

# The Effects of Information And Communication Technology In Hungarian Economic Sectors

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**Abstract**— As the author could not find a reassuring mathematical and statistical method in the literature for studying the effect of information communication technology on enterprises, the author suggested a new research and analysis method that he also used to study the Hungarian economic sectors. After a brief introduction to the theoretical background of the Information Age, the author examines the question of what factors have an effect on their net income is essential for enterprises. First, the potential indicators related to economic sectors were studied, then the author compared those indicators to the net income of the surveyed enterprises. The data resulting from the comparison showed that the growing penetration of electronic marketplaces contributed to the change of the net income of enterprises in various economic sectors. Among all the potential indicators, only the indicator of electronic marketplaces has a direct influence on the net income of enterprises. It was practical to determine two clusters based on the potential indicators.

**Keywords**- Information society, ICT, Economic sector, Electronic presence, Electronic marketplace

## I. INTRODUCTION

The current age is often referred to as the Information Age. This concept was first introduced by Manuel Castells, the best-known theoretician of the information society [1]. The information society is a new, special variant of the existing societies in which producing, processing and distributing information become a fundamental source in the economy.

According to the related literature data, the Information Age began in the second half of the 1950s when, for the first time in history, the number of white-collar workers (engineers, administrative employees etc.) exceeded the number of blue-collar workers [6].

One of the main driving forces of the Information Age is the phenomenon called Information and Communication Revolution. Its significance is often compared to the agricultural and industrial revolutions taken place in the history of mankind. In important fields of high-end technology (computer technology and telecommunication) not only the robust growth of quality, quantity and performance parameters can be observed but the approximation of these two fields along with the appearance of compound applications can also be detected. These phenomena of the information society cannot only be seen as one of the results of technological development but also a coherent system affecting the society as a whole [3].

## II. THE CHARACTERISTICS AND IMPACTS OF INFORMATION AND COMMUNICATION SYSTEMS

Information and communication technology can be regarded as a universal technological system, which is closely linked to all of the previous systems and creates new, more complex technological systems. ICT's main characterizing function is to assure acquiring, storing, processing, delivering, distributing, handling, controlling, transforming, retrieving and using information. ICT has a different effect on the actors of the economy, including companies, employees and consumers. Nowadays we witness a change of paradigm in the operation of enterprises. They have become a rapidly changing system of independent work groups and projects. Enterprises are characterized by flexible operation and demand for flexible labour force. In this new situation, employees have to leave the traditional patterns and develop a new kind of mentality. If they want to stay afloat in the labour market, they have to be flexible as enterprises are no longer strongly interested in improving the professional knowledge of their employees through various trainings. Beside the changes experienced in the attitude of enterprises and employees, consumers' behaviour has also been changed essentially by the effect of ICT. As consumers are freed from their isolation by the Internet, they become active and conscious actors in the economy.

The relationship between buyers and sellers has also been transformed, it has become harder for sellers to recognize and influence the trends in demand and consumers are better informed than ever before.

Information and communication technology has brought a deep change into the opportunities for consumers compared to the opportunities provided by industrial capitalism. This change is as profound as the one caused by the Industrial Revolution earlier. The new generation of consumers is, first and foremost, well informed, collecting and using other consumers' existing experiences. Companies (especially corporations) previously focused on products and markets, nowadays they concentrate on consumers instead. It is not enough to recognize consumers' problems, identifying the problems in order to solve them is also needed. The opportunities provided by ICT identify actual consumers, based on actual problems that occur during the use of a product. Companies can keep pace with the speed of the development of ICT only by introducing job enrichment. The requirement of versatility can be met only by employees with high-level general education ([3].

The decrease of the number of strict positions together with the changing requirements of the remaining ones allows employees to acquire new skills but it also stretches their responsibility. Cross-trainings are also organized for the group of employees in order to enable them to perform various tasks. Team-based companies have better problem-solving skills, higher productivity, more efficient use of human resources, more creativity and more innovations when compared to traditional non-team based organizations. Nowadays, when digital information is regarded as the chief mean of production, the efficiency of production is highly dependent upon obtaining and processing information. Based on the achievements of ICT, companies have shaped up the infrastructure of obtaining and processing information, and help their employees to co-operate by compressing time and space. The intention of raising efficiency gave room for virtual teams. By being part of a virtual team, employees do not have to work under the same roof and other employees from outside the company can take part in the work performed by a virtual team.

Nowadays, the majority of changes in work organization, decision mechanisms and corporate organization structures requires enhanced flexibility. Flexibility means quick reaction, the removal of strict limits and the frequently mentioned job enrichment as well as openness for innovations and unconventional answers to the newer and newer challenges. The environmental impulses do not affect the operators of the assembly lines or the workers of call centres through a long chain. Companies were operated centrally from a single headquarters earlier, nowadays managers and workers try to find answers to the current challenges in many local corporate decision nodes. The coordination of numerous independent units is generated by the company as a self-organizing system, and the company's philosophy is determined by the self-organization of independently operating units based on market principles.

### III. THE AIM OF THE RESEARCH

Based on the considerations presented above, it is not the subject of my paper to answer whether there is a need for ICT or creating the necessary conditions for the information society. Within the broad subject of information and communication technology, my aim is a specific one: it is to measure the possible economic impacts it has on the society. The rich literature of the information society discusses these aspects in detail. In my work, I take the information society as a normative future plan for Hungary, and I am looking for the answer of what progress has been made in building the information society in the Hungarian economic sectors. I examine the following issues:

- to what extent we can speak about the information society in Hungary nowadays,
- what is the development level of the information society in several economic branches and company sizes compared to each other and to the member states of the European Union,
- how this development level can be measured and calculated,
- how the development level of information and communication technology increases at certain company sizes,
- what trends can be observed in the development process in the individual economic sectors and company sizes.

My examination extends to the static, momentary state of the development level of ICT devices used in the economic branches as well as to their dynamic analysis, expected pace of growth and their qualification. When establishing the aims of the research, there is always the question of how to position the individual parts of the subject. Should they be positioned in a broader subject or should they be selected for further and deeper examination? The former possibility means that we aim to make suggestions by putting the practical analysis into a broader structure. The aim of my research is exactly this, as the information society means a stage representing a new quality, and the changes of the information and communication technology can be observed in every part of our life nowadays.

#### IV. THE METHOD OF THE RESEARCH

Similar problems are raised by the quantification of the various components of the information society as the definition of its concept. There is a wide range of variables that can be measured: a great number of explanatory variables can be listed from the perhaps more easily measurable infrastructural components to the more difficult components related to knowledge and willingness for using information. That is why most analyses use sets of variables and complex indices as there is no easily measurable (one-dimensional) index that would characterize the information society. The examination of the subject is interdisciplinary as it has social and scientific references, so a complex approach was needed when I started processing the literature. I needed to study literature on economics, law, sociology and technology connected to the information society. In consideration of the complexity of the studied subject, I selected several analytical methods and approaches. In the phase of data collection, I relied on the available Hungarian [8] and international data [7] as well, and I managed to process a large amount of secondary information consisting of more than 6.000 items. I extended my research to printed as well as electronic publications and artifacts available on the Internet. The reason for conducting a primary research was to reduce some shortcomings originated from secondary data sources. In fact, it covered an empirical survey among Hungarian companies and enterprises. The questionnaire I used for collecting data on the subject was filled in by 554 respondents altogether, providing nearly 3.000 data records. As Figure 1 shows, the literature on the development of ICT distinguishes five development stages.

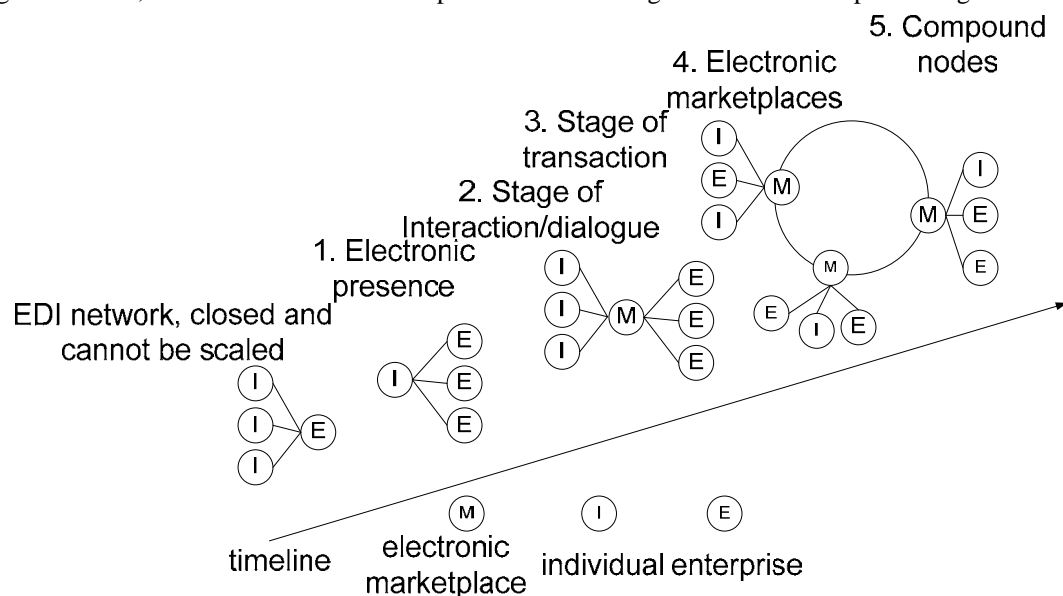


Figure 1. The development stages of information and communication technology [5]

These stages are built upon each other. With the help of the elaborated model, I measured the individual development stages. By averaging the data of the first three development stages, I examined the enterprises' willingness for adaptation. With the help of an own model, which comprises five elements, I analysed the development and growth of the size categories and economic sectors.

The steps of this procedure are as follows:

- Processing the data of the primary and secondary research,
- Assigning single indicators to individual development stages, calculating potential indicators,
- Calculating the values of potential indicators from single indicators,
- Studying potential indicators,
- Determining potential indicators at the individual development stages.

Then, with the help of the resulting indicators, I performed a cluster analysis, a compound regression analysis.

#### V. THE RESULTS OF THE ANALYSIS OF INFORMATION AND COMMUNICATION TECHNOLOGY

Clustering is the assignment of a set of observations into subsets so that observations in the same cluster are similar in some sense. The clustering process is successful when the subsets are similar to each-other and different from the elements of other subsets at the same time. Based on theoretical considerations, I decided to make groups of economic activity categories from the five previously defined potential indicators.

1 <sup>st</sup> cluster	2 <sup>nd</sup> cluster
(A) Agriculture, hunting and forestry (F) Construction (G) Wholesale and retail trade; repair work (H) Hotels and restaurants (K) Real estate, renting and business activities (M) Education (N) Health and social work (O) Other community, social and personal service activities	(C) Mining and quarrying (D) Manufacturing (E) Electricity, gas and water supply (I) Transport, storage and communication (J) Financial intermediation
<b>Underdeveloped</b>	<b>Developed</b>
<b>relative</b>	

Figure 2. Two-cluster model of the national economic sectors

As a summary of the results of the cluster analysis, it can be stated that the sectors "Electricity, gas and water supply", "Transport, storage and communication", "Mining and quarrying", "Manufacturing" and "Financial intermediation" belong to the second cluster by better average values. The results of this analysis are presented in Figure 2.

I used the path model to study how the potential indicators influence one another and what direct or indirect effect they have on the average net income of the individual economic sectors.

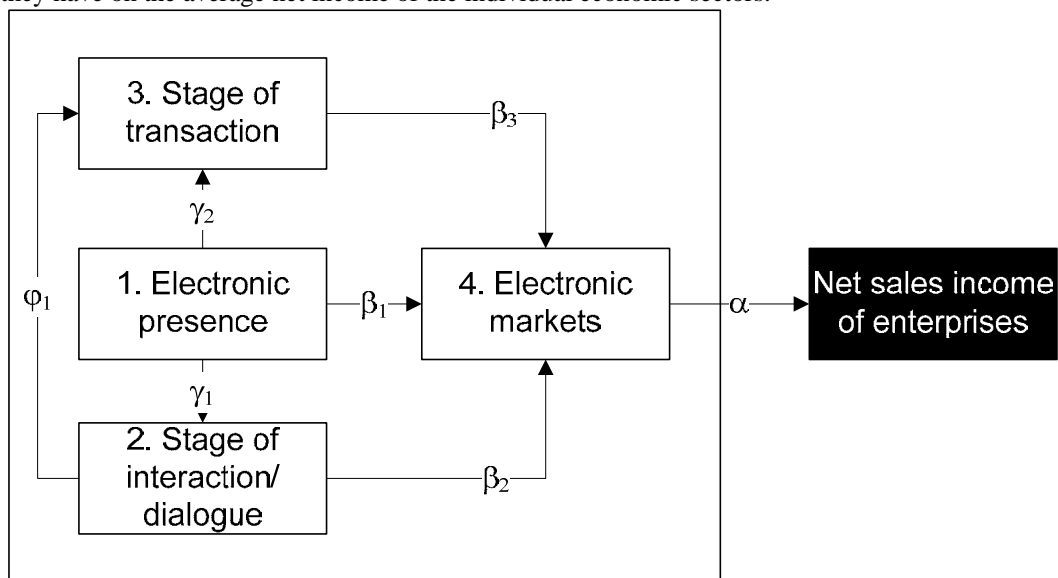


Figure 3. The scheme of the path model of the potential indicators

As it is indicated in Figure 3, the variables presented in the path model are linked with arrows to one another, showing the direction of their relationships. I assumed in my causal model that the potential indicator of electronic presence is the exogenous variable. Based on the arrows starting from it, the potential indicator of electronic presence has an effect on the other potential indicators, also having an indirect effect on the average net income of enterprises in several economic sectors. These paths are called indirect paths by the literature and in my model they show how the effect of the potential indicator of electronic presence takes place through the potential indicators of interaction/dialogue, transaction and electronic markets. The potential indicators of interaction/dialogue and transaction became endogenous variables. Endogenous variables are variables with causal links leading to them from other variables in the model. In other words, endogenous variables have explicit causes within the model. The dependent variable in my model is the average net income of enterprises in economic sectors, the arrows starting from the other variables point at this one but it has no arrow or link pointing back at the other variables.

The aim of setting up a path model was to divide the zero linear correlation between the independent and the dependent variables into two parts. The first part is the effect that the independent variable directly has on the dependent variable, while the second part shows the effect being had on the dependent variable caused by the independent variable through another endogenous variable.

Only the potential indicator of electronic markets has a direct effect on the average net income of enterprises as it is illustrated in Figure 4. However, the effect of the potential indicator of electronic presence is significant as it influences the potential indicator of electronic markets to a great extent. The value of the indirect effect of electronic presence was  $(87.4\% * 60.5\%)$  56.2%. In the table below, a new arrow also appears with a value of 70%, showing the effect of non-specified variables from outside the model on the average net income of enterprises.

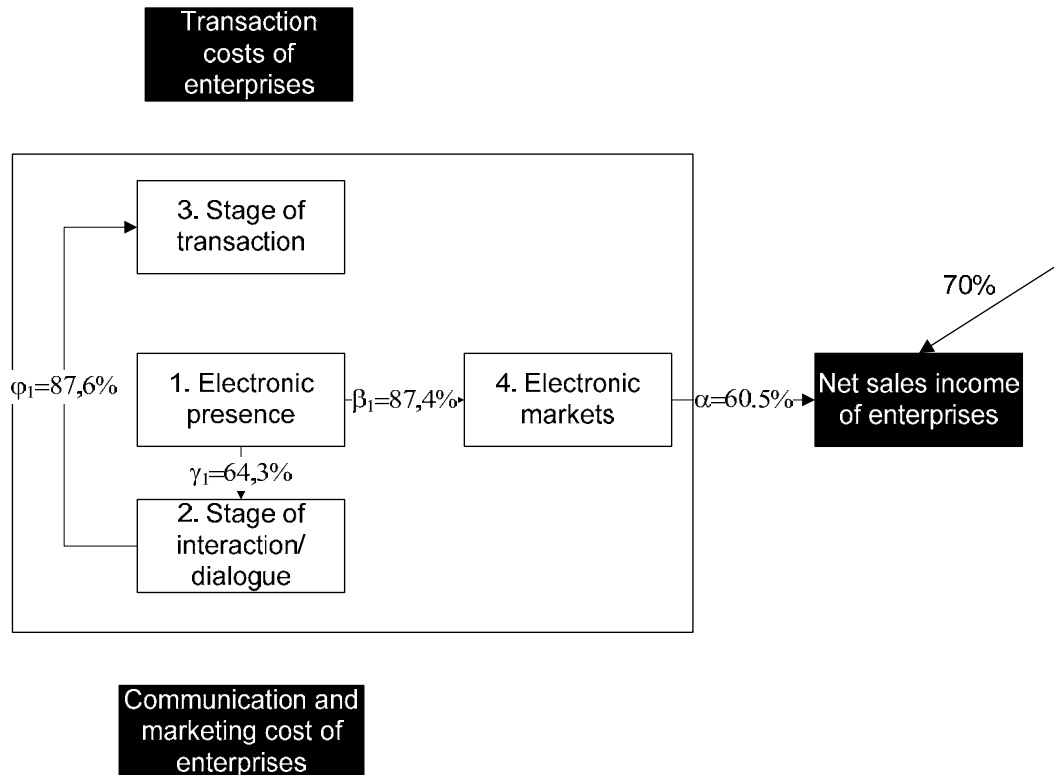


Figure 4. The final path model of the potential indicators

Electronic presence has no direct effect on the potential indicator of transaction. The value of the strength of its indirect effect was  $(64.3\% * 87.6\%)$  56.3%, according to my computation. The model verified the hypothesis according to which electronic presence largely determines interaction/dialogue, it has an indirect effect on transaction and it has the strongest correlation with electronic markets. Before creating the model, I assumed a direct correlation between transaction and electronic markets but I could not verify the existence of the relationship between them. However, the new result of my research was that there was a direct correlation between electronic markets and the average net income of enterprises.

## VI. THE METHOD OF THE RESEARCH

ICT devices contribute to the improvement of productivity, the economic growth or the acceleration of the economy in several areas. As far as macroeconomic effects are concerned, the technological development is very rapid alongside with the productivity and the total factor productivity (TFP) in the economic sectors producing ICT devices. On the one hand, this process increases the national average in itself, especially when its share tends to grow in the GDP; on the other hand it makes other economic sectors more dynamic by the technological and economic connections throughout the whole economic system.

(D) Manufacturing	(G) Wholesale and retail trade; repair work	(I) Transport, storage and communication	(K) Real estate, renting and business activities
Manufacture of business machines 3001 Manufacture of computers 3002 Manufacture of industrial electronics 3220 Manufacture of consumer electronics 3230	Wholesale trade of softwares and computers 5164	Telecommunication 6420	Software publishing services 7221, Other software consultation services 7222, Lending office machinery and computers 7133, Hardware consultancy services 7210, Data processing services 7230, Data bank services 7240, Office machinery and computer repair services 7250, Other computer related services 7260

Figure 5. Economic activities classified as ICT activities according to TEÁOR-NACE [8]

Profits gained with the help of the rapid technological development and the improvement of productivity was eroded by the drop in ICT prices. Countries producing ICT devices lost a part of their profits realized from production because of the deteriorating swap ratio.

The source of productivity and growth benefits is capital deepening (it describes an economy where the amount of capital per worker is increasing), that is the growing rate of using ICT devices, which is stimulated by the huge drop in ICT prices. These benefits appear in the form of the increased output of existing products and services, manufacturing new products or providing new services, fulfilling customer needs more efficiently and decreasing transition costs etc. The effect of ICT devices on the increased productivity and more dynamic growth was connected to capital deepening. The countries and businesses using these new technologies have benefited more from the revolution of information technology, than the countries producing them.

ICT devices increase the total factor productivity, that is they improve the degree of utilization of capital and labour force. The total factor productivity (TFP) expresses the overall effect on the savings of economies of scale, management skills, production externalities and other, non-traditional factors influencing productivity. The significance of the growing total factor productivity is that it accelerates the pace economic growth without additional costs and without having to increase the quantity input. Capital deepening is a necessary but not sufficient condition for improving productivity. It unfolds in its fullest form when the potential efficiency surplus of ICT devices is exploited. A more dynamic TFP automatically accelerates the pace of labour productivity, thus it helps to boost economic performance.

Using ICT devices also improves productivity and makes economic growth more dynamic because information technology cannot be regarded as capital goods in the traditional sense of the word. The installation of a new information technology device raises the value of other existing devices as well. Network effects may occur within companies, moreover they may appear between industrial branches, and they may necessitate shaping new forms of cooperation (outsourcing).

ICT devices increase productivity and output by capital deepening, improved total factor productivity and network externalities at the microeconomic level. The advantages of using ICT devices at the macroeconomic level come from all the advantages of the companies' improved productivity and from the network advantages based on the feature of reducing transition costs and accelerating innovation. The network advantage does not depend on the operation of a given company and its business strategy.

The effects of ICT devices on the productivity of companies cannot be measured unequivocally at the microeconomic level because of certain statistical and methodological imperfections, the difficulties in measuring network effect at a business level and the lack of data enabling to make international comparisons. Furthermore, the effects of ICT devices on productivity appear at a later time, as they are preceded by a longer or shorter learning process. The productivity paradox has started to vanish by now. It has become clear that statistics cannot or just partially show the secondary effects of using ICT devices in the economy (faster information processing, improvement of productivity in producing knowledge, for instance).

In those countries where the competition is fierce in the market, companies using ICT devices are not necessarily the main winners of capital deepening. They are the customers who can benefit from it in the form of lower prices, better quality or more convenience.

In countries where competition is weak, companies are able to realize a greater part of benefits coming from capital deepening. But it has its own price as the secondary effects of using ICT devices are more limited in the economy.

With the help of the compound indicator and the financial data of the studied economic sectors, I made an attempt to find a connection between the development level of ICT and their profitability. Profitability and productivity are influenced by a lot of other factors as well. As I could not measure and show the effect of those other factors, the results are not full but informative.

Based on the statistical connection between the compound indicator and the increment of the Gross Value Added per worker, the correlation coefficient is 0.13, while the gradient of the regression trend line is 0.17. Both numbers show a positive connection between the compound indicator and the profitability.

Then, using a coordinate system, I illustrated the connection between the changes of the specific indicators of the studied economic sectors and the development level of those sectors. The Y axis shows the growth pace of Gross Value Added per capita in the economic activities between 2003 and 2006. The X axis shows the compound indicator that I created for measurement. The points defined by the two values show clearly where a given economic sector can be found in the coordinate system, what groups can be constituted and what tendency can be observed.

The highest increment of specific Gross Value Added was produced by the sectors 'Manufacturing', 'Electricity, gas and water supply', 'Transport, storage and communication' and 'Financial intermediation'. With the exception of 'Electricity, gas and water supply', all of these economic activities belong to the group of underdeveloped sectors (below 50%).

High (but not reaching the developed status) compound indicators were shown by the sectors 'Mining and quarrying' and 'Wholesale and retail trade; repair work', as they produced an increment of Gross Value Added below the average, these economic sectors can be found in the lower right part of the coordinate system.

The sectors 'Construction', 'Health and social work' and 'Hotels and restaurants' can be seen as laggards, so they got into the lower left part of the coordinate system.

The 'Agriculture, hunting and forestry' sector can also be classified as a laggard economic activity, but as the effect of the compound indicator on the increment of Gross Value Added was less significant, it can be found in the upper left part of the coordinate system.

Drawing a trend line on the points, it is clear that the line shows a positive gradient, that is, the higher the usage of ICT devices, the higher improvement can be detected in the specific Gross Value Added.

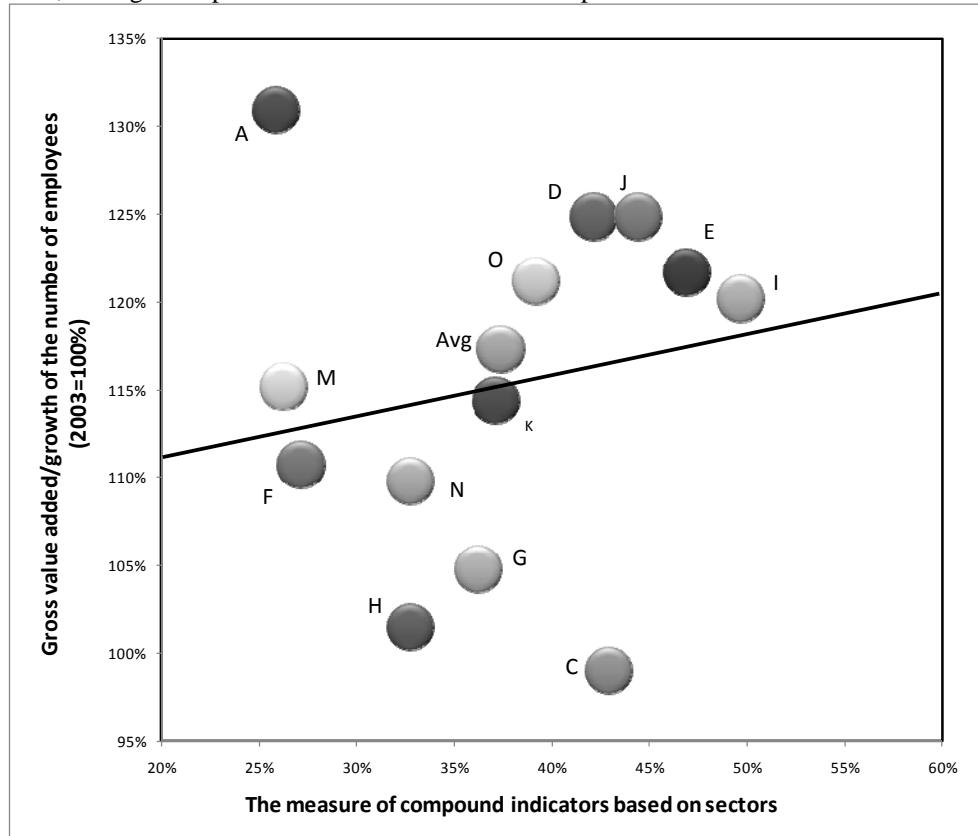


Figure 6. Connection between the growth of gross value added and the development level of information and communication technology in several economic activities<sup>1</sup>

## VII. CONCLUSIONS

The most important step of the cluster analysis is to determine the number of clusters. The data show that it is expedient to form two clusters based on the potential indicators. The first cluster comprises eight, while the second comprises five economic activities. As a consequence, those economic sectors belong to the first cluster that use ICT devices less frequently than the national average, while the second cluster contains those economic sectors that can be seen as developed ICT-users.

The multiple regression analysis is the series of regression models built upon each other. Using the regression model, I studied the direct and indirect effect of the potential indicators on each other and the companies' net income in several economic sectors. The only potential indicator affecting a company's net income is the indicator of electronic marketplaces. However, the effect of the electronic presence is significant, since it has a great influence on the potential indicator of electronic marketplaces. During my primary research, I found out that the effect of the non-specified variables out of the regression model on a company's net income is 70%.

<sup>1</sup> A=Agriculture, hunting and forestry, C=Mining and quarrying, D=Manufacturing, E=Electricity, gas and water supply, F=Construction, G=Wholesale and retail trade; repair work, H=Hotels and restaurants, I=Transport, storage and communication, J=Financial intermediation, K=Real estate, renting and business activities, M=Education, N=Health and social work, O=Other community, social and personal service activities.

I could not find a reassuring mathematical and statistical method for studying the effect of the information communication technology on businesses in the literature, that is why I proposed a new research and analysis method that I also used to study the Hungarian economic sectors.

The primary possibility of utilizing the proposed method appears in situation report. I managed to measure the relative (economic sectors correlated to each other) and the absolute (economic sectors correlated to the same ones in a different country) development level of the information communication technology with the help of creating development stages, quality categories and the willingness for adaptation belonging to the given development stages.

The secondary possibility for utilization lies in following patterns. The development of ICT is different in several countries, regions and economic sectors. The European Union proposed a strategic framework for its member countries. The main aims of establishing a strategic framework are:

- a single European information space;
- boosting investment and innovation in ICT researches;
- establishing a receptive European information society.

The economy of the United States is regarded as a model economy where two-third of the employees were dealing with information process during working hours in 2000. One of the causes of the massive economic performance in the United States is the highly-developed information processing. If we manage to measure this level of development, a strategy can be formulated in the European Union and in the individual member states in order to catch up with the most developed countries.

The object of the study is generally the national economy of a given country. With the help of the method I have worked out, it is possible to analyse and assess the sections, subsections, divisions, groups and classes of a given national economy. Beside the economic sectors, company sizes and organization forms can also be studied.

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