washing machines, refrigerators and TV sets, we also noted the age of these appliances. The elemental variables were transformed into standardised Z-scores, so that commonly possessed items had a lower weight and rare goods a higher weight in the contracted index. This index was then also used to produce quintiles.

*4. Movable and immovable property of great value*. Components included possession of holiday homes, motor vehicles, garage stalls and land plots. In the case of motor vehicles we noted the brand and age of the vehicle, and we took into account the size of land plots. These variables were contracted by a procedure similar to that used with durable consumer goods.

We used cluster analysis to join the individual dimensions. People who appeared in the worst situation with regard to all the studied dimensions jointly were regarded as poor. We used this method with the intention to ensure that the group of the poor include not only those who are in the worst situation in all the dimensions, but also people who might live in better circumstances with respect to one or another dimension, yet are altogether closer to the families who had drifted to the lowest quintile in all dimensions than they are to any other cluster.

Thereby, 17.1 percent of families, 15.7 percent of all population over 15 years of age were categorised as poor by our working definition. Among the poor, the average income per consumption unit of families does not reach 23 thousand HUF. Nearly one third of them lack a bathroom and almost half have no toilets within their homes. One family in ten does not own a refrigerator or a washing machine. A proportion of 70 percent owns only an old-fashioned washing machine. Modernisation goods such as microwave ovens and personal computers are almost completely absent. Even with widespread articles such as televisions, there are significant shortfalls. Nearly a quarter have only a black-and-white television. 95 percent of poor families do not own a car.

The figure in the following presents those demographic and sociological characteristics that indicated a risk of poverty below average or above average, i.e. the probability of groups with these characteristics being in the group of the poor.[2] The figure allows for a scrutiny of the structural differences between the poor and the non-poor.[3]

The type of settlement plays an important role with regard to the appearance of poverty. Progression downward along the hierarchy of settlements shows an increase in the risk of poverty. While the residents of Budapest comprise almost 20 percent of the entire population over 15 years, less than one tenth of the poor live in the capital, 36 percent of the total population, but 42 percent of the poor live in villages.

With respect to age groups, the most outstanding difference is in the elderly generation. Even those over 60 are over-represented among the poor, but the greatest structural difference appears in those over 70. While they represent less than 10 percent of the total population over 15 years, this group still comprises 17 percent of the poor.

With regard to family status, divorce and widowhood are most prone to increase the risk of poverty. The proportion of the divorced is 8 percent to the entire population, while it is 14 percent among the poor. The same indices for widows are 11 percent and 16 percent, respectively.

As regards the number of children, the extremes are most endangered. There is a higher risk of poverty in families where there are no dependent children – though probably effects of age are behind this – and in those where there are 3 or more children. The proportion of the latter group among those over 15 is nearly 5 percent, while it exceeds 7 percent among the poor.

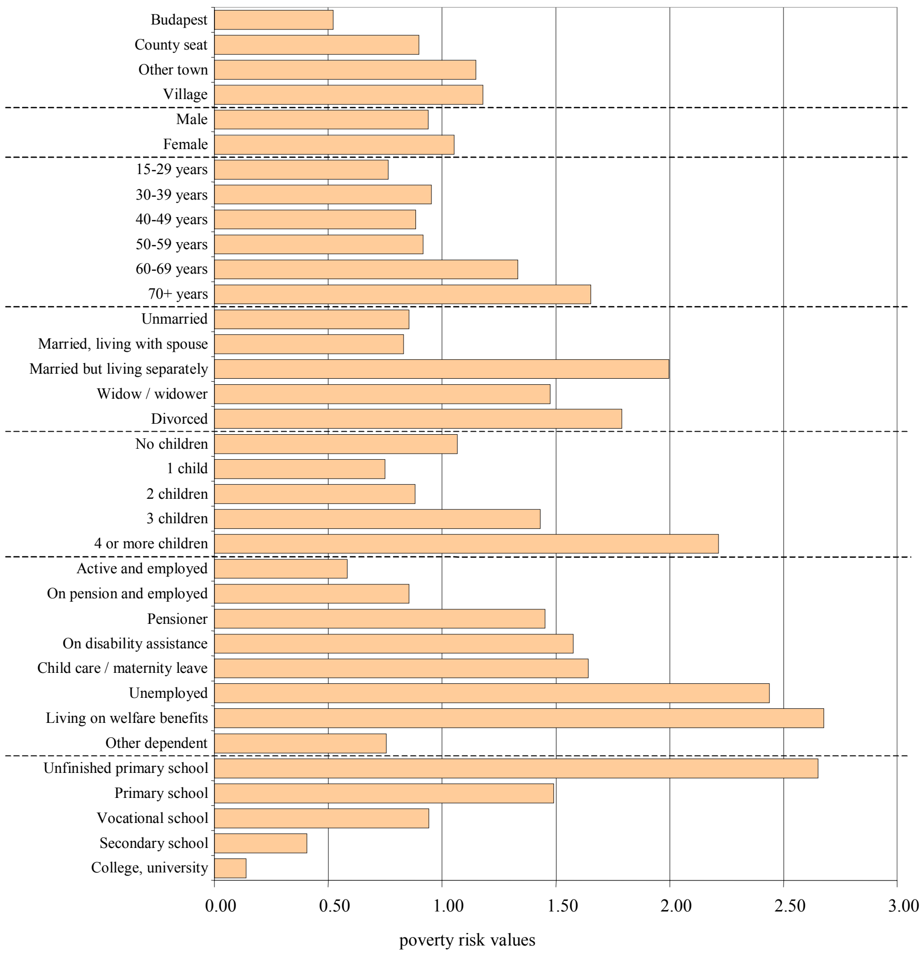
With respect to the labour market dimension, it can be stated that inactivity definitely increases the risk of poverty. While 53 percent of the population over 15 are inactive, this index is 73 percent among the poor. However, there are significant differences within the inactive subset. Within the group of pensioners, those on disability assistance are most endangered, but those living on welfare benefits and the unemployed also have a high poverty risk.

With regard to educational level, it can be stated that higher education levels entail increasingly lower risks of poverty.

[2] Risks of poverty were computed as follows. First, we examined the proportion of those belonging to the demographic or sociological group concerned, to the entire population. The same proportion was calculated within the group of those living below various poverty thresholds. The risk value was 1 if a certain group was represented in the same proportion within the entire population as within the group of the poor. If their proportion was higher among the poor, the risk index had a value over 1, and correspondingly, it had a value below 1 if the proportion was higher in the entire population. The value of the index was $Q=q_p/q$, where $Q$ is the risk of poverty, $q_p$ is the proportion of the group within the poor, and $q$ is the proportion of the group within the entire population.

[3] Data appearing in the table represent the population between ages 15 and 84, i.e. those who had been interviewed with regard to the use of time use in the survey.

*Risk of poverty in demographic and sociological groups*




## CHARACTERISTICS OF THE USE OF TIME AMONG THE POOR AND THE NON-POOR

The time the poor allot to social relationships is influenced by the structure of their entire time management, since time is a finite resource of which we can spend more on one activity only if we take it from another one.

The first major structural element of time management is *time used to satisfy physiological needs.* Within this, the largest share is taken by sleep, amounting to nearly one third of each day. Time spent on body care and hygiene takes about 1 of the 24 hours of a day. The third component of physiological needs is eating, to which respondents allot somewhat less than one and a half hours per day. However, meals are also one of the manifestations of family socialisation, of friends and colleagues being together, therefore this activity will be the first one that we will subsequently examine with regard to time spent on social relationships. All modes of passive rest that serve physical regeneration were also included among physiological activities. The poor spend 45 minutes with passive rest on an average day, while the amount of time thus spent is under half an hour among the non-poor. The following table shows these data broken down along the dimension of activity against inactivity (see Table 1).

Table 1

*Time allotted to physiological needs on an average day*
(minutes)

| The person | Sleep | | Body hygiene | | Eating, drinking | | Passive rest | |
|---|---|---|---|---|---|---|---|---|
| | poor | non-poor | poor | non-poor | poor | non-poor | poor | non-poor |
| Active age, working | 494 | 488 | 57 | 59 | 86 | 87 | 18 | 14 |
| Active age, not working | 545 | 526 | 49 | 59 | 90 | 91 | 40 | 33 |
| Inactive age, working | 525 | 497 | 50 | 59 | 82 | 88 | 61 | 27 |
| Inactive age, not working | 570 | 557 | 51 | 54 | 88 | 90 | 79 | 60 |
| Active age, studying | 563 | 543 | 54 | 58 | 77 | 81 | 11 | 12 |
| *Total* | *539* | *514* | *52* | *57* | *87* | *88* | *45* | *26* |

*Source*: The source of all data is the Living Conditions and Time Budget Survey of the Hungarian Central Statistical Office.

The second major group of activities is comprised of so-called *socially bound activities.* This includes all welfare-producing activities, i.e. all work, regardless of whether it is done for money, on the principle of reciprocity or on a voluntary basis. It also includes household chores, which we regard as work done for one's own household. We have also included studying and all forms of self-education in the sphere of socially bound activities.

One major component of work was time spent on working in one's principal occupation. On an average day, the poor spent one and a half hours and the non-poor over two and a half hours working in their principal occupations. However, this difference is a result of structural differences, as the proportion of the inactives is higher among the poor. Time spent on subsidiary work for money is higher among the poor, although relative to principal occupations, the time spent on such work is very little. On an average day, the poor spend 7 minutes and the non-poor 3 minutes on such activity. The proportion of voluntary work is low; it does not amount to a notable part of the daily time use of either the poor or the non-poor. In the exploration of social time use, we have also attempted to delineate activities within the sphere of work but related to the construction and maintenance of the network of personal relationships. Activities thus classed included those that a person living in a household performs for that household in the company of relatives, friends or neighbours; as well as those performed for other private households without taking payment. Time spent on such activities was 19 minutes in the case of the poor and 13 minutes among the non-poor. Within both groups, people of active age but not working registered the highest values here. As a last type of work activities, we examined home chores and all activities related to the maintenance of the household. The non-poor spend somewhat less than 4 hours on these, while the poor spend over 4 hours. The difference between the average values for the two groups is nearly 45 minutes. This is probably related to the fact that the non-poor are able to redeem more housework by the use of services than the non-poor.

The second great group of socially bound activities is studying. In total, the poor spend significantly less time on this than the non-poor. However, this is fundamentally due to the fact that the younger generations are under-represented in the poor group. Table 2 presents the differences arising from activity and inactivity.

Table 2

*Time allotted to welfare producing activities, studying and household maintenance on an average day*
(minutes)

| The person | Principal occupation | | Other work for money | | Voluntary work | | Work for own household with others, or for other households | | Housework for own household | | Studying | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | poor | non-poor | poor | non-poor | poor | non-poor | poor | non-poor | poor | non-poor | poor | non-poor |
| Active age, working | 287 | 301 | 10 | 4 | - | 1 | 18 | 12 | 193 | 169 | - | 3 |
| Active age, not working | - | - | 10 | 4 | 1 | 1 | 28 | 22 | 329 | 358 | 2 | 2 |
| Inactive age, working | 210 | 207 | 14 | 6 | 4 | 1 | 5 | 7 | 218 | 186 | - | - |
| Inactive age, not working | - | - | 2 | 1 | - | 1 | 13 | 12 | 272 | 280 | - | - |
| Active age, studying | 10 | 12 | 5 | 2 | - | 1 | 10 | 9 | 81 | 76 | 154 | 148 |
| *Total* | *90* | *160* | *7* | *3* | *1* | *1* | *19* | *13* | *258* | *215* | *8* | *20* |

Finally, we examined *free time* as the third major area of time use, which is also the main scene where social relationships become manifest. The extent of leisure activities is somewhat less among the non-poor, and amounts to exactly 5 hours among the poor. All activities that individuals carry on with their relatives, friends and neighbours were included in this sphere and registered as social activities.

Most free time is available to students and those of inactive age and not working; they are followed by those of active age but not working (see Table 3).

Table 3

*Time allotted to leisure activities on an average day*
(minutes)

| The person | Free time | |
|---|---|---|
| | poor | non-poor |
| Active age, working | 234 | 238 |
| Active age, not working | 317 | 308 |
| Inactive age, working | 217 | 294 |
| Inactive age, not working | 343 | 353 |
| Active age, studying | 323 | 342 |
| *Total* | *302* | *282* |

## SOCIAL CONNECTIONS OF THE POOR

The social relationships of the poor will be examined in three aspects: those of relationships with relatives, relationships with friends, and relationships with neighbours.[4] We intend to examine whether the social relationships of the poor are more intensive than those of the non-poor.

The data of time spent in the company of relatives, friends and neighbours were regarded as primary indicators of intensity. Time allotted to social relationships was computed from the figures of work done without taking payment, of free time spent together, and of shared meals or drinks.[5]

### *Relationships with relatives*

Our results indicate no difference between the poor and the non-poor with regard to the amount of time spent in the company of relatives. The time spent with relatives on an average day was somewhat over two hours in both groups. The poor have spent 129 and the non-poor 130 minutes, while the entire population 129 minutes in the company of relatives.

However, the structure of the poor with respect to demographic and sociological properties does differ from that of the non-poor (see the Figure), which may have two consequences with regard to the causes of this phenomenon. One is that the mechanisms bearing on this phenomenon among the poor are different from those that prevail among the non-poor. The other is that the factors working among the poor are the same, but due to the structural differences the opposing effects counterbalance each other.

We first tested the former assumption. Analysing groups created by types of settlement, our data confirm the results of earlier research according to which time spent with relatives increases with a downward progression along the hierarchy of settlements. This mechanism manifests itself in a different manner among the poor, for on the one hand the differences are not so great, and on the other, no correlation is found with the type of settlement. Poor people living in villages do not spend more time with their relatives than those living in cities.

In the groups broken down by age, the dependent variable exhibits an inverted U-shaped curve. Values are lowest in the youngest and oldest groups, while the highest values appear in the age group of 30 to 39 years. Among the poor, the differences between age groups are smaller. Furthermore, the time spent with relatives by the youngest age group is not one of the lowest values as compared to other age groups.

With regard to the differences by sex and by family status, the poor exhibited the same pattern as the entire population. Time spent in the company of relatives is higher for women and the married, and lower in other groups.

[4] In the Living Conditions and Time Budget Survey it was left to respondents to classify each of their relationships as one with a relative, with a friend or with a neighbour.

[5] Only those activities were considered that refer to shared activity. For example we did not consider time spent watching TV if no activity was performed together while watching, even though several people might have been present. This approach helps dampen the distortion arising from the fact that a substantial part of the time spent with relatives consists of activities resulting from living together. This is an important point, as we had no possibility to break down relatives according to whether they live in the same family or not.

Table 4

*Time spent with relatives on an average day*
(minutes)

| Characteristics | Poor | Non-poor | Entire population |
|---|---|---|---|
| Type of settlement | | | |
| Budapest | 126 | 118 | 118 |
| County seat | 130 | 123 | 124 |
| Town | 131 | 132 | 131 |
| Village | 127 | 138 | 136 |
| Sex | | | |
| Male | 121 | 122 | 121 |
| Female | 135 | 137 | 137 |
| Age group | | | |
| 15-29 years | 137 | 112 | 115 |
| 30-39 years | 172 | 167 | 167 |
| 40-49 years | 128 | 133 | 132 |
| 50-59 years | 118 | 134 | 131 |
| 60-69 years | 116 | 134 | 130 |
| 70 + years | 100 | 104 | 102 |
| Family status | | | |
| Unmarried | 106 | 92 | 94 |
| Married | 172 | 165 | 165 |
| Married but living separately from spouse | 128 | 104 | 113 |
| Widow/widower | 75 | 79 | 77 |
| Divorced | 98 | 100 | 100 |
| Number of children in the family | | | |
| No children in the family | 106 | 112 | 110 |
| 1 child | 143 | 144 | 143 |
| 2 children | 182 | 163 | 165 |
| 3 children | 195 | 201 | 199 |
| 4 or more children | 219 | 201 | 207 |
| Economic activity | | | |
| Active and employed | 115 | 122 | 121 |
| On pension and employed | 128 | 134 | 132 |
| Pensioner | 108 | 126 | 121 |
| On disability assistance | 140 | 153 | 152 |
| On child care or maternity leave | 295 | 342 | 330 |
| Unemployed | 149 | 169 | 159 |
| Living on welfare benefits | 153 | 172 | 165 |
| Other dependent | 121 | 107 | 109 |
| Level of education | | | |
| Unfinished primary school | 112 | 112 | 112 |
| Primary school | 132 | 127 | 128 |
| Vocational school | 134 | 134 | 134 |
| Secondary school | 139 | 129 | 129 |
| College, university | 122 | 140 | 138 |

If a family has dependent children, then the time spent with relatives is significantly higher than if there are no children in the family. A higher number of children entails an increased amount of time spent with relatives. These statements are equally valid for the poor and the non-poor group.

Neither do differing mechanisms appear among the poor and non-poor with respect to activity in the labour market; the differences between individual subgroups are similar in the two samples. The inactives typically spend more time with their relatives, the only exception being pensioners. However, this is probably also due to effects of age and family status (see Table 4).

To return to our original question, whether it is possible to find any mechanisms that operate only among the poor, bivariate analyses allow us to answer that apart from a few exceptions, generally the same criteria determine the extent of time spent with relatives among the poor as in the group of the non-poor.

However, the structure of the poor by the examined criteria does differ from that of the non-poor, while the values of the dependent variable are not different for the two groups (129 and 130 minutes). The explanation of this phenomenon is that some of the groups over-represented among the poor entail a higher value of the dependent variable, while other, similarly over-represented groups are characterised by lower time-use figures. These effects counterbalance one another. The categories over-represented among the poor include single people, the elderly, divorcees and widows. The over-representation of these groups would result in the poor spending less time in the company of relatives than the non-poor. However, the high proportion of people with large families, and especially of inactive people, has an effect contrary to the former. Thus, ultimately no significant differences are apparent between the poor and the non-poor in this respect.

In the next stage of our analysis, we applied a multivariate statistical model (linear regression) to examine whether poverty has an effect of its own on time spent with relatives, after eliminating the effects of demographic and social characteristics. This is essentially a measurement of whether it would be possible to register a significant difference in the values of the dependent variable in the poor and the non-poor groups, if the distribution of these two groups was identical with regard to the demographic and sociological criteria studied. Our results confirm the supposition stated after the bivariate analyses, i.e. that poverty has no effect of its own on the amount of time spent with relatives, once the effects of specific demographic and sociological criteria have been removed out (see Table 5).

We also wanted to find out how poverty modifies the effect of individual criteria. In the bivariate analyses we had found that certain categories of some variables had different effects on the dependent variable in the poor and the non-poor samples. To measure this, we incorporated interaction effects into our regression model. These independent variables indicate whether the effects of a given feature are significantly modified by the state of poverty, and if so, how. An example of this may be the effect of the type of settlement, where bivariate analyses indicated that the time use of those living in villages differed from those in other settlements in different ways depending on whether the poor or the non-poor group was studied.

The first feature that had different effects on the dependent variable when in interaction with poverty was the fact of living in villages, also corroborated by the multivariate analysis. Respondents who lived in a village and were not poor spent more time with relatives according to our estimations than the group designated as the reference category. However, those who were poor and lived in a village, spent significantly less time with their relatives.

Table 5

*Demographic and sociological variables determining time spent in the company of relatives*
(Linear regression analysis)

| Variables | *B* (minutes) | *p*-value |
|---|---|---|
| Constant | 190.206 | 0.000 |
| Poor | -2.864 | 0.122 |
| Type of settlement | | |
| County seat | -0.695 | 0.746 |
| Town | 4.454 | 0.024 |
| Village | 6.898 | 0.000 |
| Sex | | |
| Male | -12.316 | 0.000 |
| Age group | | |
| 15-29 years | 1.039 | 0.681 |
| 40-49 years | -20.105 | 0.000 |
| 50-59 years | -20.305 | 0.000 |
| 60-69 years | -31.875 | 0.000 |
| 70 + years | -46.550 | 0.000 |
| Family status | | |
| Unmarried | -70.141 | 0.000 |
| Married but living separately from spouse | -50.943 | 0.000 |
| Widow/widower | -80.278 | 0.000 |
| Divorced | -58.340 | 0.000 |
| Number of children in the family | | |
| No children in the family | -28.962 | 0.000 |
| 1 child | -7.256 | 0.001 |
| 3 children | 3.337 | 0.385 |
| 4 or more children | 13.603 | 0.046 |
| Economic activity | | |
| On pension and employed | 32.980 | 0.000 |
| Pensioner | 48.590 | 0.000 |
| On disability assistance | 45.003 | 0.000 |
| On child care or maternity leave | 165.044 | 0.000 |
| Unemployed | 44.278 | 0.000 |
| Living on welfare benefits | 48.456 | 0.000 |
| Other dependent | 10.746 | 0.000 |
| Level of education | | |
| Unfinished primary school | -14.998 | 0.000 |
| Primary school | -17.274 | 0.000 |
| Vocational school | -14.572 | 0.000 |
| Secondary school | -12.293 | 0.000 |
| $R^2$ | *0.145* | |

*Note*: Reference categories: non-poor, Budapest, female, 30-39 years, married, with 2 children, active and employed, graduate.

Another feature that had a significant effect in interaction with poverty was being married but living separately from the spouse. Without considering the effect of interaction, this feature effected a significant reduction in the value of the dependent variable. However, in conjunction with poverty, this reduction was substantially less in compari son to the reference category. On the other hand, the divorced spent significantly less time with their relatives, and this difference was even more apparent among those who were divorced and poor as well.

The effect of the categories formed according to the number of children was also modified by the fact of belonging to the group of the poor. The value of the dependent variable was below that of the reference category if a family had no dependent children, or only one. According to our estimates, respondents from such families who are also poor spend even less time with their relatives. On the other hand, the effect of having a large family was significantly stronger when the effect of interaction was disregarded. Incorporation of the interaction effect allows the conclusion that people with large families, i.e. those with 3 or more dependent children, show opposite effects when they are poor, i.e. they spend less time with their relatives than the reference group.

The last category where poverty influenced the effect of the independent variable was that of people staying at home with a child on child care or maternity leave. Here, time spent with relatives was outstandingly high; however, it was decreased significantly by poverty.

*Relationships with friends*

With regard to relationships with friends, data other than those of time use were also analysed, as the questionnaire included questions about the number of friends, the frequency of meeting the most important friend, and the origin of this latter friendship.

Our data reveal that the number of people without friends is significantly higher among the poor. Here, 41 percent of respondents said they had no friends, while this figure was 26 percent among the non-poor (see Table 6.). Furthermore, within those who do have friends, the frequency of people who mention only one friendship is higher (32%) in the case of the poor than among the non-poor (26%). Also, the proportion of people reporting an extended network of friendships (5 or more friends) is lower among the poor. Here, 7 percent answered that they had at least 5 friends, while the same index was 12 percent among the non-poor. Thus, it can be stated that the relationships of the poor with friends are less extensive than those of the non-poor.

Poverty also entailed a significantly lower number of friends when the relation between these two variables was controlled using the effects of demographic and sociological characteristics.

Table 6

*Number of friends*
(percent)

| The person | Poor | Non-poor | Entire population |
|---|---|---|---|
| Has no friends | 41.1 | 25.6 | 27.9 |
| Has 1 friend | 18.9 | 19.0 | 19.0 |
| Has 2 friends | 17.1 | 21.3 | 20.7 |
| Has 3 to 5 friends | 18.7 | 25.4 | 24.4 |
| Has more than 5 friends | 4.2 | 8.7 | 8.0 |
| *Total* | *100.0* | *100.0* | *100.0* |

How are these data reflected in the time use of the poor? Do the poor spend less time nurturing these relationships? According to the figures of time use, the poor spend 37 minutes of an average day in the company of their friends, while the non-poor spend 42 minutes.

Table 7

*Time use allotted to friends on an average day*
(minutes)

| Characteristics | Poor | Non-poor | Entire population |
|---|---|---|---|
| Type of settlement | | | |
| Budapest | 43 | 43 | 43 |
| County seat | 42 | 45 | 45 |
| Town | 36 | 43 | 42 |
| Village | 34 | 38 | 37 |
| Sex | | | |
| Male | 54 | 53 | 53 |
| Female | 23 | 31 | 30 |
| Age group | | | |
| 15-29 years | 72 | 82 | 80 |
| 30-39 years | 30 | 32 | 32 |
| 40-49 years | 40 | 26 | 28 |
| 50-59 years | 28 | 26 | 26 |
| 60-69 years | 26 | 21 | 22 |
| 70 + years | 13 | 15 | 14 |
| Family status | | | |
| Unmarried | 72 | 86 | 84 |
| Married | 22 | 22 | 22 |
| Married but living separately from spouse | 35 | 45 | 40 |
| Widow/widower | 18 | 21 | 21 |
| Divorced | 40 | 33 | 35 |
| Number of children in the family | | | |
| No children in the family | 36 | 43 | 42 |
| 1 child | 40 | 44 | 43 |
| 2 children | 39 | 34 | 35 |
| 3 children | 37 | 34 | 35 |
| 4 or more children | 32 | 44 | 42 |
| Economic activity | | | |
| Active and employed | 34 | 38 | 38 |
| On pension and employed | 34 | 29 | 29 |
| Pensioner | 20 | 20 | 20 |
| On disability assistance | 27 | 32 | 31 |
| On child care or maternity leave | 9 | 15 | 13 |
| Unemployed | 74 | 70 | 71 |
| Living on welfare benefits | 72 | 42 | 56 |
| Other dependent | 78 | 90 | 88 |
| Level of education | | | |
| Unfinished primary school | 19 | 20 | 19 |
| Primary school | 42 | 44 | 43 |
| Vocational school | 45 | 43 | 44 |
| Secondary school | 36 | 46 | 45 |
| College, university | 37 | 35 | 35 |

There are no significant differences between types of settlements in the time spent with friends. However, in the case of the poor the dividing line is rather evident between major cities and smaller settlements (towns and villages), while the greatest step is between towns and villages in the case of the non-poor.

The amount of time spent with friends was influenced significantly by the age of the respondent. Higher ages entail less time allotted to friendly relationships. In most age groups, hardly any differences are evident between the poor and the non-poor. There are only two groups where major differences can be detected. One is the youngest age category, where the young spend less time with their friends, while the other is that of 40 to 49 years, where on the contrary, the poor allot more time to friends.

With regard to the other demographic characteristic, namely sex, two statements may be made. One is that in both sub-samples men spend significantly more time in the company of their friends. The other is that while in the case of men the value of the dependent variable is not influenced by the fact of poverty, poor women spend less time with their friends than non-poor women.

Family status is also a definite predictor of the figures of relationships with friends. People without a spouse spend most time on such relationships, with the only exception being widows and widowers. Significant differences between the poor and the non-poor are detectable in three groups. One is that of the unmarried, another is that of people living separately from their spouses, and the third is that of the divorced. In the first two cases, the poor spend less time with their friends; in the third one they spend more time with them than the non-poor.

With regard to economic activity, the most pregnant difference is found in those living on welfare benefits. Poor people living on allowance spend significantly more time on relationships with friends than the non-poor. On the other hand, estimated values are lower for the poor in the cases of those subsisting on child care or maternity leave and the dependent than for their non-poor counterparts.

Categories by educational level show that in the case of the non-poor, those with the lowest and highest levels of education spend the least time on relationships with friends. The only difference from this among the poor is that no difference is detectable among the values of the dependent variable in the groups of those with secondary school education and of college or university graduates (see Table 7).

After performing the bivariate analyses, we again examined whether poverty had an influence on the figures of time spent with friends after the effects of demographic and sociological characteristics have been removed. According to the estimates of the multivariate analysis, poverty has no independent effect on time spent in the company of friends. The differences found by the bivariate analyses were rather due to the structural differences existing between the poor and the non-poor (see Table 8).

Next, we determined the criteria whose effect on the dependent variable is modified by poverty. We found significant values in three of the categories whose interaction effects were included in the regression model. The first was the category of men. In comparison to the reference group, the fact of the respondent being a man significantly increased the amount of time spent with friends; and if poverty was also present, then the dependent variable had even higher estimated values.

Table 8

*Demographic and sociological characteristics determining time spent with friends*
(Linear regression analysis)

| Variables | *B* (minutes) | *p*-value |
|---|---|---|
| Constant | 9.738 | 0.000 |
| Poor | -2.289 | 0.131 |
| Type of settlement | | |
| County seat | 2.403 | 0.175 |
| Town | -0.175 | 0.914 |
| Village | -3.834 | 0.017 |
| Sex | | |
| Male | 20.202 | 0.000 |
| Age group | | |
| 15-29 years | 16.598 | 0.000 |
| 40-49 years | -5.696 | 0.002 |
| 50-59 years | -12.730 | 0.000 |
| 60-69 years | -21.549 | 0.000 |
| 70 + years | -30.268 | 0.000 |
| Family status | | |
| Unmarried | 32.192 | 0.000 |
| Married but living separately from spouse | 16.098 | 0.000 |
| Widow/widower | 13.204 | 0.000 |
| Divorced | 13.744 | 0.000 |
| Number of children in the family | | |
| No children in the family | 13.555 | 0.000 |
| 1 child | 2.259 | 0.217 |
| 3 children | -1.614 | 0.611 |
| 4 or more children | -0.184 | 0.974 |
| Economic activity | | |
| On pension and employed | 4.583 | 0.243 |
| Pensioner | 11.488 | 0.000 |
| On disability assistance | 6.148 | 0.009 |
| On child care or maternity leave | -7.080 | 0.045 |
| Unemployed | 32.623 | 0.000 |
| Living on welfare benefits | 26.191 | 0.000 |
| Other dependent | 27.260 | 0.000 |
| Level of education | | |
| Unfinished primary school | -5.683 | 0.043 |
| Primary school | -3.673 | 0.072 |
| Vocational school | 0.060 | 0.975 |
| Secondary school | -0.552 | 0.768 |
| $R^2$ | *0.085* | |

*Note*: Reference categories: non-poor, Budapest, female, 30-39 years, married, with 2 children, active and employed, graduate.

The second significant interaction could be detected in the category of the unmarried. Compared to the reference group, here the fact of poverty entailed a negative estimate, i.e. although the unmarried generally spend more time with friends than the categories based on other family statuses, these differences are decreased by poverty. Finally, dif fering effects on the dependent variable were found in the group of those living on welfare benefits. The presence of both poverty and being on allowance increased time spent with friends significantly.

*Relationships with neighbours*

In this part of our study, we proceed to examine the significance of the relationships of the poor with neighbours. We attempt to confirm our hypothesis that such relationships have a greater significance in the lives of the poor than among the non-poor.

Time spent in the company of neighbours is higher among the poor than in the non-poor sample. While the poor spend 26 minutes with people living in their immediate vicinity on an average day, the non-poor spend 15 minutes. Poverty had a decisive effect on time spent with neighbours in each of the groups formed by individual demographic and sociological criteria. The pattern characteristic of the poor and the non-poor in the groups of various criteria, i.e. the relation of the individual groups to one another was also basically similar (see Table 9). Progression downward along the hierarchy of settlements entails an increase in the amount of time spent with neighbours. Inhabitants of villages spend the most time in the company of their neighbours among both the poor and the non-poor. With respect to the difference between the sexes, it can be stated that men spend more time with their neighbours than women do. With regard to age groups, the value of the dependent variable showed an increase corresponding to progression from the younger generations to the elderly. This trend only drops back in the oldest group, that of people over 70 years.

As far as family status is concerned, it is widows and widowers who spend the most time with people living in their immediate vicinity, among both the poor and the non-poor. In the case of the poor, similarly high values are apparent among the divorced, who spend nearly half an hour in the company of their neighbours on an average day. On the other hand this value is only half as much, i.e. one quarter of an hour among the non-poor. The greatest difference was detected in the group of the unmarried. Members of this group rely much more on such relationships among the poor than among the non-poor. The former spend 24 minutes with neighbours on an average day, while their non-poor counterparts spend only 11 minutes.

Grouping respondents by the number of dependent children living in their families yields the result that the highest values are found at the extremes. People who are not raising any children spend 28 minutes of a day in the case of the poor and 17 minutes in that of the non-poor with their neighbours. On the other hand, the corresponding figures for people with 4 or more children are 29 and 16 minutes, respectively. In the dimension of activity versus inactivity, ‘hanging out’ with neighbours is most prevalent among pensioners, the unemployed and those living on welfare benefits. As regards level of education, a decrease of time allotment corresponding to the rise in the hierarchy of schooling is evident among the non-poor. This trend, however, is not detectable among the poor. In the case of the poor, people with vocational or secondary school education are the ones who exhibit the lowest values (see Table 9).

Since higher use of time figures are found among the poor in almost every category, the multivariate analysis can be expected to indicate an independent effect of poverty on the dependent variable. Our analysis supports this hypothesis, since our results indicate that poverty had a significant effect on, i.e. increased the value of the dependent variable (see Table 10).

Table 9

*Time use allotted to neighbours on an average day*
(minutes)

| Characteristics | Poor | Non-poor | Entire population |
|---|---|---|---|
| Type of settlement | | | |
| Budapest | 17 | 10 | 11 |
| County seat | 22 | 15 | 16 |
| Town | 24 | 15 | 16 |
| Village | 31 | 18 | 20 |
| Sex | | | |
| Male | 30 | 17 | 19 |
| Female | 22 | 13 | 15 |
| Age group | | | |
| 15-29 years | 21 | 9 | 11 |
| 30-39 years | 21 | 13 | 14 |
| 40-49 years | 27 | 15 | 16 |
| 50-59 years | 30 | 20 | 21 |
| 60-69 years | 32 | 22 | 24 |
| 70 + years | 27 | 22 | 23 |
| Family status | | | |
| Unmarried | 24 | 11 | 13 |
| Married | 24 | 15 | 16 |
| Married but living separately from spouse | 22 | 16 | 18 |
| Widow/widower | 33 | 26 | 27 |
| Divorced | 28 | 15 | 18 |
| Number of children in the family | | | |
| No children in the family | 28 | 17 | 19 |
| 1 child | 17 | 12 | 12 |
| 2 children | 25 | 11 | 13 |
| 3 children | 23 | 12 | 15 |
| 4 or more children | 29 | 16 | 21 |
| Economic activity | | | |
| Active and employed | 16 | 11 | 11 |
| On pension and employed | 27 | 11 | 13 |
| Pensioner | 30 | 23 | 24 |
| On disability assistance | 27 | 27 | 27 |
| On child care or maternity leave | 12 | 10 | 10 |
| Unemployed | 46 | 31 | 37 |
| Living on welfare benefits | 52 | 25 | 38 |
| Other dependent | 20 | 12 | 13 |
| Level of education | | | |
| Unfinished primary school | 30 | 27 | 28 |
| Primary school | 28 | 17 | 20 |
| Vocational school | 23 | 18 | 18 |
| Secondary school | 15 | 11 | 11 |
| College, university | 30 | 9 | 9 |

Table 10

*Demographic and sociological variables determining time spent with neighbours*
(Linear regression analysis)

| Variables | *B* (minutes) | *p*-value |
|---|---|---|
| Constant | -0.639 | 0.668 |
| Poor | 4.973 | 0.000 |
| Type of settlement | | |
| County seat | 4.428 | 0.000 |
| Town | 4.081 | 0.000 |
| Village | 6.286 | 0.000 |
| Sex | | |
| Male | 5.927 | 0.000 |
| Age group | | |
| 15-29 years | -4.817 | 0.000 |
| 40-49 years | 1.481 | 0.185 |
| 50-59 years | 2.402 | 0.079 |
| 60-69 years | -1.294 | 0.515 |
| 70 + years | -5.511 | 0.012 |
| Family status | | |
| Unmarried | 0.234 | 0.839 |
| Married but living separately from spouse | 1.002 | 0.705 |
| Widow/widower | 8.456 | 0.000 |
| Divorced | 1.741 | 0.159 |
| Number of children in the family | | |
| No children in the family | 2.701 | 0.014 |
| 1 child | -0.107 | 0.922 |
| 3 children | 0.059 | 0.975 |
| 4 or more children | 4.724 | 0.161 |
| Economic activity | | |
| On pension and employed | 0.825 | 0.726 |
| Pensioner | 9.970 | 0.000 |
| On disability assistance | 10.224 | 0.000 |
| On child care or maternity leave | 3.258 | 0.123 |
| Unemployed | 22.919 | 0.000 |
| Living on welfare benefits | 22.192 | 0.000 |
| Other dependent | 5.314 | 0.000 |
| Level of education | | |
| Unfinished primary school | 7.578 | 0.000 |
| Primary school | 3.810 | 0.002 |
| Vocational school | 5.017 | 0.000 |
| Secondary school | 1.379 | 0.218 |
| $R^2$ | *0.023* | |

*Note*: Reference categories: non-poor, Budapest, female, 30-39 years, married, with 2 children, active and employed, graduate.

Taking the effects of interaction into consideration, significant differences among the poor and the non-poor can be detected first of all in the case of men. Men spend more time with neighbours than the reference group, and this difference becomes sharper in the case of poor men.

Being poor also had a significant effect in the categories formed according to the number of children. People whose family included no children or had only one child spent significantly less time with their neighbours if they were poor. On the other hand, an analysis without considering interaction had showed a significantly higher value in the former category, that did not differ significantly from the reference category in the latter one.

Values were significantly higher in the groups of the unemployed and those living on welfare benefits, and this difference was increased by the fact of being poor.

Most categories of educational level also exhibited different effects in the poor and the non-poor groups. Compared to the reference category, estimates were lower for people with primary school education, and also significantly negative for people with a vocational or secondary-school education, when interaction with poverty was included in the analysis.

The intensity of relationships with neighbours is further supported by the fact that inquiry about the origin of one's most important friendship revealed that a higher proportion of the poor indicated neighbourhood as the origin of friendships than the non-poor. These relationships had been registered as friendships, even though many of these people are presumably still neighbours as well as friends (see Table 11).

Table 11

*The origin of one's most important friendship*
(percent)

| Origin | Poor | Non-poor | Entire population |
|---|---|---|---|
| Childhood | 24.1 | 24.2 | 24.2 |
| School | 14.8 | 25.3 | 24.0 |
| Workplace | 18.2 | 21.6 | 21.1 |
| Kinship | 11.6 | 5.9 | 6.7 |
| Neighbourhood | 21.5 | 11.8 | 13.0 |
| Other | 9.9 | 11.2 | 10.9 |
| *Total* | *100.1* | *100.0* | *99.9* |

## THE ROLE OF WELFARE-PRODUCING ACTIVITY IN THE SOCIAL RELATIONSHIPS OF THE POOR

Apart from the intensity of the social relationships of the poor, we also examined the hypothesis that welfare-producing activities (namely work activity performed for their own households in the company of relatives, friends and neighbours, and for other households without taking payment) play a greater role in their network of personal relationships. To study this, we produced three variables. One of these expressed the proportion of time allotted to work within the time spent with relatives, another the same within time spent with friends, and the third the proportion of welfare-producing activities within the time spent with neighbours. All these indices could only be interpreted in cases where the respondent did allot some time to such activities on the day under review (see Table 12).

Table 12

*The proportion of those performing a specific activity on an average day*
(percent)

| Time | Poor | Non-poor | Entire population |
|---|---|---|---|
| Time spent with relatives | 78 | 83 | 82 |
| Time spent with friends | 19 | 22 | 22 |
| Time spent with neighbours | 21 | 13 | 14 |

The proportion of work within time spent with relatives was around 30 percent among both the poor and the non-poor. In the case of the poor, this value was 3 points higher. As regards time spent with friends, the poor allotted 37 percent of this time to work, and the non-poor 26 percent. However, within time spent with neighbours, it was the poor who allotted a smaller proportion to work activity (see Table 13).

Table 13

*The proportion of time allotted to a specific activity*
(percent)

| Proportion of time | Poor | Non-poor | Entire population |
|---|---|---|---|
| Work within time spent with relatives | 30 | 27 | 27 |
| Work within time spent with friends | 37 | 26 | 27 |
| Work within time spent with neighbours | 37 | 44 | 42 |

The structural differences between the poor and the non-poor obviously hide important differences in this case too. Therefore we performed a multivariate analysis to examine whether poverty still has a significant effect on the values of the dependent variable if this effect is controlled with other variables. Our results show that poverty had a significant effect on the figures of the proportion of work within time spent with relatives and friends; however, this effect did not prove to be significant in relationships with neighbours (see Table 14).

The influence of poverty on the effects of individual criteria was again analysed by using the incorporation of interaction components.

Most age groups had a significant influence on the proportion of work within time spent in the company of relatives. The older a respondent was, the smaller the value of this index became. However, poverty modified this effect substantially. When these categories were applied in our model in conjunction with poverty, then positive estimates resulted in the case of the age groups over 40, and increasingly older generations entailed increasingly higher coefficients. Poverty also reversed the effect of the criterion in the case of the unmarried. This group had yielded significantly lower values than the reference category, but examined with the incorporation of the effect of poverty, this coefficient assumed a positive value. Furthermore, negative estimates in comparison to the reference category were intensified by the presence of poverty in the cases of those without children, those with one child, and those of the lowest level of education.

Table 14

*The proportion of work within time allotted to specific relationships*
(Linear regression analysis)

| Variables | Relatives | | Friends | | Neighbours | |
|---|---|---|---|---|---|---|
| | *B* (percent) | *p*-value | *B* (percent) | *p*-value | *B* (percent) | *p*-value |
| Constant | 43.513 | 0.000 | 29.702 | 0.000 | 55.691 | 0.000 |
| Poor | 1.427 | 0.004 | 3.781 | 0.002 | -2.047 | 0.172 |
| Type of settlement | | | | | | |
| County seat | 3.656 | 0.000 | 7.893 | 0.000 | 12.331 | 0.000 |
| Town | 1.585 | 0.002 | 8.813 | 0.000 | 8.170 | 0.000 |
| Village | 4.640 | 0.000 | 13.645 | 0.000 | 7.198 | 0.000 |
| Sex | | | | | | |
| Male | -7.056 | 0.000 | -5.116 | 0.000 | 3.494 | 0.009 |
| Age group | | | | | | |
| 15-29 years | -1.684 | 0.010 | -10.891 | 0.000 | 8.401 | 0.002 |
| 40-49 years | -8.127 | 0.000 | 2.387 | 0.155 | -6.827 | 0.005 |
| 50-59 years | -7.726 | 0.000 | 4.517 | 0.026 | -12.590 | 0.000 |
| 60-69 years | -9.188 | 0.000 | -0.536 | 0.862 | -25.029 | 0.000 |
| 70 + years | -13.007 | 0.000 | -9.682 | 0.006 | -35.278 | 0.000 |
| Family status | | | | | | |
| Unmarried | -11.415 | 0.000 | -18.366 | 0.000 | 3.945 | 0.072 |
| Married but living separately from spouse | -0.934 | 0.533 | -19.555 | 0.000 | -9.058 | 0.071 |
| Widow/widower | -0.629 | 0.386 | -4.236 | 0.037 | -2.402 | 0.190 |
| Divorced | -1.740 | 0.014 | -15.093 | 0.000 | 0.601 | 0.792 |
| Number of children in the family | | | | | | |
| No children in the family | -12.783 | 0.000 | -0.133 | 0.926 | -1.636 | 0.497 |
| 1 child | -2.626 | 0.000 | 1.030 | 0.474 | -1.745 | 0.494 |
| 3 children | 1.035 | 0.273 | 7.849 | 0.004 | 2.252 | 0.583 |
| 4 or more children | 3.207 | 0.056 | 2.677 | 0.555 | 1.557 | 0.809 |
| Economic activity | | | | | | |
| On pension and employed | 6.515 | 0.000 | 3.741 | 0.275 | 1.580 | 0.478 |
| Pensioner | 5.863 | 0.000 | 10.724 | 0.000 | 3.351 | 0.569 |
| On disability assistance | 4.733 | 0.000 | 8.157 | 0.000 | -9.570 | 0.000 |
| On child care or maternity leave | 25.476 | 0.000 | 4.889 | 0.217 | -17.440 | 0.000 |
| Unemployed | 9.396 | 0.000 | 10.218 | 0.000 | -0.238 | 0.933 |
| Living on welfare benefits | 8.551 | 0.000 | 14.962 | 0.000 | -3.495 | 0.451 |
| Other dependent | -3.172 | 0.000 | -4.379 | 0.001 | 0.092 | 0.972 |
| Level of education | | | | | | |
| Unfinished primary school | -4.312 | 0.000 | 13.550 | 0.000 | -12.033 | 0.000 |
| Primary school | -3.631 | 0.000 | 6.971 | 0.000 | -9.555 | 0.000 |
| Vocational school | -1.053 | 0.088 | 8.733 | 0.000 | -2.169 | 0.405 |
| Secondary school | -1.865 | 0.002 | 6.014 | 0.000 | -0.847 | 0.744 |
| $R^2$ | *0.137* | | *0.186* | | *0.151* | |

*Note*: Reference categories: non-poor, Budapest, female, 30-39 years, married, with 2 children, active and employed, graduate.

As regards time spent with friends, people living in towns and in villages spent more time with work than the group assigned as the reference category. The fact of poverty intensified this effect. Differences between the sexes occurred with regard to time spent with friends, where men spent a smaller proportion of this time doing work. The influ ence of poverty on this phenomenon was that it produced even lower indices for men. Apart from the previous, three more demographic categories showed impacts that were altered significantly when in interaction with poverty. One was the age group of 15 to 29 years, where the negative estimate was further aggravated by the presence of poverty. The other two effects were found in families that had no dependent children or had one child. Both of these cases had a negative influence on the dependent variable when poverty was also present.

With respect to relationships with neighbours, the effect of only one category was altered when analysed in conjunction with poverty. This was the age group of 15 to 29 years, where the interaction component had a negative impact on the dependent variable.

## POVERTY AND THE PERCEPTION OF SOCIAL INTEGRATION

So far, our study has been concerned with the manner that poverty influences the patterns of the network of personal relationships. We principally focused on illuminating relationship ties that appear in time use. However, the existence of a personal relationship network can be measured not only by objective, but by subjective factors as well. The latter indicate the way respondents experience the presence of these ties. In the subsequent section we will elaborate the connection of a few such indicators with poverty.

A characteristic feature of subjective indicators is that they integrate numerous factors in a unique way, and it is thus very hard to equate them with objective figures. The first indicator whose connection with poverty we studied was the feeling of loneliness. It is quite obvious that this indicator is also an integration of many various feelings, probably also including satisfaction with one’s family, friends, neighbours and relationships at work. The weight of such individual factors in the indicator is probably dependent on individual life stages as much as on traits of personality.

Among our subjects, nearly 20 percent of the poor, but merely 10 percent of the non-poor often feel lonely. The proportion of those who sometimes, but not often, feel lonely is similarly higher among the poor (see Table 15).

Table 15

*Feeling lonely*
(percent)

| The person | Poor | Non-poor | Entire population |
|---|---|---|---|
| Often feels lonely | 19.7 | 9.2 | 10.9 |
| Sometimes feels lonely | 24.1 | 19.1 | 19.8 |
| Does not really feel lonely | 24.0 | 27.2 | 26.6 |
| Does not feel lonely | 30.2 | 43.6 | 41.7 |
| Does not know | 1.9 | 0.9 | 1.1 |
| *Total* | *99.9* | *100.0* | *100.1* |

Another indicator of the perception of social integration is even more extensive than the indicator of loneliness. This is the extent to which subjects feel that they hold their fate in their own hands, that they are able to control the paths of their lives, that they are not drifting along with the events of their lives. The values of this indicator reveal that the proportion of those who feel they are not in control of their lives is much higher among the poor than among the non-poor (see Table 16).

Table 16

*Faith in the ability to influence individual existence*
(percent)

| The person | Poor | Non-poor | Entire population |
|---|---|---|---|
| Feels unable to influence his/her fate | 25.9 | 14.7 | 16.4 |
| Sometimes feels unable to influence his/her fate | 47.4 | 44.9 | 45.2 |
| Does not feel unable to influence his/her fate | 15.1 | 22.8 | 21.8 |
| Feels able to influence his/her fate | 8.2 | 16.4 | 15.0 |
| Does not know | 3.5 | 1.2 | 1.7 |
| *Total* | *100.1* | *100.0* | *100.1* |

Another issue directly related to the issue of the network of personal relationships is the extent to which subjects generally trust people. This has an obvious bearing on the formation of their relationships with friends, neighbours and colleagues.

Beyond the fact that mistrust of others has a strong presence in society at large, this feeling is even more intense among the poor. A mere 17 percent of the poor feel that most people can be trusted (see Table 17).

Table 17

*Faith in people*
(percent)

| Denomination | Poor | Non-poor | Entire population |
|---|---|---|---|
| Most people can be trusted | 16.7 | 24.4 | 23.3 |
| It is better to be careful and not to trust people | 76.2 | 71.5 | 72.1 |
| Does not know | 7.2 | 4.1 | 4.6 |
| *Total* | *100.1* | *100.0* | *100.0* |

Table 18

*Perception of solidarity in society*
(percent)

| The person | Poor | Non-poor | Entire population |
|---|---|---|---|
| Feels that no one cares about what is happening to others | 32.0 | 19.8 | 21.6 |
| Feels that people frequently do not care about what is happening to others | 42.6 | 45.3 | 44.8 |
| Feels that people care about others rather than not | 15.6 | 23.6 | 22.5 |
| Feels that people do care about what is happening to others | 4.6 | 8.8 | 8.0 |
| Does not know | 5.2 | 2.5 | 3.1 |
| *Total* | *100.0* | *100.0* | *100.0* |

While the indicators studied so far were expressions of individual feelings with regard to one’s social relationships and the faith in one’s social environment, the indicator in

Table 18 is one that reflects the subject's perception of the openness of his or her environment to human relationships, i.e. his or her experience of social solidarity. This indicator shows highly significant differences among the poor and the non-poor too. Nearly a third of the poor but only one quarter of the non-poor feel that people do not care at all about what is happening to others.

*

Our study analysed the patterns of the personal relationship networks of the poor. On the basis of the theory of social exclusion we first examined whether the social relationships of the poor are indeed more limited than those of others. We attempted to prove our initial hypotheses with the aid of data of the use of time of the subjects. The same data were used in the examination of another phenomenon, one that has already been partially explored by network research and sociographical literature on poverty, namely the role of neighbours in the life of the poor. Subsequently, we attempted to determine the role played in the social relationships of the poor by so-called welfare producing activities, e.g. work that the poor perform for themselves in company, or that they perform for others without taking payment. Finally, we collected a few subjective indicators that reflect the perception of social relationships and the possibility of integration.

Our results show that with respect to the objects of social relationships, poverty had a significant influence only on one type of relationship, namely that with neighbours. Regardless of various demographic and sociological criteria, the poor spend more time in the company of their neighbours than the non-poor. However, this does not imply that the co-existence of poverty with certain criteria does not have an effect on the relationships studied. For example, it is the youngest age group who spend most time with friends, when the factor of age is examined on its own, i.e. after removing the effects of other variables. Yet poverty significantly modifies this, as respondents in the age group of 15 to 29 years spend significantly less time with their friends if they are poor than if they belong to the reference category. Thus, poverty can have both global effects and localised ones acting through specific criteria. Our attempt in this study has been to reveal both types of effects.

With regard to time use in the network of social relationships, the proportion of work within the time spent with relatives and friends was significantly higher among the poor. This could not be proven for relationships with neighbours.

Scrutiny of social integration, of the perception of social relationships, i.e. of the subjective experience of the network of social relationships indicates that among the poor there is a higher proportion of people who feel lonely, who do not trust their environment, and who also experience mistrust on the part of others surrounding them. Further inquiry is necessary about the causes of this. One reason might be that objective and subjective loneliness do not reflect the same phenomenon. Possibly, subjective feelings integrate a greater number of factors, perhaps not only a closer personal relationship network, but also connection, or lack thereof, to other institutions of society (e.g. civil organisations). And it is also possible that other methods of studying networks of relationships – which have been referred to at the beginning of this study – might indicate a closer correlation with the subjective indicators.

## REFERENCES

ALBERT F. – DÁVID B. (1998): A barátokról. In: KOLOSI T. – TÓTH I. GY. – VUKOVICH GY. (eds.) *Társadalmi Riport*. TÁRKI, Budapest. p. 257–276.

ANGELUSZ R. – TARDOS R. (1988): A magyarországi kapcsolathálózatok néhány sajátossága. *Szociológia*, No. 2.

ANGELUSZ R. – TARDOS R. (1998): A kapcsolathálózati erőforrások átrendeződésének tendenciái a kilencvenes években. In: KOLOSI T. – TÓTH I. GY. – VUKOVICH GY. (eds.) *Társadalmi Riport*. TÁRKI, Budapest. p. 237–256.

LEWIS, O. (1969): La cultura material de los pobres. *Pensamiente Critico*, No. 7.

ROOM. G. (1997): Poverty and social exclusion: the new European agenda for policy and research. In: ROOM, G. (ed.) *Beyond the threshold*. 1-9. The Policy Press, University of Bristol. Bristol.

*Non-monetary indicators of poverty and social exclusion*. (1995) CESIS.

UTASI Á. (1990): Baráti kapcsolatok. In: ANDORKA R. – KOLOSI T. – VUKOVICH GY. (eds.) *Társadalmi Riport*. TÁRKI, Budapest. p. 475–486.

# PRODUCTIVE EFFICIENCY IN THE HUNGARIAN INDUSTRY*

ÁDÁM REIFF[1] – ANDRÁS SUGÁR[2] – ÉVA SURÁNYI[3]

The paper estimates industry-specific stochastic production frontiers for selected Hungarian manufacturing industries on a rich panel-data set between 1992–1998, then calculates firm-specific inefficiency estimates. One of the main findings is that between-industry differences in average inefficiency can be explained partially by differences in industry concentrations. Nevertheless, the within-industry differences are best explained by the presence of foreign owners, and also partially by the region of operation, but not by the exporting activity of the firms.

KEYWORDS. Stochastic production frontiers; Frontier estimation; Efficiency.

Measuring productivity and efficiency are very important when evaluating production units, the performance of different industries or that of a whole economy. It enables us to identify sources of efficiency and productivity differentials, which is essential to policies designed to improve performance.

The productivity of a production unit is defined as the ratio of its outputs to its inputs (both aggregated in some economically sensible way). Productivity varies due to differences in production technology, differences in the efficiency of the production process, and differences in the environment in which the production occurs. In this paper we are interested in isolating the efficiency component of productivity.

We define the efficiency of a production unit as the relation of the observed and optimal values of its inputs and outputs. The comparison can be a ratio of the observed to maximum possible output obtainable from the given set of inputs, or the ratio of the minimum possible amount of inputs to the observed required to produce the given output. (This is the widely used definition of technical efficiency.)

Until recently analyses have been facing difficulties when trying to determine empirically the potential production of a unit, and the productivity literature ignored the effi

* Our research is funded by the Phare-Ace Research Project entitled 'The adjustment and financing of Hungarian enterprises', and was carried out in the Hungarian Ministry of Economic Affairs, Institute for Economic Analysis in 1999. We gratefully appreciate the inspiration and useful comments of *László Mátyás*, *Jerôme Sgard*, and the seminar participants of several project discussions. All the remaining errors are ours.

[1] PhD student at the Economics Department of the Central European University, Budapest.
[2] Head of Department at the Hungarian Energy Office.
[3] PhD student at the Economics Department of the Central European University, Budapest.

ciency component. Only with the development of a separate efficiency literature has the problem of determining productive potential seriously been addressed.

The measurement of technical efficiency is also important, as it enables us to quantify theoretically predicted differentials in efficiency. Examples include the theories connecting efficiency with market structure (see *Hicks*; 1935, *Alchian–Kessel*; 1962), models investigating the effects of ownership structure on performance (*Alchian*; 1965), and the area of economic regulation (for example, *Averch–Johnson* (1962) and *Bernstein–Feldman–Schinnar* (1990) examine the impact of economic environment and regulation on the efficiency of the firms). The paper is organized as follows. In the first part we provide theoretical backgrounds for our empirical calculations, from both economic and econometric points of view, while in the second part we analyze our data set, exploring the main characteristics of the firms in different branches of industry included in the sample. We also examine the time trends of these relevant variables, together with the representativity of our data set. The third part contains the estimates of the production function frontiers for different branches of the Hungarian industry. Our results about production functions also lets us draw some conclusions about different returns to scale in different industries. Next, in the fourth part we analyze sources of inefficiency differentials: the influence of export orientation, ownership structure and region of operation on the efficiency of the firms.

## 1. THEORETICAL BACKGROUNDS

This section presents the theoretical backgrounds for determining efficiency measures, and the details of our estimation technique.

### *Definitions and measures of productive efficiency*

Productive efficiency has two components. The purely technical, or physical component refers to the ability to use the inputs of production effectively, by producing as much output as input usage allows, or by using as little input as output production allows. The allocative, or price component refers to the ability to combine inputs and outputs in optimal proportions in the light of prevailing prices. In this paper we only deal with the technical component of productive efficiency.

*Koopmans* (1951. p. 60) provided a formal definition of technical efficiency: 'a producer is technically efficient if an increase in any output requires a reduction in at least one other output or an increase in at least one input and if a reduction in any input requires an increase in at least one other input or a reduction in at least one output.' Thus a technically inefficient producer could produce the same outputs with less of at least one input, or could use the same inputs to produce more of at least one output.

*Debreu* (1951) and *Farrell* (1957) introduced a measure of technical efficiency. Their measure is defined as one minus the maximum equiproportionate reduction in all inputs that still allow continuous production of given outputs. Therefore, a score of unity indicates technical efficiency, a score less than unity indicates technical inefficiency. The conversion of the Debreu–Farrell measure (that is defined to inputs) to the output expansion case is straightforward.

Since our technical efficiency measurement is oriented towards output augmentation, we will examine them in that direction. Production technology can be represented with an output set:

$$L(x)=\{y: (x,y) \text{ is feasible}\}, \qquad /1/$$

where $x$ stands for inputs, and $y$ for output(s). From this we can define the Debreu–Farrell output-oriented measure of technical efficiency:

$$DF_0\,(x,y) = max\ \{\theta: \theta y \in L(x)\}. \qquad /2/$$

This concept will be used in this paper. We note that the Debreu–Farrell measure of technical efficiency does not coincide perfectly with Koopmans' definition of technical efficiency. Koopmans' definition requires that the point of production should belong to the efficient subset-part of a particular isoquant, while the Debreu–Farrell measure only requires that the production point should be on a particular isoquant. Consequently the Debreu–Farrell measure of technical efficiency is necessary, but not sufficient for Koopmans' technical efficiency. However, this problem disappears in many econometric analysis, in which the parametric form of the function used to represent production technology (e.g. Cobb–Douglas) ensures that isoquants and efficient subsets are identical.

*The econometric approach to the measurement of productive efficiency: the theory of stochastic production function frontiers*

The econometric measurement of productive efficiency is based on the well-known stochastic production function frontier approach of the efficiency analysis. The stochastic frontier production function, proposed independently by *Aigner, Lovell* and *Schmidt* (1977) and *Meeusen* and *van den Broeck* (1977), has been applied and modified in a number of studies later. The earlier studies involved the estimation of the parameters of the stochastic frontier production function and the mean technical efficiency of the firms in a given industry. It was initially claimed that technical inefficiencies for individual firms could not be predicted. But later *Jondrow et al.* (1982) presented two predictors for the firm effects of individual firms for cross-sectional data, and later panel data estimates were discovered as well.

To introduce the main idea, let us consider the well-known stochastic production function frontier approach of the efficiency analysis. In the most general setting (*Greene*; 1993) we assume a well-defined, smooth, continuous, continuously differentiable, quasi-concave production function, and we accept that producers are price-takers in their input-markets.

Our starting point is exactly the production function:

$$Q_i = f\left(\mathbf{x}_i;\boldsymbol{\beta}\right), \qquad /3/$$

where $Q$ denotes the somehow measured single output, $\mathbf{x}$ denotes the vector of inputs, $\boldsymbol{\beta}$ are parameters and $i$ is used to index the firms.

In most applications, the specification of the function $f(\cdot)$ is either Cobb–Douglas or translog production function. These choices are mainly made for convenience, as either of these allows us to obtain linear equations in the parameters when taking the logarithm of /3/. Therefore if we introduce $y_i = \ln Q_i$, and from this point we denote by $\mathbf{x}_i$ the appropriately transformed input-vector of /3/, then we can write the logarithm of /3/ as:

$$y_i = \alpha + \boldsymbol{\beta}^T \mathbf{x}_i + \varepsilon_i \qquad /4/$$

$$\varepsilon_i = v_i - u_i . \qquad /5/$$

Here the $\varepsilon_i$ residual term has two components: irregular events (like weather, unforeseen fluctuation in the quality of inputs etc.), and the firm's inefficient production.

The effect of irregular events is captured by the variable $v_i$,[4] and we assume that this can affect the actual production in either way; hence $v_i$ can be both positive and negative. In particular, it is typical to assume that $v_i$ is normally distributed with mean 0 and variance $\sigma_v^2$. This assumption will be used throughout the paper.

The effect of the firm's inefficient production is captured by term $u_i$. It is obvious that inefficiency negatively influences the production, that is why it has a negative sign in /5/. This means that the $u_i$ variable itself is assumed to be non-negative.[5] As for the relation between the two parts of the compound error term, we will stick to the assumption (when applicable) that $u_i$ is independent from $v_i$. The assumptions concerning $u_i$ distinguish the different families of models from each other. We can list the following possibilities.

*1.* We can assume that $u_i$ is constant for each observation (firm). This would mean that $u_i$ is deterministic. However, these firm-specific constants can only be estimated if we have several observations for each firm. Therefore this approach (often called as fixed effects approach) can only be used for panel data.[6]

*2.* Alternatively, we can assume that $u_i$ is stochastic, and the efficiency component of each unit can be characterized with the same probability distribution. With these assumptions, this approach can be used for both cross-sectional and panel data. (In case of panel data set, this is the random effects approach.)

If $u_i$ is stochastic, there are other possible choices regarding to its distribution.

[4] One of the first attempts to estimate production frontiers was done by *Aigner* and *Chu* (1968), but they disregarded this irregular term; therefore they searched for the deterministic frontier of the production function. This method can be criticized from several aspects (see for example *Greene*; 1993), moreover it is only a special case of the general model introduced here (namely, when $\sigma_v = 0$). Therefore further we will not deal with this model.

[5] When first describing the stochastic frontier of the production functions, *Aigner, Lovell* and *Schmidt* (1977) defined $\varepsilon_i = v_i + u_i$, assuming in the same time that $u_i$ is non-positive. Since then our notation became conventional.

[6] This is easy to see if we consider the following: if $u_i$ is constant for all *i*, then adding it to the constant term of the regression we obtain the 'firm-specific' constant terms: one constant term for each firm (observation). This means as many parameters as many observations we have, therefore in cross-sectional data (when we have only one observation for each firm) the number of parameters to estimate would be higher than the number of observations.

*a*) We can assume: $u_i$ is half-normally distributed, i.e. it follows a truncated normal distribution (truncated at 0), where the mean of the original normally distributed variable is 0.[7]

*b*) More generally, it is possible to assume that $u_i$ follows a truncated normal distribution (where the mean of the original variable is $\mu$, and truncation is made at 0).

*c*) It is also a usual assumption that $u_i$ is exponentially distributed with parameter $\theta$.

*d*) *Beckers* and *Hammond* (1987), and *Greene* (1990) consider the case when $u_i$ follows a *gamma-distribution* with parameters $(\theta; P)$. This is the so-called gamma-normal model (the normal term reflecting to the normal distribution of $v_i$), and it can also be estimated, but it imposes so much numerical difficulties when computing the estimated parameters that it has been hardly used so far.

In the following, we will first present the estimators for the cross-sectional model, and then we generalize our results to panel data.

*The cross-sectional model.* We will insist on the assumption that the $v_i$ variables are normally distributed, and its outcomes are independent. Furthermore, we saw previously that when we have a cross sectional model, we can only apply the approach of random effects. Therefore $u_i$ must be stochastic: we assume that $u_i$ follows a truncated normal distribution; the parameters of the underlying normal distribution are $\left(\mu; \sigma_u^2\right)$, and truncation is made at 0.

If we wish to determine the density function of our compound error term, $\varepsilon = v - u$, then we can use the well-known convolution rule (note that *u* and *v* are assumed to be independent):

$$f(\varepsilon) = \int_{-\infty}^{\infty} f_u(t) f_v(\varepsilon + t)\, dt =$$

$$= \frac{1}{\sqrt{\sigma_u^2 + \sigma_v^2}\,\Phi\left(\frac{\mu}{\sigma_u}\right)} \phi\left(\frac{\varepsilon + \mu}{\sigma_u}\right) \Phi\left(\frac{\mu \sigma_v}{\sigma_u \sqrt{\sigma_u^2 + \sigma_v^2}} - \frac{\varepsilon \sigma_u}{\sigma_v \sqrt{\sigma_u^2 + \sigma_v^2}}\right).$$

Here $\phi(.)$ is the distribution function, $\Phi(.)$ is the cumulative distribution function of a standard normally distributed variable.

At this point it is a convention in the literature to rewrite the parameters of the model in the following way: introduce $\sigma = \sqrt{\sigma_u^2 + \sigma_v^2}$ and $\lambda = \frac{\sigma_u}{\sigma_v}$, or equivalently, $\sigma_v = \frac{\sigma}{\sqrt{1 + \lambda^2}}$, and $\sigma_u = \frac{\lambda \sigma}{\sqrt{1 + \lambda^2}}$.

[7] An alternative definition for the half-normally distributed variable is the absolute value of a normally distributed variable with mean 0.

With these parameters

$$f(\varepsilon) = \frac{1}{\sigma\Phi\left(\frac{\mu\sqrt{1+\lambda^2}}{\lambda\sigma}\right)} \phi\left(\frac{\varepsilon+\mu}{\sigma}\right)\Phi\left(\frac{\mu}{\lambda\sigma} - \frac{\varepsilon\lambda}{\sigma}\right). \qquad /6/$$

From /6/ the log-likelihood function of model /4/ is /5/ is as follows:

$$\ln \ell(\alpha;\boldsymbol{\beta};\mu;\sigma;\lambda) = \sum_{i=1}^{N} \ln f(\varepsilon_i) = -N \ln \sigma -$$

$$-N \ln \Phi\left(\frac{\mu\sqrt{1+\lambda^2}}{\lambda\sigma}\right) - \frac{N}{2}\ln(2\pi) - \frac{1}{2\sigma^2}\sum_{i=1}^{N}(\varepsilon_i - \mu)^2 + \sum_{i=1}^{N} \ln \Phi\left(\frac{\mu}{\lambda\sigma} - \frac{\varepsilon_i\lambda}{\sigma}\right), \qquad /7/$$

where $N$ denotes the size of our cross-sectional sample, and $\varepsilon_i = \alpha - \boldsymbol{\beta}^T \mathbf{x}_i - y_i$.

The maximum likelihood estimates of this model can be obtained by maximizing this expression. Having this result accomplished, we can compute the estimates of the $\varepsilon_i$ -s; denoted by $e_i$. As *Jondrow et al.* (1982) show, we can infer $u_i$ from the estimated $\varepsilon_i$. Their main idea is that it is possible to determine the conditional cumulative distribution function of $u_i$, under the condition that the estimated value of $\varepsilon_i$ happens to be $e_i$:

$$F(u_i | e_i) = \Pr(u < u_i | e_i) = \frac{\int_0^{u_i} f_u(t) f_v(e_i + t)\, dt}{\int_0^{\infty} f_u(t) f_v(e_i + t)\, dt}. \qquad /8/$$

With this, the conditional density function and the conditional expected value of $u_i$ can be written as:

$$E(u_i | e_i) = \int_0^{\infty} u f(u | e_i)\, du = \frac{\lambda\sigma}{1+\lambda^2}\left[\frac{\phi\left(\frac{\mu}{\lambda\sigma} - \frac{e_i\lambda}{\sigma}\right)}{\Phi\left(\frac{\mu}{\lambda\sigma} - \frac{e_i\lambda}{\sigma}\right)} + \frac{\mu}{\lambda\sigma} - \frac{e_i\lambda}{\sigma}\right]. \qquad /9/$$

Having the maximum likelihood estimates for the parameters, this can be computed for all *i*. As *Greene* (1993) notes, this estimator is unbiased, but inconsistent. (Inconsistent, because regardless of *N*, the variance of it remains non-zero.)

*The panel model.* Now we turn to the panel model, which can be formulated as

$$y_{it} = \alpha + \boldsymbol{\beta}^T \mathbf{x}_{it} + \varepsilon_{it}, \qquad /10/$$

$$\varepsilon_{it} = v_{it} - u_i. \qquad /11/$$

Here the variables have the same meaning as in equations /4/ and /5/, with the exception that *t* stands for the time index. We assume that for each firm *i*, we have $T_i$ observations.[8]

According to /11/, the inefficiency component of any firm is constant over time. If we omitted this assumption, we would have to estimate each firm's inefficiency component for each period, which would lead us back to the cross-sectional case. Furthermore, this assumption is not unreasonable for our data set, where we have at most seven observations for each firm. As we saw earlier, we can choose among different assumptions regarding to $u_i$ : it can be either deterministic (fixed effects approach) or stochastic (random effects approach). Now we turn to the analysis of these.

*Case 1. Fixed effects model.* If $u_i$ is deterministic, we can rewrite our model in /10/ and /11/ in the following way:

$$y_{it} = \alpha + \boldsymbol{\beta}^T \mathbf{x}_{it} + v_{it} - u_i = \left(\alpha - u_i\right) + \boldsymbol{\beta}^T \mathbf{x}_{it} + v_{it} = \alpha_i + \boldsymbol{\beta}^T \mathbf{x}_{it} + v_{it} . \qquad /12/$$

We can represent therefore the fixed and non-stochastic inefficiency term with the constant term of the regression, obtaining firm-specific constant terms. This model is the usual fixed effects panel model, of which the estimation is well-known.

Once we have the estimates for the firm-specific constant terms, we can estimate the firm-specific inefficiency terms as well. As *Gabrielsen* (1975) and *Greene* (1980) showed , in equation /12/ the OLS-estimates for $\boldsymbol{\beta}$ are consistent, and $\hat{\alpha} = \max_i \hat{\alpha}_i$ is also a consistent estimator for the overall constant term.[9] Hence

$$\hat{u}_i = \hat{\alpha} - \hat{\alpha}_i = \max_i \hat{\alpha}_i - \hat{\alpha}_i \qquad /13/$$

can be used for the estimation of the firm-specific inefficiency terms. Therefore, we will have by construction at least one firm which is producing on its efficiency frontier, the rest being under it (i.e., having positive inefficiency measure). The advantages and disadvantages of this method are summarized by *Greene* (1993). The advantages are the following.

– Unlike to the random effects model, where the inefficiency term is a part of the error term in the regression and is assumed to be uncorrelated with the inputs in the regression, here it is included in the constant term and no such implicit (and unrealistic) assumption is needed.

– We do not have to assume normality; our parameter estimates (with the previous correction for the constant term) are consistent in *N* without assuming normality.

– The firm-specific inefficiency estimates are consistent in $T_i$.

The disadvantages are as follows.

– This method does not allow us to include time-invariant inputs (like capital usage) in the model, as this would be exactly multicollinear with the firm-specific (and also

[8] We will see in the following that it is unnecessary to assume that $T_i$ is the same for all firms.

[9] In both cases, consistency is understood as consistency in *N*, but not as consistency in *T*.

time-invariant) inefficiency terms, as both of these are constants for each observations of the same unit. Furthermore, if we simply omit these inputs from our model, then the effect of these time-invariant inputs will appear in the inefficiency component. The solution can be a random effect model under such circumstances.

*Case 2. Random effects model with truncated normal distribution.* We again assume that $v_{it}$ is normally distributed, $u_i$ follows a truncated normal distribution, and each realizations of $u$ and $v$ are pair-wise independent. Furthermore, different realizations of $v$ are independent also, and this is true for $u$ as well.

When constructing the likelihood function, we have to consider that by /11/, the residual terms $\left(\varepsilon_{i1},\varepsilon_{i2},\ldots,\varepsilon_{iT_i}\right)$ are not independent from each other, while these residual vectors are independent for different $i$-s. So what have to be constructed is the joint probability distribution function for the parameter vectors $\left(\varepsilon_{i1},\varepsilon_{i2},\ldots,\varepsilon_{iT_i}\right)$, $i=1,2,\ldots,N$. As

$$\varepsilon_{i1}=v_{i1}-u_i,\varepsilon_{i2}=v_{i2}-u_i,\ldots,\varepsilon_{iT_i}=v_{iT_i}-u_i,$$

the convolution formula generalizes to:

$$f\left(\varepsilon_{i1},\varepsilon_{i2},\ldots,\varepsilon_{iT_i}\right)=\int_{-\infty}^{\infty}f_u(t)f_v(\varepsilon_{i1}+t)f_v(\varepsilon_{i2}+t)\ldots f_v\left(\varepsilon_{iT_i}+t\right)dt=$$

$$=\frac{1}{\Phi\left(\dfrac{\mu}{\sigma_u}\right)\sigma_u\sqrt{2\pi}}\frac{1}{\left(\sigma_v\sqrt{2\pi}\right)^{T_i}}\int_0^{\infty}e^{-\left(\frac{(t-\mu)^2}{2\sigma_u^2}+\frac{(\varepsilon_{i1}+t)^2+(\varepsilon_{i2}+t)^2+\ldots+\left(\varepsilon_{iT_i}+t\right)^2}{2\sigma_v^2}\right)}dt.$$

With a similar reparametrization as in the cross-sectional case,

$$f\left(\varepsilon_{i1},\varepsilon_{i2},\ldots,\varepsilon_{iT_i}\right)=$$

$$=\frac{\left(\dfrac{\sqrt{1+T_i\lambda^2}}{\sigma_i}\right)^{T_i-1}e^{-\frac{T_i\lambda^2}{2\sigma_i^2}\sum_{j=1}^{T_i}\left(\varepsilon_{ij}-\bar{\varepsilon}_i\right)^2}}{\sigma_i\Phi\left(\dfrac{\mu\sqrt{1+T_i\lambda^2}}{\lambda\sigma_i}\right)}\left[\prod_{j=1}^{T_i}\phi\left(\frac{\varepsilon_{ij}-\mu}{\sigma_i}\right)\right]\Phi\left(\frac{\mu}{\lambda\sigma_i}+\frac{\sum_{j=1}^{T_i}\varepsilon_{ij}\lambda}{\sigma_i}\right). \qquad /14/$$

(In the former equation, $\bar{\varepsilon}_i=\dfrac{1}{T_i}\sum_{j=1}^{T_i}\varepsilon_{ij},\lambda=\dfrac{\sigma_u}{\sigma_v},\sigma_i=\sqrt{\sigma_v^2+T_i\sigma_u^2}$ .) From this the log-likelihood function and error terms $e$ can easily be computed.

To obtain estimates for the firm-specific inefficiency parameters, the method to follow is exactly the same as it was before. Following the procedure by *Jondrow et. al* (1982), we can determine the conditional cumulative distribution function, the conditional distribution function, and the conditional expected value of $u_i$, under the condition of the observed *e*-s.

$$E\left(u_i \middle| e_{i1}, e_{i2}, \ldots, e_{iT_i}\right) = \frac{\lambda\sigma_i}{1+T_i\lambda^2}\left[\frac{\phi\left(\dfrac{\mu}{\lambda\sigma_i} - \dfrac{\sum_{j=1}^{T_i} e_{ij}\lambda}{\sigma_i}\right)}{\Phi\left(\dfrac{\mu}{\lambda\sigma_i} - \dfrac{\sum_{j=1}^{T_i} e_{ij}\lambda}{\sigma_i}\right)} + \frac{\mu}{\lambda\sigma_i} - \frac{\sum_{j=1}^{T_i} e_{ij}\lambda}{\sigma_i}\right]. \qquad /15/$$

A very important feature of this estimator is that if $T_i \to \infty$, then $E\left(u_i \middle| e_{i1}, e_{i2}, \ldots, e_{iT_i}\right) \to \overline{e_i}$, which converges to $u_i$ as our maximum likelihood parameter estimates are consistent.

Finally, the consistency of our inefficiency term estimator in $T_i$ is true for all estimation methods that estimate the model parameters consistently. So we do not have to use the maximum likelihood estimator, any method resulting consistent parameter estimates will be appropriate.

## 2. THE BASIC CHARACTERISTICS OF THE DATA SET

The data set contains information from the balance sheets and profit and loss accounts of non-financial, profit-oriented corporations between 1992 and 1998. (The 7-year average of the number of employees at the selected enterprises was at least 20.) We wanted to examine a panel data set in our study, i.e., we only selected enterprises which had the same code number in each of the seven years. This means that instead of the original 4–6000 companies we included only 1839 in our data set. Because of our use of the panel data our study is relevant for the whole manufacturing and energy sectors.

This sample of course does not represent all the double entry book keeping companies in Hungary, but it does describe enterprises which are solidly present in, and represent a significant portion of the Hungarian economy. In order to characterize the weight and structure of the sample, we collected data from all Hungarian double entry book keeping, non financial companies and compared these with the distribution of some of the key variables in our sample, but these figures are not presented in this paper.

In this study we define productivity by using the classic concept of the production function, i.e., we approach it from the point of view of the productivity of production in puts. For this reason, our most important variables are output, labour and capital. We operationalized each variable using several number of measures.

*For the output variable*, we use: net sales revenues and value added. *For the labour variable* we use payments to personnel; average number of employees and *for the capital variable*: tangible assets and depreciation.

In the case of productive efficiency we explored the most important factors which affect its variability. These are:

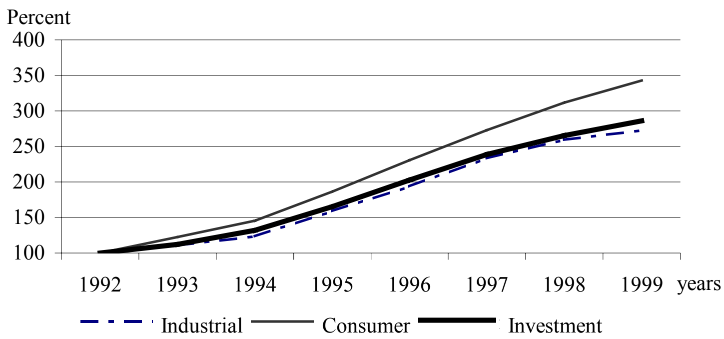
– region,
– type of economic activity (industrial classification),
– share of export activity,
– ownership of the enterprises.

We present the empirical information in two steps. First we analyze changes in the key variables of the double entry book keeping non financial companies between 1992 and 1998, and the productivity (absolute efficiency) of the companies in our sample and its variability. Secondly we use the stochastic production frontier method to analyze relative efficiency and the factors affecting it. Since there is a significant variability across industrial sectors we carried out the analysis for each sector separately. In order to ensure homogeneity within each group and at the same time to make sure that we have a sample large enough, we had to make some compromises.

*Price changes between 1992 and 1998*

Since most of our analyzed categories represent current prices it is necessary to deflate them using price indices. We gathered the producer price indices of each branch as well as the consumer and investment indices (see Figure 1).

*Figure 1. Industrial, consumer and investment price indices*
(Index: 1992=100)




As it is obvious from Figure 1, industrial and investment prices increased slower than consumer prices. In this paper we deflate the net sales revenue and the value added in each industry using its producer price index, the indicators of capital using the invest ment, and the value of personnel payments using the consumer price index. In the case of the volume index of the value added it would make sense to use the method of double deflation, but in Hungary input price indices are not calculated by industry (except in the agriculture). Therefore, we assumed that the companies suffered the same level of price increases from both the input and output side.

*Time trends in output and ownership structure in the sample*

In what follows we only analyze data from our sample of enterprises. First we explore changes over time in the key variables in each branch, focusing on input and output factors and the measures of labour and capital productivity. Before analyzing the factors of output and production, we present the ownership structures of the companies in our sample.

Table 1

*The proportion of different types of equities by industries*
(percent)

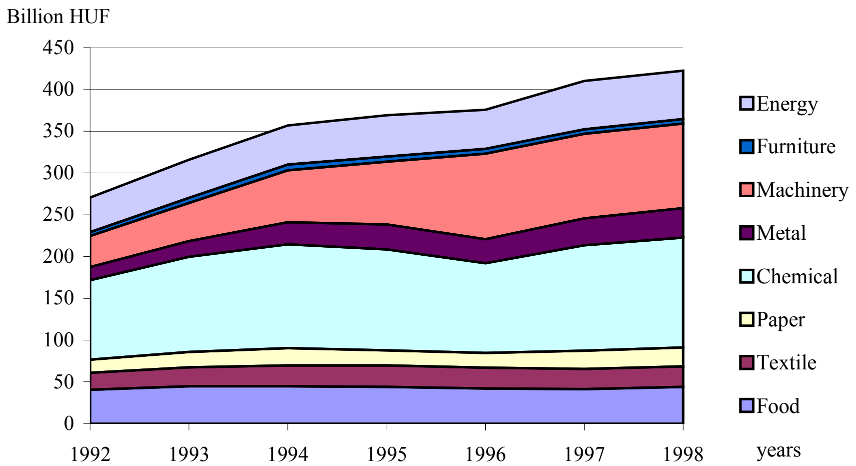
| Industries | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| | year | | | | | | |
| | State owned | | | | | | |
| Food | 36.9 | 24.9 | 14.9 | 10.8 | 10 | 1.9 | 1.3 |
| Textile | 40.4 | 32.8 | 25.7 | 9.9 | 8.3 | 7.7 | 6.9 |
| Paper | 37 | 29.1 | 23 | 9.6 | 6.6 | 1.3 | 1.3 |
| Chemical | 77.1 | 71.9 | 61.9 | 43.1 | 28.1 | 16.8 | 12.1 |
| Metal | 40.9 | 20.6 | 15.4 | 15.6 | 13.2 | 4.7 | 4.5 |
| Machinery | 27.8 | 18 | 13.1 | 9.8 | 7.9 | 3.6 | 3.8 |
| Furniture | 35.3 | 20.6 | 16.8 | 8.9 | 8.2 | 3.4 | 3.3 |
| Energy | 93 | 90.1 | 88 | 68.7 | 61.3 | 53.1 | 48.1 |
| Total | 75.4 | 67.6 | 61.8 | 45.6 | 38 | 29.1 | 25.2 |
| | Foreign owned | | | | | | |
| Food | 43.1 | 56.6 | 60.5 | 63.8 | 63.1 | 72.2 | 71.8 |
| Textile | 26.1 | 32.5 | 35.7 | 47.7 | 49.5 | 50.4 | 49.1 |
| Paper | 27.1 | 43.1 | 43.9 | 54.5 | 52.5 | 60.4 | 59.5 |
| Chemical | 14.4 | 19.8 | 25.6 | 43.1 | 53.6 | 60.9 | 63.3 |
| Metal | 24.2 | 34.7 | 36.8 | 38.1 | 47 | 59 | 60.1 |
| Machinery | 22.6 | 50.3 | 55.6 | 59.8 | 65.9 | 66.6 | 66.4 |
| Furniture | 18.6 | 29.3 | 32.2 | 34.7 | 35.8 | 36.4 | 36.7 |
| Energy | 0.4 | 0.6 | 0.6 | 20.9 | 27 | 30.3 | 41.3 |
| Total | 10.7 | 17.5 | 20.4 | 36.3 | 42.7 | 48.1 | 53.9 |

The proportion of state (and local government) ownership declined to its third, and by 1998 it represented a significant part only in the energy sector. Foreign ownership in our sample increased from 10 percent to over 50 percent by 1998. We can observe the highest rate in the food sector and the lowest in the furniture industry, but it exceeds one-third even here. The two indicators of output are the net sales revenues and the value added. Both indicators have been deflated by the producer price index of each branch so we analyze the output at 1992 constant prices.

The volume of output roughly doubled according to both indicators during the seven years. The value added increased a bit more rapidly and this is particularly true for the chemical and metal industries. In other words, the proportion of material requirements decreased in these sectors. The same is true for the energy sector but we have to take into account the fact that in the period under study prices were under state control in the energy sector and especially until 1995 the rise in retail prices remained well below that of the input, that is, the deflation of the value added using the producer price index overestimates its volume. After 1995 (and the privatization of the sector) cost based price setting was introduced so this problem is less significant.

Figure 2 displays the volume of the value added by industries. It is clear how the average increase in the share of metal and machinery industries raised their share in the overall output. The machinery industry produced only 14 percent of the value added in 1992, but 25 percent by 1998.

*Figure 2. Value added at constant price in 1992–1998 by industries*




*Simple productivity indicators*

Having characterized both output and inputs using two indicators, we will now describe the productivity of labour and capital using the following variables. For the productivity of labour: net sales/number of employees, value added/number of employees, net sales/payments to personnel, value added/payments to personnel. For the productivity of capital: net sales/depreciation, value added/depreciation, net sales/tangible assets, value added/tangible assets.

We calculated the changes in the size of these eight indicators at constant prices by industries, but in Table 2 we only present those that are based on value added.

The labour and capital requirements of the branches vary widely. Our indicators persuasively demonstrate that the textile and furniture industries are the most labour intensive ones, and the chemical and energy sectors are the least. During the seven years productivity increased most in the metal production and machinery industries. Examining time trends, the rate of increase seems relatively smaller (or the rate of decrease larger) comparing with personnel payments and with the size of the personnel. This indicates that the relative cost of labour increased even in real terms during the seven years under review.

Table 2

*Value added indicators*

| Industries | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | Index: 1992=100 |
|---|---|---|---|---|---|---|---|---|
| | year | | | | | | | |
| | Value added/number of employees (thousand HUF/capita) | | | | | | | |
| Food | 712.7 | 855 | 882.5 | 888.9 | 918 | 868.2 | 867.6 | 121.7 |
| Textile | 351.7 | 407.8 | 469.2 | 448 | 406.5 | 410.7 | 442.5 | 125.8 |
| Paper | 684 | 865.9 | 885.4 | 807.8 | 843 | 1049.1 | 1086.1 | 158.8 |
| Chemical | 1150.4 | 1550.2 | 1667.9 | 1668.4 | 1508.3 | 1790.2 | 1872.5 | 162.8 |
| Metal | 254.9 | 583.3 | 849.6 | 963.2 | 913.5 | 1009 | 1119.8 | 439.3 |
| Machinery | 423.9 | 563.5 | 803.2 | 939.5 | 835.3 | 1153.2 | 1117.2 | 263.6 |
| Furniture | 404.6 | 499.7 | 546.5 | 554.2 | 545.5 | 544.6 | 529 | 130.7 |
| Energy | 1187.7 | 1180.5 | 1116.1 | 1197 | 1175.9 | 1519.3 | 1641 | 138.2 |
| Total | 651.4 | 861.6 | 980 | 1012.3 | 930.5 | 1123.3 | 1160.4 | 178.1 |
| | Value added/ payments to personnel (HUF/HUF) | | | | | | | |
| Food | 1.8 | 1.7 | 1.7 | 1.7 | 1.8 | 1.7 | 1.6 | 88.9 |
| Textile | 1.3 | 1.2 | 1.4 | 1.5 | 1.5 | 1.3 | 1.4 | 107.7 |
| Paper | 1.4 | 1.4 | 1.5 | 1.5 | 1.6 | 1.9 | 1.9 | 135.7 |
| Chemical | 2.1 | 2.2 | 2.4 | 2.4 | 2.2 | 2.5 | 2.4 | 114.3 |
| Metal | 1.1 | 1.1 | 1.6 | 1.8 | 1.7 | 1.8 | 1.9 | 172.7 |
| Machinery | 0.9 | 1.1 | 1.5 | 1.8 | 2.3 | 2.3 | 2.1 | 233.3 |
| Furniture | 1.2 | 1.4 | 1.5 | 1.6 | 1.6 | 1.6 | 1.5 | 125 |
| Energy | 2.4 | 2 | 1.7 | 1.9 | 1.8 | 2.3 | 2.3 | 95.8 |
| Total | 1.6 | 1.6 | 1.8 | 1.9 | 2 | 2.1 | 2.1 | 131.3 |
| | Value added/depreciation (HUF/HUF) | | | | | | | |
| Food | 7.2 | 7.3 | 6.8 | 6.6 | 6.6 | 6.2 | 6.4 | 88.9 |
| Textile | 7.1 | 13.4 | 15.8 | 17.4 | 17.6 | 15.5 | 14.2 | 200 |
| Paper | 6.8 | 6.9 | 4.7 | 7.1 | 7.4 | 8.3 | 7.9 | 116.2 |
| Chemical | 2.5 | 3.4 | 4.1 | 4.9 | 5.2 | 5.6 | 5.9 | 236 |
| Metal | 4.9 | 5.4 | 8 | 8.8 | 8.6 | 9.3 | 9.2 | 187.8 |
| Machinery | 5.4 | 6.2 | 8.2 | 10 | 12.5 | 12.4 | 12.2 | 225.9 |
| Furniture | 10.4 | 12.9 | 14.1 | 13.8 | 14.5 | 13.7 | 13 | 125 |
| Energy | 1.9 | 2.6 | 3.1 | 3.1 | 2.5 | 3.3 | 3.5 | 184.2 |
| Total | 3.3 | 4.3 | 5.1 | 5.9 | 6.1 | 6.5 | 6.7 | 203 |
| | Value added/tangible assets (HUF/HUF) | | | | | | | |
| Food | 0.44 | 0.54 | 0.56 | 0.62 | 0.69 | 0.67 | 0.76 | 172.7 |
| Textile | 0.83 | 1.01 | 1.28 | 1.51 | 1.63 | 1.47 | 1.42 | 171.1 |
| Paper | 0.45 | 0.64 | 0.85 | 0.84 | 0.84 | 1.03 | 1.03 | 228.9 |
| Chemical | 0.26 | 0.38 | 0.49 | 0.56 | 0.56 | 0.69 | 0.69 | 265.4 |
| Metal | 0.35 | 0.47 | 0.74 | 0.92 | 0.92 | 0.98 | 1.1 | 314.3 |
| Machinery | 0.37 | 0.55 | 0.84 | 1.16 | 1.49 | 1.73 | 1.61 | 435.1 |
| Furniture | 0.62 | 0.96 | 1.11 | 1.27 | 1.35 | 1.45 | 1.43 | 230.6 |
| Energy | 0.1 | 0.14 | 0.16 | 0.21 | 0.24 | 0.34 | 0.36 | 360 |
| Total | 0.25 | 0.35 | 0.45 | 0.55 | 0.64 | 0.75 | 0.77 | 308 |

It is obvious that the productivity of capital is the lowest in the energy sector and in the chemical sector (that is, these are the most capital intensive branches). The dynamics of change over time, however, differs quite a bit according to the four indicators, although they all show significant (two- or threefold) increase. At the same time, we can observe some contradicting figures in some of the branches. In most sectors the size of output relative to the value of tangible assets increased more steep than relative to the depreciation. This means that the real value of tangible assets grew slower than the depreciation. Since we calculate the value of tangible assets for a given year by adding investments to its value in the previous year and deducting the depreciation this means that in most branches the value of new investments increased slower (or decreased faster) than the depreciation. Exceptional from this trend are textile and clothing industries with reverse situation.

We measured the productivity of both factors of production using four indicators of each. We analyzed the covariation of the variables (at the level of the enterprise) using principal component analysis. The four indicators of the productivity of labour move together relatively closely. The first principal component explains 62 percent of the variance.

The correlations between the first principal component and the variables are as follows: the net sales/number of employees is 0.62, the value added/number of employees is 0.79, the net sales/payments to personnel is 0.72 and the value added/payments to personnel is 0.81. On the basis of the previous we can approximate the common factor in the indicators of efficiency the best by using the value added/payments to personnel variable but the value added/number of employees variable is almost as good.

In the case of capital efficiency the first component explains 63 percent of the total variance. The correlation coefficients of the variables and the factor are: the net sales/depreciation is 0.77, the value added/depreciation is 0.82, the net sales/tangible assets is 0.64 and the value added/tangible assets is 0.70. In this case the variable value added/depreciation is the most useful one.

Obviously, the differences in productivity and the factors determining them can not be described very precisely by using these very simple descriptive statistics, therefore in the following we will employ more sophisticated statistical methods.

## 3. ESTIMATING THE INDUSTRY-SPECIFIC PRODUCTION FRONTIERS AND THE FIRM-SPECIFIC INEFFICIENCIES

In this part we describe how we chose the functional form for the production function and the variables to measure output, labour and capital input, how we estimated the parameters of the production function frontiers, calculated the firm-specific inefficiencies, transformed the data prior to estimation, and the effects of this if any. At last we would interpret the results obtained in this part.

*The choice of production function*

We assumed that in each industry there is an industry-specific, Cobb–Douglas type production function frontier of the following form:

$$y_{it}^{*} = \alpha_0 + \alpha_1 l_{it} + \alpha_2 k_{it} + v_{it} \, .$$

Here $\alpha = (\alpha_0, \alpha_1, \alpha_2)$ denotes the industry-specific parameters of the production function, $y^*_{it}, l_{it}, k_{it}$ are the logs of the appropriately measured efficient output, labour input and capital input variables for firm *i* at time *t*, and finally $v_{it}$ is the random disturbance term affecting firm *i*'s efficient output at time *t*. (The distribution of $v_{it}$ is assumed to be normal).

The actual output of firm *i* at time *t* equals its efficient output $y^*_{it}$ minus the firm-specific inefficiency, $u_i \geq 0$:

$$y_{it} = y^*_{it} - u_i = \alpha_0 + \alpha_1 l_{it} + \alpha_2 k_{it} + v_{it} - u_i \,. \qquad /16/$$

An alternative assumption could have been that the production function frontier is of translog-type (see, for example *Greene*; 1997). In this case the production function is the following:

$$y^*_{it} = \alpha_0 + \alpha_1 l_{it} + \alpha_2 k_{it} + \alpha_3 l^2_{it} + \alpha_4 k^2_{it} + \alpha_5 l_{it} k_{it} + v_{it} \,. \qquad /17/$$

It is obvious that this contains the Cobb–Douglas production function as a special case (when $\alpha_3 = \alpha_4 = \alpha_5 = 0$), and the relevancy of the Cobb–Douglas model can be tested.

Indeed, we prepared estimates with this formulation as well for selected industries (containing the most influential machinery), and the results were as follows. The new parameters were jointly significant, indicating that the Cobb–Douglas type production function frontier may not be appropriate; however, the estimated firm-specific inefficiencies remained practically the same in the two cases (with a correlation coefficient above 0.98). Therefore, for the sake of simplicity of exposition, we decided to present the results obtained with Cobb–Douglas production function. We note, however, that obtaining the full set of results with the more flexible translog production function formulation remains for future research (affecting mainly the production function estimates, not the firm-specific inefficiency estimates).

*The choice of variables*

For each variable (output, labour, capital) we had two possible choices:

– for output, we used either total sales revenues (in what follows, simply revenues) or value added;
– for labour input, we used either wage costs or the number of employees;
– for capital input, we used either depreciation or tangible assets.

This gave us eight possibilities for the formulation of our model, summarized in Table 3. We estimated each possible model, to see whether the extent of the estimated parameters are sensitive to changes in the input variables. A detailed comparison of the results will be provided later.

Table 3

*Variables in different models*

| Model | LHS variable | RHS variables | |
|---|---|---|---|
| | | labour | capital |
| Model 1 | Revenue | Wage cost | Depreciation |
| Model 2 | Revenue | Wage cost | Capital |
| Model 3 | Revenue | Number of employees | Depreciation |
| Model 4 | Revenue | Number of employees | Capital |
| Model 5 | Value added | Wage cost | Depreciation |
| Model 6 | Value added | Wage cost | Capital |
| Model 7 | Value added | Number of employees | Depreciation |
| Model 8 | Value added | Number of employees | Capital |

However, we should add at this point some theoretical consideration concerning the choice of the variables. For the output, our preferred variable is value added, since revenues can be pumped up by simply buying materials and then reselling them, without any real activity. On the other hand, value added can be negative,[10] which is hard to interpret (and makes estimation impossible because of the need to take the log of the variables).

For the labour input, we could not choose any of the two candidate variables only on theoretical grounds. The number of employees has the advantage of being a real measure, and does not require any discounting. Furthermore, it does not make any difference between different qualities of labour, and does not incorporate any changes in productivity of labour force, which played a significant role in the period under investigation. These shortcomings are at least partially resolved in the wage cost variable, which should be correlated to the productivity of the labour. However, an appropriate discount rate should be found to make the variables at different time comparable. In any case, these two variables are not the same, as one of them represents effective labour, while the other one does not. We will see what differences arise at the final results due to this effect.

Finally, we face the most difficult problem when trying to estimate the capital usage, as we do not have reliable variables for this one. We have the intangible assets, which is a stock variable, clearly insufficient to represent the current capital usage (which is a flow). Moreover, this measure of capital can change very quickly (when any investment is activated), and then experience does not change at all during several time periods (when despite the investment activity nothing is activated). An alternative way of measuring current capital usage is the use of depreciation. Admitting that the reported values of this can be influenced by taxing considerations, and are therefore also inappropriate to some extent, we still believe that this is more closely correlated to the capital input than the former asset variable.

*Estimation of the parameters of the production function frontier*

As we have only seven years of data ($t$=1992, 1993, …, 1998), we assumed that the firm-specific inefficiency $(u_i)$ is constant over time. Moreover, we assumed that it is

[10] In our data set, only a small proportion of the observations have negative value added.

stochastic, with a half-normal distribution among firms in each industry. Finally, we also assumed that the inefficiency components are independent from the $v_{it}$ random shocks affecting the stochastic production frontier.

Under these assumptions the parameters of the model can consistently be estimated by the random-effects panel model, described previously. Here we repeat the exact formulation of the model to be estimated (for each industry separately):

$$y_{it} = \alpha_0 + \alpha_1 l_{it} + \alpha_2 k_{it} + v_{it} - u_i . \qquad /18/$$

A technical note is appropriate here: in /18/, the expected value of the compound disturbance term $\varepsilon_{it} = v_{it} - u_i$ is non-zero, as $u_i \geq 0$, and therefore $E(u_i) > 0$. But consider:

$$y_{it} = \left[\alpha_0 - E(u_i)\right] + \alpha_1 l_{it} + \alpha_2 k_{it} + v_{it} - \left[u_i - E(u_i)\right], \qquad /19/$$

the same model with a disturbance variable of zero expected value. The standard estimated random-effects model parameters will be the parameters of this latter model, so, to obtain the parameters of our original model, we will have to add $E(u_i) = \sqrt{\frac{2}{\pi}}\sigma_u$ to the estimated constant parameter. [11] The random-effects estimates of the parameters of the labour and capital variables $(\alpha_1, \alpha_2)$ are consistent estimates of the true parameters in the initial model.

## 4. ESTIMATION OF THE FIRM-SPECIFIC INEFFICIENCIES

With consistent estimates of the parameters of the previous model in hand,[12] we can prepare estimates of the compound disturbance terms in model /19/:

$$\hat{e}_{it} = \left(v_{it} - u_i + E(u_i)\right) = y_{it} - \left(\hat{\alpha}_0 - E(u_i) + \hat{\alpha}_1 l_{it} + \hat{\alpha}_2 k_{it}\right). \qquad /20/$$

If we subtract $E(u_i)$ from these estimates, we obtain estimates for the disturbance terms of our original model:

$$e_{it} = \hat{e}_{it} - E(u_i) = \left(v_{it} - u_i\right) = y_{it} - \left(\hat{\alpha}_0 - E(u_i) + \hat{\alpha}_1 l_{it} + \hat{\alpha}_2 k_{it}\right) - E(u_i) . \qquad /21/$$

As demonstrated previously, the estimates of the firm-specific inefficiencies can be obtained by using the formula defined by *Jondrow et al.* (1982) (see /15/ with $\mu = 0$ ).

With given observations $e_{it}, t = 1,...,T_i$, and given estimates for $\sigma_u$ and $\sigma_v$, we can calculate the conditional expected value of the firm-specific inefficiencies according to /15/. These will be consistent estimates of the true $u_i$ -s.[13]

[11] This formula comes from the assumption that *u*-s are half-normally distributed among the firms in each industry.
[12] We made all calculations by LIMDEP; the program code was written by the authors, and available upon request.
[13] As in our data set the maximum value of *T* is 7, this is only of theoretical interest here.

*Initial data manipulations*

The initial transformations that we made prior estimation are the following.

*1*. We divided our data set into eight industries, investigated in the previous section of the paper.

*2*. From each industry, we excluded all observations that contained implausible information: non-positive net sales revenues, value added, intangible assets, depreciation , wage costs or number of employees.

*3*. We also excluded those observations that changed industries during the seven year observation period, and this way our industry classification of the firm changed. (For example, textile industry in our sample contains industries from 17 to 19. If a firm was initially in industry 17, then changed to industry 18, then this firm was not excluded, as it operated in our classification of textile industry during the entire period. But, if a firm changed its classification from 17 to say, 29, then those observations with classification 29 were excluded from the textile industry, while observations with classification 17 could remain there.)

*4*. We also deflated the variables when it was appropriate.

Table 4 represents the remaining size of our data set after the exclusions.

Table 4

*The effect of initial exclusions of the implausible observations*

| Industries | Initial number of observations | Initial number of firms | Number of observation after exclusions | Number of firms after exclusions |
|---|---|---|---|---|
| Food | 1 547 | 221 | 1 463 | 221 |
| Textile | 2 429 | 347 | 2 300 | 346 |
| Paper | 1 505 | 215 | 1 405 | 214 |
| Chemical | 1 652 | 236 | 1 589 | 235 |
| Metal | 1 694 | 242 | 1 581 | 242 |
| Machinery | 3 101 | 443 | 2 885 | 441 |
| Furniture | 679 | 97 | 617 | 95 |
| Electric | 266 | 38 | 255 | 38 |
| *Total* | *12 873* | *1 839* | *12 095* | *1 832* |

*Summary of the results*

The Appendix contains all estimated parameters for the 64 models (8 possible models for 8 industries). We also included the Wald test-statistics considering the hypothesis that the production frontier of the industry is of constant returns to scale (i.e., the sum of the two reported estimated parameters is 1), and to the significance level of this test-statistics. Our main findings are as follows.

*1*. The estimated parameters are highly dependent of the variables chosen to measure output, labour input and capital input. Sometimes there is a conflict among the alternative models even in their returns to scale predictions (there are instances when some of the models indicate increasing, some other models decreasing returns to scale for the same industry). This is clearly a discrepancy that not only our parameter estimates are not robust to the choice of the model, but our return to scale estimates are either.

*2*. However, there is a systematic difference among the parameter estimates and return to scale predictions of different models. The most obvious difference is that replacing the wage cost variable to the number of employees variable, the sum of the estimated parameters systematically reduces. Sometimes this causes that predictions about an increasing/constant returns to scale with the wage cost variable (models 1, 2, 5, 6) change to predictions about constant/decreasing returns to scale with the number of employees variable (models 3, 4, 7, 8). The same occurs when replacing the value added variable (in models 5, 6, 7, 8) with revenue (models 1, 2, 3, 4). Finally, the incorporation of capital instead of depreciation tends to reduce the share of capital relative to the labour (i.e., smaller estimated parameters are obtained for the capital variable), while the sum of the two estimated parameters remains constant.

*3*. Let us summarize the results for the models containing our preferred dependent variable, value added (models 5-8).

– For the textile industry, all models predict increasing returns to scale.
– For industries of food, furniture and electricity, there is a consensus about the predictions of constant returns to scale.
– For paper and machinery, the prediction of all the models is decreasing returns to scale.
– For the chemical models with wage cost (5, 6) predict increasing, models with number of employees (7, 8) predict constant returns to scale.
– Finally, for the metal industry, models with wage cost (5, 6) predict constant, models with the number of employees (7, 8) predict decreasing returns to scale.

*4*. Finally, the relative labour intensiveness of the different industries matches our intuition. In our most preferred models, in model 5 and 7, the two industries with the highest labour shares are textile and furniture, which are clearly the most labour intensive industries. The most capital intensive industry is paper industry, with machinery also being relatively capital intensive in both cases.

*Inefficiencies in different branches of the industry*

From our production function estimates, for each industries we have calculated the average firm efficiencies, i.e. the average across firms inefficiency estimates. Different models lead to very similar results, the efficiencies in our two preferred models (5 and 7) are highly correlated ($r$=0.752). However, there is a systematic difference between the two measures: the average inefficiency terms estimated by model 5 (ineff5) are in each cases less than the model 7 estimations (ineff7); the reason for this was explained earlier. But luckily this does not change relative inefficiency measures, i.e. the order of industries with regard to inefficiencies. So both measures lead to the same results. The most efficiently operating branches (with the smallest inefficiency terms) are electricity, textile and paper industry; furniture, chemistry and food are around the average; while there are great inefficiencies in metal and machinery industries.

The main aim of the following section is to find some explanations for these differences both among and within different branches. Two possible sources of the between-industry differences are the extent of concentration of the industry and the share of foreign enterprises.

In the second part we will examine relative efficiencies within the industries: the effects of ownership structure, firm-size, the market share of the enterprises and the region of operation.

*Concentration and inefficiencies*

For each industries we calculated an index of the concentration, by calculating the share of the first 10 percent of the companies in the total value added and revenues (averages over the period).

Table 5

*Concentration indices and average inefficiencies in different industries*

| Industries | Concentration | | Ineff7 | Ineff5 |
|---|---|---|---|---|
| | value added | revenues | | |
| | percent | | | |
| Food | 57.77 | 57.71 | 0.5623 | 0.4377 |
| Textile | 54.18 | 60.83 | 0.4800 | 0.2794 |
| Paper | 60.59 | 63.26 | 0.6222 | 0.3539 |
| Chemical | 82.07 | 83.59 | 0.6711 | 0.4378 |
| Metal | 68.88 | 81.31 | 0.6524 | 0.5319 |
| Machinery | 73.51 | 77.26 | 0.6798 | 0.4907 |
| Furniture | 49.09 | 50.57 | 0.5178 | 0.3557 |
| Electric | 46.04 | 64.37 | 0.3788 | 0.2177 |

*Note*: Ineff7 and ineff5 stand for the estimated inefficiency measures in model 7 and model 5, respectively.

In Table 5 we can see the concentration indices and the average inefficiencies for the industries under investigation. It is apparent that there is a strong correlation between the two types of variables, and this is why we suppose that the higher the concentration is, i.e. the higher the monopolization in a specific industry is, the higher inefficiencies we expect to occur. In the case of the two variables in the figure, the correlation coefficient between them is 0.8905.

*The share of foreign enterprises in the sector*

The measure of the share of foreign enterprises in the sector can have opposite effect of what we have explained in the previous part; a higher foreign enterprise share in the sector probably refers to higher (international) market competition in the branch. To measure this effect we calculated two foreign enterprise share indices for each industry, i.e. the proportion of value added and the proportion of net sales revenues of foreign enterprises relative to all enterprises. We defined foreign owned companies as firms with more than 25 percent of foreign ownership on average over the period.

Table 6

*Foreign share indices and average inefficiencies in different industries*

| Industries | Foreign share | | | Ineff7 | Ineff5 |
|---|---|---|---|---|---|
| | value added | revenues | number of firms | | |
| | percent | | | | |
| Food | 76.40 | 73.74 | 33.80 | 0.5623 | 0.4377 |
| Textile | 47.78 | 48.58 | 30.98 | 0.4800 | 0.2794 |
| Paper | 68.15 | 72.76 | 31.73 | 0.6222 | 0.3539 |
| Chemical | 49.61 | 39.29 | 50.43 | 0.6711 | 0.4378 |
| Metal | 47.87 | 48.98 | 29.24 | 0.6524 | 0.5319 |
| Machinery | 67.26 | 72.56 | 32.11 | 0.6798 | 0.4907 |
| Furniture | 39.92 | 41.47 | 21.74 | 0.5178 | 0.3557 |
| Electric | 69.21 | 54.57 | 28.95 | 0.3788 | 0.2177 |
| Total | 60.26 | 56.71 | 33.86 | 0.4144 | 0.6018 |

The result is ambiguous. When measured with value added, foreign share shows a slight negative correlation with inefficiency terms, just as we would expect, but when measured with revenue the sign of the correlation coefficient turns into positive, though the coefficient is not significant (in neither cases). We can find the explanation for this phenomenon in Table 6. In the third column we can see the share of foreign enterprises in the different sectors when this share is measured simply by the number of firms. We can easily observe that the proportion declines to about the half compared to the previous ones, which means that foreign enterprises are usually the ones with higher than the average market share. This is reasonable as we think of the great number of multinational firms entering the Hungarian markets. So it seems that foreign enterprise presence not only means higher international competition but it is also connected with higher concentration in the branch,[14] which has just the opposite effect on efficiency. The outcome is somehow ambiguous.

The correlation coefficients between the inefficiency terms (ineff7 and ineff5) and the foreign share are –0.06 if it is measured with the value added, 0.18 and 0.16 respectively if the share is measured by the revenues.

*The effect of ownership structure*

In this section we transformed the standardized inefficiency terms into an interval between 0 and 100, therefore zero inefficiency term refers to a firm which is the most efficient, while a hundred indicates the less efficient company.

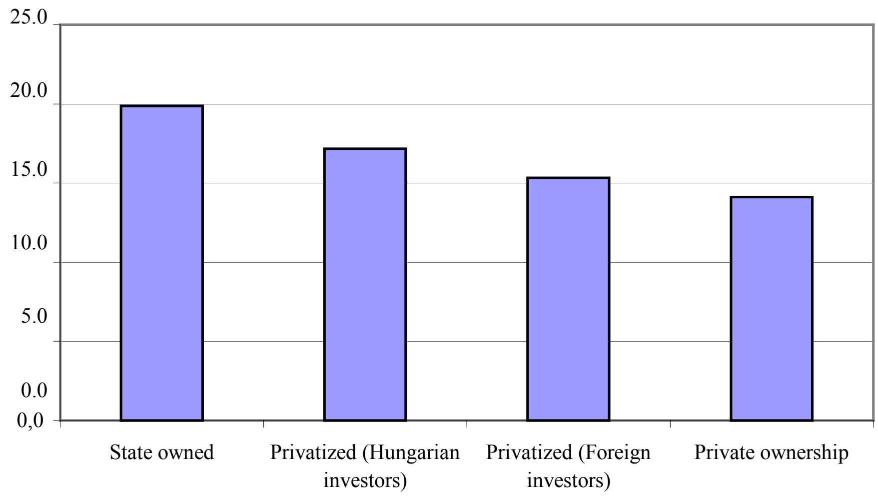
[14] This is justified if we examine the correlation coefficients between the proportion of the foreign firms and the concentration indices (as defined in Table 5). These are 0.75 and 0.64 (the former refers to the value added based concentration index, while the latter is calculated with the revenue based index).

*a*) *State and local government ownership*. To examine the effect of state ownership on productivity we have divided the firms in the sample into four main subgroups:

*1*. state owned during the whole period (1.1%),
*2*. privatized (state owned in 1992 but mainly private owned in 1998) to Hungarian investors (10.86%),
*3*. privatized to foreign investors (7.47%),
*4*. private (Hungarian and foreign) owned companies (average private ownership exceeds 30 percent). This means 74.24 percent of firms in the sample.

Figure 3 shows the average inefficiency terms in the defined subgroups.[15] We can see that private owned firms do outperform state owned ones. We can also conclude that privatization was successful when evaluating efficiencies: privatized firms perform better than state owned ones, especially when they are purchased by foreign investors.

*Figure 3. Average inefficiencies in state and private owned firms*
(model7)




Increasing inefficiencies in the state owned firms can be observed in nearly each industries (see Table 7). There are two interesting exceptions: the food and the metal industry. In both cases state owned firms operate nearly as efficiently as private owned, while privatized ones seem to be less efficient. This probably refers to the fact that in most cases the state sells its firms when they operate less efficiently, but especially in the food industry there are some huge companies that are world wide famous and operate so successfully (even if state owned) that the state do not want to sell them. An alternative explanation addresses the problems that firms just under privatization have to overcome: the costs of reorganization can be quite large, and normal operation is reached only after a certain period.

[15] Ineffiencies are measured by method 5 (explained in the previous sections).

Another interesting feature is that in electric industry there is a huge difference according to the effect of the direction of the privatization. Those firms that are sold to Hungarian investors are nearly as inefficient as state owned ones, while those that were purchased by foreign investors have significantly improved their efficiency.

Table 7

*Average inefficiencies in different industries and different ownership*
(method 5)

| Industries | State owned | Privatized to Hungarian investors | Privatized to foreign investors | Private owned |
|---|---|---|---|---|
| Food | 14.2 | 17.0 | 15.0 | 13.9 |
| Textile | 27.4 | 18.6 | 18.6 | 14.2 |
| Paper | 16.4 | 16.4 | 13.7 | 14.8 |
| Chemical | 25.2 | 17.2 | 15.2 | 14.1 |
| Metal | 14.8 | 17.9 | 16.8 | 13.7 |
| Machinery | 20.8 | 17.1 | 15.1 | 14.1 |
| Furniture | – | 10.8 | 23.1 | 14.3 |
| Electric | 21.9 | 21.5 | 9.9 | 11.3 |
| Total | 19.9 | 17.2 | 15.3 | 14.1 |

*b*) *Foreign investors*. Because of the huge changes in the ownership structure during the given period it seemed reasonable to examine the performance of the following subgroups of companies:[16]

*1*. foreign owned (during the whole period) (18.4%),
*2*. privatized to foreign owners (3.5%),
*3*. sold from Hungarian private owners to foreign investors (1.7%),
*4*. private owned (during the whole period) (57.7%),
*5*. state owned (during the whole period) (1.3%).

Figure 4 shows the average inefficiency terms in these subgroups (calculated with model 7). We can observe that foreign firms in Hungarian markets overperform even the domestic private ones, the effect is probably caused by the great inflow of multinational companies into the country.

Although privatization has a negative effect on efficiency among the firms that are purchased by foreign investors too, probably because of the reorganization costs, we would expect they will probably catch up after a short transitional period. But again we would like to note that privatization was successful in terms of improving the efficiency of their operation relative to state owned ones.

When examining these effects in different branches we can observe some interesting features of the Hungarian industry[17] (see Table 8). Parallel to the results of the previous

[16] In this case for simplicity ownership was defined according to the ‘dominant’ owner; for example we say an enterprise is state owned if the share of state among the owners is larger than 50 percent. This way of course some firms will be missing from the sample; the valid number of observations is 1062.

[17] In this case we could not evaluate state owned firms and those which have been sold from Hungarian to foreign private owners because of the small number of valid cases.

section we can see again the special case of the food sector, where both private and privatized firms perform worse than the overall average, while state owned ones show great advantages.

*Figure 4. Average inefficiencies in foreign and Hungarian owned firms*


Table 8

*Average inefficiencies in different industries and different ownership*

| Industries | Foreign owned (the whole period) | Privatized to foreign owners | Private owned (the whole period) |
|---|---|---|---|
| Food | 19.0 | 24.7 | 22.3 |
| Textile | 17.8 | 15.9 | 22.5 |
| Paper | 14.8 | 17.9 | 24.2 |
| Chemical | 15.6 | 19.4 | 23.6 |
| Metal | 19.1 | 17.9 | 20.7 |
| Machinery | 18.1 | 17.6 | 20.0 |
| Furniture | 13.1 | 29.6 | 19.6 |
| Electric | 8.3 | 15.6 | 8.5 |
| Total | 17.2 | 19.4 | 21.7 |

In textile industry we see right the opposite features. Those firms that were privatized to foreign investors are the most efficient ones, while the rest is less efficient. In chemical and furniture industry foreign firms are especially efficient relative to Hungarian ones, and also in metal and machinery branches, but with smaller differences among the two groups of firms. In electric industry we also see some very efficiently operating companies, owned by the private sector (either Hungarian or foreign), but we must note that in these categories there are only few firms in the sample, so the reliability of this result is quite low.

*The effect of the size of the enterprise*

It is also interesting to examine whether the size of the company is a good predictor of efficiency differences or not: can small companies catch up with big multinational ones? To measure this hypothesis we created three categories of enterprises in the sample:

– small enterprises (the average number of employees is smaller than 100 persons, 61.5 percent),
– medium size enterprises (the average number of employees is between 100 and 500 persons, 24.7 percent),
– large enterprises (the average number of employees exceeds 500 persons, 8.6 percent).

As Table 9 shows, larger enterprises are more efficient (have smaller average inefficiency terms) than smaller and medium ones. Indeed, we found significant negative correlation between size and inefficiency.[18] It seems that small enterprises cannot be as efficient as large multinational firms. The result is quite robust: according to Table 9, we reach the same conclusion in each of the industries. This can have strong implications for policy makers.

Table 9

*Average inefficiency terms in small, medium and large enterprises*

| Industries | Small enterprises | Medium size enterprises | Large enterprises |
|---|---|---|---|
| Food | 22.3 | 18.1 | 18.9 |
| Textile | 21.3 | 20.4 | 17.7 |
| Paper | 21.7 | 18.6 | 10.8 |
| Chemical | 22.5 | 17.4 | 19.6 |
| Metal | 21.2 | 19.3 | 21.6 |
| Machinery | 21.1 | 21.8 | 16.8 |
| Furniture | 23.1 | 17.3 | 13.5 |
| Electric | 24.6 | 23.9 | 17.0 |
| Average | 21.7 | 19.6 | 18.0 |

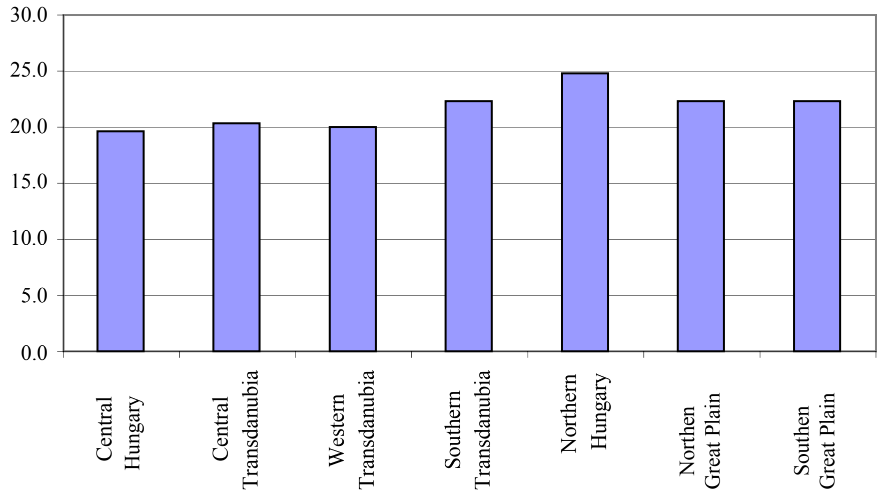
*Region*

It is well known that there are huge regional differences in the Hungarian industry. To explore regional differences in the performance of the enterprises we divided the country into seven regions: Central Hungary, Central Transdanubia, Western Transdanubia, Southern Transdanubia, Northern Hungary, Northern Great Plain, Southern Great Plain.

Efficiency terms on Figure 5. show that the centralized feature of the country leads to the relative advantages of the central part compared to some other regions. Transdanubia, especially Central and Western Transdanubia are also nearly as efficient as the central region of the country. Nevertheless there are huge inefficiencies in the operation of the firms in Southern Hungary and the Great Plain.

[18] The correlation coefficient is –0.67 in case of inefficiency measured by model 7.

*Figure 5. Average inefficiencies in different regions*




*An alternative method of measuring determinants of inefficiency*

To test for the significance of the previously analyzed relations we estimated efficiency equations. We regressed firm level efficiency terms against export share, proportion of state, foreign and private ownership and regions. Due to size considerations, we can present only a summary of our main findings.

The first observation is that the choice of the capital variable (depreciation against tangible assets) does not have much influence on the final results. On the other hand, replacing the labour input variable of the number of employees with wage costs has dramatic effects for the final results. Therefore we decided to split our results into two subgroups: to demonstrate them when the labour input variable is the number of employees, and when it is the wage costs.

To see all the significance relationship at the same time, we constructed 'significance tables', where we can see each significant variables for each industries. Table 10 contains the results when the labour input variable is the number of employees, while Table 11 has the same structure, but the labour input variable is the wage costs. In both tables, cells with dark backgrounds represent highly significant variables, while those with light background refer to weaker relationships (significant at 10 percent, but not significant at 5 percent).

The following conclusions can be drawn from the Tables 10 and 11.

*1. The role of exports.* The exporting companies do not seem to be more efficient than their non-exporting counterparts. The important exception can be found in the case of food industry, where there is a very small number of exporters (20 percent of the firms). These rare companies tend to be more efficient. In other industries, however, it is more common for a company to sell its products to foreign markets (in a typical industry the proportion of exporters is approximately 40 percent), then the competition at the domes tic markets among these exporting firms forces their non-exporting competitors to be more efficient, so that exporting alone is not an efficiency-improving activity. There is an interesting exception as well: in paper industry, exporting firms tend to be significantly less efficient. We explained this by industry-specific features: exporting firms are raw-material (like wood, etc.) exporters, while the non-exporter efficient firms (publishing and printing firms) operate mainly on domestic markets.

Table 10

*Significance table of the explanatory variables when the labour input variable is the number of employees*

| Denomination | Food | Textile | Paper | Chemical | Metal | Machinery | Furniture | Electricity |
|---|---|---|---|---|---|---|---|---|
| Export (-) | ■ | ■ | | | | | | |
| Export 2 (-) | ■ | ■ | | | ▒ | | | |
| Export (+) | | | ■ | | | | | |
| Export 2 (+) | | | ■ | | | | | |
| State share (-) | | | | | ■ | | | ■ |
| State share 2 (-) | | | | | ■ | | | ■ |
| Privatized | | | | | | | | |
| Foreign (-) | | ▒ | ■ | ■ | ■ | ■ | | ■ |
| Partly foreign (-) | ▒ | ■ | | ■ | | | | |
| Partly foreign (+) | | | | | ■ | ■ | | |
| Hungarian private owner (-) | | | | | ■ | ■ | | ■ |
| Central Transdanubia (+) | | | ■ | ▒ | | | | |
| Western Transdanubia (+) | | | ■ | ▒ | | | | |
| Southern Transdanubia (+) | | | ■ | ▒ | | ■ | | |
| Northern Hungary (+) | ■ | | ■ | ▒ | | ▒ | | |
| Northern Great Plain (+) | | | ■ | ■ | | | | |
| Southhern Great Plain (+) | | | ■ | ■ | | | | |

Table 11

*Significance table of the explanatory variables when the labour input variable is the wage cost*

| Denomination | Food | Textile | Paper | Chemical | Metal | Machinery | Furniture | Electricity |
|---|---|---|---|---|---|---|---|---|
| Export (-) | ■ | | | | | | | |
| Export 2 (-) | ■ | | | | | | | |
| Export (+) | | | ■ | | | | | |
| Export 2 (+) | | ■ | ■ | | | | | |
| State share (+) | | | | ■ | | | | |
| State share 2 (+) | | | | ■ | | | | |
| Privatized | | | | | | | | |
| Foreign (-) | | ■ | ■ | ■ | ■ | ■ | | ▒ |
| Partly foreign (-) | ■ | | | ■ | | | | ▒ |
| Partly foreign (+) | | | | | ■ | ■ | | |
| Hungarian private owner (-) | ■ | ■ | ▒ | ■ | ■ | ■ | ■ | |
| Central Transdanubia (+) | | | | | | | | |
| Western Transdanubia (+) | | | | | | | | |
| Southern Transdanubia (+) | | | | | | | | |
| Northern Hungary (+) | | | ▒ | | | | ▒ | |
| Northern Great Plain (+) | | | ▒ | | | | ▒ | |
| Southern Great Plain (+) | | | ▒ | | | | ▒ | |

*Note*: In Table 10 and 11 the directions of impact on inefficiency are in parenthesis.

*2. The role of state ownership*. We would expect that firms under public ownership operate less efficiently, but this is not justified in our data set. In some cases we saw exactly the opposite: state owned companies were found to be more efficient. We explained this phenomenon by the fact that the number of state-owned companies is recently very small, in a typical industry, it is around 10 percent; among these companies there are several strategically important, relatively well-performing companies. (This is especially true for the electricity sector, where the state was reluctant to sell the big national suppliers.) Though, it is still interesting that we have found inefficiency corresponding to state in only one instance (at the chemical industry, when the labour input variable is wage costs). Another significant issue is privatization: we expected that inefficiencies can be explained (at least to some extent) by the dramatic changes in the ownership structure. But we could not detect any evidence that newly privatized companies were more efficient. This may be explained by the fact that: first, the observation period is too short to detect any significant change in efficiency for a specific company; second, the majority of private firms gave the controlling rights for the former management and workers, who had limited financial backgrounds for the necessary investments. (This is especially true for the smaller firms.)

*3. The role of foreign ownership*. This is the variable that seems to explain the most successfully the differences in inefficiencies. According to almost all models in all industries under investigation, dominant (above 50 percent) foreign control increases efficiency. However, the role of partial foreign ownership is not so obvious. We have found evidence that it may even reduce efficiency (in metal and machinery).

*4. The role of domestic private ownership*. Here we observed a very interesting pattern of significance: when our labour input variable is the number of employees, Hungarian private ownership tends to have not a significant effect on efficiency. However, when labour input is measured in wage costs, Hungarian private firms are found to be much more efficient. This may be explained by the differences in wage levels among multinational and other companies: when we measure efficiency per unit wage costs, those Hungarian firms that pay lower salaries outperform the other ones. This is not true, however, if we consider ‘raw labour’, i.e. efficiency per worker.

*5. The role of regional dummies*. There is a sharp difference between the two types of models. When we consider the number of employees, Budapest and the Central region are the most efficient on average. (The estimated regional dummies are almost always positive, relative to East Hungary, though sometimes insignificant.) Though changing to wage costs as labour input variable, Budapest and the Central region (which is characterized by much higher wage levels) looses its efficiency advantage, and several times it becomes the least efficient region. (In this case the estimated parameters for the regional dummies tend to turn into negative, though remaining mainly insignificant.)

## CONCLUSION

In this paper we estimated industry-specific production function frontiers and found that our estimates are highly dependent on the choice of input and output variables. Based on simple statistical methods, and on theoretical arguments, our preferred output variable is value added, and our preferred capital input variable is depreciation. We cannot choose between wage costs and number of employees as a labour input measure, as it influences significantly our final results.

The results show that average efficiency is highest in textile, electric and paper industries, while machinery and metal industries are the least efficient on average. We explained the differences by several factors. When examining all industries together, we found that the highest the concentration is, the highest is the average inefficiency; private and foreign owned firms generally outperform the rest of the companies. Large companies tend to be more efficient as well and regional differences do not play an important role in explaining inefficiency, the western and central region being only slightly more efficient than eastern firms.

We also tried to explain firm-specific inefficiencies in all industries separately. Our main results were that the only variable that could robustly (i.e., independently from the model setting and the industry under investigation) explain higher efficiency is foreign ownership. State owned companies tend to be as efficient as privatized ones. Export-orientation is also a weak indicator of higher efficiency, examined at industry level. Hungarian private ownership also tends to increase efficiency in those models when the labour input is measured as wage costs. Regional dummies gain significance only when the labour input variable is the number of employees.

## APPENDIX

*Estimated parameters for different models*

| LHS variable | RHS variables | | Variable coefficient for labour | Variable coefficient for capital | Wald test statistics | Significance level |
|---|---|---|---|---|---|---|
| | labour | capital | | | | |
| | | | **Food** | | | |
| Revenue | Wage cost | Depreciation | 0.83 | 0.16 | 0.64 | 0.43 |
| Revenue | Wage cost | Capital | 0.92 | 0.06 | 2.34 | 0.13 |
| Revenue | Number of employees | Depreciation | 0.66 | 0.31 | 2.64 | 0.10 |
| Revenue | Number of employees | Capital | 0.81 | 0.12 | 9.03 | 0.00 |
| Value added | Wage cost | Depreciation | 0.88 | 0.13 | 0.36 | 0.55 |
| Value added | Wage cost | Capital | 0.93 | 0.08 | 0.42 | 0.52 |
| Value added | Number of employees | Depreciation | 0.70 | 0.33 | 1.60 | 0.21 |
| Value added | Number of employees | Capital | 0.82 | 0.20 | 0.70 | 0.40 |
| | | | **Textile** | | | |
| Revenue | Wage cost | Depreciation | 0.87 | 0.16 | 3.39 | 0.07 |
| Revenue | Wage cost | Capital | 0.93 | 0.08 | 1.85 | 0.17 |
| Revenue | Number of employees | Depreciation | 0.68 | 0.29 | 3.99 | 0.05 |
| Revenue | Number of employees | Capital | 0.76 | 0.19 | 8.87 | 0.00 |
| Value added | Wage cost | Depreciation | 0.99 | 0.07 | 46.36 | 0.00 |
| Value added | Wage cost | Capital | 1.04 | 0.03 | 41.50 | 0.00 |
| Value added | Number of employees | Depreciation | 0.84 | 0.24 | 25.24 | 0.00 |
| Value added | Number of employees | Capital | 0.91 | 0.15 | 14.74 | 0.00 |
| | | | **Paper** | | | |
| Revenue | Wage cost | Depreciation | 0.59 | 0.29 | 54.44 | 0.00 |
| Revenue | Wage cost | Capital | 0.71 | 0.12 | 80.05 | 0.00 |
| Revenue | Number of employees | Depreciation | 0.43 | 0.39 | 80.67 | 0.00 |
| Revenue | Number of employees | Capital | 0.55 | 0.15 | 179.49 | 0.00 |
| Value added | Wage cost | Depreciation | 0.73 | 0.22 | 10.93 | 0.00 |
| Value added | Wage cost | Capital | 0.85 | 0.09 | 11.32 | 0.00 |
| Value added | Number of employees | Depreciation | 0.49 | 0.40 | 25.91 | 0.00 |
| Value added | Number of employees | Capital | 0.62 | 0.15 | 80.98 | 0.00 |
| | | | **Chemistry** | | | |
| Revenue | Wage cost | Depreciation | 0.77 | 0.19 | 8.44 | 0.00 |
| Revenue | Wage cost | Capital | 0.85 | 0.11 | 6.07 | 0.01 |
| Revenue | Number of employees | Depreciation | 0.60 | 0.33 | 11.53 | 0.00 |
| Revenue | Number of employees | Capital | 0.74 | 0.18 | 16.83 | 0.00 |
| Value added | Wage cost | Depreciation | 0.87 | 0.16 | 6.60 | 0.01 |
| Value added | Wage cost | Capital | 0.97 | 0.07 | 7.59 | 0.01 |
| Value added | Number of employees | Depreciation | 0.62 | 0.37 | 0.14 | 0.71 |
| Value added | Number of employees | Capital | 0.80 | 0.18 | 1.46 | 0.23 |

*(Continued on the next page.)*

*(Continuation.)*

| LHS variable | RHS variables: labour | RHS variables: capital | Variable coefficient for labour | Variable coefficient for capital | Wald test statistics | Significance level |
|---|---|---|---|---|---|---|
| | | Metal | | | | |
| Revenue | Wage cost | Depreciation | 0.74 | 0.24 | 1.79 | 0.18 |
| Revenue | Wage cost | Capital | 0.85 | 0.11 | 4.10 | 0.04 |
| Revenue | Number of employees | Depreciation | 0.50 | 0.39 | 40.39 | 0.00 |
| Revenue | Number of employees | Capital | 0.60 | 0.20 | 91.17 | 0.00 |
| Value added | Wage cost | Depreciation | 0.89 | 0.13 | 0.97 | 0.33 |
| Value added | Wage cost | Capital | 0.97 | 0.04 | 0.54 | 0.46 |
| Value added | Number of employees | Depreciation | 0.56 | 0.34 | 22.38 | 0.00 |
| Value added | Number of employees | Capital | 0.68 | 0.17 | 44.40 | 0.00 |
| | | Machinery | | | | |
| Revenue | Wage cost | Depreciation | 0.71 | 0.25 | 14.33 | 0.00 |
| Revenue | Wage cost | Capital | 0.82 | 0.13 | 14.41 | 0.00 |
| Revenue | Number of employees | Depreciation | 0.51 | 0.37 | 56.84 | 0.00 |
| Revenue | Number of employees | Capital | 0.67 | 0.19 | 80.60 | 0.00 |
| Value added | Wage cost | Depreciation | 0.83 | 0.15 | 3.99 | 0.05 |
| Value added | Wage cost | Capital | 0.91 | 0.07 | 3.97 | 0.05 |
| Value added | Number of employees | Depreciation | 0.59 | 0.31 | 39.14 | 0.00 |
| Value added | Number of employees | Capital | 0.74 | 0.14 | 54.08 | 0.00 |
| | | Furniture | | | | |
| Revenue | Wage cost | Depreciation | 0.77 | 0.10 | 29.93 | 0.00 |
| Revenue | Wage cost | Capital | 0.82 | 0.04 | 30.54 | 0.00 |
| Revenue | Number of employees | Depreciation | 0.60 | 0.23 | 28.16 | 0.00 |
| Revenue | Number of employees | Capital | 0.68 | 0.13 | 31.28 | 0.00 |
| Value added | Wage cost | Depreciation | 0.91 | 0.09 | 0.04 | 0.85 |
| Value added | Wage cost | Capital | 0.94 | 0.05 | 0.01 | 0.93 |
| Value added | Number of employees | Depreciation | 0.68 | 0.27 | 2.35 | 0.13 |
| Value added | Number of employees | Capital | 0.76 | 0.18 | 3.11 | 0.08 |
| | | Eletricity | | | | |
| Revenue | Wage cost | Depreciation | 0.39 | 0.29 | 101.18 | 0.00 |
| Revenue | Wage cost | Capital | 0.54 | 0.17 | 72.39 | 0.00 |
| Revenue | Number of employees | Depreciation | 0.22 | 0.37 | 128.61 | 0.00 |
| Revenue | Number of employees | Capital | 0.38 | 0.19 | 115.08 | 0.00 |
| Value added | Wage cost | Depreciation | 0.82 | 0.20 | 0.92 | 0.34 |
| Value added | Wage cost | Capital | 0.94 | 0.10 | 4.22 | 0.04 |
| Value added | Number of employees | Depreciation | 0.63 | 0.36 | 0.24 | 0.63 |
| Value added | Number of employees | Capital | 0.85 | 0.17 | 0.56 | 0.46 |

## REFERENCES


AIGNER, D. – CHU, S. (1968): On estimating the industry production function. *American Economic Review*, No. 58. p. 826–839.

AIGNER, D. – LOVELL, K. – SCHMIDT, P. (1977): Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics,* Vol. 6. No. 1. p. 21–37.

ALCHIAN, A. A. (1965): Some economics of property rights. *Il Politico,* Vol. 30. No. 4. p. 816–829.

ALCHIAN, A. A. – KESSEL, R. A. (1962): Competition, monopoly, and the pursuit of money. In: *Aspects of Labour Economics*. Princeton University Press for The National Bureau of Economic Research, Princeton. p.157-175.

AVERCH, H. – JOHNSON, L. L. (1962): The behaviour of the firm under regulatory constraint. *American Economic Review*, Vol. 52. No. 5. p.1052–1069.

BATTESE, G. – COELLI, T. (1988): Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. *Journal of Econometrics,* Vol.38. No. 3. p. 387–399.

BECKERS, D. – HAMMOND, C. (1987): A tractable likelihood function for the normal-gamma stochastic frontier model. *Economics Letters,* No. 24. p. 33–38.

BERNSTEIN, M. A. – FELDMAN, S. L. – SCHINNAR, A. P. (1990): Impact of pollution controls on the productivity of coal-fired power plants. *Energy Economics,* Vol. 12. No. 1. p. 11–17.

DEBREU, G. (1951): The coefficient of resource utilization. *Econometrica,* Vol. 19. No. 3. p. 273–292.

GABRIELSEN, A. (1975): *On estimating efficient production functions*. Working Paper, No. A-85, Chr. Michelsen Institute, Bergen, Norway.

GREENE, W. (1980): Maximum likelihood estimation of econometric frontier functions. *Journal of Econometrics,* Vol. 13. No. 1. p. 27–56.

GREENE, W. (1990): A gamma-distributed stochastic frontier model. *Journal of Econometrics,* Vol.46. No. 1–2. p. 141–163.

GREENE, W. (1993): The econometric approach to efficiency analysis. In: *The measurement of productive efficiency, techniques and applications. Fried, H. O. – Lovell, C. A. K. – Schmidt, S. S.* (ed.) Oxford University Press.

GREENE, W. (1997): *Econometric Analysis*. Prentice-Hall Inc. New Jersey.

HICKS, J. R. (1935): The theory of monopoly: A survey. *Econometrica*, Vol. 3. No. 1. p. 1–20.

JONDROW, J. ET AL. (1982): On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of Econometrics,* Vol. 19. No. 2–3. p. 233–238.

KOOPMANS, T. C. (1951): An analysis of production as an efficient combination of activities. In: *Koopmans, T. C.* (ed.) *Activity analysis of production and allocation*. Cowles Commission for Research in Economics, John Wiley and Sons, Inc. New York.

MEEUSEN, W. – VAN DEN BROECK, J. (1977): Efficiency estimation from Cobb-Douglas production functions with composed error. *International Economic Review,* Vol. 18. No. 2. p. 435–444.

SHEPHARD, R.W. (1970): *Theory of cost and production functions*. Princeton University Press, Princeton.

# SPATIAL GRAVITY CENTRES OF THE DYNAMICS AND THE CRISIS IN HUNGARY

JÓZSEF NEMES-NAGY[1]

The transition into market economy in Hungary was coupled with an increase in regional disparities and the restructuring of the spatial pattern of economy. The study presents some spatial processes of the Hungarian transition (1990–2000) by the classic method of the spatial analysis: method of gravity centres. The basic points of the analysis are the settlements of the country. The characteristic geographical location of individual gravity centres – population, income, unemployment, phone lines – and their mobility or stability refer to the fact that the method is suitable not only for the analyses of static features of spatial structures of society or showing long-time, historical trends of movements, but for describing new connections in the examination of periods of radical changes (typically in the transition in Eastern Europe). The investigations prove the dominant role of capital in the spatial structure of transition as well as the sharp West-East disparities.

KEYWORDS: Gravity centres; Regional inequalities.

The transition into market economy in Hungary was coupled with an increase in regional disparities and the restructuring of the spatial pattern of economy. This process has been analysed substantially by using statistical methods as well. Regarding the analytical methods of these studies two characteristic ones can be distinguished: *the classification of regional units* which uses complex mathematical-statistical and multi-dimensional methods (*Faluvégi*; 2000) and the analyses focusing on the tendency in these regional inequalities (latest: *Nagy*; 2002). In an attempt to analyse regional processes this paper works with different methodology: it uses an analogue model applied in physics, the method of gravity centres, which takes demographic and economic gravity centres as the base of the analysis.

## THE METHOD

The co-ordinates of the gravity centres in a planar system consisting of *n* elements can be calculated as the weighted arithmetical means of the co-ordinates of the points in condition that the location of the points in the system of co-ordinates (map) is fixed and all the points are associated with ‘weights’. The centre of gravity represents an optimal

[1] Professor at the Eötvös Loránd University of Sciences and head of the Institute of Geography.

point: the weighted sum of the distances between gravity centre and the basic points is minimal. The calculation of the points of gravity (*X*, *Y*) needs co-ordinates of basic points ($x_i$ and $y_i$) and their weights ($f_i$):

$$x = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i} ; \; y = \frac{\sum_{i=1}^{n} f_i y_i}{\sum_{i=1}^{n} f_i} .$$

The application of the model in social science roots in social-physics, which was established in the first part of the XX[th] century (*Stewart–Warntz*; 1958). The applicability of the model is proved by the fact that it can reflect the geographical patterns of population in any spatial unit (county, region), where the basic points are the settlements and the weights are the numbers of inhabitants. The gravity centre of a population is a spatial (geographic) mean of the population pattern. In the calculations the role of weight can be played not only by the population but by any other social or economic variable: growth of economic production, income, number of employed persons (economic centres of gravity), number of votes for parties (political centres of gravity), number of crime events, suicides, accidents (social centres of gravity) etc.

Papers based on the application of this model in Hungary primarily deal with demographic processes. The first contribution was made by *Bene* and *Tekse* (1966) who carried out a comprehensive analysis of this type aiming at the description of the historical changes of spatial population pattern in the period 1900-1960. The shift of the centre of population in the last decades was analysed by *Mészáros* (1995). Both papers conclude that the gravity centre of the total population of Hungary in the XX[th] century move gradually towards the capital, the motion of the centre of gravity of the urban population is characterised with a South-Eastern–North-Western direction, by contrast the gravity centre of the rural population shifts with a South-Western–North-Eastern vector. The relocation of the demographic centres reflects the pull effect of the capital and the industrial axis with the relative depopulation of the Great Plain, primarily as a result of emigration from the area. *Illés* (2000) used the model for the analysis of the elements of the internal migration processes. The change of gravity points of the industrial production in the (former) socialist countries in the period 1960–1975 was investigated with this model (*Nemes-Nagy*; 1987). The analysis showed a clear shift in economic (industrial) development with a common vector directed in the East for these countries.

The spatial structure of social processes and patterns can be characterised by the distance and direction between the different centres of gravity e.g. the relationship between geometric and population centres of gravity characterises the geographical differentiation of population density, the relationship between the centres of gravity of population and income describes the regional pattern of income inequalities.

The analysis of gravity centres can be undoubtedly regarded as a useful method in the historical investigation of spatial transformation, however it is not applicable in expressing certain type of processes, not even theoretically. Substantial changes in spatial structure can occur without a slight movement of the gravity centre, when the changes (growth or increase) take place symmetrically around the gravity centre. The average, weighted distance of basic points measured from the gravity centres, the *standard distance* makes the difference among these cases. The smaller the value, the more characteristic is that the given phenomenon concentrates around the gravity centre.

In our analysis a map based co-ordinate system with the capital city in the middle was used. The basic points were settlements, the signed distances measured in kilometres from the capital from West-East or South–North directions give the co-ordinates of their centres. The considered period for the individual indicators are not quite the same. The reason is that data are available on settlement level for distinct years.

In an attempt to analyse the most important processes, we calculated four typical socio-economic gravity centres – for the earliest and latest years of the transition period with data available. These are the following:

*1*. size of population (permanent population),
*2*. incomes (volume of taxable incomes),
*3*. unemployment (registered unemployed persons),
*4*. supply of phone lines (main phone lines).

The source of data in case of phone lines and the population is the database of the Hungarian Central Statistical Office (TSTAR), in case of registered unemployment and in taxable incomes on settlement level we use the database of the National Employment Office (Foglalkoztatási Hivatal) and the Hungarian Ministry of Finance and the Hungarian Tax and Financial Control Administration (PM–APEH), which is not a public database on settlement level.

Table 1

*Regional inequalities between the distribution of population and the analysed economic indicators*
(Hoover-indices, percent)

| Year | Budapest countryside (*n*=2) | Regions (*n*=7) | Counties (*n*=20) | Micro-regions (*n*=150) | Settlements (*n*=3157) |
|---|---|---|---|---|---|
| | | | Income | | |
| 1988 | 6.9 | 7.6 | 7.7 | 9.1 | 10.8 |
| 1996 | 9.0 | 10.1 | 10.3 | 12.7 | 15.2 |
| 2000 | 9.3 | 11.3 | 11.5 | 13.5 | 15.6 |
| | | | Unemployment | | |
| 1991 | 17.52 | 26.35 | 26.71 | 30.53 | 33.16 |
| 1996 | 7.71 | 12.70 | 13.57 | 15.39 | 18.28 |
| 2001 | 12.01 | 22.50 | 22.58 | 24.30 | 26.46 |
| | | | Phone lines | | |
| 1992 | 23.24 | 17.89 | 23.59 | 29.02 | 34.32 |
| 1996 | 13.26 | 13.09 | 13.64 | 17.31 | 20.43 |
| 2000 | 7.67 | 7.50 | 7.79 | 9.39 | 11.10 |

*Note*: Hoover-index: $H= \frac{1}{2} \Sigma | x_i - y_i |$, where $x_i$ and $y_i$ are the shares (%) of the i. spatial units (regions, counties, micro-regions, settlements) in the total volume of the compared indicators. $H_{min} = 0$, $H_{max} = 100$.

*Source*: *Hoover* (1941).

In our paper the population gravity centre has an outstanding importance not only in itself but also in comparison with other analysed economic indicators. We can provide a comprehensive view by analysing the taxable incomes, a description of the spatial characteristics of socio-economic dynamism by using the index of telephone lines supply regarded as a rapidly growing sector, while by using the unemployment data we can make the spatial processes of this crises phenomena. In every case we calculated the gravity centres including all the settlements (3147) as basic points, in the case of the incomes all the cities (251 settlements without the capital) and villages as basic points.

The selection of three indices mentioned previously (income, phone lines, unemployment) is motivated by the fact that they radically differ from each other in their spatial inequality patterns at the end of the XX$^{th}$ century (see Table 1).

At the beginning of the nineties a marked trend in differentiation can be realised, which stabilising itself on a high level resulted a divided income space in the second half of the decade. In contrast in phone lines supply – which is the most dynamically developing sector of the infrastructure – regional levelling is marked, while in the case of unemployment we can see a special waving character of the regional inequalities. Definite spatial directions can be posted to the previously mentioned tendencies by using the gravity centre method.

## THE LOCATION OF THE GRAVITY CENTRES

For the interpretation of the location of different gravity centres unweighted (geometric or geographic) centres of gravity and a special centre, called 'geographic centre of the country' mean good points to relate to. (The location of the calculated gravity points on the map of Hungary can be seen on Figure 1.)

*Figure 1. Calculated gravity points in Hungary*


### *Geometric (geographic) centres*

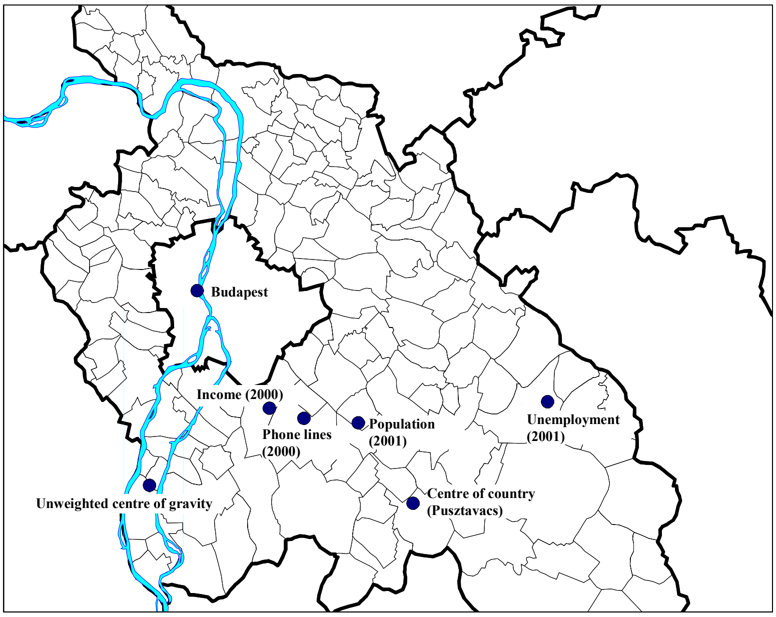
The point mentioned is situated in South-Eastern direction from the capital about 2 kilometres from the centre of Pusztavacs village (Pest county) and its marking was not carried out with the gravity centre method, but with taking the average of the longitudes and latitudes bordering the country (*Atlas of Hungary*; 1999 p. 9.). This point is quite near to that gravity centre – though it does not fully coincide with it – which we can get by calculating with all the settlements in the country as basic points taking the public administration area belonging to them as the weight. (The difference between them comes from the fact, that settlements are usually not situated in the geometrical centre of their administration area.)

We get the next interesting 'neutral', unweighted gravity centre if we simply take the average of the place co-ordinates of the settlements in the country. The position of this centre (the gravity centre of the settlements) is quite unique: it is located, not in East-Hungary, but in an isle of the Danube, the Csepel-island (see Figure 2). The reason of it can be attributed to the settlement structure of the country. Though the greater proportion of the area belongs to the Eastern part of the country, Transdanubia has a higher density of settlements, (e.g. large range of regions in West and South Transdanubia is characterised by small settlements), while on the Great Plain we can find fewer (but more populous) settlements.

### *Location of the gravity centres of the population and economy*

During the whole XX$^{th}$ century the economic and population gravity centres of the country were situated mainly in the South-East of the capital city (a characteristic tendency was that they were getting nearer and nearer to the capital first of all because its attracting power of population and economy). At the turn of millennium the situation was the same.

*Figure 2. Location of the gravity centres at the end of the XX$^{th}$ century*



The population gravity centre in the year 2000 is located near Vasad (33 air kilometres from the 0 kilometre standpoint at the bridge head of Lánchíd in Buda, that is the theoretical centre of Budapest). The income gravity centre of the country has got very close to the capital, and it is the nearest to the centre of the village Alsónémedi community (22.2 kilometres from the capital). Similarly to the income gravity centre, the phone lines gravity centre falls between the capital and the population gravity centre, it is situated at a 26.2 kilometres distance from Budapest, (near Ócsa). The unemployment gravity centre lays far from the other centres, being located to the East of the capital, in a 58.6 kilometres distance from it in 2001. (Near Tápiószele, in Pest county.) The special difference in the location of the distinct gravity centres demonstratively shows the marked regional separation of elements of dynamism and factors of crises (see Figure 2 and Table 2).

Table 2

*Location of the gravity centres*

| Analysed points | Year | Co-ordinates of the gravity centres (kilometre, Budapest = 0;0) | |
|---|---|---|---|
| | | West-East | South-North |
| | | Geometric | |
| Settlements (unweighted points) | 2000 | -7.58 | -31.73 |
| Settlements (weighted by area) | 2000 | 26.61 | -35.66 |
| | | Population | |
| Settlements | 1988 | 24.64 | -21.54 |
| Settlements | 2000 | 25.03 | -21.48 |
| Villages | 1988 | 26.42 | -21.90 |
| Villages | 2000 | 25.55 | -21.31 |
| Towns (excluded Budapest) | 1988 | 33.22 | -29.90 |
| Towns (excluded Budapest) | 2000 | 33.73 | -29.39 |
| | | Income | |
| Settlements | 1988 | 17.44 | -19.57 |
| Settlements | 2000 | 11.33 | -19.06 |
| Villages | 1988 | 18.36 | -20.33 |
| Villages | 2000 | 6.60 | -19.85 |
| Towns (excluded Budapest) | 1988 | 26.33 | -29.71 |
| Towns (excluded Budapest) | 2000 | 19.84 | -29.05 |
| | | Unemployment | |
| Settlements | 1991 | 70.28 | -13.24 |
| Settlements | 2001 | 60.41 | -16.41 |
| | | Phone lines | |
| Settlements | 1992 | 10.62 | -16.93 |
| Settlements | 2000 | 16.74 | -20.64 |

*Standard distances*

In the case of Hungary the gravity centres and the standard distances connected to them are mainly determined by the effect of the capital.

It also originates from this fact that we get the highest value of standard distance just regarding the unweighted settlement gravity centre (140.9 kilometres), as in that calculation the weight of the capital is equal to any other small communities, and this way the gravity centre is not attracted close to the capital. Among the analysed gravity centres the standard distance of unemployment gravity centre situated the farthest from the capital is the biggest. The change of the index follows the movement of the gravity centre related to the capital: when the gravity centre comes nearer to the capital, its value decreases, when it goes farther, its value increases. This fact demonstrates well, that in the case of the unemployment gravity centre the capital has a determining effect, where the unemployment rate is always far under the national average, but regarding the absolute numbers most of the unemployed people have always lived in Budapest. In the case of the other investigated gravity centres the formation of standard distance is basically determined by their position to the capital (see Table 3).

Table 3

*Standard distances of different gravity centres*

| Indicator | Year | Weighted standard distance (kilometre) |
|---|---|---|
| Settlements (unweighted points) | 2000 | 140.9 |
| Population | 1988 | 107.4 |
| Population | 1996 | 107.2 |
| Population | 2000 | 107.3 |
| Income | 1988 | 96.0 |
| Income | 1996 | 93.8 |
| Income | 2000 | 92.2 |
| Unemployment | 1991 | 128.8 |
| Unemployment | 1996 | 119.9 |
| Unemployment | 2001 | 126.5 |
| Phone lines | 1992 | 83.7 |
| Phone lines | 1996 | 89.5 |
| Phone lines | 2000 | 96.8 |

*Distances of gravity centres*

As a result of the stability of the population gravity centre and the motion of income gravity centre the two gravity centres have moved relatively far from each other (in 1988 7.5 kilometres, in 2000 13.9 kilometres), which, complemented with direct geographical meaning proves unambiguously the growing inequalities of incomes and highlights the role of regional potential factor in the social processes.

In the case of phone lines as well as the population gravity centres – reinforcing the levelling trend of Hoover-indices published in Table 1 – the distance decreased from 15 to 8.3 kilometres in the period 1992–2000 (as the population gravity centre was basically stable, the approaching of the two gravity centres can be attributed to the effect of the growing phone lines supply). Comparing the gravity centres of unemployment and population in 1991 and in 2000 the distances are much bigger (46.2 or 31.1 kilometres), and the decrease, though in a smaller degree, reflects to the more balanced spatial structure of the labour market (see Table 4).

Table 4

*Distances between the population centres of gravity and the other analysed centres*

| Compared gravity centres | Years | Distance (kilometre) |
|---|---|---|
| Population-Income | 1988 | 7.5 |
| Population-Income | 1996 | 12.3 |
| Population-Income | 2000 | 13.9 |
| Population-Unemployment | 1991 | 46.2 |
| Population-Unemployment | 1996 | 20.5 |
| Population-Unemployment | 2001 | 31.1 |
| Population-Phone lines | 1992 | 15.0 |
| Population-Phone lines | 1996 | 13.7 |
| Population-Phone lines | 2000 | 8.3 |

If we do not insist on comparing two years from the beginning and from the end of the transformation period, though we follow through the whole period, the movement of the three economic-well-being gravity centres show further interesting features of the spatial processes.

## SHIFT OF GRAVITY CENTRES

The movement of each of the gravity centres demonstrate spectacularly, that the transition processes were accompanied by radical geographical changes.

### *Income*

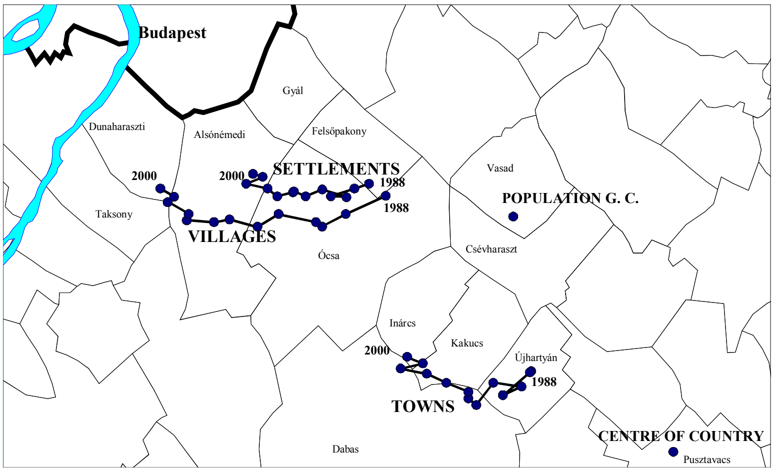
While the population gravity centre in each of the investigated categories of settlements seems to be almost fixed, meaning that at the end of millennium in the macro-regional dispersion of population no definite rearrangement happened, the mobility of the income gravity centres are significant. While the results of the population gravity centres indicate small, only some hundred metres movement, the income gravity centre between 1988 and 2000 moved 6.1 kilometres to the direction of North–West, more dominantly to the West.

The measurement of the movement of two subsets of settlements (towns and villages) represents almost the same scale. It might be surprising, that the most mobile geographical centre of incomes is that of the villages, its shift is about twice as high as in the case of the gravity centre of the income of the 251 cities. This fact shows the relative stability of the network of cities as they serve as 'economic skeleton' of the country. The villages comparing to the cities – mainly as a function of their location – took a more different path after the transition.

In Figure 3 one can observe the motion of gravity centres year by year during the whole period and it calls attention to a South direction component in terms of the geographical direction. One can identify a specific geographical and economic development process in that period: the 'underlevelling' inside the countryside, which process was basically in connection with the economic shock of North-Eastern–South-Western industrial axis. In this period the development level of the Eastern part of the country (North-

Hungary and the Great Plain) got almost balanced, from an above average position; the first one has radically fallen down, while the latter one has stagnated. In the recent years the income gravity centres have turned to the North again. This refers – at least in the Western part of the country, in the Transdanubian region – to the slow process of re-establishment of the former North–South duality. (This fact can be proved by other data, too, e.g. GDP per capita in a county.) The explanation of it is partly the dynamism induced by the foreign capital in the Northwest, nearby to the Austrian border zone, but one can mention at least with the same weight the mosaic like, steadily deteriorating position of South-Transdanubia.

*Figure 3. Shift of the income gravity centres (1988–2000)*

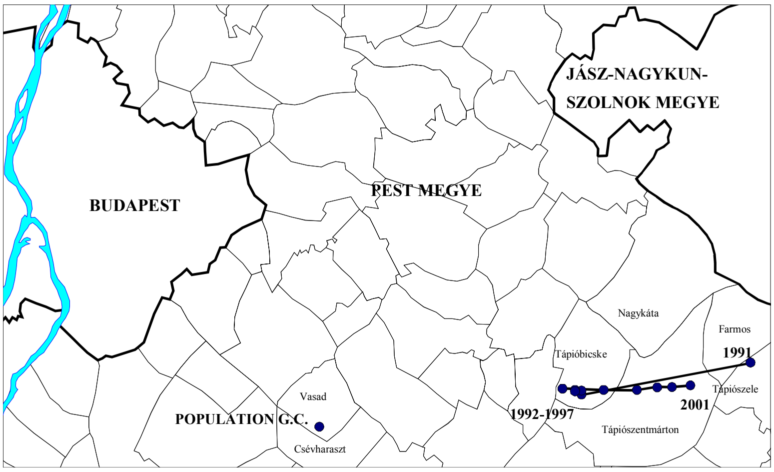



According to our investigations in every settlement category there was a movement away from each other in terms of the income and the population gravity centre between 1988 and 2000, which is a new proof for the fact that the recent income inequalities – independently from the size of settlements – were growing both in the group of the cities and in the villages (about the relation of the location and the settlement structure see *Nemes-Nagy–Jakobi–Németh.*; 2001).

*Unemployment*

The mass unemployment, the very process of the decade, which caused the greatest shock for the society was characterized by special course both in time and space, and produced mechanism of 'ebb and tide'. In the first phase of the transition process the phenomenon of unemployment – besides becoming a mass symptom – had a definite regional concentration (for the disadvantage of North-East). Afterwards the unemployment crises diffused in the country and later the gravity centre of unemployment came nearer to that of the population, and by now it has again drawn back to its original spatial structure (see Figure 4). The highest unemployment rates today are again in the North-Eastern part of the country. Here, mainly in the rural areas, the labour market has become rigid without any hope for change, and the younger generation took the place of the permanently unemployed persons after elderly persons got excluded from the labour market.

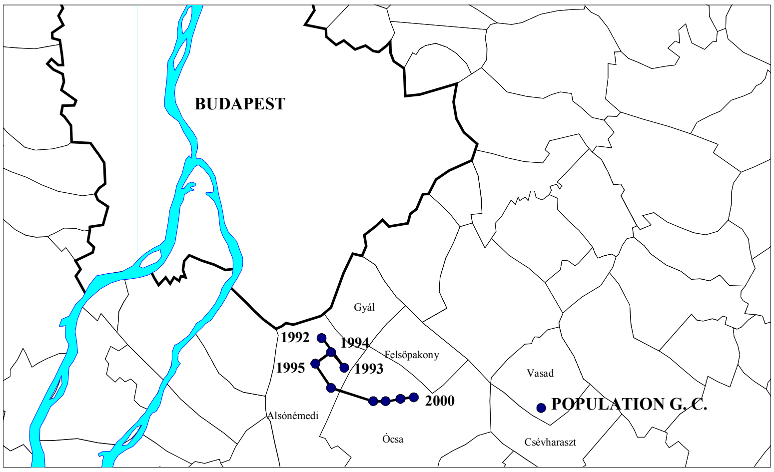
*Figure 4. Shift of the unemployment gravity centres (1991–2001)*




*Phone lines*

Between 1992 and 2000 the number of phone lines grew by more than 2 millions, today every third person has a line. Nowadays this development has resulted in a total supply on national level. Though the density of lines – as well as the data of Table 1 show – is rather different among the regions of the country.

*5. Figure. Shift of the phone lines gravity centres (1992–2000)*




The location of the gravity centres indicates the advantage of the Western part of the country, but in its motion we can recognize two special phases (see Figure 5). In the pe riod between 1994–1995 and characterized by the building up of regional networks in those areas, which were not supplied, the gravity centre moved almost randomly year by year, its position were modified by the subscriber of a new connected network district. After this period on the basis of the existing network the 'saturating' phase comes. At that time the direction of the movement of the gravity centre suggests that the Eastern and Southern zone of the country having been earlier in a disadvantaged situation started to catch up. In the middle of the 90's as a result of the basically opposite direction in the movement of the income and phone lines gravity centres the two gravity centres got quite close to each other, but the tendencies of the latest years refer to the fact, that the phone lines supply is going to become a basic function, which is independent from the income and therefore the two gravity centres have moved further away from each other.

## *Conclusions*

The study presents some spatial processes of the Hungarian transition by using a special method for the investigation of space, the calculation of gravity centre. The results (the characteristic geographical location of individual gravity centres and their spectacular motions) refer to the fact that the method, nowadays considered as a classic method in spatial investigation, is suitable not only for the analysis of static features of spatial structures of society or showing long-time, historical trends of movements, but for describing new connections in the analysis of periods of radical changes (typically in the transition in Eastern Europe). The investigations prove the dominant role of the capital in the spatial structure of transition as well as the sharp West-East disparities. Though besides these comprehensive effects analyses of the different gravity centres highlight that there are quite different movements in the individual socio-economic segments.

## REFERENCES

BENE, L. – TEKSE, K. (1966): *Vizsgálatok a népesség területi eloszlásának alakulásáról Magyarországon 1900-1960*. KSH Népességtudományi Kutató Csoport Közleményei 9. Budapest.

FALUVÉGI, A. (2000): A magyar kistérségek fejlettségi különbségei. *Területi Statisztika,* Vol. 40. No. 4. p. 319–346.

HOOVER, E. M. (1941): Interstate redistribution of population, 1850–1940. *Journal of Economic History,* Vol. 1. No. 1. p. 199–205.

ILLÉS S. (2000): *Belföldi vándormozgalom a XX. század utolsó évtizedeiben*. KSH Népességtudományi Kutató Intézet Kutatási jelentései 63. Budapest.

MÉSZÁROS, Á. (1995): A népesség területi átrendeződése és települési koncentrációja. *Statisztikai Szemle,* Vol 73. No. 7. pp. 525–543.

NAGY, G. (2002): Oldódtak-e az öröklött területi különbségek a rendszerváltás éveiben? In: *A magyar társadalomföldrajzi kutatás gondolatvilága*. Szegedi Tudományegyetem Gazdaság és Társadalomföldrajzi Tanszéke. Szeged. p. 211–225.

NEMES-NAGY, J. (1987): *A regionális gazdasági fejlődés összehasonlító vizsgálata.* Akadémiai Kiadó, Budapest.

NEMES-NAGY, J. – JAKOBI, Á. – NÉMETH, N. (2001): A jövedelemegyenlőtlenségek térségi és településszerkezeti összetevői. *Statisztikai Szemle*, Vol. 79. No. 10–11. p. 862–884.

STEWART, J. Q. – WARNTZ, W. (1958): Physics of population distribution. *Journal of Regional Science,* Vol. 1. No. 1. p. 99–123.

# ANALYSIS OF LONG-TERM TENDENCIES IN THE WORLD ECONOMY AND HUNGARY*

BÉLA SIPOS[1]

This study tries to prove the fact, that not the national features are characteristic in the Kondratev cycles. Kondratev cycles are global; they are the cycles of the entire world economy.

Economic development realized through introduction of new innovations that means introduction of new products and production-organization methods, opening new markets and finally exploiting new raw materials, therefore we studied the role of basic innovations. The relationship between innovations and long-term cycles has been investigated and the long-term tendencies have been analysed with some empirical results: at first the industrial series then the long waves of plant cultivation. The results of empirical investigations proved the existence of long-term cycles.

KEYWORDS: Kondratev cycle; Century trends; Innovation.

The research of market conditions and the theory of business cycles seem to be arisen in crisis periods. Computations concerning the basic economic factors proved the existence of Kondratev waves. The author carries out a wide scope empirical research in this field being sponsored by the Hungarian Academy of Sciences. The investigation covers the Hungarian industry and agriculture. Processing the data measured in natural units supported by the fact that the currency had been changed during the examined period in Hungary and that makes the data expressed in value terms unreliable. Data collection was limited by the fact that gathering long-term data series is difficult from 1920 because during the period of Second World War the system of data collection was not always formed.

The data set processed in this research consists of some 1000 data.[2] The author improved Kondratev's method and evolved with his collaborators a computer program (for PC computer SPSS 10, Excel and PC with software REGAL) which, following data input, carries out a series of computations. After having tested the computational results, the author

* This research was carried out with the support of Hungarian Scientific Research Fund (OTKA), theme number T 34101, the research is led by the author.

[1] Doctor of economic science, general vice-rector at the University of Sciences Pécs.

[2] Data source: Time series of world economics 1860–1960 (1965). 157. p. Data for the period 1961–1999 are from: International Statistical Yearbook. 1965, 1970, 1974, 1981, 1985, 1994, 1996, 1999. Statistical Yearbook of Hungary. 1964, 1971, 1976, 1979/80, 1982, 1983, 1994, 1995, 1996, 1997, 1998, 1999, 2000. Hungarian Central Statistical Office, Budapest.

selects the appropriate secular trend, then makes estimates of the long cycles and delineates them using moving averages. The innovation theories resulting in long cycles are reviewed. The research is focused on empirical investigation and statistical induction. The author's results prove the existence of Kondratev cycles in the investigated fields.

Some members of the economic school of *Farkas Heller* (*Heller*; 1928, 1934) were interested in the work of Kondratev for the first time in Hungary in the 1930s and 1940s. After a long pause historians published studies about Kondratev in the 1980s, and then Kondratev's cycles aroused the interest of economists.

Results of international and Hungarian researches confirm that the causes of Kondratev cycles are not in the ownership of the means of production. Scholars have found the existence of long-term cycles even in the Middle Ages.[3] Based on the experiences gathered till now it seems that there are several equilibrium points around which the economy fluctuates (*Kövér*; 1988). The reason of cyclical fluctuation is the different adaptability of the economic factors, and their different reaction speed. When a course is started then, caused by the effects of different factors on each other, it becomes a self-strengthening mechanism. The turning point is the fact that the longer the distance of economy from the equilibrium is the stronger counter-forces are also getting started, their effects become more and more manifest, and they force the economy to return to and over the equilibrium state again. At what intervals the cycle repeated itself, this is a substantial aspect. Thus cycles can be classified by their duration, that is the returning intervals of the cycle, i. e. the interval within the cycle runs its course. This time interval is called period. The existence of cycles of various periods in economic life means that there are different equilibrium points caused by the fact that commodities and goods perform their own economic functions during very different periods, so their production requires different lengths of time and various sorts of resources.

## THE KONDRATEV CYCLES

Kondratev (*Kondratev*; 1980) and *Kuznets* have distinguished equilibrium types of shorter and longer term. At first, Kondratev regards the market supply as constant. Some commodities and goods are consumed in the short term without reshaping and updating. In this category various consumer goods can be ranked, several sorts of raw materials and means of production. The replacement and supplement of stock of these goods can take place within short (1–4 year) periods. In the second, already longer stage Kondratev regards the machinery stock of fixed assets as constant. Large part of means of production (machinery, equipment), are classified among these. *Marx* has found that the material basis of crisis or middle-term cycles returning at ten year interval is the material deterioration, replacement and supplement of means of production because it happens impulse-like (*Kondratev*; 1989).

The Nobel prize winner Kuznets, who is also of Russian birth, discovered the so-called 'secondary secular movements' mainly on the basis of the data of the United

[3] *F. Simiand* investigated the long-term fluctuations of prices and wages from 16th century and has showed that fluctuations lasted several decades. See *Simiand* (1932) p. 16–18. *C. E. Labrousse* has showed long-term cycles using prices of cereals in France and Europe. 1668-[1698]-1732-[1817]-1835-[1871]-1895. The data in brackets mark the culmination of the process i. e. the rising branch turns into declining branch at this time. See *Labrousse* (1933) p. 139–142.

States. He did not regard these movements as cycles but regarded them as ‘waves’ like other contemporary economists. In his opinion this period lasts for 21–23 years. These waves shape a middle-term equilibrium type. Material base of the fourth equilibrium type, the long-term cycle, according to Kondratev is created by depreciation, replacement and increasing of the stock of basic capital goods functioning for many decades. In this category such capital goods as enormous buildings, considerable railways, canal building, soil amelioration equipments, training of qualified workforce etc. can be classified.

The international nature of cycles are showed by *Artis-Kontolemis-Osborn* (1997) analysing the economy of the highly developed G7 group and other European countries as well as the United States and Canada. The cycle is usually asymmetrical, i. e. the duration of the declining branch is longer and deeper than that of the rising branch.[4] The results show that the cyclic behaviour of European countries is closely associated with each other and through Germany with the economies of the United States, Canada and Japan.

The following grouping of business cycles is recognized (*Sipos*; 1997. p. 119–128.).

*1. Kitchin cycle (Kitchin*; 1923. p. 10–16): 3-4 year short-term cycles concerning the movements of stocks.

*2. Juglar cycle* (*Juglar*;1862): 6-8 year middle-term cycle (2 Kitchin cycles) which, according to *C. Juglar's* work is called ‘commercial cycle’.

*3. Labrousse cycle*: 10-12 year middle term cycles (Juglar and Labrousse cycles), these can be explained with the changes in investments.

*4. Kuznets cycle* (*Kuznets*; 1930): middle term, 20-23 year hyper-cycle (doubled Labrousse cycle).

*5. Kondratev cycle* (*Kondratev*; 1935. p. 105–115.): 40-60 year long-term cycle (2 Kuznets cycles). Theories clarifying Kondratev cycles have not explained the reason for the appearance of these cycles yet. There are interpretations based on facts related to monetary, agricultural and production (see innovative, demographic, and investment cycles) (*Schumpeter*; 1939), as well as other factors. Since the first oil-crisis in 1973, we were in the declining of the Kondratev cycle, and the rising branch of the Kondratev cycle began at 1995.

*6. Changes in secular trends*: Historians draw distinctions between 100 (2 Kondratev cycles) and 200-400 year cycles, which may be called century-trend changes. Since the first oil-crisis in 1973, we are in the declining of the secular trends. Secular trends are long-term movements that lasted for more than hundred years in the last thousand years and their nature have been showed on the example of wage and price movements (see Figures 1, 2).

During the last hundred years Kuznets cycles have preceded Kondratev cycles and there were three-three Kuznets cycles during the last two Kondratev cycles. After Word War II the through of Juglar cycles meet the through of Kitchin cycles (*van Duijn*; 1983). According to other views the effects of four cycles are independent (e.g. *Forrester*; 1982). Based on scientific knowledge, at present, it can not be decided which one of

[4] The reason for this is that both century-trend and long-term cycle are in declining branch since 1973.

these theories approaches better the reality. The fluctuation of investments often seems to be as the engine of economic cycle. As mentioned previously the cycles with different duration can be connected with individual type of investments: the Kitchin cycle with investments in stocks, the Juglar cycle with investments in machines and assets, the Kuznets cycle with construction investments and the Kondratev cycle with production of basic capital goods. Naturally other factors may also play a role in causing cycles with different periods (e. g. basic innovation in creating long-term cycles).

When elaborating his procedure Kondratev assumed that he could distinguish the previous components in the time series and random changes.

The 20-30 year long Kuznets cycles were founded later by Kondratev. He fitted polynomial trends to the data and removed the random fluctuations of the residuals by using 9-element moving averages. The details of his method are given in (*Sipos*; 1997).

In this research we followed Kondratev's method. In the first stage we eliminated the trend-effect, and then we used moving averages. For cutting out the shorter cycles we used a nine-element-moving averages.

Kondratev has found four empirical regularities; these are the following.

*1*. Before or at the beginning of increasing branch of long-term cycles fundamental changes occur in economic life: discoveries and implementations of new inventions; changes in relations of production, widening of world economic relations, changes of circulation of money, increasing of gold production etc.

*2*. During the increasing branch of long-term cycles social convulsions and changes (revolutions, wars) are more frequent.

*3*. During the declining branch of long-term cycles the agriculture is also in a long-lasted crisis.

*4*. During the declining branch of long-term cycles depressions of 8-11 year middle-term cycles are longer and deeper while prosperity phases are short and weak.

On the basis of national and international results in the following we summarize the features of century- and long-term cycles[5]

The century-cycles:

| | trough | | peak | | trough |
|---|---|---|---|---|---|
| I. | 1250 | – | [1350] | – | 1510 |
| II. | 1510 | – | [1650] | – | 1743 |
| III. | 1743 | – | [1817] | – | 1896 |
| IV. | 1896 | – | [1973] | – | 2030? |

The long-term-cycles:

| | trough | | peak | | trough |
|---|---|---|---|---|---|
| I. | 1780 | – | [1815] | – | 1848 |
| II. | 1848 | – | [1873] | – | 1896 |
| III. | 1896 | – | [1929] | – | 1945 |
| IV. | 1945 | – | [1973] | – | 1995? |

[5] *Braudel F.* (1980): A tér és idő felosztása Európában. Anyagi civilizáció, gazdaság és kapitalizmus a XV–XVII. században. A világ ideje. In: *Világtörténet*, No 4. p. 3–39.

Nevertheless, the cycles with different periods occur simultaneously, mixing together, and their movements increase or decrease the amplitude of the whole vibration. It is obvious from the illustration that the length of the period of the century trend shortens, which can be explained by the shortening of the length of doubling periods. In *Braudel's* opinion the world is a closed entity so doubling of cycle periods is caused by interference. In a declining branch of century trend in the Middle Ages there was also a demographic ebb and wars occurred more frequently. In contradiction between 1896–1974 (during a rising branch) there were two world wars and several local wars, while doubling time of the population of the world shortened further. Investigating rising branches we can find that firstly the feudal representative monarchies succeeded feudal anarchy (1250–1350), then the absolute monarchy was born in the 16$^{th}$ century in France, the next rising branch (1740–1817) resulted the establishing of national states (constitutional monarchies), the victory of the French Revolution, which was followed by the period of restoration. The rising branch of the last secular trend (1896–1973) brought the birth of the developed capitalist systems and the shaping of welfare states, the victory of socialism in the Soviet Union, Mongolia, then, after 1945, in the East European and in the developing countries (e. g. Cuba, Vietnam, Kampuchea, Ethiopia, Angola etc.). While after 1973 the so-called socialist countries were not able to respond to the challenges caused by turning and declining Kondratev cycle (e. g. restructuring production).

Rising branch of the secular trends is characterized by new intellectual movements such as the Reformation in the first half of 16$^{th}$ century (Luther 1517, Calvin 1541), the Enlightenment in the 18$^{th}$ century and the Marxism in the mid XIX$^{th}$ –XX$^{th}$ century.

Investigation of long cycles has also resulted in that the traditional models cannot describe the development of economy when the cycle is turning. Recent research findings of chaos theory are encouraging on this field. (*Nováky*; 1992. p. 223., *Nováky*; 1993, *Nováky*; 1995. p. 156.)

Relationships between the Kondratev cycles and basic innovations are as follows:

| | The basic innovations | The long-term-cycles trough – peak – trough |
|---|---|---|
| I. | steam engine (1790–1842) | 1780 – [1815] – 1848 |
| II. | railway (1843–1997) | 1848 – [1873] – 1896 |
| III. | electricity and car (1898–1949) | 1896 – [1929] – 1945 |
| IV. | atomic energy, electronics, aircraft, plastics, PC and biotechnics (1950–2000) | 1945 – [1973] – 2000? |

Kondratev[6] elaborated his procedure for demonstrating and separating the long waves at the beginning of the 1920s. Globalization proved that the Kondratev theory is not only a hypothesis.

One can see from the following the tendency of the shortening of the length of the period of the century cycles. The lengths of century-cycles were as follows: the first was 260, the second was 233 and the third was only about 153 year long. One can follow the shortening character of the long-term cycles. The first lasted for approximately 68, the second for 48, and the third one for 49 years. The switches of the Kondratev and the

[6] See Kondratev's more important publications in the References.

shorter cycles caused the changes in the ratio of the length of the rising and declining branches. The declining branches of the fourth cycles started with the first oil-crisis in 1973.

The match of the declining branch of the century-trend and the declining trend of the Kondratev cycle caused serious crises in the early 1920s. The example of the two cycles strengthening each other is the convergence of the rising branch of the Kondratev cycle after 1945 and the rising branch of the century-trend cycle. Almost similar procedures of the restoration periods encouraged prosperity.

## RELATIONSHIP BETWEEN LONG WAVES AND INNOVATION CYCLES

All components required to the theory of inner dynamics of long waves were at hand for Kondratev. He realised the importance of technical and technological innovations and he was aware of the timing and clustering of innovations. He knew that the inventions have arisen during depression, they were introduced in wide-range at the beginning of the next recovery, and he also recognized that the rising branch of long waves was in line with the increasing production of basic capital goods. But he did not relate one with another, he was not aware that they require their own infrastructure. There is no simple match between long waves and innovation cycles. Long waves are also caused by fluctuations in infrastructural investments.

*Van Duijn* (1983. p. 129–144.) accomplished the synthesis. He classified the innovations into four categories:

*1*. major product innovations which create new industries;
*2*. major product innovations in existing industries;
*3*.process innovations in existing industries; and
*4*. process innovations in basic sectors.

On the experiences obtained about introduction of innovations he summarized the propensity to innovate during the four stages of the long wave. Table 1 shows the propensity to innovate for each category of innovations. Major product innovations, which create new industries, will be introduced mostly during the recovery when increasing demand for replacement investment will turn the pessimism of the depression into a more optimistic economic outlook. In existing industries the majority of innovation will be introduced during periods of the depression and recovery since these industries can respond more quickly to the declining branch of a long wave and they are more aware of the life cycle phases of their own products. Changing the technological base of a product is less risky when it is continuously serving the same market, to meet the same need. As soon as the new generation of products (e. g. CDs, DVDs and their players) has gained public acceptance then instead of the need of further and more radical product innovations the improving of technological process comes to the front. Innovations in basic sectors usually can be interpreted as responses to final demand increases. Process innovations induced by demand in producer goods sectors will be introduced mainly during the rising branch of long waves.

Table 1

*The propensity to innovate during different phases of the long wave*

| Type of innovation | Depression | Recovery | Prosperity | Recession |
|---|---|---|---|---|
| Product innovations (new industries) | + | ++++ | ++ | + |
| Product innovations (existing industries) | +++ | +++ | + | + |
| Process innovations (existing industries) | +++ | + | ++ | ++ |
| Process innovations (basic sectors) | + | ++ | +++ | ++ |

*Note:* Number of + signs denote the strength of the innovation propensity.

As Table 1 shows, the overall propensity to innovate is highest during the recovery and lowest during the recession. It also illustrates the contradiction that appears in different opinions about innovation. On the one hand some emphasize the lack of innovations, and on the other hand such expressions as 'chip revolution' and 'information revolution' suggest an abundance of innovations. There is indeed the lack of employment creating product innovations in new industries but there is equally no lack of labour-saving innovations in existing industries. In the field of innovation only the recovery, of which origin can be estimated at turn of the century or millennium can bring breakthrough. The engine of long-term development is the rapid growth of the basic sectors including several basic innovations.

Two kinds of infrastructural investments can be distinguished: one which serves more directly the growth of leading sectors, industrial complexes, harbours and others, and another which provides transportation and communication infrastructure for the economy as a whole. When innovations enter their growing phase, demand for both categories of infrastructural investment will increase, output in the first responding rather more quickly than output in the second one. Long wave prosperity will be therefore characterized by rapid growth in leading sectors as well as rapid growth of infrastructural investment. Overall output growth will be slowed only by productive capacity constraint. During the recession the infrastructure of the economy will approach completion, but multiple lags that are characteristic in investment projects of long duration will possibly make overshooting.

Projection of future demand for infrastructure will be based on extrapolation of prosperity. It is not recognized that the growth in this phase is much higher than the average growth over a complete long wave. The seeds of depression are sown during recession. If firms become engaged in a competition to increase their market share by being the first to reduce unit cost, the outcome of that will be excess capacity. Investment behaviour is basically determined by expectation. Once expectations change (e.g. it becomes abundantly clear that overcapacity is in the making) it is difficult to turn around. The ensuing depression will tend to prolong itself. Initially it is visible that the economy can work out this situation very quickly, but gradually it will become evident that time is necessary in which the excess capacity disposes. It will also become obvious that the former group of growing industries has too limited potential for the future. In such an unfavourable economic environment the propensity to innovate will be low. In the same way that prosperity was extrapolated to give a prosperous future, depression will now be extrapolated to make the economic outlook unnecessarily gloomy. In the absence of any aggressive innovation-promotion government strategy the day will also come when excess capacity will be eliminated, and even if new growing industries are lacking, the existing infrastructure will need to be renewed. The basic industries may lead to the 'technical recovery'. In itself this cannot sustain prolonged macroeconomic growth, but the important function of investment surge is that it will change the overall economic outlook, thus removing hindrances to innovation and paving the way for a new cluster of growing industries.

Cycles of great innovations, modernizations and technical-economic changes prove the relationship between innovation cycles and long waves as follows. There were five great periods of modernizations[7] and five technical-economical changes in history. The great innovations are:

*1*. textile steam engine between 1805–1810,
*2.* railway between 1848–1850,
*3.* electricity, chemical industry between 1896–1900,
*4.* flying in air and space, radio, TV between 1946–1950,
*5.* electronic computer, biogenetics, information revolution in 2000.

It can be seen that the epoch-making inventions have arisen in the declining branch of the Kondratev cycles and in the rising branch basic innovations give a rise to the following considerable technical-economic changes:

– mechanization of sector B (light industry) from 1775–1780 to 1815–1820,
– modernization of material infrastructure from 1815–1820 to 1871–1876,
– mechanization of heavy industry from 1871–1876 to 1928–1933,
– modernization of communication, nuclear technology from 1928–1933 to 1973–1976,
– information processing, automatization, biotechnic systems from 1973–1976 to nowadays.

## ANALYSING THE LONG-TERM TENDENCIES

Long-term forecasting requires different approach since in the long term many things may and do change which modify substantially the created, established patterns and/or existing relationships. This makes our prediction inaccurate and misleading and the identification and extrapolation of megatrends becoming essentially confusing. Successful strategy and effective long range planning (e. g. capital budgeting) require calculating the implications of long-term trends and the distinction of such trends from cycles linked with them. Although long-term economic trends can also change, it is not probable to do so since by definition they lasted for a very long time and therefore they would be regarded as the implications of the free market economic systems. Thus this kind of trends can be extrapolated with acceptable confidence, if we have a reason to suppose that the present economic system will change in some basic manner.

In the following we try to characterize the changes of century trend with some long-term time series.[8] Figure 1. shows the estimated real daily wages in England from 1264.

[7] Based on *Szabó* (1983. p. 461.).
[8] Data source: *Makridakis–Wheelwright–Hyndman* (1998. p. 642.) figures are prepared by the author.

It indicates clearly that real wages increase exponentially, at first about from 1625 to 1725 as a consequence of the effect of first agricultural revolution (*Makridakis–Wheelwright–Hyndman*; 1998), secondly from about 1800 due to the impact of industrial revolution. Since real wages are increasing, also real GNP and wealth do so, which rise exponentially at least from 1800. Real wages have increased from 4.41 pounds/day in 1260 to 45 pounds/day by 1994 so during 735 years the growth is greater than tenfold, this means average 0.2 percent annually.

To the original series which show the change of real daily wages in pounds, England between 1260–1994, second degree parabolic and exponential trends were fitted. The second degree parabolic ($R^2$ = 0.7614) trend fits better than the exponential one ($R^2$ = 0.4921). Since there are difficulties in comparing data so they can regard as estimations.

*Figure 1. Changes of real wages in England, 1260–1994*

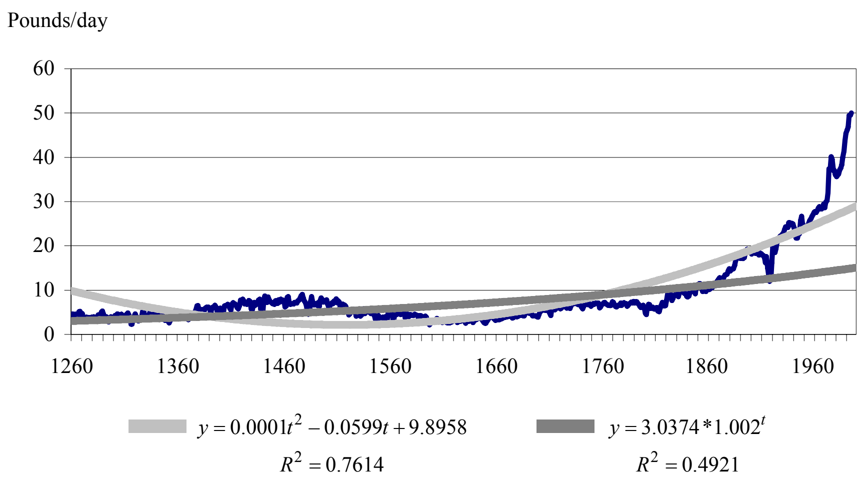



*Figure 2. Wheat prices in constant 1996 pounds, 1264–1996*

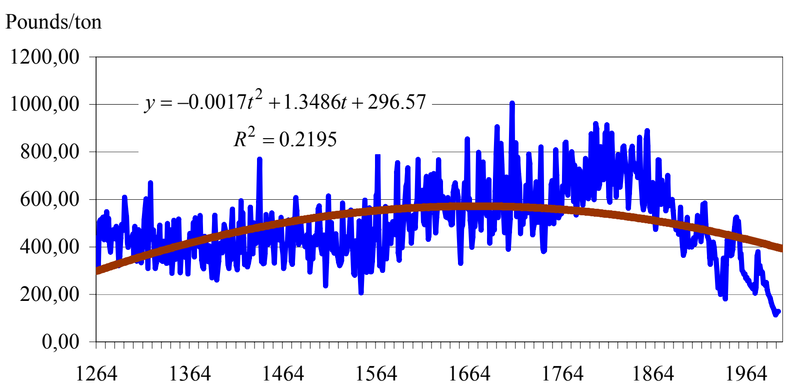


Figure 2. presents real wheat prices since 1264. A significant decrease can be seen from about 1800 when the industrial revolution have started and exerted its effects on agriculture. Since then wheat prices have decreased exponentially since supply exceed demand (although population have risen sixfold between 1800 and 1997 increasing demand considerably) so forcing real prices to decrease. The starting price was 385 pounds/ton in 1234, the highest price in 1710 was 1006 pounds/ton, in 1993 and the lowest wheat price was 113 pounds/ton. The original data show a considered fluctuation around the parabolic trend of the second degree.

Figure 3. illustrates the prices of crude oil (USD/barrel) between 1870 and 1997. The starting price of 49 (USD/barrel) in 1870 decreases to 21 (USD/barrel) by 1997. Oil crisis can be seen well since the unit price per barrel increased in 1974 by 57 percent compared to the previous year, while in 1980 it increased by 50 percent compared to the previous year. The second degree parabolic trend forecasts increase in 2000 and the real price reaches the forecasted price of 30 (USD/barrel).

*Figure 3. Changes of crude oil prices in world market, 1870–1997*
(in constant 1997 USD)

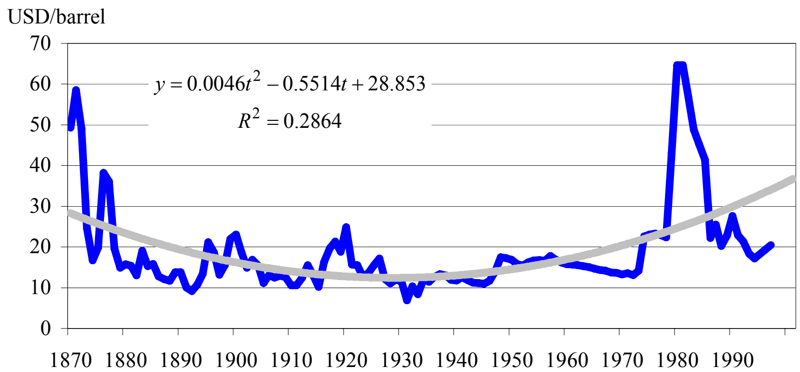
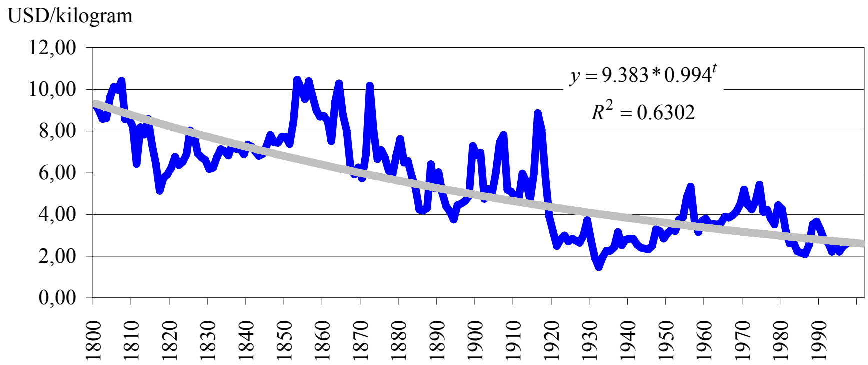



Figure 4. shows the decreasing tendency of copper price in the long-term.

*Figure 4. Copper price, 1800–1997*
(in constant price level in 1997 USD)



The tendency of copper price changes is shown in Figure 4. in constant price level in 1997 USD from 1800 (which is a proper starting point since the implications of Industrial Revolution have started around this time). It displays the exponentially decreasing trend and a lot of cycles with different duration and length ($R^2 = 0.6302$).

Although long-term economic trends can also be changed it is not likely that it happens as by definition, they have lasted for a very long time, being the outcome of the economic system of free competition. Such trends can, therefore, be extrapolated with a reasonable degree of certainty unless we have reasons to believe that the present economic system will change in the future.

These examples and further investigations (*Makridakis-Wheelwright-Hyndman*; 1983, p. 459.) show that the price, excluding inflation, of most standardized (commodity type) products or services decreases. The implication of decreasing behaviour of real prices in the long run is that the firms have to improve their productivity continuously through technological and/or organizational innovation in order to be able to reduce their costs and real prices permanently. That is true at least for the companies producing standardized goods. Moreover it is possible that such decreasing behaviour will keep on in the future. Even it can accelerate as a consequence of the recent information revolution. Since the beginning of information revolution real income increases in countries of free market economy (EU, United States, Canada) although this increase is characterized by cyclical volatility. Long-term forecasting must accept the great consistency of long-term trends and the substantial degree of uncertainty (as we cannot forecast their turning points statistically), accompanied by considerable fluctuation around these trends. Success and high profits must come from the technological and other innovations and the use of these innovations for opening new markets and meeting new customer needs since almost all existing needs have already been satisfied.

## KONDRATEV CYCLES IN THE HUNGARIAN ECONOMY

In the following we introduce some empirical results for the Hungarian economy. Extrapolation of long-time trends is limited by the fact that little or no historical information are available, much less data series go back to 1800. In such cases analogies can be used for making possible that the forecasters prepare prognoses based on similar situation on which past data or gathered experiences are available. Short-term analogies are used to forecast implications of special events or competitive actions based on past examples. In the medium term for example they are applied to the evaluation of length and depth of recessions, comparing current recession with all the recession occurred after the Second World War. Similarly in the long run the sales of such new products or services which are based on past demand of similar products are used for prediction. World-wide interest towards research of market conditions and in the theory of business cycles is usually arisen during crisis periods. Computations concerning the basic economic factors proved the existence of Kondratev-waves.

Evaluating the empirical results for Hungary[9] the following factors are to be taken into account. Hungary has lost 71.3 percent of its original territory and 63.3 percent of its

[9] Data source: Time series of world economics 1860–1960 and Statistical Yearbook of Hungary 1960–1999. *K. Brenkus*, student of Budapest University of Economic Sciences and Public Administration have also contributed to the data collecting.

inhabitants after the Trianon peace-treaty ($4^{th}$ June 1920).[10] This differences are so considerable that they cannot be corrected by computing per capita data. Hungary became a new economic unit from the 1920s.[11] That is why we accomplished the empirical investigations again considering the period between 1920 and 1999 except for natural gas production since data are available only from 1945. We have applied only data measured in natural units since the value and mixed measures contain high uncertainty as the currency in Hungary has changed several times between 1920 and 1946.[12] The empirical study covered the field of industry (including the production of steel,[13] brown coal, lignite, coal and natural gas) and agriculture (including the production of wheat, maize, sugar and potato and livestock of pigs). For the better comparison *per capita* data were used. The dimensions of per capita data were ton/capita and after multiplying by thousand it became kilogram/capita. This paper analyses the Hungarian steel production in details while some results of production of other goods can be seen in Table 2.

At first we fitted an analytical trend to the data series, namely a second-degree parabolic trend, since there was a turning point in time series. In the next step we computed the estimated values and the difference between original and estimated data. That is the way how we eliminate the change of secular trends. Considering that century trend was in the rising branch in world economy between 1896 and 1973 (in our study it happened between 1920 and 1973) and after 1973 it turned its declining branch, fitting the second-degree parabolic trend was reasonable. In the last step we presented the long-term cycles by using a 9-element moving average. So the effect of random changes as well as 3 and 9 year cycles have been eliminated.

In Figure 6 the dark line shows the time series of steel production (kilogram/capita) between 1920 and 2000 and the bold line depicts the second-degree parabolic trend function. The equation of the second-degree parabola is the following:

$$y = -0.0721t^2 + 9.8628t - 66.518 ,$$

where $t$ = time variable ($t$ = 1,2,...).

Initially parabola shows increase then decrease since the coefficient of $t$ is positive while that of $t^2$ is negative. The coefficient of multiple determination ($R^2$) demonstrates a rather good accuracy of fitting:

$$R^2 = 0.7267$$

Figure 7 illustrates the difference between the original data and the estimated trend function (dotted line) and its 9-element moving averages (the continuous line) showing Kondratev cycle. Accordingly, steel production was in the declining branch between 1932 and 1951 and it was in the rising branch between 1951 and 1983 in Hungary. Difference or delay from the world tendency is 3–10 years. In Hungary the rising branch started later (1951 versus 1948, 3 year lag) and the beginning of the declining branch shows greater delay during the oil-crisis (1983 versus 1973, 10 years lag).

[10] Új Magyar lexikon (1962). Akadémiai Kiadó, Volume S–Z, p. 504.
[11] Because of secession from Austro-Hungarian Monarchy, the territorial rearranging and the ravages of war difficulties.
[12] Korona existed from 1892 to 1926, pengő from 1927 to 1946 and forint from 1946 until now.
[13] Data are available up to the year 2000.

*Figure 6. Changes in steel production, 1920–2000 in Hungary*
(original data and trend line)

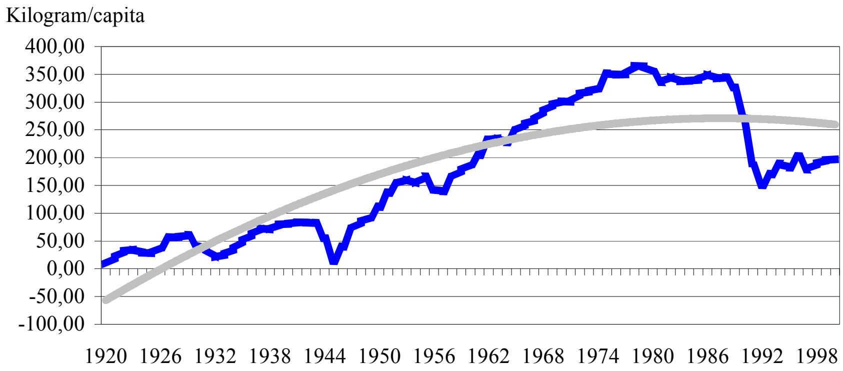
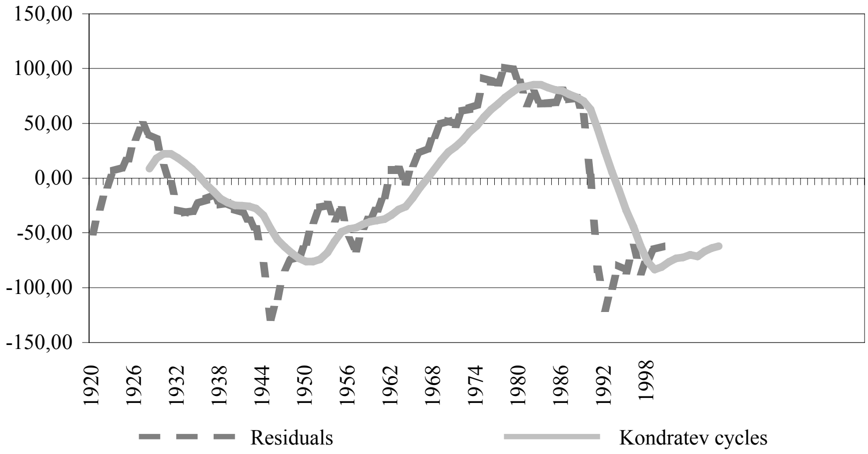



*Figure 7. Residuals and 9-year moving average of steel production, 1920–2000*




The lowest level of steel production was 7.8 kilogram/capita in 1920, and then it rose to 1929 reaching 59.89 kilogram /capita, trough of the declining branch was in 1945 (14.3 kilogram/capita), it reached the maximum in 1986 (350.38 kilogram /capita),[14] then its fluctuation decreases gradually to 195.7 kilogram/capita in 1999. As far as the historical background of the steel production is concerned, after 1920, the consolidation, initiated by *István Bethlen* the prime minister, created better conditions for coping economic difficulties and a slow growth begun. In steel production for example the Bessemerian process was considered obsolete and the electric steel production was introduced. Prosperity was broken by the Great Depression in 1929 that afflicted strongly the heavy industry including the steel production. Production was 514 thousand tons in 1929 in Hungary then it decreased to

[14] At the same time steel production decreased considerably, for example in Great-Britain the per capita steel production was significantly lower in 1986, 259 kilogram/capita than in Hungary (350.38 kilogram/capita)

180 thousand tons by 1932. The signs of prosperity became visible really in 1935, that can be accounted also for war preparations. After 1945 the forced development of heavy industry had effects also on steel production, which can also be seen in Figure 6. The reason is that the Communist party wanted to transform Hungary to the country of iron and steel. After a short decrease between 1956 and 1958, increase continued till 1986. Following the transition the decline was considerable, steel production decreased from 3700 thousand tons in 1986, to almost its half, 1980 thousand tons in 2000.

Table 2 supports the previous statements with some empirical results. It shows among others the long-term cycles of production of brown coal and lignite. Declining branch lasted from 1920 to 1951; a rising branch followed it till 1967 since then a declining branch can be seen again. Between the two world wars the exploitation of capacity of coalmines was low. There was no improvement in the technical equipment and further coal-pits were not opened. Following the Second World War the investments increased and production growth can be observed. This tendency lasted up to 1965, at this time production was the highest (2670 thousand tons), from this time coal production was limited in contrast to the cheaper carbo-hydrogene with higher calorific value. Similar tendency depicts the long-term cycles of hard coal production. Between 1920 and 1953 we have found a declining branch, between 1953 to 1973 a rising branch, after 1973 a declining branch began again.

Table 2. also illustrates the long waves of natural gas. Because of the shortness of time series, we can show only one rising branch between 1967 and 1986. This differs considerably from world tendencies. The domestic natural gas production began only during the Second World War, the rising branch lasted till the beginning of the 1980s.

Table 2. presents the production of some agricultural products as well. Among these we illustrate the long waves of plant cultivation. In the long waves of wheat production fluctuation is not considerable and it is opposite to the world tendency: 1920-[1940]-1966-[1990] (where the years in brackets mark the peaks). The great depression between 1929 and 1933 afflicts less the wheat production than heavy industry. In 1934 the average production was 198 kilogram/capita that reaches the maximum of 695 kilogram/capita in 1984 and decreased to 265 kilogram/capita in 1999. Table 2. also presents the long waves of domestic maize production. From 1920 to 1955 a declining and between 1955 and 1983 a rising branch could be observed. The long-term cycle approaches the world tendencies: from 1931 to 1947 a declining, from 1947 to 1968 a rising branch could be showed, after 1968 the movement is irregular but it was above the equilibrium axis to 1995 when it intersects the axis.

In the long-term cycles of potato production from 1920 to 1945 a rising, from 1945 to 1954 a declining then from 1954 to 1963 again a rising branch could be seen. The long-term cycles do not coincide with the world tendencies.

The long-term cycles of pig-breeding is characterised by a declining, from 1920 to 1953, a rising branch from 1953 to 1988. The long-term cycles move partly along with the world tendencies.

The results in Table 2 show that the increasing branch of Kondratev cycle II has not started in harmony with world tendencies, in 1945. The delay in the case of the steel, brown coal and lignite and hard coal production are 6–6 and 8 years respectively, while for agricultural products the lag is even longer, 8–11 years, except for sugar-beet, where it is only 2 years.

Table 2

*Summary of empirical results for Hungary*

| Observed time series, Hungary. Production of | Observation period | | Cycle I | | | | | Cycle II | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | period | duration (year) | Rising branch (year) | | Declining branch (year) | | Duration of cycle (year) | Rising branch (year) | | Declining branch (year) | | Duration of cycle (year) |
| | | | period | duration | period | duration | | period | duration | period | duration | |
| Steel | 1920–2000 | 81 | | | 1932–1951 | 20 | | 1951–1983 | 33 | 1983- | | |
| Brown coal and lignite | 1920–1999 | 80 | | | 1920–1951 | 32 | | 1951–1967 | 17 | 1967– | | |
| Hard coal | 1920–1999 | 80 | | | 1920–1953 | 34 | | 1953–1973 | 21 | 1973– | | |
| Natural gas | 1945–1999 | 55 | | | | | | 1967–1986 | 20 | 1986– | | |
| Wheat | 1920–1999 | 80 | 1920–1940 | 21 | 1940–1966 | 27 | 48 | 1966–1990 | 25 | 1990– | | |
| Maize | 1920–1999 | 80 | | | 1920–1955 | 36 | | 1955–1983 | 29 | 1983– | | |
| Sugar-beet | 1920–1999 | 80 | | | 1931–1947 | 17 | | 1947–1968 | 22 | 1968– | | |
| Potatoes | 1920–1999 | 80 | 1920–1945 | 26 | 1945–1954 | 10 | 36 | 1954–1963 | 10 | 1963– | | |
| Pigs | 1920–1999 | 80 | | | 1920–1953 | 34 | | 1953–1988 | 36 | 1988– | | |

The declining branch of Cycle II also appears with delay except for hard coal production, which turned in declining branch in 1973 and the brown coal and lignite production where the cycle turned earlier.

These delays, besides the mentioned economic factors, are closely related to political ones. The impact of the most important political events to the long term economic movements is clear. In the second half of the last century the Hungarian economy was an appendage of the Soviet economy and policy, the political events and changes in the Soviet Union and in Hungary modified and shifted the long term cycles analyzed before. Among these the changing political and economic periods conducted by Stalin, Hrushtsev, Breshniev an Gorbatshov, and the most important events of the Hungarian political – economic life (the crisis of the 1950-s, the revolution in 1956, the consolidation and the experimental reforms of the Kádár era, the new economic crisis of the late 1980-s and the transition) are to be mentioned.

It is obvious that the impacts are mutual: some political changes are forced by long-term economic movements, manifested just in the investigated long term cycles. This happens, even if sometimes the influence or even the existence of these cycles are denied. Political events are often connected to persons, political leaders but the driving force can always be sought in the economy and in the long-term cycles.

## CONCLUSION

This study tries to prove the fact, that the Kondratev cycles are not characterised by the national features. Kondratev cycles are global; they are the cycles of the entire world economy, even if significant time-shifts of the cycles of different economics can be observed.

Economic development is realized through introduction of new innovations that means introduction of new products and production-organization methods, opening new markets and exploiting new raw materials, therefore we studied at first the role of basic innovations. We have investigated the relationship between innovations and long-term cycles. We have found that in the declining branch of Kondratev cycles with duration of 50-60 years, have arisen those epoch-making inventions in the past 200 years which then turned to the declining branch of cycle making the prosperity possible. It is a general experience that before or at the beginning of increasing branch of long-term cycles substantial changes take place in the economy; arising and introduction of inventions, changes in production relation, broadening of connections in world economy, changes of money circulation, increasing of gold production, etc.

There is no simple match between long waves and innovation cycles. Long waves are also caused by fluctuations in infrastructural investment. Two kinds of infrastructural investments can be distinguished: one which serves more directly the growth of leading sectors, and another which provides transportation and communication infrastructure for the economy as a whole. When innovations enter their growing phase, demand for both categories of infrastructural investment will increase, output in the first responding rather more quickly than output in the second. Long wave prosperity will therefore be characterized by a rapid growth in leading sectors as well as a rapid growth of infrastructural investments. In the absence of any aggressive innovation-promotion government strategy the day also will come when excess capacity will be eliminated, and even in the lack of new growing industries, the existing infrastructure will need to be renewed.

At last we have shown some empirical results of long waves for industrial series and plant cultivation. The results of empirical investigations proved the existence and the global feature of long-term cycles.

REFERENCES

ARTIS, M. J. – KONTOLEMIS, Z. G. – OSBORN, D. R. (1997): Business cycles for G7 and European countries. *Journal of Business*, Vol. 70, No. 2. p. 249–279.

FORRESTER, J. W. (1982): Nach jeder Depression ein neuer Aufschwung. *Bild der Wissenschaft*, No. 2. p. 95–108.

HELLER F. (1943): *A közgazdasági elmélet története*. Gergely R., Budapest.

HELLER F. (ed.) (1928): *Tanulmányok a konjunktúrakutatásról*. Közgazdasági Könyvtár VI. Magyar Közgazdasági Társaság, Budapest.

JUGLAR, CL. (1862): *Des crises commerciales et leur retour périodique en France, en Angleterre et aux États Unis*. Paris.

KITCHIN, CF. J. (1923): Cycles and trends in economic factors. *Review of Economic Statistics*, Vol. 6. No.1. p. 10–16.

KONDRATEV, N. D.(1922): Mirovoje hozjajsztvo i jego, konjunkturü vo vremja i poszle vojnü. The Institute for Business Research, Moscow.

KONDRATEV, N. D. (1925): Bolsoje cikli konjunkturi. Voproszi Konjunkturi, The Institute for Business Research, Moscow.

KONDRATEV, N. D.(1926): Die langen Wellen der Konjunktur. *Archív für Sozialwissenschaft und Sozialpolitik*, Vol. 56. p. 573–610.

KONDRATEV, N. D. (1935): The long waves in economic life. *The Review of Economic Statistics*, Vol. 17. No. 6. p. 105–115.

KONDRATEV, N. D. (1979.): The long waves in economic life. *Review of Economic Statistics,* , Vol. 2. No. 4. p. 519–562.

KONDRATEV, N. D. (1980): A gazdasági fejlődés hosszú hullámai. *Történelmi Szemle*, No. 2. p . 241–269.

KONDRATEV, N. D. – OPARIN, D. I. (1989): A konjunktúra nagy ciklusai. *Politikai gazdaságtan füzetek 66.* Marx Károly Közgazdaságtudományi Egyetem, Budapest.

KÖVÉR GY. (1988): N. D. Kondratev és a gazdasági konjunktúra nagy ciklusai. *Magyar Filozófiai Szemle*, No. 5–6. p. 559–617.

KUZNETS, S. (1930): *Secular movements in production and prices*. Houghton-Mifflin, Boston and New York.

LABROUSSE, E.(1933): *Esquisse du mouvement des prix et des revenus en France au XVIII[e] siècle*. Dalloz. Paris.

NOVÁKY E. (szerk.) (1992): *Jövőkutatás*. BKE, Budapest.

NOVÁKY E. (1993): Jövőkutatás és káosz. *Magyar Tudomány*, Vol. 38. No. 4. p. 512–517.

NOVÁKY E. (szerk.) (1995): *Káosz és jövőkutatás*. BKE, Budapest.

SCHUMPETER, J. A. (1939): *Business cycles: A theoretical historical and statistical analysis of the capitalist process*, McGraw-Hill, New York.

SIMIAND, F. (1932): *Les fluctuations économique à longue periode et la crise mondiale*. Paris.

SIPOS B. (1997): Empirical research of long-term cycles. *Hungarian Statistical Review*. Vol. 75. Special Number. p. 119–128.

SZABÓ K. (1985): *Arányossági elv és érték a modern gazdaságban*. Akadémiai Kiadó, Budapest

VAN DUIJN, J. J. (1983): *The long wave in economic life*, George Allen and Unwin. London.

*Világgazdasági idősorok 1860–1960* (1965). Közgazdasági és Jogi Könyvkiadó, Budapest.

www.maths.monash.edu.au/~hyndman/forecasing/ In: *Makridakis, S. – Wheelwright, S. C. – Hyndman, R. J.* (1998): *Forecasting*. John Wiley and Sons, Inc. New York.

# CATEGORY SELECTION AND CLASSIFICATION BASED ON CORRESPONDENCE COORDINATES

OTTÓ HAJDU[1]

The paper presents the description and an application of the explorative multivariate technique known as multiple correspondence analysis of an indicator matrix. Correspondence coordinates have been used to reveal relevant categories of economic organizations in connection with their financial bankruptcy. Illustrative calculations are based on data from balance sheets of Hungarian enterprises. The aim of the paper is twofold. On the one hand, it seeks correspondences among categories of the variables investigated. On the other hand, based on the relevant categories it discriminates the two groups of active and bankrupt firms and classifies an additional supplementary category of firms to one of them. This third category is the group of those who are still currently active but already affected by bankruptcy proceedings. Finally, an individual firm is also predicted. To clarify the meaning of the correspondence coordinates a detailed explanation of their theory is provided.

KEYWORDS: Explorative multivariate techniques; Categorical data analysis; Multiway contingency tables.

Correspondence analysis is an exploratory multivariate technique that converts a data matrix of non-negative numbers (usually frequency table) into a graphical display in which rows and columns are depicted as points. By comparing row and column proportions in a two- or multiway table it provides a method for visually interpreting multivariate categorical data. Especially, displaying row and column profiles as points in a two dimensional subspace we can discuss the structure of association between the row and column categories.

Simple correspondence analysis (CA) involves two categorical variables and the graphical display of the corresponding two-way contingency table. Mathematically, CA decomposes the Pearson-$\chi^2$ measure of association for the table into components to underlie dimensions of heterogeneity between rows or columns. This is done in a manner similar to that of variance decomposition by principal component analysis for continuous data. On the other hand, CA simultaneously assigns a scale to rows and a separate scale to columns so as to maximize the correlation between the resulting pairs of variables.

For multiple correspondence analysis (MCA) the latter concept is the more appropriate. MCA is an extension of CA to the case of three or more categorical variables. It is

[1] Associate professor of the Budapest University of Technology and Economic Sciences.

characterized by similar graphical displays in which either the categories of the variables or the individual cases themselves can be represented as points. MCA resembles a principal component analysis for categorical variables.

Using MCA the main purpose of this paper is to select appropriate predictor categories associated with a financial bankruptcy in an average sense based on some economic data of Hungarian enterprises. Besides, taking outcomes of the relevant predictor variables (such as type of activity, legal form, the level of profitability etc.) into account, we illustrate how to classify an additional, currently active organization whether it seems similar (or not) to those who had finished their activities due to a bankruptcy. Although, category selection from more than two scales prefers using MCA, a brief but detailed overview of the general theory of correspondence axes is necessary because MCA is merely an application of CA carried out on a special contingency table with individual cases as rows and categories (expressed by dummy variables) as columns. This kind of the data set is called indicator matrix. In order to serve a guide to the correct interpretation of the MCA results we also focus on the specific considerations that must be taken into account due to the special form of the indicator matrix.

## PROPERTIES OF THE CORRESPONDENCE COORDINATES

The measure of association for a two-way contingency table of $n$ observations is completely determined by the pattern of the relative frequencies in the table proportional to the grand total $n$. Considering the $p_{ij}=f_{ij}/n$ joint relative frequency of row $i$ and column $j$ CA basically analyses the correspondence matrix with elements $p_{ij}$ (see Table 1) where $f_{ij}$ is the observed frequency in the $j^{\text{th}}$ column of row $i$.

Table 1

*Correspondence table*

| Category | Column | | | | | Total: mass of the row |
|---|---|---|---|---|---|---|
| | 1 | … | $j$ | … | $J$ | |
| Row 1 | $p_{11}$ | | $p_{1j}$ | | $p_{1J}$ | $s_1$ |
| ⋮ | | | | | | ⋮ |
| Row $i$ | $p_{i1}$ | | $p_{ij}=f_{ij}/n$ | | $p_{iJ}$ | $s_i$ |
| ⋮ | | | | | | ⋮ |
| Row $I$ | $p_{I1}$ | | $p_{Ij}$ | | $p_{IJ}$ | $s_I$ |
| *Total: mass of the column* | $o_1$ | | $o_j$ | | $o_J$ | 1 |

The row total $s_i$ and the column total $o_j$ are the relative marginal (unconditional) frequencies termed masses expressed also as percentages of the grand total $n$. Considering the conditional set of relative frequencies within a row category we use the term *row profile* and respectively within a column the term *column profile* (see Table 2 and Table 3). The row profiles are treated as points in the $J$-dimensional space spanned by the columns while column profiles are points in the $I$-dimensional space spanned by the rows. Hence, the row and column profiles constitute two clouds of points in respective $J$- and $I$-

dimensional spaces. The associated masses of the axes are included in and denoted by the vectors **s** and **o** and assigned to these axes as weights.

Table 2

*Row profiles:* $[\mathbf{R}]_{ij}=s_{ij}$

| Row profile | Axis | | | | | Total |
|---|---|---|---|---|---|---|
| | 1 | … | $j$ | … | $J$ | |
| 1 | $s_{11}$ | | $s_{1j}$ | | $s_{1J}$ | 1 |
| ⋮ | | | | | | ⋮ |
| $i$ | $s_{i1}$ | | $s_{ij}=p_{ij}/s_i$ | | $s_{iJ}$ | 1 |
| ⋮ | | | | | | ⋮ |
| $I$ | $s_{I1}$ | | $s_{Ij}$ | | $s_{IJ}$ | 1 |
| *Centroid (mass)* | $o_1$ | | $o_j$ | | $o_J$ | 1 |

Table 3

*Column profiles:* $[\mathbf{C}]_{ij}=o_{ij}$

| Axis | Column profile | | | | | Centroid (mass) |
|---|---|---|---|---|---|---|
| | 1 | … | $j$ | … | $J$ | |
| 1 | $o_{11}$ | | $o_{1j}$ | | $o_{1J}$ | $s_1$ |
| ⋮ | | | | | | ⋮ |
| $i$ | $o_{i1}$ | | $o_{ij}=p_{ij}/o_j$ | | $o_{iJ}$ | $s_i$ |
| ⋮ | | | | | | ⋮ |
| $I$ | $o_{I1}$ | | $o_{Ij}$ | | $o_{IJ}$ | $s_I$ |
| *Total* | 1 | | 1 | | 1 | 1 |

It is obvious, that the row and column profiles are closely related to each other and to the elements of the correspondence table as follows:

$$p_{ij} = s_i \cdot s_{ij} = o_j \cdot o_{ij} \quad . \qquad /1/$$

Taking the summations of both sides in /1/ it is apparent based on Table 1 that masses $s_i$ and $o_j$ are the weighted averages of the column and row profiles respectively, using the other set of masses as weights:

$$s_i = \sum_{j=1}^{J} o_j o_{ij} \ , \quad o_j = \sum_{i=1}^{I} s_i s_{ij} \ .$$

Hence, the $o_j$ masses of the columns constitute the centroid of the row profiles and the $s_i$ masses of the rows the centroid of the column profiles. Then, the independence (lack of association) between the row and column clouds is defined as row profiles identical to each other and hence to their centroid too. Necessarily, when the lack of association occurs in the contingency table the column profiles are also identical to each other. In other words, a non-zero variation of the points in a cloud indicates a lack of independence.

Comparing then simply the row profiles with respect to the columns as axes or comparing the column profiles with respect to the rows as axes reveals the nature of association between rows and columns.

However, when the number of the rows or the columns or both is too large it is difficult to identify similarities and dissimilarities by simply scanning the row and column percentages. Then, information on association involved in the contingency table can be summarized briefly by the well-known Pearson-$\chi^2$ measure which hereafter will be termed the *total inertia*:

$$INR = \sum_{i=1}^{I}\sum_{j=1}^{J}\frac{(p_{ij}-s_io_j)^2}{s_io_j} = \sum_{i=1}^{I}\sum_{j=1}^{J} g_{ij}^2 \,, \qquad /2/$$

where $s_io_j$ is the expected relative frequency of cell $(i,j)$ for the case of independence and

$$g_{ij} = \frac{p_{ij}-s_io_j}{\sqrt{s_io_j}} \qquad /3/$$

is the standardized correspondence frequency. Value of $g_{ij}$ that deviates markedly from zero indicates a positive or negative association between row $i$ and column $j$. Based on equation /1/ the total inertia can be expressed as a weighted multidimensional dispersion measure considering either the row or the column profiles as points:

$$INR = \sum_{i=1}^{I} s_i \sum_{j=1}^{J}\frac{1}{o_j}(s_{ij}-o_j)^2 = \sum_{i=1}^{I} s_i \sum_{j=1}^{J}\frac{s_{ijc}^2}{o_j} \,, \qquad /4/$$

$$INR = \sum_{j=1}^{J} o_j \sum_{i=1}^{I}\frac{1}{s_i}(o_{ij}-s_i)^2 = \sum_{j=1}^{J} o_j \sum_{i=1}^{I}\frac{o_{ijc}^2}{s_i} \qquad /5/$$

where $s_{ijc}=s_{ij} - o_j$ and $o_{ijc}=o_{ij} - s_i$ are the centered row and column profiles respectively. In this context *INR* is a multivariate extension of variance defined as the weighted average of the squared deviates from the respective centroid. It is to be noted, that the centroid of a centered profile is always the origin.

In CA, instead of comparing the rows using directly the centered profiles we create a smaller number of coordinates. These coordinates are computed so that each successive ($k=1,2,...,K$) coordinate axis accounts for a decreasing portion of the total inertia. The first coordinate accounts for the largest part, the second for the next largest part, and so on. The first coordinate or the first two coordinates often account for the major part about 80-90 percent or more. When these first two coordinates explain most of the inertia we can summarize each row of them instead of the original row percentages. This permits almost all of the information to be presented in a one- or two-dimensional plot. The same argument holds for analyzing the column pattern. The centered row profiles are replaced by CA coordinates $x$ presented in the matrix $\mathbf{X}_{(I,K)}$ and the centered transposed column profiles are replaced by CA coordinates $y$ presented in the matrix $\mathbf{Y}_{(J,K)}$. The maximum number of the new axes is $K = \min\{I\text{-}1, J\text{-}1\}$ because the relative frequencies within a profile always sum up to 1. This is shown in Table 4 and Table 5.

Table 4

*Centered row profiles and their correspondence coordinates*

| Row profile | Centered profile: $[\mathbf{S}]_{ij}=s_{ijc}$ | | | | | Row CA coordinate: $\mathbf{X}$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $s_{11c}$ | … | $s_{1jc}$ | … | $s_{1Jc}$ | $x_{11}$ | … | $x_{1k}$ | … | $x_{1K}$ |
| ⋮ | | | | | | | | | | ⋮ |
| $i$ | $s_{i1c}$ | | $s_{ijc}$ | | $s_{iJc}$ | $x_{i1}$ | | $x_{ik}$ | | $x_{iK}$ |
| ⋮ | | | | | | | | | | ⋮ |
| $I$ | $s_{I1c}$ | | $s_{Ijc}$ | | $s_{IJc}$ | $x_{I1}$ | | $x_{Ik}$ | | $x_{IK}$ |
| *Centroid* | 0 | | 0 | | 0 | 0 | | 0 | | 0 |

Table 5

*Transposed centered column profiles and their correspondence coordinates*

| Column profile | Centered profile: $[\mathbf{O}^T]_{ji}=o_{jic}$ | | | | | Column CA coordinate: $\mathbf{Y}$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $o_{11c}$ | … | $o_{1ic}$ | … | $o_{1Ic}$ | $y_{11}$ | … | $y_{1k}$ | … | $y_{1K}$ |
| ⋮ | | | | | | | | | | ⋮ |
| $j$ | $o_{j1c}$ | | $o_{jic}$ | | $o_{jIc}$ | $y_{j1}$ | | $y_{jk}$ | | $y_{jK}$ |
| ⋮ | | | | | | | | | | ⋮ |
| $J$ | $o_{J1c}$ | | $o_{Jic}$ | | $o_{JIc}$ | $y_{J1}$ | | $y_{Jk}$ | | $y_{JK}$ |
| *Centroid* | 0 | | 0 | | 0 | 0 | | 0 | | 0 |

The computed CA coordinates (over all extractable dimensions) are required to leave the inertia of a point unchanged:

$$INR(s_i) = s_i \sum_{k=1}^{K} x_{ik}^2 = \sum_{j=1}^{J} s_i \frac{s_{ijc}^2}{o_j}, \qquad INR(o_j) = o_j \sum_{k=1}^{K} y_{jk}^2 = \sum_{i=1}^{I} o_j \frac{o_{ijc}^2}{s_i}, \qquad /6/$$

where

$$\sum_{k=1}^{K} s_i x_{ik} = 0, \qquad \sum_{k=1}^{K} o_j y_{jk} = 0\,. \qquad /7/$$

Equation /6/ says that the sum of the squared CA coordinates preserves the information entirely. Consequently, using equations /4/ and /6/ the total inertia also remains unchanged:

$$INR = \sum_{i=1}^{I} INR(s_i) = \sum_{j=1}^{J} INR(o_j)\,.$$

Along with a separated CA axis $k$ the measure of inertia reduces to variance so that the variance of the rows and the variance of the columns are equal:

$$Var(x \mid k) = \sum_{i=1}^{I} s_i x_{ik}^2 = Var(y \mid k) = \sum_{j=1}^{J} o_j y_{jk}^2 = Var(k)\,,$$

where $Var(k)$ is the inertia of the CA axis $k$. This property will be clarified by equation /16/. The spread of the inertia is illustrated in Table 6. It is obvious that the total inertia is partitioned by the CA axes as follows: $INR = \sum_{k=1}^{K} Var(k)$.

Table 6

*The structure of inertia*

| Point | Correspondence axis | | | | | Total |
|---|---|---|---|---|---|---|
| | 1. | ... | $k$. | ... | $K$. | |
| Row 1 | $s_1x_{11}^2$ | | $s_1x_{1k}^2$ | | $s_1x_{1K}^2$ | $INR(s_1)$ |
| ⋮ | | | | | | ⋮ |
| Row $i$ | $s_ix_{i1}^2$ | | $s_ix_{ik}^2$ | | $s_ix_{iK}^2$ | $INR(s_i)$ |
| ⋮ | | | | | | ⋮ |
| Row $I$ | $s_Ix_{I1}^2$ | | $s_1x_{Ik}^2$ | | $s_Ix_{IK}^2$ | $INR(s_I)$ |
| Total | $Var(1)$ | | $Var(k)$ | | $Var(K)$ | $INR$ |
| Column 1 | $o_1y_{11}^2$ | | $o_1y_{1k}^2$ | | $o_1y_{1K}^2$ | $INR(o_1)$ |
| ⋮ | | | | | | ⋮ |
| Column $j$ | $o_jy_{j1}^2$ | | $o_jy_{jk}^2$ | | $o_jy_{jK}^2$ | $INR(o_j)$ |
| ⋮ | | | | | | ⋮ |
| Column $J$ | $o_Jy_{J1}^2$ | | $o_Jy_{Jk}^2$ | | $o_Jy_{JK}^2$ | $INR(o_J)$ |

In order to calculate CA coordinates let us define the diagonal matrices $\mathbf{D}_s$=<$s_1,...,s_I$>, $\mathbf{D}_o$=<$o_1,...,o_J$>, $\mathbf{D}_\mu$=<$\mu_1,...,\mu_K$> and the matrix $\mathbf{G}_{(I,J)}$ with the $g_{ij}$ standardized correspondence frequencies as its elements. At this stage based on equations /1/ and /3/ we rewrite matrix $\mathbf{G}$ as $\mathbf{G} = \mathbf{D}_s^{1/2}\mathbf{S}\mathbf{D}_o^{-1/2} = \mathbf{D}_s^{-1/2}\mathbf{O}\mathbf{D}_o^{1/2}$ and then take its $\mathbf{G}=\mathbf{U}\mathbf{D}_\mu\mathbf{V}^T$ so-called 'Singular Value Decomposition' (SVD)[2]. By definition of SVD this yields the following equation:

$$\mathbf{G} = \mathbf{D}_s^{1/2}\mathbf{S}\mathbf{D}_o^{-1/2} = \mathbf{D}_s^{-1/2}\mathbf{O}\mathbf{D}_o^{1/2} = \mathbf{U}\mathbf{D}_\mu\mathbf{V}^T , \qquad /8/$$

where $\mu_1,\mu_2,...,\mu_K$ are the singular values, the columns of the matrix $\mathbf{U}_{(I,K)}$ are the left singular vectors and the columns of the matrix $\mathbf{V}_{(K,K)}$ are the right singular vectors of $\mathbf{G}$ satisfying the orthonormality requirement of $\mathbf{U}^T\mathbf{U}=\mathbf{V}^T\mathbf{V}=\mathbf{I}$. ($\mathbf{I}$ stands for the $\mathbf{I}_K$ identity matrix.) The columns of $\mathbf{U}$ define the principal axes of the column cloud and the columns of $\mathbf{V}$ define the principal axes of the row cloud of $\mathbf{G}$. Now, the $\mathbf{X}$ and $\mathbf{Y}$ CA coordinates of our interest are defined as the principal coordinates with respect to the principal axes of $\mathbf{S}$ and $\mathbf{O}$ respectively. From /8/ the weighted SVD of $\mathbf{S}$ and $\mathbf{O}^T$ yields:

$$\mathbf{S} = \left(\mathbf{D}_s^{-1/2}\mathbf{U}\mathbf{D}_\mu\right)\left(\mathbf{D}_o^{1/2}\mathbf{V}\right)^T = \mathbf{X}\left(\mathbf{D}_o^{1/2}\mathbf{V}\right)^T \qquad /9/$$

[2] For more details see e.g. *Greenacre* (1984).

$$\mathbf{O}^T = \left(\mathbf{D}_o^{-1/2}\mathbf{V}\mathbf{D}_\mu\right)\left(\mathbf{D}_s^{1/2}\mathbf{U}\right)^T = \mathbf{Y}\left(\mathbf{D}_s^{1/2}\mathbf{U}\right)^T, \quad /10/$$

where

$$\mathbf{X} = \mathbf{D}_s^{-1/2}\mathbf{U}\mathbf{D}_\mu = \mathbf{S}\mathbf{D}_o^{-1/2}\mathbf{V} \quad /11/$$

$$\mathbf{Y} = \mathbf{D}_o^{-1/2}\mathbf{V}\mathbf{D}_\mu = \mathbf{O}^T\mathbf{D}_s^{-1/2}\mathbf{U}\,. \quad /12/$$

Alternatively, the transition of the column coordinates into row coordinates is also possible:

$$\mathbf{X} = \mathbf{S}\mathbf{Y}\mathbf{D}_\mu^{-1} = \left(\mathbf{R} - \mathbf{1}\mathbf{o}^T\right)\mathbf{Y}\mathbf{D}_\mu^{-1} = \mathbf{R}\mathbf{Y}\mathbf{D}_\mu^{-1}, \quad /13/$$

where, conversely, the transition of the row coordinates into column coordinates in a similar manner is given by:

$$\mathbf{Y} = \mathbf{O}^T\mathbf{X}\mathbf{D}_\mu^{-1} = \left(\mathbf{C}^T - \mathbf{1}\mathbf{s}^T\right)\mathbf{X}\mathbf{D}_\mu^{-1} = \mathbf{C}^T\mathbf{X}\mathbf{D}_\mu^{-1}, \quad /14/$$

where $\mathbf{s}$=diag$\mathbf{D}_s$, $\mathbf{o}$=diag$\mathbf{D}_o$ and recall that based on equation (7) the centroid of the CA coordinates is the origin that is $\mathbf{o}^T\mathbf{Y}=\mathbf{0}^T$ and $\mathbf{s}^T\mathbf{X}=\mathbf{0}^T$. Writing in more details:

$$x_{ik} = \sum_{j=1}^{J}\frac{s_{ij}y_{jk}}{\mu_k}, \quad y_{jk} = \sum_{i=1}^{I}\frac{o_{ij}x_{ik}}{\mu_k}\,. \quad /15/$$

It is to be noted, that each row coordinate is a weighted average of the standardized column coordinates with row profile elements as weights and conversely. It is obvious that $x_{ik}$ and $y_{jk}$ tend to be close to each other when column $j$ has a large $s_{ij}$ proportion in the row profile $i$ or row $i$ has a large $o_{ij}$ proportion in the column profile $j$. In this case a large row coordinate on the CA axis $k$ necessarily yields also a large column coordinate on the same axis. Thus, the CA row and column coordinates can be thought of as the result of a dual scaling of row and column scales. The pair of sets of coordinates $x_{i1}$ and $y_{j1}$ provide one dual scaling with standard deviation $\mu_1$, along one dimension while $x_{i2}$ and $y_{j2}$ provide another dual scaling in an orthogonal dimension with standard deviation $\mu_2$ etc. A very important role of the transition formulas /13/ and /14/ in CA to add supplementary points (either rows or columns) to the CA plots. In other words, transition formulas enable us to predict row or column profiles that are omitted from the actual computation of the CA coordinates.

From equations /11/ and /12/ follows that the covariance matrix $\mathbf{Cov}_{xx}$ of coordinates $\mathbf{X}$ and the covariance matrix $\mathbf{Cov}_{yy}$ of the coordinates $\mathbf{Y}$ are identical and diagonal with the squared singular values in the main diagonal:

$$\mathbf{Cov}_{xx} = \mathbf{X}^T\mathbf{D}_s\mathbf{X} = \mathbf{Cov}_{yy} = \mathbf{Y}^T\mathbf{D}_o\mathbf{Y} = \mathbf{D}_\mu^2 = \left\langle \mu_1^2, \mu_2^2, \ldots, \mu_K^2 \right\rangle, \quad /16/$$

where $\mu_k^2 = Var(x \mid k) = Var(y \mid k)$ termed the ‘principal inertia’.

It must be emphasized at this stage that it is always possible to analyze a higher-dimensional table in a two-way form. Then, a row refers to a combination of the levels of two or more variables and a column refers to a combined category of an another set of variables. This method of forming two new combined variables is called 'stacking'.

## MEASURING GOODNESS OF FIT

Extracting exactly the first $m<K$ leading CA axes (typically one or two) the question arises that how well the points are represented in the reduced lower dimensional subspace. Information involved in the CA coordinates is summarized in the following goodness of fit measures.

*a)* Inertia explained:

$$IE(m) = \frac{\sum_{k=1}^{m} \mu_k^2}{\sum_{k=1}^{K} \mu_k^2}.$$

This measure tells us that the first $m$ axes account for the $IE(m)$ percentage of the total inertia. Supposed that almost all of the inertia is accounted for by the first two axes, it indicates that a two-dimensional representation of the rows and columns is very accurate.

*b)* The quality of a point:

$$QLT_i(m) = \frac{\sum_{k=1}^{m} x_{ik}^2}{\sum_{k=1}^{K} x_{ik}^2}, \qquad QLT_j(m) = \frac{\sum_{k=1}^{m} y_{jk}^2}{\sum_{k=1}^{K} y_{jk}^2}.$$

This measure indicates the contribution of the first $m$ principal axes to the inertia of row $i$ or column $j$ respectively. A low quality implies that the point considered (row or column) lies outside of the $m$ dimensional plane.

*c)* Contribution to the inertia of an axis:

$$CTR_{ik} = \frac{s_i x_{ik}^2}{\mu_k^2}, \qquad CTR_{jk} = \frac{o_j y_{jk}^2}{\mu_k^2},$$

where $\Sigma_i CTR_{ik} = \Sigma_j CTR_{jk} = 1$. This measure reports the relative contribution of row $i$ or column $j$ to the inertia (variance in this case) of the $k^{th}$ CA axis.

*d)* Squared correlation:

$$COR2_{ik} = \frac{s_i x_{ik}^2}{INR(s_i)}, \qquad COR2_{jk} = \frac{o_j y_{jk}^2}{INR(o_j)}.$$

It reports the contribution of axis $k$ to the inertia of row $i$ and column $j$ respectively. A low *COR2* implies that the point is not well represented in that dimension.

Apparently, *QLT* and *COR2* are independent on the marginal proportions (masses) whilst *CTR* depends on the masses.

When results are poor regarding the goodness of fit measures it is suggested to confirm the results by collapsing or deleting certain table categories. Checking results within a stratum (i.e. a selected level) of an additional variable could also be meaningful.

As an immediate consequence of /11/ and /12/ we have the following formula for reconstituting the elements $p_{ij}$ of the correspondence matrix **P**:

$$\mathbf{G} = \left(\mathbf{D}_s^{½}\mathbf{X}\right)\mathbf{D}_\mu^{-1}\left(\mathbf{D}_o^{½}\mathbf{Y}\right)^T,$$

that is

$$g_{ij} = \frac{p_{ij} - s_i o_j}{\sqrt{s_i o_j}} = \sqrt{s_i o_j}\sum_{k=1}^{K}\frac{x_{ik}y_{jk}}{\mu_k}$$

and finally the exact and then the approximate reconstitution $p_{ij}$ value:

$$p_{ij} = s_i o_j\left(1 + \sum_{k=1}^{K}\frac{x_{ik}y_{jk}}{\mu_k}\right) \approx \qquad /17/$$

$$\approx s_i o_j\left(1 + \sum_{k=1}^{m}\frac{x_{ik}y_{jk}}{\mu_k}\right). \qquad /18/$$

The approximate reconstitution of the $p_{ij}$ from the CA axes display can be used on the one hand to impute missing values in the data matrix. On the other hand, underlining the situation when $m$=1 we stress that it is not only the closeness of a row point to a column point that determines their degree of association, but also the comparison of their distances from the origin. Therefore when the product $x_{i1}y_{i1}$ is near zero, the standardized deviate $g_{ij}$ is also near zero and consequently, the association between the $i^{\text{th}}$ row and the $j^{\text{th}}$ column is low.

## MULTIPLE CORRESPONDENCE ANALYSIS (MCA)

When more than two discrete variables have been observed on each of the $n$ individuals, instead of stacking variables *MCA* is a more appropriate tool for multiple analysis. The multiple analysis is equivalent to a simple CA carried out on the so-called indicator matrix. The rows of the indicator matrix $\mathbf{Z}_{(n,J)}$ correspond to the $i$=1,2,...,$n$ observational units (individuals, cases) of the study, while the columns correspond to the categories of the discrete variables $Z_q$ ($q$=1,2,...,$Q$) where $Z_q$ has $J_q$ categories. Thus, the matrix consists of $Q$ sets of $J$ columns ($J = J_1+J_2+...+J_Q$) and each row has $Q$ ones indicating the categories into which the observational units fall. This is illustrated in Table 7.

There are $nQ$ ones scattered throughout **Z**, $n$ in each submatrix $\mathbf{Z}_q$, otherwise the elements of **Z** are zeros. Each row of $\mathbf{Z}_q$ adds up to 1, and each row of **Z** adds up to $Q$.

Table 7

*Indicator matrix*

| Individual (case) | Columns of the indicator matrix **Z** ($j$=1,2,…,$J$) | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Categories of variable: $Z_1$ | | | | … | Categories of variable: $Z_q$ | | | | … | Categories of variable: $Z_Q$ | | | | |
| | 1 | 2 | … | $J_1$ | … | 1 | 2 | … | $J_q$ | … | 1 | 2 | … | $J_Q$ | |
| 1 | 1 | | | | | | 1 | | | | | | | 1 | $Q$ |
| 2 | | 1 | | | | | 1 | | | | | 1 | | | $Q$ |
| ⋮ | | | | | | | | | | | | | | | ⋮ |
| $i$ | | | | 1 | | 1 | | | | | | 1 | | | $Q$ |
| ⋮ | | | | | | | | | | | | | | | ⋮ |
| $n$ | | 1 | | | | | | | 1 | | 1 | | | | $Q$ |
| Total ($f_j$) | $f_1^1$ | $f_2^1$ | … | $f_{J_1}^1$ | … | $f_1^q$ | $f_2^q$ | … | $f_{J_q}^q$ | … | $f_1^Q$ | $f_2^Q$ | … | $f_{J_Q}^Q$ | $n \cdot Q$ |

Interpretation of the MCA results based on the following properties of **Z.**

*1*. The sum of the masses $o_j=f_j/(nQ)$ of the columns of $\mathbf{Z}_q$ is $1/Q$ for all $q$=1,2,…,$Q$. Thus each discrete variable $q$ receives the same mass, which is distributed over the 1,2,…,$J_q$ categories according to the frequencies $f^q$ of responses.

*2*. The centroid of the $o_{ij}=(1/f_j)=1/(n\cdot Q\cdot o_j)$ column profiles of $\mathbf{Z}_q$ is at the centroid of all the column profiles. Thus each sub cloud of categories is balanced at the origin of the display. Further, each row mass is $s_i=Q/(n\cdot Q)=1/n$ and each row profile element is $s_{ij}=1/Q$.

*3*. The inertia shared by a single cell of row $i$ and column $j$ (from equations /1/ and /2/ is

$$INR(i,j) = s_{ij}o_{ij} - 2p_{ij} + s_i o_j$$

hence, the inertia shared by a single column $j$ is

$$\Sigma_i\, INR(i,j) = INR(j) = f_j s_{ij} o_{ij} - 2f_j p_{ij} + n s_i o_j = 1/Q\text{-}o_j.$$

The inertia contributed by a category increases as the response to this category decreases, with an upper bound of $1/Q$.

*4*. The inertia of the column profiles of $\mathbf{Z}_q$ is:

$$INR(q) = \sum_{j_q=1}^{J_q} INR(j_q) = \frac{J_q}{Q} - \frac{1}{Q}.$$

The inertia contributed by a discrete variable increases linearly with the number of the response categories.

*5*. The total inertia of the column profiles (and of the row profiles) is:

$$INR = \sum_{q=1}^{Q} INR(q) = \frac{J}{Q} - 1.$$

*6*. The number of non-trivial dimensions with positive inertia is at most $J$-$Q$.

*7*. The row profiles lie at the equal-weighted barycentre of the column profiles representing their responses, up to a re-scaling by the inverse square root of the principal inertias along the respective principal axis.

*8*. The $n$ row profiles are vectors originally in the $J$-dimensional space, but they occur at only $J_1 x J_2 x \ldots J_Q$ distinct positions.

*9*. In general, only principal inertias above the value $1/Q$ are 'interesting' and it is clear that a rather pessimistic impression of the quality of a display is obtained by the usual percentages of inertia. Especially, when the $J_q$ categories are derived from segmenting the range of a continuous variable then we have the undesirable result that the usual percentages tend to zero, even on the major dimensions, as the subdivisions are made finer and finer. Considering an indicator matrix with $J_1 x J_2 x \ldots J_Q$ rows, one row for each of the possible responses to the $Q$ variables, then the $J$-$Q$ principal inertias are all $1/Q$. This is the justification for taking $1/Q$ as a 'baseline' value for the principal inertias. Considering the goodness of fit measures of an MCA application, it is apparent that it is not the magnitude of their values rather the rank positions that are informative to make a selection of influential categories.

*10*. The standard coordinates (of the rows or the columns) in the CA analysis of $\mathbf{Z}^T\mathbf{Z}$ are identical to the standard coordinates of the columns in the CA analysis of $\mathbf{Z}$. The positive semidefinite $(J,J)$ order symmetric matrix $\mathbf{Z}^T\mathbf{Z}$ is called the Burt matrix. This property follows directly from the transition formula /13/ which can be written as:

$$\mathbf{C}^T\mathbf{X}\mathbf{D}_\mu^{-1} = \mathbf{C}^T\mathbf{R}\mathbf{Y}\mathbf{D}_\mu^{-2} \qquad /19/$$

and using /14/ the column coordinates $\mathbf{Y}$ of $\mathbf{Z}$ satisfy the following eigen-equation:

$$\mathbf{Y} = \mathbf{C}^T\mathbf{R}\mathbf{Y}\mathbf{D}_\mu^{-2}\,. \qquad /20/$$

Now, the row profile matrix $\mathbf{R}$ is simply $(1/Q)\mathbf{Z}$, while the column profile matrix is $\mathbf{C}^T=(nQ\mathbf{D}_o)^{-1}\mathbf{Z}^T$. Since the column masses $\mathbf{D}_o$ of $\mathbf{B}$ are identical to those of $\mathbf{Z}$, equation /20/ can be written as

$$\mathbf{Y} = \left(\frac{1}{nQ^2}\left(\mathbf{D}_o^{Burt}\right)^{-1}\mathbf{Z}^T\mathbf{Z}\right)\mathbf{Y}\mathbf{D}_\mu^{-2} = \mathbf{R}^{Burt}\mathbf{Y}\mathbf{D}_\mu^{-2}\,. \qquad /21/$$

Because $[nQ^2\mathbf{D}_o^{(Burt)}]^{-1}\mathbf{Z}^T\mathbf{Z}$ is the row profile matrix of the Burt matrix and the row and column coordinates of $\mathbf{B}$ are identical, /21/ is precisely the transition formula in the analysis of the Burt matrix. Hence, $\mathbf{Y}^Z=\mathbf{Y}^B$. The principal inertias $\mu^{2(B)}$ in the analysis of the Burt matrix are the squares of those of the indicator matrix: $\mu^{2(B)} = (\mu^{2(Z)})^2$ .

It is instructive at this point to compare the analysis of $\mathbf{Z}$ with that of the Burt matrix. Using the $\mathbf{Z}_q$ submatricies from Table 7, the Burt matrix has the following block structure:

$$\mathbf{Z}^T\mathbf{Z}_{(J,J)} = \mathbf{B} = \begin{bmatrix} \mathbf{Z}_1^T\mathbf{Z}_1 & \mathbf{Z}_1^T\mathbf{Z}_2 & \cdots & \mathbf{Z}_1^T\mathbf{Z}_Q \\ \mathbf{Z}_2^T\mathbf{Z}_1 & \mathbf{Z}_2^T\mathbf{Z}_2 & & \mathbf{Z}_2^T\mathbf{Z}_Q \\ \vdots & & \ddots & \\ \mathbf{Z}_Q^T\mathbf{Z}_1 & \mathbf{Z}_Q^T\mathbf{Z}_2 & & \mathbf{Z}_Q^T\mathbf{Z}_Q \end{bmatrix}.$$

Each ‘off-diagonal’ submatrix $\mathbf{Z}_q^T\mathbf{Z}_{q^*}$ ($q \neq q^*$) is a two-way contingency table which condenses the association between variables $q$ and $q^*$ across the $n$ individuals (cases). Each ‘diagonal’ submatrix $\mathbf{Z}_q^T\mathbf{Z}_q$ is the diagonal matrix of the column sums of $\mathbf{Z}_q$. Because the Burt matrix is positive, semidefinite and symmetric, it is clear that its CA produces two identical sets of coordinates for the rows and columns. The only difference between the analysis of **B** and **Z** lies in the values of the principal inertias, which will affect the scales of the principal coordinates.

The fact that the analysis of the multivariate indicator matrix **Z** is equivalent to that of the Burt matrix illustrates that these analyses should be regarded as joint bivariate rather than multivariate ones. The Burt matrix is the analogue of the covariance matrix of $Q$ continuous variables, where each ($J_q$,$J_{q^*}$) submatrix is analogous to a covariance. The CA of **Z** (or equivalently, of **B**) does not take into account associations among more than two discrete variables but rather looks at all the two-way associations jointly. In the context of multiway contingency table analysis we consider only the second-order interactions. Thus the CA treatment of a multivariate indicator matrix **Z** seems to be at an interface between the classical joint bivariate treatment of continuous multivariate data and the complex interaction modelling of multiway contingency tables.

## PREDICTION OF FINANCIAL BANKRUPTCY

In the following analysis the prediction of financial bankruptcy is illustrated based on the data set of Hungarian corporations and unincorporated enterprises (firms hereafter).

### *The data set*

The data characterize the years of 1998 and 1999. The variables investigated are partly categorical and partly continuous but measured also on a scale of categories. The categorical variables of interest are the status (Status) and the legal form of the firm (*F*) and the type of industry (*I*) and the region that the firm belongs to (*R*). The corresponding categories are as follows.

– The Status=OK, if the firm is active, Status=BRUPT if it has finished its activity due to bankruptcy proceedings and Status=PROC, if the unit is actually under bankruptcy proceedings.

– The Legal Form takes the values of F={COP,GP,LP,LLC,JSC} if the firm is a Cooperative (COP), a General Partnership (GP), a Limited Partnership (LP), a Limited Liability Company (LLC), a Joint Stock Company (JSC) respectively or F=Other otherwise.

– The type of industry (according to the SNA classification) is indicated simply by its order number *I*={*i*1, *i*2,..., *i*15}.

– The categories of Region are R={CHU,CTD,WTD,STD,NHU,NGP,SGP}, corresponding to regions of Central Hungary (CHU), Central Transdanubia (CTD), Western Transdanubia (WTD), Southern Transdanubia (STD), Northern Hungary (NHU), Northern Great Plain (NGP) and Southern Great Plain (SGP).

Further, four continuous financial indicators are also of our interest as potential indicators of the activity moving toward bankruptcy.

The definitions of the continuous variables are as follows:

– Profitability = after-tax profit / total assets (P),
– Liquidity = current assets / short-term liabilities (L),
– Debt Ratio = Liabilities / total assets (D),
– Equity Ratio = equity / (inventories + invested assets) (E).

Subsequently, the range of each ratio-type measure has been divided into a few adjacent intervals using appropriate cut points hence, yielding ordinal categories of firms as homogeneous as possible. We identify the categorized financial indicators with capital letters P, L, D, E. The number of their respective categories depends on their frequency distributions according to the following procedure. First, the range of each ratio-type measure has been standardized to have zero mean and unit variance. Secondly, the standardized range is segmented uniformly into 10 intervals by the upper bounds of {-2, -1.5, -1,…,1, 1.5, 2, ∞} with the corresponding discrete values of $u$={1,2,3,…,10}. As a result, by an agglomeration of the $u$ categories the following scales will be applied:

– P = Low, Moderate, Average, High, Extreme, (with upper bounds in $u$: 2,4,6,8,10),
– L = Low, Moderate, Average, High, (with upper bounds in $u$: 5,6,8,10),
– D = Low, Average, High, (with upper bounds in $u$: 5,6,10),
– E = Low, Moderate, Average, High. (with upper bounds in $u$: 4,5,6,10).

Based on the outcomes of the predictor variables F, I, R, P, L, D, E, our main purpose is to classify a PROC firm (who is still not bankrupt) whether it remains active (belonging to the dependent category OK) or is going to become a bankrupt one (belonging to the other dependent category BRUPT). This needs on the one hand exploring correspondences between the dependent and the predictor categories. On the other hand, finding clear distinctions between the average OK and BRUPT row profiles while scanning the predictor categories is also necessary. Furthermore, it is worth plotting all the firms in the database in order to investigate their nearest neighbours whether they are mostly bankrupt or not. The latter problems involve apparently a discriminant analysis stage as well as a subsequent prediction step. All the computations are based on correspondence analysis of an indicator matrix. Correspondences among the categories are explored including the entire set of the categories available. Discrimination and prediction on the other hand is carried out using a different indicator matrix with columns corresponding to the categories of the predictor variables only. This reduced set of columns is as follows (UCM percent means the unconditional mass (distribution) of that variable):

| Column | UCM% | Column | UCM% | Column | UCM% | Column | UCM% | Column | UCM% | Column | UCM% | Column | UCM% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F_Other | 1.6 | I_i1 | 3.8 | R_CHU | 55.7 | P_Low | 2.7 | L_Low | 94.4 | D_Low | 97.3 | E_Low | 0.1 |
| COP | 1.7 | i2 | 0.1 | CTD | 7.0 | Mod | 5.4 | Mod | 5.3 | Av | 2.7 | Mod | 17.6 |
| GP | 0.9 | i3 | 0.2 | WTD | 7.3 | Av | 80.1 | Av | 0.2 | Hi | 0.0 | Av | 82.2 |
| LP | 27.6 | i4 | 15.1 | STD | 6.8 | Hi | 11.2 | Hi | 0.1 | | | Hi | 0.1 |
| LLC | 67.0 | i5 | 0.3 | NHU | 6.1 | Ext | 0.6 | | | | | | |
| JSC | 1.3 | i6 | 8.0 | NGP | 8.1 | | | | | | | | |
| | | i7 | 31.4 | SGP | 9.1 | | | | | | | | |
| | | i8 | 3.7 | | | | | | | | | | |
| | | i9 | 3.9 | | | | | | | | | | |
| | | i10 | 0.2 | | | | | | | | | | |
| | | i11 | 25.2 | | | | | | | | | | |
| | | i12 | 0.0 | | | | | | | | | | |
| | | i13 | 1.1 | | | | | | | | | | |
| | | i14 | 2.3 | | | | | | | | | | |
| | | i15 | 4.8 | | | | | | | | | | |

The number of ‘OK and BRUPT’ firms together is 169 610 from which 321 is bankrupt whilst the number of PROC firms is 3682. Because PROC firms are to be classified they are omitted from the computations. Hence, the number of cases contributing to our analysis is 169 610 constituting the 169 610 rows of the indicator matrix with 45 or 43 columns depending on the current analysis. Computations were made by using the BMDP Program Package.

*Plotting associations*

The total inertia considering the indicator matrix with 45 columns is (45/8–1)=4.625. In this case 1/Q=1/8=0.125 hence the CA axes with squared singular values greater than 0.125 are worth being extracted. The percentages of the total inertia accounted for by the three leading axes are: $\mu_1^2$=0.248 (5.4%), $\mu_2^2$=0.184 (4%), $\mu_3^2$=0.159 (3.4%). The number of meaningful axes actually extracted is 3, no matter the cumulative percentage of inertia accounted for by them. Table 8 provides information given in the column coordinates. In the table NAME identifies the column concerned and MASS stands for the category total as a proportion of all cases. Again, according to the definitions introduced earlier QLT is a quality-measure of how well the distance from the origin of this point in the reduced dimension (three in this case) represents the full distance from the origin. The contribution of the given category to the total inertia is measured by INR. Furthermore, attributes for each extracted dimension are as follows:

– FACTOR: the category coordinate or column score for the corresponding axis.

– COR2: the ‘squared correlation’ indicates how well the distance of the point along that axis from the origin represents the total distance of the point from the origin. The sum of COR2 values for the axes extracted equals QLT.

– CTR shows the category’s relative contribution to the inertia accounted for by that axis.

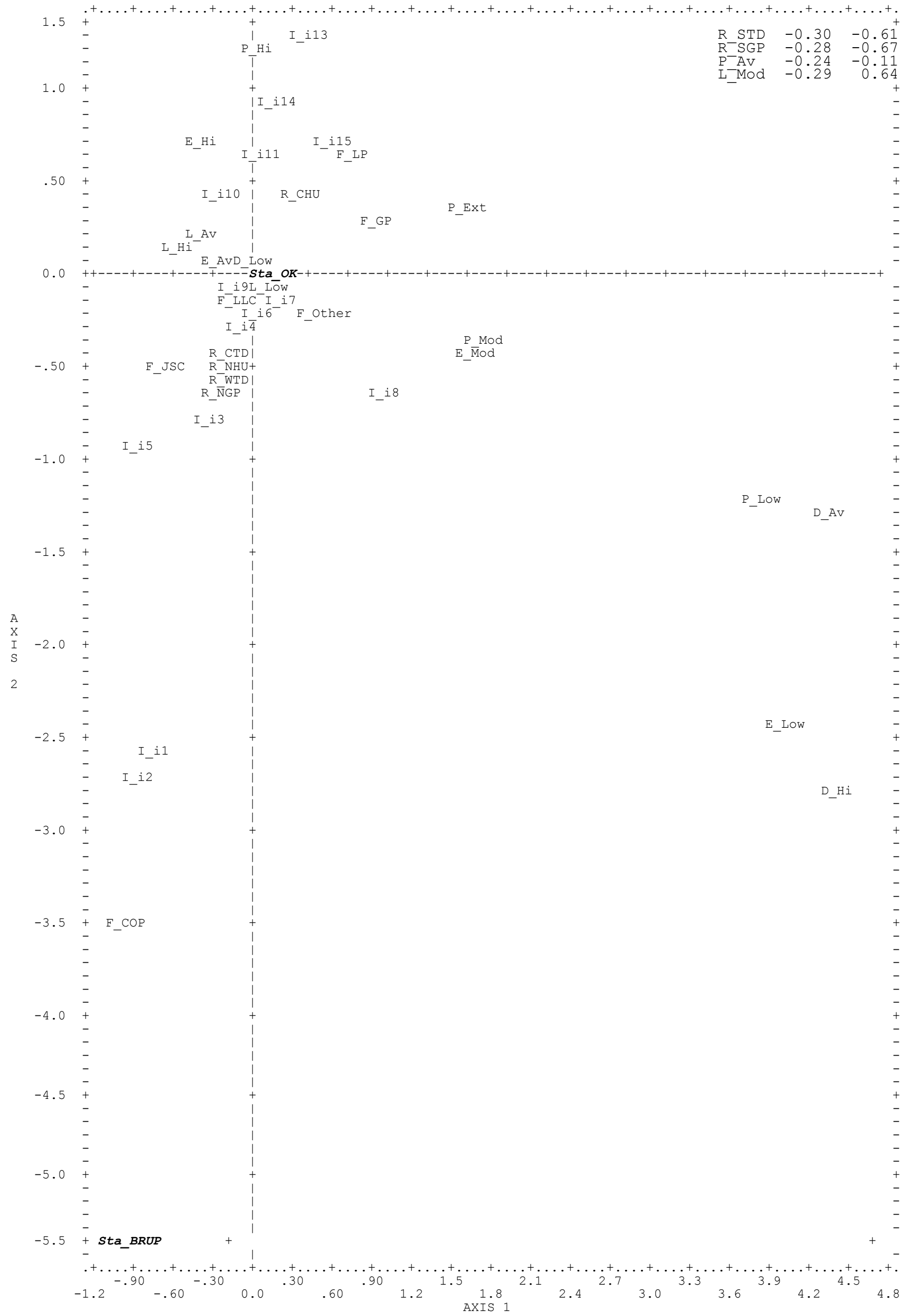
When column profiles in the indicator matrix are similar, the corresponding category points in the graphical display will tend to be close together. Thus, the same or similar firms will be in categories represented by adjacent points. In addition, Figure 1 labels category areas using the FACTOR values on Axis 1 and Axis 2, Figure 2 shows the category positions in the plain of Axis 1 and Axis 3 and, finally Figure 3 plots the column points along Axis 2 and Axis 3. The category point could also be interpreted as the category mean scores for the first three axes. Thus, the interpretation of the axes is as follows.

– The first axis contrasts: P_Low, E_Low,D_High, I-i8, F_GP, F_LP, P_Mod, P_Ext with positive coordinates against Sta_BRUPT, F_COP, F_JSC, I_i1, I_i2, I_i5, L_Hi, with negative coordinates.

– The second axis contrasts: I_i13, P_High, I_i14, I_i15, E_High, F_LP, I_i11 with positive coordinates against Sta_BRUPT, F_COP, D_High, E_Low, I_i1, I_i2, P_LOw, I_i5, D_Av with negative coordinates.

– The third axis contrasts: Sta_BRUPT, F_COP, I_i1, I_i2, E_High, with positive coordinates against D_High, E_Low, I_i5, I_i3 with negative coordinates.

*Figure 1. Correspondences between the column categories on Axis 1, 2*
*X*=5.36 %, *Y*=3.98 %




*Note*: On Figures 1,2,3,4,5,6 the labels and coordinates of points which would overwrite points already plotted are given in the right hand upper corner of the display.

*Figure 2. Correspondences between the column categories on Axis 1, 3*
*X*=5.36 %, *Y*=3.44 %

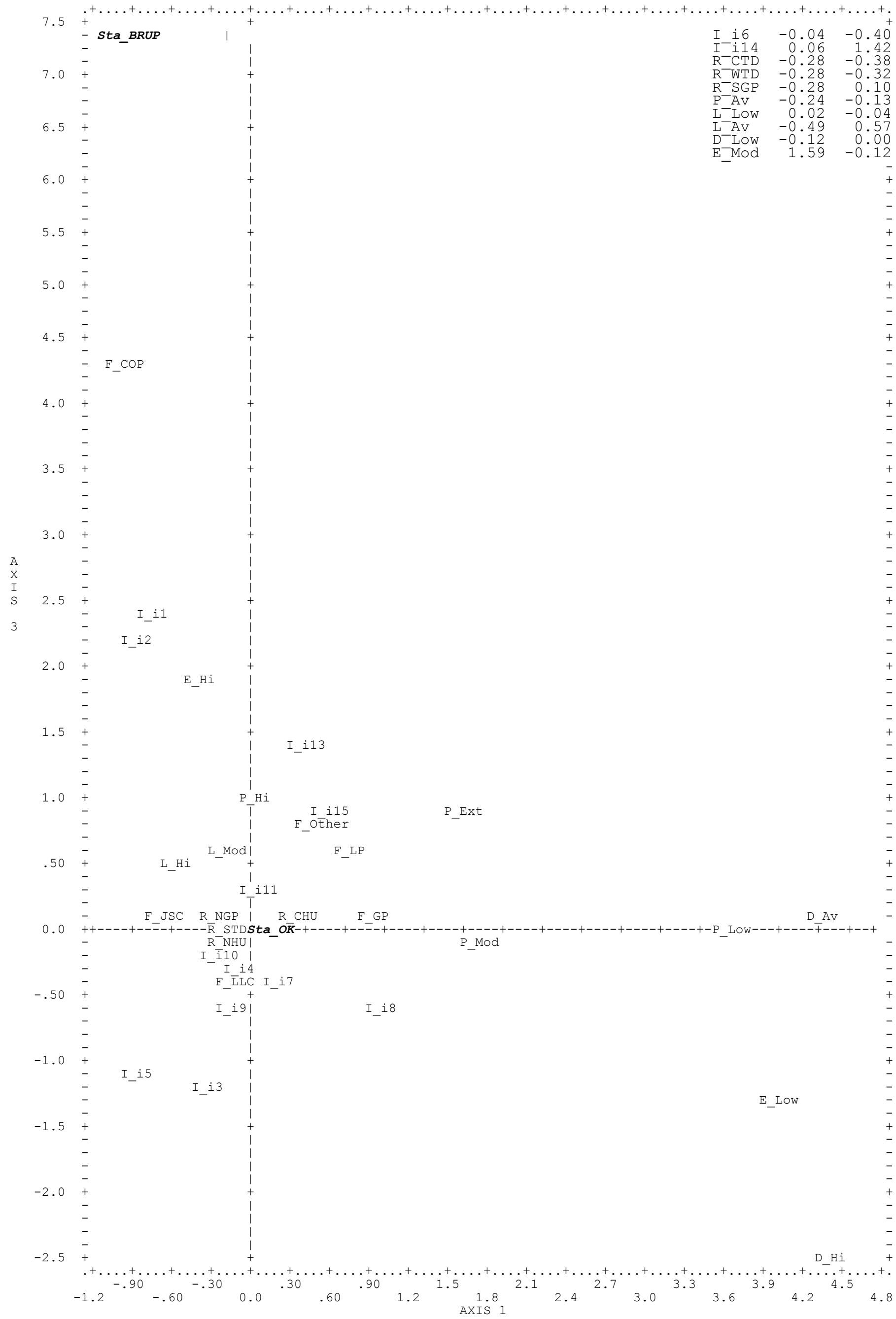


*Figure 3. Correspondences between the column categories on Axis 2, 3*

*X*=3.98 %, *Y*=3.44 %

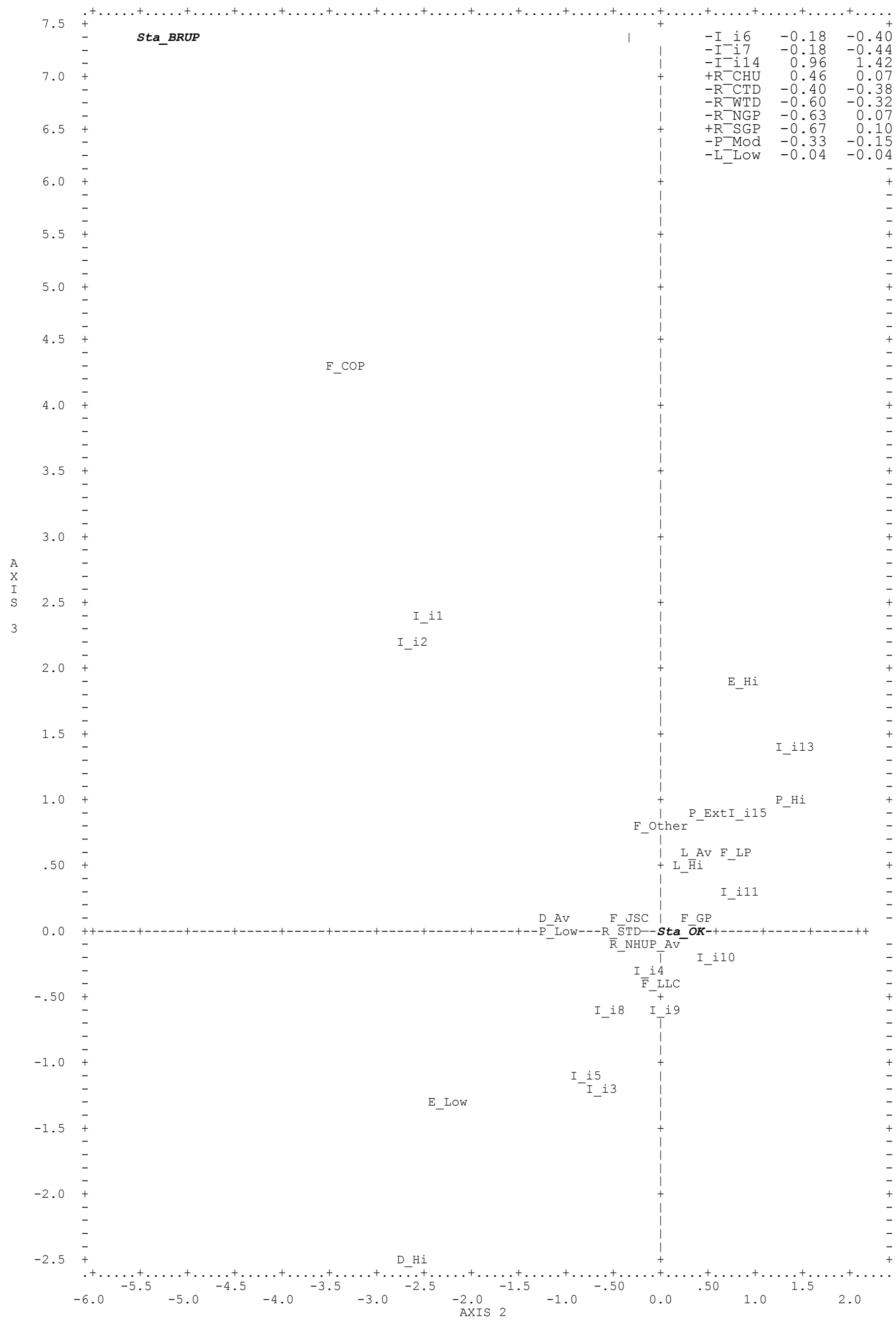


Table 8

*Report on the categories as column points of the indicator matrix*

| NAME | MASS | QLT | INR | FACTOR | COR2 | CTR | FACTOR | COR2 | CTR | FACTOR | COR2 | CTR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | AXIS 1 | | | AXIS 2 | | | AXIS 3 | | |
| Sta_OK | 0.125 | **0.164** | 0.000 | 0.002 | 0.003 | 0.000 | 0.010 | 0.057 | 0.000 | -0.014 | **0.105** | 0.000 |
| Sta_BRUP | 0.000 | **0.164** | 0.125 | -1.158 | 0.003 | 0.001 | -5.471 | 0.057 | 0.038 | 7.445 | **0.105** | **0.082** |
| F_Other | 0.002 | 0.014 | 0.123 | 0.331 | 0.002 | 0.001 | -0.220 | 0.001 | 0.001 | 0.837 | 0.011 | 0.009 |
| F_COP | 0.002 | **0.545** | 0.123 | -1.093 | 0.020 | 0.010 | -3.496 | **0.208** | **0.139** | 4.321 | **0.317** | **0.245** |
| F_GP | 0.001 | 0.007 | 0.124 | 0.842 | 0.006 | 0.003 | 0.270 | 0.001 | 0.000 | 0.116 | 0.000 | 0.000 |
| F_LP | 0.034 | **0.462** | 0.091 | 0.658 | **0.165** | 0.060 | 0.645 | **0.158** | 0.078 | 0.603 | **0.138** | **0.079** |
| F_LLC | 0.084 | **0.475** | 0.041 | -0.248 | **0.125** | 0.021 | -0.168 | 0.057 | 0.013 | -0.380 | **0.293** | **0.076** |
| F_JSC | 0.002 | 0.011 | 0.123 | -0.764 | 0.008 | 0.004 | -0.481 | 0.003 | 0.002 | 0.135 | 0.000 | 0.000 |
| I_i1 | 0.005 | **0.508** | 0.120 | -0.843 | 0.028 | 0.013 | -2.564 | **0.257** | **0.168** | 2.390 | **0.223** | **0.169** |
| I_i2 | 0.000 | 0.008 | 0.125 | -0.943 | 0.001 | 0.000 | -2.721 | 0.005 | 0.003 | 2.159 | 0.003 | 0.002 |
| I_i3 | 0.000 | 0.003 | 0.125 | -0.409 | 0.000 | 0.000 | -0.792 | 0.001 | 0.001 | -1.183 | 0.002 | 0.002 |
| I_i4 | 0.019 | 0.030 | 0.106 | -0.201 | 0.007 | 0.003 | -0.253 | 0.011 | 0.007 | -0.253 | 0.011 | 0.008 |
| I_i5 | 0.000 | 0.008 | 0.125 | -0.969 | 0.002 | 0.001 | -0.938 | 0.002 | 0.002 | -1.062 | 0.003 | 0.002 |
| I_i6 | 0.010 | 0.017 | 0.115 | -0.039 | 0.000 | 0.000 | -0.179 | 0.003 | 0.002 | -0.403 | 0.014 | 0.010 |
| I_i7 | 0.039 | 0.109 | 0.086 | 0.110 | 0.006 | 0.002 | -0.178 | 0.015 | 0.007 | -0.442 | 0.089 | **0.048** |
| I_i8 | 0.005 | 0.059 | 0.120 | 0.879 | 0.030 | 0.015 | -0.645 | 0.016 | 0.011 | -0.590 | 0.013 | 0.010 |
| I_i9 | 0.005 | 0.017 | 0.120 | -0.258 | 0.003 | 0.001 | -0.098 | 0.000 | 0.000 | -0.580 | 0.014 | 0.010 |
| I_i10 | 0.000 | 0.001 | 0.125 | -0.371 | 0.000 | 0.000 | 0.400 | 0.000 | 0.000 | -0.185 | 0.000 | 0.000 |
| I_i11 | 0.032 | **0.178** | 0.093 | -0.055 | 0.001 | 0.000 | 0.657 | **0.146** | 0.074 | 0.305 | 0.031 | 0.018 |
| I_i13 | 0.001 | 0.043 | 0.124 | 0.283 | 0.001 | 0.000 | 1.286 | 0.019 | 0.013 | 1.439 | 0.024 | 0.018 |
| I_i14 | 0.003 | 0.071 | 0.122 | 0.063 | 0.000 | 0.000 | 0.964 | 0.022 | 0.015 | 1.419 | 0.048 | 0.037 |
| I_i15 | 0.006 | 0.073 | 0.119 | 0.452 | 0.010 | 0.005 | 0.721 | 0.026 | 0.017 | 0.860 | 0.037 | 0.028 |
| R_CHU | 0.070 | **0.344** | 0.055 | 0.243 | 0.074 | 0.017 | 0.456 | **0.262** | 0.079 | 0.075 | 0.007 | 0.002 |
| R_CTD | 0.009 | 0.029 | 0.116 | -0.282 | 0.006 | 0.003 | -0.395 | 0.012 | 0.007 | -0.382 | 0.011 | 0.008 |
| R_WTD | 0.009 | 0.042 | 0.116 | -0.279 | 0.006 | 0.003 | -0.595 | 0.028 | 0.017 | -0.321 | 0.008 | 0.006 |
| R_STD | 0.008 | 0.033 | 0.117 | -0.300 | 0.007 | 0.003 | -0.606 | 0.027 | 0.017 | 0.019 | 0.000 | 0.000 |
| R_NHU | 0.008 | 0.024 | 0.117 | -0.302 | 0.006 | 0.003 | -0.508 | 0.017 | 0.011 | -0.126 | 0.001 | 0.001 |
| R_NGP | 0.010 | 0.049 | 0.115 | -0.387 | 0.013 | 0.006 | -0.632 | 0.035 | 0.022 | 0.070 | 0.000 | 0.000 |
| R_SGP | 0.011 | 0.053 | 0.114 | -0.280 | 0.008 | 0.004 | -0.666 | 0.044 | 0.027 | 0.100 | 0.001 | 0.001 |
| P_Low | 0.003 | **0.426** | 0.122 | 3.697 | **0.383** | **0.188** | -1.243 | 0.043 | 0.029 | 0.011 | 0.000 | 0.000 |
| P_Mod | 0.007 | 0.155 | 0.118 | 1.612 | **0.148** | 0.071 | -0.327 | 0.006 | 0.004 | -0.150 | 0.001 | 0.001 |
| P_Av | 0.100 | **0.349** | 0.025 | -0.237 | **0.226** | 0.023 | -0.111 | 0.050 | 0.007 | -0.134 | 0.073 | 0.011 |
| P_Hi | 0.014 | **0.316** | 0.111 | -0.057 | 0.000 | 0.000 | 1.240 | **0.194** | **0.117** | 0.985 | **0.122** | **0.085** |
| P_Ext | 0.001 | 0.018 | 0.124 | 1.478 | 0.013 | 0.006 | 0.322 | 0.001 | 0.000 | 0.891 | 0.005 | 0.004 |
| L_Low | 0.118 | 0.050 | 0.007 | 0.018 | 0.005 | 0.000 | -0.037 | 0.023 | 0.001 | -0.036 | 0.022 | 0.001 |
| L_Mod | 0.007 | 0.048 | 0.118 | -0.291 | 0.005 | 0.002 | 0.638 | 0.023 | 0.015 | 0.606 | 0.021 | 0.015 |
| L_Av | 0.000 | 0.001 | 0.125 | -0.493 | 0.000 | 0.000 | 0.237 | 0.000 | 0.000 | 0.574 | 0.001 | 0.000 |
| L_Hi | 0.000 | 0.001 | 0.125 | -0.681 | 0.000 | 0.000 | 0.139 | 0.000 | 0.000 | 0.491 | 0.000 | 0.000 |
| D_Low | 0.122 | **0.546** | 0.003 | -0.118 | 0.500 | 0.007 | 0.036 | 0.046 | 0.001 | -0.002 | 0.000 | 0.000 |
| D_Av | 0.003 | **0.542** | 0.122 | 4.237 | **0.497** | **0.244** | -1.284 | 0.046 | 0.030 | 0.094 | 0.000 | 0.000 |
| D_Hi | 0.000 | 0.005 | 0.125 | 4.337 | 0.003 | 0.001 | -2.770 | 0.001 | 0.001 | -2.512 | 0.001 | 0.001 |
| E_Low | 0.000 | 0.016 | 0.125 | 3.928 | 0.010 | 0.005 | -2.439 | 0.004 | 0.003 | -1.314 | 0.001 | 0.001 |
| E_Mod | 0.022 | **0.575** | 0.103 | 1.587 | **0.537** | **0.223** | -0.407 | 0.035 | 0.020 | -0.118 | 0.003 | 0.002 |
| E_Av | 0.103 | **0.577** | 0.022 | -0.342 | **0.539** | 0.048 | 0.088 | 0.036 | 0.004 | 0.023 | 0.002 | 0.000 |
| E_Hi | 0.000 | 0.006 | 0.125 | -0.456 | 0.000 | 0.000 | 0.715 | 0.001 | 0.001 | 1.871 | 0.005 | 0.004 |

*Note*: Measures with relatively high values are emphasized in the table.

As the number of the OK firms dominates the frequency of the BRUPT firms the average profile of the OK group is almost the same as the centroid of all firms. Hence, on the plots the OK category is well represented by the origin. Thus, categories located around the origin (but not too close to it because of the reconstitution formula /18/) can be associated with no bankruptcy. Categories such as F_GP, P_Ext, F_LP, I_i15 are obviously far from bankruptcy in the plane of Axis 1 and Axis 2 while category F_COP and I_i2 are obviously close to Sta_BRUPT. On the other hand, category BRUPT moves far from the origin and pulls some predictor categories in the same direction on the respective axes such as I_i1, I_i3, I_i5, F_JSC on the first axis and D_High, E_Low, P_Low, D_Av on the second axis. Considering the transition formula /15/ and recalling its interpretation the distances among the points on the plots show how strongly or slightly are these points associated with the category BRUPT.

## PREDICTIVE MAPS

It is supported by Multiple Correspondence Analysis to add further points to the plots representing the categories of additional or supplementary variables. Supplementary variables correspond to dependent or response variables. Simply we plot the column points of the indicator matrix in a two dimensional space to explore dependencies among the predictor categories. This is called a *predictive map*. Then we project the supplementary row profile onto this predictive map (using the transition formula /15/). The positions of the supplementary categories in relation to the positions of the predictor categories reveal their dependencies or independencies. In our case the OK and BRUPT categories play the role of supplementary categories desired to be discriminated on the predictive map while the position of the PROC supplementary category (an average of the individual PROC-member points) is compared with the positions of OK and BRUPT. Obviously, all PROC members are excluded from the computations of the predictive map. Nevertheless, an additional individual firm could also be projected onto the predictive map letting us investigate its neighbours whether they are mostly bankrupt or not. However, this latter concept of visual classification would need a 'scatter plot of firms' with the difficulty in its interpretation due to the large number of the firms to be plotted actually in the display.

Table 9

*Report on the predictor categories as column points of the indicator matrix*

| NAME | MASS | QLT | INR | FACTOR | COR2 | CTR | FACTOR | COR2 | CTR | FACTOR | COR2 | CTR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | AXIS 1 | | | AXIS 2 | | | AXIS 3 | | |
| F_Other | 0.002 | 0.019 | 0.141 | 0.333 | 0.002 | 0.001 | -0.183 | 0.001 | 0.000 | 1.020 | 0.017 | 0.013 |
| F_COP | 0.002 | **0.532** | 0.140 | -1.029 | 0.018 | 0.009 | -3.019 | **0.155** | **0.105** | 4.599 | **0.359** | **0.284** |
| F_GP | 0.001 | 0.007 | 0.142 | 0.840 | 0.006 | 0.003 | 0.293 | 0.001 | 0.001 | 0.051 | 0.000 | 0.000 |
| F_LP | 0.039 | **0.464** | 0.103 | 0.656 | **0.164** | **0.060** | 0.704 | **0.189** | **0.094** | 0.541 | **0.111** | **0.065** |
| F_LLC | 0.096 | **0.478** | 0.047 | -0.249 | **0.126** | 0.021 | -0.206 | 0.086 | 0.020 | -0.362 | **0.266** | **0.071** |
| F_JSC | 0.002 | 0.010 | 0.141 | -0.753 | 0.007 | 0.004 | -0.414 | 0.002 | 0.002 | -0.006 | 0.000 | 0.000 |
| I_i1 | 0.005 | **0.591** | 0.137 | -0.817 | 0.026 | 0.013 | -2.422 | **0.229** | **0.152** | 2.929 | **0.335** | **0.259** |
| I_i2 | 0.000 | 0.006 | 0.143 | -0.890 | 0.000 | 0.000 | -2.344 | 0.003 | 0.002 | 1.896 | 0.002 | 0.002 |
| I_i3 | 0.000 | 0.004 | 0.143 | -0.402 | 0.000 | 0.000 | -0.837 | 0.001 | 0.001 | -1.327 | 0.003 | 0.002 |
| I_i4 | 0.022 | 0.032 | 0.121 | -0.199 | 0.007 | 0.003 | -0.267 | 0.013 | 0.007 | -0.267 | 0.013 | 0.009 |
| I_i5 | 0.000 | 0.007 | 0.142 | -0.971 | 0.002 | 0.001 | -1.084 | 0.003 | 0.002 | -0.837 | 0.002 | 0.001 |
| I_i6 | 0.011 | 0.017 | 0.131 | -0.039 | 0.000 | 0.000 | -0.216 | 0.004 | 0.003 | -0.386 | 0.013 | 0.010 |
| I_i7 | 0.045 | **0.112** | 0.098 | 0.109 | 0.005 | 0.002 | -0.217 | 0.022 | 0.010 | -0.430 | **0.085** | **0.047** |
| I_i8 | 0.005 | 0.059 | 0.138 | 0.880 | 0.030 | 0.015 | -0.697 | 0.019 | 0.012 | -0.513 | 0.010 | 0.008 |
| I_i9 | 0.006 | 0.017 | 0.137 | -0.260 | 0.003 | 0.001 | -0.154 | 0.001 | 0.001 | -0.567 | 0.013 | 0.010 |
| I_i10 | 0.000 | 0.001 | 0.143 | -0.375 | 0.000 | 0.000 | 0.376 | 0.000 | 0.000 | -0.207 | 0.000 | 0.000 |
| I_i11 | 0.036 | **0.178** | 0.107 | -0.058 | 0.001 | 0.000 | 0.695 | **0.163** | **0.084** | 0.202 | 0.014 | 0.008 |
| I_i13 | 0.002 | 0.046 | 0.141 | 0.278 | 0.001 | 0.000 | 1.399 | 0.022 | 0.015 | 1.409 | 0.023 | 0.018 |
| I_i14 | 0.003 | 0.080 | 0.140 | 0.060 | 0.000 | 0.000 | 1.057 | 0.027 | 0.018 | 1.489 | 0.053 | **0.042** |
| I_i15 | 0.007 | 0.075 | 0.136 | 0.450 | 0.010 | 0.005 | 0.795 | 0.032 | 0.021 | 0.816 | 0.033 | 0.025 |
| R_CHU | 0.080 | **0.360** | 0.063 | 0.241 | 0.073 | 0.016 | 0.477 | **0.286** | **0.087** | -0.012 | 0.000 | 0.000 |
| R_CTD | 0.010 | 0.029 | 0.133 | -0.281 | 0.006 | 0.003 | -0.432 | 0.014 | 0.009 | -0.351 | 0.009 | 0.007 |
| R_WTD | 0.010 | 0.042 | 0.132 | -0.277 | 0.006 | 0.003 | -0.640 | 0.032 | 0.020 | -0.220 | 0.004 | 0.003 |
| R_STD | 0.010 | 0.038 | 0.133 | -0.298 | 0.006 | 0.003 | -0.635 | 0.029 | 0.019 | 0.180 | 0.002 | 0.002 |
| R_NHU | 0.009 | 0.024 | 0.134 | -0.299 | 0.006 | 0.003 | -0.527 | 0.018 | 0.012 | -0.056 | 0.000 | 0.000 |
| R_NGP | 0.012 | 0.056 | 0.131 | -0.385 | 0.013 | 0.006 | -0.658 | 0.038 | 0.024 | 0.241 | 0.005 | 0.004 |
| R_SGP | 0.013 | 0.057 | 0.130 | -0.275 | 0.008 | 0.003 | -0.671 | 0.045 | 0.028 | 0.212 | 0.004 | 0.003 |
| P_Low | 0.004 | **0.427** | 0.139 | 3.706 | **0.385** | **0.189** | -1.223 | 0.042 | 0.028 | 0.172 | 0.001 | 0.001 |
| P_Mod | 0.008 | **0.156** | 0.135 | 1.615 | **0.148** | **0.071** | -0.313 | 0.006 | 0.004 | -0.182 | 0.002 | 0.001 |
| P_Av | 0.114 | **0.349** | 0.028 | -0.237 | **0.226** | 0.023 | -0.126 | 0.064 | 0.009 | -0.122 | 0.060 | 0.010 |
| P_Hi | 0.016 | **0.319** | 0.127 | -0.062 | 0.000 | 0.000 | 1.328 | 0.222 | **0.136** | 0.875 | **0.097** | **0.069** |
| P_Ext | 0.001 | 0.018 | 0.142 | 1.484 | 0.013 | 0.007 | 0.446 | 0.001 | 0.001 | 0.779 | 0.004 | 0.003 |
| L_Low | 0.135 | 0.052 | 0.008 | 0.018 | 0.006 | 0.000 | -0.039 | 0.026 | 0.001 | -0.035 | 0.021 | 0.001 |
| L_Mod | 0.008 | 0.051 | 0.135 | -0.294 | 0.005 | 0.002 | 0.679 | 0.026 | 0.017 | 0.600 | 0.020 | 0.015 |
| L_Av | 0.000 | 0.001 | 0.143 | -0.496 | 0.000 | 0.000 | 0.252 | 0.000 | 0.000 | 0.654 | 0.001 | 0.001 |
| L_Hi | 0.000 | 0.000 | 0.143 | -0.675 | 0.000 | 0.000 | 0.231 | 0.000 | 0.000 | 0.282 | 0.000 | 0.000 |
| D_Low | 0.139 | **0.547** | 0.004 | -0.118 | **0.502** | 0.007 | 0.035 | 0.044 | 0.001 | -0.006 | 0.001 | 0.000 |
| D_Av | 0.004 | **0.544** | 0.139 | 4.247 | **0.499** | **0.245** | -1.245 | 0.043 | 0.029 | 0.235 | 0.002 | 0.001 |
| D_Hi | 0.000 | 0.005 | 0.143 | 4.347 | 0.003 | 0.001 | -2.973 | 0.001 | 0.001 | -1.971 | 0.001 | 0.000 |
| E_Low | 0.000 | 0.015 | 0.143 | 3.939 | 0.010 | 0.005 | -2.556 | 0.004 | 0.003 | -0.870 | 0.001 | 0.000 |
| E_Mod | 0.025 | **0.575** | 0.118 | 1.590 | **0.539** | **0.224** | -0.400 | 0.034 | 0.019 | -0.100 | 0.002 | 0.001 |
| E_Av | 0.117 | **0.577** | 0.025 | -0.342 | **0.542** | **0.049** | 0.086 | 0.034 | 0.004 | 0.019 | 0.002 | 0.000 |
| E_Hi | 0.000 | 0.006 | 0.143 | -0.445 | 0.000 | 0.000 | 0.944 | 0.001 | 0.001 | 1.654 | 0.004 | 0.003 |

*Note*: Measures with relatively high values are emphasized in the table.

The total inertia considering the indicator matrix with only the 43 columns is (43/7–1)=5.1429. The percentages of the total inertia accounted for by the 3 leading axes are: $\mu_1^2$=0.283 (5.5%), $\mu_2^2$=0.208 (4.0%), $\mu_3^2$=0.178 (3.5%). The 'quality' measures and the coordinates for the predictive maps are given in Table 9 and for the supplementary points in Table 10. The 0.291 PROC coordinate on Axis 1 for example, is the weighted average of the Axis 1 coordinates given in Table 9 using the PROC average row profile values as a weighting scheme. Based on this interpretation and the fairly high QLT values 'OK firms' are still represented by the origin, while 'BRUPT firms' mostly come from the categories close to –0.283, 0.745, 0.688 on the respective axes and 'PROC firms' belong to the categories with coordinates near 0.291, 0.411, –0.102.

Table 10

*Supplementary profiles (centroids) of groups OK, BRUPT, PROC*

| NAME | QLT | FACTOR AXIS 1 | COR2 1 | FACTOR AXIS 2 | COR2 2 | FACTOR AXIS 3 | COR2 3 |
|---|---|---|---|---|---|---|---|
| OK | 0.721 | 0.001 | 0.050 | 0.001 | 0.321 | -0.001 | 0.350 |
| BRUPT | 0.721 | -0.296 | 0.050 | -0.748 | 0.321 | 0.781 | 0.350 |
| PROC | 0.740 | 0.291 | 0.233 | -0.426 | 0.499 | -0.054 | 0.008 |

Thus, the predictive categories associated with category OK are: F_LLC, I_i4, I_i6, I_i7, I_9, I_i10, R_CHU, R_CTD, L_Low, D_Low, E_Av. Further, the predictive categories associated with category BRUPT based on Axis1 and Axis 2 are: I_i2, R_WTD, R_STD, R_NHU, R_NGP, R_SGP, and based on Axis1 and Axis 3 are:L_Mod, L_Av.

As mentioned earlier, a single firm can also be classified by its projection on the predictive map. Apparently, because we have 7 predictor variables any firm's row profile (as its weighting scheme) contains a value of 1/7 at each column position that this firm belongs to and a zero anywhere else. Hence, only the column coordinates associated with the firm concerned play a role in an individual's prediction. Once the firm's coordinates are given, we can compare them with the centroid of any supplementary category.

For example the first coordinate of a firm with F=LLC, I=i1, R=CHU, P=Low, L=Low, D=High, E=Low profile is calculated as the simple average of FACTOR_1 the second coordinate is the simple average of FACTOR_2 and the third coordinate is the simple average of FACTOR_3 averaged on the corresponding categories only as follows:

$$\mu_1 \cdot \text{FACTOR\_1} = (-0.249 - 0.817 + 0.241 + 3.706 + 0.018 + 4.347 + 3.939) / 7 = 1.5978$$
$$\mu_2 \cdot \text{FACTOR\_2} = (-0.206 - 2.422 + 0.477 - 1.223 - 0.039 - 2.973 - 2.556) / 7 = -1.2774$$
$$\mu_3 \cdot \text{FACTOR\_3} = (-0.362 + 2.929 - 0.012 + 0.172 - 0.035 - 1.971 - 0.870) / 7 = -0.0213$$

and the standardized coordinates are:

$$\text{FACTOR\_1} = 1.5978 / 0.283^{1/2} = 3.003$$
$$\text{FACTOR\_2} = -1.2774 / 0.208^{1/2} = -2.801.$$
$$\text{FACTOR\_3} = -0.0213 / 0.178^{1/2} = -0.050.$$

*Figure 4. Map of the predictive variables by Axes 1,2*
*X*=5.50 %, *Y*=4.04 %

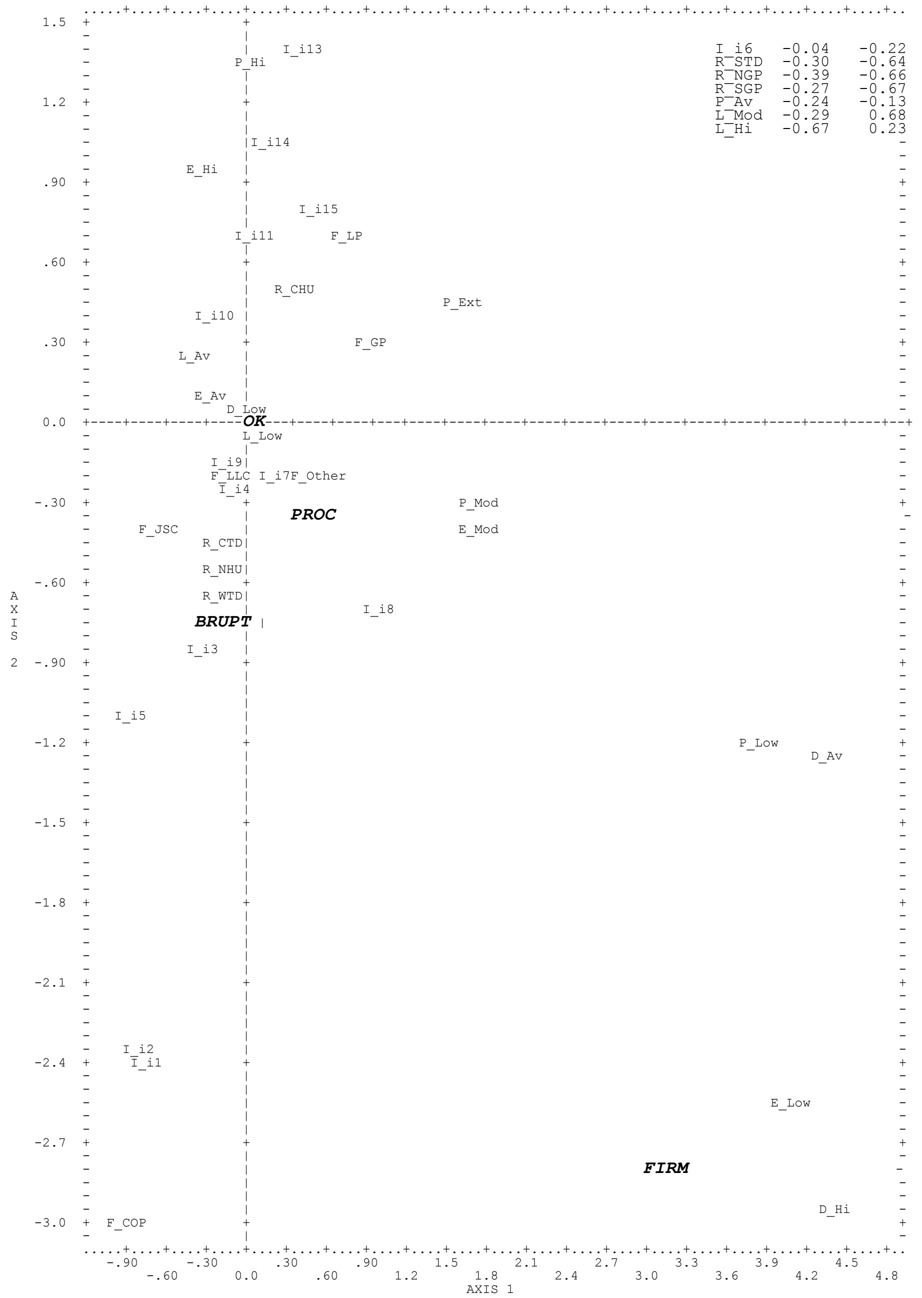


*Figure 5. Map of the predictive variables by Axes 1, 3*
*X*=5.50 %, *Y*=3.46 %

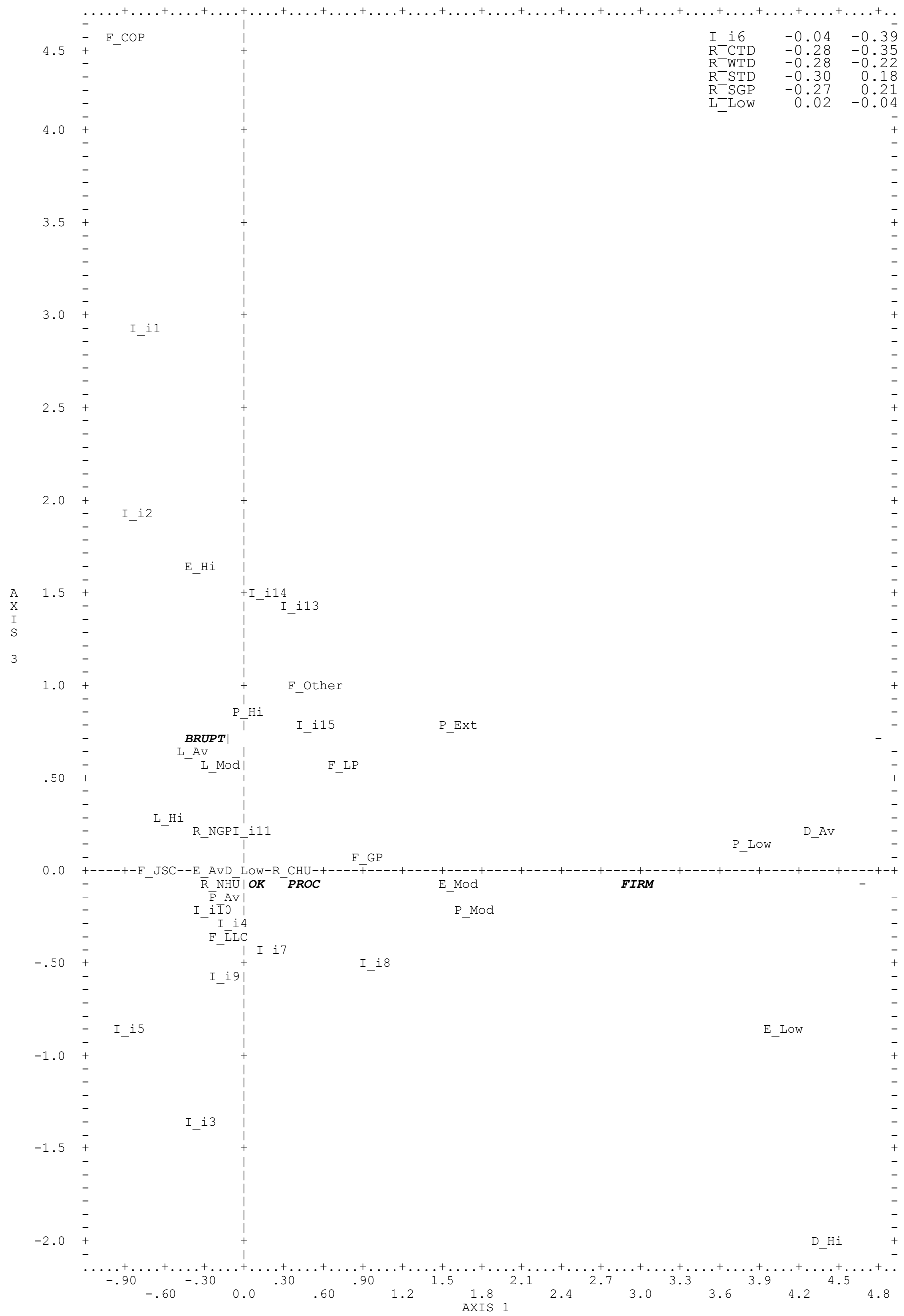
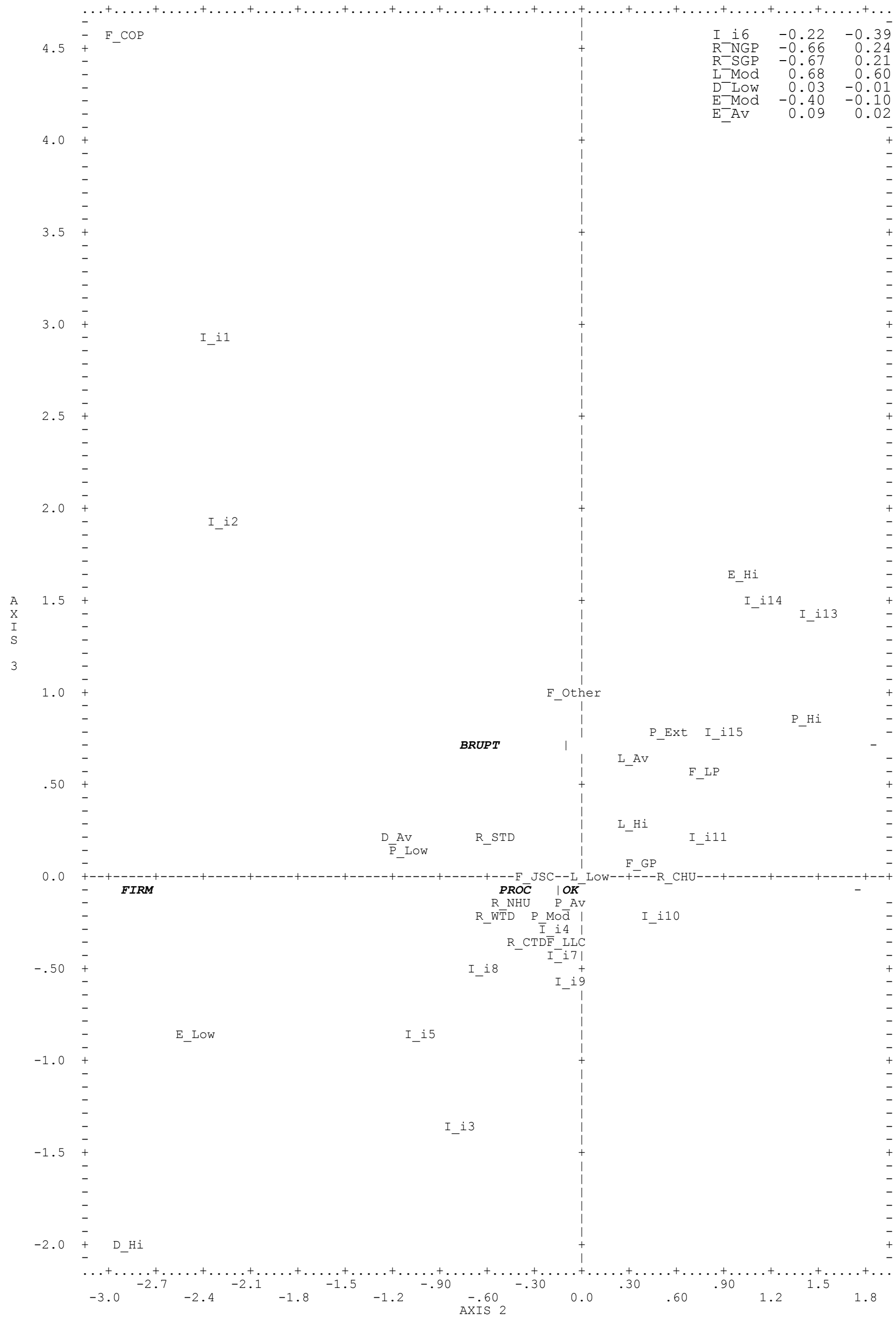


*Figure 6. Map of the predictive variables by Axes 2,3*
*X*=4.04 %, *Y*=3.46 %



It should be noted, that L=Low (the lowest category of liquidity) could be omitted from the calculation leaving the factor scores calculated almost unchanged. Plotting this profile on Figure 4, 5, 6 serves for a classification of the firm of interest. According to these figures a clear OK, PROC, BRUPT line can be explored and a limited liability company from Central Hungary and from industry 1, with low profitability, low liquidity, high debt ratio and low equity ratio (labelled FIRM) exhibits extreme coordinates in the direction of those who are currently bankrupt.

REFERENCES

DIXON, W. J. (chief editor) (1992): *BMDP statistical software manual*. Vol. 2, University Press of California, Berkely, Los Angeles, Oxford.

GREENACRE, M. J. (1984): *Theory and application of correspondence analysis*. Academic Press, Inc., London.

HIGGS, N. T. (1990): Practical and innovative uses of correspondence analysis. *The Statistician*, Vol. 40. p. 183–194.

# HETEROSCEDASTICITY AND EFFICIENT ESTIMATES OF BETA

JÓZSEF VARGA[1] – GÁBOR RAPPAI[2]

This study investigates the presence of conditional heteroscedasticity in the market model residual terms and the efficiency of beta estimates. Nonnormality and heteroscedasticity in the market model residual terms make the estimators inefficient and some of the significance tests invalid. An extension of the Autoregressive Conditionally Heteroscedastic (ARCH) model, the Bollerslev's Generalized Autoregressive Conditionally Heteroscedastic (GARCH) model, is applied to a sample composed of securities traded at the Budapest Stock Exchange, which allows us to test whether the conditional heteroscedasticity, mainly observed in the United States market, is also present in the Hungarian stock market.

**KEYWORDS:** Conditional heteroscedasticity; Beta estimates; GARCH models.

In the terminology of the capital asset pricing model (CAPM), beta is a measure or price of risk that arises from the reasonable and widespread idea that changes in stock returns are directly related to market changes. It is the difference between the expected rate of return on market portfolio and the riskfree rate of return. The equation describing this relationship has been developed by *Sharpe* (1963) and is known as the *market model*. The market model is a simple statistical model which relates the return of any given security to the return of the market portfolio. The model's linear specification follows from the assumed joint normality of asset returns. For any security $i$ we have

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$
$$\mathrm{E}\left[\varepsilon_{it}\right] = 0 \qquad \mathrm{Var}\left[\varepsilon_{it}\right] = \sigma^2_{\varepsilon_i}, \qquad /1/$$

where

$R_{it}$ is the random return on stock $i$ in period *t,*

$R_{mt}$ is the random return on the market index in period *t,*

$\alpha_i$ is the component of stock $i$ 's return that is independent of the market performance,

[1] Professor at the University of Sciences Pécs.
[2] Associate professor, at the University of Sciences Pécs.

$\beta_i$ or beta is the measure of the expected change in $R_{it}$ given change in $R_{mt}$ ,

$\varepsilon_{it}$ is the random disturbance term with an expected value of zero and variance of $\sigma^2_{\varepsilon_i}$ .

Equation /1/ is frequently used to forecast stock returns. As the future returns are unknown, in practice it is necessary to rely on estimates of the model parameters based on historical data, that is

$$\hat{R}_{it} = \hat{\alpha}_i + \hat{\beta}_i R_{mt} , \qquad /2/$$

where $R_{mt}$ denotes the actual return of the market index regarding it as the proxy of the market portfolio, $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the estimates of $\alpha_i$ and $\beta_i$ respectively.

When using the ordinary least squares (OLS) technique, which generates best linear unbiased estimates (BLUE), the beta estimates are given by the following formula

$$\hat{\beta}_i = \frac{\sigma_{im}}{\sigma^2_m} = \frac{\mathrm{Cov}(R_i, R_m)}{\mathrm{Var}(R_m)} , \qquad /3/$$

widely used in finance. In the Sharpe model the endogeneous variables (individual returns) are not independent, what is more they partly compose the exogeneous variable (market portfolio return). Thus, this is a multivariate regression model consisting of non-independent equations. Estimating these equations separately, the estimates probably will contain certain SUR bias, but it should also be remembered that in the original Sharpe model the market return is present and not the value of the market portfolio (or as its proxy the index value) and the market return is not a linear combination of the individual returns.

The ordinary method assumes that the disturbance term is *white noise*, that is, conditions of normality with zero mean, finite and constant through time (homoscedastic) variance, and universal uncorrelation are hold. However a number of studies have raised questions on the validity of the market model to estimate the systematic risks of financial assets using the OLS technique. It has been shown that some of the assumptions such as homoscedasticity do not always hold. The most important implications of heteroscedasticity are:

*1*. The OLS estimators will be inefficient, since they will not have the minimum variance in the class of unbiased estimators. This fact can partly explain the nonstability of beta estimates and makes impossible to use past values of betas for forecasting their future values. So the accuracy of beta estimates also can not be evaluated in a correct way. (*Blume*; 1971, *Levy*; 1971, *Theil*; 1971, *Lin–Chen–Boot*; 1992).

*2*. Significance hypothesis tests of the estimates will be performed with a higher type I error than it is assumed, since the estimated covariance matrix will be biased. In similar way, other tests, based on homoscedasticity, e. g., the Chow test for parameter stability will no longer be valid.

*3*. The coefficient of determination $R^2$ will decrease, wich means that systematic risk will be understated, while diversifiable risk will be overstated. As *Fisher* and *Kamin* state (*Fisher–Kamin*; 1985, p. 129), errors in beta estimates are the equivalent of extra non-systematic individual risks.

For these reasons, it is necessary to take heteroscedasticity explicitly into account. Although many of the previous studies consider it in the CAPM tests, only a few exceptions investigate this question in the estimation of betas with the market model. *Miller* and *Scholes* (1972), *Brenner* and *Schmidt* (1975), *Martin* and *Klemkovsky* (1975), *Belkaui* (1977), *Brown* (1977), and *Bey* and *Pinches* (1980) find evidences of heteroscedasticity in the market model. The previously listed authors use a wide variety of methods: from simple analysis of scatter diagrams and regressions, to the Bartlett, the Glejser, or the Goldfeld-Quandt tests. However, *Giaccotto* and *Ali* (1982) point out that unconditional acceptance of that evidence can not be advisable, among other reasons, because the tests are not reliable if regression residuals are non-normal. This is a very common case, as probability distributrion of asset returns are usually markedly leptokurtic (see, for example, *Varga*; 1998). But apart from this evidence, rarely has literature dealt with the estimation of beta explicitly considering heteroscedasticity. We mention the following exceptions. *Schwert* and *Seguin* (1990) apply the weighted least squares (WLS) technique, instead of the OLS one, to estimate betas. This procedure requires the introduction of an exogenous variable – normally, the market return – in order to predict the residual variance and takes into account unconditional heteroscedasticity. *Bera*, *Bubnys* and *Park* (1988), *Diebold*, *Im* and *Lee* (1988) and *Morgan* and *Morgan* (1987) use the Autoregressive Conditionally Heteroscedastic (ARCH) model of *Engle* (1982), that is, they estimate betas considering residual variance of today depending upon yesterday's error. This model is used by Schwert and Seguin, who find similar results to those of the WLS regression. Finally, *Corhay* and *Rad* (1996) apply a market model which accounts for GARCH (Generalized Autoregressive Conditionally Heteroscedastic) effects.

The following part of this study is divided into four sections. First, the applicability of the GARCH models to capture the serial correlation of volatility in financial time series is discussed. The second section presents the data used for model specification. In the third section the empirical findings of normality and heteroscedasticity are presented and discussed. The final section of the paper contains brief conclusions.

## THE GARCH MODEL

In order to concentrate on volatility of a time-series $\xi_{t+1}$, we assume that $\xi_{t+1}$ is an innovation, that is, it has zero mean conditional on time *t* information. In an application in finance, $\xi_{t+1}$ might be the innovation in an asset return. We define $\sigma_t^2$ to be the time $t$ conditional variance of $\xi_{t+1}$ or equivalently the conditional expectation of $\xi_{t+1}^2$. It is also assumed that conditional on time $t$ information, the innovation is normally distributed: $\xi_{t+1} \sim N(0,\sigma_t^2)$. The unconditional variance of the innovation, $\sigma^2$, is just the unconditional expectation of $\sigma_t^2$. (For a series with a time-varying conditional mean, the unconditional variance is not the same as unconditional expectation of the conditional variance. This result holds only because we are working with an innovation series that has a constant (zero) conditional mean).

To capture the serial correlation of volatility in financial time series, *Engle* (1982) proposed the class of ARCH models. These regard conditional variance as a distributed lag of past squared innovations:

$$\sigma_t^2 = \omega + \theta(L)\,\xi_t^2, \tag{/4/}$$

where $\theta$ is a polynomial in the lag operator. To keep the conditional variance positive, $\omega$ and the coefficients in $\theta(L)$ must be non-negative.

As a possible way to model persistent movements in volatility without estimating a large number of coefficients in a high-order polynomial $\theta(L)$, *Bollerslev* (1986) suggested the GARCH model:

$$\sigma_t^2 = \omega + \rho(L)\,\sigma_{t-1}^2 + \theta(L)\,\xi_t^2, \tag{/5/}$$

where $\rho(L)$ is also a polynomial in the lag operator. This is called a $\text{GARCH}\,(p, q)$ model, when the order of polynomial $\rho(L)$ is $p$ and the order of the polynomial $\theta(L)$ is $q$. The most commonly used model in the GARCH class is the simple $\text{GARCH}\,(1, 1)$ which can be written as

$$\begin{aligned}\sigma_t^2 &= \omega + \rho\,\sigma_{t-1}^2 + \theta\,\xi_t^2 = \omega + (\rho+\theta)\sigma_{t-1}^2 + \theta\,(\xi_t^2 - \sigma_{t-1}^2) = \\ &= \omega + (\rho+\theta)\,\sigma_{t-1}^2 + \theta\,\sigma_{t-1}^2\,(\varepsilon_t^2 - 1).\end{aligned} \tag{/6/}$$

The term $(\xi_t^2 - \sigma_{t-1}^2)$ in the second equality in /6/ has zero mean, conditional on time $t$–1 information, and can be thought of as the shock to volatility. The coefficient $\theta$ measures the extent to which a volatility shock today feeds through into the next period's volatility, while $(\rho+\theta)$ measures the rate at which this effect dies out over time. The third equality in /6/ rewrites the volatility shock as $\sigma_{t-1}^2\,(\varepsilon_t^2 - 1)$, the square of a standard normal variable less its mean, i.e. a demeaned $\chi^2$ (1) random variable, multiplied by past volatility $\sigma_{t-1}^2$.

The $\text{GARCH}\,(1, 1)$ model can also be written in terms of its implications for squared innovations $\xi_{t+1}^2$. We have then

$$\xi_{t+1}^2 = \omega + (\rho+\theta)\xi_t^2 + (\xi_{t+1}^2 - \sigma_t^2) - \rho(\xi_t^2 - \sigma_{t-1}^2). \tag{/7/}$$

This last representation makes it clear that the $\text{GARCH}\,(1, 1)$ model is an $\text{ARMA}\,(1, 1)$ model for squared innovations, but the standard $\text{ARMA}\,(1, 1)$ model has homoscedastic shocks, while in this model the shocks $(\xi_{t+1}^2 - \sigma_t^2)$ are themselves heteroscedastic.

In the GARCH (1, 1) model it is easy to construct multiperiod forecasts of volatility. When $\rho + \theta < 1$, the unconditional variance of $\xi_{t+1}$, or equivalently the unconditional expectation of $\sigma_t^2$, is $\omega/(1-\rho-\theta)$.

The GARCH (1,1) model with $\rho + \theta = 1$ has a unit autoregressive root so that today's volatility affects forecasts of volatility into the indefinite future. It is therefore known as an integrated GARCH, or IGARCH (1,1) model (*Engle* and *Bollerslev*; 1986).

## THE DATA

In the model specification the daily closing prices of stocks traded at the Budapest Stock Exchange (BSE) for the period August 1998 to January 2000 (365 trading day) are used. Results are based on a sample containing 18 individual securities as well as the stock compound index (BUX). The stocks under investigation (their names and codes used in the analysis are shown in the columnar composition) were selected because of their high volume (nearly 90 percent of the trading volume of the BSE) and frequency of trading in the last years. In the investigated time horizont of the analysis – practically without any changes – these stocks formed the stock index. This confirms the suitability of the sample as an adequate representation of the Hungarian stock market.

*The stocks under investigation and their codes used in the study*

| Code | Stock | Code | Stock |
|---|---|---|---|
| BCHEM | Borsodchem Rt. | NABI | NABI Rt. |
| DANUB | Danubius Rt. | OTP | OTP Bank Rt. |
| DEMASZ | Démász Rt. | PPLAST | Pannonplast Rt. |
| EGIS | Egis Rt. | PICK | Pick Szeged Rt. |
| FOTEX | Fotex Rt. | PGAZ | Primagáz Rt. |
| GRABO | Graboplast Rt. | RABA | RÁBA Rt. |
| IEB | Inter-Europa Bank Rt. | RICHTER | Richter Gedeon Rt. |
| MATAV | Matáv Rt. | TVK | TVK Rt. |
| MOL | MOL Rt. | ZALAKER | Zalakerámia Rt. |

Returns used to estimate the parameters of the market model were computed in the usual way by the formula

$$R_{it} = \frac{P_{it} - P_{i,t-1}}{P_{i,t-1}} \times \frac{365}{d_{t,t-1}},$$

where $P_{it}$ is the closing price of stock $i$ on day $t$ and $d_{t,t-1}$ denotes the real number of days between trading days $t-1$ and $t$. This transformation (mean and variance stabilization) results in mean and covariance stationarity and ergodicity of the return series to guarantee the validity of all the statistical tests containing as an assumption the stationarity of the time series under investigation. Return values computed by the previous formula approximate the log returns widely used in finance. The market return was determined by the changes of the stock index (BUX).

## THE EFFICIENCY OF BETA ESTIMATES, NORMALITY AND HETEROSCEDASTICITY OF THE RESIDUAL TERMS

As a first step of the empirical analysis the usually specified model (see equation /1/, white noise with random error) was estimated using the method of ordinary least squares (OLS), then tested the normality and heteroscedasticity of the residual terms. The normality test was performed by the Jarque-Bera statistic. For testing the heteroscedasticity the White test (*White*; 1980) was used. The results are summarized in Table 1.

Table 1

*Results of parameter estimation with the OLS technique*

| Stock | BETA* estimates | *p*-value | Jarque-Bera statistic | *p*-value | White statistic | *p*-value |
|---|---|---|---|---|---|---|
| BCHEM | 1.103<br>(23.28) | 0.000 | 154.84 | 0.000 | 16.90 | 0.000 |
| DANUB | 0.771<br>(15.06) | 0.000 | 100.80 | 0.000 | 60.90 | 0.000 |
| DEMASZ | 0.784<br>(19.64) | 0.000 | 514.36 | 0.000 | 51.60 | 0.000 |
| EGIS | 1.046<br>(18.05) | 0.000 | 477.96 | 0.000 | 10.90 | 0.000 |
| FOTEX | 0.658<br>(12.09) | 0.000 | 12 043.88 | 0.000 | 22.85 | 0.000 |
| GRABO | 0.852<br>(8.69) | 0.000 | 12 476.17 | 0.000 | 12.09 | 0.000 |
| IEB | 0.474<br>(9.03) | 0.000 | 438.06 | 0.000 | 2.28 | 0.104 |
| MATAV | 0.735<br>(27.39) | 0.000 | 351.33 | 0.000 | 67.83 | 0.000 |
| MOL | 0.834<br>(28.69) | 0.000 | 11.71 | 0.003 | 6.06 | 0.003 |
| NABI | 0,983<br>(14.8) | 0.000 | 831.10 | 0.000 | 6.58 | 0.002 |
| OTP | 1.189<br>(33.11) | 0.000 | 729.43 | 0.000 | 20.43 | 0.000 |
| PANNONPLAST | 0.847<br>(12.91) | 0.000 | 630.22 | 0.000 | 3.89 | 0.021 |
| PICK | 0.928<br>(15.44) | 0.000 | 16 940.09 | 0.000 | 6.35 | 0.002 |
| PRIMAGAZ | 1.034<br>(18.53) | 0.000 | 189.26 | 0.000 | 27.41 | 0.000 |
| RÁBA | 0.963<br>(17.98) | 0.000 | 543.77 | 0.000 | 12.26 | 0.000 |
| RICHTER | 1.522<br>(26.56) | 0.000 | 3 266.85 | 0.000 | 2.39 | 0.093 |
| TVK | 1,124<br>(19.69) | 0.000 | 1 467.73 | 0.000 | 3.48 | 0.032 |
| ZALAKERÁMIA | 1.074<br>(16.95) | 0.000 | 728.84 | 0.000 | 5.95 | 0.003 |

* *t* statistics in parentheses.

In the second step of the analysis, the estimation procedure was repeated using a GARCH(1,1) model for the error term. Results are presented in Table 2. Table 3 contains the estimated parameters of the GARCH(1,1) model and the *p*-values for the deviations from zero.

Table 2

*Estimates of betas, values of t-statistic, p-values, and the Jarque-Bera test values for individual securities using GARCH(1,1) model*

| Stock | BETA* estimates | *p*-value | Jarque-Bera statistic | *p*-value |
|---|---|---|---|---|
| BCHEM | 1.069 (24.94) | 0.000 | 131.69 | 0.000 |
| DANUB | 0.681 (13.56) | 0.000 | 67.25 | 0.000 |
| DEMASZ | 0.693 (25.63) | 0.000 | 164.51 | 0.000 |
| EGIS | 1.021 (23.63) | 0.000 | 631.21 | 0,000 |
| FOTEX | 0.576 (24.99) | 0.000 | 643.26 | 0.000 |
| GRABO | 0.654 (17.77) | 0.000 | 1932.64 | 0.000 |
| IEB | 0.414 (11.95) | 0.000 | 276.91 | 0.000 |
| MATAV | 0.717 (51.07) | 0.000 | 307.38 | 0.000 |
| MOL | 0.833 (45.02) | 0.000 | 6.42 | 0.040 |
| NABI | 0.672 (12.93) | 0.000 | 92.66 | 0.000 |
| OTP | 1.150 (57.09) | 0.000 | 88.89 | 0.000 |
| PPLAST | 0.874 (16.16) | 0.000 | 375.02 | 0.000 |
| PICK | 0.678 (16.13) | 0.000 | 528.00 | 0.000 |
| PGAZ | 1.026 (30.87) | 0.000 | 169.33 | 0.000 |
| RABA | 0.931 (37.42) | 0.000 | 291.82 | 0.000 |
| RICHTER | 1.349 (44.51) | 0.000 | 576.10 | 0.000 |
| TVK | 1.083 (19.75) | 0.000 | 2226.53 | 0.000 |
| ZALAKER | 0.823 (25.17) | 0.000 | 1380.39 | 0.000 |

* *t* statistics in parentheses.

Table 3

*The estimated parameters of the GARCH (1,1) model and the p-values for the deviances from zero*

| Stock | $\hat{\theta}$ | *p*-value | $\hat{\rho}$ | *p*-value | $\hat{\theta}+\hat{\rho}$ |
|---|---|---|---|---|---|
| BCHEM | 0.082 | 0.000 | 0.870 | 0.000 | 0.952 |
| DANUB | 0.049 | 0.011 | 0.916 | 0.000 | 0.965 |
| DEMASZ | 0.084 | 0.000 | 0.860 | 0.000 | 0.944 |
| EGIS | 0.191 | 0.012 | 0.509 | 0.008 | 0.700 |
| FOTEX | 1.074 | 0.000 | 0.303 | 0.000 | 1.377 |
| GRABO | 0.248 | 0.000 | 0.691 | 0.000 | 0.939 |
| IEB | 0.328 | 0.000 | 0.339 | 0.001 | 0.667 |
| MATAV | -0.038 | 0.000 | 0.119 | 0.847 | 0.081 |
| MOL | 0.141 | 0.010 | 0.673 | 0.000 | 0.814 |
| NABI | 0.077 | 0.000 | 0.910 | 0.000 | 0.987 |
| OTP | 0.175 | 0.000 | 0.757 | 0.000 | 0.932 |
| PPLAST | 0.411 | 0.000 | 0.311 | 0.000 | 0.722 |
| PICK | 0.239 | 0.000 | 0.576 | 0.000 | 0.815 |
| PGAZ | 0.131 | 0.000 | 0.284 | 0.183 | 0.415 |
| RABA | 0.336 | 0.000 | 0.451 | 0.000 | 0.787 |
| RICHTER | 0.191 | 0.000 | 0.793 | 0.000 | 0.984 |
| TVK | 0.058 | 0.000 | 0.837 | 0.000 | 0.895 |
| ZALAKER | 0.468 | 0.000 | 0.296 | 0.000 | 0.764 |

Evaluating the results the following can be stated.

*1*. The beta estimates based on both the OLS technique and the GARCH(1,1) adjusted model are the same from the view point of the risk evaluation with only one exception (ZALAKER) , being the estimated beta in the first case greater, and in the second case less than 1.

*2*. Based on the OLS estimates, it seems to be clear that in most of the models (16 out of 18) significant heteroscedasticity does exist.

*3*. Assuming the GARCH(1,1) model for the error term the estimates result in higher *t*-values than the ordinary method in 16 (out of 18) cases. (It should be noticed that all the beta estimates using even the ordinary or the GARCH(1,1) adjusted models are significantly different from zero.) It also should be emphasized that even in the case of GARCH specification the normality assumption of the residual variable does not hold, i. e., the increasing in *t*-values does not necessarily mean significant improvement.

*4*. The results of the normality test (Jarque-Bera test) also represent an improvement (in 15 out of 18 cases the test statistics are lower), but the residuals are not normally distributed.

*5*. The estimates of parameter $\alpha$ in the market model tends to be zero indicating the efficiency of the security market, because in an efficient market assets tend to flow to higher return securities or portfolios.

Calculations were repeated for portfolios in order to test whether some differences arose from grouping of individual stocks. Different groups of stocks were composed to test the influence of the size and composition of portfolios.

The investigation was conducted for three portfolios with different size and composition. Composition was determined on the basis of the stock's weights in the stock index. The weights are proportional to the size of capitalization. The portfolios under investigation are as follows:

*1.* PORT1: Consists of the most traded stocks (nearly half of the trading volume); MATAV, MOL, OTP, RICHTER, with the weights 1/4 all.

*2.* PORT2: A chemical industry's portfolio; BCHEM, GRABO, PPLAST, RICHTER, TVK, with proportions of 15-10-3-6-48-18 percents, respectively.

*3.* PORT3: A power industry's portfolio; DEMASZ, MOL, PGAZ, with weights of 30-60-10 percents, respectively.

Table 4

*Results of the portfolio analysis using the OLS technique*

| Portfolios | BETA* estimates | *p*-value | Jarque-Bera statistic | *p*-value | White statistic | *p*-value |
|---|---|---|---|---|---|---|
| PORT1 | 1.070 (68.94) | 0.000 | 639.89 | 0.000 | 7.51 | 0.001 |
| PORT2 | 1.290 (42.7) | 0.000 | 1072.71 | 0.000 | 8.47 | 0.000 |
| PORT3 | 0.820 (36.82) | 0.000 | 100.23 | 0.000 | 4.64 | 0.010 |

* *t* statistics in parentheses.

Table 5

*Results of the portfolio analysis using GARCH (1,1) model for the error term*

| Portfolios | Estimated BETA* | *p*-value | Jarque-Bera statistic | *p*-value |
|---|---|---|---|---|
| PORT1 | 1.094 (71.71) | 0.000 | 1330.69 | 0.000 |
| PORT2 | 1.261 (106.41) | 0.000 | 293.07 | 0.000 |
| PORT3 | 0.817 (51.52) | 0.000 | 71.94 | 0.000 |

* *t* statistics in parentheses.

Table 6

*Parameter estimates of the portfolios with the GARCH (1,1) adjusted model*

| Portfolios | $\hat{\theta}$ | *p*-value | $\hat{\rho}$ | *p*-value | $\hat{\rho}+\hat{\theta}$ |
|---|---|---|---|---|---|
| PORT1 | 0.109 | 0.000 | 0.848 | 0.000 | 0.957 |
| PORT2 | 0.282 | 0.000 | 0.620 | 0.000 | 0.902 |
| PORT3 | 0.169 | 0.003 | -0.236 | 0.326 | -0.067 |

These portfolios are different with respect to the number of individual securities composing the portfolios, as well as the individual securities in the compositions. Tables 4, 5, and 6 present the result of the analysis. As it can be seen, the findings for portfolios are keeping with those of individual securities. The estimates become more efficient in all the cases with minimum changes in betas, however normality does not hold.

## CONCLUSION

The present paper emphasizes the importance of the conditional heteroscedasticity in the market model residual terms. Non-normality and heteroscedasticity of those residual terms make the estimators inefficient and some significance tests invalid. Thus, it is necessary to take this matter into account in beta estimates, so that they become more accurate and reliable. There must also be pointed out that the results achieved for Hungarian stocks are similar to those of *Bera–Bubnys–Park* (1988) using the data of the United States stock market suggesting that the presence of conditional heteroscedasticity is a general problem in the market model on capital markets. In applications of the market model, as well as the more general CAPM, non-normality does not cause problems, because normality is a sufficient and not necessary condition for the theoretical model. It should be emphasized that non-normality confuses the validation of significance hypothesis tests for parameters.

## REFERENCES

BERA, A. – BUBNYS, E. – PARK, H. (1988): Conditional heteroscedasticity in the market model and efficient estimates of betas. *The Financial Review*, Vol. 23, No. 2, p. 201–214.

BEY, R. – PINCHES, G. (1980): Additional evidence of hetroscedasticity in the market model. *Journal of Financial and Quantitative Analysis*, Vol. 15, No. 2, p. 299–322.

BOLLERSLEV, T. (1986): Generalized autoregressive conditional heteroscedasticity. *Journal of Econometrics*, Vol. 31, No. 3, p. 307–327.

BRENNER, M. – SMIDT, S. (1975): *A simple model of non-stationarity of systematic risk*. Working Paper, University of New York, New York.

CORHAY, A. – RAD, A. (1996): Conditional heteroscedasticity adjusted market model and an event study. *The Quarterly Review of Economics and Finance*, Vol. 36. No. 4, p. 529–538.

DIEBOLD, F. – IM, J. – LEE, C. (1988): Conditional heteroscedasticity in the market. Board of the governors of the Federal Reserve System. *Finance and Economics Discussion Series*, No. 42.

ENGLE, R. (1982): Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica*, Vol. 50, No. 4, p. 987–1007.

ENGLE, R. – BOLLERSLEV, T. (1986): Modelling the persistence of conditional variances. *Econometric Review*, Vol. 5, p. 1–50.

FISHER, L. – KAMIN, J. (1985): Forecasting systematic risk: Estimates of „raw" beta to take account of the tendency of beta to change and the heteroscedasticity of residual returns. *Journal of Financial and Quantitative Analysis*, Vol. 20, No. 2, p. 127–149.

GIACCOTTO, C. – ALI, M. (1982): Optimum distribution-free test and further evidence of heteroscedasticity in the market model. *The Journal of Finance*, Vol. 37, No. 5, p. 1247–1257.

LEVY, R. (1971): On the short-term stationarity of beta coefficient. *Financial Analysits Journal*, Vol. 27, No. 6, p. 55–62.

LIN, W.– CHEN, Y. – BOOT, J. (1992): The dynamic and stochastic instability of betas: implications for forecasting stock returns. *Journal of Forecasting*, Vol. 11, No. 6, p. 517–541.

MARTIN, J. – KLEMKOSKY, J. (1975): Evidence of heteroscedasticity in the market model. *Journal of Business,* Vol. 48, No. 1, p. 81–86.

MILLER, M. – SCHOLES, M. (1972): Rates of return in relation to risk: A re-examination of some recent findings. In: JENSEN, M. C. (ed.): *Studies in the theory of capital markets*. Praeger, New York, p. 47–78.

MORGAN, A. – MORGAN, I. (1987): Measurement of abnormal returns from small firms. *Journal of Business and Economic Statistics*, Vol. 5. No. 1, p. 121–129.

SCHWERT, G. – SEGUIN, P. (1990): Heteroscedasticity in stock returns. *The Journal of Finance*, Vol. 45, No. 4, p. 1129–1155.

SHARPE, W. (1964): Capital asset prices: a theory of market equilibrium under conditions of risk. *The Journal of Finance*, Vol. 19, No. 3, p. 425–442.

THEIL, H. (1971): *Principles of Econometrics*. Wiley, New York.

VARGA J. – RAPPAI G. (1997): Applicability of the CAPM on the Hungarian Stock Market. In: ZOPOUNIDIS, C. (ed.), *New operational approaches for financial modelling.* (Contributions to Management Science), Physica Verlag, Heidelberg-New York, p. 133–143.

VARGA J. (1998): On distribution for stock returns. In: PARDALOS, P. – ZOPOUNIDIS, C. (eds.) *Managing in uncertainty: theory and practice.* Kluwer Academic Publishers, Dordrecht, p. 139–151.

WHITE, H. (1980): A heteroscedasticity-consistent covariance matrix and a direct test for heteroscedasticity. *Econometrica,* Vol. 48, No. 4. p. 817–838.

# STOCK RETURN DISTRIBUTION AND MARKET CAPITALISATION

PÉTER LUKÁCS[1]

The paper focuses on the relationship between the distribution of stock returns and the market capitalisation of stocks. The analysis is based on the returns of 21 stocks listed on the Budapest Stock Exchange (BSE). First, these stocks are ranked according to their market capitalisation, and then different moments of distribution as well as normalised moments such as skewness and kurtosis are calculated. Results are evaluated both by charts and rank-correlation. A significant relationship is demonstrated between the distribution of returns and the market capitalisation.

KEYWORS: Distribution; Skewness; Kurtosis.

The basic issue of financial modelling, and specifically the modelling of stock prices, is how to approach the uncertainty characterising the prices of different stocks, indices and derivatives. The treatment of uncertainty may result in difficulties both in theory and in methodology. Analysing the distributions of returns and setting up different autoregressive volatility models there are two very popular methods to treat the previous uncertainty. The current paper focuses on the first i.e. the distribution-based approach of uncertainty.

*Bachelier* derived the first basic model of the distribution of stock returns (*Bachelier*; 1900). The lognormal model has a long and illustrious history. For other reasons the lognormal model has become the workhorse of the financial asset pricing literature.

Doubts in connection with the normality of stock returns appeared relatively early in scientific literature. Empirical research revealed extreme kurtosis and, consequently, extremely fat tails in most stock returns. Stable Pareto-Lèvy or stable Paretian distributions (*Lévy*; 1925) offered an excellent opportunity to model these phenomena and have been very popular to model fat tail problems ever since. The stable distributions are natural generalizations of the normal one in that, as their name suggests, they are stable under addition, i. e., a sum of stable random variables is also a stable variable. However nonnormal stable distributions have more probability mass in the tail areas than the normal. In fact, the nonnormal stable distributions are so fat-tailed that their variance and all higher moments are infinite. Sample estimates of variance or kurtosis for random variables with

[1] PhD student of the University of Sciences Pécs.

these distributions will not converge as the sample size increases, but will tend to increase indefinitely.

Closed-form expressions for the density functions of stable random variables are available for only three special cases: the normal, the Cauchy and the Bernoulli cases. *Lèvy* derived the following explicit expression for the logarithm of the characteristic function $\varphi(t)$ of any stable random variable $X$:

$$\log\varphi(t) \equiv \log \mathrm{E}\left[e^{itX}\right] = i\delta t - \gamma\left|t\right|^{\alpha}\left[1 - i\beta\,\mathrm{sgn}(t)\tan\left(\alpha\pi/2\right)\right],$$

where

$(\alpha,\beta,\gamma,\delta)$ – are the four parameters that characterise each stable distribution,
$\alpha \in (0,2]$ – is the exponent index,
$\beta \in (-\infty,\infty)$ – is the skewness index,
$\gamma \in (0,\infty)$ – is the scale parameter, and
$\delta \in (-\infty,\infty)$ – is said to be the location parameter.

When $\alpha = 2$, the stable distribution reduces to normal. As $\alpha$ decreases from 2 to 0, the tail areas of the stable distribution become increasingly ‘fatter’ than the normal. When $\alpha \in (1,2)$, the stable distribution has a finite mean given by $\delta$, but when $\alpha \in (0,1]$, even the mean is infinite. The parameter $\beta$ measures the symmetry of the stable distribution; when $\beta = 0$ the distribution is symmetric, and when $\beta > 0$ (or $\beta < 0$) the distribution is skewed to the right (or left). When $\alpha = 1$ és $\beta = 0$ we have the Cauchy distribution, and when $\alpha = 1/2,\ \beta = 1,\ \gamma = 1$ and $\delta = 0$ we have the Bernoulli distribution.

A very good evaluation of the application of Pareto-Lévy distributions to model stock returns can be found in the papers of *Varga* (1999, 2001) which also contain the results of empirical research. The results of empirical research on the Hungarian stock market are summarised in the work of *Rappai* and *Varga* (1997).

Research focuses on estimating the parameter $\alpha$ out of the four parameters of Pareto-Lévy distributions. This parameter characterises the ‘peakedness’ of the central part of the distribution and consequently the fatness of tails. The Hill method – to be detailed later – leads to the consistent and the most efficient estimation of the reciprocal value of the $\alpha$ parameter. This procedure allows us to model the phenomenon of ‘peakedness’ without having presume the normality of the theoretical distribution. In addition to the Hill method, plenty of procedures can be applied to model the fat tail problem; *t*-distributions with different degrees of freedom, mixture of normal distributions, etc. The literature of modelling fat tail problem does not have a long history; (*Koedjik–Schafgans–de Vries*; 1990, *Koedjik–Stork–de Vries*; 1992), (*Kähler*; 1993), (*Koedjik–Kool*; 1993).

This paper investigates the relationship between capitalisation and the previously detailed kurtosis problem using stocks listed on Budapest Stock Exchange (BSE). While the existence of extra kurtosis in the case of stock and index return distributions is widely accepted by researchers, the problem of asymmetry divides them significantly. This paper also tests the relationship between capitalisation and asymmetry. Additionally the paper also explores a third issue. How does the risk of a risk avoiding investor change as he/she rearranges his/her portfolio towards less capitalised stocks with respect to dispersion, asymmetry and peakedness.

## DATA AND DEFINITION OF STOCK RETURNS

The research reported in the paper involves the closing prices of 21 stocks listed on the BSE. Stock returns are calculated according to the following formula:

$$r_t = \ln (P_t / P_{t-1}) = \ln P_t - \ln P_{t-1}, \qquad /1/$$

where

$r_t$ – is the daily return in time *t,* and

$P_t$ – is the stock price in time *t*.

According to equation /1/ daily returns (later returns) are calculated for all the analysed 21 stocks listed on the BSE. The distribution-characteristics of the returns are compared to the rank-position of market capitalisation. The first daily closing price is as of 1st April 1997 if the given stock had already been listed at that time. In all other cases the first daily closing price was as of the first trade-day of the given stock. The last closing prices are as of 9th May 2001. Consequently the number of returns is 1023 in most cases, and the minimum number of returns is 843 (in the case of Rába Magyar Vagon Rt., the latest listed stock).

The main consideration in stock selection was to involve the six ‘market-leader’ stocks of the BSE (Matáv, MOL, OTP Bank, Richter Gedeon, TVK, BorsodChem). Other stocks were selected randomly in order to represent all the capitalisation segments of the BSE.

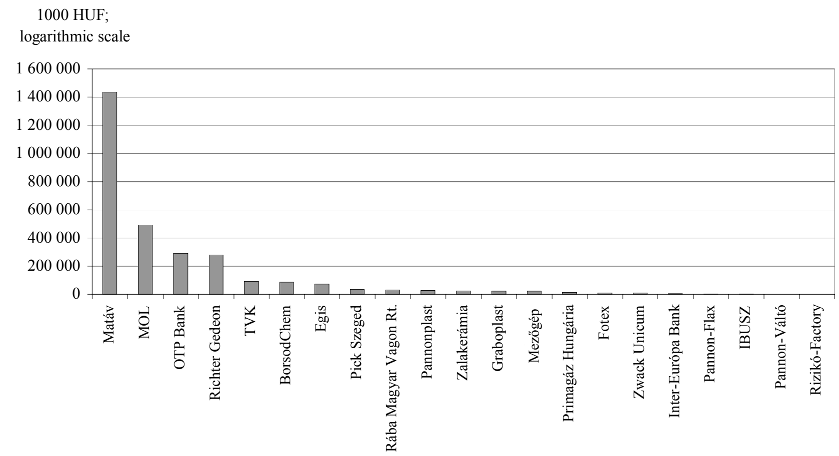
Multiplying the simple arithmetic average of prices performed the calculation of market capitalisation for a given stock and the volume introduced to the BSE on 9th May, 2001.

The following columnar composition shows the 21 analysed stocks ranked by their market capitalisation.

*Stocks ranked by their market capitalisation*

| Stock | Capitalisation (HUF) | Stock | Capitalisation (HUF) |
|---|---|---|---|
| Matáv | 1 437 621 758 438 | Graboplast | 23 114 041 039 |
| MOL | 492 286 344 000 | Mezőgép | 22 988 926 080 |
| OTP Bank | 291 126 226 500 | Primagáz Hungária | 13 931 460 000 |
| Richter Gedeon | 279 475 607 681 | Fotex | 13 326 457 370 |
| TVK | 90 677 577 007 | Zwack Unicum | 11 339 800 000 |
| BorsodChem | 85 602 570 878 | Inter-Európa Bank | 7 199 055 825 |
| Egis | 72 675 600 953 | Pannon-Flax | 2 406 904 923 |
| Pick Szeged | 35 439 942 545 | IBUSZ | 1 129 562 885 |
| Rába Magyar Vagon Rt. | 33 003 309 913 | Pannon-Váltó | 1 017 275 000 |
| Pannonplast | 27 227 522 892 | Rizikó-Factory | 392 411 244 |
| Zalakerámia | 23 727 071 258 | | |

*Figure 1. Stocks ranked by their market capitalisation*




The columnar composition and Figure 1 clearly show that capitalisation decreases at an increasing pace, e.g., the capitalisation of the first, the most capitalised stock, exceeds the capitalisation of the next ten stocks. (In Figure 1 we would like to illustrate the tendency only. For a more accurate analysis different measures of concentration can be used.)

## RISK AND CAPITALISATION

Asset price theories describe the risk of an asset by using the second and higher central moments of the return distribution (*Bodie–Kane–Marcus*; 1996). In the case of even moments (second, fourth…), increasing values imply increasing risk. In the case of odd moments (third, fifth…), the plus or minus sign of the values indicates whether extra-risk arises from the asymmetry of the distribution. The three-moment based portfolio selection model developed by *Gamba* and *Rossi* (1998) suggests adding a third component to the existing two components of the basic CAPM model (Capital Asset Pricing Model) in order to represent the favourable–unfavourable effect of the asymmetry of distributions. Positive skewness i.e., left asymmetry is favourable for a risk-avoiding investor, as the probability of realising huge negative returns is less. In case we accept the normality of the stock return distribution, risk can be interpreted as the second central moment, i.e., variance. The relationship between the range of dispersion and capitalisation is demonstrated in Figure 2, and the relationship between the standard deviation and capitalisation is shown in Figure 3.

Figures 2 and 3 show that both the ranges of dispersion and the standard deviation tends to increase as capitalisation decreases. Regarding the increasing pace of decreasing capitalisation values the linear trend fitted to the data naturally does not imply a linear relationship between the two indicators and the capitalisation values. A Bartlett test performed on the basis of the variances of the examined stock returns unquestionably proves that standard deviations differ from each other significantly. (Test value: 3155.4, critical value: 31.41).

*Figure 2. The range of dispersion with respect to capitalisation*
(percent)

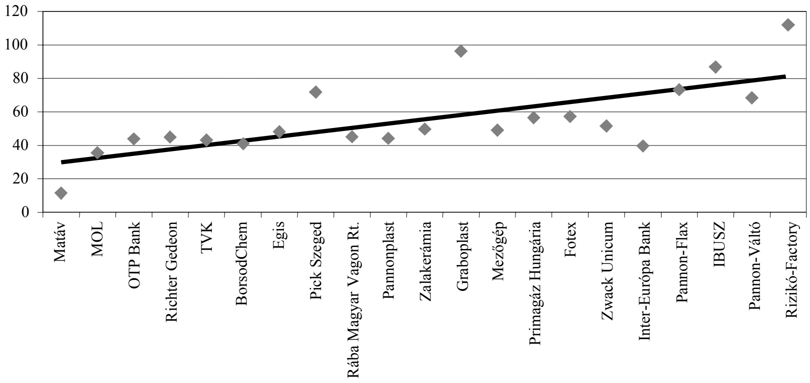
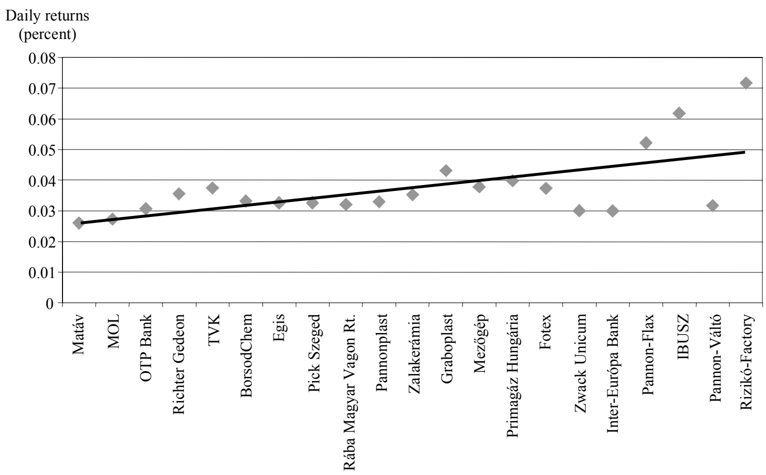



*Figure 3. Standard deviation with respect to capitalisation*




## PRESUMING NORMALITY

If the theoretical distribution of returns is presumed normal, the difference between the theoretical and the empirical distribution can be detected by estimating the third and fourth moments of the distribution from the empirical data. More precise methods are available to test normality (e.g., Chi Squared tests) but analysing the third and fourth moments presents a clear picture. Skewness is tested by the third, and kurtosis is tested by the normalised fourth moment. Equations /2/, and /3/ define the applied formula to estimate the third and fourth normalised moments respectively.

$$\hat{S} = 1/(n\hat{\sigma}^3)\sum_{t=1}^{n}(r_t - \hat{\mu})^3, \qquad /2/$$

$$\hat{K} = 1/(n\hat{\sigma}^4)\sum_{t=1}^{n}(r_t - \hat{\mu})^4, \qquad /3/$$

where

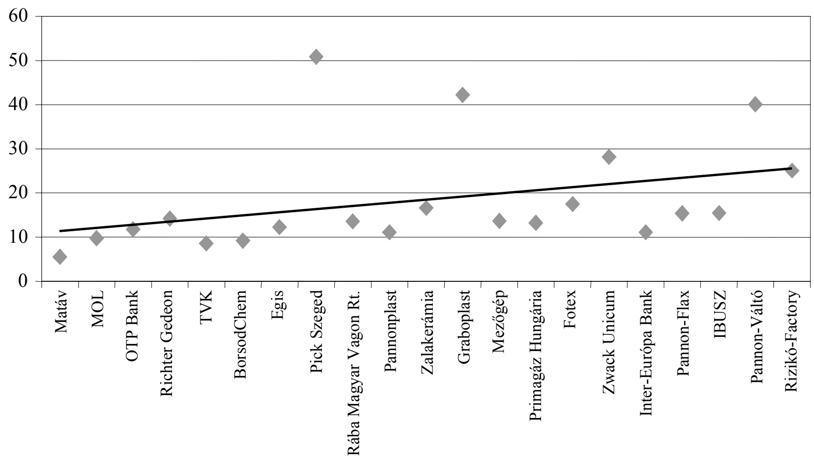
$r_t$ – is the daily return in time *t*,
$n$ – is the number of returns,
$t$ – is the time period,
$\hat{\mu}$ – is the sample mean of returns, and
$\hat{\sigma}^2$ – is the sample variance of returns.

Presuming the normality of the theoretical distribution a confidence interval can be determined to the estimated values of skewness and kurtosis. Standard deviations can be calculated for skewness and kurtosis by the formulas $\sqrt{6/n}$ , and $\sqrt{24/n}$ , respectively.

It is worth mentioning that adding a confidence interval to estimate skewness and kurtosis values raises a very complex methodological problem (*Shiang et al.*; 1989).

Results are shown in Figures 4 and 5.

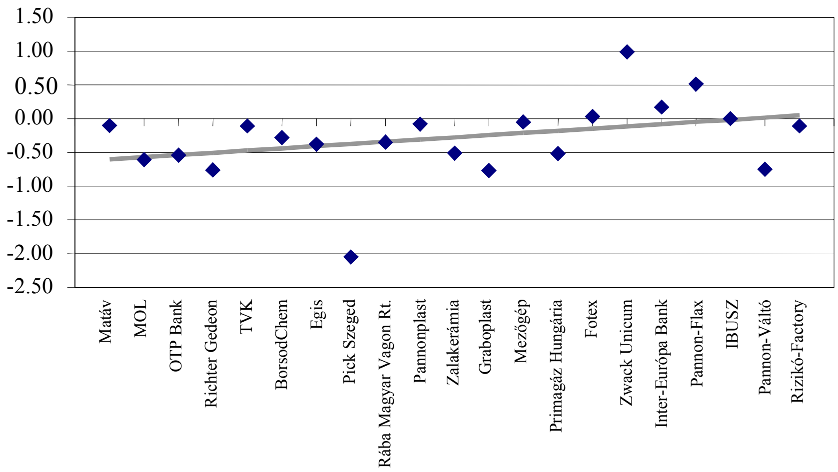
*Figure 4. Kurtosis with respect to capitalisation*




The hypothesis of normality of the distributions must be rejected because the estimated kurtosis values are significantly above the value of 3 of the theoretical normal distribution. Figure 4 shows that kurtosis values tend to grow as capitalisation decreases. (The fitted linear trends do not imply a linear relationship.)

Analysing skewness values the picture is more complicated. In 8 cases out of 21, the hypothesis of asymmetry must be rejected on a 99 percent confidence level. In addition, results demonstrate an interesting relationship between asymmetry and capitalisation. As far as capitalisation decreases, negative skewness values tend to zero, further turn into positive i.e., less capitalisation value means a more positive skewness measure. Conse quently, from the point of view of a risk avoiding investor, the risk decreases as the decision-maker restructures its portfolio to less capitalised papers.

*Figure 5. Skewness with respect to capitalisation*




Analysing kurtosis, normality had to be rejected in all cases, so more sophisticated methods seem to be necessary to model the distribution of returns.

## KURTOSIS TESTS WITH THE HILL-METHOD

A high peaked distribution in our case means that more values belong to the central and tail parts of the distribution and fewer values belong to the medium parts as compared to the normal distribution. Consequently, if kurtosis values are high, fat tails are revealed.

This effect can be modelled by applying, on the one hand, Pareto-Levy stable distributions (*Palágyi*; 1999), and on the other hand distribution-free methods, e.g., the Hill-method (*Lux–Varga*; 1996), (*Varga*; 1998, 1999).

With the Hill-method (*Hill*; 1975), two indices characterise the fatness of tails. Specifying the range that contains tail data is a basic dilemma when using this method. It is important that the Hill-indices show an approximate stability when changing the tail ranges. The Hill-index values were calculated for 5, 10 and 25 percent tail range both for positive and negative values.

The Hill-indices are given in equations /4/ and /5/.

$$\gamma_{H+} = 1/\alpha_{H+} = (1/m)\sum_{i=1}^{m}\left[\log X_{(i)} - \log X_{(m)}\right], \qquad X(1) \geq X(2) \geq \ldots \geq X(m), \qquad /4/$$

$$\gamma_{H-} = 1/\alpha_{H-} = 1/n\sum_{j=1}^{n}\left[\log\left|Y(j) - Y(n)\right|\right], \qquad \left|Y(1)\right| \geq \left|Y(2)\right| \geq \ldots \geq \left|Y(n)\right|. \qquad /5/$$

In equations /4/ and /5/:

$\alpha_{H+}$ – is the positive tail index,
$\alpha_{H-}$ – is the negative tail index,
$m$ – is the number of returns belonging to positive tail,
$n$ – is the number of returns belonging to negative tail,
$X(i)$ – are return values belonging to positive tail, and
$Y(j)$ – are return values belonging to negative tail.

Given /4/ and /5/, the more peaked the distribution is, the fatter the tails that it has, and the smaller the value of Hill tail-index that is calculated. Figure 6 shows the Hill-index values when 25 percent of the data belongs to the upper and lower tails.

*Figure 6. Hill-index values*
(tail range: 25 percent)

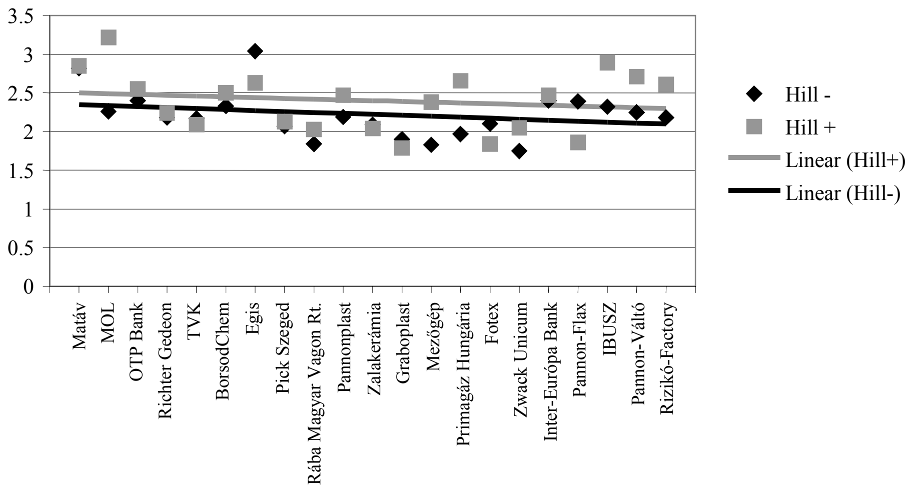



Figure 6 demonstrates that the Hill-index values do not change significantly as long as capitalisation decreases. While, presuming normality, kurtosis tends to grow as capitalisation decreases, kurtosis implied by the Hill-index values does not seem to change as capitalisation decreases. A more precise test can be conducted to test whether there is a significant difference between the Hill-index values of stock returns. Formulas for the positive and negative ranges respectively are demonstrated in equations /6/ and /7/.

$$Q^{+} = \sum_{i=1}^{21} (\alpha^{+} / \alpha_i - 1)^2 \cdot m, \qquad /6/$$

$$Q^{-} = \sum_{i=1}^{21} (\alpha^{-} / \alpha_i - 1)^2 \cdot n. \qquad /7/$$

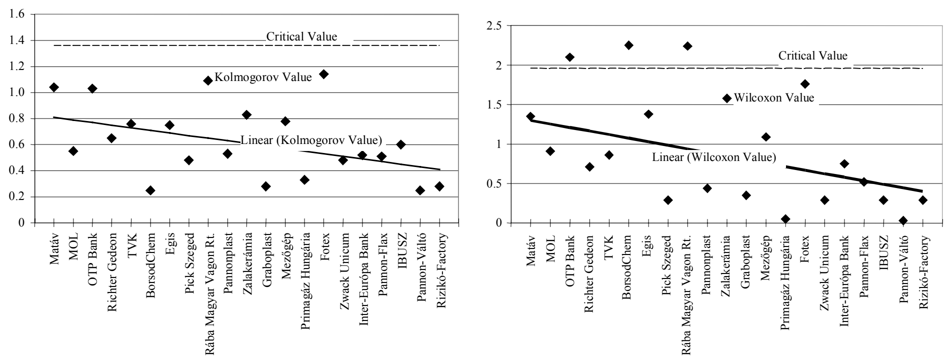
$Q^+$ and $Q^-$ are the test statistics calculated for the adequate tail ranges. $Q^+$ and $Q^-$ are characterised by a $\chi^2$ distribution with 21 degrees of freedom. At the 5 percent significance level the critical value is 32.67 in both cases. The test value is 26.81 in the positive range and 17.78 in the negative one. Consequently, the hypothesis that the Hill-index values do not differ from each other significantly as capitalisation changes cannot be rejected.

## ROBUST TESTS ON SYMMETRY

In the first part of this paper the hypothesis of the normality of stock returns was rejected. Consequently, other robust methods seem to be adequate to test symmetry. These robust methods do not depend on the distribution. The two tests described in the following had been created originally to test the identity of two distributions. In our case the given distribution is split into two parts; positive and negative returns are treated as separate distributions. By multiplying the negative values by –1, the identity of the two split distributions can be tested. The acceptance of the hypothesis of identity means the acceptance of the hypothesis of symmetry; and, in reverse, the rejection of the hypothesis of identity means the acceptance of the hypothesis of asymmetry. The results of the Kolmogorov-Smirnov test and the results of the Wilcoxon tests are demonstrated in Figure 7 respectively.

In both cases the hypothesis of symmetry can be accepted at the 5 percent significance level. In the case of two stocks (OTP Bank and Rába Magyar Vagon Rt.) the hypothesis of symmetry must be rejected according to the Wilcoxon test. Furthermore, Figures 7 demonstrate that the asymmetry of stock return distributions tends to decrease as capitalisation decreases. This result is very similar to the case of normality.

*Figure 7. The result of the Kolmogorov-Smirnov test and the Wilcoxon test*




As far as capitalisation decreases, the variance and the standard deviation of returns increase, so the risk of a risk-avoiding investor grows. This effect is reduced by the favourable change in the symmetry of stock returns. This result is in accordance with the extended, three-moment based CAPM (*Gamba–Rossi*; 1998), which involves skewness into the model.

## RESULTS ANALYSED BY RANK-CORRELATION

The correlation between the position in the capitalisation list and the different distribution indicators are analysed in this section. The Spearman rank-correlation is calculated according to equation 8:

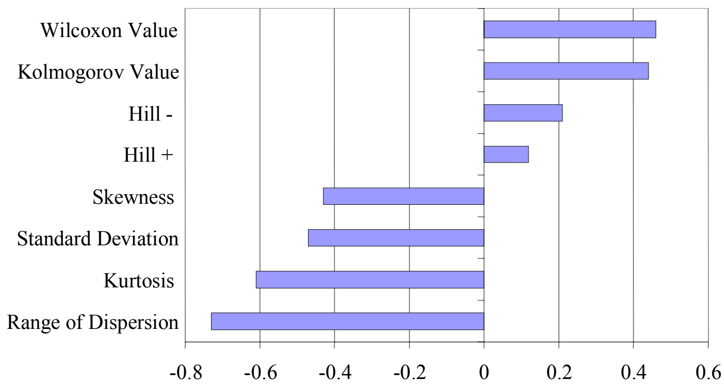
$$\rho = 1 - \frac{6\sum_{i=1}^{n}(x_i - y_i)}{n(n^2 - 1)}, \qquad /8/$$

where

$x_i$ – is the rank value of stock '*i*' as capitalisation decreases,
$y_i$ – is the rank value of stock '*i*' as for the given distribution character, and
$n$ – is the number of stocks under discussion, in our case it is 21.

The results are summarised in Figure 8. The results demonstrated in the following are in accordance with the results shown by the graphic methods described earlier. Besides the Hill-indices, a strong or medium correlation can be found between the rank in decreasing capitalisation and the different characters of distribution.

*Figure 8. Rank correlation among the different distribution characters and the decreasing capitalisation*




*

Summarising the results of the investigations the following statements can be regarded as proven.

1. *Presuming the normal theoretical distribution* of stock returns, as capitalisation decreases, the empirical distributions tend to have higher and higher kurtosis values, thus exhibiting greater departures from normality. The case is the reverse when analysing skewness; as capitalisation decreases the distributions tend to become more similar to the normal distribution.

2. *Discarding the assumption at a normal distribution* of stock returns, the picture is different from the previous case. Analysing the tails of the distributions, the fatness of the tails was proven the same in all cases, so capitalisation has no effect on that. Robust symmetry tests showed that the hypothesis of asymmetry of distributions must be rejected in almost all cases; however, the symmetry tends to grow as capitalisation decreases.

The risk of a *risk avoiding investor* grows as he/she restructures his/her portfolio towards less capitalised stocks due to the increasing variance and possibly growing kurtosis. This effect is reduced by the favourable change in asymmetry while going less capitalised.

REFERENCES

BACHELIER, L. (1964): Theory of speculation. In: COOTNER, P. (ed.), *The random character of stock market prices.* Massachusetts Institute of Technology Press, Cambridge, MA.

BODIE – KANE – MARCUS (1996): *Befektetések*. Tanszék Kft. Budapest.

GAMBA, A – ROSSI, F. A. (1998): A three-moment based portfolio selection model. *Rivista di Matematica per le Scienze Sociali*, No. 1. p. 25–48.

HILL, B. M. (1975): A simple general approach to interference about the tail of a distribution. *Annals of Statistics*, No. 3, p. 1163–1173.

LAU, H. SH. – WINGENDER, J. R. – LAU, A. H. L. (1989): On estimating skewness in stock returns. *Management Scienze*, September No. 9.

KAHLER, J. (1993): *On the modelling of speculative prices by stable paretian distributions and regularly varying tails*. ZEW University of Mannheim, mimeo.

KOEDIJK, K. G. – SCHAFGANS, M. M. A. – DE VRIES, C. G. (1990): The tail index of exchange rate returns. *Journal of International Economics*, No. 29. p. 93–108.

KOEDIJK, K. G. – STORK, P. A. – DE VRIES, C. G. (1992): Differences between foreign exchange regimes: The view from the tails. *Journal of International Money & Finance*, No. 11. p. 462–473.

LÉVY, P. (1924): Théorie des erreurs, la loi de Gauss et les loi exceptionelles. *Bulletin of Social Mathematics*, No. 52. p. 49–85.

LUX, T. – VARGA, J. (1996): A Pareto hipotézis vizsgálata – Értékpapírpiaci hozamok és az extremális hozamok eloszlása. *Szigma*, Vol. 27. No. 4. p. 1–23.

MARTON, R. (2001): A magyar tőkepiac hatékonyságának vizsgálata. *Bankszemle*, Vol. 45. Április–május p. 72–88.

PALÁGYI, Z (1999): Árfolyamingadozások és kockázatbecslés a Budapesti Értéktőzsdén. *Szigma*, Vol. 30. No. 1–2. p. 27–32.

RAPPAI, G. – VARGA, J. (1997): Applicability of the CAPM on the Hungarian Stock Market, In: *New operational approaches for financial modelling (Contribution to management science*). Physica Verlag, Heidelberg–New York.

VARGA, J. (1998): On distributions for stock returns: A survey of empirical investigations. In: PARDALOS, P. – ZOPOUNIDIS, C. (eds.) *Managing in uncertainty: Theory and practice.* Kluwer Academic Publishers, Dordrecht, p. 139–151.

VARGA, J. (1999): Stock return distribution: A survey of empirical investigations. *Hungarian Statistical Review*, Vol. 77, Special Number. p. 23–34.

VARGA, J. (2001): Pénz-és tőkepiaci idősorok sztochasztikus volatilitás modelljei. *Szigma*, Vol. 32. No. 1–2. p. 71–86.