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**Miscellanea**

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Aleksander Lotko<sup>1</sup>

## CLASSIFYING VARIABLES WITH CLUSTER ANALYSIS WHEN MEASURING QUALITY OF SERVICES IN CONTACT CENTERS

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### *Abstract*

*The goal of the paper was to discover, whether using one of multidimensional exploratory techniques - cluster analysis in quantifying quality of services in contact centers brings logical classification of variables and if this classification can be used and measure quality of these services.*

*On a basis of literature studies important attributes of services delivered by contact centers were identified. They were examined as observable variables with the use of a computer assisted telephone interview method on a sample of 1000 contact center customers. Then, variables were classified using cluster analysis. Clusters link observed data into meaningful structures, that is, develop taxonomies.*

*Using factor analysis to quantify and measure quality of contact centers allowed to distinguish the following clusters: „answer”, „empathy”, „availability” and „time”. The profile of contact center services quality obtained from cluster analysis shows that the highest quality assessment is for the cluster „answer”, then for „availability”. The quality concerning cluster „empathy” is visibly lower, while the cluster „time” is of decidedly the lowest quality assessment.*

*Proposition of classifying variables into clusters creates a theoretical model which quantify quality of services delivered by contact centers and make its structure more comprehensible. In practice, a proposed classification allows to identify quality gaps and design contact centers services with a special attention paid to the matters of quality to meet customers' expectations.*

*The paper's contribution is a novel way of quantifying and measuring quality of services in contact centers.*

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JEL Classification Code: **C380, M310** .

**Keywords:** contact center, service quality, cluster analysis, communication, ICT.

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## **Introduction**

The service sector is expanding at an increasing rate and is becoming intensely competitive (Chen, Gupta and Rom, 1994; Johnson, Dotson and Dunlap, 1988). The growth has been occurred as many service providers are now seeking to lower the cost of providing services while increasing the time period access is available (Staples, Dalrymple and Phipps, 2001). It also reflects the desire of companies to improve access to their services, in a cost-effective manner, and retain satisfied customers (Bird, 1998). This can be done via a contact center. Contact center can be defined as an office in which large numbers of telephone calls are handled, especially one providing the customer services functions of a large organization, helped by advanced IT solutions. The contact center industry is one of the most rapidly growing service industries in the developed world today (Dalrymple and Phipps, 1999; Upal, 2008).

As an integral part of most organizations, today contact centers play a key role in the service delivery chain. Presently in many industries, contact centers are the primary source of contact for customers. This important role implies that the performance management of contact centers is of critical importance to organizations, especially the delivery of customer satisfaction. Beside the others, it is possible by harnessing information technology into providing services (Gilmore, 2001; Lotko, 2009). Still, the role of people is not to be underestimated (Marr and Schiuma, 2001; Bowen and Lawler, 1992; Wallace, Eagelson and Waldersee, 2000; Bittner, 1990). The goal of the paper was to discover, if attributes describing quality of services delivered by contact centers can be grouped into some logical items.

From this goal the following 2 hypotheses were drawn:

**H1:** attributes of service quality in contact centers can be grouped into few logical items.

**H2:** there are between cluster differences of assessed quality.

Then, the results of measurement of the quality of contact center services with the use of the discovered clusters are presented.

## **Role of a contact center in modern organizations**

The essential condition for an organization's functioning is having customers and maintaining contacts with them. This task is very difficult on strongly competitive markets. Hence, the main aim of an organization should be building and improving a relationship with a customer. Currently, stress is put on the importance of loyalty, responsibility and emotions, particularly satisfaction (Mazur, Jaworska and Mazur, 2001). This concept requires a departure from the traditional (i.e. transactional) attitude towards the customer. According to the classification of encounters proposed by V. Zeithaml and M. Bittner (Zeithaml and Bittner, 2000), which are: (1) the remote encounter (e.g. ATM, WWW, where there is no direct human contact between organization and the customer), (2) the phone encounter and (3) the face-to-face

encounter (e.g. cashier's desk, where the customer physically interacts with service provider or his personnel), contact center encompasses the two first types.

One of the methods that can be used by the organization to gain advantage over its competitors is providing the client with a wide range of services connected with the product, forming a relationship in which the client feels respected, appreciated and important for the organization, as well as treating the client in the most individualized manner possible (personalization of contacts). To do so, organizations have been implementing a single central contact point (organizational unit) whose task is to deal with calls, inquiries, problems and other matters connected with customer service. This contact point is most commonly named a contact center. It can be said that contact center is „an organization or organizational unit in which each contact with a customer (phone call, personal contact) may be dealt with by one or many employees with access to common information” (Kostecki, 2002). So contact center is a centralized office used for the purpose of receiving or transmitting a large volume of requests by telephone or other method of distance communication. Trying to come up with a concise and precise definition of the term one may say that the contact center is a team of people, equipment and technology facilitating contacts between the supplier and the customers via all available means of communication (Lotko, 2003).

Separating the operations of a contact center is based on the following assumptions:

- all customer inquiries reach a single place, i.e. a contact center (the customer has to know only one phone number, fax number, web page or email address),
- communication with the customer takes place via various channels, e.g. telephone, fax, email,
- contact center is equipped with suitable software which serves to access all the information needed for efficient customer service.

Contact centers today not only provide customers with information but also function as a source of information for telemarketers (Wardaszko, 2001). Apart from playing an important informative role, the centers are becoming a significant link in the sales chain.

Nowadays the contact center industry expands powerfully. According to Deloitte (Deloitte, 2013):

- 77% of organizations expect to maintain or grow in size within 12-24 months,
- all contact channels expect growth of volume within 12-24 months,
- 62% of organizations view customer experience provided through contact centers as a competitive differentiator,
- 56% of organizations believe cost and quality management are equally important.

Summing up, the global call center industry is set to continue witnessing strong growth moving forward. This growth should be driven primarily by increasing focus on providing efficient customer service as a part of business development. However, industry players will need to continue investing in technology, human resources and quality of services to differentiate themselves from competitors.

## **Service quality in contact centers – the state of the art**

Research on service quality began in the beginning of the eighties of the 20th century. Two trends are noticeable in this research: (1) elaboration of conceptual models and (2) elaboration of measurements scales. They are connected with each other and the first trend very often triggers the second one (Seth, Deshmukh and Vrat, 2005).

Recommendations concerning organization of the work of contact centers and an exemplary general classification of the dimensions of the service quality perceived by the customers (Anton, 1997) were found in the literature together with the results of the study in customers' satisfaction of the used contact channels (Kostecki, 2006). J. Horovitz (Horovitz, 2006) and N. Lake and K. Hickey (Lake and Hickey, 2006) discuss the issue of the quality of customers' attendance, however they do not distinguish the attendance through the telecommunication interface. K. Mazurek-Łopacińska gives some of the solutions improving the quality of the remote customers' attendance, however without pointing out the use of centers of contact with the customer (Mazurek-Łopacińska, 2003). P. Kotler observes the issue of providing high quality of services within the scope of customers attendance (Kotler, 1994). A broad comparison of the most popular tools of the measurement customers satisfaction and service quality is presented by Hill and Alexander, however there are no tools dedicated to the measurement of the quality of services provided by the telecommunication interface (Hill and Alexander, 2003).

Some results of researches performed with the use of traditional service quality models are available (Gilmore, 2001; Upal, 2008), but these seem lacking the specificity of contact centers. It is underlined, that there is a need for accurate measurement of service quality in contact center and it should be treated as a priority (Gilmore, 2001). Some clues on measuring customer satisfaction and managing service quality in contact centers can be concluded in works by R. Feinberg, K. de Ruyter and L. Bennington (Feinberg, de Ruyter and Bennington, 2005) and S. Bartsch (Bartsch, 2012), in both books based on case studies. Other researches underline that the quality of contact center services is highly influenced by personal engagement and attitudes of the staff (Bowen and Lawler, 1992; Wallace, Eagleson and Waldersee, 2000; Bittner, 1990).

In the face of the stated research gap, author took an effort to construct a service quality model with the use of one of multidimensional exploratory techniques – cluster analysis.

## **Remarks on methodology**

On the basis of literature analysis a set of observable variables composed of sixteen elements was elaborated. Three potential suggested dimensions of service quality were derived directly from the literature: availability (Dalrymple and Phipps, 1999), quality of the answer (Anton, 1997) and empathy (Parasuraman, Berry and Zeithaml



1988; Burgers et al., 2000). Among information quality attributes mentioned in the literature (Stefanowicz, 2004), the following were selected: comprehensibility, completeness, accuracy and relevance (variables from 9-12). Variables number 5, 6 and 8 are derived from the analysis of the literary output (Anton, 1997). Four variables (13-16) originate from the SERVQUAL scale (Parasuraman, Berry and Zeithaml 1988). The analysis of other literature positions (Anton, 1994; Horovitz, 2006; Kostecki, 2006; Burgers et al., 2000) and sessions with the managers allowed for the creation of the supply of the remaining variables.

Subsequently a questionnaire for the measurement of the values of 16 latent variables was built. 10-point Likert scales were used to register the results.

The sample size was 1000. For the reliability coefficient  $1-\alpha = 0,95$  ( $z_\alpha = 1,64$ ) an acceptable level of error –  $d = 2,59\%$  was reached. The study was carried out with the use of infrastructure and human resources of the company Call Center Poland S.A. The method of Computer Assisted Telephone Interview (CATI) was applied. Telephone base was selected by means of the RDD method (*Random Digit Dialing*).

Observable variables considered in the study and obtained results of descriptive statistics are presented in Table 1.

To identify items describing quality of contact center services, cluster analysis was applied.

**Table 1.** Observable variables and their descriptive statistics

Var. no.	Statement	Mean	Std. dev.
1	Contact data of contact center are easily accessible	6,36	2,51
2	Contact center offers convenient ways of contact	6,47	2,46
3	Contact center is available in convenient hours	7,39	2,52
4	Time for waiting for connection with contact center is short	5,52	2,93
5	Contact center employees quickly solve my problems	6,72	2,67
6	Contact center employees are interested in my problems	6,58	2,70
7	Contact center employees' behavior builds trust	7,40	2,42
8	Contact center employees have knowledge allowing to give an answer	7,41	2,39
9	Contact center gives comprehensive answers	7,74	2,27
10	Contact center gives complete answers	7,28	2,38
11	Contact center gives precise answers	7,20	2,36
12	Contact center gives relevant answer	7,05	2,37
13	Contact center employees treat me individually	7,11	2,53
14	Contact center employees give special attention to me	6,62	2,57
15	My matters are close to contact center employees' hearts	6,29	2,61
16	Contact center employees understand my special needs	6,48	2,53

Source: autor's own study.

## Using cluster analysis

The term cluster analysis was introduced by R. Tryon (Tryon, 1939) and then developed by R. Cattell (Cattell, 1944). The use of cluster methods has increased dramatically in the last 30 years (Gore, 2000). Cluster analysis encompasses a number of different algorithms and methods for grouping objects of similar kind into respective categories. A general question facing researchers in many areas of inquiry is how to organize observed data into meaningful structures, that is, to develop taxonomies. In other words cluster analysis is an exploratory data analysis tool which aims at sorting different objects into groups in a way that the degree of association between two objects is maximal if they belong to the same group and minimal otherwise (StatSoft, 1997). The objective of cluster analysis is to group objects into clusters such that objects within one cluster share more in common with one another than they do with the objects of other clusters. (Gore, 2000).

Cluster analysis can be used to discover structures in data without providing an explanation and interpretation. In other words, cluster analysis simply discovers structures in data without explaining why they exist (StatSoft, 1997). This method is unsupervised, which means that all the relationships are found only on a basis of input variables. It should be added, that cluster analysis is not as much a typical statistical test as it is a collection of different algorithms that put objects into clusters according to well defined similarity rules. The point here is that, unlike many other statistical procedures, cluster analysis methods are mostly used when we do not have any a priori hypotheses, but are still in the exploratory phase of our research.

Clustering techniques have been applied to a wide variety of research problems. Whenever it is needed to classify a large amount of information into manageable meaningful piles, cluster analysis is of great utility. The methods used in cluster analysis encompass (StatSoft, 1997):

- joining (tree clustering),
- k-means clustering,
- two-way joining,
- expectation maximization clustering.

Two types of clustering algorithms can be distinguished: hierarchical and non-hierarchical. Hierarchical methods lead to creating a hierarchical tree-like structure of the elements of the analyzed set, which in its horizontal version is called a tree plot, and in its vertical version - an icicle plot. So, the effects of the algorithm can be presented as a tree, which shows the next steps of the performed analyses (Migut, 2009). This way a final segmentation can be obtained, which means an orderly combination of a breakdown into segments. Different methods can be used here. Owing to the efficiency of reproducing the real data structure, the Ward method is recommendable. It uses the rule of minimizing variation (Migut, 2009). These methods do not require an earlier assumption on the number of clusters – a plot can be „cut off” on a proper height in the end of an analysis and then interpreted. As

a criterion for specifying an optimal number of segments, the first distinct growth of the distance, implying from the analyses of the distance graph for the next stages of bonding can be acknowledged. However, for the large data sets they require high computing power. The most popular method here is joining (tree clustering). In turn, non-hierarchical methods are quick to calculate, but they require to declare the assumed number of clusters in advance, which strongly influences the quality of obtained segmentation. Here, a method of k-means is very popular.

In the paper, for clustering variables (columns) the Ward method was used. It was enough to identify clusters and rationally interpret them.

Vertical tree graph (icicle plot) in Figure 1 shows clusters for service quality obtained in another steps of analysis, while graph in Figure 2 shows the growth of linkage distance in another steps (iterations).

From Figure 2 it can be seen that cutting a plot off at a standardized linkage distance e. g. 70, 4 clusters are obtained. Figure Y shows that the substantial increase in linkage distance took place in 11 and 13 out of 15 analysis steps.

Interpretation of the obtained clusters is as follows (the order of linking variables was preserved, hence they are not sorted):

- cluster 1, „answer” (A), encompasses variables no. 12, 11, 10, 9, 8 and 7, that is relevancy, precision, completeness and comprehensiveness of an answer, as well as contact center employees knowledge and trust they are able to build,

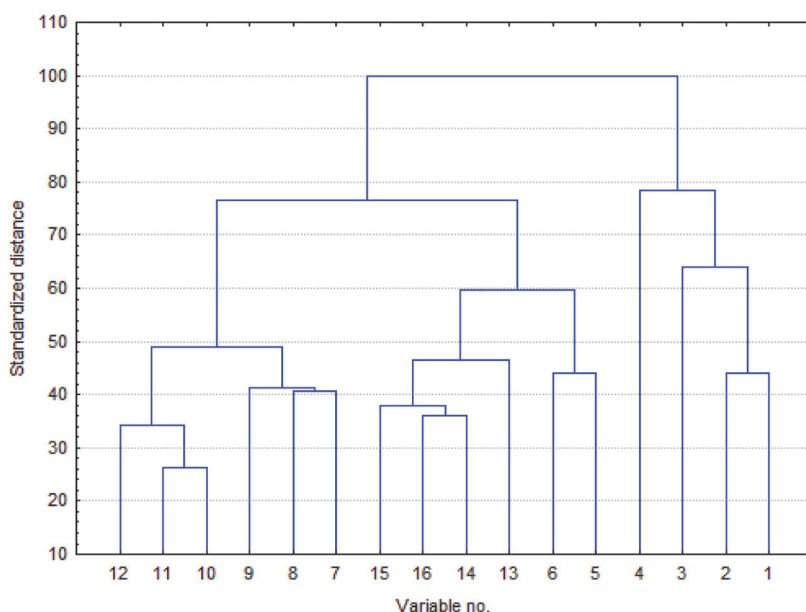
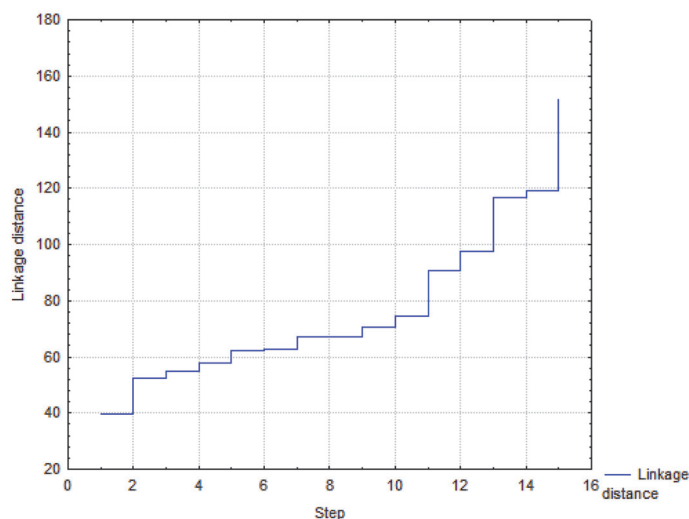


Figure 1. Icicle plot for service quality cluster analysis

Source: authors' own study.

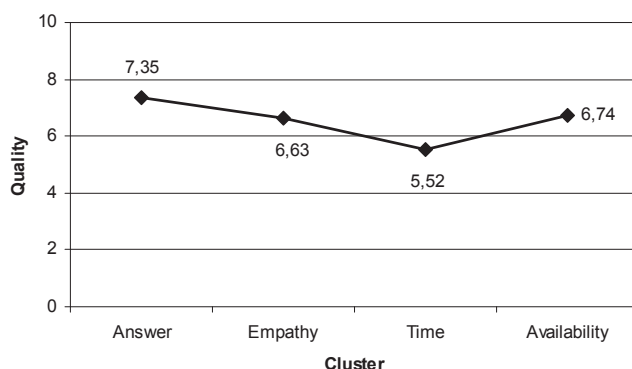


**Figure 2.** Linkage distance in another steps for service quality cluster analysis

Source: authors' own study.

- cluster 2, „empathy” (E), encompasses variables no. 15, 16, 14, 13, 6 and 5, that is sympathy, understanding special customer needs, giving special attention to a customer, individual treating, interest in and quick problem solving,
- cluster 3, „time” (T), encompasses variable no. 4 (time of waiting in a queue for connection),
- cluster 4, „availability” (AV), encompasses variables no. 3, 2 and 1, that is availability of contact center services in convenient hours, using convenient contact channels and easiness of finding contact data.

The results of quality measurement (quality profile) for each cluster are shown in Figure 3.



**Figure 3.** Service quality for quality clusters

Source: authors' own study.

In Figure 3 the profile of contact center services quality obtained from cluster analysis is drawn. At this figure it can be observed that the highest quality assessment is for the cluster „answer” (A) – 7,35. Then, for „empathy” (E) quality reaches 6,63. The quality concerning cluster „availability” (AV) is at the level of 6,74. Cluster „time” (T) is of decidedly the lowest quality assessment (5,52). Comparing these results to the results of the previous research performed with the use of factor analysis (Lotko, 2009), it seems an advantage of cluster analysis to distinguish this cluster, as meaningfully important for improving quality of services provided by contact centers, as this variable has visibly the lowest quality of all.

## Summary

Today’s information and communication technology offers possibilities to communicate with customers in mass, yet customized manner with the use of multiple contact channels. This is done via contact centers, which are a tool for fulfilling the relationship marketing assumptions. Taking advantage on technology, organizations are seeking contact with their customers to inform them, offer additional services and learn about their behavior. Still, a problem of technology-intermediated service quality arises, contradicting a traditional face-to-face relationship during service delivery.

As a result of the empirical research it can be stated that the results obtained by applying cluster analysis to assessment of the quality of contact center services are sensible and logical. The results show that service quality in customer contact centers can be successfully measured using the set of the four clusters: „answer”, „availability”, „time” and „empathy”. In more detail, it can be concluded, that the results obtained using cluster analysis are as follows:

- cluster 1, „answer” (A), covers relevancy, precision, completeness and comprehensiveness of an answer, as well as contact center employees knowledge and trust they are able to build,
- cluster 2, „empathy” (E), covers sympathy, understanding special customer needs, giving special attention to a customer, individual treating, interest in and quick problem solving,
- cluster 3, „time” (T), covers time of waiting in a queue for connection with contact center,
- cluster 4, „availability” (AV), encompasses availability of contact center services in convenient hours, using convenient contact channels and easiness of finding contact data.

The highest quality assessment is for the cluster „answer” (A). Then, for „empathy” (E) it reaches 6,63. The quality concerning cluster „availability” (AV) is at the level of 6,74. Cluster „time” (T) is of decidedly the lowest quality assessment (5,52).

The applied approach makes the measurement of contact center services quality more comprehensible. The results of the research are of both cognitive and utilitarian character. The first explain the structure of the construct „quality of services in contact centers”. The second can be used to design contact centers services with a special attention paid to the matters of quality to fully meet customers’ expectations.

As further research, it is predicted to compare the achieved results with the results achieved with the use of other multidimensional exploratory techniques.

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Izabela Młynarzewska-Borowiec<sup>1</sup>

## CONVERGENCE TENDENCIES IN THE EU MEMBER STATES – A STATISTICAL STUDY FOR THE PERIOD 1980–2013

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### *Abstract*

*The aim of the article is empirical analysis of convergence process in the European Union especially after extending it by the groups of less developed countries („cohesion” countries after their accession in the 1980s and Central and Eastern Europe countries after 2004). The econometric methods, based mainly on regression growth models, are implemented, first of all, to verify the hypothesis about the existence of beta convergence and its impact on sigma convergence; secondly, to verify the theoretically proved statement that capital accumulation become less important in convergence processes as compared to the increasing role of technological progress. The results of the investigation point at the existence of beta convergence and its important but decreasing impact on reducing income disparities among European Union Member States. An additional survey on the existence of convergence clubs, conducted using the approach based on polynomial functions, confirms, that all the analysed countries were approaching the same steady state and creating a common convergence club.*

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JEL Classification Code: **G10, G15.**

**Keywords:** convergence, economic growth, convergence club, catching-up process.

### **Introduction**

As early as the mid-eighties of the twentieth century, economic literature started to challenge the hypothesis of real convergence on a global scale and, therefore, the existence of the phenomenon of absolute convergence (Baumol, 1986; Dowrick, Nguyen, 1989; de Long, 1988). Most economists, however, agree with the view on the existence of convergence of per capita income within countries which differ in initial

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capital resources but have identical production functions and levels of savings and strive for the same „goal”, i.e. a long-term equilibrium called the steady state. These groups of countries are referred to as convergence clubs.

According to the concept of conditional convergence, a country with low initial capital resources is characterised by larger increments in income due to a high rate of return on investment. The increase in income in richer countries with larger capital resources is lower, leading over time to aligning the income levels in both countries (Barro, Sala-i-Martin, 1991, 1992; Mankiw, Romer, Weil, 1992). It has been theoretically and empirically proved, however, that this „catching up” (convergence  $\beta$ ) does not guarantee real convergence of income levels in economies in the long term or the reduction of disparities in the level of development, and therefore, it does not guarantee the so-called convergence  $\sigma$  (Friedman, 1992; Quah, 1993). The differences in the level of GDP per capita between countries may even increase if during the process of reaching the steady state random and asymmetric shocks occur (Sala-i-Martin, 1996).

Type  $\beta$  convergence is thus a necessary condition for the existence of convergence  $\sigma$ , but it is not sufficient. Moreover, theoretically speaking, the assumption about the decreasing revenues from capital implies the inability to continuously increase production by expanding capital resources. It turns out that in the long run, the importance of capital accumulation decreases, and the only source of growth of per capita income is technical progress, thanks to which the economy is able to produce more with the same capital resources. The existence of convergence is dependent, inter alia, on differences in total factor productivity or TFP (Hulten, 2000; Caselli, Tenreyro, 2005).

The convergence of countries to a common steady state and belonging in the convergence club is undoubtedly conditioned by their similar level of economic and technological development, complementarity of economic structures and institutional interrelationships. Convergence is therefore more likely in integration groups such as the European Union (Bukowski, 2011). In the history of integration within the European Union, there are cases of accession of countries that are at a relatively lower level of economic development, such as the accession of Greece, Spain and Portugal in the 1980s, or the countries of Central and Eastern Europe in 2004. Taking into account the above theoretical discussion, the logical consequence of the accession of this type of countries should be  $\beta$  convergence, which is a gradual process of „catching up” with relatively richer countries by these countries. Thanks to the process of integration in the „underdeveloped” countries, key channels of accelerating economic growth are opened, i.e. restructuring of the economy, the development of competition, the influx of technology, investments in infrastructure and the liberalisation of trade and the exchange rate regime. These changes manifest themselves even before the official accession as a result of the so-called integration anchor (Rapacki, Próchniak, 2012). The process of „catching up” is also affected by EU policies focused on reducing disparities in the level of development, reflected in intense influx of aid funds to relatively less developed countries (Fayolle, Lecuyer, 2000,

Beugelsdijk, Eijffinger, 2003). The existence of  $\beta$  convergence within EU Member States may, but does not have to, translate into eliminating development disparities within the group ( $\sigma$  convergence). In addition, the existence of a negative correlation between the initial level of GDP per capita and the average growth rate in a group of integrating countries does not guarantee that each of them „moves” toward the same steady state. It may happen that some of them even show divergence. On the other hand, a positive correlation between both economic values within a group as a whole does not exclude the possibility that some of them show convergence of income, thereby forming a convergence club (Bernard, Durlauf, 1996).

The purpose of this paper is to analyse the processes of convergence in the European Union (and EEA), taking place especially during the period of expanding the group with countries which are at a relatively lower level of economic development. Particular attention is paid to the processes of growth occurring after the accession of Greece, Spain and Portugal in the eighties of the twentieth century and in the period of preparation and after the accession of CEE countries. The study verifies the existence of type  $\beta$  convergence and its impact on reducing development disparities in the analysed group of countries, i.e.  $\sigma$  convergence. An attempt is also made to check whether in the case of the European Union, the statement, proved on a theoretical basis, about the declining importance of capital accumulation ( $\beta$  convergence) in the creation of convergence processes is confirmed. In addition, by performing appropriate tests for the existence of convergence clubs, it is examined whether all Member States follow the same path of growth, striving for the same long-run equilibrium point, hence belonging in the same convergence club.

## **1. The phenomenon of real convergence of European Union Member States in the different periods of their integration**

### **1.1. Metodology**

Studies on the convergence processes can be conducted using panel data, average data obtained from 10 or 5-year sub-periods or averaged data for the entire analysed period. The methods mentioned above have advantages and disadvantages (Rapacki, Próchniak, 2012).

Taking into account a large number of observations and various methods of estimation, it may be said that studies based on panel data are more solid. However, from the economic point of view, an analysis that uses that kind of data is distorted by the influence of business cycles and other irregular fluctuations of the economy.

A better solution is to use average data for sub-periods. The connection between the initial income and middle- and long run growth processes can be then investigated. The longer the sub-period is (e.g. 10 years), the more reliable the results are from the economic point of view (business cycles, lasting usually less than 10 years, are

eliminated), and less significant from the statistical point of view. Furthermore, the following method including relatively short 20-year period is difficult to implement.

Taking into account the method based on average data for the entire analysed period, one should be aware that a limited number of observations influences the statistical credibility of the obtained results. However, from the economical point of view, the mentioned approach seems to be more adequate. It focuses on the long-run relations between variables, in other words, gives an opportunity to investigate the relation between initial conditions of economies and their long-run growth processes. In research based on average (thus stationary) data, the simple linear regression model and the classical least squares method of estimation can be implemented.

The study of real convergence of the European Union Member States in the different periods of their economic integration, used the two most popular measures of real convergence,  $\beta$  convergence and type  $\sigma$  convergence.

The easiest way to verify the hypothesis of conditional  $\beta$  convergence is estimating the structural parameters of the following equation:

$$\frac{1}{T} \ln \frac{Y_T}{Y_0} = \alpha_0 + \alpha_1 \ln Y_0 + \varepsilon \quad (1)$$

The left side of the equation represents the average growth rate of GDP per capita between the period  $T$  and the base period 0. The explanatory variable is the logarithm of the initial level of per capita income. The negative value of the parameter  $\alpha_1$  means the occurrence of convergence, whose rate is reflected by the coefficient  $\beta$  defined by the following formula:

$$\beta = -\frac{1}{T} \ln(1 + \alpha_1 T) \quad (2)$$

The higher the coefficient  $\beta$  value (between 0 and 1), the higher the convergence rate (Barro, Sala-i-Martin, 2003; Próchniak, 2006).

Due to the fact that the  $\beta$  convergence can be treated as one, but not the only, determinant of the convergence process manifested by a reduction in disparities in GDP per capita of a certain group of countries, i.e.  $\sigma$  convergence, it appears reasonable to investigate the existence and the rate of this type of convergence in the analysed group of countries. A relatively simple way to verify the  $\sigma$  convergence hypothesis is to estimate the trend lines for the difference levels of income between countries (measured by the standard deviation of the GDP per capita logarithm):

$$\text{sd}(\ln Y_t) = \alpha_0 + \alpha_1 t + \varepsilon \quad (3)$$

A negative  $\alpha_1$  coefficient value (ranging from -1 to 0) indicates the occurrence of  $\sigma$  convergence.

The above mentioned formulas were used to conduct a study of real convergence in a group of 15 (in the period 1980- 2004) and 27 (in the periods 1993- 2004 and

2004-2013) European Union Member States. Data on GDP per capita in the Member States was obtained from the International Monetary Fund World Economic Outlook Database, 2014 (data in USD, current prices).

### 1.2. Beta convergence of European Union Member States – results

The analysis of the process of „catching up” (type  $\beta$  convergence) among the European Union Member States was conducted for several periods. This is due to the EU expansion (and earlier EEC) to other countries and the associated difficulties in providing a general overview of convergence in the group. The first studied period covers the years 1980-2004, starting with the accession of the relatively less developed Greece, then Spain and Portugal, and ends before the accession of the next group of countries with relatively lower GDP per capita, i.e. the countries of Central and Eastern Europe. The second area of analysis relates to the period 1993-2013 and is associated with the preparation of the above group of countries for the accession, i.e. after signing association agreements (sub-period 1993-2004) and their functioning in the EU as Member States (sub-period 2004-2013).

The results in Table 1 confirm the existence of a negative correlation between the initial level of wealth and the growth rate of GDP per capita of the EU Member States (EEC) of that time, and therefore, the  $\beta$  type convergence in the period 1980-2004. Greece, Spain and Portugal, which at the time of accession had approximately half the level of GDP per capita compared to the average for the EU-15, in the analysed period approached the most developed EU countries at a rate of about 2% per year. Analysing, on the other hand, the European Union after 1993, i.e. including the then candidate countries, a much faster pace of „catching up” (3.5%) may be observed. CEE countries, which in 1993 were characterised by significantly lower than those „cohesion countries” GDP per capita of only about 30% of the average level of this ratio for the whole group, showed a high rate of developmental catching up, which is fully compatible with the concept of convergence arising directly from Solow’s model (1956). The process of „catching up” was particularly evident within the EU-12. These countries, during the period 1993 – 2013, were drifting towards a common steady state at a rate of 5.2%. This observation confirms the validity of the concept of conditional convergence, and therefore the importance of homogeneity of countries in shaping the convergence processes and their dynamics.

For a more detailed analysis of the convergence process, which, as has been proved above, took place in the European Union after 1993, new models were constructed for the EU-27 and EU-12 in the periods 1993-2004 and 2004-2013. Results of the estimation and evaluation of the quality of the models are presented in Table 2.

Generally, the official membership of the so-called „new” EU Member States, whose accession took place in 2004 and 2007, did not significantly influence their catching up process in terms of developmental distance to both the richest countries in the Union and to one another. The rate of convergence in the EU-27 and EU-12

after 2004 was even lower than in the period of intensive preparation of the CEE countries for the EU membership.

**Table 1.** Estimation results of growth regression models describing absolute convergence  $\beta$  among the European Union Member States (EU-15, EU-12, EU-27) in the period 1980-2013; dependent variable:  $\ln(Y_t/Y_0)/T$ ; classical least squares method estimation

Variable / model diagnostics	EU-15	EU-27	EU-12
	1980-2004	1993-2013	
constant	0,20101	0,29035	0,342989
stand. error	0,0466337	0,0190009	0,030827
Student's t	4,3104	15,2809	11,1262
p value	0,00085	<0,0001	<0,00001
significance	***	***	***
$\ln$ GDP per capita in 1980/1993	-0,0163375	-0,0256328	-0,0324152
stand. error	0,0050789	0,00209429	0,00386027
Student's t	-3,2167	-12,2394	-8,3971
p value	0,00675	<0,00001	<0,00001
significance	***	***	***
F- Snedecor's test <sup>1</sup>			
F-statistic	10,34743	149,8023	70,51188
critical value	4,66146	4,2417	4,9646
p value	0,006747	4,70e-12	7,68e-06
result	rejection of $H_0$	rejection of $H_0$	rejection of $H_0$
White's test <sup>2</sup>			
test's statistic	0,064508	1,01952	4,66443
critical value	5,99146	5,99146	5,99146
p value	0,9682	0,60064	0,0970804
result	acceptance of $H_0$	acceptance of $H_0$	acceptance of $H_0$
Adjustment of models			
$R^2$	0,443194	0,856981	0,875795
Adjusted $R^2$	0,400362	0,851261	0,863374
Convergence analysis			
$\beta$ convergence	yes	yes	yes
$\beta$ coefficient <sup>3</sup>	0,0210 (2,1%)	0,035939 (3,5%)	0,052249 (5,2%)
Number of observations	15	27	12

1 – F-Snedecor's test:  $H_0: \alpha_1 = \alpha_2 = \dots = \alpha_k$ ; rejection of hypothesis  $H_0$  indicates that the estimated model includes significant variables.

2 – White's test:  $H_0$ : random component is homoscedastical; acceptance of the hypothesis  $H_0$  indicates the existence of homogeneity of variance.

3 – calculated according to formula (2).

Source: own calculations using GRETl software.

**Table 2.** Estimation results of growth regression models describing absolute convergence  $\beta$  among the European Union Member States (EU-27, EU-12) in the period 1993-2013; dependent variable:  $\ln(Y_t/Y_0)/T$ ; classical least squares method estimation

Variable / model diagnostics	EU-27		EU-12	
	1993-2004	2004-2013	1993-2004	2004-2013
constant	0,368147	0,338949	0,405581	0,419077
stand. error	0,055004	0,0636833	0,0547132	0,0608094
Student's t	6,6332	5,3224	7,4128	6,8917
p value	<0,00001	0,00002	0,00002	0,00004
significance	***	***	***	***
$\ln$ GDP per capita in 1993/2004	-0,0318587	-0,029632	-0,03956	-0,0396535
stand. error	0,00587952	0,00625495	0,0068514	0,00671979
Student's t	-5,4186	-4,7374	-5,7740	-5,9010
p value	0,00001	0,00007	0,00018	0,00015
significance	***	***	***	***
F- Snedecor's test <sup>1</sup>				
F-statistic	29,36106	22,44269	33,3391	34,82195
critical value	4,2417	4,2417	4,9646	4,9646
p value	0,000013	0,000074	0,000179	0,000151
result	rejection of $H_0$	rejection of $H_0$	rejection of $H_0$	rejection of $H_0$
White's test <sup>2</sup>				
test's statistic	1,79256	2,28403	1,64721	1,36035
critical value	5,99146	5,99146	5,99146	5,99146
P value	0,408085	0,319175	0,438847	0,506527
result	acceptance of $H_0$	acceptance of $H_0$	acceptance of $H_0$	acceptance of $H_0$
Adjustment of models				
$R^2$	0,540112	0,473048	0,769262	0,776895
Adjusted $R^2$	0,521716	0,451970	0,746188	0,754585
Convergence analysis				
$\beta$ convergence	yes	yes	yes	yes
$\beta$ coefficient <sup>3</sup>	0,040147 (4%)	0,03446 (3,4%)	0,053652 (5,4%)	0,049047(5%)
Number of observations	27		12	

1 – F-Snedecor's test:  $H_0: \alpha_1 = \alpha_2 = \dots = \alpha_k$ ; rejection of hypothesis  $H_0$  indicates that the estimated model includes significant variables.

2 – White's test:  $H_0$ : random component is homoscedastical; acceptance of the hypothesis  $H_0$  indicates the existence of homogeneousness of variance.

3 – calculated according to formula (2).

Source: own calculations using GRETL software.

A slight decrease in the rate of „catching up” in the period 2004-2013 can be partly explained by the effects of the economic crisis which started in 2007. However, the downward trend in the value of coefficient  $\beta$  may also be evidence that the passage of time and the catching-up of developmental distance also in the case of the „new”



EU countries capital accumulation ceases to be the main cause of convergence and its place is gradually overtaken by changes in total factor productivity (TFP). The above hypothesis is confirmed by the fact that significantly lower coefficient  $\beta$  was observed in the EU-15 and the entire EU-27.

The diagnostic tests of individual models included in Table 1 and Table 2, i.e. the F-Snedecor test and White's test for heteroscedasticity<sup>2</sup>, allow to consider them sufficient in studying the phenomenon of convergence. Also satisfactory values of determination coefficients were obtained ( $R^2$  and adjusted  $R^2$ ).

### 1.3. Sigma convergence of European Union Member States – results

In light of the results of the study on the existence of  $\sigma$  convergence presented in Table 3, it can be concluded that developmental disparities between Member States decreased during the analysed 34-year period of the operation of the group.

Negative values of the structural parameters of the time variable  $t$  in each of the estimated equations indicate a gradual decrease in the standard deviation of the logarithm of per capita GDP in the analysed groups. Neutralising developmental differences was particularly evident in the expanded European Union (EU-27) and in the group of the „new” Member States. It was observed to a much lesser extent in the „former fifteen”. Therefore, in the case of the European Union one can observe a clear correlation between the rate of „catching up” and type  $\sigma$  convergence. A higher rate of  $\beta$  convergence translates into faster reduction of the disparities in income per capita in the analysed groups of countries and vice versa.

**Table 3.** Estimation results of models describing sigma convergence among the European Union Member States (EU-15, EU-27, EU-12) in the period 1980-2013; classical least squares method estimation

Variable / model diagnostics	EU-15	EU-27	EU-12
Dependent variable	sd UE 15 1980_2004	sd UE 27 1993_2013	sd UE 12 1993_2013
constant	0,457403	1,17749	0,874513
stand. error	0,00814288	0,0181603	0,0115022
Student's t	56,1722	64,8386	76,0299
p value	<0,00001	<0,00001	<0,00001
significance	***	***	***
$t$ variable	-0,0048227	-0,0287946	-0,0262944
stand. error	0,0005477	0,00151599	0,00103293
Student's t	-8,8046	-18,9940	-25,4561
p value	<0,00001	<0,000001	<0,00001
significance	***	***	***

<sup>2</sup> In the case of models based on cross-sectional data, there is a suspicion of the existence of heteroskedasticity, because the variance of the random component may depend on the size of GDP in a given country. Therefore, a desirable feature of the model is heteroskedasticity.



Table 3 continued.

Variable / model diagnostics	EU-15	EU-27	EU-12
F- Snedecor's test <sup>1</sup>			
F- statistic	77,52050	360,7705	648,0133
critical value	4,27934	4,41387	4,41387
p value	7,97e-09	2,34e-13	9,34e-14
result	rejection of $H_0$	rejection of $H_0$	rejection of $H_0$
White's test <sup>2</sup>			
test's statistic	5,07429	8,30839	7,17272
critical value	5,99146	9,21034	9,21034
P value	0,0790919	0,0156985	0,0276989
result	acceptance of $H_0$	acceptance of $H_0$	acceptance of $H_0$
Adjustment of models			
$R^2$	0,771191	0,952478	0,977376
Adjusted $R^2$	0,761243	0,949838	0,975868
Convergence analysis			
Sigma convergence	yes	yes	yes
Number of observations	25	21	

1 – F-Snedecor's test:  $H_0: \alpha_1 = \alpha_2 = \dots = \alpha_k$ ; rejection of hypothesis  $H_0$  indicates that the estimated model includes significant variables.

2 – White's test:  $H_0$ : random component is homoscedastical; acceptance of the hypothesis  $H_0$  indicates the existence of homogeneity of variance.

3 – calculated according to formula (2).

Source: own calculations using GRETl software.

The study achieved high significance of the structural parameters. Diagnostic tests included in Table 3 indicating a relatively good quality of the models allow to consider the adopted method of testing this type of convergence as sufficient.

## 2. Test on the existence of convergence clubs among European Union Member States in the different periods of their integration

The concept of convergence clubs refers to the notion of the existence of the multiple equilibria in the global or regional range. Similar countries converge in the long-run towards each other and their initial conditions move towards the same stationary equilibrium (Galor, 1996). The cross-country regressions, implemented above, do not account for the existence of multiple equilibria. If we estimate a negative correlation between the average growth rate and initial GDP per capita, it's impossible to know if all the countries are converging (and creating a convergence club) or only some of them. Moreover, the conducted study on sigma convergence in UE Member States concerns the analysis of income dispersion mostly by looking at the

development of income standard deviation over time, not at the relative income levels. The hypothesis of the convergence club can be more efficiently tested using nonparametric methods, e.g. introducing polynomial functions in the growth equation (Chatterji, 1992; Quah, 1996).

### 2.1. The model of convergence clubs- an approach based on polynomial functions

To test the existence of the convergence club among the EU Member States the approach of Chatterji and Dewhurst (1996) has been implemented. The starting point of the model construction is the following equation proposed by Barro and Sala-i-Martin<sup>3</sup> (1995):

$$\ln\left(\frac{Y}{L}\right)_{i,t} - \ln\left(\frac{Y}{L}\right)_{i,0} = a_i + b \ln\left(\frac{Y}{L}\right)_{i,0} + \varepsilon \quad (4)$$

In the model constructed by Chatterji and Dewhurst, the development of income dispersion is analysed by determining all variables in equation (4) as gap forms by subtracting all the logarithmic levels from the maximal level and rearranging the same year gaps to the same side (equation 5).

$$\ln\left(\frac{Y}{L}\right)_{\max,t} - \ln\left(\frac{Y}{L}\right)_{i,t} = (1 + b) \left[ \ln\left(\frac{Y}{L}\right)_{\max,0} - \ln\left(\frac{Y}{L}\right)_{i,0} \right] + \varepsilon \quad (5)$$

$\ln(Y/L)_{\max,t}$  and  $\ln(Y/L)_{\max,0}$  are GDP per capita in the richest country in the terminal year  $t$  and the initial year  $0$ .  $\ln(Y/L)_{i,t}$  and  $\ln(Y/L)_{i,0}$  are GDP per capita in all other economies in the terminal year  $t$  and the initial year  $0$ , respectively. To model the possibility of multiple equilibria, Chatterji and Dewhurst included in the above equation variables measuring wideness of the gap between the initial income of the „leader” country and that of the country  $i$ . Describing this gap as  $GAP_{GDP} = \ln(Y_{\max}) - \ln(Y_i)$ , the convergence model can be written as:

$$GAP_{GDP,t} = \sum_{k=1}^k A_k (GAP_{GDP,0})^k + \varepsilon \quad (6)$$

The number of convergence clubs will depend on the value of  $k$ . When  $k=3$  a cubic function is taken into account that stands for two mutually exclusive convergence clubs. The convergence model is the following:

$$GAP_{GDP,t} = A_1 (GAP_{GDP,0}) + A_2 (GAP_{GDP,0})^2 + A_3 (GAP_{GDP,0})^3 \quad (7)$$

<sup>3</sup> where:  $a_i = x_i + (1 - e^{-\beta}) \ln(y_i^* + x_{i,0})$ ;  $b = -(1 - e^{-\beta})$ ;  $x_i$  – the speed of technological process,  $y^*$  – steady state point,  $\beta$  – the speed of beta convergence.

In the equilibrium of function (7) the gap is constant ( $GAP_{GDPt} = GAP_{GDP0}$ ). Therefore, three possible equilibria exist<sup>4</sup> and two different cases may appear (see Fig. 1).

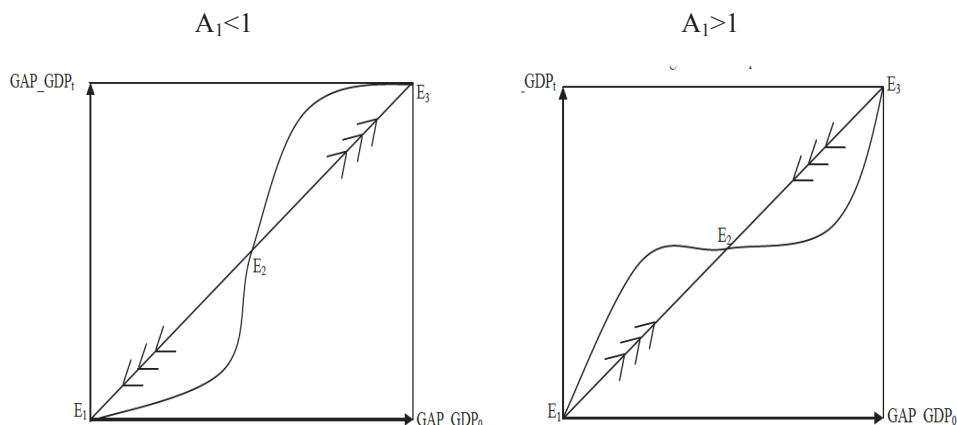


Figure 1. Possible convergence clubs: case  $A_1 < 1$ , case  $A_1 > 1$

Source: own work.

If  $A_1 < 1$  the solving of equation (7) leads to three different equilibria (two stable  $E_1$  and  $E_3$  and one unstable  $E_2$ ). Countries that have a gap of GDP per capita with the „leader” country below the  $E_2$  level will converge towards the  $E_1$  income level. These countries converge to the same income level as the „leader” in the long term. When the gap is too large (above  $E_2$ ), then countries diverge from the level of the „leader” country and converge to the lower income level ( $E_3$ ).

In the case where  $A_1 > 1$ , the only one stable equilibrium is  $E_2$ . All countries that have an income gap with the „leader” below the  $E_3$  level  $E_3$  converge to the  $E_2$  level  $E_2$ . Countries with the initial gap between  $E_2$  and  $E_3$  actually also converge to the „leader” country. In turn, countries that have a gap between  $E_1$  and  $E_2$  diverge from the „leader”, similarly to the economies with the gap greater than  $E_3$ . The last group of countries diverges from all other economies.

## 2.2. Results

To test the existence of a convergence club among the EU Member States in the different periods of their integration the following equations are estimated:

$$GAP_{GDP,2004} = A_1 (GAP_{GDP,1980}) + A_2 (GAP_{GDP,1980})^2 + A_3 (GAP_{GDP,1980})^3 \quad (8)$$

<sup>4</sup> in the points where function (7) line cuts 45 degree line (benchmark line).

$$GAP_{GDP,2013} = A_1 (GAP_{GDP,1993}) + A_2 (GAP_{GDP,1993})^2 + A_3 (GAP_{GDP,1993})^3 \quad (9)$$

$$GAP_{GDP,2004} = A_1 (GAP_{GDP,1993}) + A_2 (GAP_{GDP,1993})^2 + A_3 (GAP_{GDP,1993})^3 \quad (10)$$

$$GAP_{GDP,2013} = A_1 (GAP_{GDP,2004}) + A_2 (GAP_{GDP,2004})^2 + A_3 (GAP_{GDP,2004})^3 \quad (11)$$

Equation (8) tests the existence of a convergence club within „the former UE-15” in the period 1980- 2004. The gap variable (for the year 1980 and 2004) was formed by taking a natural logarithm of GPP per capita in the leader country (in that case Luxembourg) over the GDP per capita in each other country. Models (9), (10) and (11) test the club convergence of 27 members of the EU (respectively in the periods 1993-2013, 1993-2004 and 2004- 2013). The gap variables in the analysed year t and initial year 0 were constructed with Luxembourg as a benchmark country. The obtained results of the regressions are included in table 4. Each row of the table reports the coefficients, t-statistics, the fit of the regression and the equation standard errors.

**Table 4.** Convergence clubs in the European Union from 1980 to2013 (classical least squares method estimation)

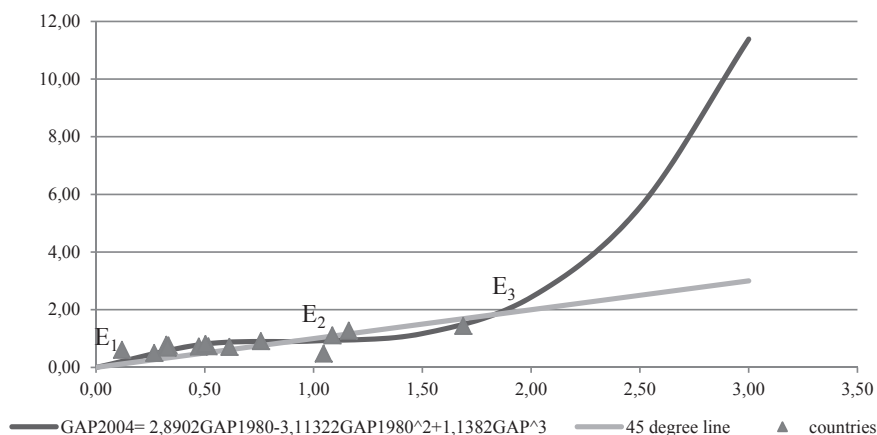
Model	$GAP_{GDPt}$	$GAP_{GDP0}$	$A_1$ (stand. error) Student's t	$A_2$ (stand. error) Student's t	$A_3$ (stand. error) Student's t	F-statistic (p value)	$R^2$ Corr. $R^2$
(8)	$GAP_{GDP2004}$	$GAP_{GDP1980}$	2,8902*** (0,4592) 6,2944	-3,11322*** (0,8877) -3,5072	1,1383** (0,3916) 2,9069	72,1423 (1,61e-07)	0,9516 0,9428
(9)	$GAP_{GDP2013}$	$GAP_{GDP1993}$	1,6881*** (0,1189) 14,2019	-0,5263*** (0,0924) -5,6960	0,0640*** (0,0167) 3,8236	610,7661 (4,65e-22)	0,9876 0,9865
(10)	$GAP_{GDP2004}$	$GAP_{GDP1993}$	1,14319*** (0,1408) 8,1166	-0,137537* (0,1095) -1,2562	0,0089* (0,0198) 0,4484	498,2717 (4,67e-21)	0,9848 0,9835
(11)	$GAP_{GDP2013}$	$GAP_{GDP2004}$	1,60713*** (0,09364) 17,1625	-0,50026*** (0,09582) -5,2208	0,0820067*** (0,02303) 3,5607	1823,991 (1,76e-27)	0,9958 0,9955

\*\*\*/\*\*/\* statistically significant at the level of 1%, 5%, 10%

Source: own calculations using GRETl software.

Based on a preliminary analysis of the results, it can be concluded that in the case of the EU Member States at different stages of integration, there exists one steady state (values of  $A_1$  coefficients for each of the estimated equations are higher than 1) to which the analysed countries converge or (possibly) from which they diverge. A graphical interpretation of the results broken down by sub-periods is shown below.

Fig. 2 shows the creation of the convergence club within the 15 EU in the period 1980-2004. The equilibrium points ( $E_1$ ,  $E_2$ ,  $E_3$ ) were determined by intersecting the estimated function (8) with a 45-degree line.

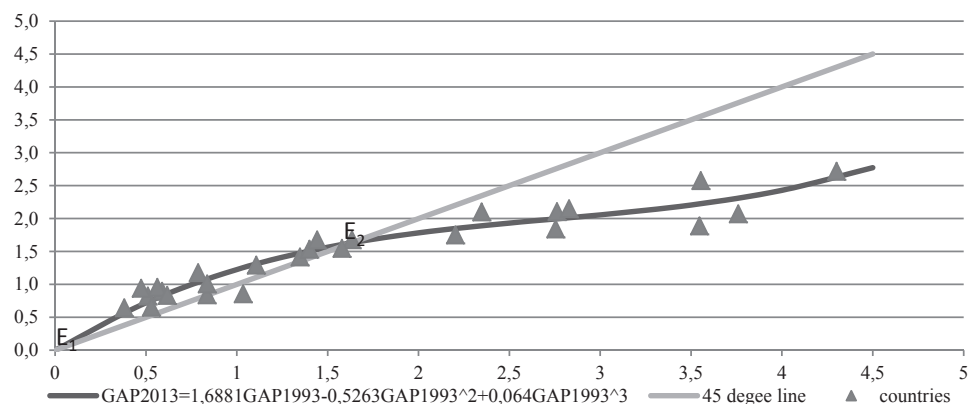


**Figure 2.** Convergence clubs from 1980-2004

Source: own calculations

All the Member States from that period drifted towards the common long-run equilibrium  $E_2$ , thereby creating a convergence club. In the base period, none of them showed a gap in GDP per capita (compared to the most developed Luxembourg) with values higher than 1.83 (corresponding to point  $E_3$ ). Portugal got closest to this point (the gap in 1980 was 1.69). Despite moving towards the same steady state the countries of the EU-15 can be clearly divided into two groups, i.e. converging upward and converging downward. The former includes countries with the GDP per capita gap in the range of (0.91, 1.83]. They were characterised by a smaller gap in 2004 as compared to 1980 (the line of the estimated function is below the line of 45 degrees). Therefore, they were catching up with relatively richer countries. Countries in this group, i.e. Greece, Spain, Portugal and Ireland, not only converged among themselves, but showed convergence to the leader (Luxembourg). The latter group includes countries with the gap in the range of (0, 0.91], to which countries of the „former 15” may be included, characterised by an increase in the GDP gap relative to the leader (the line of the estimated function (8) is above the line of 45 degrees). They showed both internal convergence and divergence with respect to Luxembourg.

A similar study was conducted for the period 1993-2013 and the European Union expanded with the next 12 member states. In the light of the obtained results, presented in Fig. 3, all countries covered by the study showed convergence to a common long-run equilibrium at point  $E_2$  (the border level of the gaps that guarantees being in the club was 6.59, and the highest level in the group was 4.30 for Bulgaria).



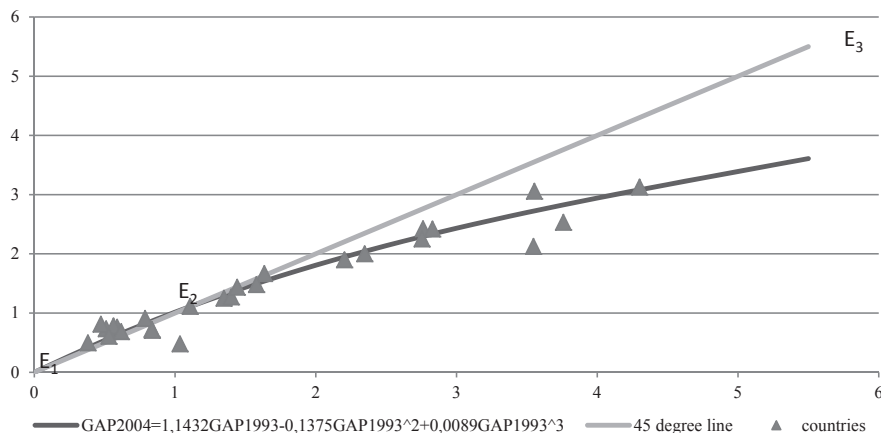
**Figure 3.** Convergence clubs from 1993-2013

Source: own calculations.

In the analysed period, the group of the „catching up” countries (with the size of the gap falling between (1.63, 6.59]) were Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Romania. The greatest progress in reducing this gap was showed by the countries with its highest levels in the base year, which is consistent with the high rate of  $\beta$  convergence of the „new” Member States. Other EU states with the size of the gap in relation to the leader in the base period in the range of (0, 1.63] showed no significant progress in reducing the gap and low intensity upward convergence in moving towards the long-term equilibrium. Ireland was an exception in this group, in the case of which a lower level of the gap compared to the base year was observed in 2004.

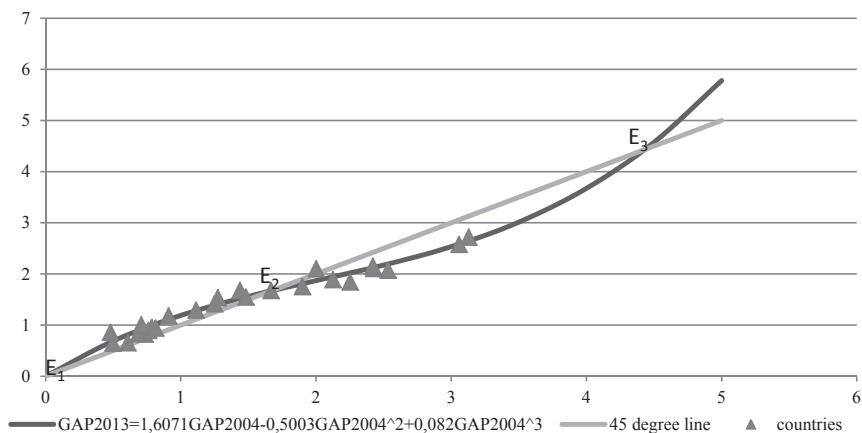
The results of a detailed analysis of these phenomena for the period 1993-2013 broken down into the periods before and after the official accession of the 12 relatively less developed countries to the EU is presented in the graphs below. They clearly confirm the importance of downward convergence in reducing the disparities between countries, especially in the period 1993 - 2004 (Figure 4). Fourteen of the 27 analysed countries (i.e. Bulgaria, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Ireland, Lithuania, Latvia, Poland, Romania, Slovakia, Slovenia, and even Finland) had lower levels of the gap in GDP per capita in 2004 as compared to the base year of 1993.

After 2004, the group of the so-called „catching-up” countries clearly shrank (Figure 5). It comprised Bulgaria, the Czech Republic, Estonia, Lithuania, Latvia, Poland, Romania and Slovakia. The rate of reduction of the gap in GDP per capita in these countries before and after the accession to the EU dropped considerably. In the period 1993-2004 the group of the abovementioned countries decreased its distance in relation to the most developed Luxembourg by an average of 22%, while in the period 2004-013 only of about 12%.



**Figure 4.** Convergence clubs from 1993-2004 Fig.4 Convergence clubs from 1993-2004

Source: own calculations.



**Figure 5.** Convergence clubs from 2004-2013

Source: own calculations.

Other EU Member States were characterised by a slight increase in the development gap in relation to Luxembourg, while demonstrating internal convergence. All countries „moved”, however, towards a common steady state designated in point  $E_2$ , thus constituting one convergence club.

## Conclusions

According to the conducted analysis, one can undoubtedly state, that the mechanism of absolute convergence (resulted directly from Solow's neoclassical model) was and still is an important determinant of growth of the European Union Member States, especially of those „new” ones with a relatively lower level of economic development. So far, the mentioned mechanism has supported the elimination of income disparities among integrating countries (sigma convergence).

The role of capital accumulation as an „engine” of convergence has been incrementally decreasing. Results of the survey on the existence of beta convergence conducted for the most developed UE members in the period 1980-2004 confirm the above statement. The first symptoms are also noticeable in the extended UE in the period 1993-2013. While the integration connections are strengthening, the catching-up processes that are characteristic for less developed (in the pre-accession period) countries, are not enhancing, just the opposite- are starting to fade out in the post- accession period. Thus, the results of the analysis conducted using econometric methods seem to confirm the theoretically proved thesis on the declining importance of capital accumulation in creating convergence processes and the increasing role of productivity changes resulting from technological progress. Consequently, one can suppose that the positive changes in TFP will become more and more important in eliminating income disparities among EU member states.

In the light of the conducted surveys, the dynamics of convergence depend on how homogenous the group of analysed countries is. A higher pace of beta convergence is observed among the „new” member states, and much lower -among all the UE members. That regularity is evidence that conditional convergence among the EU member states exists.

Due to the fact, that cross-sectional regressions are used in the surveys, they do not provide detailed information whether all the countries of the sample are converging or only some of them. Since the estimation of club convergence models is included, it is possible to state that all the analysed countries were converging towards a common steady state and creating a „convergence club” in any period taken into account. Within the „convergence clubs” one can distinct two groups of countries: (1) converging downward, i.e. diverging from the leader (Luxemburg) and converging internally, (2) converging upward, i.e. converging to the „leader” and internally. The results of studies conducted for the different periods of European integration, lead to the conclusion that the number of countries included in the second group has been gradually declining while the integration connections have been deepening. It is also additional evidence of the declining importance of the catching-up process based on capital accumulation (beta convergence) in eliminating income disparities in the European Union.



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## THE CONTEXTS OF THE COMPETITIVENESS IN THE HIGHER EDUCATION

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### *Abstract*

*The term of competitiveness in referring to the Higher Education and its institutions is the subject of research and it is mentioned in the foreign and in the Polish literature of the subject in some different aspects. The most important contexts of competitive analysis are: competitiveness of national systems of the Higher Education, competitiveness of education offer quality and competitiveness in the sector of the Higher Education in the quantification of resources, skills and position school.*

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JEL Classification Code: **I21, I22, I25.**

**Keywords:** knowledge, finance, higher school, competitiveness.

### **Introduction**

The knowledge both possessed as a result of scientific researches and that which is passed in the process of education is more and more becoming the main resource of economy. 'In advanced societies not work nor natural resources and even not money are not basic resources; they were replaced by information and knowledge'. (see more: Gasparski, 2000, p. 47). Those two factors were becoming constant basis of developing and building knowledge based economy. That economy is supported by information society (johokashakai) described in the sixties of the 20th century by Tadao Umesamo and next popularized by a future visioner Kenchi Koyama (see more: Kenchi, 1997, p. 72).

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Information civilization that is in building process is shaped by subjects responsible for creation and knowledge distribution- higher schools. Those subjects and their role in economy are bound by very intensive changes which noticed both by theoreticians and practitioners of economy.

Main trend observed in the wide circles of discussions led in last 30 years is more common referring and using by the subjects of sector of the higher education the market mechanism. Marketability is often determined by label of a new paradigm of contemporary university (see more: Antonowicz, 2005, p. 145) or treated as a factor with the higher influence changes and transformation of university reality in Europe (see more: Kwiek, 2010, pp. 88).

The basic reason of implementation of market mechanism in the Higher Education is assumption that it leads possible the best using resources in the given society. Necessary factors for function mechanisms of a market character are:

- ensuring freedom on the side of the provider of education services particularly in the range of possibility of coming on the market, forming an offer, using resources and price policy.
- ensuring freedom on the side of the buyer of education services particularly in the range of choice of service provider choice of the academic programme.
- ensuring access to necessary education for doing choices of market character
- introduction of price mechanism that ensures totally or partly covering the costs of studies (see more: Brown, 2011, pp. 8-9).

As a natural of introducing market mechanism to the system of the Higher Education is appearance the category of competitiveness what is one of the leading ideas of reform of the Polish education and in the effect category of competitiveness.

The importance of competitiveness problems and intensively of changes in the Higher Education sector (see more: Dietl, Sapijaszka et.al., 2012; Ratajczak, 2012, p. 53) decided about undertaking thinking in the frame of this article. The aim of this work is presenting main contexts of competitiveness in the sector of Higher Education.

## **International competitiveness of Higher school and its influence on competitiveness of a country and region**

The term of competitiveness in referring to the Higher Education and its institutions is the subject of research and it is mentioned in the foreign and in the Polish literature of the subject in some different aspects. The first context is referring to **competitiveness of national systems of the Higher Education** regardless each other in the global scale.

The most often mentioned areas of verification of such interpreter competitiveness are the results gained by universities in particular countries in the international ranking (Shanghai Ranking, Laiden Ranking, Times Higher Education) (see more *Strategia Rozwoju Szkolnictwa Wyższego*, 2010, p. 49) and results of competition for getting foreign students with the most often mentioned instrument of the position

of competition to get foreign students, the most often used instrument is the number of these students in the general population of students in a given country. Besides competitiveness of the national educational systems is also referred to area of the scientific research and its measures are regarded as an outlay participation in the research and developing in the gross national product, bibliography indicators and among them also cite indicators. The Polish Higher Education unfortunately shows very weak results if we compare them with the results of other European countries (see more Wolszczak-Derlac, Parteka, 2010, p. 52).

It is worth mention that in the wider prospective as a policy of European Union it is said not only about national competitiveness of the systems of the Higher Education but also about competitiveness of the European system of the Higher Education what is included in the logic of Lisbon Strategy and it reflects in the mechanisms of Bologna Process which one of aims is to rise attractiveness and 'to improve competitiveness position of system of the Higher Education in such way it could refer to contribution of this geographical into civilisation development' (see more: Kraśniewski, 2004, p. 52). The method of rising competitiveness of institutions which are main elements of this system) was creating common education system that still is lack of unified conception in this case. Besides creating of such system would demand for unified administration structures what seems to be a less probable with such big political and structure divergence of Union (see more: Dziewulak, 1997, p. 120).

## The finance of the Higher Education

The second area of the discussion in the subject topic refers to **competitiveness mechanisms of public financial means** in the frames of given national system of the Higher Education and introducing the mechanisms of the competitiveness between particular universities in two basic spheres:

- means assigned for research activity, where the rule of the competitiveness is done by so called education bon (see more: Cieciora, 2004, pp. 74-76) or proper algorithm of financing universities from public sources
- means assigned on research activity where grants competition system can be implemented from these funds (competitive funding) (see more: Brown et. all., 2011, pp. 168-169) functioning in the most developed countries of the world (see more Santiago, Tremblay, Arnal, 2008, pp. 109-114)

An intrinsically meaning for implementation competitiveness in the distribution of public funds destined on the Higher Education has the grade of implementation of such competitiveness mechanism of improving quality especially in the research sphere but at the same time unfavourable effects coming from the fact that it is financing mainly of short term character. Finally effectiveness is strongly depended on quality of law regulation introducing those mechanisms into life (see more *Partnerstwo publiczno-prywatne w świetle doświadczeń międzynarodowych oraz strate-*

*gii rozwoju szkolnictwa wyższego*, Warszawa: Instytut Społeczeństwa Wiedzy, 2012, pp. 25-44) and removing of bureaucratic barriers that limit competitiveness (see more: Żylicz, 2012, pp. 17-18).

The third area of solutions, being derivative of national competitiveness of the Higher Education System is an **influence of the Higher Education on competitiveness of country region or city**.

With relations to **influence on country competitiveness** the Higher Education is conceived as one of twelve columns of competitiveness, national economy (see more *The Global Competitiveness Report 2009-2010*, Geneva: World Economic Forum; Schwab, 2009, p. 5), constituting a key element of the country innovation system (see more et.al., Gornitzka, Lengfeldt, Gornitzka, 2008, p. 5) and provide qualified human resources for economy (see more *Reflection of higher education aspects In the conception of national competitiveness*, In *Baltic Journal of Management*, Vol. 6, Issue 1; Ramonienė, Lanskoronskis, 2011, pp. 124-139) what is particularly essential facing globalisation process (see more Szablowski et.al., 2002, pp. 49-55; Marciniak) and also itself can be relevant sector ensuring incomes and also from sale (export) of educational services (see more *Knowledge In the Marketplace: The Global Commodification of Teaching and Learning in Higher Education*, In Peter Ninnes Meeri-Hellstén (Ed.) *Internationalizing Higher Education. Critical Explorations of Pedagogy and Policy*, CERC Studies in Comparative Education, Vol. 16, Dordrecht: Springer, Naidoo, Jamieson, 2008, p. 38)

Also, **the Higher Education effect on region or cities competitiveness** (see more: Szczepańska-Woszczyzna, 2001, pp. 149-151). The literature of subject refers in that range to multiple relations starting from universities influence on supply of highly-qualified labour force. generating students demand on goods and services and at the same time the rise of local economy by engaging commercialize of research result and technology transfer i.a. in the form of technological parks, companies of type spin-off and every activities in the cluster structures up to the role of universities in revitalization post-industrialcity areas. In connection with the higher schools stop being an instrument to support economy growth and competitiveness reinforcement of national economy (see more *Szkolnictwo wyższe. Wyzwania XXI wieku. Polska Europa, USA, Difin*, Warszawa, 2009, p. 24).

## Graduates, high school teachers and institutions competitiveness

Analysing different aspects of competitiveness in the sector of the higher education it is not allowed to omit the main stakeholder of it. the consideration deal.a.with graduates competitiveness in the labour market what results from the double nature of demand for educational services and in the effect of the double nature of competitiveness verification. On one hand the supplying that is the Higher Education schools answer to the demand recommended for the needs of educational market repre-

sented by potential students and audience, on which the graduates of universities compete (see more: Dietl, Sapijaszka et.al., 2001, pp. 333-335; Buchner-Jeziorska). Competitiveness in this area is verified by such quantity index as the percentage of employed or self-employed, graduates on by the level of incomes in the determined time after graduating and also by the quality index such as employer opinion about graduates preparation to work. The question of graduates competitiveness on the labour market gets a special meaning in the context of percentage rising of people having higher education diplomas (see more: Piróg, 2013, p. 313) what leads to growth the rate of unemployed between who we graduated.

An essential area of discussing about **competitiveness in Higher Education is personal competitiveness of academic teachers**. In this range it is necessary to put attention on area of didactic activity, verified by the effectiveness of teaching process, effects of studying gained by the effects, posed by students and the area scientific-research activity reflected by gaining researching grants, effectiveness of publication, the index of quotations and out coming of them professional promotions (see more Koroński, 2012, pp. 25-26). Personal competitiveness differ academic teachers' salaries in dependence of gained effect of work (see more *Najważniejsze propozycje zmian w systemie zarządzania szkolnictwem wyższym w Polsce w opinii ankietowanych profesorów – wyniki badań*, In *Zarządzanie i Finanse*. Journal of Management and Finance, Chapter 1, Vol. Gdańsk; Wawak, 2012, p. 381).

The next area to analyse is institutions of Higher Education competitiveness on the education market which can be defined as 'ability to improve an offer in order to get students and financial means for realisation research projects, didactic and other and also building reputation in the frame of the Higher Education school and in the relation with other academic institutions' (see more *Zarządzanie uczelnia. Koncepcje i współczesne wyzwania* Warszawa: Wolter Kluwer; Leja, 2013, p. 193).

## Competitiveness of education offer quality

A change of geopolitical situation and social-economical in Poland what was an effect inter alia of be a member of European Union effect with closer contacts between European countries. Those relations took place on many planes, they cause that it is necessary to raise the level of education on all steps of education on all steps of education. To fulfil this demand in the Higher Education there is implicated the necessity to reorient aims, content and method of teaching. As an effect it can new quality of schooling result from some essential trends in this area:

1. Evolution of price strategy used by particular school- it is essential not only the rate of price but also price relation to quality of schooling and other elements of competitiveness of school (the quality of service, access, practicality, friendship).
2. An effect of encapsulation of the Higher Education school comprehend as rebuilding one educational service by the other one.



3. The changes of the roles of a student and a lecturer in didactic process. The student has an influence on content and form of teaching. He is an active side of the process of passing knowledge.
4. Individual approach to a student. The students present different kind of learning and different habits connected with studying lectures. Exercises have to visualise them that they have ability to assimilate and gain knowledge by their own. It supports an active attitudes supplied by academic teachers.
5. Developed abilities to learn continual and self-study. the students more and more often are equipped by the school in proper technique and strategy of studying. thanks to it they can borden their competence of schooling, self-study and flexible reacting on possible change of job.
6. Development the generation Net Gen brought up on possibilities which are given by the Internet. Abilities passed earlier by using traditional methods, in the second decade of the 21st century the students posses with the help on the net. Thanks to the access of knowledge increased, disappeared time limits and increased the access to professional lecturers.

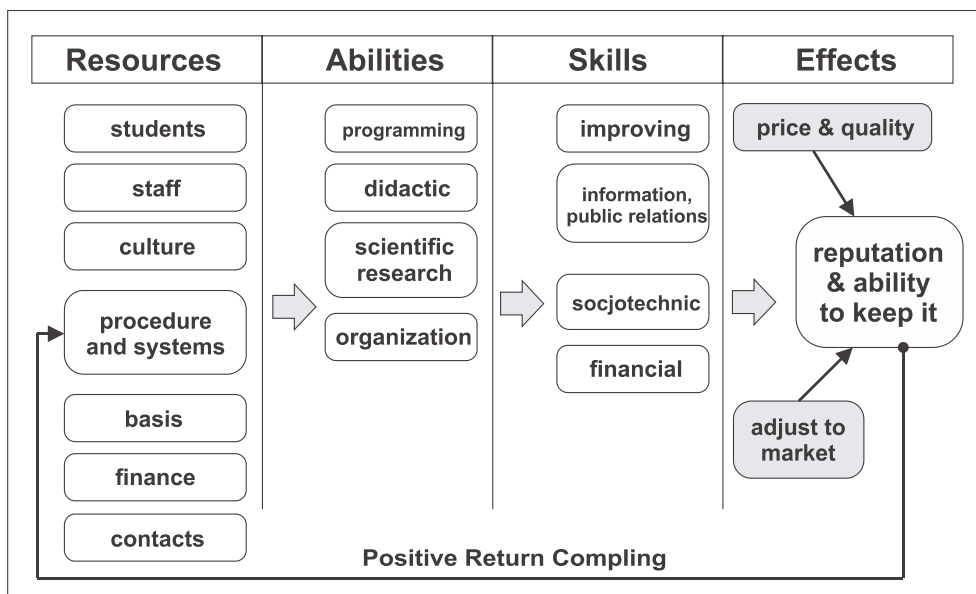
Mentioned trends do not constitute closed collection; they only indicate a direction of changes. These transformation result particularly from reorientation of buyer's function of education services on higher level. Similarly to other sectors of service he acts here in a double role buyer or consumer service. Being prosument he actively takes part in the process of projecting educational service. Effective using this trend can be one of the source of the competitiveness advantage at school on condition skilful shaping by it emotion, experience and experience of service buyer. This is the area to develop by marketing (see more *Zastosowanie koncepcji marketingu relacji w uczelniach wyższych w Polsce na podstawie badań własnych*, In *Marketingowe źródła uzyskiwania przewagi konkurencyjnej w działalności nowoczesnych podmiotów gospodarujących, Przedsiębiorczość i zarządzanie*, Tom XII, Vol. 5, Łódź: SWSZiP; Seliga, 2011, pp. 105-120), partners marketing (see more: Nowaczyk, Sobolewski et.al., 2013, pp. 243-256; Hall) and feelings marketing, which roles are more and more seen by schools of the Higher Education. Activities in this range should deal both with current study candidates (see more: Nowaczyk, Sobolewski et.al., 2011, pp. 197-210; D. Rapińska, 2010, pp. 29-38; Dejnaka) and graduates (see more Nowaczyk, Lisiecki et.al, 2006, pp. 243-244).

### **Competitiveness in the sector of the Higher Education in the quantification of resources, skills and position school**

Analysing the views presented in the literature of the subject related to competitiveness of higher education schools it should be maintain that they are related to resources, skills and position schools.



As an example to the first approach can be the analysis by A. Koźmiński, (see more: Koźmiński, 2006, pp. 243-244) who puts attention on the basic function of strategy which is creating advantage of higher education school competitiveness. This function reflects in the schools reputations among its key interesarium—students, employers, government and local administration, receivers of scientific research results. Reputation influences on ability of possessing valuable sources by the higher education school and ensuring proper conceived relation between quality and proper conceived relation between quality and price of higher education school. the model of creating competitiveness advantage of higher education school according to A. Koźmiński was presented on Picture 1.



**Picture 1.** The sources of competitiveness advantage of the higher education

Source: Koźmiński, 1999, p. 243.

An essential feature of the model by A. Koźmiński is back compling mechanism between gained competitiveness position and ability of possessive and keeping proper resources by the higher education school what next leads to improving existing competitiveness position.

Looking into getting competitiveness advantage by the school according to resources and skills school it would be necessary to put attention on the following elements of the competitiveness potential:

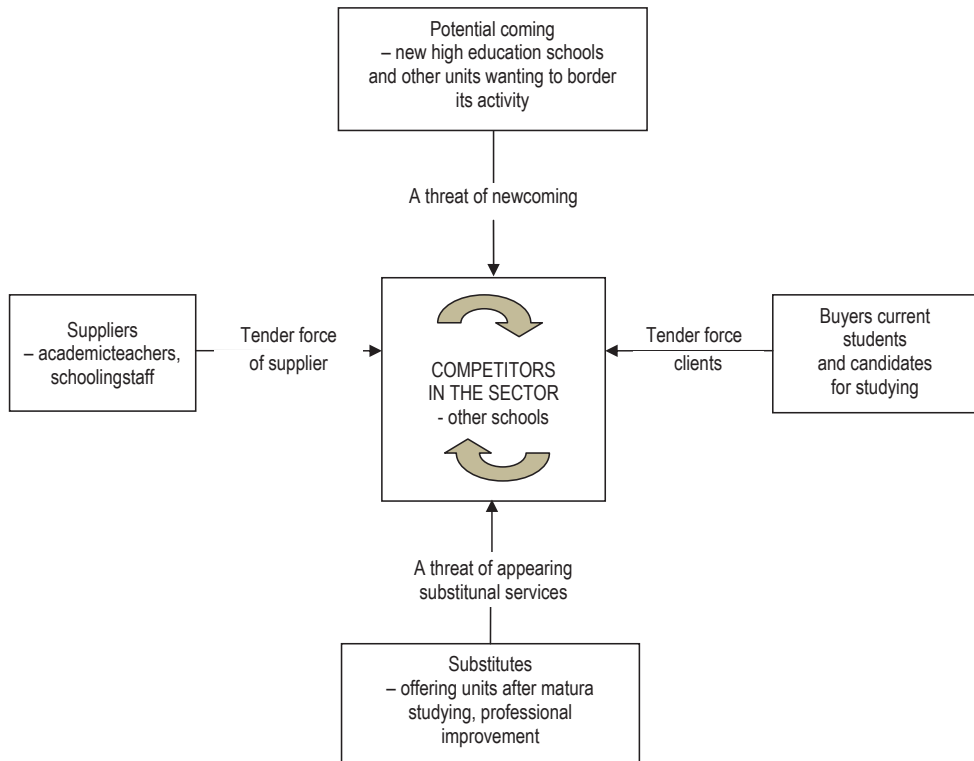
- a) an immanent **features of the Higher Education school** such as: image, prestige and reputation, innovativeness, the quality of the offered services and managing,

flexibility, undertaking international orientation ability to meet client's needs, client's loyalty, the image of graduates, admitting to school criteria employer opinions, school traditions, seeding place, the size of school, priority effect on the market.

- b) **non-material sources of school**-intellectual capital, knowledge, key competence, organise culture, professional staff of lectures (it size, scientific level, represented areas, involving in school life).
- c) **material sources of school**-premises and social conditions, location of buildings providing with things.
- d) **processes realised at school** particularly students service, development of Staff policy, knowledge management, loss of schooling management
- e) **using techniques and tools of management** such as: planning, strategy management benchmarking, competing by participation in the market, team work.
- f) **Tools supporting managing** – information technology especially systems of class ERB, CRM, systems ensuring quality of type ISO, BSC.
- g) **using instruments of marketing** – particularly price strategies, building the mark of the school, public relations, creating a unique selling offer – USP (Unique Selling Proposition)
- h) **organising structures** – such as Career and Practice Office, Library
- i) **didactic products** – schooling offer, specialities, according with KRK, the number of hours, e-learning using modern methods and techniques of teaching, respected diploma, salary, scholarship offer, international cooperation, studying foreign languages order, number, sort and structure of didactic hours individual process of schooling, methodology of activities, relation with practice and employers (learning by doing), diplomas accepting, product certification (lifelong learning)
- j) **products connected with scientific searches** – novelty, unique led experiments, meritoric level of the research works in the international scale, won prizes, distinguishes, continuity of led researches, international contacts, the number of scientific publications, scientific conference
- k) **business partnerships** – cooperation with units of the local government, state and local institutions and entertainments.

The analyse of possibility of building competition on advantage of higher education school is based on position approach is concentrated on model of 5 powers M. Potera (see more: Porter, 2001, p. 24). The picture 2 is a graphic presentation of this approach. According to J. Nogieć competitions between them will become stronger because useless demographic trend. The risk of new suppliers coming in the market is rather low what reflects from high formal barrier regulation of coming in market. As a substitute of educational services the higher education school are other form of schooling (school after matura exams, courses, trainings) and they at a little degree can compete with a traditional academic education because they cannot offer a diploma for adult students. The role of suppliers according to authors is very

strong because of shortage which is typical in the Polish Condition (see more *Model współdziałania uczelni publicznych i niepublicznych – stan obecny i perspektywy*, Warszawa: Fundacja Promocji i Akredytacji Kierunków Ekonomicznych, Instytut Społeczeństwa Wiedzy; Woźnicki et. al, 2004, pp. 125-134). The biggest tender force in the market have current students and potential clients- students



**Picture 2.** The model of 5 powers according by M.Potter

Source: Nogieć, 2009, p 171.

I. Seredocha (see more *Strategie marketingowe uczelni prywatnych w Polsce Elbląg: Elbląska Uczelnia Humanistyczno-Ekonomiczna*; Seredocha, 2007, pp. 30-32) using the model of five powers by M. Porter, he regards for the key suppliers of knowledge (academic staff) and also the suppliers of permissions (government agency) estimating the power of warding contract by tenders of those group as high. The suppliers of weaker warding contract are grammar school which are the suppliers of candidates for studying and suppliers of different sort of commodity and services necessary for a university to function. For buyers of services the author recognizes not only

students but also wider the whole society in which the school function what results from cultural role of the higher education school.

Another author A Sulejewicz (see more: Dietl, Sapijaszk et.al., op. cit., 77-91) introduces the sixth power- complementary goods. He does an analyse according this model of the Polish system of the higher education in the 90s of the 20th century and also an analyse rivalry forces in world higher education presented in the Table 1.

**Table 1.** Comparison of complete powers in the Polish High Education schools in the 90s of the second decade of 20<sup>th</sup> century.

Competitiveness powers	The Polish higher education in the 90s of the 20 <sup>th</sup> century	The Polish Higher Education in the second decade of 21st century	World Higher Education schools
Competition inside branch	Low, increased together with the development private sector, regional	Strong, especially between public and non-public sector mainly of regional character	Strong connected with marketing and privatisation process of the higher education basing on benefits of scale, international.
Substitutes	None	Training service opened internet courses, gaining qualification out of school system, systems of certification qualification of unions and branch societies	Alternative forms of getting qualification validity, services training for schools, universities, corporations, knowledge offered by Internet portals
Complementary goods	Not big influence noticed in case of schools created in non-traditional locations	Growing influence of services, B+R, projects financed from EU means	The market of service B+R, however endangered by static higher school approach
The force of buyers	Individual buyers, little rising in case of after graduate schooling, buyer institutional – meaningful	Growing, also in the night of saving consumer	Growing – both individual and institutional (company)
The force of suppliers (didactic staff)	Varied after appearing the private sector high	Varied, fall down because of less demand for didactic work, temporary changeable because of limiting two shifts work	On mass scale falling down but at the same time growing in case of so called 'stars'.
Newcomers/Barrier of coming in	At the beginning high (political) after legislative change	High market barriers on the side of demand rising barriers legislative	Falling down together with introduction learning by Internet

Source: Sulejewicz, 2006, pp. 79-85.

Basing on presented forces of competitiveness in the higher education schools A. Sulejewicz also shows on acting which can be taken traditional schools in order to keep competitiveness position. In range to step up barriers of coming in he shows on:

- possibility of using of varied strategies based on labour- consuming didactic techniques impossible to copy by the subjects which base their strategy of acting on advantages of scale and low changeable costs.
- offering except education some benefits of scale and low changeable costs
- barrier creating by accreditation and certification

Lower of the force of buyers the higher school services can follow by real impediment of students mobility (points transfer, programme differences, price – promotion policy rewarding early and packet shopping of services, or acting in the range of branding. As two possible strategies he shows then:

1. Innovative adoption of modern educational strategies in big universities set on using profits scale.
2. Limit of market pool for those areas in which school has non imitable, isolated from competition sources, ensuring long-term advantage realised on focused area of basic actions

In the area of limiting competing it shows on possibility or realisation of fusion strategy and taking and reducing the force of each other force of competitiveness by strategy system with putting attention at the same tie on risk of interpretation of some action done by government agenda as useless for consumer and breaking the anti-monopoly rules.

It is worth to notice that coming into strategy aliases, building of schools net and the process of their fusion may result on getting a scale affect what leads to improving competitiveness (see more Światowy et.al., 2001, p. 189). As a result of fusion and take up and there follow reducing intensity of complete fighting in the sector, border of warding contract by tenders position of school in relation environment i.e. state institutions possessing by school in short time some different means what was not possible to get them in limited way or they would not be possible or they could demand long time, possibility of occurring different synergetic effects (see more: Zygarłowski, 2012, pp. 45-46). An essential effect reflecting from the process of consolidation is also capital concentration, which is necessary for investments and introducing by universities of modern service products (see more: Wawak, 2012, 0p. 249).

It is necessary to underline the fact, that researches confirm that gained compete position of the Polish private schools creating the groups of schools of holding character is in comparison with universities functioning by themselves. It refers both with them financial incomes and also compete for prestige and academic position (see more *Pozycja konkurencyjna niepublicznych uczelni sieciowych w Polsce*. In Zeszyty Naukowe Wyższej Szkoły Administracji i Biznesu im. E. Kwiatkowskiego w Gdyni, Vol. 16; Zygarłowski, 2011, pp. 121-134).

There is also a need to put attention on particular role in building attention on particular role in building competitiveness advantage of net connection which are the response to chances and threatening's reflecting from the Internet development and possibilities of its using in didactic. The connections can have both the character of multi institutional in the form of net, where the participants are other and also competing universities (see more Gołębiowski, Dąbrowski, Mierzejewska et. al., 2005, p. 67) and also strategy alianse with service suppliers that are not the higher education schools which function on the rule of outsourcing (see more *What business wants from higher education*, (Phoenix: American Council on Education, Oryx Press; Oblinger, Lee Verville, 1998, pp. 146-147).

## Conclusions

The way of competitiveness of managing of the higher education school and the grade and measure of gained compete position should also relate to school mission. From this prospective it seems that it is the key relation to such aspects as:

- established range of geographical acting and competing of schools: global nation-wide and regional
- an area of key activity of schools: mainly researching, mainly didactic, researching-didactic
- established student's profile: school teachers elite, school of international character, school allows to complete education and connect studying with work, school bets to equal social differences

Among the views basing on quite traditional approach to competitiveness based on typical factors and theories of economic character it is necessary to notice also some views more 'philosophical' reflecting to need of study of interdisciplinary and looking for criteria of future competitiveness of universities in such factors as: **true** and recognizing objectivity as a factor deciding about quality of schooling, **the pictures** of graduates which will be the base of creating 'society of wisdom', **participation** of academic teachers and students in the process of building culture based on science, **leadership** as a factor of competitiveness of studying organisation and **entrepreneurship** (see more *Uniwersytet trzeciej generacji. Stan i Perspektywy rozwoju*, Poznań: ECWP; Burawski, 2013, pp. 39-58)

To sum up the consideration related to competitiveness in the sector of the Higher Education there is a need to claim that the fact of common implementation market mechanism school abilities to compete is becoming directly new element of social mission of university. (see more *Misja i służebność uniwersytetu XXI wieku*, Warszawa: Instytut Społeczeństwa Wiedzy, Fundacja Rektorów Polskich, Woźnicki, 2013, pp. 127-132). Ability to compete is based on knowledge and it rely on using not only existing knowledge but also on consciously target to reach it and completing, in such

way to better win limits (see more: Koźminski, 2005, p. 103). Creating new knowledge is an effect of dynamic interaction between three players: knowledge practiser, knowledge constructor commander (see more *The Knowledge Creating Company* New York: Oxford University Press; Nonaka, Takeuchi, 2000, pp. 184-185). In order the interaction could give positive effects each of group should have features copied from organisational culture what is a resultant of features of contractor. Such approach to competitiveness dominates in sectors and branches in which knowledge gives particular advantage and is used also in the Higher Education school.

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Zbigniew Śleszyński<sup>1</sup>

## USING BORDERED MATRICES FOR DURBIN-WATSON $D$ STATISTIC EVALUATION

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### *Abstract*

*In this paper the usage of bordered matrices for Durbin-Watson  $d$  statistic evaluation in linear time series model is presented. It is shown how to obtain this statistic without estimation of structural parameters and vector of residuals. As an example – the model of GDP growth in Poland, basing on empirical data from 1991–2013 – is shown.*

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JEL Classification Code: **C010, C120.**

**Keywords:** Autocorrelation in the residuals, Durbin–Watson test, bordered matrices.

### **Introduction**

Let's consider the linear econometric model for empirical time series data. While estimating model parameters using least squares method we should test if obtained estimators are minimum-variance unbiased estimators (the best in class of unbiased linear estimators). – what means they are effective (Gajda, 2004). One of the main conditions for using least squares method is no autocorrelation in model residuals. The most popular test, used also for testing cointegration among variables (Charemza, Deadman, 1997), detecting the presence of first order autocorrelation, is Durbin-Watson test. It determines if first order autocorrelation coefficient of residuals is significantly different from zero. While computing Durbin-Watson  $d$  statistic we have to know the vector of residuals, thus we have to estimate least squares parameters of the model. To avoid such procedure we will show how to estimate  $d$  statistic using bordered matrices, without model parameters and residuals estimation.

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## Basic formulas

An econometric model is considered:

$$Y = \alpha_0 Z_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \dots + \alpha_k Z_k + \xi \quad (1)$$

assume we have empirical data from  $n$  time periods:

$$Z = [z_{tj}]_{n \times (k+1)} \quad \text{and} \quad y = [y_t]_{n \times 1} \quad (2)$$

Denoting estimated structural parameters for model (1) using least squared method as:

$$A^T = [a_0 \quad a_1 \quad \dots \quad a_k]_{(k+1) \times 1} \quad (3)$$

we have:

$$A = (Z^T Z)^{-1} Z^T y \quad (4)$$

Vector of theoretical values of dependent variable  $Y$  has the form:

$$y^* = Z \cdot A = Z(Z^T Z)^{-1} Z^T y \quad (5)$$

Vector of residuals is computed as follows:

$$u = y - y^* = y - Z \cdot A = y - Z(Z^T Z)^{-1} Z^T y \quad (6)$$

According to Durbin-Watson test, while testing for first order autocorrelation in model residuals, we have to evaluate  $d$  statistic:

$$d = \frac{\sum_{t=2}^n (u_t - u_{t-1})^2}{\sum_{t=1}^n u_t^2} \quad (7)$$

It is known that (Kolupa i Śleszyński, 2010):

$$\sum_{t=1}^n u_t^2 = u^T u = y^T y - y^T Z(Z^T Z)^{-1} Z^T y \quad (8)$$

Let's denote:

$$u_{(-)} = \begin{bmatrix} u_2 - u_1 \\ u_3 - u_2 \\ \vdots \\ u_n - u_{n-1} \end{bmatrix}_{(n-1) \times 1} \quad (9)$$

Basing on (9) we have:

$$\mathbf{u}_{(-)} = \mathbf{u}_{(-1)} - \mathbf{u}_{(-n)} \quad (10)$$

where vectors  $\mathbf{u}_{(-1)}$  and  $\mathbf{u}_{(-n)}$  are obtained from vector  $\mathbf{u}$  by dropping respectively the first and the last component. Denoting matrices obtained from matrix  $Z$  given by (2) by dropping respectively the first and the last row by  $Z_{(-1)}$  and  $Z_{(-n)}$  and vectors obtained from vector  $\mathbf{y}$  given by (2) by  $\mathbf{y}_{(-1)}$  and  $\mathbf{y}_{(-n)}$  then basing on (6) we have:

$$\begin{aligned} \mathbf{u}_{(-1)} &= \mathbf{y}_{(-1)} - Z_{(-1)} \cdot \mathbf{A} = \mathbf{y}_{(-1)} - Z_{(-1)} (Z^T Z)^{-1} Z^T \mathbf{y} \\ \mathbf{u}_{(-n)} &= \mathbf{y}_{(-n)} - Z_{(-n)} \cdot \mathbf{A} = \mathbf{y}_{(-n)} - Z_{(-n)} (Z^T Z)^{-1} Z^T \mathbf{y} \end{aligned} \quad (11)$$

Denoting:

$$Z_{(-)} = Z_{(-1)} - Z_{(-n)} \quad (12)$$

$$\mathbf{y}_{(-)} = \mathbf{y}_{(-1)} - \mathbf{y}_{(-n)} \quad (13)$$

basing on (10), using (11), (12) and (13) we have:

$$\mathbf{u}_{(-)} = \mathbf{y}_{(-)} - Z_{(-)} \cdot \mathbf{A} = \mathbf{y}_{(-)} - Z_{(-)} (Z^T Z)^{-1} Z^T \mathbf{y} \quad (14)$$

It's worth adding we have assumed that there is intercept in the model (the first column in matrix  $Z$  contains only ones and matrix  $Z_{(-)}$  has zeros in first column). Let's notice that to evaluate Durbin-Watson  $d$  statistic given with equation (7) it is enough to compute quotient of squared components of vector  $\mathbf{u}_{(-)}$  given with (14) by sum of squares of residuals given with (8).

### Using bordered matrices for $\mathbf{u}^T \mathbf{u}$ and $\mathbf{u}_{(-)}$ evaluation

In order to evaluate (8) and (14) we will use bordered matrices. For the purposes of this paper let's use slightly modified definition of bordered matrix.

Given is a matrix  $F = [f_{ij}]$  with  $p$  rows and  $q$  columns,  $p, q \geq 2$ ,  $m < \min\{p-1, q\}$ . Matrix  $F$  divided into blocks according to scheme

$$F = \left[ \begin{array}{c|c} A & B \\ \hline C_1 & D_1 \\ \hline C_2 & D_2 \end{array} \right] \quad (15)$$

where inner matrix  $A = [a_{ij}]$  is a square non-singular matrix of order  $m$ , is called bordered matrix.

It is known that (Kolupa, Śleszyński, 2010) doing elementary transformations on elements of matrix  $F$  given with (15) such that in place of inner matrix  $A$  we obtain upper triangular matrix with diagonal elements equal to one, in place of matrix  $C_1$  and  $C_2$  zero matrices, then in place of  $D_1$  and  $D_2$  we obtain  $\tilde{D}_1$  and  $\tilde{D}_2$  satisfying:

$$\begin{aligned}\tilde{D}_1 &= D_1 - C_1 A^{-1} B \\ \tilde{D}_2 &= D_2 - C_2 A^{-1} B\end{aligned}\quad (16)$$

In order to determine  $d$  statistic given with (7) we will use bordered matrix:

$$F = \left[ \begin{array}{c|c} Z^T Z & Z^T y \\ \hline y^T Z & y^T y \\ \hline Z_{(-)} & y_{(-)} \end{array} \right] \quad (17)$$

Doing elementary transformations on  $F$ , basing on (16), using (8) and (14) we will obtain:

$$F = \left[ \begin{array}{c|c} Z^T Z & Z^T y \\ \hline y^T Z & y^T y \\ \hline Z_{(-)} & y_{(-)} \end{array} \right] \sim \left[ \begin{array}{c|c} (Z^T Z)^* & (Z^T y)^* \\ \hline 0_{l \times (k+1)} & u^T u \\ \hline 0_{(n-1) \times (k+1)} & u_{(-)} \end{array} \right] \quad (18)$$

Received in matrix (18) number  $u^T u$  and vector  $u_{(-)}$  can be used to compute Durbin Watson  $d$  statistic according to equation (7).

In the next part practical example of described procedure will be shown.

## Example

Let's consider a model:

$$y_t = \alpha_0 z_{0t} + \alpha_1 z_{1t} + \alpha_2 z_{2t} + \alpha_3 z_{3t} + \alpha_4 z_{4t} + \xi_t \quad (19)$$

Where:

$Y$  – growth of GDP in Poland (in percents),

$Z_0$  – variable identically equal to 1,

$Z_1$  – inflation in Poland during previous year (in percents),

$Z_2$  – growth of capital expenditures in Poland during previous year (in percents),

$Z_3$  – binary variable equal to 1 during 1993–1997, zero in other cases,

$Z_4$  – binary variable equal to 1 during 2001–2007, zero in other cases.

In the model empirical data from statistical yearbooks of Central Statistical Office from years 1991–2013 will be used, it means number of observations  $n = 23$ . Empirical data is shown in table 1.

**Table 1.** Values of model (19) variables

T	$y_t$	$z_{0t}$	$z_{1t}$	$z_{2t}$	$z_{3t}$	$z_{4t}$
1991	-7	1	585,8	-10,1	0	0
1992	2,6	1	70,3	-4,1	0	0
1993	3,8	1	43	0,4	1	0
1994	5,2	1	35,3	2,3	1	0
1995	7	1	32,2	8,1	1	0
1996	6	1	27,8	17,1	1	0
1997	6,8	1	19,9	19,2	1	0
1998	4,8	1	14,9	22,2	0	0
1999	4,1	1	11,8	15,3	0	0
2000	4	1	7,3	5,9	0	0
2001	1	1	10,1	1,4	0	1
2002	1,4	1	5,5	-9,5	0	1
2003	3,8	1	1,9	-10	0	1
2004	4	1	0,8	0,6	0	1
2005	5,5	1	3,5	6,5	0	1
2006	6,1	1	2,1	7,7	0	1
2007	6,6	1	1	16,8	0	1
2008	4,8	1	2,5	20,4	0	0
2009	1,6	1	4,2	10,7	0	0
2010	3,9	1	3,5	-0,8	0	0
2011	4,3	1	2,6	0,2	0	0
2012	1,9	1	4,3	10,6	0	0
2013	1,6	1	3,7	-2,8	0	0

Source: statistical yearbooks of Central Statistical Office.

Basing on data from table 1 we estimate matrices needed for bordered matrix (17) construction. We have:

$$Z^T Z = \begin{bmatrix} 23 & 894 & 128,1 & 5 & 7 \\ 894 & 354048,3 & -4305,78 & 158,2 & 24,9 \\ 128,1 & -4305,78 & 2840,55 & 47,1 & 13,5 \\ 5 & 158,2 & 47,1 & 5 & 0 \\ 7 & 24,9 & 13,5 & 0 & 7 \end{bmatrix} \quad (20)$$

$$Z^T y = \begin{bmatrix} 83,8 \\ -2769,72 \\ 830,81 \\ 28,8 \\ 28,4 \end{bmatrix} \quad y^T y = [494,22] \quad (21)$$

$$Z_{(-)} = \begin{bmatrix} 0 & -515,7 & 6 & 0 & 0 \\ 0 & -27,3 & 4,5 & 1 & 0 \\ 0 & -7,7 & 1,9 & 0 & 0 \\ 0 & -3,1 & 5,8 & 0 & 0 \\ 0 & -4,4 & 9 & 0 & 0 \\ 0 & -7,9 & 2,1 & 0 & 0 \\ 0 & -5 & 3 & -1 & 0 \\ 0 & -3,1 & -6,9 & 0 & 0 \\ 0 & -4,5 & -9,4 & 0 & 0 \\ 0 & 2,8 & -4,5 & 0 & 1 \\ 0 & -4,6 & -10,9 & 0 & 0 \\ 0 & -3,6 & -0,5 & 0 & 0 \\ 0 & -1,1 & 10,6 & 0 & 0 \\ 0 & 2,7 & 5,9 & 0 & 0 \\ 0 & -1,4 & 1,2 & 0 & 0 \\ 0 & -1,1 & 9,1 & 0 & 0 \\ 0 & 1,5 & 3,6 & 0 & -1 \\ 0 & 1,7 & -9,7 & 0 & 0 \\ 0 & -0,7 & -11,5 & 0 & 0 \\ 0 & -0,9 & 1 & 0 & 0 \\ 0 & 1,7 & 10,4 & 0 & 0 \\ 0 & -0,6 & -13,4 & 0 & 0 \end{bmatrix} \quad y_{(-)} = \begin{bmatrix} 9,6 \\ 1,2 \\ 1,4 \\ 1,8 \\ -1 \\ 0,8 \\ -2 \\ -0,7 \\ -0,1 \\ -3 \\ 0,4 \\ 2,4 \\ 0,2 \\ 1,5 \\ 0,6 \\ 0,5 \\ -1,8 \\ -3,2 \\ 2,3 \\ 0,4 \\ -2,4 \\ -0,3 \end{bmatrix} \quad (22)$$

We can now construct bordered matrix F given with (17).



$$F = \left[ \begin{array}{c|c} \frac{Z^T Z}{y^T Z} & \frac{Z^T y}{y^T y} \\ \hline \frac{Z_{(-)}^T}{y_{(-)}^T} & \frac{y_{(-)}^T y}{y_{(-)}^T y} \end{array} \right] = \begin{bmatrix} 23 & 894 & 128,1 & 5 & 7 & 83,8 \\ 894 & 354048,3 & -4305,78 & 158,2 & 24,9 & -2769,72 \\ 128,1 & -4305,78 & 2840,55 & 47,1 & 13,5 & 830,81 \\ 5 & 158,2 & 47,1 & 5 & 0 & 28,8 \\ 7 & 24,9 & 13,5 & 0 & 7 & 28,4 \\ \hline 83,8 & -2769,72 & 830,81 & 28,8 & 28,4 & 494,22 \\ 0 & -515,5 & 6 & 0 & 0 & 9,6 \\ 0 & -27,3 & 4,5 & 1 & 0 & 1,2 \\ 0 & -7,7 & 1,9 & 0 & 0 & 1,4 \\ 0 & -3,1 & 5,8 & 0 & 0 & 1,8 \\ 0 & -4,4 & 9 & 0 & 0 & -1 \\ 0 & -7,9 & 2,1 & 0 & 0 & 0,8 \\ 0 & -5 & 3 & -1 & 0 & -2 \\ 0 & -3,1 & -6,9 & 0 & 0 & -0,7 \\ 0 & -4,5 & -9,4 & 0 & 0 & -0,1 \\ 0 & 2,8 & -4,5 & 0 & 1 & -3 \\ 0 & -4,6 & -10,9 & 0 & 0 & 0,4 \\ 0 & -3,6 & -0,5 & 0 & 0 & 2,4 \\ 0 & -1,1 & 10,6 & 0 & 0 & 0,2 \\ 0 & 2,7 & 5,9 & 0 & 0 & 1,5 \\ 0 & -1,4 & 1,2 & 0 & 0 & 0,6 \\ 0 & -1,1 & 9,1 & 0 & 0 & 0,5 \\ 0 & 1,5 & 3,6 & 0 & -1 & -1,8 \\ 0 & 1,7 & -9,7 & 0 & 0 & -3,2 \\ 0 & -0,7 & -11,5 & 0 & 0 & 2,3 \\ 0 & -0,9 & 1 & 0 & 0 & 0,4 \\ 0 & 1,7 & 10,4 & 0 & 0 & -2,4 \\ 0 & -0,6 & -13,4 & 0 & 0 & -0,3 \end{bmatrix} \quad (23)$$

On matrix (23) we make elementary transformations according to schema (18). As a result we receive:

$$F \sim \left[ \begin{array}{c|c} (Z^T Z)^* & (Z^T y)^* \\ \hline 0_{5 \times 5} & u^T u \\ \hline 0_{22 \times 5} & u_{(-)} \end{array} \right] = \left[ \begin{array}{ccccc|c} 1 & 138,87 & 5,57 & 0,22 & 0,3 & 3,64 \\ 0 & 1 & -0,03 & -0,00011 & -0,0008 & -0,02 \\ 0 & 0 & 1 & 0,01 & -0,02 & 0,1 \\ 0 & 0 & 0 & 1 & -0,33 & 2,16 \\ 0 & 0 & 0 & 0 & 1 & 1,14 \\ \hline 0 & 0 & 0 & 0 & 0 & 33,784 \\ \hline 0 & 0 & 0 & 0 & 0 & 1,34 \\ 0 & 0 & 0 & 0 & 0 & -2,17 \\ 0 & 0 & 0 & 0 & 0 & 1,1 \\ 0 & 0 & 0 & 0 & 0 & 1,19 \\ 0 & 0 & 0 & 0 & 0 & -1,94 \\ 0 & 0 & 0 & 0 & 0 & 0,48 \\ 0 & 0 & 0 & 0 & 0 & 0,17 \\ 0 & 0 & 0 & 0 & 0 & -0,08 \\ 0 & 0 & 0 & 0 & 0 & 0,74 \\ 0 & 0 & 0 & 0 & 0 & -3,66 \\ 0 & 0 & 0 & 0 & 0 & 1,39 \\ 0 & 0 & 0 & 0 & 0 & 2,39 \\ 0 & 0 & 0 & 0 & 0 & -0,84 \\ 0 & 0 & 0 & 0 & 0 & 0,97 \\ 0 & 0 & 0 & 0 & 0 & 0,46 \\ 0 & 0 & 0 & 0 & 0 & -0,4 \\ 0 & 0 & 0 & 0 & 0 & -0,99 \\ 0 & 0 & 0 & 0 & 0 & -2,24 \\ 0 & 0 & 0 & 0 & 0 & 3,4 \\ 0 & 0 & 0 & 0 & 0 & 0,29 \\ 0 & 0 & 0 & 0 & 0 & -3,38 \\ 0 & 0 & 0 & 0 & 0 & 0,99 \end{array} \right] \quad (24)$$

Basing on matrix (24) we compute:

$$\sum_{t=2}^{23} (u_t - u_{t-1})^2 = (u_{(-)})^T u_{(-)} = 66,8662 \quad (25)$$

Finally, according to equation (7), we receive Durbin-Watson statistic:

$$d = \frac{\sum_{t=2}^{23} (u_t - u_{t-1})^2}{\sum_{t=1}^{23} u_t^2} = \frac{66,8662}{33,7838} = 1,979241 \quad (26)$$

Even without checking in tables of Durbin-Watson test critical values, according to rule of thumb, as  $d$  is close to 2, we can say that there is no first order autocorrelation in considered model (Górecki 2010).

At the end, to confirm correctness of given computations, let's have a look at a table from Gretl program, where in particular  $d$  statistic is shown.

**Table 2.** Model 1: OLS, using observations 1991-2013 (T = 23), Dependent variable: Y

	Coefficient	Std. Error	t-ratio	p-value
Z0	2.78624	0.526231	5.2947	0.00005
Z1	-0.0148921	0.00274124	-5.4326	0.00004
Z2	0.0968611	0.0341131	2.8394	0.01088
Z3	2.53251	0.74715	3.3896	0.00327
Z4	1.13707	0.712408	1.5961	0.12787
Mean dependent var	3.643478		S.D. dependent var	2.930223
Sum squared resid	33.78377		S.E. of regression	1.369991
R-squared	0.821152		Adjusted R-squared	0.781408
F(4, 18)	20.66103		P-value(F)	1.57e-06
Log-likelihood	-37.05718		Akaike criterion	84.11436
Schwarz criterion	89.79183		Hannan-Quinn	85.54223
rho	-0.000685		<b>Durbin-Watson</b>	<b>1.979241</b>

Source: output from Gretl.

## Conclusions

Presented procedure show that it is possible to compute Durbin-Watson  $d$  statistic without estimation of model parameters and vector of residuals. It is important as very often detecting autocorrelation in residuals means necessity to specify model once again, thus results of previous estimations are useless. Using bordered matrices makes it possible to compute sum of squared residuals and vector of residuals differences, and thus statistic  $d$ , what makes computational process shorter. It is worth noting that elementary transformations, even with huge bordered matrix, are easy to perform using for example spreadsheet.

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Paweł Korneta<sup>1</sup>

## WHAT MAKES CUSTOMERS WILLING TO RECOMMEND A RETAILER – THE STUDY ON ROOTS OF POSITIVE NET PROMOTER SCORE INDEX

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### *Abstract*

*Net Promoter Score index (NPS index) is examined from customers perspective. The statistical analysis of NPS index obtained for different retailers by customers survey is presented. The correlation coefficients between NPS index and a set of criteria are given and the key drivers of NPS index are determined. It is shown that the most important factor in the creation of positive NPS index is the trust, while perception of the low price is less influential. The direction in which retailers should move with their communication and in-store activities is suggested.*

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JEL Classification Code: **M310.**

**Keywords:** Net Promoter Score, Customer Perception, Drivers of loyalty – Recommendations.

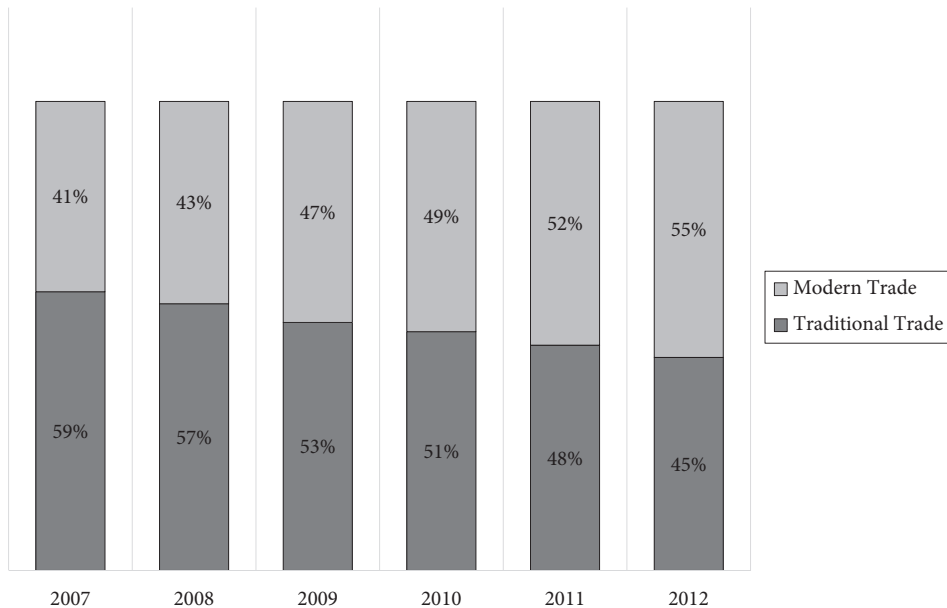
### **Introduction**

The Polish retail market is in transition period. In recent years there is ongoing trend of replacement of traditional trade with modern trade, what is shown in figure 1. Large chains grow at the expenses of local stores through new stores opening. It is clearly visible on grocery market, where large international chains invest in new store format (e.g. Tesco with Tesco Extra, or Carrefour with Carrefour Express). Besides that, market is in consolidation phase, e.g. Piotr i Paweł took over BOMI, Zabka acquired local chains PS Food, Argo and Torg. Accordingly, local independent stores in order to gain economy of scale, move to franchise model. Chains expansion meets with market saturation, what enables customers to switch between retailers in an easy way. Fierce competition on the market and changes in society impose on retailers necessity to revitalize their strategies in building loyalty and relation with

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customers. Therefore, it is highly important for retailers to identify key drivers of loyalty, undertake activities and use suitable metrics of loyalty.



**Figure 1.** Evolution of traditional and modern trade value shares on grocery market

Source: own study based on Euromonitor database, access 10.03.2014.

The study of customers loyalty has been the object of much research in the past decades Tucker (1964), Jacoby and Chestnut (1978), Griffin (1997), Dziejwanowska (2007). Among many methodologies and tools used to measure the loyalty like Customer Retention Rate presented by Kozielski (2004), customer satisfaction (CSAT) and Customer Effort Score (CES) presented by Dixon, Freeman and Toman (2010), the Net Promoter Score index (NPS index) is one of the most widely used in theoretical studies and in practice. The value and benefits of using NPS index to measure and quantify the loyalty has been shown e.g. Reichheld (2006), Jeanjean (2011). There are also studies related to drivers of NPS conducted by Jeske, Callanan and Li Guo (2011) or by Chang and Fan (2013). Nevertheless, there are still many question marks regarding roots of NPS index, e.g. why customers are willing to recommend particular company?

The aim of this paper is to examine NPS index from customers perspective and to determine the key drivers of this index. Our studies are based on customers surveys conducted in June-July 2013 and June-July 2012.

This paper is organized as follows. In Section 2 the role of loyalty in business performance is discussed. In Section 3 the Net Promoter Score index is defined and

its value to quantify the loyalty is discussed. It is also compared with other loyalty metrics. In Section 4 the methodology is described. In Section 5 the analysis of NPS indices obtained for different retailers by customers survey is presented. In Section 6 the key drivers of NPS index are determined and described. Finally, we provide conclusions in Section 7.

## **The role of loyalty in business growth**

The role of loyalty has been the subject of studies throughout many decades. In these studies from the very beginning there was a hypothesis that loyalty is linked with growth of business performance. Reichheld and Sasser (1990) showed that 5% growth of customer maintenance transfers into 25-85% growth ( depending on the industry ) of profits. Anderson, Fornell and Lehmann (1994) presented positive correlation between customer satisfaction, loyalty and long term performance growth. Wansink (2003) pointed attention that companies invest in loyalty programs, because they noted that costs to attract new customers are higher than maintenance costs. Loyal customers buy more frequently and they are more profitable. Therefore companies started to use loyalty programs and other activities to enhance customer satisfaction.

Along with studies of loyalty impact on business performance, emerged constraints related to the correlation between those two factors. Keaveney (1995) showed that with higher loyalty the company is exposed to more interaction with a client. Therefore company has to have high quality of the whole spectrum of services. Otherwise customers may switch to some other service provider. As the result of that, the improved loyalty will have contrary effect on long term business growth. Bolton, Kannan and Bramlett (2000) also investigated the condition under which loyalty programs will have a positive effect.

Even though loyalty is a good indicator of business growth, not all loyal customers are beneficial ones. In depth studies conducted by Reinartz, Kumar (2002) on 16 000 customers through 4 years on 4 companies, proved that:

- it is not true, that maintenance of each loyal customer cost less than not loyal one,
- loyal customers don't pay more than regular ones, as loyal customers very often receive incentives and discounts,
- not all loyal customers are brand ambassadors, who recommend company to others.

Therefore, some companies may have high level of loyal customers, but in a long term can create losses or reach not relevant growth. It is important to identify drivers of customer loyalty. Urban and Siemieniako (2008) presented four different types of loyalty:

- loyalty based on relationship between customer and company, e.g. customers feel emotional bound with retailer and do not even consider buying from other retailer,
- loyalty based on social impact, e.g. customers buy a product because it is trendy and popular,

- loyalty based on profits and losses assessment, e.g. customers buy a product because it is less expensive than from competitors,
- loyalty based on external constraints, e.g. customers buy a product because there is no other place to buy it.

Strength of correlation between loyalty and business performance growth depends on the type of loyalty. Loyal customer driven by external constraints may switch to competitors, when limitation disappears. Therefore, in order to use loyalty as a good indicator of business strength, loyalty has to reflect loyalty based on relation or social impact. In a turbulent market environment, purchases behaviors can easily change. Therefore opinions and positive experiences are better foundation for long term business development.

The aspect of opinions and emotional engagement was embraced in definitions of loyalty presented by Griffin (1997) or Dziwanowska (2007). This approach is in line with current researches. Implications from Lotko (2013) paper clearly show that: opinions spread by customers do meaningfully influence on the image of an organization defined as a way the organization is perceived by its real and potential clients. Therefore, it sounds rational to accept this approach to loyalty in this paper.

Monitoring of loyalty index gain importance along with social and environmental changes. Sroga (2005) showed that importance of loyalty had been growing on the back of the following trends:

- increase of data availability about customers, markets and competitors,
- switch from local domestic marketing to global international marketing,
- move from mass marketing to mass individualization and product diversification,
- necessity to marketing cost optimization.

Moreover, in due course of technology development, importance of other people opinions in buying decision is expected to continue growing tendency. Based on Megapanel Gemius (2014), there are over 15 mln of Facebook and 2,5 mln of Twitter real users in Poland. Those people are willing to share information, pictures and, what's the most important, opinions. Simonson and. Rosen (2014) presented growing role of opinions in purchase decisions due to those trends.

In accordance with above studies and modern definitions of customer loyalty, it is important to use relevant metrics to assess customer loyalty. Chłodnicki and Rogoziński (2006) proposed to analyze customer loyalty in respect to the following three aspects:

- repetition of purchases,
- positive attitude towards a company,
- consider a company as the only provider of products.

Those aspects stress, that metrics used to measure loyalty should embrace not only behavioral actions, but also emotional attitude towards the company.



## Net Promoter Score index as a metric of loyalty

In due course of studies on loyalty emerged many metrics of customer loyalty based on emotional engagement of a consumer. Taylor (1998) proposed to assess loyalty measuring customers willingness to wait for particular product to buy it from particular company. The other way to measure loyalty presented Bloemer, et al. (1999). They focused on feedback provided by customers. Reichheld (2003) introduced Net Promoter Score index (NPS index) based on customers willingness to recommend a company to a friend. Long history of NPS index can be found in Hays (2008) paper. Due to popularity of NPS index, emerged alternative metrics, like: customer satisfaction (CSAT) and Customer Effort Score (CES) presented by Dixon, Freeman, and Toman (2010). In their works, they placed NPS index in the middle in terms of accuracy to predict growth of performance. Subsequently, Morgan and Rego (2006) evaluated different loyalty metrics. The conclusion coming out of their paper is that top two box and average methods are good indicators of companies growth and better than NPS. Contrary to complains ratio and repurchase likelihood metrics, which have little correlation with predicting business performance growth.

The NPS index is nowadays widely used loyalty metric. The idea behind NPS index is very simple and is based on asking customers just one question: „How likely is it that you would recommend us to a friend or colleague?“ on zero-to-10 scale. Subsequently, customers are clustered into 3 groups: promoters, passively satisfied and detractors. This is shown in fig. 2. Customers who will rate 9 or 10 are considered as promoters, 7-8 as passively satisfied and rest are classified as detractors. Each cluster is link with expected customer behavior. Promoters are likely to stay with a company in case of emergence of competitors. Moreover, they are more likely to repeat purchases. Finally, promoters may have positive impact on other potential customers. Therefore promoters are expected to contribute to growth of company performance. On the other hand, detractors have negative impact on business performance expectations. They are likely to create negative opinions or switch to competitors. NPS is calculated as subtraction between share of promoters and share of detractors. NPS index above 0 is considered as positive. It means, that company is likely to increase their profit and perform well on the market.

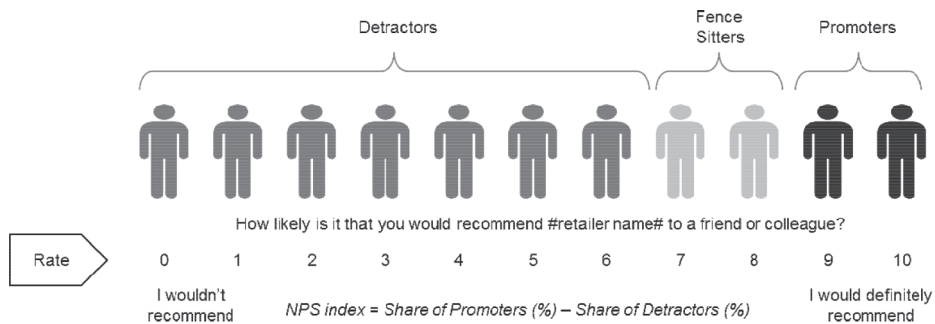


Figure 2. Classification of responders and brief view on NPS calculation method

Nevertheless, NPS index was criticized by Morgan and Rego (2006) or by Keiningham et al. (2007). In their papers, NPS index was set against company total growth measured by total profitability or revenues. Revenues growth of company may come not from like-for-like sale, but for example new stores opening or high investments. On mature markets role of loyalty and its link with overall company performance is much stronger. Reichheld (2006) presented rationales standing behind NPS index, which make NPS index so useful and successful. Jeanjean (2011) examined correlation between 3 factors: Net Promoter Score, Customer Willingness to Pay and mobile operators performance (revenues, profit). Even though Willingness to Pay appeared to be more accurate metric related to the growth, the author presented clear positive relation between NPS index and the growth.

Knowing importance of NPS index, arise two questions: what drives positive NPS index and how to build customer loyalty and in a consequence receive positive NPS. Lotko (2012) showed that NPS index depends on various factors, e.g. type of offer or time for how long a customer has been with a company, and companies can undertake numerous of activities to improve customers loyalty measured by NPS index. Research on NPS index drivers conducted also Jeske, Callanan and Li Guo (2011). They didn't provide the answer regarding drivers, but their paper demonstrates how statistical classification model can be used to identify key drivers of NPS. Chang and Fan (2013) examined NPS index in online environment to present what aspects of e-stores are the most influential on this index. The need to conduct quantitative analysis based on consumer survey presented Owen and Brooks (2008). They connected this analysis with a decision making process. The quantitative studies to identify roots of NPS index have not been performed to our knowledge and the question regarding roots of NPS index is still opened for a discussion.

## **Remarks on methodology**

Studies conducted by Perry (2009) presented that there is a gap between company thinking and customers thinking. Therefore, to identify predictors of NPS index, it is required to examine real customer opinions and perception. The results obtained in this paper are based on customer surveys Computer-Assisted Web Interview (CAWI) conducted in June-July 2013 and June-July 2012. In order to make research valid for Polish population, 2568 responders took part in the survey. Each customer was asked a set of questions about 50 Polish retailers to evaluate its customer perception. At the very beginning of the survey responders were asked, whether they know, visited or bought from particular retailer within previous 3 months. It was asked to classify responders and analyze recommendations in response to those answers. Besides key NPS question: „How likely is it that you would recommend #retailer name# to a friend or a colleague?” in scale from 0 to 10. Subsequently, NPS index was calculated for each retailer as described in section 3.

Moreover in order to identify roots of NPS index, each retailer were examine in comprehensive set of criteria's. Responders were asked to rate each retailer on scale from 1 to 5 according to seven criteria as follows: low prices, value for money, quality of products, wide choice of products, products that are suited to me, service and the store look & feel. Subsequently, above criteria's retailer ratings was converted into a 0-100 index, as as shown in figure 3.

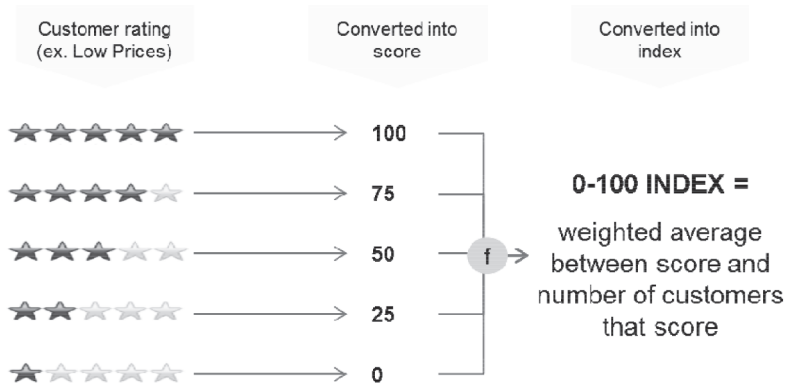


Figure 3. Criteria's 0-100 index calculation methodology description

Criteria's index presents percentage view on how well a retailer is assessed according to particular criteria eg. Low Price, Trust, Value for Money. It is used to examine impact of particular criteria on NPS index.

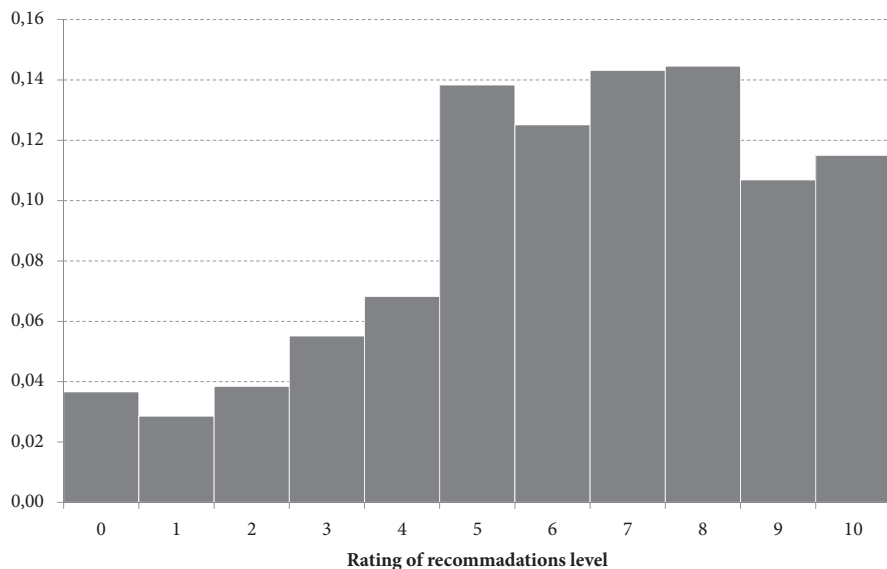
## The obtained results

The obtained probability distribution of recommendation ratings is shown in fig. 4. One can notice that there is high discrepancy between ratings above and below 4. The lower quartile, the median and the upper quartile of this distribution are 4.16; 6.07 and 7.81 respectively, whereas its average value is 6.25.

Therefore, it is worth to validate whether usage of different metrics based on recommendations vary between each other and leads to different conclusions in terms of loyalty roots identification. In table 1 we show the correlation matrix calculated from our data between three different loyalty metrics, i.e. NPS index, Top 2 boxes and Average. Based on results in this table, we can infer that different metrics introduced by different authors, are in this case highly correlated and in fact measure the same thing. Therefore, the analysis can be run in respect to one of them. Due to popularity of business usage of NPS index, in this paper NPS index is consider as the main metric.

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**Figure 4.** The probability distribution of recommendation rating

Source: own study based on survey conducted by OC&C Strategy Consultants (2013).

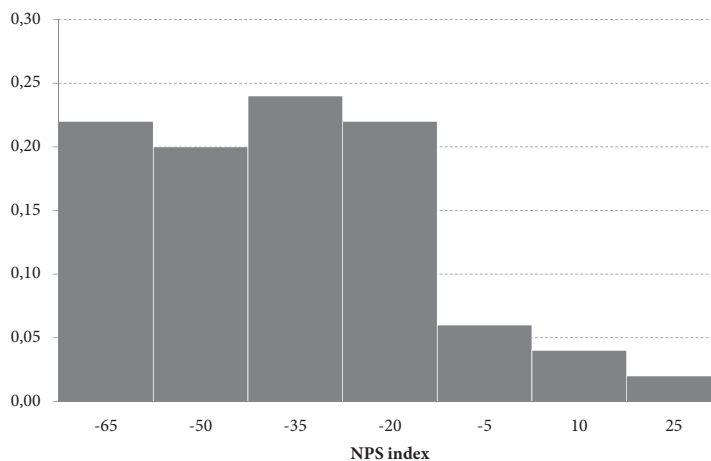
**Table 1.** Correlation matrix between different loyalty metrics based on recommendations of visitors and customers

	NPS	Top 2 boxes	Average
NPS	1,00		
Top 2 boxes	0,979	1,00	
Average	0,984	0,938	1,00

Source: own study based on survey conducted by OC&C Strategy Consultants (2013).

The probability distribution of NPS index obtained for different retailers is shown in fig. 5. All responders, who are aware, visited or bought from particular retailer were taken into account. NPS index is in range between -100 (when all responder rate below 7) and 100 (when all responders rate at least 9). The average among 50 retailers is amounted for -28,8, while Lower quartile equals -45,7, median -30,6, and

upper quartile -17,7. Moreover, standard deviation equals 23. Therefore, NPS index is highly diverse among retailers and most of retailers was rated negatively. Only 10% of retailers reached positive NPS index above 0, while 6% scored above 10. It clearly presents that some retailers managed to build positive loyalty index. However the most of retailers struggle to reach positive NPS index. Therefore, it sounds important for 90% of retailers to improve their customers loyalty and in a result NPS index.



**Figure 5.** The probability distribution of NPS index obtained for different retailers

Source: own study based on survey conducted by OC&C Strategy Consultants (2013).

## Key drivers of NPS index

In Polish retail market, there are highly important in store personal experiences. In fig. 6. we present the relation between NPS index of aware of retailer responders and NPS index of visitors or customers of retailer responders. One can notice the discrepancy between retailers ratings by responders who are only aware of retailer, but haven't been there, and responders, who were in store of particular retailer. We calculated NPS index differences between those two group. The standard deviation of those differences amounts for 21 points. Therefore retailers should focus on in stores activities. Moreover, based on it, we conclude that retailers can shape their NPS index – it is not constant. Positive NPS index is not beyond retailer reach.

The correlation coefficient between NPS index and different criteria is shown in fig. 7. It is visible that retailers should build trust. It is the most important factor in the creation of positive NPS index. It is crucial to investigate, what trust mean for customers and how can retailers build on it. There are several following hypothesis:

- keep their promises, e.g. when organize promotion, than products are available at discounted prices,
- there are no obstacles to return products,

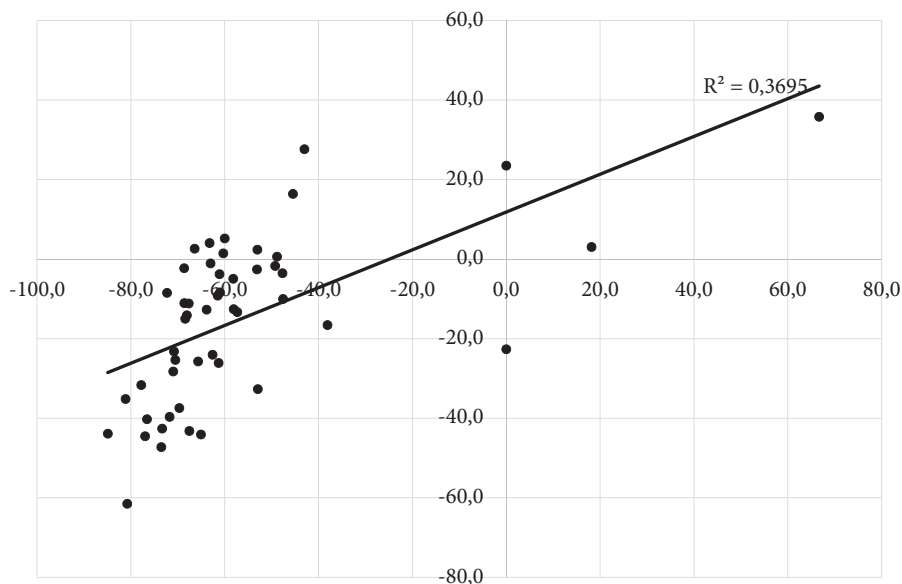


Figure 6. The dependence of NPS index of aware of retailer responders on NPS index of visitors or customers of retailer responders

Source: own study based on survey conducted by OC&C Strategy Consultants (2013).

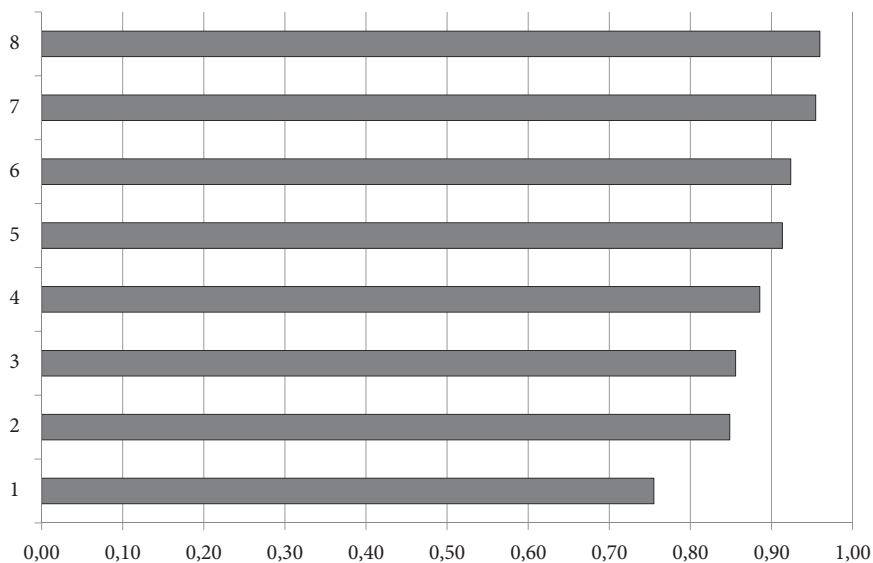


Figure 7. The Correlation coefficient between NPS index and a set of criteria

Source: own study based on survey conducted by OC&C Strategy Consultants (2013).

- products are high quality and meet customer requirements, e.g. products are fresh, no overdue products in stores,
- retailer undertakes Corporate Social Responsibility activities, i.e. care about employees, environment and suppliers,
- retailer is present for a long time and customers know history of a retailer,
- pay fair taxes,
- retailers culture play a role i.e. how it is positioned, what retailers communicate, what are presented values of a retailer.

Above hypothesis present direction in which further research on trust should lead.

The other interesting finding is that, low price is the less important factor. Contrary, Value for Money factor is just behind trust. It means, that customers perceive value not through low prices, but they take into account other factors. Therefore, price wars may have interruptive influence on building loyalty and in a consequence companies growth in a long term. Companies should focus on building value for customers, and pay attention to other than price factors. Nevertheless, correlation coefficients between different criteria given in table 2 show that Low prices are the less correlated with other criteria. It means, that it is important independent factor, which should be taken into account. Correlation coefficients between set of criteria and NPS index.

**Table 2.** Correlation coefficients between set of criteria and NPS index

	NPS	Low Price	Quality of Products	Wide Choice of Products	Products Suited To Me	Service	Store Look & Feel	Value For Money	Trust
NPS	1,00								
Low Price	0,76	1,00							
Quality of Products	0,85	0,43	1,00						
Wide Choice of Products	0,91	0,64	0,86	1,00					
Products Suited To Me	0,92	0,75	0,85	0,96	1,00				
Service	0,89	0,51	0,93	0,83	0,85	1,00			
Store Look & Feel	0,86	0,41	0,95	0,86	0,83	0,95	1,00		
Value For Money	0,95	0,87	0,81	0,89	0,94	0,83	0,77	1,00	
Trust	0,96	0,71	0,92	0,91	0,94	0,94	0,91	0,95	1,00

Source: own study based on survey conducted by OC&C Strategy Consultants (2013).

## Conclusions

Retailers in due course of their business development should focus on building relationship with customers. High share of customers, who are willing to recommend a company, is a good indicator of strong business performance and a predictor of business growth. In accordance to ongoing trends (technology development, social media, ease of communication), the influence of opinions and recommendation are expected to grow.

In order to measure customers attitude towards company, companies may use NPS index, which is considered as a very appropriate metric to measure loyalty. Based on the research, NPS index highly vary among companies. Moreover, only 10% of retailers score above 0, i.e. reached positive NPS index. It shows that there is still a lot of space for improvement in this area for most of retailers.

Customers create their opinions, and attitude towards retailers based on their experience. NPS index vary between customers. Responders, who are aware of a retailer, but haven't been there have different opinions than responders, who were in store. Therefore, it is crucial for retailers to effectively manage in-store execution, which should be aligned with corporate strategy.

NPS index is highly correlated with Trust. Therefore, retailers should pay attention to all marketing activities and store proposition in order to create high level of trust. The trust can be built on many different levers (products are not overdue, I will receive product, which I am looking for, company pay fair taxes, etc.). This paper presents only a direction in which activities and communication should go, based on roots of positive NPS index. Further research on trust is highly recommended, to indicate what cause positive trust perception and how companies can create it.

There is also high correlation between NPS and other criteria's: value for money, products that are suited to me or wide choice of products. Contrary, low prices are the less influential factor. Nevertheless, low prices are the less correlated with other criteria's. It means that, customers consider it as a completely separate factor.

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