JOURNAL

of Applied Economic Sciences

JAES

Journal of Applied Economic Sciences

Journal

of Applied Economic Sciences

Journal of Applied Economic Sciences

Journal of Applied Economic Sciences is a young economics and interdisciplinary research journal, aimed to publish articles and papers that should contribute to the development of both the theory and practice in the field of Economic Sciences.

The journal seeks to promote the best papers and researches in management, finance, accounting, marketing, informatics, decision/making theory, mathematical modelling, expert systems, decision system support, and knowledge representation. This topic may include the fields indicated above but are not limited to these.

Journal of Applied Economic Sciences be appeals for experienced and junior researchers, who are interested in one or more of the diverse areas covered by the journal. It is currently published quarterly with three general issues in Winter, Spring, Summer and a special one, in Fall.

The special issue contains papers selected from the International Conference organized by the European Research Centre of Managerial Studies in Business Administration (www.cesmaa.eu) and Faculty of Financial Management Accounting Craiova in each October of every academic year. There will prevail the papers containing case studies as well as those papers which bring something new in the field. The selection will be made achieved by:

Journal of Applied Economic Sciences is indexed in SCOPUS www.scopus.com, CEEOL www.ceeol.org, EBSCO www.ebsco.com, RePEc www.repec.org and in IndexCopernicus www.indexcopernicus.com databases.

The journal will be available on-line and will be also being distributed to several universities, research institutes and libraries in Romania and abroad. To subscribe to this journal and receive the on-line/printed version, please send a request directly to jaes_secretary@yahoo.com.

Journal of Applied Economic Sciences

Table of Contents

MANAGEMENT OF LABOR CONFLICTS IN PUBLIC HEALTH ORGANIZATIONS

Adriana Elena BELU
Faculty of Law and Public Administration, Craiova
Spiru Haret University, **Romania**
adyelenabelu@yahoo.com
Elena BICĂ
Faculty of Accounting and Financial Management, Craiova
Spiru Haret University, **Romania**
ebica62@yahoo.com

Abstract:
The paper treats a very important issue, of the present, with extensive and multiple implications for public health (Anderson, et al., 2005). The work can be considered as an interdisciplinary study justified by the following two arguments.

First, it is essential to applied research step, the knowledge and use of enshrined informational content in management literature, especially of models and mechanisms of managerial activity on the administration of human resources, managerial style, mobilization capacities, communication, coordination or decision ones and, not least the mechanisms characteristic to collective relations established between managers and employees. Second, it is required for the implementation phase of research findings, capitalization of an informational sphere of law field, specifically, labor law, because labor conflicts are based both on specific regulations of labor law and on a juridical literature, of great interest and of strict use for a concrete optimization of labor social relations.

Keywords: management, labor conflicts, public health organizations, manager, public health organizations.

JEL Classification: J40, J41, J50, J53, K31.

1. Introduction

The work highlights, as a work concentrating on labor conflicts management in public health organizations, the possibilities to improve the relations among the following three factors:
- management, understood as the formal ability of the leader to achieve performance in the organization's work with people;
- labor conflicts, i.e. conflicts between health professionals and public health organizations with which they concluded the individual employment contract, based on failure to resolve claims of professional, economic, social character or not giving rights that are based on labor law, labor collective contract or the individual employment contract;
- public healthcare organizations, defined as public institutions entirely financed from own revenues made under contracts with Social Health Insurance Houses. Without a doubt that the activity of all healthcare organizations is influenced by economic or social factors, but as resulting from the findings of this study, internal managerial factors have a determined role in preventing labor conflicts and, as a consequence, in optimizing psychological climate at work, thus ensuring a good quality of health services.

We found that healthcare organizations can feel a "management pressure" forcing inert systems and structures to become more flexible and to be concerned with the implementation of modern practices specific to management in healthcare organizations. In healthcare there must be exceeded the "necessity management" characterized by resorting to management only when crises or conflicts reach climax. It is true that we can learn something from crisis or conflicts, we draw conclusions, but the consequences of the unsolved crisis or failures of unsolved conflicts, in due time, are very costly (Bass and Avolio, 1990).

Organizational development and management in healthcare organizations is a productive orientation. Organizational development process requires common research approaches and particular needs of each health system hospital organizations. Research can provide decision-makers to materialize concrete conclusions and proposals which can ensure a better state of the system and a

psycho-socio-professional climate in hospitals that can prevent conflicts and optimize the relationship with beneficiaries.

2. Management of labor conflicts considerations

The conflict has always existed and still exists between people, either separately or in groups of one kind or another. Wherever there are people there are also ideas, values, circumstances, styles and standards that may conflict, which means that anything can cause a conflict: objectives, goals, aspirations, expectations unconfirmed, habits, prejudgments, personalities and ideologies, competition, sensitivity and offence, aggression and many more. Therefore, the conflict between people is installed, in all situations and, it is humanly expressed at any stage, and the attempts to analyze or solve it which do not take into account these truths are doomed to failure. With all that, there are many conflicts that are not minor, but may be more serious because they can damage the morale, behavior, positive or supportive attitude of staff performance [Constantinescu, Nistorescu, 2000).

Also, like any social organization the existence and dynamics of any organization requires both cooperation or dialogue and conflict because conflict is an inherent organizational process. Given the inevitable character of conflicts, it results that management is one of the most important activities, and the management of conflicts is considered by more and more specialists in the field as being as important as the other functions of human resources management.

The causes of labor conflicts to organizational level are multiple: lack of communication; lack of open communication, honest, sincere; faulty communication, intermittent, truncated; spread rumors, fake information; major differences between the perceived value system of managers and that of their employees; predominantly or exclusively authoritarian management; ambiguous management, which lacks clarity and consistency; dependence of the organization on external factors; impossibility to achieve the objectives assumed by the organization due to irrational planning; lack of a personal politics regarding the development of human resources; perceptions and misinterpretation of social, economic or legal events; reinforcing a climate of anxiety and mistrust; unacceptable discrimination in industrial relations.

Not every labor conflict must be qualified as "destructive", since there are specific instances in which the result of the employees' will has a positive sense, in one way to correct organizational or decision errors and, on the other to reestablish some broken rights or wrongfully not given .

In this kind of situation, the labor conflict is considered as being "beneficial" and there are imposed the following recommendations: the solving of the conflict must begin at the first signal of divergences; the communication between the parts must be direct, sincere, complete; the dialog must allow each part to expose all its arguments; the parts must show availability to solve the main issues and the details; they must start from the idea that the parts can gain equally by solving the declared state of conflict, in other words, it is not wanted the advantage of one party at the expense of the other (Belu, 2004).

Depending on the situation, conflict management must be understood as a management of success. The conflict must not be perceived as a negative force but as a positive force which may determine new performance in the organization. In this sense, the manager must find how the conflict can be directed and managed to maximize its positive effects and reduce the negative ones. Predominantly authoritarian management lacks efficiency and it is ambiguous, lacks clarity and consistency. Employees should be helped and encouraged by positive motivation and not manipulated and blackmailed with the loss of some rights including their jobs.

Establishing the healthcare organizations included in the case study. In order to verify the mentioned work hypothesis we decided to include in the scope of the investigation only public organizations and so we chose among healthcare organizations: „Filantropia" Municipal Clinical Hospital in Craiova, The Municipal Hospital of Băileşti and The City Hospital of Calafat.

All three organizations are healthcare units of public use with legal personality, having as main object of activity the supply of medical services.

We found within each of these organizations a conflict of rights that started at the beginning of 2006 and continued during the entire year of 2007: they did not receive individual food allowance (in the form of meal vouchers).

The mentioned hospitals were ordered by an internal decision that in the budget revenue and expenditure of healthcare organization there are provided food allowance amounts only to employees

who work in the sections with beds and not to those who work in outpatient (former clinic) or school medical cabinets. In this way, the personnel of the outpatient and school medical cabinets were convinced by the managers for an entire year that they were not entitled to receive meal vouchers because the state budget law said that (Băcanu, 1997). Lacking a legal training and a full trust in their manager, the staff that had this right denied continued its work, in silence, in spite of the discrimination for meal vouchers. After a short while this category of staff became aware of the illegality of the disposition of the manager and triggered the conflict of rights.

The conflict of rights for the denial of meal vouchers could have been prevented or even resolved without the intervention of the court. Thus, outside the optimal working climate which ensures in all the cases a high performance and for the organization a high efficiency, the money funds would have not been touched to pay court expenditures and revised amounts including the inflation index.

Retaining the criterion of internal communication, the managers in the investigative sample proved deficiencies under the following aspects:
▪ In his quality as a leader he/she did not know how to communicate, and the purpose of managerial communication consists in achieving efficient and effective information both vertically and horizontally. Communication of each manager with chief accountant regarding to respect a right of the employees by legal norms and by the clauses of collective contract of labor for healthcare branch proved lack of information and the dismissal of arguments of the legal advisor regarding a legal right led to the outbreak of a labor conflict and not to its prevention.
▪ When coordinating, the managers have defied operational feedback when employees informed them of the legal content of applicable law. Thus, both labor law specialist (counselor of Healthcare Organization), and employees advised by the lawyer were irrationally rejected by a manager who had no idea on managerial communication.
▪ When the court was notified and saw the content of the actions brought by the lawyer chosen by the employees, the manager had to be reconciled and recognize the justified claims of healthcare staff. He preferred to insist on his vulnerable decision thus bringing prejudice to the patrimony of the Healthcare Organization.
▪ The managers did not know how to use the specific guidelines of communication during a crisis or professionally approach the conflict. At the first hearing it was appropriate that the managers solve the conflict already existing to support the granting of rights issue. If managers had recognized at that phase that the claim of their employees were satisfied then the Healthcare Organization were no longer obliged to pay the court costs and could have been avoided that prejudice because of incompetence, to the organization (Băcanu, 2006).

First investigation aimed at understanding and use of components of the motivational process in order to prevent labor conflicts in Dolj public health organizations. Organization as a whole can provide the context that can achieve high levels of motivation by providing incentives and rewards, work satisfaction and learning and developing possibilities.

Motivation at work must take place in a procedural not episodic manner, it must settle a stimulating and rewarding feeling and not to draw some confusing views. Hence, we opted for a relevant method in order to know the role of motivation in preventing conflict situations: opinion survey. People are showing an external view, which can be passed through a filter of self-censorship, protecting themselves from possible consequences resulting from sincerity, sometimes upsetting, of telling the truth, as may hide (or not) an internal view, a faith or belief considered fully consistent with objective reality. The researcher must be capable to win the cooperation of the person investigated, ensuring anonymity to his/her opinions and their use in professional or social practice interpreted in a statistical context (Bărbulescu, Bâgu, 2001).

The case study proved that in healthcare units where the manager proves a preoccupation for motivational process, there is a positive correlation with equity division and with procedural equity and the consequence is expressed by a state of contentment, in an optimal working climate, with no conflicts.

Without being removed the financial incentives policy, the manager must introduce in the motivational process the complementary ways of motivation, the core of which must be behavioral strengthening, i.e. evidence, praise. Thus, health professionals accept, even justification for lack of

funds for cash rewards and appreciate participatory, encouraging style practiced by the manager. Work performance can certainly be stimulated by using tactful, psycho-behavioral techniques towards which the attitude of the healthcare staff is always friendly and rally (Băcanu, 2008).

The manager can provide valences to motivational process specific to high quality and performance, if it keeps in mind the following key principles:

- motivation must be equilibrated by the ability of the employee. Thus, it is not sufficient for an individual to be well motivated to do a certain thing, if that person does not have the skills, knowledge, experience, etc. to do so. The inexistence of such equilibrium between motivation and skills leads, most of the times, to the failure of some motivational programs promoted by companies;
- the existing individual differences when choosing the reasons: people are motivated by different things, the same motivational program can have success to some employees and prove inefficient to others. That is why, it is necessary to consider the individual differences when elaborating some motivational programs;
- motivation of employees cannot be evidenced for each and everyone because cannot be perceived on site, i.e. directly; the dynamic nature of motives: the factors which motivate individuals are changing, because the employees must deal with new conditions, maturate or regress etc. This has direct consequence on motivational programs: many of the managers observe that the people they work with do not answer favorably to motivational forms used in the past and yet, they do not give up in using them. The conclusion is clear: motivational programs must be based on a deep and continuous analysis of employees.

Thus, motivation is a source, a incentive to performance but should not be viewed separately from the other aspects and modalities of professional activities: organizational culture, managerial style, social signification of work, experience and structure of character of the employee.

Another case study highlighted the "Impact of organizational culture on labor conflicts". Organizational culture is a type of social phenomena that cannot structurally exist with the same content "anyplace" and "anytime", i.e. private organization can have a type of culture, public organization another kind, so that among public organizations there can be identified during the research of varied modalities of culture from a public domain to another and, why not, even within the structure of the same domain to exist differences among the composing organizations, depending on the cultural criteria.

The case study aimed to the relationship "organizational culture – working climate – conflicts" and highlighted the following:

- health professionals proves mistrust in the autonomy of hospitals in terms of human resource allocation in line with staffing needs, capital investments (equipment, machinery), field specific purchases (medicaments, combustible etc.), insufficient understanding to use a management of information etc.
- in healthcare organizations where the employed staff has a trust culture regarding the manager of the hospital, there is a positive working climate and consequently, there are no labor conflicts. On the contrary, the lack of trust in the manager is equal to tensioned climate and bursting of conflicts;
- the interventions on some competence of organizational culture were synthesized in the expression "management of change" having as object the working climate. In healthcare organizations conducted by managers that prove indifferent to the nature of working climate there were noticed conflicts, comparatively to the organizations conducted by managers preoccupied with organizational changes, where the climate was optimized and the conflicts prevented (Constantinescu, Nistorescu, 2008);
- mentality expresses a culture of personality expressed specifically in relations with work colleagues, professional tasks and self.
- We found that healthcare professionals of surveyed organizations are satisfied with mutual relations established within daily routine, so that the structure of working climate nuanced positively on the basis of collegiality;
- organization's culture can be a potential source of stress mainly on action and communication dimensions (i.e., what is done and what is said), and "hospital health" is

permanently affected by stress factors, pressure, being possible a weakening of the public or physiologic state of the staff employed. However, hospital employees showed full accommodation to the life of healthcare organization and did not invoke the internal environmental factor as a stress factor with implications on the environment or conflicts.

Staff management, understood as a responsibility of all those who lead people as managers, must include a permanent interest towards the culture of the organization because the value orientation of the employees determinate efficiency, optimal climate and full engagement in a activity which generates satisfaction. In healthcare units, health professionals internalized the culture of a priority: the care for the inpatient. The ideal must be held only by the patient: "I was treated fairly and selflessly!"

Can the manager, by exercising his/her power as a leader to decide the prevention and solving of a conflict qualified by antagonism, with negative impact on the performance of the organization? The answer concerns the nature of power-conflict relationship in public organization and the case study expresses the reality found in downstream healthcare organizations in the city of Craiova.

The research was carried out based on the call method and questionnaire-based survey. The conversation held with some of healthcare staff suggested the development of items (questions) in terms of content, and the application of the questionnaire to a representative sample gave us the possibility to process the answers and interpret statistic values.

The advanced formalization of the business of public healthcare organizations determines an appropriate formalization on organization level including on the organizational structure level. In order to avoid the probability that some arbitrary comportments of healthcare professionals may appear, the formalization of the organization means to establish who, what and whom they command. This imperative determines the distribution of management authority towards chiefs of department and other persons with responsible functions in healthcare organization. The lack of management knowledge of the one elected to lead the organization can concretize, under this aspect, in exclusive assumption of authority and implicitly in avoiding the distribution of leading forms and control.

The case study confirmed the relation between the authoritarian, individualistic power exercised by the managers of the two healthcare organizations (Clinical Hospital no.1 and „Filantropia" Clinical Hospital) and the bursting of labor conflicts in the context of a tensioned organizational climate, comparatively to another healthcare organization (Contagious-infectious diseases hospital) where the manager made a distribution of authority, and so organizational conflicts were prevented.

A manager with leadership ambitions must have an internal structure "transactional", communicative, and balanced. In spite of the conditions imposed to decisional process by the environment or internal climate of the organization, the manager has to prove availability to listen and adapt to realities expressed by human structure of the organization he/she leads. In other words, the preoccupation of the manager to accomplish the objectives of the organization and for public image must be accompanied by a cooperative attitude, empathic towards the members of the organization. The transaction does not mean indulgence or tolerance or complicity. On the contrary, it means receptivity and consistency in stimulating those who respect the performance criteria. The transactional leader establishes the clauses in working relations and respects the assumed commitment.

The case study highlighted the relation "transactional leader – labor conflict" in the two possible variants:

- healthcare organization led by a manager recognized in transactional style, work climate was favorable to the activity specific to the field, without registering any labor conflicts (Contagious-infectious diseases hospital);
- rigid manager, stuck in bureaucratic decisions, not concerned with psycho-social climate in the healthcare organization, contributed with this style in transforming the states of dissatisfaction expressed by healthcare professionals, in labor conflicts that reached the courts.

Participative management was defined, based on researches, as "ideal system", because productivity is excellent and the key word is participation.

Managerial necessities of healthcare organizations request the structure of a participative manager profile, understood as "total leader", which creates an optimal working climate, prevents

conflicts and ensures superior results in medical practice. Such desired relation is highlighted also by the data of this research (Mathis, *et al.* 1997).

The investigation revealed a positive relation between participative management and psychological climate, free of labor conflicts. In contrast with authoritarian style, participative style leans the views of subordinates towards the qualification "ideal manager".

Participative manager should not be confused with the administrator of the organization who is willing to do anything possible to see accomplished the proposed or imposed objectives. On the contrary, he/she is a leader who contributes to the development of the organization counting on the collective support of which he/she respects and defends its interests and towards which he/she adopts an exclusively democratic style. Being a participative manager and having subordinates capable of performance, it supposes an effort of both parties, possible by two-way communication.

Participative manager is an excellent leader characterized by: good strategist, a balanced use of formal power and freely consented authority, has the capacity to orient towards the task and also towards the people, he/she is objective – correct – just in his/her relations with the subordinates, is the adept of change because he/she is a flexible and transactional nature, inspires trust, shares a vision, has charisma and is preoccupied with the optimization of his/her own leading style.

Participative manager has permanent knowledge of the affective pulse of the participants to organizational life, he/she gets rationally involved in creating the optimal work climate and eliminates from the start any pretext generating labor conflicts.

The main objective of managers in the sphere of their relations with the employees must be obtaining the cooperation of labor power to meet the objectives of the organization, i.e.: financially efficient performances (in the case of hospitals, major revenues in terms of contracts made with the health insurance houses and correlatively the reduced expenditures with labor power); the control and optimization of organizational and functional changes on criteria of efficiency; avoiding the interruption of work because of labor conflicts.

The employees are guaranteed both the right to collective negotiation and the possibility to claim for normal working conditions. Therefore, the conflicts of interests can be determined only by the misunderstandings related to collective negotiation.

The situations when there can be opened conflicts of interests are the following:
- The unit refuses to start the negotiation for a new collective employment contract, in the case it did not sign a collective employment contract or the one before was terminated;
- The unit does not accept the claims made by the employees;
- The unit refuses, in an unjustified manner the signing of the collective employment contract, even though the negotiations had been defined;
- The unit does not comply with its obligations provided by law to start the annual obligatory negotiations for salaries, the working duration, working program and labor conditions.

By the end of the year 2008, the people employed in the studied healthcare organizations asked the manager to start the collective negotiation because at unit level there is no collective employment contract, and the law established the obligation to initiate negotiations as being a manager's tasks. None of the managers responded favorably to the legal norm, so that it was necessary an official request, registered, of the employees' representatives. Only in this secondary phase the managers from two public health organizations agreed to start collective negotiations which finalized as a collective employment contract.

The managers of these two healthcare organizations are doctors and they happily included themselves in the "picture" of technocratic manager, of which we learn:
- authentic technocrats are excellent managers; they work in a precise manner, rapid too, without hesitation or complexes, putting their principles into value, their models and their excellent managerial technique. As presented above, in terms of dictionaries, technocrats make possible the prevail specific issues, technical ones of a problem at the expense of social consequences;
- Technocrat managers control their emotions, maintain distance from subordinates, are serious, analytical, methodical, cerebral, conservative, decided and prove, most of the times, excellence (Maxwell, 1999). They are respected but, they are not loved. Their power consists in their deep analysis of the situations that they completely control. They are

capable to offer for any situation alternative solutions. They have the capacity to transmit to others their knowledge, which is a quality appreciated by the subordinates.
- as a strategy, technocrat managers count on alliances and prove opportunity in the programs they assume.

To the public health organizations where there started the conflict of interests, the managers made the following errors:
- they did not start the collective negotiation and did not accept its beginning when asked by the trade union organization, even though the law obliged them to act as requested by the employees;
- they had no legal justification for it, motivating that healthcare branch has a collective employment contract and, at organization level the negotiation would be useless. They also proved an informational deficit and a totally ineffective communication with the subordinates;
- they did not gave in and accepted to give up their wrong, abusive and illegal point of view not even in front of the arguments presented by the delegate of labor ministry in the conciliation phase, or the mediator present during mediation;
- they decided in a completely irrational way not to accept the presentation of the conflict of interests to an arbitrary commission that based on documentation would have certainly solved the labor conflict and the way to strike would have been stopped;
- the rigidity of the manager and the refuse of a social dialog where economic and human arguments may prevail, propelled the conflict of interests to its peak point: the strike.

Through the conclusions of the study we express an orientation to a management of functional conflicts, i.e. to maintain an optimal level of conflict reported to the correlation to the evolution of organizational processes. This imperative scientifically motivated is dependent on the level of managerial development in the public health organization, because the management of labor conflicts represents an essential criterion to reach global managerial performances (Mayer *et al.* 1995).

3. Conclusions:

Knowing that the consolidation mechanism of an organizational culture, both managers and employees, react to internal or external events through the filter of some dominants crystallized in time, we decided the application of sociological survey made of written questions which will not disturb and will allow the same interpreting sense for all that there are questioned. The components of the culture that made the object of the present case study drawn from conclusions from other published researches by valuable authors and adapted to the realities of Romanian Healthcare Organizations, were the following: trusting climate, management of change, stressing environment, management of solving the claims and mentality doubled by daily behavior by which is characterized the working force in the hospitals.

References:

[1] Bass, B.M., Avolio, B.J. (1990). *The implications of transactional and transformational leadership for individual, team, and organizational development*. In W. Pasmore & R.W. Woodman (Eds.). Research in organizational change and development: Vol.4. Greenwich, CT: JAI Press. (pp. 231-272).

[2] Constantinescu D., Nistorescu T. (2000). *Entreprise economy,* Economică Publishing House, București.

[3] Belu, A. (2004). *Introduction to the study of legal personality,* Reprograph Publishing House, Craiova.

[4] Bărbulescu, C., Bâgu, C. (2001). *Production management policies,* Tribuna Economică Publishing House, Bucharest.

[5] Băcanu, B. (2008). *Public organization. Theory and management*, Polirom Publishing House, Iași.

[6] Constantinescu D., Nistorescu T. (2008). *Project management. Fundamentals, methodes and și tehniques,* Sitech Publishing House, Craiova.

[7] Mathis, R.L., Nica, P.C., Rusu, C. (1997). *Human resources management,* Economică Publishing House, Bucharest.

[8] Maxwell, A. (1999). Supreme law of the 21 management*,* Amalteea Publishing House, Bucureşti.

[9] Mayer, R.C., Davis, J.H., Schoorman, F.D. (1995). *An integration model of organizational trust,* The Academy of Management Review, 20 (3): 709-734.

LOGISTIC OPTIMIZATION OF THE COMPLEX MANUFACTURING SYSTEM WITH PARALLEL PRODUCTION LINES

Robert BUCKI
Institute of Management and Information Technology, Bielsko-Biała, **Poland**
rbucki@wsi.edu.pl
Petr SUCHÁNEK
Silesian University in Opava
School of Business Administration in Karviná, **Czech Republic**
suchanek@opf.slu.cz
Bronislav CHRAMCOV
Tomas Bata University in Zlín
Faculty of Applied Informatics, **Czech Republic**
chramcov@fai.utb.cz

Abstract:

The paper highlights the problem of mathematical modeling of a complex manufacturing system which is a potential synthetic representation of a real production environment. Production lines are parallel. Each production line consists of work stations which are placed serially along the predetermined trajectory. Each work station is equipped with the predefined tool used to manufacture the dedicated product. The system is controlled by means of heuristic algorithms to meet the manufacturing criteria. Equations of state illustrate the behavior of the system at every stage.

The paper shows basic characteristics of current manufacturing systems emphasizing models for further optimization and simulation processing. First of all, the general background related to this topic is given. The second part of the paper focuses on the specific manufacturing system and suggests the ways of optimizing it to meet the given criteria with the use of heuristic algorithms.

Keywords: manufacturing system, model, logistics, mathematical modelling, optimization, simulation, heuristic algorithms, manufacturing criteria.

JEL Classification: C20, C61, C63

1. Introduction

Manufacturing companies in the 21st century face unpredictable, high-frequency market changes driven by global competition. To stay competitive, companies must possess new types of manufacturing systems that are cost-effective and very responsive to all these market changes. In this context, increasing emphasis is put on the so called reconfigurable manufacturing systems (RMS) whose components are reconfigurable machines and reconfigurable controllers as well as methodologies for their systematic design and rapid ramp-up. They are the cornerstones of this new manufacturing paradigm (Koren, 1999). New manufacturing and production systems and requirements placed on them implement new approaches for their development, optimization and, in general, management. It is always necessary to take into account the purpose of the system to define its type and architecture. Other indispensable modeling elements to be considered are monitoring operations, optimization and simulation. The primary component of each model is, of course, its mathematical description enabling and facilitating the system optimization. In connection with the above, the main objective of the article is to present a concrete example of the optimization of the manufacturing system which consists of production lines which are arranged in a parallel way.

2. Manufacturing systems and basis of its optimization

2.1 Types of manufacturing systems

Generally, a manufacturing system can be considered as a subsystem of the so called production system that includes all functions required to design, manufacture, distribute and service manufactured products. Many types of manufacturing systems are complex e.g. assembly and batch production. They can be developed and analyzed in terms of flexible manufacturing systems, lean production, mass production, computer-integrated manufacturing etc.

Despite the fact that we live in times of rapid technological development, we cannot be limited only to fully automated production systems but we must also consider all general types of systems. The four traditional types of manufacturing systems are the job shop, the disconnected flow line, the connected flow line and the continuous flow process (Vuuren, 2007). The characteristics of individual types of systems are presented in Table 1 and can be found in (Charalambous, 1997), (Shivanand, 06), (Wright, 2000) and (Buzacott, 1993).

Table 1 - Types of manufacturing systems

MANUFACTURING SYSTEM TYPE	DESCRIPTION
Custom Manufacturing System	This type represents one of the oldest and most widely used forms of product making. In this system, a single craftsman produces one item at a time by hand or with the use of a machine. If machines are used in this system, they are often highly specialized and capable of producing only a single line of merchandise. This system offers the lowest level of efficiency and highest cost per unit and results in very low levels of production.
Intermittent Manufacturing System	Such systems are often called "job shops" and are capable of producing multiple items at the same time. These objects must be identical or very similar and cannot be customized for individual buyers. This type of system works best for limited production runs or for companies looking to produce a low volume of goods.
Continuous Manufacturing System	Continuous manufacturing systems allow for mass production of products. In this system, the product moves from station to station along an assembly line with different workers performing various production tasks along the way. Continuous systems were first used during the Industrial Revolution and are often associated with the Ford Company's Model T production. This type of system allows companies to meet high production goals and results in a lower per-unit cost. Because of the large amount of equipment required to create an assembly line, as well as the level of labor, this type of system is often associated with large capital investments.
Flexible Manufacturing System	Flexible manufacturing systems represent one of the most widely used modern production systems. In this type of setup, companies invest in a variety of machinery that can be reconfigured quickly and easily to produce a large number of products. Flexible manufacturing often incorporates robots or automatic vehicles to help move products through the production process, eliminating the need for skilled labour. This type of system allows for a high degree of flexibility in terms of product mix and helps the company maintain high volume in each production run. Because robots replace human labour in this type of system, products tend to be fairly consistent and their quality remains high. This system requires a high degree of capital investment as well as frequent maintenance and oversight.

The basic indicator of the characteristics of the system is its performance in relation to the purpose of its use. System performance is usually measured against a number of measurable parameters that can be determined on the basis of the assembled system models. Manufacturing system models are very important for the system design, improvement and prediction of system performance.

2.2 Manufacturing system models

For our purposes, we can take into account two types of models which are simulation models and analytical models. As described in (Vuuren, 2007), simulation models represent the events that could occur as a system operates by a sequence of steps in a computer program.

The probabilistic nature of many events, such as machine failure and processing times, can be represented by sampling from a distribution representing the pattern of the occurrence of the event. Thus, to represent the typical behavior of the system, it is necessary to run the simulation model for a sufficiently long time so that all events can be occuring a sufficiently large number of times.

Virtual reality techniques are relatively new, having experienced significant development only during the last few years in accordance with the progress achieved by computer science with the use of hardware and software technologies. The study of such advanced design systems has led to the realization of an immersive environment in which new procedures for the evaluation of product prototypes, ergonomics and manufacturing operations have been simulated (Marzano, 2009). Simulations and generally development and parameterization of system models have a much wider use not only in manufacturing systems but also in general production systems. In connection with simulation models and simulations in general, it is necessary to mention the use of process oriented models (Řepa, 2006), value-chain oriented models (Vymětal, 2009), and multi-agents approach shown for example in (Šperka, 2012).

Analytical models describe the system using mathematical or symbolic relationships. These relationships are then used to derive a formula or to define an algorithm by which the performance measures of the system can be evaluated. Often, it is not possible, within a reasonable amount of computer time or data storage space, to obtain the performance measure from the relationships describing the system. Further assumptions that modify these relationships then have to be made. The resulting model is approximate rather than exact, and to validate this approximation, a simulation model may be required (Vuuren, 2007).

Analytical and simulation models should not be strictly separated because of direct relations between them. The model highlighted in the article can either be considered as the analytical model or the simulation one. Development of system models and their description, especially mathematical, helps companies and their management to create an intelligent strategy e.g. (Li, 2009). Their performance can be measured in many ways and in different contexts as shown in (Chen, 1996) or (Rezaie, 2009). Modelling of the system has major importance for its optimization.

2.3. Manufacturing system optimization

There are four areas that can be examined from different perspectives and in different contexts for each production system (Figure 1).
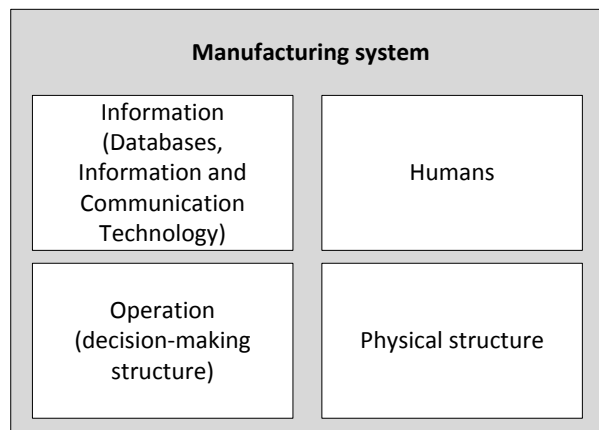
Figure 1 - Components of general manufacturing system

In addition to monitoring and analysis of individual areas, it is also very important to consider the individual links between different areas. In other words, the manufacturing and, in general, production system must be designed as a fully integrated system.

For the purpose of manufacturing system optimization it is always necessary to precisely define the requirements, and it is always possible to go from the universal principles and requirement which are as follows:

- high degree of automation;
- high degree of performance;
- required level of quality of outputs;
- production at the lowest cost;
- production in the shortest time;

- the highest possible degree of flexibility;
- the highest possible degree of adaptability.

This paper is strictly oriented only towards one element of manufacturing system optimization which is its physical structure and functionality in terms of optimization of material flows between production lines and their work stations. Therefore, we can say that this is a problem of optimization of logistic processes. As shown as an example in (Groover, 2010), management of manufacturing logistics is a very important component of management processes, and specifically, a lot of emphasis should be put on relations between material properties and process variables in the discussed process.

If we look again at the issue in general terms, the optimization of the manufacturing system in terms of logistics and especially material and intermediate products (charge), the supply chain can be viewed from many perspectives e.g.:

- the amount of material;
- the type of material;
- the mode of material transport;
- the time of material transport;
- the failure (such as the failure of the conveyor belt described in (Padhi, 2013));
- the intensity of human labours;
- the financial demands of material transport;
- the material transport safety, etc.

3. Mathematical methods and algorithms

3.1. Mathematical methods

Generally, problems are classified depending on mathematical methods which are implemented to describe them. In accordance with it, the following problems can be distinguished:

- continuous or discrete (non-continuous);
- deterministic or probabilistic (non-deterministic).

Continuous problems are connected with processes described by means of differential equations where time is a changeable variable e.g.:

- *One-dimensional ordinary differential equations* (contain the unknown x in the form of a derivative).
- *Multi-dimensional partial differential equations* (contain the unknowns x and y in the form of partial derivatives).
- *Integral equations* (contain unknowns in the form of an integral).

In a general case, continuous processes can be described by means of equations in which unknowns appear in the form of derivatives or integrals. Information technology solves differential and integral equations with the use of numerical methods by approximating a quantity or series using a discrete quantity or quantities. Numerical methods discretize continuous mathematical models and present them in the form of differential equations. Also, these equations use various algorithms to solve them after implementing discretization in the form of time as an independent variable for a partial derivative. It is possible to use numerical methods to solve problems which are impossible to solve analytically, e.g. by integration.

Non-continuous problems (the so-called discrete problems) are connected with complexes of operations. The complex of operations is a graph with time, logical and space limitations. An operation is determined by the time which depends on recourses used to its performing. Such complexes of operations are subject to operations research in informatics. Combinatorial algorithms are used to optimize complexes of operations.

A characteristic feature of discrete problems is a large number of allowable solutions of which only one is the best acceptable. Solving a discrete problem requires doing an effective review of allowable solutions. The basic problem remains the time of determining the solution. From the point of view of the mathematical description, the following classification is used:

- *Continuous deterministic problems* (e.g. the flow of electricity, water, gas, etc.);
- *Continuous stochastic/probabilistic problems* (e.g. exchange rates of currencies, rates of shares, prices of metals, etc.);

- *Discrete deterministic problems* (e.g. complexes of operations performed by robots, etc.);
- *Discrete stochastic/probabilistic problems* (e.g. complexes of stochastic/probabilistic operations).

3.2. Algorithms

An algorithm is a list of operations which are to be carried out to solve the problem. Classic algorithms are realized by one processor (the so-called serial algorithms). However, in a general case, algorithms can be realized by many processors. To solve discrete problems the following serial algorithms are distinguished:

- Optimal algorithms in which the decision tree is generated in stages. The idea of these algorithms is based on dynamic programming (recurrent functions).
- Sub-optimal algorithms in which the decision tree is generated by trajectories. These algorithms determine allowable solutions subsequently and only the best current solution is stored. As not all allowable solutions are generated, the current best solution is not usually the optimal one, however there exits the measure of quality of such a solution.
- Conversational algorithms in which an operator of the computer makes decisions in the process of generating a solution with information support. The characteristic feature of these algorithms is the possibility of returning after a generated trajectory if it is not perspective.
- Agent algorithms in which decisions are made on the basis of artificial intelligence. The decision about transition from one stage to the subsequent stage consists in choosing a heuristic which may deliver the best expected solution to the stated problem. These algorithms require the knowledge about the effectiveness of heuristics.
- Heuristic algorithms in which the allowable solution is generated by means of determined rules without optimization guaranty. The entire trajectory, from the initial stage to a goal stage, is generated by means of the same heuristic.
- Random heuristics in which allowable solutions are generated at random. Every subsequent decision about generating a subsequent state is a random choice in the set of allowable options. The best of generated solutions is treated as the best one currently. Moreover, the histogram of solutions is created.

Serial algorithms can be generalized to the form of parallel algorithms. Parallel algorithms enable calculations with the use of many processors. However, acceleration of calculations is not multiplied by the number of processors because of constraints of algorithms, software and hardware.

Deterministic problems are characterized by deterministic data of time and other resources. There are no random variables in deterministic models. Non-deterministic models consist of non-determined data. Stochastic non-deterministic models contain random variables whereas probabilistic models contain probabilities of random variables. Non-deterministic models describe real processes in a better way; however making use of such models is difficult in practice. Non-deterministic processes are used in modelling and computer-based simulation while implementing generators of pseudo-random numbers (Marecki, 2010).

Another issue that plays an important role in supporting solving deterministic problems is the convexity approach which can be used as a risk-management tool to measure and manage the amount of risk (Worswick, 1957). A wide range of optimal selection problems are formulated as non-linear constrained optimization problems. One of the most common characteristics of these problems is the presence of non-convexities in their modelling representations. Non-convexities complicate solution methodologies since most existing optimization algorithms rely on identifying stationary points in the feasible space. Locating the global minimum solution of a general non-convex optimization models remains of a primary importance. A common characteristic of all global optimization approaches is their increased computational requirement as the size of the problem increases (Pardalos, 1999).

Different algorithms meet different needs and so can be classified by their main purposes. Some algorithms operate as read only, some modify elements, and some change the order of elements (Josuttis, 2012). Heuristic algorithms are responsible for meeting the set criterion. The criteria are implemented to either maximize the production output or minimize the lost flow capacity of the logistic system or minimize the tool replacement time. Equations of state are given in order to represent the flow of material through the logistic system. The problem of modelling also consists in

determining the best order realization sequence in order to minimize the total production time. The idea of time scaling by means of the simulation method should be implemented in order to determine the best possible order realization time. A possibility of simulation of such production systems must be outlined.

Methods of mathematical modelling supported by heuristic approaches can be implemented in a lot of fields of contemporary experiments e.g. in modelling sustainable environment tasks (Antonyová, 2013). Another aspect worth considering remains implementing RFID methods in order to support manufacturing tasks. These methods lead to minimizing service time of manufacturing processes. As the key innovative solution it automatically captures and tracks the movement of material items throughout an entire supply chain (Modrák, 2012). In multi stage job problems, simple priority dispatching rules such as shortest processing time and earliest due date can be used to obtain solutions of minimum total processing time, but may not sometimes give sequences as expected that are close to optimal (Modrák, 2010).

From the programming point of view algorithms can be classified as follows:

- Non-modifying algorithms change neither the order nor the value of the elements they process. These algorithms operate with input and forward iterators; therefore they can be called for standard containers.
- Modifying algorithms change the value of elements. Such algorithms might modify the elements of a range directly or modify them while they are being copied into another range. If elements are copied into a destination range, the source range is not changed.
- Removing algorithms are a special form of modifying algorithms. They can remove the elements either in a single range or while these elements are being copied into another range. An associative or unordered container cannot be used as a destination because the elements of these containers are considered to be constant.
- Mutating algorithms change the order of elements by assigning and swapping their values which is not changed. An associative or unordered container cannot be used as a destination because the elements of these containers are considered to be constant.
- Sorting algorithms are a special kind of mutating algorithm because they also change the order of the elements. However, sorting is more complicated and therefore usually takes more time than simple mutating operations. Sorting algorithms usually have worse than linear complexity and require random-access iterators for the destination. Time is often critical for sorting elements.
- Sorted-range algorithms require that the ranges on which they operate be sorted according to their sorting criterion. As for associative containers, these algorithms have the advantage of a better complexity. The result of these algorithms is also sorted.
- Numeric algorithms combine numeric elements in different ways. These algorithms are more powerful and flexible.

4. General assumptions of the manufacturing system

Let us assume that the manufacturing system consists of L production lines which are arranged in a parallel way. There are J work stations in each l-th production line, $l = 1,...,L$. Each j-th work station, $j = 1,...,J$ is equipped with the i-th tool to realize the n-th order, $i = 1,...,I$, $n = 1,...,N$. There are buffer stores between each two work stations in each l-th production line. The capacity of buffer stores is assumed to be unlimited. Let us introduce the matrix of assignments of tools to work stations (1):

$$\Xi(n) = \begin{bmatrix} \theta(n)_{1,1} & \cdots & \theta(n)_{1,j} & \cdots & \theta(n)_{1,J} \\ \vdots & & \vdots & & \vdots \\ \theta(n)_{i,1} & \cdots & \theta(n)_{i,j} & \cdots & \theta(n)_{i,J} \\ \vdots & & \vdots & & \vdots \\ \theta(n)_{I,1} & \cdots & \theta(n)_{I,j} & \cdots & \theta(n)_{I,J} \end{bmatrix} \quad i = 1,...,I,\ j = 1,...,J,\ n = 1,...,N \tag{1}$$

where: $\theta(n)_{i,j}$ - assigning the i-th tool to the n-th order in the j-th work station.

The elements of the above matrix take the following values:

$$\theta(n)_{i,j} = \begin{cases} 1 & \text{if the } n\text{-th order is made with the use of the } i\text{-th tool in the } j\text{-th work station,} \\ 0 & \text{otherwise.} \end{cases}$$

Products can be made from M charges. After completing the manufacturing procedure the final products are stored in the dispatch store.

Let k, $k = 1,...,K$ be the moment of making any decision in the discussed system. Let us introduce the vector of orders at the k-th stage (2):

$$Z^k = \left[z_n^k \right], \ k = 1,...,K, \ n = 1,...,N \tag{2}$$

where: z_n^k - the number of conventional units of the n-th order at the k-th stage.

The order vector Z changes after every production decision (3):

$$Z^0 \to Z^1 \to ... \to Z^k \to ... \to Z^K \tag{3}$$

The order vector is modified after every decision about production:

$$z_n^k = \begin{cases} z_n^{k-1} - x_n^k & \text{if the number of units } x_n^k \text{ of the } n\text{-th order is realized at the } k\text{-th stage,} \\ z_n^{k-1} & \text{otherwise.} \end{cases}$$

Let us introduce the vector of charges at the k-th stage (4):

$$\Omega^k = \left[\omega_m^k \right], \ k = 1,...,K, \ m = 1,...,M \tag{4}$$

where: ω_m^k - the number of conventional units of the m-th charge at the k-th stage.

The state of charges is modified after each decision about production:

$$\omega_m^k = \begin{cases} \omega_m^{k-1} - x_n^k & \text{if the number of units } x_n^k \text{ is realized at the } k\text{-th stage,} \\ \omega_m^{k-1} & \text{otherwise.} \end{cases}$$

It is assumed that each unit of n-th order is made from one unit of the m-th dedicated charge. Let us propose the matrix of assignment charges to orders (5):

$$\Phi = \left[\phi_{m,n} \right], \ m = 1,...,M, \ n = 1,...,N \tag{5}$$

where: $\phi_{m,n}$ - the assignment of the m-th charge to the n-th order.

Elements of the matrix of assignment charges to orders take the following values:

$$\phi_{m,n} = \begin{cases} 1 & \text{if the } n\text{-th order can be made from the } m\text{-th charge,} \\ 0 & \text{otherwise.} \end{cases}$$

We assume that there is the sufficient number of charges needed to realize the n-th order at every k-th stage. The number of conventional units of the m-th charge, $m = 1,...,M$ at the stage $k = 0$ is maximal. If $\bigvee_{1 \leq m \leq M} \omega_m^k < 0{,}5 \cdot \omega_m^0$, the supplying process of the m-th charge begins at the determined rate of α_m units of the m-th charge during the subsequent k-th stage where $1 \leq \alpha_m \leq 0{,}5 \cdot \omega_m^0$.

5. Equations of state of manufacturing system

The state of the whole discussed logistic manufacturing system changes in the production course as follows (6):

$$S^0 \to S^1 \to ... \to S^k \to ... \to S^K$$

(6)

The state of the l-th discussed production line, $l = 1,...,L$ changes in the production course as follows:

$S(l)^k = S(l)^{k-1}$ if no product is realized in the l-th production line,

$S(l)^k \neq S(l)^{k-1}$ otherwise.

Let us define the state matrix of tools in the *l*-th production line at the *k*-th stage (7):

$$S(l)^k = \left[s(l)^k_{i,j} \right] , \quad i = 1,...,I , \quad j = 1,...,J , \quad l = 1,...,L , \quad k = 1,...,K$$

(7)

where: $s(l)^k_{i,j}$ - the state of the *i*-th tool in the *j*-th work station in the *l*-th production line at the *k*-th stage (number of units which have already been manufactured by the *i*-th tool in the *j*-th work station in the *l*-th production line till the *k*-th stage).

The state of the *i*-th tool in the *j*-th work station in the *l*-th production line changes consequently (8):

$$s(l)^0_{i,j} \to s(l)^1_{i,j} \to ... \to s(l)^k_{i,j} \to ... \to s(l)^K_{i,j}$$

(8)

which can be written in the following form:

$$s(l)^k_{i,j} = \begin{cases} s(l)^{k-1}_{i,j} & \text{if no product is realized in the } j\text{-th work station of the } l\text{-th production} \\ & \text{line with the use of the } i\text{-th tool at the stage } k\text{-th} - 1\text{-th,} \\ \\ s(l)^k_{i,j} + x^k_n & \text{otherwise.} \end{cases}$$

where: x^k_n - the number of units of the *n*-th order realized at the *k*-th stage.

Let $u(l)_{i,j}$ be the *i*-th tool in the *j*-th work station to be replaced with a new one in the *l*-th production line, $1 \leq u(l)_{i,j} \leq I$. The state of the *i*-th tool in the *j*-th work station in the *l*-th production line changes in case of replacement in the way shown below:

$$s(l)^k_{i,j} = \begin{cases} s(l)^{k-1}_{i,j} & \text{if the i-th tool in the j-th work station in the l-th production line is not} \\ & \text{replaced at the stage k-1,} \\ \\ 0 & \text{otherwise.} \end{cases}$$

Let us define the life matrix of tools (9):

$$G(l) = \left[g(l)_{i,j} \right] , \quad i = 1,...,I , \quad j = 1,...,J , \quad l = 1,...,L$$

(9)

where: $g(l)_{i,j}$ - the life of the *i*-th tool in the *j*-th work station in the *l*-th production line (the number of units which can be manufactured by the *i*-th tool in the *j*-th work station in the *l*-th production line before the discussed tool is completely worn out).

Let us define the flow capacity matrix at the *k*-th stage (10):

$$P(l)^k = \left[p(l)^k_{i,j} \right] , \quad i = 1,...,I , \quad j = 1,...,J , \quad l = 1,...,L , \quad k = 1,...,K$$

(10)

where: $p(l)_{i,j}^{k}$ - the flow capacity of the *i*-th tool in the *j*-th work station in the *l*-th production line at the *k*-th stage (the number of units which still can be manufactured by the *i*-th tool in the *j*-th work station in the *l*-th production line at the *k*-th stage).

The flow capacity of the *i*-th tool in the *j*-th workstation in the *l*-th production line at the *k*-th stage is calculated as follows (11):

$$p(l)_{i,j}^{k} = g(l)_{i,j} - s(l)_{i,j}^{k}$$

(11)

6. Manufacturing times

The manufacturing times of products are given in the matrix form (12):

$$T^{pr} = \left[\tau(n)_{i,j}^{pr} \right], \; i = 1,...,I, \; j = 1,...,J, \; n = 1,...,N$$

(12)

where: $\tau(n)_{i,j}^{pr}$ - the manufacturing time of one unit of the *n*-th order with the use of the *i*-th tool in the *j*-th work station.

The operation times in the discussed manufacturing system are shown in Figure 2.

$$
\begin{array}{ccccccccccc}
\tau(1)_{i,1}^{pr} & \circ & \tau(2)_{i,1}^{pr} & \cdots & \circ & \tau(n)_{i,1}^{pr} & \circ & \cdots & \tau(N-1)_{i,1}^{pr} & \circ & \tau(N)_{i,1}^{pr} \\[2ex]
\tau(1)_{1/2}^{b} & \circ & \tau(2)_{1/2}^{b} & \cdots & \circ & \tau(n)_{1/2}^{b} & \circ & \cdots & \tau(N-1)_{1/2}^{b} & \circ & \tau(N)_{1/2}^{b} \\[2ex]
\tau(1)_{i,2}^{pr} & \circ & \tau(2)_{i,2}^{pr} & \cdots & \circ & \tau(n)_{i,2}^{pr} & \circ & \cdots & \tau(N-1)_{i,2}^{pr} & \circ & \tau(N)_{i,2}^{pr} \\[2ex]
\cdots & & \cdots & & & \cdots & & & \cdots & & \cdots \\[2ex]
\tau(1)_{(j-1)/j}^{b} & \circ & \tau(2)_{(j-1)/j}^{b} & \cdots & \circ & \tau(n)_{(j-1)/j}^{b} & \circ & \cdots & \tau(N-1)_{(j-1)/j}^{b} & \circ & \tau(N)_{(j-1)/j}^{b} \\[2ex]
\tau(1)_{i,j}^{pr} & \circ & \tau(2)_{i,j}^{pr} & \cdots & \circ & \tau(n)_{i,j}^{pr} & \circ & \cdots & \tau(N-1)_{i,j}^{pr} & \circ & \tau(N)_{i,j}^{pr} \\[2ex]
\tau(1)_{j/(j+1)}^{b} & \circ & \tau(2)_{j/(j+1)}^{b} & \cdots & \circ & \tau(n)_{j/(j+1)}^{b} & \circ & \cdots & \tau(N-1)_{j/(j+1)}^{b} & \circ & \tau(N)_{j/(j+1)}^{b} \\[2ex]
\cdots & & \cdots & & & \cdots & & & \cdots & & \cdots \\[2ex]
\tau(1)_{i,J-1}^{pr} & \circ & \tau(2)_{i,J-1}^{pr} & \cdots & \circ & \tau(n)_{i,J-1}^{pr} & \circ & \cdots & \tau(N-1)_{i,J-1}^{pr} & \circ & \tau(N)_{i,J-1}^{pr} \\[2ex]
\tau(1)_{(J-1)/J}^{b} & \circ & \tau(2)_{(J-1)/J}^{b} & \cdots & \circ & \tau(n)_{(J-1)/J}^{b} & \circ & \cdots & \tau(N-1)_{(J-1)/J}^{b} & \circ & \tau(N)_{(J-1)/J}^{b} \\[2ex]
\tau(1)_{i,J}^{pr} & \circ & \tau(2)_{i,J}^{pr} & \cdots & \circ & \tau(n)_{i,J}^{pr} & \circ & \cdots & \tau(N-1)_{i,J}^{pr} & \circ & \tau(N)_{i,J}^{pr}
\end{array}
$$
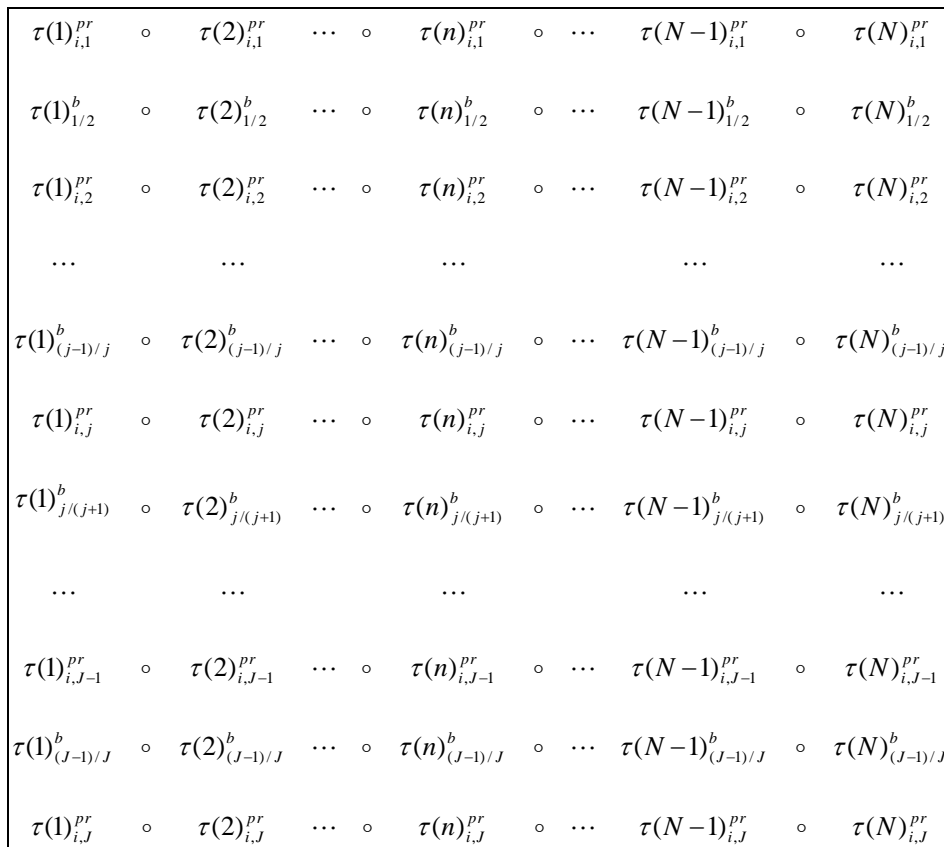
Figure 2 - The scheme of operation times in work stations and buffer stores

Notes to Figure 2:

$\tau(n)_{i,j}^{pr}$ - the production time of the *n*-th product in the *j*-th work station with the use of the *i*-th tool,

$\tau(n)_{(j-1)/j}^{b}$ the sum of transport times of the *n*-th product to and out of the buffer store between the workstations *j*-1 and *j*.

During the manufacturing process tools get worn out and must be replaced. It is assumed that tools are not regenerated. Moreover, we assume that there is a sufficient number of tools which replace the worn out ones. The replacement time of tools is given in the following matrix (13):

$$T^{repl} = \left[\tau_{i,j}^{repl} \right], \ i = 1,...,I, \ j = 1,...,J \tag{13}$$

where: $\tau_{i,j}^{repl}$ - the replacement time of the *i*-th tool in the *j*-th work station.

7. Transporting device in the manufacturing system

Let us assume further that each *m*-th charge is transported to the *l*-th production line by means of only one transporting device. After completing the manufacturing process, the ready unit of the *n*-th order is transported to the adequate element of the dispatch store.

We assume there are two transport agents:

1) $\rho_{m \to l}$ - covers the route from the charge element store ω_m to production line σ_l.

After delivering the required *m*-th charge to the *l*-th production line, the transport agent returns to the charge store to pick up the next charge and delivers it to the determined production line.

2) ρ_l - covers the route from the last work station of the *l*-th production line σ_l to the dispatch store. After determining the ready unit of the *n*-th order, the transport agent delivers it to the *n*-th element of the dispatch store and returns to the next determined production line to transport the next ready product. Transport times of charges to production line are given in the matrix of transport times (14):

$$T_{m \to l} = \left[\tau_{m \to l} \right], \ m = 1,...,M, \ l = 1,...,L \tag{14}$$

where: $\tau_{m \to l}$ - the transport time of the *m*-th charge to the *l*-th production line.

Transport times of ready products to the dispatch store are given in the matrix of transport times (15):

$$T_{l \to n} = \left[\tau_{l \to n} \right], \ l = 1,...,L, \ n = 1,...,N \tag{15}$$

where: $\tau_{l \to n}$ - the transport time of the ready unit of the *n*-th order from the *l*-th production line to the *n*-th element of the dispatch store.

The discussed manufacturing system is arranged as shown in Figure 3.

Figure 3 - The scheme of the manufacturing system at the k-th stage

Notes to Figure 3:

ω_m^k - the state of charges in the *m*-th store of at the *k*-th stage;

z_n^k - the state of realized orders in the *n*-th product store at the *k*-th stage;

σ_l^k - the state of the *l*-th production line at the *k*-th stage;

$\underset{\lambda_\omega}{\leftrightarrow}$ - ransport route of a charge from the *m*-th store of charges to the crossing point with the charge route;

$\underset{\lambda_{\omega'}}{\updownarrow}$ - the transport route of a charge between two crossing points in the charge route;

$\underset{\lambda_\sigma}{\leftrightarrow}$ - the transport route of a charge from the input route of charges to a production line or the transport route of a ready product from a production line to the output route;

$\underset{\lambda_{\sigma'}}{\updownarrow}$ - the transport route of a charge between two crossing points in the input route of charges or the transport route of a ready product between two crossing points in the output route;

$\underset{\lambda_z}{\leftrightarrow}$ - the transport route of a ready product between the order route and a dispatch store;

$\underset{\lambda_{z'}}{\updownarrow}$ - the transport route of a ready product between two crossing points in the order route;

$\underset{\lambda_{\omega/\sigma'}}{\leftrightarrow}$ - the transport route of a charge between the charge route and the input route of charges;

$\underset{\lambda_{\sigma/z}}{\leftrightarrow}$ - the transport route of a ready product between the output route and the order route.

On the basis of assumptions shown in Figure 3 it is possible to put forward the scheme of operation times in the logistic manufacturing system (Figure 4).

τ_1^ω	$\circ$	$\tau^{\omega/\sigma}$	$\circ$	τ_1^σ	τ_n^{pr}	$\tau_1^{\sigma'}$	$\circ$	$\tau^{\sigma'/z}$	$\circ$	τ_1^z
$\circ$	$\tau_{2/1}^\omega$	$\circ$	$\tau_{1/2}^\sigma$	$\circ$	$\circ$	$\circ$	$\tau_{2/1}^{\sigma'}$	$\circ$	$\tau_{1/2}^z$	$\circ$
τ_2^ω	$\circ$	$\circ$	$\circ$	τ_2^σ	τ_n^{pr}	$\tau_2^{\sigma'}$	$\circ$	$\circ$	$\circ$	τ_2^z
…	…	…	…	…	…	…	…	…	…	…
$\circ$	$\tau_{m/(m-1)}^\omega$	$\circ$	$\tau_{(l-1)/l}^\sigma$	$\circ$	$\circ$	$\circ$	$\tau_{l/(l-1)}^{\sigma'}$	$\circ$	$\tau_{(n-1)/n}^z$	$\circ$
τ_m^ω	$\circ$	$\circ$	$\circ$	τ_l^σ	τ_n^{pr}	$\tau_l^{\sigma'}$	$\circ$	$\circ$	$\circ$	τ_n^z
$\circ$	$\tau_{(m+1)/m}^\omega$	$\circ$	$\tau_{l/(l+1)}^\sigma$	$\circ$	$\circ$	$\circ$	$\tau_{(l+1)/l}^{\sigma'}$	$\circ$	$\tau_{n/(n+1)}^z$	$\circ$
…	…	…	…	…	…	…	…	…	…	…
τ_{M-1}^ω	$\circ$	$\circ$	$\circ$	τ_{L-1}^σ	τ_n^{pr}	$\tau_{L-1}^{\sigma'}$	$\circ$	$\circ$	$\circ$	τ_{N-1}^z
$\circ$	$\tau_{M/(M-1)}^\omega$	$\circ$	$\tau_{(L-1)/L}^\sigma$	$\circ$	$\circ$	$\circ$	$\tau_{L/(L-1)}^{\sigma'}$	$\circ$	$\tau_{(N-1)/N}^z$	$\circ$
τ_M^ω	$\circ$	$\circ$	$\circ$	τ_L^σ	τ_n^{pr}	$\tau_L^{\sigma'}$	$\circ$	$\circ$	$\circ$	τ_N^z

Figure 4 - The scheme of the manufacturing system at the k-th stage

Notes to Figure 4:

τ_m^ω - the transport time of the *m*-th charge to the charge route;

$\tau_{m/(m-1)}^\omega$ - the transport time of any charge between the crossing points *m* and *m*-1 in the charge route;

$\tau_{\omega/\sigma}$ - the transport time of any charge between the charges route and the input route;

$\tau_{(l-1)/l}^\sigma$ - the transport time of any charge between the crossing points *l*-1 and *l* in the input route;

τ_l^σ - the transport time of a dedicated charge from the input route to the *l*-th production line;

τ_n^{pr} - the manufacturing time of the *n*-th product in the adequate production line;

$\tau_l^{\sigma'}$ - the transport time of the ready product from the *l*-th production line to the output route of products;

$\tau_{\sigma'/z}$ - the transport time of any ready product between the output route and the order route;

$\tau_{(n-1)/n}^z$ - the transport time of a ready product between two crossing points *n*-1 and *n* in the order route;

τ_n^z - the transport time of the *n*-th product from the order route to its dispatch store;

$\circ$ - the crossing point between any two routes in the logistic manufacturing system.

In order to illustrate the way of calculating the transport time of the *m*-th charge to the *l*-th production line and the transport time of the ready unit of the *n*-th order to the adequate dispatch store the following simplifications must be assumed:

$$\bigvee_{1 \le m \le M} \tau_m^\omega = \tau^\omega \tag{16}$$

$$\bigvee_{1 \le m \le M} \tau_{m/(m-1)}^\omega = \tau_{cross}^\omega \tag{17}$$

$$\bigvee_{1 \le l \le L} \tau_{(l-1)/l}^\sigma = \tau_{cross}^\sigma \tag{18}$$

$$\bigvee_{1 \le l \le L} \tau_l^\sigma = \tau^\sigma \tag{19}$$

$$\bigvee_{1 \le l \le L} \tau_{l/(l-1)}^{\sigma'} = \tau_{cross}^{\sigma'} \tag{20}$$

$$\bigvee_{1 \le l \le L} \tau_l^{\sigma'} = \tau^{\sigma'} \tag{21}$$

$$\bigvee_{1 \le n \le N} \tau_{n/(n+1)}^z = \tau_{cross}^z \tag{22}$$

$$\bigvee_{1 \le n \le N} \tau_n^z = \tau^z \tag{23}$$

On the basis of the above assumptions it is possible to calculate:
- the *m*-th charge transport time to the *l*-th production line (24):

$$\tau_{m \to l} = \tau^\omega + (m-1)\tau_{cross}^\omega + \tau^{\omega/\sigma} + \tau^\sigma + (l-1)\tau_{cross}^\sigma \tag{24}$$

- the *n*-th ready product transport time from the *l*-th production line to the *n*-th element of the dispatch store (25):

$$\tau_{l \to n} = \tau^{\sigma'} + (l-1)\tau_{cross}^{\sigma'} + \tau^{\sigma'/z} + \tau^z + (l-1)\tau_{cross}^z \tag{25}$$

8. Heuristic algorithms

In order to control the logistic process we need to implement heuristics for determining the orders (elements from the vector *Z*) for the production process. It is assumed that once the heuristic is implemented, it consequently realizes the order till it is fully realized. The following control algorithms are put forward.

The algorithm of the maximal order

This algorithm chooses the biggest order characterized by the biggest coefficient γ_n^{k-1} in the state S^{k-1}. To produce the element *a*, the following condition must be met (26):

$$(q^k = a) \Leftrightarrow \left[\gamma_a^{k-1} = \max_{1 \le n \le N} \gamma_n^{k-1} \right], \tag{26}$$

where: $\gamma_n^{k-1} = z_n^{k-1}$

The algorithm of the minimal order

This algorithm chooses the smallest order characterized by the smallest coefficient γ_n^{k-1} in the state S^{k-1}. To produce the element *a*, the following condition must be met (27):

$$(q^k = a) \Leftrightarrow \left[\gamma_a^{k-1} = \min_{1 \le n \le N} \gamma_n^{k-1} \right], \tag{27}$$

where: $\gamma_n^{k-1} = z_n^{k-1}$

The algorithm of the shortest charge delivery route

This algorithm chooses the order whose charge can be delivered to the *l*-th production line by the shortest route. To produce the element *a*, the following condition must be met (28):

$$(q^k = a) \Leftrightarrow \left[\gamma_{m \to a}^{k-1} = \min_{1 \le l \le L} \tau_{m \to l}^{k-1} \right], \tag{28}$$

where: $\gamma_{m \to l}^{k-1} = \tau_{m \to l}^{k-1}$

9. Manufacturing Criteria

It is possible to use some manufacturing criteria for evaluation of the used heuristic algorithms of control. In this case, the production maximization criterion, the lost flow capacity criterion and the minimal tool replacement time criterion are put forward.

The production maximization criterion

Let us introduce the production maximization criterion (29):

$$Q_1 = \sum_{k=1}^{K} q_1^k = \sum_{k=1}^{K} \sum_{n=1}^{N} x_n^k \to \max \tag{29}$$

where: x_n^k - the number of units of the *n*-th order realized at the *k*-th stage.

The tool replacement bound (30):

$$\sum_{l=1}^{L} \sum_{j=1}^{J} \sum_{i=1}^{I} y(l)_{i,j}^k \tau_{i,j}^{repl} \le c \tag{30}$$

where: c - the maximal allowable tool replacement time;

$\tau_{i,j}^{repl}$ - the replacement time of the *i*-th tool in the *j*-th work station;

$y(l)_{i,j}^k$ - the decision about the tool replacement of the *i*-th tool in the *j*-th work station in the *l*-th production line where: $y(l)_{i,j}^k = 1$ in case of replacement, otherwise $y(l)_{i,j}^k = 0$.

The flow capacity bound (31):

$$y(l)_{i,j}^k \sum_{i=1}^{I} p(l)_{i,j}^k \le g(l)_{i,j} \tag{31}$$

where: $p(l)_{i,j}^k$ - the lost flow capacity of the *i*-th tool in the *j*-th work station in the *l*-th production line at the *k*-th stage.

The production-maximizing criterion is reduced to the replacement time of tools in work stations and flow capacity bounds.

The lost flow capacity criterion

Let us introduce the flow capacity criterion (32):

$$Q_2 = \sum_{k=1}^{K} q_2^k = \sum_{k=1}^{K} \sum_{l=1}^{L} \sum_{i=1}^{I} \sum_{j=1}^{J} y(l)_{i,j}^k \sum_{l=1}^{L} \sum_{i=1}^{I} \sum_{j=1}^{J} p(l)_{i,j}^k \to \min \tag{32}$$

The tool replacement bound (33):

$$\sum_{l=1}^{L}\sum_{i=1}^{I}\sum_{j=1}^{J} y(l)_{i,j}^{k}\tau_{i,j}^{repl} \leq c \tag{33}$$

The order bound (34):

$$\sum_{n=1}^{N} x_n^k \leq z_n \tag{34}$$

The lost flow capacity criterion is reduced to the replacement time of tools and order bounds.

The minimal tool replacement time criterion

Let us introduce the flow capacity criterion (35):

$$Q_3 = \sum_{l=1}^{L}\sum_{k=1}^{K}\sum_{i=1}^{I}\sum_{j=1}^{J} y(l)_{i,j}^{k}\tau_{i,j}^{repl} \to \min \tag{35}$$

The flow capacity bound (36):

$$y(l)_{i,j}^{k}\sum_{i=1}^{I}\sum_{j=1}^{J} p(l)_{i,j}^{k} \leq g(l)_{i,j} \tag{36}$$

The order bound (37):

$$\sum_{n=1}^{N} x_n^k \leq z_n \tag{37}$$

The minimal tool replacement time criterion is reduced to the flow capacity bound and the order bound.

10. Conclusions

In fact, each manufacturing system must be modelled in an independent way based on autonomous assumptions. Software engineering is responsible for delivering the ready product in the form of a simulator imitating the discussed production activity. The specification is the first step and cannot fail the needs of the synthetic environment representing the real system. The following step is to carry out the modeling process. These two steps are mutually connected and lead to creating the software which, after a successful testing process, can be used to train operators of the potential manufacturing system.

The manufacturing system presented hereby requires the control approach which is based on heuristic algorithms to meet the stated criterion or criteria. The result of this publication is to lead to creating fully functional software which could ease a training process for operators of manufacturing systems similar in nature and minimize the period of time devoted to preparing the staff responsible for introducing a new set of products in a similar manufacturing environment.

Acknowledgement

References

[1] Antonyová A. *et al.* (2013). Hygrothermal Properties of Building Envelopes: Reliability of the Effectiveness of Energy Saving, *Journal Energy and Buildings,* 57: 187–192.

[2] Buzacott, J.A., Shanthikumar, J.G. (1993). *Stochastic Models of Manufac-turing Systems*, Prentice Hall, New Jersey.

[3] Charalambous, C., (1997). Applying GAs to complex problems: the case of scheduling multi-stage intermittent manufacturing systems, in: *Proceedings of Second International Conference on Genetic Algorithms in Engineering Systems: Innovations and Applications*, Galesia 97, pp 467 – 471.

[4] Chen, F.F., Thinphangnga, S., (1996). Analytical modeling and analysis of flexible manufacturing systems considering system component failure/repair rates, *Journal of Manufacturing Systems*, 15(3): 143-154.

[5] Groover, M.P. (2010). *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*, 4th Edition, Willey.

[6] Josuttis, N., (2012). *The C++ Standard Library: A Tutorial and Reference*, 2nd Edition. Addison-Wesley Professional, p. 1128.

[7] Koren, Y., Heisel, U., Jovane, F., Moriwaki, T., Pritschow, G., Ulsoy, G., Brussel, H. (1999). Reconfigurable Manufacturing Systems, *CIRP Annals - Manufacturing Technology*, 48(2):527–540.

[8] Li, W., Gao, L., Li, X. (2009). Application of Intelligent Strategies for Cooperative Manufacturing Planning, *Journal of Universal Computer Science*, 15(9): 1907 – 1923.

[9] Marecki, J., Łużny, D., Marecki, F. (2010). *Logistyka informatyczna kompleksów operacji*. Wyższa Szkoła Informatyki i Zarządzania, Bielsko-Biała.

[10] Marzano, A. (2009). *Manufacturing system simulation,* in: *VDM Verlag*.

[11] Modrák, V., Moskvich, V. (2012). Impacts of RFID implementation on cost structure in networked manufacturing, *International Journal of Production Research*, 50 (14): 3847-3859.

[12] Modrák, V., Pandian, R.S., (2010). Flow shop scheduling algorithm to minimize completion time for n-jobs m-machines Problem, *Tehnicki Vjesnik*, 17(3): 273-278.

[13] Padhi, S.S., Wagner, S.M., Niranjan, T.T., Aggarwal, V. (2013). A simulation-based methodology to analyse production line disruptions, *International Journal of Production Research*, 51(6): 1885-1897.

[14] Pardalos, P. (1999). Parallel processing of discrete problems, *The IMA Volumes in Mathematics and its Applications*, 106: 1 – 54.

[15] Rezaie, K., Shirkouhi, S.N., Alem, S.M. (2009). Evaluating and selecting flexible manufacturing systems by integrating data envelopment analysis and analytical hierarchy process model, *Proceedings of Third Asia International Conference on Modelling & Simulation*, Volume 1 and 2, pp. 460-464.

[16] Řepa, V. (2006). *Podnikové procesy - Procesní řízení a modelování*, Praha: Grada Publishing.

[17] Shivanand, H.K., Benal, M.M., Koti, V. (2006). *Flexible Manufacturing System*, New Age International Pvt Ltd Publishers.

[18] Šperka, R., Spišák, M. (2012). Tobin tax introduction and risk analysis in the Java simulation, *Proceedings of 30th International Conference Mathematical Methods in Economics*, Part II. Silesian University in Opava, pp. 885-890.

[19] Vuuren, M. (2007). *Performance Analysis of Manufacturing Systems*, Technische Universiteit Eindhoven.

[20] Vymětal, D. (2009). Value chain and process models. Is the gap between them real*?, Proceedings of International Conference on Distance Learning, Simulation and Communication*, Brno.

[21] Worswick, G. (1957). The convexity of the production possibility function, *The Economic Journal*, 67(268): 748-750.

[22] *Wright, T.R. (2000). Manufacturing Systems. Goodheart-Willcox Co Inc., US; 2nd Revised edition.*

AN ANALYSIS OF INTERNAL MIGRATIONS ON THE BASIS OF PROVINCES IN TURKEY WITH THE PERFORMANCE INDICATORS: A SPATIAL PROBIT MODEL

Fatma ZEREN
[1]Inonu University, Department of Econometrics, Malatya, **Turkey**
fatma.zeren@inonu.edu.tr
Sevinç Yaraşır TÜLÜMCE
Department of Public Finance, Pamukkale University, **Turkey**
syarasir@pau.edu.tr

Abstract:

   As a controversial topic in developed and developing countries, migration has been a dynamic field explained on the basis of cause and effect by economists. Migration is the movement of people from one settlement to another. In all countries, migration occurs as the result of economic, social, and political causes. In Turkey, the migration from east to the west mostly results from regional and provincial disparities. The advancement and industrialization of western provinces in comparison to the eastern provinces is deemed a critical factor in the rise of Turkey's internal wave of migration. As a result, it became necessary to analyze the migration-triggering factors on a provincial basis. In this study, determinants of the net migration level in the NUTS 3 level of 81 provinces in Turkey for the year 2000 have been estimated by using a spatial probit model. Findings demonstrate the positive and significant effects of industrialization, welfare, and human capital on the level of net migration. Another finding of this research is that there is spatial dependence between provinces.

Keywords: migration, ınternal migration, spatial econometrics, spatial probit models, Turkey, critical cut-off neighbourhood.

JEL: C31, C34, F22, R23

1. Introduction

   Movement of people from one geographical territory to another is called migration. There are many causes of migration, including the economic, social, and cultural. Migrations are analyzed with respect to their causes in relevant literature, and there are some studies focusing on their effects.

   In relevant literature, the migration phenomenon is treated within the framework of diversified approaches. A group of researchers has focused on migration decisions with respect to the return-costs approach; some have analyzed migration on the basis of push-pull approach, while others have concentrated on the qualifications of migrants by employing a selective approach.

   In the present study, the first step has been to render a perspective on migration literature by providing information on internal migrations and migration approaches. Next, numerical analysis of migration figures between provinces in Turkey has been given, and determinants of internal migration have been tested by using a set of industrialization and development performance indicators. The empirical analysis for the 81 provinces at a NUTS 3 level by employing the Spatial Probit Model is provided.

2. The migration concept and internal migration

   Based on any given reason, changing of place from one geographical settlement to another is called "migration." Though the essence of this phenomenon is change of place, migration is classified with respect to distance, continuity, and causes (Bülbül-Köse, 2010). Migrations can be performed and classified as voluntary migration or forced migration as they can also be categorized as continuous or temporary migrations. The difference between temporary migrations and continuous migrations is that change of location is not permanent. Seasonal workers' movements and movement to summer houses for vacation are some examples. A different type of classification is based on the national or international character of migration. If the migration is to the direction of international borders, it is external migration. Migration within the borders of the same national land that lasts less than one year in a different city or region is classified as internal migration. The causes of internal migration can be economic, social, cultural, demographic, geographic, and political. Disparity in local and regional

income distribution is a substantial factor triggering migration. Martin and Zurcher (2008), list the factors that affect migration decisions in three groups. As illustrated in Table 1, pull factors are labor recruitment in migrated destinations and flow of information with the help of networks while unemployment or underemployment issues, such as low wages, are push factors.

Table 1. Factors that affect migration

	DEMAND-PULL	SUPPLY-PUSH	NETWORK/OTHER
Economic	Labour recruitment	Unemployment or underemployment issues such ad low wages	Jobs and wage information flow
Non-Economic	Family Unification (husbands and wives join spouses, children join parents)	Fleeing war and/or civil unrest	Communications; transportation; assistance organization; desire for new experience

Source: Martin, P., Zurcher, G., "Managing Migration: The Global Challenge," *Population Bulletin*, 63 (1).

Internal migration is assessed with respect to two key situations. The first is the supply-side condition. The rise in the ratio of internal migration brings forth a surge of job seekers parallel to the climb in urban population. The wave of migration attracts better-educated people, and these people enable a growth in city's labor supply.

On the demand-side, in a good number of city centers employment creation is more costly than in rural regions since the need for employment for the modern industrial sector would come to the surface. In addition, costs climb much higher once combined with the pressure of the increase in wages in cities and the necessity to employ technologies rather than manual labor. At the same time, there is a rise in productivity. Thus, internal migration has both supply- and demand-side effects (Todaro, 1980).

In the literature, the basic research domain of internal migration is set upon particular questions including who migrates, why people migrate, what the direction of migration is, how the decision to migrate is shaped, and how migration takes place over time. The basic research domain of internal migration calls for finding answers to these particular questions (Farwick, 2009). The internal migration phenomenon is analyzed by regional, labor and development economists. Regional economists focus on the effects of internal migration, influential factors on internal migration, and linkage of internal migration with local economic development. To illustrate, one of the questions to be answered in regional economic literature is whether people follow jobs or whether jobs follow people. Internal migrations are also studied by labor economists who dwell on geographical disparities introduced by return rates provided by human capital. Lastly, development economists have been interested in internal migration because of its distributional effects. One sample question examined by development economists is whether in developing countries migration from rural to urban areas diminishes or increases poverty (Bodvarsson-Berg, 2009).

As a rule, migrations take place from undeveloped regions or provinces to developed regions or provinces. The main source of migrants is parallel to industrialization, thus urbanized industrial regions or provinces are attraction centers that pull people who have decided to migrate. Within this context, it can be suggested that the main cause of migration is disparities between regions or provinces (Öztürk - Altıntepe, 2008). In relevant literature both causes and adverse effects introduced by internal migrations are detailed. As a result of migration a range of problems emerges in cities, such as population density, unplanned urbanization, squatting, unemployment, social conflicts, housing, environment, traffic, and resource deficiencies. As a result, it is essential that governments implement policies that steer public investments to emigrant provinces.

3. Migration approaches

There exists no migration theory acknowledged globally, yet there are certain general rules and hypotheses set forth by economists, sociologists, and planners. Hypotheses and generalizations in the first group are related to the causes bringing forth migration in social systems as well as types of migration. A second group of hypotheses focuses on the way people decide to migrate and key factors

in the migration decision. Hypotheses in the third group relate to the differences and qualifications in migrating and non-migrating groups. A fourth group of generalizations lightens the effects of migration, while the last group of hypotheses investigates the social changes having surfaced by taking migration as an independent variable (Tekeli, 1975)

In the literature there are three main approaches examining and treating internal migration phenomenon: return-costs, pull-push, and selective approaches. The return-costs approach considers migration as human capital. It holds that the migration decision is determined by return and costs of migration, which means that people migrate only when they are convinced that return of migration is higher than its cost. The key factor in the rationalization of migration decision is maximization of incomes upon making a return-cost analysis. This approach is the exact counterpart of the human capital theory advocating that migration takes place as an attempt of people to maximize their life-long income after settling in a new place. In such attempts, people need to conduct a cost analysis by drawing a comparison between the cost of a new settlement and the high costs in the new destination or net return. Henceforth, migration is considered an investment to obtain higher wages.

This investment also is evaluated within the scope of human capital theory (Beyene, 2011). The approach based on the hypotheses that push- pull factors set the basis of migration movement is called the "push-pull factors approach." Though many studies are related to non-economic factors, it is widely recognized that the primary factor affecting migration is economic. It is reasonable to argue that migrants in developing countries flow toward dynamic and wealthy regions that offer greater job opportunities. In simple terms, dynamic places and regions attract migrants. From this perspective, the source of economic factors underlying migration is termed "push-pull factors." The push-pull factors approach is established on the basis that people change location from their place of origin to new conditions offering better opportunities (Kainth, 2009).

Pull factors include high wages, employment, better welfare system, and similar factors, while in emigrant places low wages and low growth ratio, high unemployment, poverty, low productivity, depletion of natural resources, existing disparities, and deprivation of development opportunities are push factors (Velazquez, 2000). Agricultural unemployment and low productivity in rural lands as well as deficient state services are also push factors. These push-pull factors are used to clarify the causes and the ways such migration movements take place. In the studies conducted on the basis of factors influential on migration, researchers cannot reach consensus on whether push or pull factors are more influential on the emergence of a migration decision.

A group of researchers sets forth views emphasizing the significance of pull factors while some researchers underline push factors. There are also some views suggesting that there is a tight connection between the two (Kainth, 2009). Nonetheless, the common point in literature is that, parallel to the rise of industrialization, there has been a continuous wave of migration toward more developed centers that is defined as the push factor or rural part of the pull factor (attraction) of the urban part (Karabulut-Polat, 2007). The push-pull factors offer a research domain by exhibiting the causes of internal migration with respect to both migrated and emigrant cities.

Lastly, the selective approach is based on the hypothesis that immigrants are generally selected and qualified people. Those who migrate are, compared to the ones staying, more qualified in terms of education level, marital status, gender, and occupation. Highly educated young males are some of the most likely to migrate. Hence, young and educated people, by working longer and more adaptively, make a personal and profitable investment through migrating. Nonetheless, it should be pointed out that the selective approach becomes more visible in external migration since in internal migration language, religion, culture and legal rules do not differ hugely. In the selective approach the shared qualities in both internal and external migrations are age and level of education.

The key issue to consider in this approach is that pull factors possessed by migrated places can also determine the qualifications of people. With respect to the tourism or industry character of a migrated center, the immigrant profile is also subject to change (Yakar-Yazıcı, 2009). In this approach, there is a linear relationship between education and likelihood to migrate. Accordingly, the higher people's education level the greater is their desire to migrate since these are the people who are more active, intelligent, and likely to grasp opportunities. The negative aspect of this internal migration is called "brain drain" (Çelik, 2002).

4. Numeric analysis of ınternal migration between provinces in Turkey

In the post-1950 period, both interregional and international migrations have taken place in Turkey. This wave of migration accelerated in the post-1980 period and inevitably brought about several problems in both the destinations and the places of origin. In the post-1980 period, as an outcome of migration mobility, a variety of social, cultural, and political transformations created problems in the migrated provinces. In Turkey, migration is mostly toward the industrialized and wealthier western provinces where income per capita is comparatively higher than in the rest of the country.

Therefore, prior to making the decision to migrate, people should carefully evaluate all pull-push factors. An analysis of internal migration factors on a province basis in Turkey reveals that there are a number of causes such as higher employment opportunities in developed industrialized provinces, terrorism in the eastern region, advanced levels of education, health care, and other social services in developed provinces, density and abundance of young population in the general population, unemployment in rural sections, condensation of qualified labor force in cities demanding a skilled labor force, advancement in transportation and communication networks, and natural disasters (Başel, 2007).

A review of the distribution of the migratory population between Turkish cities per year demonstrates that, after 1985, there has been a boost in internal migration movements (Table 2). The migrating population between provinces for the period 1995-2000 was approximately twice as high as during the period of 1975-1980.

Table 2. Population migrating across provinces

Periods	Migrating population across provinces (number)
1975-1980	2,700,977
1980-1985	2,885,873
1985-1990	4,065,173
1995-2000	4,788,193

Source: TÜİK (Turkish Statistics Institute)

A closer look at average migration rates in the 1975-2000 reveals that population migrating from village to city was 18.74%, from city to village was 16.20%, from village to village was 8.79%, and from city to city was 56.27%. So it is clear that internal migration took place mostly from city to city TÜİK (Turkish Statistics Institute).

In the post-1980 period in some developed provinces received-migration is higher in number than given-migration. This situation results in full satisfaction of developed provinces and rise in the number of migrating population towards provinces geographically approximate to developed provinces. Particularly in internal migration flows, provinces such as İstanbul, Bursa, Kocaeli, and İzmir are recognized as regional attraction centers (Bülbül-Köse, 2010), as detailed in Table 3. The average net migration rate between 2007-2011 reveals that İstanbul, Ankara, Antalya, Bursa, İzmir, and Kocaeli provinces (those with the highest and positive net migration rate) take the first ranks. The main reason Yalova, Bursa, and Tekirdağ receive more migration than the number who emigrates is their proximity to İstanbul and because they are within the borders of the attraction region. Provinces with negative net migration rates are Ağrı, Mardin, Van, and Diyarbakır. As demonstrated in Table 3, the migration movement across provinces is mostly directed toward the developed and industrialized western provinces TÜİK (Turkish Statistics Institute).

Table 3: Net migration rate averages in 2007-2011 for provinces (Number of people)

Adana	-7,358	Kocaeli	15,855
Adıyaman	-7,768	Konya	-6,862
Afyon	-5,534	Kütahya	-4,560
Ağrı	-10,861	Malatya	-1,733

Amasya	-2,222	Manisa	-2,188
Ankara	42,881	Kahramanmaraş	-6,136
Antalya	26,348	Mardin	-11,678
Artvin	-1,044	Muğla	6,202
Aydın	2,688	Muş	-9,422
Balıkesir	2,597	Nevşehir	-2,142
Bilecik	-8	Niğde	-3,087
Bingöl	-2,110	Ordu	-5,889
Bitlis	-5,966	Rize	-1,118
Bolu	702	Sakarya	3,168
Burdur	-291	Samsun	-5,912
Bursa	19,312	Siirt	-3,273
Çanakkale	1,392	Sinop	328
Çankırı	-190	Sivas	-8,017
Çorum	-8,234	Tekirdağ	14,817
Denizli	-748	Tokat	-7,547
Diyarbakır	-11,974	Trabzon	-2,930
Edirne	-420	Tunceli	-351
Elazığ	-3,175	Şanlıurfa	-7,605
Erzincan	-271	Uşak	-1139
Erzurum	-12,934	Van	-17584
Eskişehir	7,725	Yozgat	-11,928
Gaziantep	3,579	Zonguldak	-5,431
Giresun	-1,594	Aksaray	-2,313
Gümüşhane	-349	Bayburt	-1,160
Hakkari	-1,596	Karaman	-758
Hatay	-4,637	Kırıkkale	-4,246
Isparta	-544	Batman	-621
İçel	-2,194	Şırnak	-2,425
İstanbul	72,630	Bartın	135
İzmir	18,636	Ardahan	-2,525
Kars	-6,994	Iğdır	-2,489
Kastamonu	-705	Yalova	3,027
Kayseri	3,427	Karabük	-384
Kırklareli	-110	Kilis	-779
Kırşehir	-2,188	Osmaniye	-708
Kocaeli	15,855	Düzce	1.504

Source: Prepared by our party on the basis of TÜİK data.

Note: Net migration rate indicates the difference between received-migration and given-migration. Provided that the received migration rate is higher than the given migration, net migration shows a positive value, and it shows a negative value if the reverse is true.

5. Literature review

As a controversial topic in developed and developing states, migration has been a dynamic field that economists have generally explained on the basis of cause and effect. The economic approach to explaining migration largely focuses on international migration and developed countries. In addition, there are many studies elaborating on internal migrations in developing countries (Lottum & Marks, 2011). If people are more motivated to migrate than stay, the region can safely be labeled as

an emigrant region. Toward the aim of accentuating the gravity of push-pull factors, it is better to model the migration flows between moved (destination) and original cities or regions as a function of the characteristics of those regions. These characteristics, however, are associated with labor market conditions and the unique structure of each region. The first things most potential migrants consider are unemployment, average income disparities, industrial disparities, and levels of education in the potential destination. These indicators are also used as a measurement tool in the analyses. In measuring spatial structure, central and periphery location of the region also play substantial roles (McArthur & Thorsen, 2010). Within this context, internal migration movements are open to the effects of economic, demographic, and cultural variables. Analysis of economic regional differences with respect to internal migration is generally based on factors such as income and unemployment.

Studies conducted by Harris-Todaro (1970), Brown (1997), McArthur and Thorsen (2010), and Rottum and Marks (2011) analyze migration with respect to variables such as income, unemployment, and wages. But studies by Lottum and Marks (2011), Aldashev and Dietz (2011), Greenwood (1995), and Lee (1996) placed emphasis on distance concepts as well. Some studies analyze the qualifications of migrants (Beyene, 2011). Hence, in the analysis of internal migrations, in addition to several economic factors such as income and unemployment, there are a number of issues whose migration models include education level, age, and gender as well as distance and labor force market phenomena. McArthur and Thorsen (2010), in their Norway-based study, have put forth that push factors bear greater importance than pull factors; that unemployment and income are the key determinants of migration; and that migration is directed toward the central and developed cities. Lottum and Marks (2011), in their Indonesia-based study, set forth that wage disparities have no effect, while Beyene (2011) suggests that factors like education and age affect internal migration. Aldashev and Dietz (2011) detected evidence that migration is shaped by economic factors and distance plays a negative role in the migration phenomenon.

Turkey-based studies of Gedik (1997), Gezici and Keskin (2005), Evcil *et al.* (2006), and Filiztekin and Gökhan (2008) have pointed out the determinants of internal migrations are income, unemployment, and existence of social networks. Bahar and Bingöl (2010) reported the effects of internal migrations on employment and the labor market. Yamak and Yamak (1999) drew a correlation between migration and income, and Kırdar and Saraçoğlu (2012) offered a convergence analysis while Filiztekin and Gökhan (2008) and Akarca and Tansel (2012) used a gravity model to examine internal migration. Summaries and findings of Turkey-based empirical studies are illustrated in Table 4.

Table 4. Summaries and findings of Turkey-based empirical studies on internal migration

AUTHORS/DATES/METHODS	FINDINGS
Gedik (1992): Studying the period between 1965-1985 within three separate terms and analyzing migration movement with Lowry hypothesis.	Claiming that on Net migration rates, given-migration rates are more effective than received-migration rates, it is suggested that to validate the Lowry hypothesis in Turkey, the development level must be increased.
Yamak and Yamak (1999): For 67 provinces within the period of 1980-1990 correlation between net migration rates and income per capita is investigated by using Least Squares method.	Income disparity plays a role in internal migration; cities receiving net migration are high-income cities. Around 25% of people change places because of economic motives.
Ceritli, Sunar and Demirci (2005): According to the city-based 2000 census, migration is analyzed with respect to population quality.	The foremost causes of migration are employment motives, assignment, appointment, and Marmara and Düzce earthquakes.
Gezici and Keskin (2005): According to development level between Turkish provinces, internal migration movements are analyzed on province basis and the qualities that attract people to developed regions are tested with Multiple Regression Analysis. Pearson Correlation Method has been employed for 73 provinces. Net migration rate (1985-1990), socio-economic indicators, general population, literacy rate,	Income, labor force, population growth, geographical location effect internal migration locations.

AUTHORS/DATES/METHODS	FINDINGS
number of doctors per 10,000 people, public investments, GNP, electricity use, dummy variables for western cities, etc., have been treated.	
Evcil, Dökmeci and Kıroğlu (2006): In seven regions of Turkey, the migration phenomenon has been analyzed by using Multivariate Analysis of Variance and Multiple Regression Analysis (1990 and 2000). The quantity of migrants in any region has been considered. GDP, share of agricultural, financial, industrial, and trading employees in total employed population, rate of unemployment, rate of urbanization, population density, rate of age 25 college graduates are some of the employed variables.	Net migration rate is intertwined with economic factors and GDP. In city-to-city migration, the Marmara region differs from the rest. İstanbul and Bursa are attraction centers. Population density, industrial and trading employees in total employed population are crucial factors in the rise of internal migration. Social, cultural, and educational factors are less important than economic factors. Differences in the economic conditions between eastern and western regions also play a role in migration.
Çelik (2007): On a province and region basis for the period between 1980-2000 with net migration rate and income data, regression analysis has been conducted on a regional basis.	It has been detected the role of income in pulling people to a region is 72%. Provinces with better socio-economic opportunities receive more migrants.
Pazarlıoğlu (2007): For İzmir City, the Bivariate Probit Model is used in the survey study (2000). In the study, effects of education, age, sector, profession, and distance on migration behavior are analyzed.	It has been designated that in intercity migration education and age factors play no role while distance variables play significant roles. Employees in manufacturing and service sectors have migrated to İzmir for better career opportunities. As regards migration from neighboring towns to the city of İzmir, age, education, and distance play great roles. A young age is a triggering factor on migration, and the most significant factors explaining migration to İzmir are economic.
Gürbüz and Karabulut (2008): Year 2005 migration data have been employed to analyze the correlation between migrations from rural to urban parts and socio-economic features. Correlation between migration and socio-economic variables has been studied by employing Hierarchical cluster analysis and the Pearson correlation coefficient.	Physiological population density, demographic features of population, and death ratios are significant variables.
Filiztekin and Gökhan (2008): Internal migration determinants for 1990-2000 are employed using the Gravity model. Some of the variables are income, rate of unemployment, and social networks.	Number of migrations, income disparities, rate of unemployment, age, education level, social networks, and distance play a role in migrations.
Topbaş and Tanrıöver (2009): For 67 and 73 provinces within the years 1970-2000, Lowry's hypothesis has been employed. With Pearson correlation analysis, population size, net migration rate, GDP per person, urban population, and growth ratio have also been analyzed. Correlation between internal migration movements and urban development has been comparatively analyzed.	Some of the obtained findings are that received migration is vitally effective on net migration, and the given migration rate of received-migration is more influential on the ratio of net migration.

AUTHORS/DATES/METHODS	FINDINGS
Bahar and Bingöl (2010): Effects of internal migrations on employment and labourforce market have been compared with respect to year 2000 census indicators and migration statistics. Some variables are ratio of participation to labourforce, rate of unemployment and rate of employment.	In migration-receiving regions, migration leaves negative effects on employment and unemployment. Unemployment in emigrant regions cannot be solved either.
Çiftçi (2010): On city basis for years between 1995-2000 sectoral production, GDP, public services in destinations are analyzed with Atkinson regional inequality index and push factors.	It has been demonstrated that those who migrate exhibit higher sensitivity toward public services in their destinations.
Bülbül and Köse (2010): For 12 regions, by employing year 2008 migration data, Multi Dimensional Scaling Analysis has been conducted. In the analysis of 12 regions with respect to migrations by using economic and demographic indicators, migration data, net migration speed, received and given migrations, rate of urbanization, population density, and socio-economic development rank have been taken into account.	İstanbul differs from other cities and constitutes a group on its own. The Western Marmara, Eastern Marmara, and Western Anatolia regions are similar in terms of migration-related data. The most similar regions are Aegean and the Mediterranean Regions. There is an intense flow of migration to developed western cities.
Ercilasun *et al.* (2011): For 81 provinces analyses have been made by utilizing net internal migration speed (2010). Net internal migration and speed, socio-economic development index, rate of urbanization, gross value added rate per person, real wages, ratio of unemployment, total number of university students, and similar variables have been tested with OLS (Ordinary Least Squares method).	One unit of rise in education and health-care indices affects migration speed positively. Also, the effect of urbanization ratio on internal migration is positive. While rate of unemployment is statistically insignificant and the effect of real wages is positive and significant.
Kırdar and Saraçoğlu (2012): For 67 provinces, convergence of internal migration during 1975-2000 period is analyzed. Variables are net internal migration rate, population density, GDP, etc.	Internal migration has no effect on intercity convergence.
Akarca-Tansel (2012): The gravity model is employed to analyze the migration from other provinces to southwest cities Antalya and Muğla. By utilizing variables such as number of migrations, distance, and rate of unemployment, analyses have been conducted for years 1995 and 2000.	It has been detected that the reasons accounting for migration to Antalya and Muğla are likely to find better jobs. After the 1999 earthquake, there has been a rise in the movement to these cities, and economic activities in tourism played a positive role in the migration. Better job opportunities, particularly in hotel and restaurant sectors, are the basic pull factors in this migration movement.

6. Empirical analysis of internal migrations in turkey on the basis of provinces

In this part of the research, factors affecting the net migration level of 81 Turkish provinces for NUTS 3 level and the year 2000 have been analyzed with respect to development performance indicators.

6.1. Econometric method

Spatial econometric approach has been widely employed lately in studies on regional economy. Spatial econometric models have been built on the hypothesis that between geographically approximate locations there is spatial dependence.

Probit models with spatial dependencies first studied by MacMillen (1992), which takes the following form:

$$Y^* = \rho W Y^* + X\beta + u,$$ (1)

which can be written in reduced form as:

$$Y^* = (I - \rho W)^{-1}(X\beta + u).$$ (2)

In this formula, ρ is the spatial autocorrelation parameter and W is the spatial weight matrix. This matrix is used to refer to neighborhood correlation. Two principal ways are used to evaluate neighborhood correlation, a contiguity approach and a distance approach. In the first case, assume that interactions can only exist if two regions share a common border: then $w_{ij} = 1$ if regions i and j have a common border and $w_{ij} = 0$ otherwise. In the second case, assume that the intensity of interactions depends on the distance between the centers of these regions. Several neighborhood definitions have been provided for this situation, and the most common ones are the critical cut-off neighborhood and the nearest neighborhood. In spatial econometrics, the choice of the spatial weight matrix is often made ad hoc and a priori.

The model (2) structure typically implies heteroskedasticity. The variance of error term, $(I - \rho W)^{-1} u$, which implies:

$$Euu' = \sigma_u^2 \left[(I - \rho W)'(I - \rho W) \right]^{-1}.$$

The dependent variable Y^* links to the observed binary-outcome, y and as shown below: (Case, 1992: s.495).

$$y_i = \begin{cases} 1, & Y_i^* > 0 \\ 0, & Y_i^* \leq 0 \end{cases}$$

The probability that $Y_i^* = 1$ is $\Phi\left(X_i^* \beta / \sigma_i\right)$ (MacMillen 1992 and Packages McSpatial). Φ is the standard normal distribution function ; σ_i is the standard error for observation i and define $X^* = (I - \rho W)^{-1} X$. Log-likelihood function is follows as:

$$\sum_i \left\{ y_i \ln(\Phi_i) + (1 - y_i) \ln(1 - \Phi_i) \right\}.$$

This log-likelihood function maximizing with respect to β and ρ.

6.1. Data

In the study, factors affecting the net migration level of NUTS 3 level regions of Turkey (81 provinces) have been explored for the year 2000 data because there are no available internal migration data between provinces and regions after 2000. In some provinces, the received-migration rate is higher than the given-migration rate, while the opposite is true in other provinces. Provided that a province is metropolitan or economically and socially developed, it is most likely to receive migration and have fewer people who emigrate, which results in a positive net migration.

On the other hand, given that a province is economically and socially underdeveloped, it receives less migration while people emigrate more, which results in negative net migration. Toward the aim of emphasizing such differentiation between provinces, a dependent variable, which has a binary value, has been selected. Given that received-migration in a province is higher than given-migration, the dependent variable is indicated with 1, and if received migration is less than given-migration, the dependent variable has been indicated with 0. An independent variable to represent industrial indicators shows the development level of a province, and the numbers of small industry

sites (IND) have been noted. As a human capital indicator, the ratio of college graduates compared to the age of 22 and above group (EDU) has been utilized.

This indicator is, at the same time, a reflection of the development level of this province in industry, services, and cultural aspects. One of the nonmonetary indicators of development or welfare level is electrical energy production and consumption (Han & Kaya, 2006). Hence, the per-person electricity consumption (ELEC) variable also has been taken as an explanatory variable. In addition to these variables, unemployment, gross domestic product per capita, rate of urbanization, public investments per capita, and ratio of green card citizens are the other variables that have been investigated, but no significant findings could be detected. Dependent variable data have been retrieved from the Turkish Statistics Institute while independent variables are from province-based performance indicators issued by the Republic of Turkey, Ministry of Development. Table 5 provides a description of the data.

Table 5. Description of variables for the study

Variable	Definition	Expected Sign
Net migration level	Binary variable is utilized	Dependent Variable
IND	Small Industry Sites Workplaces Number	+
EDU	Ratio of College Graduates to 22+ Age Group	+
ELECT	Per-Person Electricity Consumption Amount	+

In this research, the weight matrix (W) has been formed according to the critical cut-off neighborhood. Components of the W matrix are determined as indicated below:

$$w_{ij} = \begin{cases} 1, & 0 \le d_{ij} \langle d^* \\ 0, & otherwise \end{cases}$$

while d_{ij} is the physical distance between two regions, i and j. d^* is the certain critical threshold value. For the present study, the threshold value d^* is set to the minimum distance required to ensure that each location has at least one neighbor.

6.2. Empirical evidence

Table 6 provides a summary of both the probit model and spatial probit model estimations. According to results of the estimations, the signs of the explanatory variables match the theory. Obtained findings demonstrate that the IND variable is the industrialization indicator, EDU indicates human capital, and the ELEC variable indicates welfare; all are positive and show a significant effect. Provinces including a larger quantity of small industry sites are developed and industrialized provinces. Hence, received-migration in industrialized provinces is higher than the emigrated population.

Provinces with higher levels of education are provinces with greater levels of human capital accumulation. Indeed, these provinces bear well-educated populations by providing huge potential for employment and by meeting the demands for a qualified labor force. Likewise, migrants view provinces that offer better job opportunities and higher wages as attractive. Therefore, the rise in education level in any city correspondingly accelerates increases in both the labor force and development levels. In that case, the positive correlation between the EDU variable and the net migration is true to expectations. Lastly, one of the findings is that provinces with higher welfare levels receive more migration than other provinces. It has also been shown that there is significant spatial interaction between provinces.

Table 6: Estimation results

Variables	Standard Probit Model Estimation	Spatial Probit Model Estimation
Intercept	-4.196[*] (-4.367)	-3.453[*] (-3.295)
IND	0.0004[***] (1.860)	0.0004[***] (1.876)
EDU	0.362[*] (2.590)	0.302[***] (2.003)
ELEC	0.579[*] (2.783)	0.505[***] (1.653)
ρ		0.123[**] (2.385)

*Note***:** Values in parentheses are z-statistics. Also "*", indicates parameters are significant at 1%, "**" indicates parameters are significant at 5%, and "***" indicates parameters are 10%.

7. Conclusion

Migration is described as the movement of people from one settlement to another, and migrations are studied under a set of classifications. Nonetheless, many literature studies dwell on causes and effects of internal and external migration. Labor is treated within the framework of different questions by regional and development economists. There is a wide scope of literature focusing on the triggering factors of migration, effects of push-pull factors, whether the qualifications of people affect their migration decisions, the way migration takes place, and effects of migration on the labor market. In the studies, these questions are treated according to return-costs, pull-push, and selective approaches. Contrary to the great number of studies on developed states and external migration, there are many studies focusing on the internal migration phenomenon in developing countries. Nonetheless, the internal migration phenomenon in Turkey has been the focal point of several studies.

In Turkey, the migration phenomenon started in the 1950s and gained impetus in the 1980s. The migration movement after the 1980s has mostly taken place from rural areas to the city and from city to city. Migration is bound to several factors including the economic, social, and cultural. Nevertheless, the intercity migration in Turkey is generally directed to developed and industrialized western provinces. It can thus reasonably be argued that one of the most salient economic causes of intercity migration is development disparities and inequalities between provinces.

In this paper, the determinants of interprovince migration have been analyzed with particular performance indicators by using the spatial probit model. These findings demonstrate that the variable IND indicating industrialization level, variable EDU indicating human capital, and variable ELEC indicating welfare level are positively effected by the level of net migration. Accordingly, industrialized provinces with high welfare levels that provide job opportunities for a qualified labor force, including higher numbers of small industry sites, receive higher levels of migration.

Parallel to the population rise in western provinces as a result of migration, there is an increased demand for public services, which inevitably introduces a set of problems. Within this vicious cycle, the spending directed to industrialized western provinces is also elevated. Toward the aim of mitigating migration and filling the disparity across provinces, it is necessary to turn unindustrialized and underdeveloped provinces into attraction centers. To achieve that objective, effects of push-pull factors causing intercity migration need to be removed and policies should be put into effect in a macro framework. The foremost objective in all envisaged state policies should consider the individual qualities of every single province, thus removing existing disparities between provinces.

References

[1] Akarca, A.T. and Aysit T. (2002). South-West as the new internal migration destination in Turkey. *Discussion Paper,* 6627: 1-17.

[2] Bahar, O. and Fehime K. Bingöl. (2010). Türkiye'deki İç Göç Hareketlerinin İstihdam ve İşgücü Piyasalarına Etkileri, *SDÜ İİBF Dergisi,* 15(2): 43-61.

[3] Başel, Halis. (2007). Türkiye'de Nüfus Hareketlerinin ve İç Göçün Nedenleri. *İ.Ü. Sosyal Siyaset Konferansları Dergisi,* 53: 516-542.

[4] Beyene, Barhe M. (2011). determinants of internal and international migration in Ethiopia. *Memorandum,* 24: 1-48.

[5] Bodvarsson, O.B., Van Berg, H. (2009). *The Economics of Immigration Theory and Policy*. *New York: NY, Springer*.

[6] Brown, A.N. (1997). The economic determinants of internal migration flows in Russia during translation. *Working Paper,* 89: 1-33.

[7] Bülbül, S., Köse, A. (2010). Türkiye'de Bölgelerarası İç Göç Hareketlerinin Çok Boyutlu Ölçekleme Yöntemi İle İncelenmesi. *İ.Ü. İşletme Fakültesi Dergisi,* 39(1): 75-94.

[8] Case, A. (1992). Neighborhood influence and technological change. *Regional Science and Urban Economics,* 22: 491-508.

[9] Çelik, F. (2002). İç Göçlerin Seçkinlik Yaklaşımı İle Analizi. *EU. Sosyal Bilimler Enstitüsü Dergisi,* 13: 275-296.

[10] Çelik, F. (2007). Türkiye'de İç Göçler: 1980-2000. *Erciyes Üniversitesi Sosyal Bilimler Enstitüsü Dergisi,* 22: 87-109.

[11] Çiftçi, M. (2010). 1995-2000 Dönemi İç Göç Hareketlerinde Emeğin Varış Yerlerindeki Çekim Güçlerine Göre Mukayeseli Duyarlılık Düzeyleri. Ç*alışma ve Toplum*, 24(1): 277-292.

[12] Ercilasun, M.., E. Ayşen Hiç Gencer and Özgür Emir Ersin. (2011). Türkiye'deki İç Göçleri Belirleyen Faktörlerin Modellenmesi. *International Conference on Eurasian Economies* 12(14): 319-324

[13] Evcil, Nilay, Vedia Dökmeci and Gülay Kiroplu. (2006). Regional Migration in Turkey Its Directions and Determinants. Paper presented at the international meeting for 46th European Congress of the Regional Science Association, August 30th -September 3rd, Volos, Greece

[14] Farwick, A. (2009). Internal migration-challenges and perspectives for the research infrastructure. *Working Paper Series*, 97: 1-16.

[15] Gedik, Ayşe. (1992). The effects of in-and out-migration on urban growth in Turkey (1965-1985) and a comparison with the developed countries. *Papers in Regional Science,* 71(4): 405-419.

[16] Gezici, F.; and Berna Keskin (2005). Interaction between regional inequalities and internal migration in Turke*y*. *ERSA Conference Papers*, 1-18.

[17] Greenwood, M.J. (1995). Human Migration: Theory, Models and Empirical Studies. *Journal of Regional Science,* 25: 521-544.

[18] Gürbüz, M., Karabulut, M. (2008). Kırsal Göçler ile Sosyo-Ekonomik Özellikler Arasındaki İlişkilerin Analizi. *Türk Coğrafya Dergisi,* 50: 37-60

[19] Han, E., Kaya, A.A. (2006). *Kalkınma Ekonomisi Teori ve Politika*. *Ankara: Nobel Yayınları*

[20] Harris, J., Todaro M. (1970). Migration, Unemployment and Development: A Two Sector Analysi*s. American Economic Review,* 60(1): 126-142.

[21] Kainth, Gursharan Singh (2009). Push and Pull Factors of Migration: A Case of Brick Kiln Industry of Punjab State, *Asia Pasific Journal of Social Sciences,* 1(1): 82-116.

[22] Karabulut, Kerem and Dilek, Polat. (2007). Türkiye'de Yaşanan Göç Olgusu Üzerine Bir Alt Bölge Uygulaması. *8. Türkiye Ekonometri ve İstatistik Kongresi, İnönü Üniversitesi, Malatya,* 1-15.

[23] Kırdar, M. and Şirin Saraçoğlu. (2012). İç Göç, Bölgesel Yakınsama Sorunu ve Ekonomik Büyüme: Türkiye Örneği. *Türkiye Ekonomi Kurumu Tartışma Metni* 1-16.

[24] Lee, Everett S. (1996). A theory of migration. *Demography,* 2: 47-57.

[25] Martin, P., Gottfried Zurcher. (2008). 9 Managing Migration: The Global Challence. *Population Bulletin,* 63(1): 1-19

[26] McArthur, D. Thorsen, I. (2010). Determinants of internal migration in Norway. *ERSA Conference Papers,* 1-25.

[27] McMillen, Daniel P. (1992). Probit with spatial autocorrelation. *Journal of Regional Science,* 32: 335-348.

[28] Öztürk, Mustafa and Nihat Altıntepe. (2008). Türkiye'de Kentsel Alana Göç Edenlerin Kent ve Çalışma Hayatına Uyum Durumları: Bir Alan Araştırması. *Journal of Yasar University*, 3(11): 1587-1625.

[29] Pazarlıoğlu, V. (2007). İzmir Örneğinde İç Göçün Ekonometrik Analizi. *Yönetim ve Ekonomi*, 14(1): 121-135.

[30] Tekeli, İ. (1975). Göç Teorileri ve Politikaları Arasındaki İlişkiler. *ODTÜ Mimarlık Fakültesi Dergisi,* 1(1): 153-176.

[31] Todaro, M. (1980). Internal Migration in Developing Countries: A Survey, *NBER*, 361-402.

[32] Topbaş, Ferhat and Banu, Tanrıöver. (2009). Türkiye'de İç Göç Akımları Üzerine Bir Çalışma: Lowry Hipotezi. *DEU İİBF Dergisi,* 24(1): 93-104.

[33] Velazques, F.C. (2000). Approaches to the Study of International Migratin: A Review. *Estudios Fronterizos*, 1(1): 137-168.

[34] Yakar, M. and Hakkı, Yazıcı. (2009). Afyonkarahisar Kentinde Göçlerin Seçkinlik Yaklaşımı İle Analizi (1990-2000*). SDU Fen Edebiyat Fakültesi Sosyal Bilimler Dergisi*, 20: 55-172.

[35] Yamak, R., Yamak, N. (1999). Türkiye'de Gelir Dağılımı ve İç Göç. *DEU Sosyal Bilimler Enstitüsü Dergisi*, 1(1): 16-29.

*** Packages McSpatial http://cran.r-project.org/web/packages/McSpatial/McSpatial.pdf, (accessed 18. 12.2012)

THE STUDY OF LOGISTIC PARKS IN THE CZECH REPUBLIC

Karla JURÁSKOVÁ
VŠB - Technical University of Ostrava, **Czech Republic**
karla.juraskova.st@vsb.cz
Pavla MACUROVÁ
VŠB - Technical University of Ostrava, **Czech Republic**
pavla.macurova@vsb.cz

Abstract:

The article examines the representation and structure of logistic parks in the Czech Republic. Logistic parks in the article are complexes rented by park operators where more providers of logistics services perform their activities. A database of logistic parks has been created and analyzed by descriptive statistics and Pareto analysis methods. At the same time, two detailed case studies were carried out and information from secondary sources related to logistic real estate property was analyzed. It was found that there are many new logistic parks in the Czech Republic, whose launch was often facilitated by the state and more parks are under construction. The parks are exclusively privately owned and have a mixed structure of tenants (logistic firms and manufacturing companies). The providers of logistic services begin to prefer renting space in logistic parks to building and managing their own capacities. The following issues have been identified: the location of parks usually does not allow taking advantage of multimodality in transport, there are environmental constraints regarding the expansion of existing parks, and random method of tenant selection brings little support of synergy.

Key words: logistic park, logistic centre, supply chain, third party of logistics, logistic providers, multimodality.

JEL Classification: C83, D39, L87, L98, M19, O14, O18, R33, R58, R14

1. Introduction and objective of the article

This article was written as part of a research project focused on examining the trends of development of providers of complex logistic services. The development of activities of organizations providing complex logistic services is, among other things, dependent on the capacities and on the level of the logistic infrastructure in question, which also includes logistic parks.

The objective of this article is to map the character and representation of logistic parks in the Czech Republic, to assess the approaches to their building, to identify other anticipated trends and to formulate the questions for further research and practice.

When the topic of this article is elaborated, the initial part discusses the terminology regarding logistic parks and defines the theoretical requirements concerning the purpose of the parks. Once the research questions have been formulated, Paragraph 3 describes the methodology used for the conducted investigations, which combined the results of a statistical survey and two case studies with insights acquired from secondary sources. The results of the data analysis are presented in detail in Paragraph 4 and their synthesis is performed in the final part of this article, where the possible directions for further research are also formulated.

2. Theoretical bases of the solution of logistic parks issue

The subject of study will be represented by logistic parks within the meaning of purposefully arranged complexes of buildings, warehouses and infrastructure, in which more logistic providers perform their activities. They are complexes designed for more subjects and rented by the operator of the park. Some areas are used by the park operators themselves. That is why the subject of the survey will not include the complexes, which are set up for a sole provider of logistic services in the area that is not shared with other companies.

Our concept of logistic parks corresponds with the definition of Dutková, Dutka and Bigoš (2009), where logistic park is characterized as a complex designed and built to support logistic processes and solutions. It is characterized by the entry of carriers, shippers, forwarding agents, logistic services, logistic industry, trade organizations, state administration institutions, financial and insurance companies, etc.

Furthermore, they are connected to at least two types of transport and a positive relationship to joint projects between the participating companies in order to achieve a synergy effect.

Some authors used the term of logistic centres to mark the complexes in the sense defined above. Europlatforms (2004) as an association of European logistic centres defines logistic centre as a specific area carrying out all activities related to transportation, logistics and distribution of goods, both for national and international transit, on a commercial basis by various operators. The operators are either the owners or tenants of the buildings and facilities that are built there (warehouses, distribution centres, storage areas, offices, services for trucks, etc.). In order to comply with the rules of free market, logistic centre must be available for all companies engaged in the above presented activities.

According to the number of types of transport systems they are connected to, logistic parks can be divided into bimodal (connection to two types of transport), trimodal and multimodal. Storage areas represent a key part of logistic parks and they should have large-volume layout, as well as elevated ramps, equipment for picking, reloading operations, etc. It is preferred if customs institutions, post offices, accommodation and food services, financial services, technical services and similar facilities are also located in the logistic park.

Many authors stress the economic and environmental benefits of logistic parks. Establishment of Gardner in Kansas, USA (2009) state that logistic parks are concepts that have been utilized by major organizations as means of how to efficiently and effectively organize, manage, and ship goods. Roudná (2011) notes that logistic centre will help to reduce the cost of basic equipment, and they also allow access to facilities that would not be otherwise possible to install for economic reasons. Míková, Dorda, Famfulík (2008) think that logistic centre is an environmentally friendly solution based on the effective division of labour between the individual types of transportations.

Europlatforms (2004) identifies three important elements of the concept of logistic centre: urban and regional planning in terms of rationalization of infrastructure, quality of transport in terms of removing bottlenecks and inefficiencies, development of intermodality in terms of providing synergetic solutions. This source also says it is vital for a logistics centre to be managed as a single and neutral legal entity (the form of Public-Private Partnership is preferred) if cooperation and synergy are to be achieved.

Logistic parks respecting the principle of public interest and built with the support of public funds are often referred to as public logistic centres. That is how they are called, for example, by Roudná (2011). The most developed network of logistic centres of this kind is located, according to Soukup (2009), in Italy (under the name of Interporto) and in Germany (under the name of Güterverkehrszentren), where these centres have ambition to contribute to making advanced logistic structures accessible even to medium-sized enterprises and to achieving synergies based on the cooperation of complementary providers of logistic services.

3. Methodology of research of logistic parks in the Czech Republic

This chapter of the article formulates the research questions and describes the methods of collecting and analyzing data.

3.1 Characteristic of the researched environment

The Czech Republic has a long industrial tradition, especially in heavy industry and engineering, in which automotive industry has recently witnessed significant representation with several assembly plants (Škoda Auto, Hyundai, joined plant of Toyota - Peugeot - Citroen Automobile), where the supplies of thousands of suppliers, not only from the Czech Republic but also from abroad, have been heading for.

After 1990, many new investors entered the country in the fields of industry, trade and even the providing of logistic services. The Czech Republic has large logistics flows with the neighbouring countries of Germany, Austria, Slovakia and Poland, as well as nearby Hungary, but also with Bulgaria, Romania and Italy. As for the firms involved in logistics, which are affected by the issue of logistic parks, a detailed analysis of the structure of the business environment conducted by Ludvík and Peterková (2013) shows that only in the category of large firms with over 250 employees, there are 89 companies engaged in transport and warehousing in the Czech Republic. This number is

complemented by a few hundred small and medium-size enterprises. The companies providing complex logistic services that are active in the Czech Republic also include large global companies.

The Czech Republic has one of the densest railway networks in Europe connected to international corridors, it is equipped with a network of motorways and there are three international airports within its territory. The Elbe River provides connection with the German port of Hamburg during navigability periods.

3.2 Research questions

During the work on this topic, we were looking for the replies to these questions:

- What is the share of logistic parks in the Czech Republic, how were the parks created, what is their structure and what is the structure of logistic operators working in them?
- Do the existing logistic parks offer the possibility of rationality of logistic flows and synergies?
- What are the directions of further development of logistic parks?

3.3 Data gathering procedure

The survey was conducted in the first half of 2013. First, we were searching for logistic parks in the Czech Republic using publicly available sources of information. The basic framework used for this purpose was the Logistic Book of Lists 2012 (Logistické systémy, 2012), which is a list annually published by ATOZ Logistics to promote organizations active in logistics in the Czech Republic. The data found in the Logistics Book of Lists are collected via questionnaires, and we addressed companies whose work in this field was considered significant. The following information is gathered from logistic parks: the name of the logistic area (warehouse), region, owner, spatial parameters, rental price, present clients, and access to the individual types of transport infrastructure, year of construction, contact to the owner or real estate office.

However, some data gathered from the Logistic Book of Lists are not mandatory and remained empty, which is why other data sources have been used in the survey as well. They included websites of the individual logistic parks that were searched for using google.cz and seznam.cz browsers, where the expressions "logistic park" and "logistic centre" were inserted.

The outcome of the work using the above mentioned resource was an excel database file containing 85 logistic parks operating in the Czech Republic, which included the park owner, location, available space, current free space, rental rates and park expansion plans, if they had been provided.

The results of surveys conducted by leading real estate agencies, such as CBRE and DTZ were a helpful additional source for identifying the trends in the construction and occupancy of logistic parks. However, the applicability of these resources was limited because the indicators presented in these reports generally apply to all industrial properties, not separately to logistic property.

More detailed findings were obtained using two case studies conducted in selected logistic parks. The case studies were based on partially formalized interviews and study of documents related to parks. A protocol was prepared according to the rules introduced by Handle (2005) and Karlsson (2009), which included, among other things, the set of questions related to the strategy of developers, management of parks, structure of tenants, tenants cooperation and further development of the park. The validity of the case studies was ensured by the participation of two research workers, both during the preparation of the questions and the interview itself, as well as by taking a written record of the interview independently by each of the research workers, followed by comparison of the recorded data, agreement regarding their compliance in terms of their understanding and by creating the final version of the record.

3.4 Applied data analysis methods

The created database of logistic parks was analyzed using simple statistical methods. Analysis of frequency, analysis of the file structure and ABC classification methods were used to investigate and evaluate especially the territorial and ownership structure of the parks, the age of parks, their area, and the utilization method of parks. A descriptive analysis of the findings related to rental fee and occupancy of the parks was also carried out using data originated from additional sources.

The data obtained from these case studies were structured according to the individual studied aspects, coded and organized into tables. Each case study was analyzed separately and the two case studies were compared afterwards.

4. Data analysis results

The names of 85 identified complexes having the features of logistic parks usually included the word "park" without any attribute. The attribute "logistic" or "logistics" occurred in approximately one third of them (27 cases), usually in connection with "logistic park" or, in a smaller number of cases, "logistic centre". Sporadically, there were names "industrial and logistic area", in a few cases the name was " business park "," industrial park "or" business centre ". Thereinafter, we are going to use the term "logistic park" or abbreviated to "park" for all the examined subjects.

4.1 Outcomes of the analysis of logistic park structure
Location of logistic parks

An analysis of the territorial distribution of parks was carried out according to higher territorial municipal units of the Czech Republic (regions). The territorial distribution of 85 identified logistic parks is shown in the map (Figure 1), which is divided into 14 regions, including the independent territorial municipal unit of the capital city of Prague.
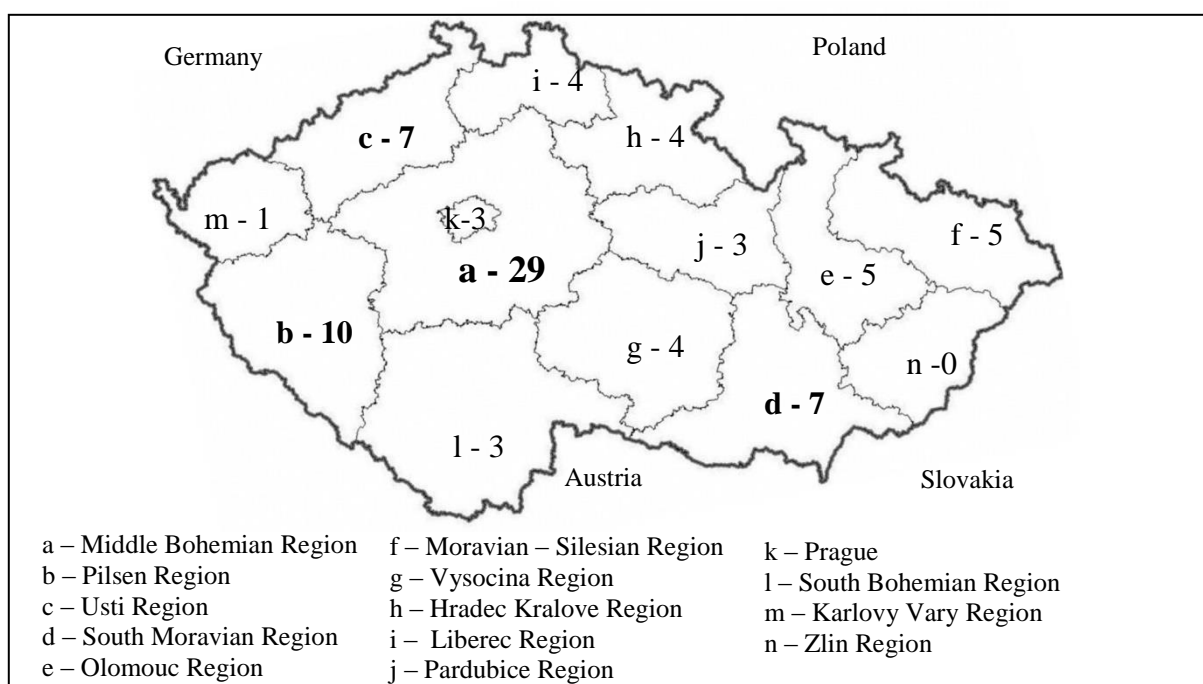

Figure 1 – Numbers of logistic parks in the individual regions of the CR

Pareto ABC analysis carried out according to the frequency of occurrence of logistic parks in each region (Figure 1 and Table 1) has shown how the individual regions were preferred during the construction of parks.
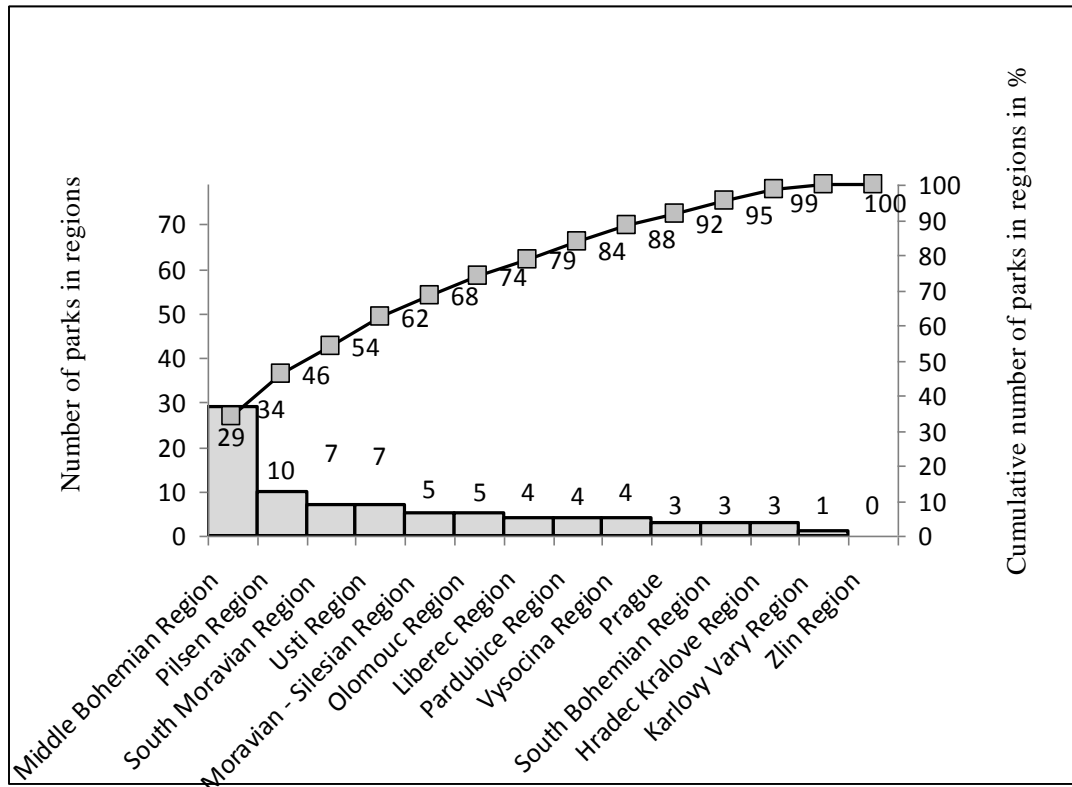
Figure 2 – Chart of the number of parks in regions and cumulative number of parks in regions

Table 1 - Division of regions into groups ABC according to the number of logistic parks

Group	Region	Share of the region on the number of parks in %	Number of regions in a group	Number of parks in a group
A	Middle Bohemian	34.1	1	29
B	Pilsen, South Moravian, Usti	28.3	3	24
C	Moravian Silesian, Olomouc, Liberec, Pardubice, Vysocina, Capital of Prague, South Bohemian, Hradec Kralove, Karlovy Vary, Zlin	37.6	10	32

Figures 1 and 2 and Table 1 show that the largest concentration of parks in the Czech Republic (29 parks, i.e. 34%) is in the Middle Bohemian Region. It is quite logical. The vast majority of these parks is located in close proximity to the capital city of Prague, it is within easy reach of motorways and it is not too far from the border with Germany, which makes the Middle Bohemian Region (group A), together with the territory of the capital city of Prague, the most attractive areas for investors. There are 32 parks in total in this area, i.e. 38%. The international airport in Prague and the railway corridor to the neighbouring countries also contribute to the popularity of this area.

Group B consists of Pilsen Region, South Moravian and Usti Region. Significant representation of logistic parks is probably related to the fact that these regions border on the neighbouring countries (Pilsen and Usti Regions border on Germany, South Moravian Region borders on the Slovak Republic and Austria) and they have good connection to motorways. Parks in the South Moravian Region are located near the second largest city of the Czech Republic - Brno, which has an international airport.

The group of regions with the lowest number of logistic parks (Group C) includes 9 regions, with 1 to 4 parks located in each of them. No logistic park is built in the Zlin Region bordering on Slovakia. Group C shows that more than a third of the parks (37.6%) are dispersed in the territory of nine of the fourteen regions.

▪ *Connection of logistic parks to transportation systems.*

The analysis of the localization of parks has uncovered that a vast majority of parks has direct connection only to road transport, some of them also to a railway spur track. Only a few parks are found in close proximity to an airport. Only one of the three international airports in the Czech Republic will be connected to railway within 1-2 years.

▪ *The structure of logistic parks according to area.*

The total available area of 80 parks has been discovered out of the 85 surveyed parks and logistic centres. According to the size of this area, the individual parks can be divided into the following classes (Table 2).

Table 2 – Number of parks according to available area in m^2

Classes of parks according to available area in m^2	Number of parks	Share of the number of parks in %
Up to 10 000	10	12.5 %
10 001 - 50000	29	36.3 %
50 001 – 100000	18	22.5 %
100 001 – 200000	10	12.5 %
Over 200 000	13	16.2 %

Table 2 shows that parks of various sizes are represented. Smaller parks up to 50,000 square meters have the highest share. The group of 13 largest parks over 200,000 square meters is not negligible (it represents 16.5% of the parks). The two largest parks have an area of over 1,000,000 square meters.

▪ *Structure of logistic parks according to owners*

The process of redetermination of the owners of logistic parks was facing the problem that the situation has been constantly changing; either individual parts or entire parks are sold and the owner was not always clearly defined. The owners of 80 parks were established out of the 85 surveyed parks and logistic centres by March 2013.

28 owners of logistic parks were identified in the Czech Republic under these circumstances. The share of owners is shown in Figure 3, in which we present only the names of the most significant owners.
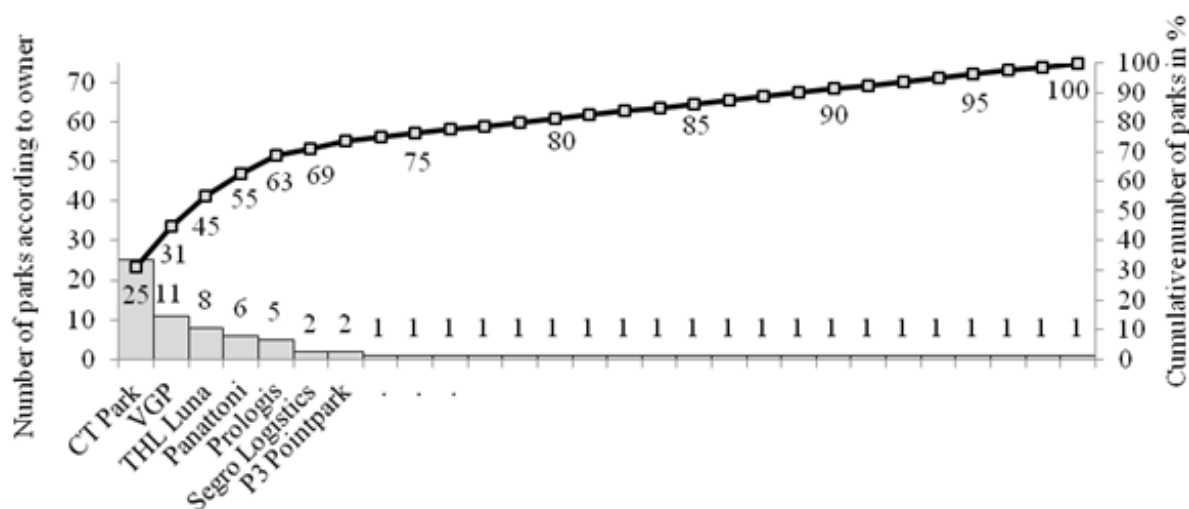

Figure 3 - Number of parks according to owners

ABC analysis performed according to the number of parks owned by the individual owners leads to the following distribution (Table 3):

Table 3 - Division of owners in ABC groups according to the number of logistic parks

Group	Owners	Share of the number of parks in %	Number of owners in group	Number of parks in group
A	CTPark	31.3	1	25
B	VGP, THL Luna, Panattoni, Prologis, SegroLogistics, P3Pointpark	42.5	7	34
C	Other owners	26.2	21	21

According to the number of parks in the Czech Republic, Table 3 shows that parks owned and managed by CTPark Company dominate with the share of 31.3% of the total number of parks and they make Group A.

Group B consists of VGP, THL-Luna, Panattoni, Prologis, SegroLogistics and P3 Pointpark. Group B contains a total of 42.5% of all parks situated in the Czech Republic.

Group C contains a total of 21 owners who manage and operate only one park each.

Foreign owners clearly dominate among the owners of parks, and they include significant share of the world's largest developers of industrial real estate.

The survey has shown that public logistic centres in the full meaning of the definition presented in part 2 of the article have not been built in the Czech Republic.

In the Czech Republic, there is a competition organized by a group of ATOZ Logistics, in which the Tenants' Award for the best logistic park is awarded on the basis of evaluation given by the tenants.

▪ *Foundation and age of logistic parks*

Only a few logistic parks were built prior to 2000. The largest wave of construction of logistic parks took place in 2001-2008, during which more than half of all the parks were built.

Most of them are newly constructed buildings and infrastructure, where the building and interior have custom-made design to a particular user. In the case of halls used for logistic purposes, the halls are equipped with numerous ramps; the buildings are adjusted to the needs of vertical space storage and modern warehouse equipment.

Industrial parks building projects have been heavily supported by the state legislation (Act no. 72/2000 of the Coll. of Investment Incentives) since 2000, as well as by the organizational assistance of government and regional authorities. Investment incentives have the character of a public support and they consist of discounts on income tax, land transfer including the associated infrastructure at a discounted price, material support of new job creation, material support for requalification and training of employees, material support for the acquisition of tangible and intangible assets for the strategic investment project.

The preparation of the land and the investment incentives had attracted mostly foreign developers, who began to construct buildings and warehouses for tenants. In this period, the parks were mostly built in the so-called green field in the outskirts or near large agglomerations or in areas near the borders. Only a few of the surveyed parks are located in the so-called brownfields. The developed parks have contributed to the creation of thousands of jobs.

After 2008, the construction of parks and also their occupation slowed down. According to the DTZ (2013) data, the vacancy of rented industrial properties in the Czech Republic in the period of 2011-2013 varies in the range of 6 - 8%.

▪ *Types of tenants*

The analysis of the major tenants of logistic parks leads to a conclusion that the utilization of the parks has a mixed character (industry, logistics, partly also administrative companies). As far as

the logistic tenants in these parks are concerned, large global logistic companies such as Schenker, DHL, Dachser, Geis, C.S. Cargo, PST CLC Mitsui-Soko Group, DSV and others are widely represented here. These companies often have rented space in more parks of different owners that are located in different parts of the country, and they begin to prefer renting space in logistic parks to building and managing their own capacities.

▪ *Notes from the case studies*

Two parks situated in the Moravian-Silesian Region in the industrial agglomeration of Ostrava were selected for the case studies. Case study no. 1 dealt with CTPark Ostrava - Hrabová, which is owned by the largest developer of parks located in the Czech Republic and can therefore serve as a representative of the parks of group A. The object of case study no. 2 was a park called Multimodal Logistic Centre of Ostrava-Mošnov. In terms of area, both parks belong to the group of large parks. Besides these two parks, two smaller logistic parks with different owners are also found in Ostrava agglomeration.

The methods of data gathering and the contact persons within the scope of the case studies are shown in Table 4.

Table 4 – Sources and contacts used for the case studies

	Case study no. 1 CTPark Ostrava-Hrabová	**Case study no. 2** Industrial zone and Multimodal Logistic Centre Ostrava-Mošnov
Data sources	Interview, Building passports, Annual reports, Reports on park occupancy, Press reports	Interview, Ostrava City Real Estate Report (2013)
Contact person	Project manager of developer organization working as a park administrator at the same time	Two specialists of the municipality: industrial zone project manager, marketing specialist of investment opportunities of the city

▪ *Findings from Case Study no. 1*

In addition to 25 parks in the Czech Republic, the company CTPark also owns several parks in the Slovak Republic and Romania. All parks use the same strategy of development and management of parks. Each of the parks has an administrative section that organizes the expansion of the park, including the relevant permits, recruitment of tenants and signing contracts, charging rent, services for tenants, contacts with local authorities, etc.

CTPark Ostrava - Hrabová is located on the outskirts of Ostrava, it has connection to an express road and, within a few kilometres, to a container terminal and railway. The international airport is located 15 km away. CTPark, which is built on a green field, occupies 800,000 square meters. It was created in 1994 when the land designated in the layout plan as an industrial zone was purchased from the city of Ostrava and, within the scope of a project of building industrial zones, the city provided financial support, prepared the terrain and built the utilities. The construction of buildings and the acquisition of additional land were funded by the developer.

There are over twenty occupied buildings in the park at the moment used for production, logistics and warehousing as well as office buildings. In addition to the standardized categories of buildings[1] designed by renowned international architects, some buildings are constructed and specially adapted to particular tenants. It is not a purely logistic park, because the park owners promote mixed tenant structure portfolio. The park management prefers the name of business rather than logistic park.

In the first half of 2013, there were 45 tenants in the park that employed 7,500 workers. 11 of the companies were engaged in logistics. These logistic firms had no ties of logistic type among each

---

[1]The most suitable category for logistic purposes is the one defined as warehouse space with area from 3,000 to 20,000 square metres, with 10.5 m ceiling height, heavy-load floors, variety of loading bay options, bulit-in sprinkler systems, energy-efficiet design, chilled and cooled space available, hazardous material storage solutions and in-bilt office and sanitary facilities.

other. The tenants were largely represented by manufacturing companies of suppliers to the automotive industry, manufacturers from the fields of mechanical engineering, plastics production, electrical engineering, welding and computer technology. The nature of the activities of tenants shows that they do not miss access to railway and air transport.

The developer deliberately retains about 10% of the area available for the case of flexible response to new requirements. The standard duration of the lease contract is app. 10 years, in case of custom-made buildings, it is 15 years, and 5 years for smaller buildings.

The park provides a variety of services related to the maintenance of lawn and planting and lighting, winter maintenance, sanitation, inspection of heating devices, and partly also building management. The park administration negotiates suitable time-tables of public transport with the provider.

The park administrator submits a report on the occupancy of the park and the number of jobs created in connection with proving the sustainability of the project of industrial zone construction to the statutory city of Ostrava once every six months.

Further expansion of the area of the surveyed CTPark is limited by the proximity of residential areas as well as by multiple increases of the fees for exclusion of land from agricultural land resources. That is why, according to the contacted person, the acquisition of certain brownfield types of land are under consideration.

▪ *Findings from Case Study no. 2*

Multimodal logistic centre Mošnov (an area of 800,000 square metres) is part of the Strategic Industrial Zone of Ostrava - Mošnov (2,000,000 square meters), the building of which started in 2005, partly in the background of the old airport and partly in a green field. It is located 25 km south of Ostrava. The industrial zone of Ostrava - Mošnov is one of the largest newly established development areas in the country.

According to the Czech legislation, strategic industrial zones have a minimum acreage of 200 ha, respectively at least 100 ha if the zone is realized in a built-up but unused area. Strategic industrial zones are also zones prepared for a major or serious investor who undertakes to realize an investment of significant amount and thus to create a certain number of jobs.

The majority of resources for the development of a strategic industrial zone were provided by the state. Other financial contributions came from the city of Ostrava, the Moravian-Silesian Region, the EU funds and energy company ČEZ were used as well. These funds were used to build a complete infrastructure for the needs of future tenants. The preparation and realization of the project and the placement of investors were carried out by the city along with a government agency CzechInvest.

Several manufacturing companies supplying the automotive industry (especially Hyundai car manufacturer located 30 km away) and Free Zone Ostrava, company providing mainly duty free zone services work and own land in the strategic industrial zone at the moment. These companies employ 1,500 workers.

Multimodal logistics centre which is now being built by development company HB Reavis Group that has a pre-emptive right to buy the land, is still in its development stage and is looking for tenants. It has a high potential for concentration of logistic activities, because it is a unique site in the Czech Republic situated in immediate vicinity of the Ostrava international airport of Leoš Janáček. The airport has customs administration, which further boosts the importance of the centre. The park is easily accessible for truck transport and the reconstruction of a railway spur track connected to the international railway corridor, which is just being completed, will provide conditions for construction of combined transport terminal. The territory of the centre will be suitable not only for logistics and warehousing, but also for light manufacturing.

The whole zone of Ostrava - Mošnov is supervised by the city of Ostrava, which also agrees on the investors. The administrative and technical management of the complex as a whole is not organized. Only the area maintenance is performed by an external company. All companies in the strategic industrial zone of Mošnov are obliged to provide information about the number of employees, investments, etc. to the city in half a year intervals, which applies to case study no. 1 as well.

▪ *Comparison of both case studies:*

The common features of both surveyed parks include the commitment of the city and other public resources in the preparation and construction of infrastructure, construction of buildings funded by private developers, ownership of acquired land by private investors, or pre-emptive right to their acquisition, cooperation of developers with regional authorities in obtaining tenants and creating traffic accessibility for employees.

The differences were found in the organization of park administration and the multimodality potential. The constructed multimodal logistic centre of Ostrava - Mošnov (case study no. 2) is closer to the concept and purpose of a logistic park in terms of its characteristic. However, it will depend on the kind of tenants it will manage to attract.

▪ *Identification of factors influencing further development of logistic parks in the CR*

The rental fee of warehouses situated in the Czech Republic according to (CBRE, 2013) is relatively stable. With increasing rented area, the rental fee per square meter decreases. The leasers are trying to offer more attractive conditions especially in the form of rent free periods, whose length ranges from 3 to 9 months.

Despite the ongoing crisis, developers are building more objects for concrete potential customers in the existing parks, especially for manufacturers and suppliers of automotive industry and major logistic providers. Completely new parks are built as well. The share of logistic organization in gross realized demand for industrial real estate property in recent years is, according to (CBRE, 2013) source, about one third. The share of speculative construction is small also with respect to the caution of banks in providing loans for cases that are not secured by contracts with future tenants.

The construction of other logistic properties will probably be influenced by the change of the incentive system in the Czech Republic, mainly in favour of support for investments with higher added value. In addition to building parks in open areas, there has been some evidence of steps focused on the utilization of brownfields. Some cities are newly preparing brownfields as industrial zones, as shown for example in Real Estate Ostrava (2013). The Czech Republic, in cooperation with its agency CzechInvest (CzechInvest, 2013), has prepared a strategy for the development of brownfields, including a list and description of each area of this type.

As stated by Libora (2013) in connection with further construction of industrial property, "good locations in the Czech Republic have already been taken and the available opportunities are associated with high risks (excessive price based on speculations, restitution disputes, unclear legal relations)."

Since 2005, the issue of localization of public logistic centres has been included in the transport policy of the Czech Republic for 2005-2013 and in the document of Strategy of Logistic Support from public funds, but due to lack of resources, the strategic objectives in this area have not started yet.

5. Conclusions

The conducted surveys lead to a conclusion that building numerous logistic parks in a relatively short period of time after 2000 has led to the creation of large capacities for logistic operations and has made the development of logistic service providers easier, including the introduction of modern logistics technologies. It is not insignificant that thousands of jobs have been created as well.

An important fact is that all the parks are private, although the start of many of them was facilitated by the state and territorial administration authorities. The occurrence of a public logistic park operating on the principle of Public-Private Partnership has not been recorded.

The discovered fact that both logistic and manufacturing companies are located in the parks, brings hope that there may be synergies in the supply chain, but research has indicated that the structure of the tenants in the same park is created quite randomly, which means the elements of synergy among the logistic companies, or between manufacturing and logistics firms are sporadic.

Uneven spatial distribution of the parks revealed by the analysis is partly due to limited available space in the densely populated Czech Republic. However, it can also be attributed to some misconceptions influenced by the actual needs of private investors. It seems that the needs to rationalize traffic flows in terms of larger areas were not sufficiently taken into account during the

construction of parks. The construction of parks mainly in green fields has caused environmental burden to countryside.

Multimodal logistic parks are not represented in the Czech Republic. The park mentioned in case study no. 2 may become an exception. In some parks that are connected only to road transport, there is a possibility to consider the completion of a railway spur track; however, this solution may face significant territorial and financial limitations. For many supply chains, the absence of the connection of parks to railway transport may become a handicap if the pressure on the economic efficiency and the use of environmentally friendly types of transport is increasing. The question therefore is whether some tenants of existing parks won´t leave in the future for that very reason.

The need to build more logistic parks in areas that will be carefully selected in order to support multimodality, to streamline the flows and to protect the inhabitants from the negative effects of traffic is expected to intensify. This is the reason why the challenge in such a situation is to join the forces of public resources and private investors so as to build public logistic parks funded and managed using the principle of Public-Private Partnership.

The authors of this article are aware of the limitations of the conclusions drawn from the study, as the range of logistic parks that have been identified was not complete and the depth of the analysis was limited by the available data. With regard to the dynamics of the business environment, it is also necessary to count with very limited validity of the findings in time. The interest in logistic parks and the tenant structure may change in the future, among other factors, depending on the overall economic development not only in the Czech Republic but also in the world.

It will be desirable to continue in the research of logistic parks. The directions we consider to be suitable for further research include searching for ways to enhance synergies in logistics through well-situated and well-occupied logistic parks. For this purpose, it would be appropriate to conduct a survey of public logistic parks abroad, and to identify good practices in this area.

Acknowledgement

References

[1] Dutková, M., Dutko, S., Bigoš, P. (2009). Logistické centrá na Slovensku. *Zdvihací zařízení v teorii a praxi* 71, no. 2, [cit. 2013-5-6]. http://www.342.vsb.cz/zdvihacizarizeni/zz-2009-2.pdf.

[2] Gardner, K. (2013). What is a Logistic Park?. [cit. 2013-7-5]. http://www.gardnerkansas.gov/images/uploads/Administration/Intermodal/WhatisaLogisticsPark.pdf.

[3] Hendl, J. (2005). *Kvalitativní výzkum.*Thirth Edition. Portál.

[4] Karlsson, C. (2009). *Research in operations management.* First Edition. Routledge.

[5] Libora, P. (2013). Firmy hledají peníze pro své investice. *Systémy logistiky*, 13(122) : 16-17.

[6] Ludvík, L., Peterková, J. (2013). Specifics of size structure and managing role of the large companies in enterprise environment in the Czech Republic. *Journal of Applied Economic Sciences*, VII (1(23)): 63 – 72.

[7] Míková, J., Dorda, M. Famfulík, J. (2008). Veřejné logistické centrum v Moravskoslezském kraji. *PernersContact*, Univerzita Pardubice, [cit. 2013-5-4]. http://pernerscontacts.upce.cz/11_2008/mikova.pdf.

[8] Roudná, J. (2001). *Prostorová lokalizace logistických center v ČR*, PhD diss., University of Pardubice.

[9] Soukup, L. (2009). *Koncepce veřejných logistických center*. [cit. 2013-6-14]. http://logistika.ihned.cz/c1-38232480-koncepce-verejnych-logistickych-center.

*** Atoz Logistics. 2013. Logistická kniha seznamů 2012. *Systémy Logistiky*.

*** CBRE. Labour & Warehouse Availability – CZ. MarketView. CBRW Global Research and Consulting. http://www.cbre.eu/portal/pls/portal/res_rep.show_report?report_id=2793.

*** CzechInvest. Strategické průmyslové zóny. [cit. 2013-11-6]. http://www.czechinvest.org/strategicke-prumyslove-zony.

*** DTZ. Property Times. Czech Republic Industrial Q1 2013. www.dtz.com.

*** Europlatforms. 2004. Logistics Centres Directionsfor Use. A report by EUROPLATFORMS EEIG January 2004. [cit. 2013-6-14]. http://www.unece.org/fileadmin/DAM/trans/main/eatl/docs/EN-REV-What_is_a_Freight_VillageFinalcorretto.pdf.

*** City of Ostrava. 2013. City of Ostrava - Real Estate Report – April 2013.

TECHNICAL EFFICIENCY OF TOP 50 WORLD BANKS

Kristína KOČIŠOVÁ
Technical University of Košice
Faculty of Economics, **Slovak Republic**
kristina.kocisova@tuke.sk

Abstract:
This study investigated the relative technical efficiency of top 50 world banks in 2011. In particular, the overall technical efficiency, pure technical efficiency and scale inefficiency were estimated and the reasons of inefficiency were defined. We distinguished three main approaches in evaluating efficiency: production, intermediation and operational approach to find out, which banks were the most efficient. The average efficiency scores were evaluated separately on the "national" and "international" level. In case of "international" approach the average efficiency scores were calculated from data of all 50 banks. If "national" approach was applied the average efficiency scores were calculated from data of banks in four regions, determined by the world´s continents (America, Asia, Australia, and Europe).

The study concludes that almost all banks reported lower intermediation efficiency than the operating efficiency; the production efficiency was the lowest one. The results suggest that American and European banks were less efficient than Asian and Australian, which may be due to lingering financial crisis, which affected mainly the American and European financial market. In this study we also investigated the interaction between efficiency and other bank specific variables like total assets, indicators of profitability, intermediation ratio, etc. The results suggest that variables total assets and loan to deposit ratio were significantly positively, and variable cost to income ratio was significantly negatively related to the pure technical efficiency.

Keywords: bank efficiency, data envelopment analysis, top 50 world banks.

JEL Classification: C14, G21

1. Introduction

Efficiency of banks and other financial institutions is very frequently discussed topic in literature. Efficiency of banking system is one of the most important issues in the financial market as efficiency of banks can affect the stability of the banking industry and thus the effectiveness of whole monetary system. (Yilmaz, 2013)

Bank efficiency can be measured by different methods. The earliest techniques, used to measure efficiency through ratio analysis, which examined the financial statements of individual banks and compared them with benchmark. Now, there is also number of other methods for efficiency measuring. We can talk about the parametric and non-parametric methods, which employ different techniques to envelop a data set with different assumption for random noise and for the structure of production technology (Stavarek and Repkova, 2012). Parametric methods include the Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA) and Distribution Free Approach (DFA). These methods measure economic efficiency. Non-parametric methods include Data Envelopment Analysis (DEA) and the Free Disposal Hull (FDH) and measure technical efficiency of production units.

This study had three objectives. The first objective was to estimate the overall technical efficiency, pure technical efficiency, scale efficiency of top 50 commercial banks in the world and to identify the reasons of efficiency. For estimation of relative efficiency, non-parametric method of Data envelopment analysis (DEA) has been used. We evaluated relative technical efficiency of top 50 world banks in 2011. The Banker Database published list of top 50 world banks. The criterion for selecting the top 50 world banks was the value of Tier 1 capital. The second objective was to compare the average efficiency of banks in different regions. Since we know that averaging without any respect of size of banks causes loss of information, we implemented into analysis also sized-adjusted average efficiency to compare the average efficiency in different regions. The third objective was to define the input and output variables (strengths and weaknesses) that influence efficiency of evaluated banks, and to find out the factors (bank specific variables like total assets, profitability, rate of intermediation etc.) positively and negatively related to the pure technical efficiency. The strengths and weaknesses that

influence efficiency were defined through the values of weights calculated in the DEA models and regression analysis was used to explain the factors that were related to efficiency.

The structure of the paper is following. Section 2 presents review of literature about usage of DEA model in banking area; section 3 presents methodology; selection of variables and results of analysis are described in section 4; and the last section concludes the paper with summary of key findings.

2. Literature review

Data envelopment analysis (DEA) was initially developed by Charnes, Cooper and Rhodes (1978). Sherman and Gorld (1985) applied DEA to banking as the first. DEA calculates the relative efficiency scores of various Decision-Making Units (DMUs) in a particular sample. The DMUs could be banking sectors, banks or branches of banks. DEA compare each of banking sectors/banks/branches in the sample with the best practice in the sample. This way it can be found, which of the DMUs in the sample are efficient and which aren't.

DEA is a method for measurement of relative efficiency of DMU, using the same multiple inputs to produce multiple outputs. In recent years, this method is becoming increasingly popular in field of effectiveness measuring of national banking sectors, but also for comparison of banking sectors in the global banking market.

For example, Pastor and col. (1997) analysed efficiency of banks in US and in selected countries of Europe. For comparison of different European and US banking systems they used value added approach. They found out, that France, Spain and Belgium appear as the countries with the most efficient banking systems, whereas the UK, Austria and Germany show the lowest efficiency levels.

On the other hand Casu and Molyneux (2003) in their study used intermediation approach to evaluate efficiency of 750 selected European banks. Overall, the results showed relatively low average efficiency scores, nevertheless, it was possible to detect a slight improvement in the efficiency levels through time.

In the case of using DEA in evaluating banks within a banking sector was DEA analysis used in evaluating the efficiency in Turkish banking system. Yilmaz and col. (2013) measured efficiency of 30 Turkish commercial banks between 2007 and 2010, while the intermediation approach was used. In their study they compared the efficiency of foreign and domestic banks and they found out, that the domestic banks were more efficient in all evaluated years.

In case of Indian banking sector was DEA used by Karimzadeh (2012). In this study was examined the efficiency of 8 major commercial banks during 2000-2010. The results suggest that the mean overall efficiency was 100% in 2000, decreasing to 98% in 2002, and remained unstable from 2003 to 2009 with fluctuating in percentage till 2010-2011, which reached to 100% again. To increase efficiency contributed positively many economic and financial reforms, which was implemented during the evaluated period, IT innovation, competition, better supervision, and enlarged investment in new information technology.

Sherman and Gold (1985) used DEA analysis to evaluate operating efficiency of 14 saving bank branches. As the result of analysis they not only measured the level of efficiency, but also defined how can be eliminated inefficiency by adjusting input and output of inefficient bank branches. Motivated by the DEA results, management indicated that the service outputs and the resources used to provide these would be further evaluated as distinct from the liquidity issues.

Very few studies have examined the efficiency of the largest banks in the world. E.g. Mostafa (2009) in his study investigated the relative efficiency of top 85 Arab banks using DEA. In his study the assets and equity were treated as inputs and net profit, return on assets and return on equity were chosen as outputs. The result of his analysis was that the Arabic bank reached lower level of efficiency compared to US, German or Austrian banking industry following difference in bank-specific operating environments in Arabia.

Seiford and Zhu (1999) in their study examined the performance of 55 US commercial banks via the DEA. In their study they analysed profitability and marketability of top banks and they found out, that large banks exhibited better performance on profitability, whereas smaller banks tended to perform better with respect to marketability.

Yue (1992) evaluated the efficiency of the 60 largest Missouri banks for the period 1984 through 1990. In his study he employed four inputs (i.e., interest and non-interest expense, and

transactions and non-transactions deposits) and three outputs (i.e., interest and non-interest income, and total loans), reported that pure technical inefficiency provides the major source of technical inefficiency.

Every one of mentioned authors used DEA model to evaluate efficiency of large banks in national economy. Therefore the aim of this study is to expand use of DEA models to assess relative efficiency of the top 50 banks of the world.

3. Methodology

DEA is used to establish a best practice group of units and to determine which units are inefficient compared to best practice groups as well as to show the magnitude of the inefficiencies present. From the set of available data, DEA models identify (Kočišová, 2013):

- the efficient frontier;
- efficiency score of each DMU.

Recommendation for each inefficient DMU, it means the target values of inputs and outputs (projection on the efficiency frontier).

In this study the units of analysis are banks. Consider *n* banks (*DMU_j, j*=1,2,...,*n*), each consumes *m* different inputs (*x_{ij}, i*=1,2,...,*m*) to produce *s* different outputs (*y_{rj}, r*=1,2,...,*s*). The matrix of inputs is marked as follows $X = \{x_{ij}, i=1,2,...,m; j=1,2,...,n\}$ and the matrix of outputs $Y = \{y_{rj}, r=1,2,...,s; j=1,2,...,n\}$. Since the used inputs and produced outputs have for each production unit (bank) another level of significance, they have different weights. The advantage of DEA models is that the weights of used inputs and produced outputs are result of the solving optimization of linear programming problem and aren't allocated on the basis of subjective perception. The optimal weights are obtained by solving following mathematical programming problem:

$$\text{Max} \sum_{r=1}^{s} u_r y_{rq} \Big/ \sum_{i=1}^{m} v_i x_{iq} \qquad (1)$$

$$\text{Subject to} \qquad \sum_{r=1}^{s} u_r y_{rj} \Big/ \sum_{i=1}^{m} v_i x_{ij} \leq 1 \qquad j = 1,2,...,n$$

$$u_r \geq 0 \quad r = 1,2,...,s$$
$$v_i \geq 0 \quad i = 1,2,...,m$$

where: u_r is optimized weight of rth output (*r*=1,2,...,*s*), v_i is optimized weight of ith input (*i*=1,2,...,*m*), y_{rq} is produced amounts of rth output (*r*=1,2,...,*s*) for *DMU_q*, x_{iq} is consumed amounts of ith input (*i*=1,2,...,*m*) for *DMU_q*, y_{rj} is produced amounts of rth output (*r*=1,2,...,*s*) for *DMU_j* (*j*=1, 2,...,*n*), x_{ij} is consumed amounts of ith input (*i* = 1,2,...,*m*) for *DMU_j* (*j*=1, 2,...,*n*).

This functional linear program can be transformed into an ordinary linear program and can be expressed as dual problem. Thus obtained linear programming problem assumes constant return to scale and is known as CCR (Charnes, Cooper and Rhodes) model. The assumption of constant return to scale can be accepted only if the DMUs operate under condition of their optimal size. Imperfect competition, financial constraints, control steps and other factors are conductive to the fact that DMUs don't operate under their optimal size.

Therefore, to overcome this problem has been developed DEA model, which allows calculate with variable returns to scale. This model is called a BCC model (Banker, Charnes, Cooper). DEA models (CCR model or BCC model) can be oriented on inputs or outputs. The input oriented models bring recommendation for inefficient units to achieve efficiency in form of reduction on the input side. Output oriented models required to achieve efficiency increase on the output side. The efficiency of a particular *DMU_q* can be obtained by solving the linear programming programs. Input oriented model with slack variables, which assumes variable return to scale (BCC model), can be defined as follow (Zijang, 2006):

$$\text{Min } \theta_q - \varepsilon \left[\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+ \right] \qquad (2)$$

Subject to $$\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \theta_q x_{iq}$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = y_{rq}$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j ; s_i^- ; s_r^+ \geq 0$$

where: θ_q is efficiency of DMU$_q$, ε is non-Archimedean constant (10^{-6}or 10^{-8}), s_r^+ and s_i^- are input or output slacks, λ_j is weight assigned to the DMU$_j$ (j=1,2,…,n).

Performing a DEA analysis in fact requires solving of *n* linear programming problems of the above form, one for each DMU. *DMU$_q$* is termed fully efficient if and only if the optimal value θ_q=1 and all the slack variables are equal to zero. If θ_q=1but slack variables aren't equal to zero we can talk about the "pseudo-efficiency". If the slack variables are equal to zero but θ_q<1 then the value θ_q signalises the inefficiency. This inefficiency can be eliminated by proportional (radial) reduction in all inputs of *DMU$_q$* by (1–θ_q)100% and thus achieve the shift on the efficiency frontier. If the slack variables aren't equal to zero and θ_q<1, to achieve efficiency is necessary also the non-radial shift expressed by slack variables.

The efficiency calculated by CCR models is often called the overall efficiency. The overall efficiency of *DMU$_q$* can be decomposed into pure technical efficiency (calculated by BCC model) and scale efficiency (SE). The decomposition of overall technical efficiency is possible according formula (5):

$$CCR_q = BCC_q \cdot SE_q \tag{3}$$

One component of CCR efficiency is scale efficiency (SE). If SE is equal to one, this means that bank is operating under conditions of constant return to scale, which means, that the bank operates at the most efficient scale size. If SE is less than one, this means that the bank operates under conditions of variable return to scale, so there is scale inefficiency (SI) for bank. The value of bank scale inefficiency can be calculated according formula (5):

$$SI_q = 1 - SE_q \tag{4}$$

This SI ratio doesn't indicate whether the bank with scale inefficiency operates under increasing or decreasing return to scale, or if it is too small or too big. To select the direction of scale inefficiency we use non-decreasing (NDRS) and non-increasing (NIRS) return to scale models. The ratio of these two rates of efficiency helps us to indicate the direction of scale inefficiency, via formula:

$$SI_q = 1 - \frac{NDRS_q}{NIRS_q} \tag{5}$$

Thus calculated scale inefficiency higher than zero predicates about too big bank which operates under conditions of increasing return to scale and inefficiency lower than zero identifies too small bank which operates under conditions of decreasing return to scale, form the point of view of the input oriented DEA model. The fact, that the bank is too big means that bank is scale inefficient, because under the given inputs could be achieved higher outputs. On the other hand, in case of too small bank the scale inefficiency was due to too high level of outputs at a given level of inputs.

A number of different approaches can be used for modelling the banking process. Each of them is used to obtain a different aspect of efficiency measures. The most important are: production, operating and the intermediation approach.

Under the production approach, banks are viewed as institutions making use of traditional production factors like land, labour and capital to produce different products and services to depositors and borrowers. As input and output variables are used e.g. labour and operating costs, while the output variables are products and services such as loans and deposits.

Intermediation approach seems to have dominated empirical research in banking area. This approach assumes that bank collects deposits and transfers them, using labour and capital, into loans. The intermediation approach describes the banking activities as transforming the money borrowed from depositors into the money lent to borrowers. This transformation activity originates from the different characteristics of deposits and loans. Deposits are typically divisible, liquid and riskless, whereas loans are indivisible, illiquid and risky. In this approach, inputs include financial capital – the deposits collected and funds borrowed from financial markets whereas the volume of loans and investment outstanding measures outputs. (Stavarek, 2003)

The operating approach evaluates the bank efficiency from the perspective of management of cost and revenues. On the side of inputs are usually all significant costs of basic banking activities and main sources of bank revenues are on the side of outputs. As the inputs are usually used interest expenses, personal costs, capital costs, fees and commissions paid and e.g. interest revenues, received fees and commissions are considered as output.

3. Empirical analysis and results

We evaluated relative technical efficiency of top 50 world banks in 2011. The term "relative" efficiency refers to achieved efficiency of evaluated production unit (bank) within the group of evaluated production units (top 50 banks) and of the criteria used (input and output variables according to apply approach). The criterion for selecting the top 50 world banks was the value of Tier 1 capital. The Banker Database published list of top 50 world banks. In our analysis we compared the relative efficiency of each from top 50 world banks and also average efficiency of banks in four world banking sectors according to bank headquarters to one of the four major represented continents (America, Asia, Australia, and Europe). For evaluation of relative efficiency were used three basic approaches for modelling the banking process – production, intermediation and operating approach.

We decided to use all three approaches in our analysis. We would like to use production approach for measurement cost efficiency of the banks, intermediation approach, as the dominated research in banking area for measurement the economic viability of the banks, and operating approach, for evaluating efficiency of costs and revenues management. For all three approaches, the data were extracted from top 50 world banks´ end-of-year consolidated balance sheets and income statements based on international accounting standards. All data were reported in USD as the reference currency. The data in national currencies were converted by using the official exchange rates. Depending on approach there were chosen input and output variables used in the evaluation of relative efficiency through the DEA. Descriptive statistics of all input and output variables used in analysis are given in Table 1.

Table 1 - Descriptive statistics of input and output variables

		Average	Minimum	Maximum	St. deviation
Fixed assets (mil. USD)	FA	18 440,08	1 734,13	83 604,00	15 483,84
Number of employees	NE	129 891	3 206	461 100	103 766,99
Personnel costs (mil. USD)	PC	10 161,01	845,00	36 965,00	6 832,78
Non-interest expenses (mil. USD)	NIE	10 707,56	1 129,71	43 309,00	8 822,88
Interest expenses (mil. USD)	IE	17 422,57	1 494,00	66 247,68	11 761,09
Total deposits (mil. USD)	TD	693 327,81	40 266,00	2 157 357,93	477 699,29
Total loans (mil. USD)	TL	601 583,00	46 357,00	1 280 222,53	328 104,43
Interest income (mil. USD)	II	37 194,61	7 258,00	93 508,97	21 700,87
Fees and commissions income (mil. USD)	FCI	9 640,73	247,49	31 262,00	6 599,90
Net interest income (mil. USD)	NETII	19 772,05	356,00	57 535,96	14 084,16

Source: Author´s calculations from the financial statements of banks

After survey of number of similar studies, we decided to use this set of inputs and outputs for all approaches for evaluating relative efficiency. For the production approach, for each bank (DMU_j; $j=1,\ldots, 50$) were selected three inputs (x_{ij}; $i=1,2,3$) and two outputs (y_{rj}; $r=1,2$). The input variables (x_{ij}) were:

- Personal costs (PC) – (x_{1j}) – covered wages an all associated expenses;
- Non-interest expenses (NIE) – (x_{2j}) – were represented by operating expenses without personal costs;
- Number of employees (NE) – (x_{3j}) – represented number of full-time employees at the end of evaluated year.

As the output variables (y_{rj}) were determined:

- total deposits received from clients and other credit institutions (TD) – (y_{1j}),
- total loans to clients and other credit institutions (TL) – (y_{2j}).

In case of intermediation approach we used three inputs (labour, capital, and deposits), and two outputs (loans and net interest income). The labour was measured by the personnel costs (PC), capital by the value of fixed assets (FA), and deposits by the total deposits received from clients and other credit institutions (TD). Fixed assets were represented by sum of net book value of premises, equipment and goodwill. Loans were measured by the total loans to clients and other credit institutions (TL) and net interest income as the difference between interest incomes and interest expenses (NETII).

For the operating approach, for each bank were selected three inputs (three types of costs) and two outputs (two main sources of revenues). The input variables were interest and related expenses (IE), non-interest expenses (NIE) and personal costs (PC). The output data were interest income (II) and commissions and fee income (FCI).

Following the described methodology, we evaluated efficiency of all banks in the estimation set and calculated efficiency scores by running separate programs for the CCR model and for the BCC model. We pooled the cross-country data and use them to define a common best-practice efficiency frontier. This allowed us to focus on determining relative differences in efficiency across banks.

The average efficiency (M) stands for the average of all optimal values of efficiencies of banks from each country. We are aware of the fact, the averaging without any respect to the size of banks, causes loss of information, and therefore we implemented into analysis a sized-adjusted average efficiency (AM), which can be used for analysing the issue of optimal bank size by comparing with "simple" average efficiency score. The size-adjusted average efficiency (AM) was calculated as: [11]

$$AM = \sum_{j=1}^{n} w_j \cdot \theta_j$$
(5)

where: AM is the size-adjusted average efficiency; w_j is the weight calculated as a share of DMU_j ($j=1, 2,...,n$) assets on total assets of all estimated DMUs; θ_j is the observed efficiency for the DMU_j ($j=1, 2,...,n$).

The average efficiency scores of banks included in the sample were calculated through input oriented CCR model and BCC model. The average efficiency scores were evaluated separately on the "national" and "international" level. In case of "international" approach the average efficiency scores were calculated from data of all banks. Three types of average efficiency scores (overall technical efficiency, pure technical efficiency and scale efficiency) were calculated in case of production, intermediation and operating approach. The results in case of "international" approach are recorded in Table 2. As can be seen in next table, the highest level of average overall efficiency (CCR model) was obtained in case of operating approach; so we can say that the banks were the most efficient in management of costs and revenues. On the other hand average pure technical efficiency (BCC model) was highest under the intermediation approach, indicating the highest economic viability of banks.

The variability of efficiency scores recorded higher levels in production approach, than in intermediation and operating approach. The efficiency fluctuated from the 3.58% to 100,00% under the production approach comparing with fluctuation from 44.56% to 100,00% under the intermediation approach and from 30.87% to 100,00% under the operating approach. The interval formed by the mean plus and minus one standard deviation covered efficiency values from 54% to 86% of observations.

Considering constant return to scale, in all approaches the sized-adjusted average efficiency was lower than the simple average efficiency. This indicates that smaller banks represented better performers than larger ones were. Highest level of performance of smaller banks was seen under the intermediation approach, as evidenced by the greatest difference between sized-adjusted CCR efficiency and "simple" CCR efficiency in all approaches.

Allowing banks to operate with variable return to scale (VRS) the situation was different. The results indicate that larger banks were generally more efficient using "simple" BCC model, which means, that smaller banks dominate the efficiency frontier in CCR model, while in the BCC model banks on efficient frontier were on average much larger. Hence, in case of common efficiency analysis, we can generalize, that bigger banks mainly operated at the wrong scale. Under the assumption of VRS was the level of sized-adjusted average efficiency higher than the simple average efficiency in case of production and intermediation approach. The positive value of the difference (*AM – M*) can be interpreted, that the big banks performed better than the smaller ones under the conditions of VRS. In case of operating approach, negative value of difference confirmed better performance of smaller banks in management of costs and revenues.

Table 2 - Descriptive statistics of efficiency scores

	Production approach		Intermediation approach		Operating approach	
	CCR model	**BCC model**	**CCR model**	**BCC model**	**CCR model**	**BCC model**
Number of DMUs	50	50	50	50	50	50
Number (and %) of efficient DMUs	4 (8 %)	9 (18 %)	11 (22 %)	21 (42 %)	16 (32 %)	19 (38 %)
Maximum	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
Minimum	3,58%	14,59%	44,56%	47,96%	30,87%	37,13%
Average efficiency (M)	48,11%	56,55%	80,94%	89,76%	85,72%	87,95%
Adjusted average eff. (AM)	47,51%	57,12%	78,04%	90,03%	85,28%	87,78%
Standard deviation (σ)	0,2743	0,2809	0,1569	0,1415	0,1581	0,1463
Interval I [M – σ; M+ σ]	0,2068	0,2846	0,6526	0,7561	0,6991	0,7332
	0,7554	0,8464	0,9663	1,0391	1,0153	1,2058
Number of DMUs in I (and %)	31 (62 %)	27 (54 %)	31 (62 %)	41 (82 %)	43 (86 %)	43 (86 %)
Average Scale efficiency	83,20%		90,44%		97,19%	
Return to scale - number of DMUs						
Constant return to scale	4		11		16	
Increasing return to scale (no. of them BCC efficient)	27 (2)		11		16	
Decreasing return to scale (no. of them BCC efficient)	19 (3)		28 (10)		18 (3)	

Source: Author´s calculations

Under the production approach the average overall technical efficiency was 48.11% and four banks had rate of overall technical efficiency equal to one, which means, that these banks operated under conditions of constant return to scale (CRS). The average efficiency in BCC model was 56.55%. The value of pure technical efficiency (BCC model) identified potential savings in the set of analysed banks needed to increase efficiency. This value indicated that the evaluated banks in the production of their outputs needed an average only 56.55% of the used inputs. This reduction on the input side should ensure the shift on efficiency frontier for inefficient banks. The BCC model identified as efficient nine banks, four of them operated under conditions of CRS and five under conditions of VRS. Banks, which were efficient in CCR model and also in BCC model operated under conditions of CRS, and we can said, that these banks operated in so called most productive scale size, as the average productivity of each of those units is maximized. In case of banks, which were only BCC efficient (five banks), we can say, that they were locally efficient, but not globally efficient precisely because of their scale size. Two banks, which were only BCC efficient, operated under conditions of increasing

return to scale. This means, that these banks are scale inefficient, because under the given inputs (PC, NIE, NE) could be achieved higher outputs (TD, TL). Other three BCC efficient banks operated under conditions of decreasing return to scale, which means that the scale inefficiency was due to too high level of outputs at a given level of inputs. As we can see most of the banks operated under conditions of VRS. In whole sample operated 19 banks under conditions of decreasing return to scale (most of these banks were located in top 20 of evaluated banks) and 27 banks operated under conditions of increasing return to scale (most of them were located between the last thirty of evaluated banks). As can be seen the banks suffered from scale inefficiency, which was the highest in case of production approach. The average scale inefficiency reaches under this approach value 16.80%.

DEA models besides the calculating of efficiency score for each bank also bring recommendations to the inputs and outputs for inefficient banks, which should lead to the shift on the efficiency frontier. In case of input oriented models are recommendations for inefficient banks to achieve efficiency in form of reduction on the input side. In case of production approach we can say, that for achieving overall technical efficiency of all banks in the sample was necessary to reduce the first input "personal costs" in average by 59.92%, the second input "non-interest expenses" in average by 53.89% and the last input "number of employees" in average by 53.67%.

Through the values of weights calculated in the DEA models, we can also define reasons for inefficiency of banks. If the value of weight is equal to one, we are talking about the factors that contribute positively to the achieving efficiency. If the value of weight is equal to zero, we are talking about factors with a negative impact on efficiency score.

In case of production approach we can say, that the efficiency was negatively influenced mainly by input "personal costs". In case of this input was average value of weight the lowest (CCR model = 0.1362; BCC model = 0.1500), and number of cases when the weight was equal to zero was the highest (23;25). As can be seen above, this input required the highest reduction for the achievement of overall technical efficiency in whole sample of banks, which confirmed negative influence on efficiency. The highest average value of weight had output "total loans" (0.6196; 0.6952) so we can say, that this variable had positive influence on efficiency. In case of this output was the number of cases when the weight was equal to one the highest (27;16).

Under the intermediation approach the average overall technical efficiency was 80.94% and 22% of banks were marked as efficient under conditions of CRS. The average efficiency in BCC model indicated that the evaluated banks in the production of their outputs needed an average only 89.76% of the used inputs. The average pure technical efficiency measured under the intermediation approach reached the highest value compared to production and operating approach. The BCC model identified 21 banks as efficient, 11 of them operated under conditions of CRS and 10 under conditions of decreasing return to scale. Most of the banks operated under conditions of VRS. In whole sample 28 banks operated under conditions of decreasing return to scale (most of these banks were located in top 30 of evaluated banks) and 11 banks operated under conditions of increasing return to scale (most of them were located between the last 20). Average scale inefficiency of all banks reached value 9.56%. If intermediation approach was applied the DEA models also brought recommendations to the inputs and outputs for inefficient banks. For achieve overall technical efficiency of all banks in the sample was necessary to reduce the first input "personal costs" in average by 21.68%, the second input "fixed assets" in average by 27,51% and the last input "total deposits" in average by 19,60%. In case of intermediation approach the efficiency was negative influence mainly by input "fixed assets". In case of this input was average value of weight the lowest (0.1321; 0.1798), and number of cases when the weight was equal to zero was the highest (15; 14). As can be seen above, this input required the highest reduction for the achievement of overall technical efficiency in whole sample of banks, which confirmed negative influence on efficiency. The highest average value of weight under the CCR model had input "total deposits" (0.6387) and under the BCC model the highest weight was in case of output "total loans" (0.6107) so we can say, that these variables had positive influence on efficiency. In case of output was the number of cases when the weight was equal to one the highest (4; 6). As can be seen above the input "total deposits" required the lowest reduction for the achievement of overall technical efficiency in whole sample of banks, which confirmed positive influence on efficiency.

Under the operating approach the average overall technical efficiency was 85.72% and 16 banks were marked as efficient under conditions of CRS. The average overall technical efficiency measured under the operating approach reached the highest value compared to production and

intermediation approach. The average efficiency in BCC model indicated that the evaluated banks in the production of their outputs needed an average only 87.95% of the used inputs. The BCC model identified as efficient 19 banks, 16 of them operated under conditions of CRS and 3 under conditions of decreasing return to scale. Most of the banks operated under conditions of VRS. In whole sample 18 banks operated under conditions of decreasing return to scale and 16 banks operated under conditions of increasing return to scale. Average scale inefficiency of all banks reached value 2.81% and was the lowest one compared to production and intermediation approach. If operating approach was applied the DEA models also brought recommendations to the inputs and outputs for inefficient banks. For achieving overall technical efficiency of all banks in the sample was necessary to reduce the first input "interest and related expenses" in average by 15.45%, the second input "non-interest expenses" in average by 14.28% and the last input "personal costs" in average by 15.17%. Under the operating approach the efficiency was negatively influenced mainly by input "personal costs". In case of this input was average value of weight the lowest (0.2393; 0.2471), and number of cases when the weight was equal to zero was the highest (10; 9). The highest average value of weight had output "interest income" (0.6666; 0.6410) so we can say, that this variable had positive influence on efficiency. In case of this output was the number of cases when the weight was equal to one the highest (7; 9).

In case of "national" approach the average efficiency score were calculated form data of banks in selected region. In our analysis were determined four main "regions" by the world´s continents (America, Asia, Australia, and Europe). The results in case of "national" approach are in Table 3. As can be seen in the next table almost all of banks reported lower intermediation efficiency than the operating efficiency; the production efficiency was the lowest one. Under all approaches and applied models, levels of average efficiency in case of Australian and Asian banks were higher than the average in whole sample; on the other hand the average efficiencies in case of European and American banks were under the total averages. The Asian banks appeared as the most efficient in production approach under the assumption of CRS and VRS, and in intermediation and operating approaches under the assumption of VRS. These banks represented the smallest part (10 banks) in the sample of evaluated banks. In case of intermediation and operating approaches under the assumption of CRS were the most efficient Australian banks. On the other hand, the last place was mainly occupied, namely for five times, by American banks and once by European banks in case of intermediation approach under assumption of VRS. The explanation of generally lower efficiency of American and European banks can be found in a couple of factors. Above all, imprudent mortgage lending, non-performing loans of the past, lack of transparency and accountability in mortgage financing, shadow banking activities, failure of risk management systems, no systematic risk regulations and other reasons which led to the financial crisis in American and European financial markets.

Table 3 – Average efficiency in selected regions

	Number of DMUs	Average efficiency	Production approach		Intermediation approach		Operating approach	
			CCR model	BCC model	CCR model	CCR model	BCC model	CCR model
America	14	M	24,88%	33,72%	77,82%	89,35%	80,25%	85,00%
		AM	20,71%	26,51%	74,20%	90,57%	77,51%	85,19%
Australia	4	M	67,16%	76,19%	91,19%	92,24%	93,40%	93,52%
		AM	66,98%	76,03%	91,19%	92,29%	93,40%	93,52%
Asia	10	M	74,33%	91,89%	85,90%	97,35%	92,90%	94,56%
		AM	70,19%	93,01%	83,74%	97,81%	94,55%	95,77%
Europa	22	M	47,51%	51,44%	78,82%	86,12%	84,54%	85,81%
		AM	45,09%	49,44%	75,57%	85,59%	82,97%	84,20%
Total	50	M	48,11%	56,55%	80,94%	89,76%	85,72%	87,95%
		AM	47,51%	57,12%	78,04%	90,03%	85,28%	87,78%

Source: Author´s calculations

Considering CCR model the sized-adjusted average efficiency was in all regions lower than the simple average efficiency, which indicates that the smaller banks performed better than the bigger ones under the all applied approaches. Highest level of performance of smaller banks was seen in case of American banks, as evidenced by the greatest difference between size-adjusted CCR efficiency and "simple" CCR efficiency in all approaches.

The sized-adjusted average BCC efficiency surpassed the "simple" average BCC efficiency in case of Asian banks under all approaches, American and Australian banks under the intermediation and operating approaches. The positive value of the difference ($AM − M$) can be interpreted, that the big banks performed better than the smaller ones under the assumption of VRS. In European banks, as under the condition of CRS or VRS, the smaller banks represented better performers than the larger ones were.

Many empirical studies in the past have examined interaction between efficiency and other bank specific variables like total assets, profitability, rate of intermediation etc. Hence in this study the results from DEA analysis were regressed on various traditional indicators. The effects of bank size and performance on pure technical efficiency (PTE) were considered. This is because PTE account with variable returns to scale, which means that there is no requirement on banks to operate at optimal size. As we know in real economy requirement on banks to operate at optimal size is not possible due to imperfect competition, financial constraints, control steps and other factors. Bank size is measured by total assets and bank profitability by ratios return to assets (ROA), return to equity (ROE), cost to income (C/I) and capital to assets ratio (CAR). Rate of intermediation is measured by ratio of bank total loans to total deposits (L/D).

Pure technical efficiency should be positively related to bank size. Profitability measured by ROA and ROE was expected to have a positive relation to efficiency and profitability measured by C/I was expected to have a negative relation to PTE. Capital to assets ratio (CAR) is expected to have a positive sign, since it is assumed that banks are predicted to be rewarded with additional revenues for holding the optimal amount of capital. Loan to deposit ratio capture the credit creation by banks, therefore is expected to have a positive sign.

As it is necessary to prepare a logarithmic transformation of data, from the group of bank there were excluded those banks where value of some indicator were negative. Results of the regression are presented in Table 4.

Table 4 – Regression analysis – depended variable BCC efficiency

	Production approach	Intermediation approach	Operating approach
Intercept	-0,7135	-0,1254	0,5583
	(-0,8330)	(-0,3783)	(1,2032)
LOG(TA)	-0,0607	0,2669	0,0423
	(-0,3667)	(4,1636)**	(0,4717)
LOG(ROA)	0,4956	-6,3413	8,5145
	(0,0441)	(-1,4593)	(1,3996)
LOG(ROE)	-1,0162	6,1995	-8,4050
	(-0,0905)	(1,4272)	(-1,3821)
LOG(C/I)	-1,8450	-0,6306	-0,5297
	(-4,5623)**	(-4,0299)**	(-2,4178)*
LOG(CAR)	-1,0587	6,9926	-8,5234
	(-0,0949)	(1,6193)	(-1,4098)
LOG(L/D)	-0,1902	0,6148	-0,1127
	(-0,6292)	(5,2554)**	(-0,6881)
R Square	0,394128901	0,64203586	0,3043983
F statistics	4,11993527	11,3593142	2,7714938
Significance F	0,002786363	3,0511E-07	0,0246627

Source: Author´s calculations

Bank size measured by value of total assets had significant impact only in case of intermediation approach. In this case, the value of total assets was positively related to PTE. Under the production and operating approach, the value of total assets hadn't significant impact on PTE.

Bank profitability measured by ROA, ROE and CAR hadn't significant impact on PTE. Bank profitability measured by cost to income ratio was significantly related to pure technical efficiency in case of all approaches. The results of regression analysis confirmed assumption that this variable negatively influences on the value of PTE. Increasing value of cost per unit of income had a negative impact on the efficiency of banks, causing its decline.

The significant positive influence was found in case of variable loans to deposits ratio, but only under the intermediation approach. This confirmed assumption, that banks which were able to produce higher value of loans per one unit of deposits, better fulfil their role of intermediaries with the resulting increase their efficiency.

5. Conclusion

In this study, efficiency of top 50 world banks was investigated using DEA. The highest level of average overall efficiency (CCR model) was obtained in case of operating approach; so we can say that the banks were the most efficient in management of costs and revenues. On the other hand average pure technical efficiency (BCC model) was highest under the intermediation approach, indicating the highest economic viability of banks. The average efficiency under production approach was the lowest one, in both CCR and BCC model, which means, that the banks achieved the lowest cost efficiency.

In case of production approach, efficiency was negative influence mainly by input "personal costs" and the output "total loans" positive influenced on efficiency. Under intermediation approach the efficiency was negative influence by input "fixed assets"; positive by output "total loans". If the operating approach was applied the efficiency was negative affected by input "personal costs" and positive affected by output "interest income".

It was found that that as the international frontier was divided into national frontiers, the average efficiency scores decline in case of American and European banks; and increased in case of Asian and Australian banks. On the "national" level almost all of banks reported lower intermediation efficiency than the operating efficiency; the production efficiency was the lowest one.

Regression was used to identify factors that influence efficiency. From the group of variables of bank size, profitability and rate of intermediation, only in case of three variables were found significant impact. It was found that variables total assets and loan to deposit ratio were significantly positively related, and variable cost to income ratio was significantly negatively related to the pure technical efficiency.

References

[1] Banker, R.D., Charnes, A., Cooper, W.W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, 9: 1078–1092.

[2] Casu, B., Molyneux, P. (2003). A comparative study of efficiency in European banking. *Applied Economics*, 17: 1865-1876.

[3] Charnes, A., Cooper, W., Rhodes, E. (1978). Measuring the Efficiency of Decision-making Units. *European Journal of Operational Research*, 6: 429-444.

[4] Karimzadeh, M. (2012). Efficiency analysis by using Data Envelop Analysis model: evidence from Indian banks. *International Journal of Latest Trends in Finance and Economic Sciences*, 3: 228-237.

[5] Kočišová, K. (2013). An analysis of bank efficiency in the Slovak and the Czech Republic by data envelopment analysis. Paper presented at the International Conference QUAERE 2013, May 20 – 24, in Hradec Králové, Czech Republic. http://www.vedeckekonference.cz/library/proceedings/quaere_2013.pdf.

[6] Mostafa, M.M. (2009). Modeling the efficiency of top Arab banks: A DEA-neutral network approach. *Expert Systems with Applications*, 36: 309-320.

[7] Pastor, J.M., Pérez, F., Quesada, J. (1997). Efficiency analysis in banking firms: An international comparison. *European Journal of Operational Research*, 2: 395-407.

[8] Seiford, L.M., Zhu, J. (1999). Profitability and marketability of the top 55 US commercial banks. *Management science*, 9: 1270-1288.

[9] Sherman, D., Gold, F. (1985). Branch operating efficiency: Evaluation with data envelopment analysis. *Journal of Banking and Finance*, 9: 297-315.

[10] Stavárek, D. (2003). European Banking Efficiency: A Cross-Country Analysis of Transition and Developed Banking Sectors. Paper presented at the Fifth International Conference Aidea Giovani: Information, Markets and Firms, in Milano, Italy.

[11] Stavárek, D. (2004). Banking efficiency in Visegrad countries before joining the EU. *European Review of Economics and Finance*, 3: 129-167.

[12] Stavárek, D., Řepková, I. (2012). Measuring the efficiency in the Czech banking industry: a non-parametric approach. *Acta Universitatis Agriculturae et Silviculturae Mendelianea Brunensis*, 2: 357-366.

[13] Yilmaz, A.A., (2013). Bank efficiency analysis in Turkish banking system. Paper presented at the WEI International Academic Conference, in Antalya, Turkey. http://www.westeastinstitute.com/wp-content/uploads/2013/02/ANT13-260-Ayse-Altiok-Yilmaz-Full-Paper.pdf.

[14] Yue, P. (1992). Data Envelopment Analysis and Commercial Bank Performance: A Primer with Applications to Missouri Bank. Federal Reserve Bank of St. Louis, *Economic Review*, 74 (January/February): 31-45.

[15] Zijang, Y. (2006). A two-stage DEA model to evaluate the overall performance of Canadian life and health insurance companies. *Mathematical and computer modelling*, 7-8: 910-919.

FISCAL IMBALANCES AND CURRENT ACCOUNT ADJUSTMENTS IN THE EUROPEAN TRANSITION ECONOMIES

Rajmund MIRDALA
Faculty of Economics
Technical University of Košice, **Slovakia**
rajmund.mirdala@tuke.sk

Abstract
  Origins and implications of twin deficits occurrence in a large scale of countries seems to be a center of rigorous empirical as well as theoretical investigation for decades. The reality of persisting fiscal and current account deficits became obvious in many advanced as well as advancing, emerging and low-income countries seemingly without a direct association with the phase of business cycle or trends in key fundamental indicators. European transition economies experienced current account deficits during the most of the pre-crisis period. Despite generally improved economic environment and high rates of economic growth it seems that countries with weaker nominal anchor experienced periods of persisting fiscal imbalances during the most of the pre-crisis period. Crises period affected both fiscal stance of government budgets and current account pre-crisis levels and trends in all countries from the group. As a result, leading path of both indicators significantly changed.
  In the paper we analyze effects of fiscal policies on current accounts in the European transition economies. Our main objective is to investigate causal relationship between fiscal policy discretionary changes and associated current account adjustments. We identify large episodes of current account and fiscal policy changes to provide an in-depth insight into frequency as well as parallel occurrence of deteriorations (improvements) in current accounts and fiscal stance of government budgets. From employed VAR model we estimate responses of current accounts in each individual country to the cyclically adjusted primary balance shocks.

Keywords: fiscal imbalances, current account adjustments, economic crisis, vector autoregression, impulse-response function.

JEL Classification: C32, E62, F32, F41, H60

1. Introduction

  Origins and implications of twin deficits occurrence in a large scale of countries seem to be a center of rigorous empirical as well as theoretical investigation for decades. The reality of persisting fiscal and current account deficits became obvious in many advanced as well as advancing, emerging and low-income countries seemingly without a direct association with the phase of business cycle or trends in key fundamental indicators. However, flows of capital resulted from excessive external imbalances followed by the periods of large current account deficits obviously strengthened intention of policy makers as well as academics to investigate the contribution of internal and external sources of current account imbalances to associated foreign debt accumulation.

  European transition economies experienced periods of improved conditions for maintaining the overall macroeconomic stability during the last decade. Accelerated convergence toward western European countries associated with high real output growth rates implied increased intention to reduce excessive internal (fiscal deficit) and external imbalances (current account deficit) to maintain fast economic growth. Despite relatively high rates of growth in export performance, all countries from the group experienced current account deficits during the most of the pre-crisis period.

  Fast economic growth, EU membership as well as euro adoption perspectives strengthened appreciation pressures on nominal exchange rates in all European transition economies but countries with pegged exchange rate arrangements (Bulgaria, Estonia, Latvia and Lithuania) (Stavarek, 2012). At the same time, real exchange rates in all countries from the group appreciated steadily despite adopted exchange rate arrangement while having relatively low negative interference with their export performance (Mirdala, 2013b). As a result, exchange rate leading paths seem to have just negligible negative effects on the current account determination in the European transition economies during the last decade.

  Despite generally improved economic environment and high rates of economic growth, countries with weaker nominal anchor experienced periods of persisting fiscal imbalances during the

most of the pre-crisis period. As a result, sovereign debt accumulation in Czech republic, Hungary, Poland, Romania, Slovak republic and Slovenia resulted from persisting fiscal deficits. Contrary, in Bulgaria, Estonia, Latvia and Lithuania we have observed a significant improvement in the sovereign debt to GDP ratio followed by the periods of much more prudential fiscal discipline necessary to maintain a sustainability of tough exchange rate arrangement.

Crises period affected both fiscal stance of government budgets and current account pre-crisis levels and trends in all countries from the group. As a result, leading path of both indicators significantly changed. Negative implications of the economic and debt crisis revealed questions associated with disputable implications of fiscal incentives that seem to be contrary to the crucial need of the effective fiscal consolidation that is necessary to reduce excessive fiscal deficits and high sovereign debts. While the challenges addressed to the fiscal policy and its anti-cyclical potential rose steadily but not desperately since the beginning of the economic crisis, the call for fiscal consolidation became urgent almost immediately and this need significantly strengthen after the debt crisis contagion flooded Europe. Overall fiscal budgetary stance thus became determined by mutually contrary discretionary fiscal forces while remained affected by lagging recession. Economic crisis has also intensified redistributive effects (cross-country expenditure shifting) that provided quite diverse and thus spurious effects on current account adjustments. Immediately after the beginning of the crisis the current accounts temporary deteriorated (with quite differing intensity in each particular economy). However, we have soon observed a positive trend (either by improvement or stable outlook) in almost all countries reflecting intensified redistributive effects of the crisis on the cross-country expenditure shifting.

In the paper we analyze effects of fiscal policies on current accounts in the European transition economies. Our main objective is to investigate causal relationship between fiscal policy discretionary changes and associated current account adjustments. From employed VAR model we estimate responses of current accounts in each individual country to the cyclically adjusted primary balance shocks. To provide more rigorous insight into the problem of the current account adjustments according to discreet changes in fiscal policy associated with cyclically adjusted primary balance changes we estimate models for each particular country employing data for two subsequent periods 2000-2007 (pre-crisis period) and 2000-2012 (extended period). This approach should help us to examine specific features in the process of the current account determination according to the different overall macroeconomic conditions. We suggest that a comparison of the results for models with different time period is crucial to understand redistributive effects of the economic crisis in the view of changes in the cyclically adjusted primary balance determination capabilities in the group of ten countries from the past Eastern block.

Following the introduction, we provide brief overview of theoretical concepts referring to the relationship between fiscal policy changes and current account adjustments in Section 2. In Section 3 we provide an overview of the current empirical evidence about current account adjustments and fiscal policy stance. While the area of our research seems to be well documented in current empirical literature it seems that causal relationship between fiscal policy changes and associated current account adjustments are unclear or even puzzled. In Section 4 we observe main trends in fiscal imbalances and current account adjustments in the European transition economies and highlight some simplified stylized facts about investigated causal relationship. At the beginning of the Section 5 we summarize key methodological remarks to episodes of large current account and fiscal policy changes. Subsequent analysis of large current account and fiscal policy episodes provides an in-depth insight into frequency as well as parallel occurrence of deteriorations (improvements) in current accounts and fiscal stance of government budgets. In Section 6 we provide a brief overview of the VAR model (recursive Cholesky decomposition is employed to identify structural shocks) we employ to investigate responses of the current account to negative one standard deviation cyclically adjusted primary balance shocks. In Section 7 we discuss main results.

2. Current account determination. Intertemporal approach

While empirical evidence on twin deficits in countries considering macroeconomic performance and different stages of business cycle seems to be limited, economic theory provides a robust background on the current account and fiscal stance determination revealing their causal relationship.

In models of closed economy macroeconomics total output is expressed by the following equation:

$$Y = C + I + G \tag{2.1}$$

This general expenditure side approach to the total output in closed economy has several crucial implications. One of them is a concept of domestic savings (S) represented by the portion of the overall output (Y) that is spent neither by households (C) nor government (G):

$$S = Y - C - G \tag{2.2}$$

In closed economy overall savings are equal to overall investments (I) as a key general equilibrium assumption:

$$S = I \tag{2.3}$$

As it seems, it is possible to increase a total wealth of the economy only by internal accumulation of new capital.

However, in opened economy it is necessary to highlight mutual interconnections between domestic economy and rest of the world. Thus, equation (2.1) has to be rewritten to include a portion of total output exported abroad (X) as well as a portion of domestic income spent on imported goods (V) following way:

$$Y = C + I + G + (X - V) = C + I + G + CuA \tag{2.4}$$

In common literature net export $(X - V)$ is substituted by current account (CuA) that we can express from the equation (2.4) as follows:

$$CuA = Y - (C + I + G) = Y - A \tag{2.5}$$

As we can see, current account is determined by total output as well as domestic absorption $(A = C + I + G)$. Current account surplus $(CuA > 0)$ thus represents a surplus of total income over total expenditures, while current account deficit $(CuA < 0)$ represents a surplus of total expenditures over total income.

As mentioned above, while in closed economy total savings are equal to total investments, in opened economy this assumption does not seem to be necessarily true provided that we may consider different interactions among savings, investments and current account. It seems that country may increase overall savings through the current account surpluses while current account deficits tend to decrease overall savings.

For the opened economy it is necessary to rewrite equation (2.3):

$$S = I + CuA \tag{2.6}$$

We may conclude that the only source of capital for domestic investments in closed economy is represented by domestic savings while opened economy may accumulate domestic capital base as well as improve its international investment position due to foreign capital inflows associated with the current account deficit. As a result, domestic economy may increase investments without adequate increase in savings. It is an example of so called intertemporal trade when country with the current account deficit increases its consumption today at a cost of sacrificed (smaller) consumption in the future. Equation (2.6) thus may be rewritten to the following expression:

$$CuA = S - I \tag{2.7}$$

If domestic savings exceed domestic investments then excessive savings are exported abroad. Domestic savings are now equal to domestic investments increased by net foreign investments $(S = I + I_F)$. Positive net foreign investments will be associated with the current account surplus. Similarly, if domestic investments exceed domestic savings then sources of domestic investments have to be acquired from abroad (foreign savings). Negative net foreign investments are now associated with the current account deficit.

Until now we have assumed that budget of a government is balanced and we did not differentiate savings of private and public entities. Private savings represent a portion of disposal income that is not spent on current consumption but is saved to be used on purchases in the future. Equation (2.2) we can now rewrite as follows:

$$S_P = Y - T - C \tag{2.8}$$

where *T* represents overall tax revenues. Savings of a government are calculated as net overall tax revenues less government expenditures.

$$S_G = T - G \tag{2.9}$$

Relationship between savings and investments can be now expressed the way that reflects opened economy conditions as well as differentiation of total savings in economy on private and public:

$$S_P = I + CuA - S_G = I + CuA + (G - T) \tag{2.10}$$

Following equation (2.10) it seems that private investments are equal to the sum of total domestic investments, current account balance and fiscal policy stance (represented by government budget balance). Fiscal deficit thus reflects negative government savings and is a measure of public borrowings requirements necessary to cover public expenditures.

Equation (2.10) can be rearranged as follows:

$$CuA = (S_P - I) - (G - T) \text{ or } (X - M) = (S_P - I) - (G - T) \tag{2.11}$$

Equation (2.11) reveals final formula of the current account determination in opened economy considering an intertemporal approach. Balance of a current account is equal to the sum of net investments of the private sector (excess of private savings over private investments) and government budget balance (surplus or deficit). Following this finding it implies that country with the current account deficit either suffers from lack of domestic savings to cover its investments and/or has fiscal deficit. As a result, it is suggested for governments willing to reduce current account deficit to keep in mind that such an effort may be really difficult without a reduction of fiscal deficit at the same time.

3. Overview of the literature

Bussiere, Fratzscher and Muller (2004) analyzed the current account determination in 33 countries employing an intertemporal approach via regression analysis considering effects of fiscal stance of government as well as real exchange rate deviations. Authors suggest that current account balances of countries included in the model are close to their structural current account positions confirming a validity of the intertemporal approach. Abbas, Bouhga-Hagbe, Fatás, Mauro and Velloro (2011) examined relationship between fiscal policy and current account on a large sample of advanced and emerging economies using a variety of statistical methods: panel regressions, an analysis of large fiscal and external adjustments, and VAR. Authors suggest that a strengthening in the fiscal balance by 1 percentage point of GDP is associated with a current account improvement of 0.3-0.4 percentage

point of GDP. The evidence is stronger especially in emerging and low-income countries, when the exchange rate is flexible, when the economies are more open, when output is above potential or initial debt levels are above 90 percent of GDP. Javid, Javid and Arif (2010) investigates the effects of fiscal policy or government budget deficit shocks on the current account and the other macroeconomic variable for Pakistan over the period 1960-2009 by employing SVAR model. Authors suggest that expansionary fiscal policy shock improves the current account and depreciates the exchange rate. The rise in private saving and the fall in investment contribute to the current account improvement while the exchange rate depreciates. Schnabl and Wollmershäuser (2012) the role of diverging fiscal policy stances on current account (im-)balances in Europe since the early 1970s under alternative institutional monetary arrangements by employing pooled panel regressions. Authors concludes that divergent fiscal policy stances are an important determinant of intra-European current account imbalances both before and after euro introduction Authors highlight that after the year 2001 there is evidence that current account imbalances have been encouraged by an expansionary ECB monetary policy stance. Fidrmuc (2002) defined twin deficits as a cointegrating relationship between the current account, the fiscal balance and investment. Author investigated that both current accounts and fiscal balances have been displaying a significant degree of hysteresis. His paper shows that while twin deficits emerged in the 1980s there seems to be a lack of evidence for twin deficits in the 1990s. On the sample of OECD countries as well as emerging economies with data between 1970 and 2001 author revealed that the countries which pursue sustainable fiscal policies also display a high flexibility of the current account.

4. Overview of main trends in fiscal and current account imbalances

During the first decade since the initiation of the transition process at the beginning of the 1990s European transition economies experienced periods of excessive current account deficits. In line with intertemporal approach it is clear that current account deficits reflect a negative trend in investment-saving ratio. While current account adjustments reveal crucial and generally expected implications of the continuously rising international economic and financial integration of European transition economies (increased indebtedness, lacking competitiveness, fiscal imbalances, foreign capital inflows, etc.), there seems to be still enough room to investigate partial effects of dynamic changes in key current account determinants to observe associated current account adjustments.

Figure 1 provides a brief overview of main trends in the current account and private, public as well as overall investment-savings balances in the European transition economies.
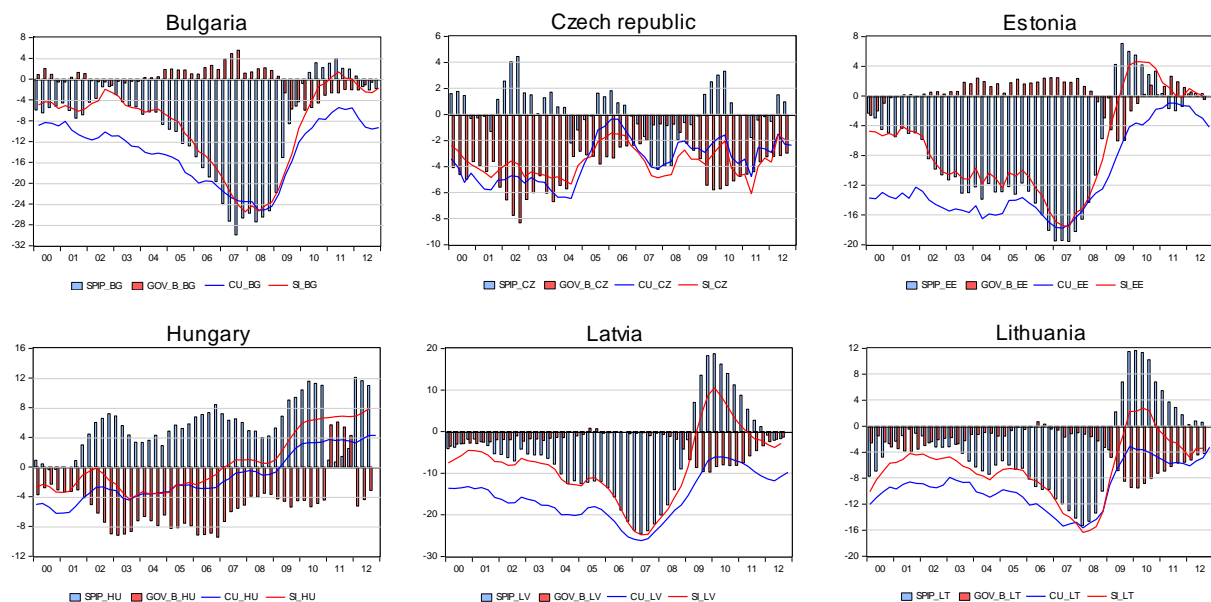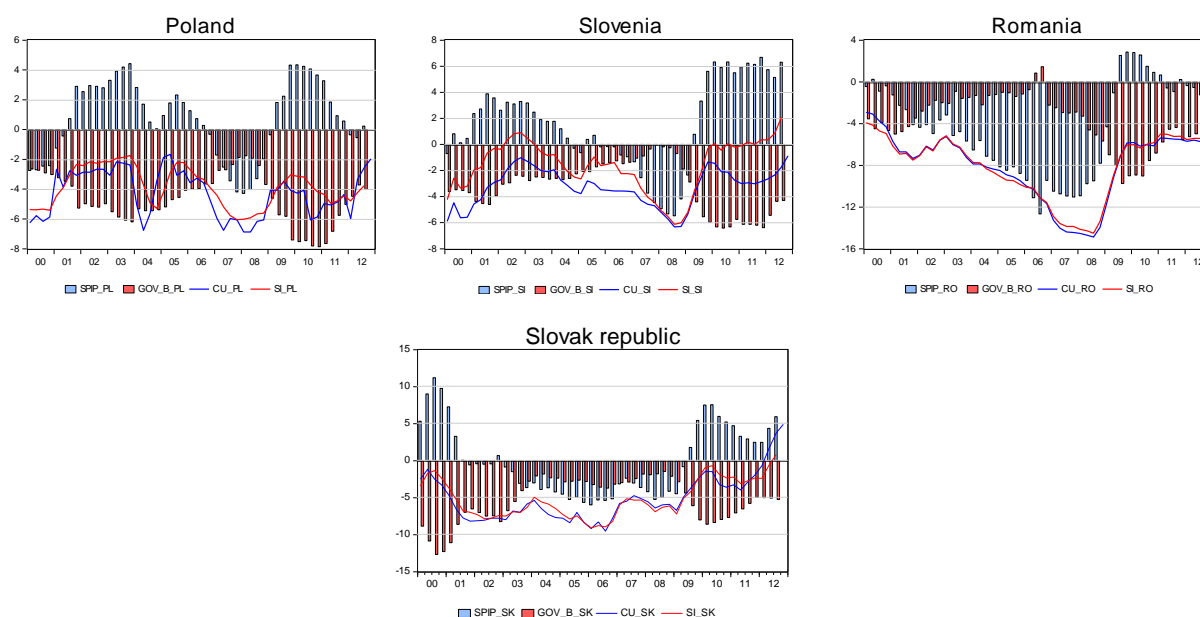
Figure 1. Overview of current account and private, public and overall net savings-investments positions
(2000Q1-2012Q4)

Note: Endogenous variables: Private savings less private investments (SPIP), primary balance (GOV_B), current
account (CU) and overall savings less investments are expressed as percentage share in GDP.
Source: Compiled by author based on data taken from IMF - International Financial Statistics (September 2013).

Intertemporal approach clearly implies that current account imbalances should be originated in corresponding savings-investments gap. Despite some differences, we have observed quite similar trend in the leading paths of current accounts and savings-investments gaps in all countries from the group. However, expenditure shifting effects associated with current account imbalances in each individual country do not seem to be determined solely by internal balance between savings and investments. It seems that countries with rigid exchange rate arrangements (Bulgaria, Estonia, Latvia and Lithuania - the group of so-called "peggers") experienced periods with generally higher discrepancies in GDP shares of both indicators though the leading paths of both indicators seem to be quite similar revealing common trends. However, the beginning of the crisis period (2008-2009) clearly reduced differences in shares. We suggest that an absence of the exchange rate flexibility and real exchange rate appreciation contributed to the overall competitiveness deterioration and thus accelerated a negative trend in the current account imbalances even more than we would expect from the savings-investments gap.

Prudential fiscal discipline and excessive current account deficits in countries with rigid exchange rate arrangements (this negative trend accelerated in the second half of the pre-crisis period) revealed significant imbalances between private savings and private investments. As a result, fiscal discipline tightening together with exchange rate based anchoring provided a convenient vehicle for spreading internal imbalances across the borders causing high current account deficits. In countries with flexible exchange rate arrangements (Czech republic, Hungary[2], Poland, Slovenia and Slovak republic - the group of so called "floaters") the situation during the pre-crisis period seems to be quite different though not uniform. In the Czech republic, Hungary, Poland and Slovenia persisting negative savings-investments imbalances originated in excessive fiscal deficits. In Romania the situation changed over time. While at the beginning the negative trend in the savings-investments GDP shares originated in fiscal imbalances, it was soon replaced by private sector expansion. Similar scenario, though with higher initial fiscal deficits and less imbalanced growth of private sector, we have observed in the Slovak republic.

Crisis period significantly changed not only current account and savings-investments gap leading paths but also relative contributions of public and private sector to both internal and external

---

[2] Hungarian forint operated during pre-crisis period in de facto fixed peg regime, but due to substantial range for fluctuations provided by wide horizontal bands it was included in the group of countries, so called "floaters".

imbalances. Even countries with prudential pre-crisis fiscal policies could not avoid a trend of significant divergence in public (deterioration) and private (large improvement) savings-investments gap associated with significant improvement in the current account stance and overall savings-investments to GDP ratio.

Figure 2 provides a brief overview of main trends in fiscal and current account imbalances in the European transition economies. The problems of persisting fiscal imbalances (fiscal deficits) seem to be much more frequent in countries with weak nominal anchor that is why Baltic countries and Bulgaria experienced much "healthier" fiscal stance of the general government.

Figure 2. Overview of fiscal and current account imbalances (2000Q1-2012Q4)

Note: Endogenous variables: Primary balance (GOV_B), cyclically adjusted primary balance[3] - CAPB (GOV_B_CA) and current account (CU) are expressed as percentage share in GDP.

Source: Compiled by author based on data taken from IMF - International Financial Statistics (September 2013).

Individual countries experienced current account deficits during the most of the period of intensified convergence (since the beginning of 2000s) toward western European countries. It seems that countries with tightly managed exchange rates (Bulgaria, Slovenia and Baltic countries) and weak overall macroeconomic performance (Romania and Bulgaria) experienced excessive current account deficits with generally negative outlook during the most of the pre-crisis period. While at the beginning of the crisis period current accounts in all countries from the group generally improved, CAPB initially deteriorated as an immediate response to the crises effects followed by subsequent improvements initiated by increased consolidation efforts of governments to prevent excessive sovereign debt accumulation.

Figure 3 reveals relationship (simple linear regression) between fiscal and current account imbalances in the European transition economies during a pre-crisis period. We have observed a positive correlation during the pre-crisis period between both indicators in all countries from the group. Despite a relative diversity in associated multipliers it seems that deterioration in CAPBs caused an increase in current accounts.

---

[3] Cyclically adjusted primary balance (CAPB) was employed as a more convenient proxy for a fiscal policy stance in comparison to a net budgetary position due to its neutrality against cyclical effects on revenue and expenditure sides of government budget. At the same time, CAPB is more appropriate indicator of discrete changes in the fiscal policy and associated effects on the government budget.
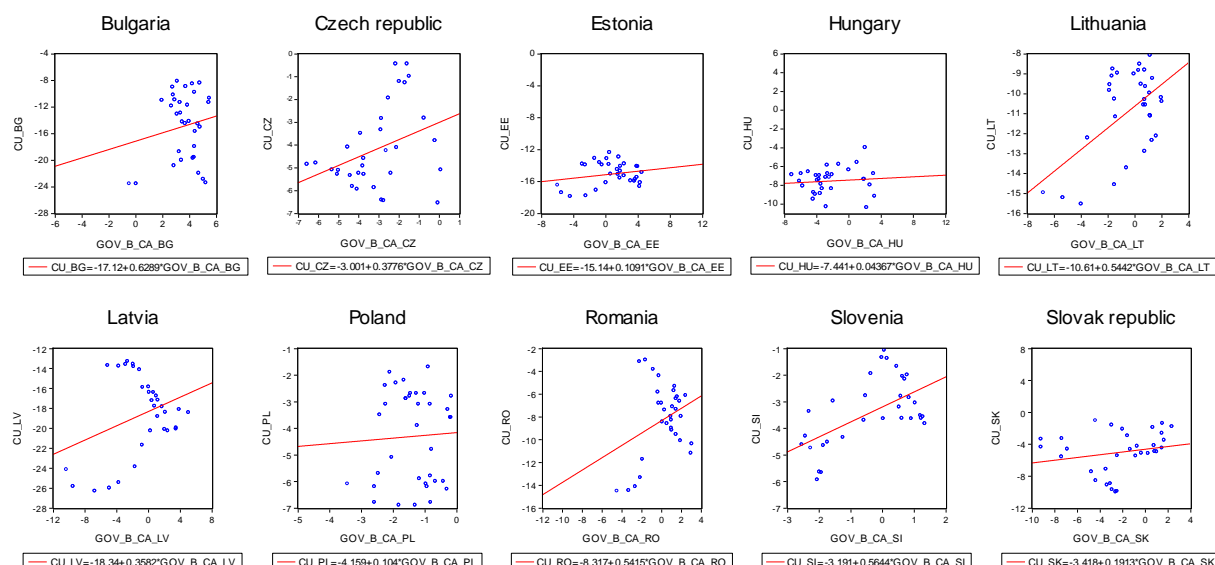
Figure 3. Fiscal imbalances and current account dynamics (2000Q1-2007Q4)

Note: Endogenous variables: Cyclically adjusted primary balance - CAPB (GOV_B_CA) and current account
  (CU) are expressed as percentage share in GDP.
Source: Compiled by author based on data taken from IMF - International Financial Statistics (September 2013).

However, while a correlation analysis between CAPBs and current accounts revealed positive relationship in all countries, a comparison of results with simple regression analysis investigating a relationship between primary balance and current account provides interesting implications of business cycle changes during the pre-crisis period. Following mixed results of investigated relationship between primary balances and current accounts (associated coefficients for primary balance were generally lower and even negative in some countries) we suggest that cyclical effects on primary balances reduced an intensity of fiscal interferences and their transmission on external imbalances.

Results of simple regression doesn't seem to provide clear results considering the size of the country, its openness, the size of the government as well as the fiscal stance during the pre-crisis period.
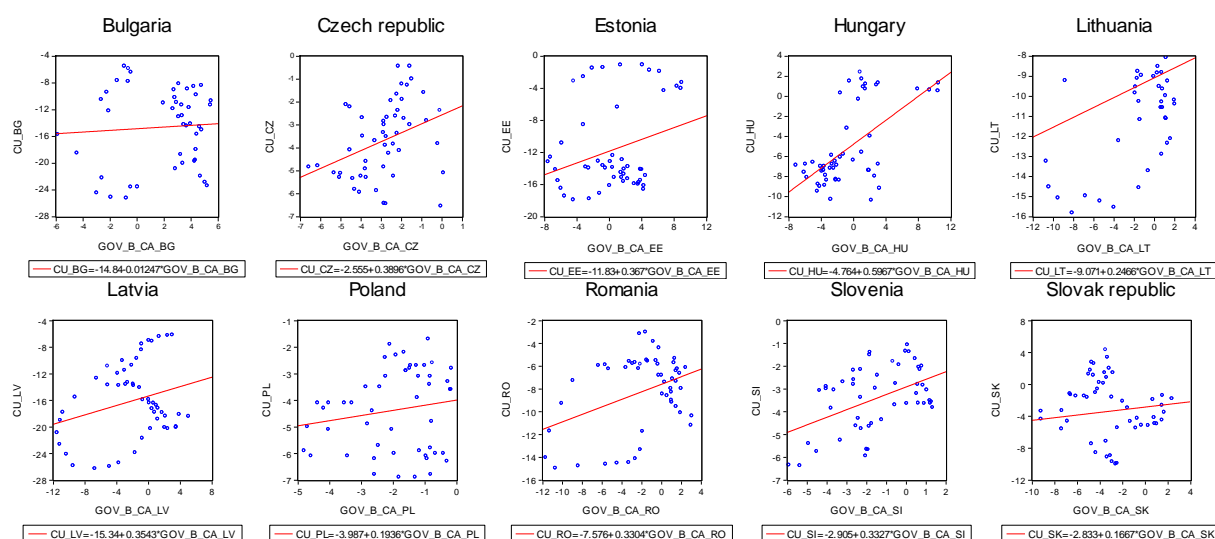

Figure 4. Fiscal imbalances and current account dynamics (2000Q1-2012Q4)

Note: Endogenous variables: Cyclically adjusted primary balance - CAPB (GOV_B_CA) and current account
  (CU) are expressed as percentage share in GDP.
Source: Compiled by author based on data taken from IMF - International Financial Statistics (September 2013).

Figure 4 provides an overview of mutual relationship between fiscal and current account imbalances in the European transition economies during an extended period. It seems that correlation between both indicators has changed as a result of crisis related effects.

In Bulgaria, Lithuania, Latvia, Romania, Slovenia, Slovak republic we have observed lower positive correlation between CAPBs and current accounts. Despite general improvement in the leading path of both indicators we suggest that crisis period accelerated mutually contrary expenditure shifting effects. As a result, direct channels of expenditure based causal relationship between CAPB and current account may seem to be reduced, though still significant. However, more rigorous investigation of changes in CAPB and their contribution to current account adjustments in the European transition economies is provided in Sections 5 and 7. Rest of the countries (Czech republic, Estonia, Hungary, Poland) experienced intensified convergence of both indicators resulting in higher correlations of their leading paths.

An overview of main trends in internal and external imbalances in the European transition economies revealed some stylized facts about relative contributions of public and private sectors to the leading path of savings-investment gaps and current accounts. Despite an observation of some crucial patterns in mutual relationships between both indicators it seems that a relative importance of substantial characteristics of each individual country (size of economy, overall openness, performance, exchange rate arrangement etc.) in determining sources and key implications of both internal and external imbalances requires more rigorous investigation.

5. Large changes in fiscal policy and external balances (event study)

5.1. Methodological notes to large changes in CAPB and current account

Observation of periods associated with large changes in CAPB and current account requires some introduction to the methodology that will be employed. Changes in the CAPB as well as the current account are usually addressed to the adjustments on one of the sides determining their overall status (or dynamics) or both at the same time. The status of the government budget is determined by the set of fiscal arrangements on the side of revenues and/or expenditures followed by an improvement or deterioration in the fiscal stance. The status of the current account is determined by the competitiveness effects associated with expenditure cross-country shifting via export (inflows) and/or import (outflows) dynamics.

There seems to be several approaches to measure large fiscal changes and to evaluate effects of fiscal episodes. For example, Alesina and Ardagna (2009) identify three types of fiscal adjustment episodes to analyze episodes of fiscal consolidation. For the purpose of our study we employ this methodology revised by Abbas, Bouhga-Hagbe, Fatás, Mauro and Velloso (2011) who investigated episodes of large fiscal and current account changes. However, we slightly adjusted key measures to suit better for our sample of countries. As a first it is necessary to emphasize that we focus on large and continuous changes in fiscal stances and the current accounts. Durability of adjustments is thus crucial to avoid misleading effects of short-term volatility. At the same time, there are no sharp reversal movements[4] in the main trend allowed during identified episodes of large changes to presume a continuity of fiscal or current account adjustments. We suggest that large and continuous changes in both indicators may provide some insight into empirical validity of the intertemporal approach.

Extracted episode of large fiscal stance and current account changes will be identified by to following measure: (1) Continuous cumulative improvement (deterioration) in CAPB or current account by at least 2 percent of GDP share. (2) Improvement (deterioration) of real output by at least 1.5 percent on annual base within identified episode of large CAPB or current account adjustment. However, we have observed relatively low interconnection between rates of real output growth and CAPB and current account dynamics that is why we identify episodes of large changes in CAPB and current account with and without real output growth rates interference separately. We also investigate large changes in overall savings-investments gap to GDP ratio as well as private savings-investments gap to GDP ratio following measure (1) to observe more detailed mechanism of intertemporal approach in the European transition economies during the crisis and pre-crisis period.

---

[4] However, small reversals are allowed (up to 20 percent in reverse direction again the main trend) to preserve a substantial quantity of identified periods. In original study from Abbas, Bouhga-Hagbe, Fatás, Mauro and Velloso (2011) no reversals in the trend are allowed at all.

5.2. Cyclically adjusted primary balance

To assess detailed overview of large fiscal policy changes and their effects, it is necessary to estimate an influence of fiscal adjustments based on tax and/or expenditures changes on fiscal balance. However, it seems to be necessary to reveal changes on revenues and expenditures sides of government balance associated with automatic effects induced by changes in macroeconomic environment and effects of discretionary fiscal policy actions. In first case, i.e. a cool-down of real output growth may be followed by a cut in government revenues (due to reduced tax capacity of an economy in the time of crisis) and an increase in government expenditures (i.e. due higher unemployment benefits). As a result, deterioration of a fiscal balance will occur. At the same time, similar effects on the fiscal balance will be followed by discretionary taxes cuts or expenditures increases. Fiscal stance of a government budget may thus reflect mixed effects of automatic changes in budgetary revenues and expenditures associated with business cycle fluctuations as well as discretionary changes on both sides of government budgets associated with discretionary fiscal policy actions.

To eliminate effects of a business cycle to the fiscal stance of a government budget it is necessary to eliminate influence of cyclical movements of fiscal variables. As a result of filtered business cycle impacts, together with some other adjustments (i.e. exclusion of interest payable on the side of government expenditures), cyclically adjusted primary balance (CAPB) will be calculated. Empirical literature provides many approaches to calculate CAPB. In general, main algorithm follows the same procedure: (1) estimation of the potential GDP, (2) determination and calculation of key revenues and expenditures categories responses to the fluctuations in cyclical GDP, (3) adjustments in budgetary revenues and expenditures according to the cyclical effects in both sides of government budget. As a result we obtain cyclically adjusted structural or primary balance. On the other hand we have found some differences in step (2) in current empirical literature reflecting relative diversity in approaches employed to estimate income elasticities of main budgetary variables (on both revenue and expenditure sides). At the same time, most studies calculated cyclical component in real output by estimating potential output (and output gap) using simple HP filter[5] or potential employment based on detrending NAIRU calculations.

Bouthevillain *et al.* (2001) calculated fiscal elasticities using econometric regressions or derivation from tax or expenditures laws and from detailed information on the distribution of income and revenue. Altăr, Necula and Bobeica (2010) estimated tax and revenues elasticities by applying methodology similar to that employed by OECD and by the European Commission. Authors decomposed main components of revenue and expenditure budgetary sides using linear system of equations. Girouard and André (2005) calculated income elasticities of four different types of taxes while on the expenditure side there is only single item - unemployment related transfers - that authors treated as cyclically sensitive.

Günaydın and Uğraş Ülkü (2002) employed vector-error correction (VEC) model to estimate income elasticities of budgetary components. Provided there is a long-run equilibrium (cointegration) between GDP and budgetary variables, expected elasticity coefficients are represented by normalized cointegrating coefficient derived from cointegrating equations.

To cyclically adjust a government budget, that is to estimate the underlying fiscal position when cyclical and/or automatic components are removed we follow a VEC methodology implemented by Günaydın and Uğraş Ülkü (2002).

Cyclically Adjusted Primary Balance (CAPB) is calculated by subtracting the cyclical component $\left(B^C\right)$ from the primary government balance $\left(PB\right)$:

$$CAPB_t = PB_t - B_t^C = PB_t - \sum_{i=1}^{n} B_{t,i}^C \tag{5.1}$$

where $\left(PB\right)$ represents actual government budget balance $\left(B\right)$ less interests payable $\left(E^I\right)$:

---

[5] Despite a wide criticism of Hodrick-Prescott (HP) filter for inducing a spurious cycle in the time series (i.e. it cannot reflect an impact of structural breaks) as well as for poor approximation near the endpoint (so called endpoint bias), it still represents one of most frequently used filter in the current empirical literature.

$$PB_t = B_t - E^I \tag{5.2}$$

and $\left(B_{t,i}^C\right)$ represents a cyclical component of each of n revenue and expenditure budgetary categories included in the model given by the following equation:

$$B_{t,i}^C = B_{t,i} \cdot e_i \cdot Y_t^{gap} \tag{5.3}$$

where $\left(e_i\right)$ represent individual elasticities of each particular budget category (that responds automatically to real output fluctuations) included in the model and $\left(Y^{gap}\right)$ represents output gap expressed as a percentage of GDP.

5.3. **Income elasticities of budgetary categories**

In our model we include three types of budget revenues (revenues from direct taxes, indirect taxes and social contributions) and one budget expenditure category (unemployment related transfers) that seem to respond to short-run (cyclical) movements in real output. As a result, we expect that selected fiscal variables automatically respond to the cyclical fluctuations in real output.

To estimate income elasticities of budgetary categories we expect that there is a long-run equilibrium relationship (cointegration) between each included fiscal variable and real output. Cointegration methodology introduced by Johansen (1988, 1991) and Johansen and Juselius (1990) will be employed to estimate the long-rum equilibrium relationships between different types of budgetary variables and real output in the European transition economies. Johansen method is applied to the unrestricted vector autoregression (VAR) model that can be written by the following moving average representation of n non-stationary variables containing p lagged values:

$$Y_t = \mu + A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + \varepsilon_t \tag{5.4}$$

where Y_t is a $n\, x\, 1$ vector of the contemporaneous endogenous variables, μ is a $n\, x\, 1$ vector of the constants, A_i are $n\, x\, n$ polynomial variance-covariance matrix, $\varepsilon_t \,\square\, N_n\left(0, \Sigma_\varepsilon\right)$ is a $n\, x\, 1$ normalized vector of exogenous shocks (innovations) to the model representing unexplained changes in the variables.

If at least two of the variables are cointegrated of the order one (I(1)) the VAR representation in the equation (5.4) can be rewritten by subtracting Y_{t-1} to the following vector error correction model (VECM):

$$\Delta Y_t = \mu + \Pi Y_{t-p} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \tag{5.5}$$

where ΔY_t is a $n\, x\, 1$ vector of the first differences of stochastic variables Y_t, $\Pi = \sum_{i=1}^{p} A_i - I$,

$\Gamma_i = -\sum_{j=i+1}^{p} A_j$, I is $n\, x\, n$ identity matrix.

Presented VECM contains information on both short-term and long-term adjustments to changes in Y_t included in estimated Γ and Π respectively. Γ is a $n\, x\, n$ matrix that represents the short-term dynamic - adjustments to changes in Y_t. Π is a $n\, x\, n$ matrix consisting of the long-run coefficients - the cointegrating relationships (cointegrating vectors) and of the error correction term. Π can be decomposed as follows:

$$\Pi = \alpha\beta^{'} \tag{5.6}$$

where α represents $n \times r$ a loading matrix containing coefficients that describe the contribution of the r long-term (cointegrating) relationships in the individual equations and denotes the speed of adjustment from disequilibrium, while β is a $n \times r$ matrix of long-run coefficients and represents the r linearly independent cointegrating vectors (each column of β is the cointegrating vector). The number of cointegrating relations among variables of Y_t is the same as the rank (r) for the matrix Π. If it has a full rank, the rank $r = n$ and it means there are n cointegrating relationships and that all variables are I(0). If a vector Y_t is a vector of endogenous variables that are I(1), then all terms in equation (5.5) are I(0), and ΠY_{t-1} must be also stationary for $\varepsilon_n \Box I(0)$ to be white noise. If the matrix Π has reduced rank, $r < n$, there are $n-1$ cointegrating vectors and even if all endogenous variables in the model are I(1), the level-based long-run component would be stationary. VECM requires that there exists at least one cointegrating relationship.

In order to find a presence of cointegrating (long-run) relationships, we use trace test and maximum eigenvalue test. Determination of rank and estimation of the coefficients are computed as maximum likelihood estimation. The corresponding likelihood-ratio test statistics are:

$$\lambda_{trace}(r) = -T \sum_{i-r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right) \quad \lambda_{\max}(r, r+1) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right) \tag{5.7}$$

where r is the number of cointegrating vectors under the null hypothesis and $\hat{\lambda}$ is the estimated value for the *ith* ordered eigenvalue from the Π matrix. Under the trace statistic, the null hypothesis that the number of cointegrating vectors is less than or equal to r, is tested against the alternative that there are more than r vectors. Whereas under the maximum eigenvalue test the null hypothesis that there are r cointegrating vectors is tested against the alternative of $r+1$ cointegrating vectors.

Provided that time series for direct tax revenues, indirect tax revenues, social contributions, unemployment related transfers and real output are I(1)[6] we estimate four different VEC models employing quarterly data for the period 2000Q1-2012Q4 (52 observations) for government expenditures, real output, inflation, tax revenues and short-term interest rates drawn from IMF database (International Financial Statistics, September 2013). Time series for direct tax revenues, indirect tax revenues, social contributions, unemployment related transfers and real output were seasonally adjusted. Tests for the cointegration were computed using two lags as recommended by the AIC (Akaike Information Criterion).

Results of both Johansen cointegration procedures (trace statistics and maximum eigenvalue statistics) confirmed our hypothesis about existence of one long-run equilibrium (cointegrating) relationship between each fiscal variable and real output. Normalized cointegrating coefficients derived from each cointegrating equation represent elasticity coefficients of each fiscal category with respect to real output.

5.4. Episodes of large current account and fiscal changes

In this section we analyze occurrence as well as substantial features of episodes containing large current account and fiscal changes in the European transition economies since 2000. Substantial changes in current accounts and CAPBs will be identified according to associated trends in the real output to observe possible interferences with the performance of the countries. At the same time we identify large changes in private savings-investments gap to GDP ratio and overall savings-investments gap to GDP ratio[7] and indicate possible causalities and implications according to an intertemporal approach.

---

[6] Detail results of unit root test are not reported here to save space. Like any other results, they are available upon request from the author.

[7] Rule for identification of large changes in the private savings-investments gap to GDP ratio and the overall savings-investments gap to GDP ratio follows just condition (1) from the section 5.1 for a proposed identification scheme. Otherwise we identified much lower occurrence of both episodes.
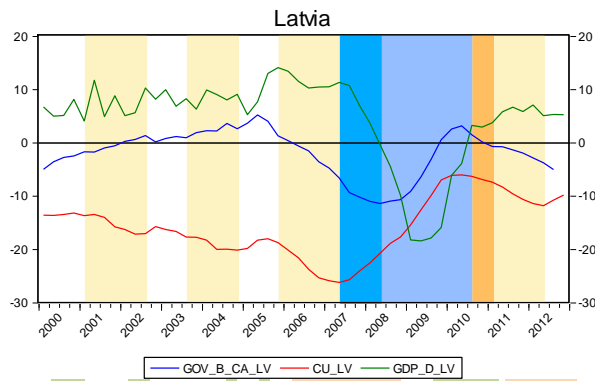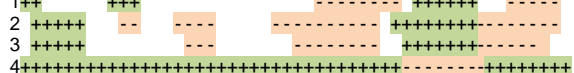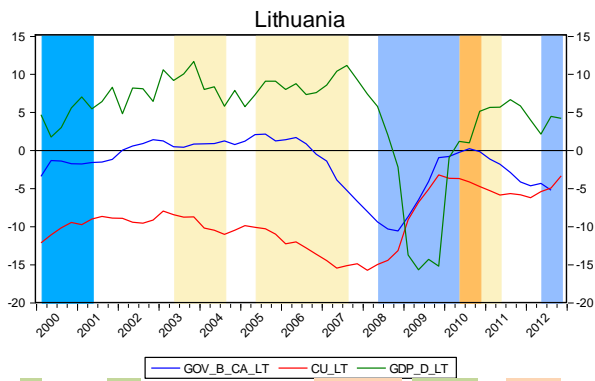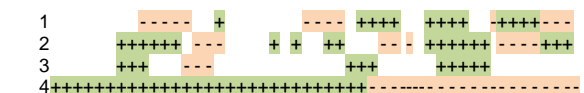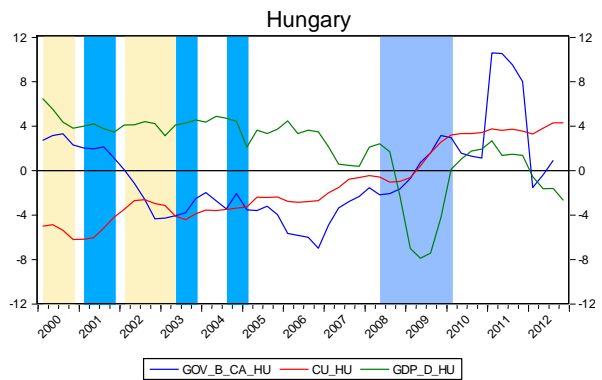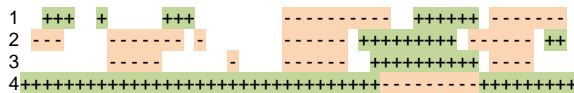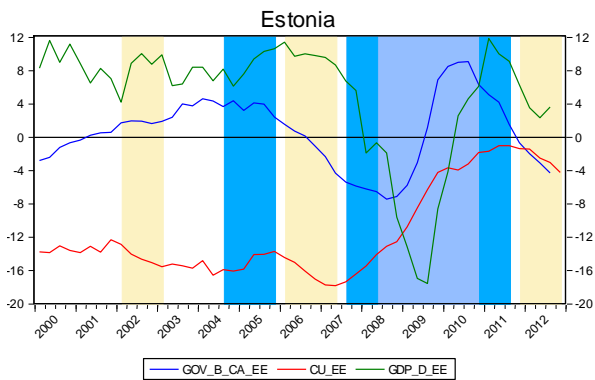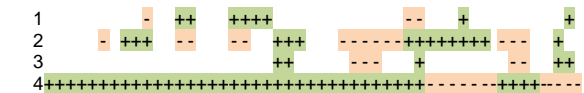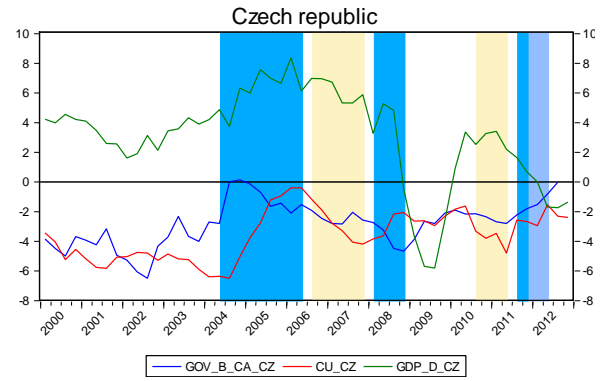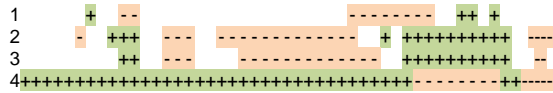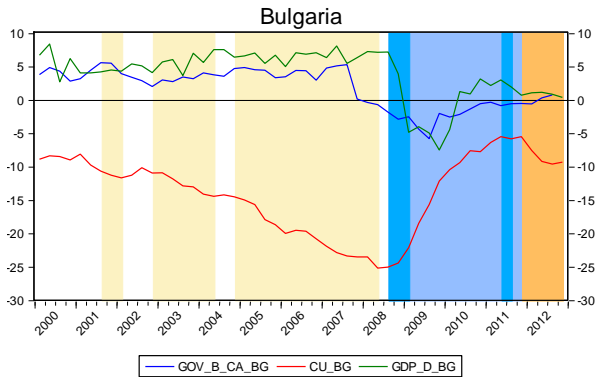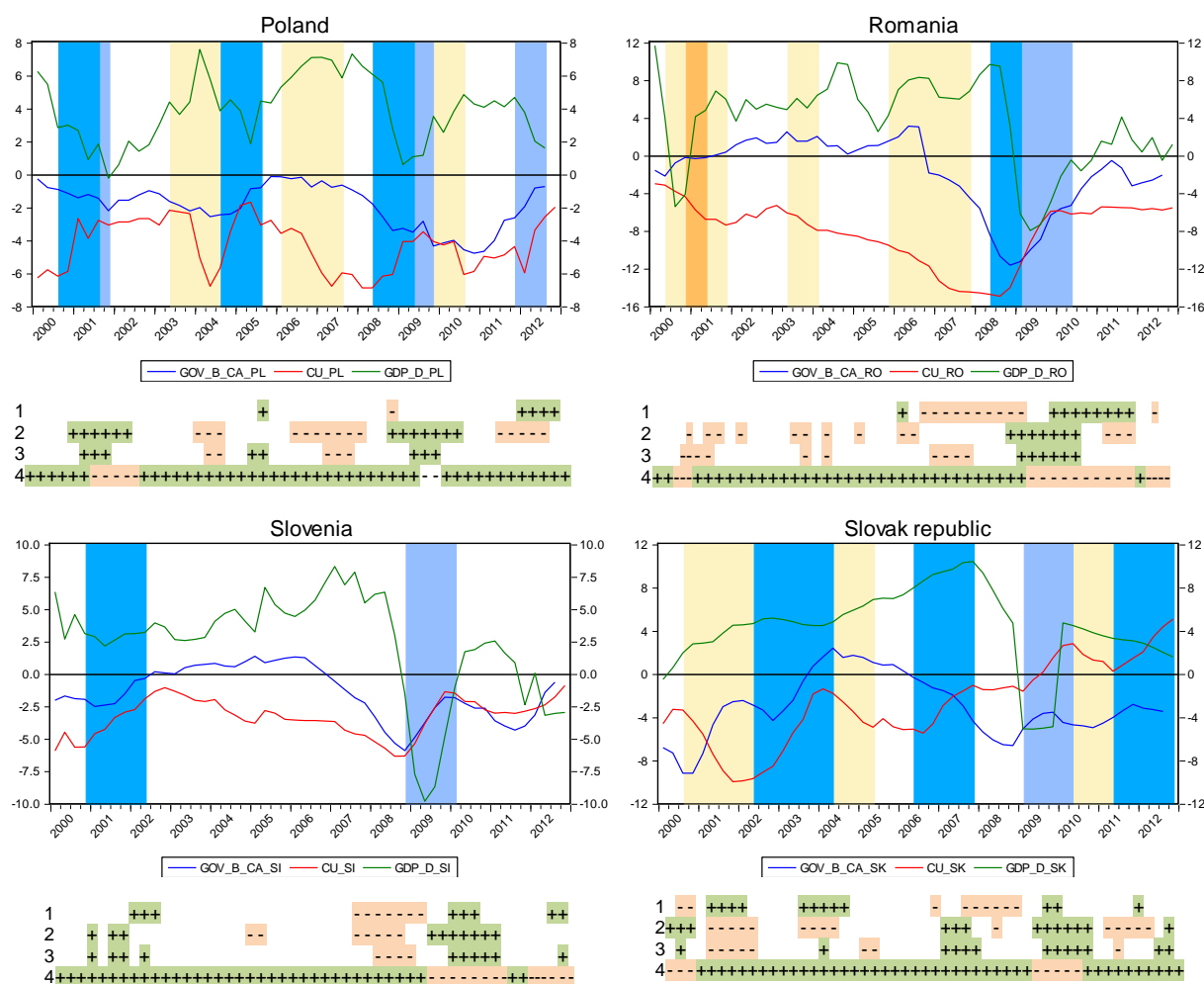
Figure 5. Episodes of large current account changes (2000Q1-2012Q4)

Note: Variables - cyclically adjusted primary balance - CAPB (GOV_B_CA) and current account (CU) are expressed as percentage share on GDP. Real output growth rate (GDP_D) is expressed as percentage change of the annual real GDP over the corresponding period in previous year.

Data in tables below each sub-figure represents large changes (+ for improvement, - for deterioration) in (1) cyclically adjusted primary balance (CAPB), (2) private savings-investments gap to GDP ratio (SPIP) and (3) overall savings-investments gap to GDP ratio (SI). Last raw represents (4) annual changes in real output. For (1), (2) and (3) each individual sign (+ or -) represents a large change during one year (four quarters) backward.

CU (-) (with negative real GDP interference)	CU (-) (w/o negative real GDP interference)
CU (+) (with positive real GDP interference)	CU (+) (w/o positive real GDP interference)

Source: Author's calculation.

Figure 5 reveals identified large current account changes. Individual countries from the group experienced several episodes of continuous current account adjustments that in total represent 66 episodes of which 35 refer to the current account improvement and 31 to the current account deterioration. We found that during more than 62 percent of episodes the current account adjustments did not interfere with the real output leading path (either positively or negatively). This result is contrary to conclusions proposed by i.e. Abbas, Bouhga-Hagbe, Fatás, Mauro and Velloso (2011).

Bulgaria experienced 8 large continuous current account changes: 4 improvements (2 episodes with and 2 episodes without GDP interference) and 4 deteriorations (3 episodes with and 3 episodes without GDP interference). Episodes of large current account changes were associated with corresponding SPIP and SI episodes. Large CAPB episodes were less frequent and were partially associated with large current account changes during the crisis period.

Czech republic experienced 6 large continuous current account changes: 4 improvements (3 episodes with and 1 episode without GDP interference) and 2 deteriorations (both 2 episodes without GDP interference). Large and durable current account improvement in the first half of the period was associated with corresponding CAPB episode. In the second half of the period (and especially during the crisis period) large current account changes were especially followed by lagged corresponding episodes of SPIP adjustments.

Estonia experienced 7 large continuous current account changes: 4 improvements (3 episodes with and 1 episode without GDP interference) and 3 deteriorations (all 3 episodes without GDP interference). During the first half of the period we observed a parallel occurrence of current account deterioration SPIP and SI episodes while CAPB episodes doesn't seem to affect current account adjustments (similarly just like in Bulgaria - we suggest it is especially due to a tightened fiscal discipline conducted under strict exchange rate anchoring). Crisis period seem to strengthened an occurrence of current account episodes and CAPB, SPIP, SI episodes, though with persistent lags.

Hungary experienced 6 large continuous current account changes: 4 improvements (3 episodes with and 1 episode without GDP interference) and 2 deteriorations (both 2 episodes without GDP interference). Episodes of large current account changes in the middle of the first half of the period were associated with a lagged occurrence of SPIP, SI and CAPB episodes. At the same time it seems that large changes of domestic (private and public) components of SI adjustments followed contrary trends with a dominance of SPIP effects. The only crisis period current account episode was associated with slightly lagged continuous changes in both CAPB and SPIP.

Lithuania experienced 7 large continuous current account changes: 3 improvements (1 episode with and 2 episodes without GDP interference) and 4 deteriorations (1 episode with and 3 episodes without GDP interference). Despite initial short CAPB episode we found that large current account adjustments were not associated with continuous CAPB changes during the most of the pre-crisis period (the last pre-crisis one was followed with a significant lag). On the other hand current account episodes strictly corresponded to SPIP episodes. Parallel occurrence of corresponding current account and CAPB, SPIP, SI episodes became much more frequent during the crisis period (similarly just like in Bulgaria and Estonia).

Latvia experienced 7 large continuous current account changes: 2 improvements (1 episode with and 1 episode without GDP interference) and 5 deteriorations (1 episode with and 4 episodes without GDP interference). Similarity with Lithuania's pre-crisis current account episodes scenario is obvious. Interconnection between current account and SPIP (as well as SI) episodes is clear. Situation changes during the crisis period though CAPB episodes slightly lagged behind large and continuous current account changes.

Poland experienced 9 large continuous current account changes: 6 improvements (3 episodes with and 3 episodes without GDP interference) and 3 deteriorations (all 3 episodes without GDP interference). During the first half of the period we observed a parallel occurrence of current account deterioration and SI episodes. However, only one current account episode (2005) was associated with short CAPB episode while the rest of them occurred in parallel with large SPIP changes. Despite general improvement in parallel occurrence of current account episodes as well as SPIP and CAPB changes, SPIP and CAPB episodes tended toward divergent adjustments.

Romania experienced 7 large continuous current account changes: 2 improvements (1 episode with and 1 episode without GDP interference) and 5 deteriorations (1 episode with and 4 episodes without GDP interference). Deteriorating current account episodes during the whole pre-crisis period were associated purely with large SPIP changes causing SI adjustments (despite the last that clearly preceded CAPB deterioration at its beginning). While an episode of continuous current account improvement at the beginning of the crisis period occurred again in parallel with large positive SPIP episode, there also seem to be a substantial, though lagged, occurrence of the episode with large CAPB improvement.

Slovak republic experienced 7 large continuous current account changes: 4 improvements (3 episodes with and 1 episode without GDP interference) and 3 deteriorations (all 3 episodes without GDP interference). Large changes in CAPB and SPIP followed contrary trends during pre-crisis period. However, episodes of large SI changes generally reflected associated large continuous current account changes and thus appear to be clearly parallel. Occurrence of volatile current account episodes

(shifting of positive and negative episodes) intensified during the crisis period and occurred in parallel with SPIP episodes.

Slovenia experienced 2 large continuous current account changes: 2 improvements (1 episode with and 1 episode without GDP interference) and no deteriorations. A rare occurrence of continuous large current account episodes reflects a relative SI stability during the pre-crisis period. Episode of the current account improvement at the beginning of the period occurred in parallel with positive SPIP and SI changes as well as subsequent, though lagged, CAPB episode (this scenario happened again at the beginning of the crisis period). However, negative CAPB, SPIP and SI episodes don't seem to be associated with corresponding current account episodes.
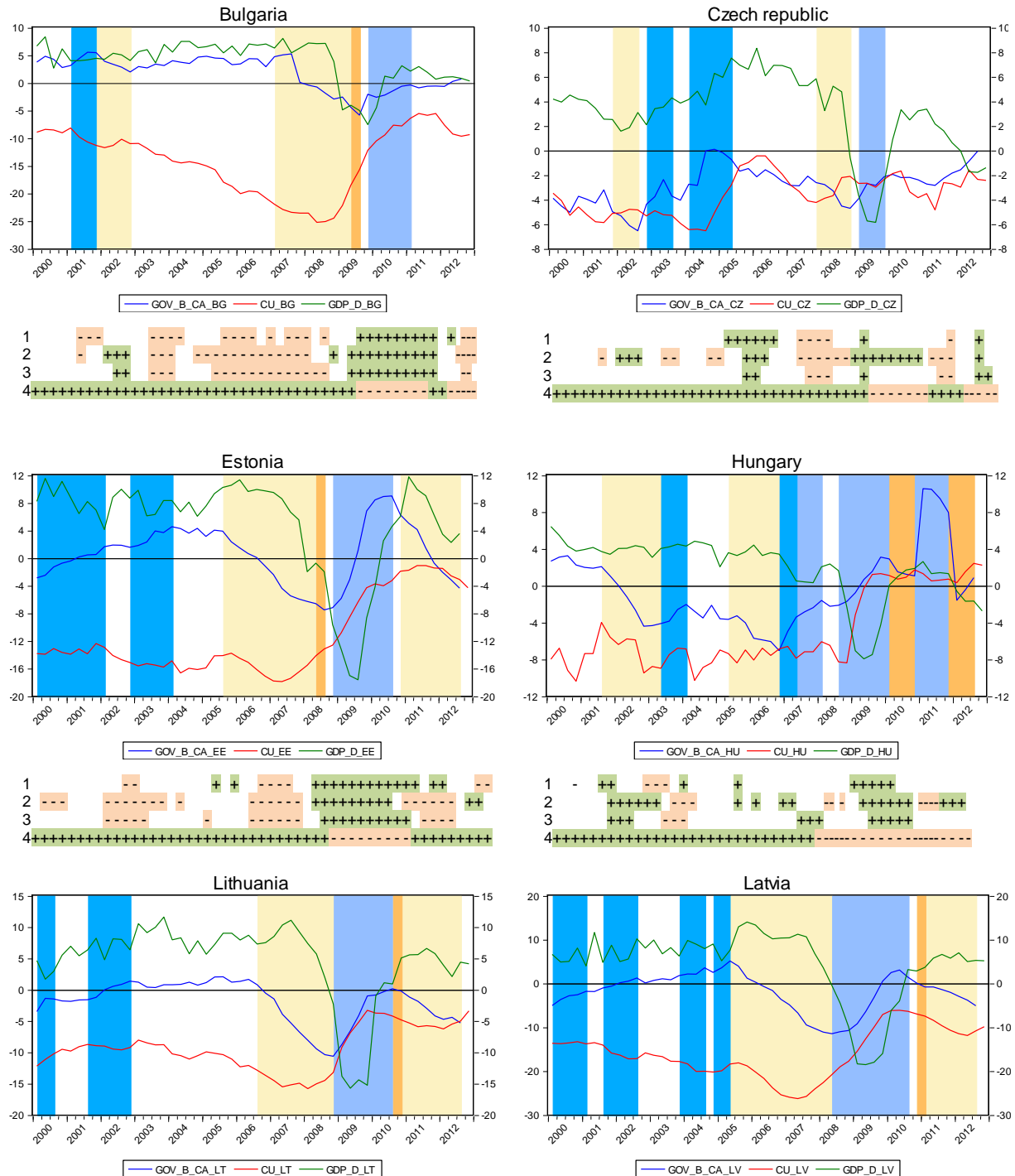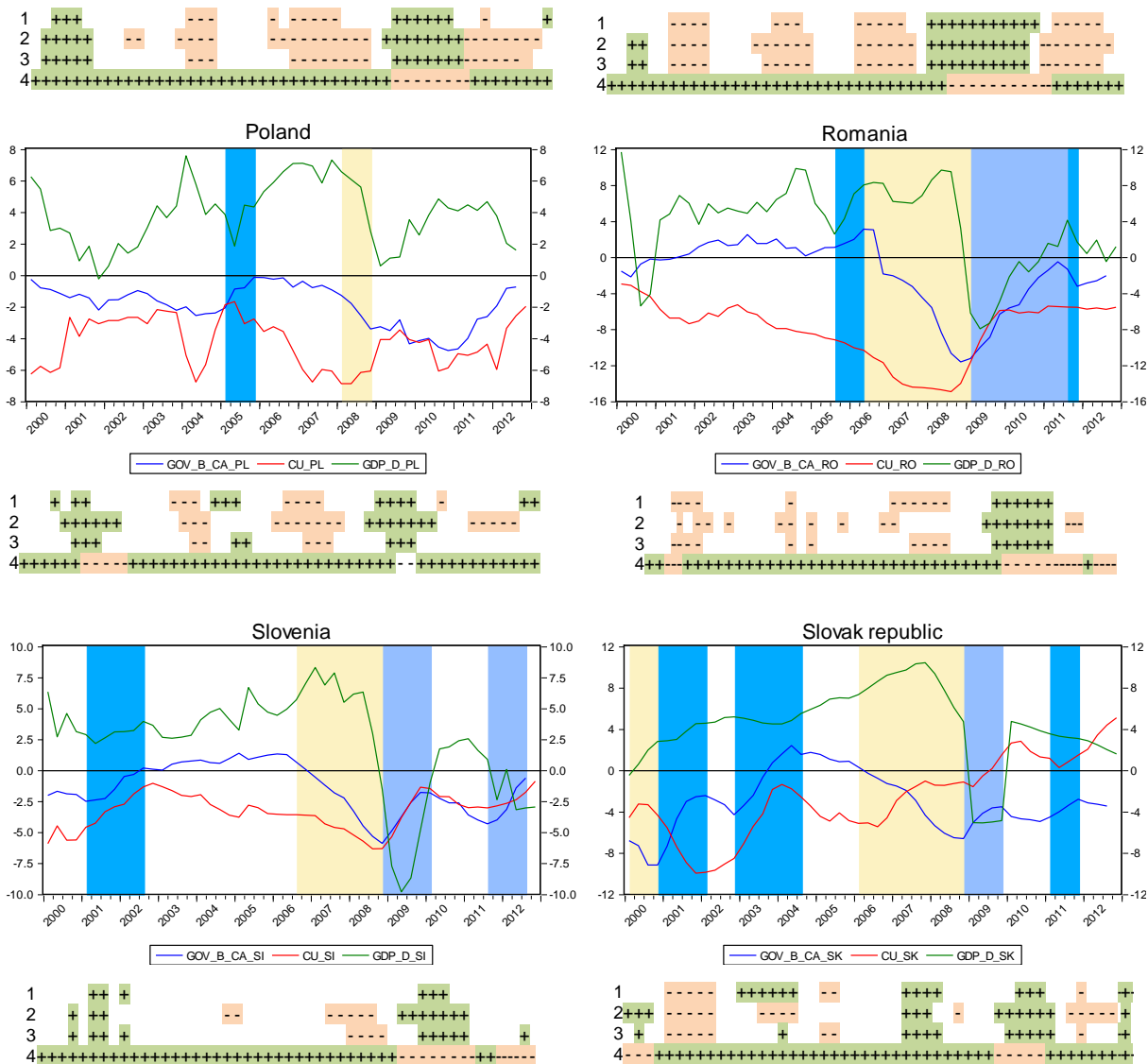
Figure 6. Episodes of large fiscal policy changes (2000Q1-2012Q4)

Note: Variables - cyclically adjusted primary balance - CAPB (GOV_B_CA) and current account (CU) are expressed as percentage share on GDP. Real output growth rate (GDP_D) is expressed as percentage change of the annual real GDP over the corresponding period in previous year.

Data in tables below each sub-figure represents large changes (+ for improvement, - for deterioration) in (1) current account (CU), (2) private savings-investments gap to GDP ratio (SPIP) and (3) overall savings-investments gap to GDP ratio (SI). Last raw represents (4) annual changes in real output. For (1), (2) and (3) each individual sign (+ or -) represents a large change during one year (four quarters) backward.

CAPB (-) (with negative real GDP interference)	CAPB (-) (w/o negative real GDP interference)
CAPB (+) (with positive real GDP interference)	CAPB (+) (w/o positive real GDP interference)

Source: Author's calculation.

Figure 6 reveals identified large fiscal changes. Individual countries from the group experienced several episodes of continuous fiscal adjustments (represented by adjustments in CAPB) that in total represent 55 episodes of which 32 refer to the fiscal stance improvement and 23 to the fiscal stance deterioration. We found that during almost 53 percent of episodes adjustments in CAPB did not interfere with the real output leading path (either positively or negatively).

Bulgaria experienced 5 large continuous fiscal changes: 2 improvements (1 episode with and 1 episode without GDP interference) and 3 deteriorations (1 episode with and 2 episodes without GDP interference). CAPB episodes seem to be rare during a pre-crisis period and while their interference with either GDP or current account was generally low. Large CAPB changes intensified during the crisis period. Parallel occurrence of CAPB episodes and current account, SPIP as well as SI episodes became obvious.

Czech republic experienced 5 large continuous fiscal changes: 3 improvements (2 episodes with and 1 episode without GDP interference) and 2 deteriorations (both 2 episodes without GDP interference). Fiscal episodes occurred with few quarters lag behind SPIP episodes that seems to neutralize these mutually contrary trends on the overall SI balance (we have observed no large SI episode during the first half of the period) during the pre-crisis period. Effects associated with the beginning of the crisis period resulted in parallel occurrence of CAPB, current account SPIP as well as SI episodes of the same direction, though with different intensity and durability.

Estonia experienced 6 large continuous fiscal changes: 3 improvements (2 episodes with and 1 episode without GDP interference) and 3 deteriorations (1 episode with and 2 episodes without GDP interference). Despite relatively high occurrence of CAPB episodes, associated interactions with large current account adjustments were not obvious though CAPB deteriorating episodes were followed by corresponding SPIP and SI episodes. However, situation significantly changed during the crisis period. We identified large continuous CAPB changes with parallel occurrence of current account as well as SPIP and SI episodes.

Hungary experienced 9 large continuous fiscal changes: 5 improvements (2 episodes with and 3 episodes without GDP interference) and 4 deteriorations (2 episodes with and 2 episodes without GDP interference). Negative large CAPB episodes were associated with lagged (first) or not significant (second) current account deteriorations. Remaining pre-crisis continuous CAPB changes was not followed by equivalent current account adjustments. At the same time, all pre-crisis CPAB episodes were associated with opposite SPIP and SI changes that probably neutralize effects of the fiscal stance changes. Only initial CAPB episode during the crisis period was parallel with large current account, SPIP and SI changes. Remaining CAPB episodes were followed just by lagged SPIP episodes.

Lithuania experienced 6 large continuous fiscal changes: 3 improvements (2 episodes with and 1 episode without GDP interference) and 3 deteriorations (1 episode with and 2 episodes without GDP interference). Occurrence of large CAPB episodes (despite initial one) was not strictly parallel with continuous current account changes during the pre-crisis period. However, we observed a significant intersection of current account, SPIP and SI episodes. Parallel occurrence significantly improved during the crisis period though the last large CAPB change was associated with less dynamic current account deterioration.

Latvia experienced 8 large continuous fiscal changes: 5 improvements (4 episodes with and 1 episode without GDP interference) and 3 deteriorations (1 episode with and 2 episodes without GDP interference). Large CAPB episodes were not associated with continuous current account changes during the most of the pre-crisis period (despite the last one). However, we observed a clear improvement in parallel occurrence of episodes in all indicators (CAPB, current account, SPIP, SI) during the crisis period.

Poland experienced 2 large continuous fiscal changes: 1 improvement with GDP interference and 1 deterioration without GDP interference. Large fiscal episodes in Poland were really rare. Both two continuous fiscal changes did not occur in strict parallel with current account episodes. First CAPB episode lagged slightly and second one significantly behind current large account changes. We did not observe any large CAPB episode during the crisis period.

Romania experienced 4 large continuous fiscal changes: 3 improvements (2 episodes with and 1 episode without GDP interference) and 1 deterioration without GDP interference. Country did not experience any parallel occurrence of large CAPB and current episodes during the pre-crisis period. However, the situation significantly changed during the crisis period. We observed a parallel occurrence of two large CAPB and current account changes (one deterioration and one improvement).

Slovak republic experienced 6 large continuous fiscal changes - 4 improvements (3 episodes with and 1 episode without GDP interference) and 2 deteriorations (both 2 episodes without GDP interference). We identified mixed results of CAPB and current account episodes occurrence during

the pre-crisis period. First large CAPB change (deterioration) was followed by the current account change of the same direction with a significant lag, clearly interfering with following CAPB episode (improvement). Parallel occurrence of CAPB and current account changes was observed only during the second episode of the CPAB improvement. During the crisis period we identified only one large current account improvement thought clearly lagging behind CAPB episode. The rest of the crisis continuous CAPB and current account changes followed contrary trends.

Slovenia experienced 4 large continuous fiscal changes: 3 improvements (1 episode with and 2 episodes without GDP interference) and 1 deterioration without GDP interference. Both pre-crisis CAPB episodes occurred in parallel with current account episodes. While the first large CAPB change was followed by the lagged current account episode, the second CAPB episode was not associated with a significant current account adjustment.

Examination of current account episodes in the European transition economies revealed some crucial implications of large and continuous current account changes. We have observed a strong evidence of large current account (CU) changes and overall savings-investments gap to GDP ratio (SI) parallel occurrence. While changes in public (CAPB[8]) and private (SPIP) savings-investments gap to GDP ratio generally corresponded with initiated large current account adjustments, in minor cases we have observed either contrary trend in both categories or magnitude of change did not meet a condition (1) to be considered as a large continuous change. SPIP episodes seem to be generally more frequent than CAPB episodes and thus provide more accurate interpretation of causal relationship between large and continuous current account changes and corresponding adjustments in SI balance. This investigation is even more relevant in countries with strong exchange rate anchor (in countries from the group of "peggers") and more prudential fiscal policy. Lower occurrence of large changes in the fiscal stance in these countries during the pre-crisis period thus corresponds with our general expectations.

Examination of fiscal episodes in the European transition economies revealed some crucial implications of large and continuous fiscal changes. Low impact of large CAPB changes on the real output was caused by reduced GDP interference with internal (fiscal) imbalances due to high real output growth rates followed by an intensified convergence during the first half of the period. At the same time it seems that crisis period associated with deterioration effects on overall demand (both internal and external) reduced exposure of GDP to internal (fiscal) imbalances too. We also observed persisting disproportions between CAPB and SGSI revealing substantial effects of the business cycle on the budgetary components.

Table 1 summarizes revealed episodes of large continuous current account and CAPB changes in the European transition economies since 2000. The number of episodes with improved current accounts was slightly higher that the number of episodes with improved CAPB. This difference is significantly higher in case of deteriorating episodes.

Table 1. Episodes of large current account and fiscal changes (2000Q1-2012Q4)
(Brief overview of episodes types occurrence)

| | CURRENT ACCOUNT CHANGES | | | | | FISCAL CHANGES | | | | |
| | Improvement | | Deterioration | | | Improvement | | Deterioration | | |
	with GDP interference	w/o GDP interfe rence	with GDP interfe rence	w/o GDP interfe rence	TOTAL	with GDP interfe rence	w/o GDP interfer ence	with GDP interfere nce	w/o GDP interfere nce	TOTAL
Bulgaria	2	2	1	3	8	1	1	1	2	5
Czech republic	3	1	0	2	6	2	1	0	2	5
Estonia	3	1	0	3	7	2	1	1	2	6
Hungary	3	1	0	2	6	2	3	2	2	9
Lithuania	1	2	1	3	7	2	1	1	2	6
Latvia	1	1	1	4	7	4	1	1	2	8
Poland	3	3	0	3	9	1	0	0	1	2

---

[8] While CAPB is not accurate measure for a calculation of overall net public (savings-investment) position, it was employed in this section to reveal intertemporal effects of discrete changes in the fiscal policy stance.

| | CURRENT ACCOUNT CHANGES | | | | | FISCAL CHANGES | | | | |
| | Improvement | | Deterioration | | | Improvement | | Deterioration | | |
	with GDP interference	w/o GDP interference	with GDP interference	w/o GDP interference	TOTAL	with GDP interference	w/o GDP interference	with GDP interference	w/o GDP interference	TOTAL
Romania	1	1	1	4	7	2	1	0	1	4
Slovak republic	3	1	0	3	7	3	1	0	2	6
Slovenia	1	1	0	0	2	1	2	0	1	4
Total	21	14	4	27	66	20	12	6	17	55
AVERAGE durability (in quarters)	5.15	6.07	3.36	5.04		4.89	6.42	2.67	7.63	

Note: Data represents a number of episodes of large current account and fiscal changes.
Source: Author's calculation.

Occurrence of both current accounts episodes types is clearly distributed between the crisis and pre-crisis periods. The most of episodes associated with large current account deteriorations occurred during the pre-crisis period revealing generally expected proposition of an intertemporal approach for converging economies catching-up western European countries. All countries experienced episodes of large current accounts improvement at the beginning of the crisis period as an immediate result of deteriorating effects affecting domestic demand. However, subsequent higher occurrence of contrary large current account episodes demonstrates accelerated redistributive effects of the crisis associated with short-term expenditure shifting across countries causing higher volatility in current account balances.

Occurrence of CAPB episodes seems to be distributed across the whole period more uniformly. However, episodes of large CAPB improvements tend to be more frequent during the pre-crisis period. Moreover, durability of continuous CAPB improvements is clearly higher in Baltic countries (with rigorous exchange rate anchoring) highlighting a commitment to conduct prudential fiscal policies necessary to maintain a sustainability of tough exchange rate arrangement. At the same time, episodes of large fiscal policy improvements helped to reduce persisting SI disequilibrium caused by deteriorating SPIP imbalances in the whole group of "peggers". In countries with flexible exchange rate arrangements ("floaters") we observed some sort of alteration in episodes of CAPB improvement and deterioration in the medium term period. All countries (except for Hungary) experienced large deteriorating episode at the beginning of the crisis period followed by improving episode (except for Poland) with differing lag revealing a crucial need of a fiscal consolidation.

Table 2 summarizes detailed overview of intertemporal effects of episodes of large continuous current account and CAPB changes and associated adjustments in SI, SPIP and SGIG balances in the European transition economies since 2000. Average length of the current account episode was more than 5.2 month (episodes of the current account improvement (5.4 months) were slightly more durable that episodes of the current account deterioration (5.16 months)) and the CAPB episode more than 5.6 months (episodes of the CAPB deterioration (6.95) were significantly more durable than episodes of the CAPB improvement (4.85)). Average change of the current account is -0.96 percent of GDP consisting of 3.38 percent of GDP for positive episodes and -4.34 percent of GDP for negative episodes. Average change of CAPB is -1.41 percent of GDP consisting of 3.16 percent of GDP for positive episodes and -4.57 percent of GDP for positive episodes and -4.57 percent of GDP for negative episodes.

Table 2. Episodes of large current account and fiscal changes (2000Q1-2012Q4)
(Detailed overview of intertemporal effects)

| Type of episode | No. of Episodes | Duration quarters | Δ | NX | | | S-I | | | SP-IP | | | SG-IG | | |
				+	-	net	+	-	net	+	-	net	+	-	net
CU	66	5.20	-0.96	6.51	-7.47	-0.96	6.36	-7.31	-0.95	4.24	-3.09	1.16	2.18	-4.29	-2.11
CU (+)	35	5.40	3.38	4.89	-1.51	3.38	4.85	-1.56	3.29	3.93	-1.31	2.62	0.91	-0.26	0.65
CU (-)	31	5.16	-4.34	1.62	-5.96	-4.34	1.51	-5.76	-4.25	0.31	-1.78	-1.46	1.26	-4.03	-2.77
CAPB	55	5.65	-1.41	3.51	-4.62	-1.11	2.86	-4.00	-1.14	1.18	0.18	1.36	1.64	-4.10	-2.46
CAPB (+)	32	4.85	3.16	2.26	-0.20	2.06	2.14	-0.12	2.02	-1.01	0.31	-0.70	3.15	-0.39	2.76

Type of episode	No. of Epi sodes	Duration quarters	Δ	NX			S-I			SP-IP			SG-IG		
				+	-	net	+	-	net	+	-	net	+	-	net
CAPB (-)	23	6.95	-4.57	1.25	-4.42	-3.17	0.72	-3.88	-3.16	2.19	-0.13	2.06	-1.51	-3.71	-5.22

Note: Data in first column represents a number of CU (current account) and CAPB (cyclically adjusted primary balance) large changes (episodes), in second column an average duration in quarters followed by estimated changes expressed as a GDP shares.
Source: Author's calculation.

Relative contribution of private and public savings-investments balances to the overall SI stance reflected in the current account improvement and deterioration episodes seems to be quite different. Around 78 percent of the average current account balance during large current account improvements is associated with SPIP balance and thus minor contribution of SGIG. On the other hand, a contribution of SPIP to the average current account balances during large current account deteriorations is only 34 percent revealing much higher impact of SGIG. Our findings seem to be contrary to the key outcomes proposed by Abbas, Bouhga-Hagbe, Fatás, Mauro and Velloro (2011)[9] who revealed that changes in the current account during average episode are driven almost exclusively by SPIP balance in advanced economies while in emerging and low-income countries it is around three-fourth of the change in the current account. Much higher contribution of SGIG to the current account deterioration reveals substantial causal relationship between deteriorating fiscal episodes and current account deteriorations. We suggest that this observation originates in weaker fiscal discipline in countries from the group of "floaters" during the pre-crisis period and associated crowding-out effects that contributed to the current accounts deterioration. Significant contribution also refers to the intensive deterioration in the fiscal stance in most countries from the group at the beginning of the crisis period. The lack of fiscal discipline in countries without explicit strong nominal anchor also reveals questions associated with fiscal sustainability after euro adoption.

Large CAPB improvements and deteriorations revealed significant responsiveness of large current account adjustments to the fiscal incentives (0.65+). The ratio is slightly higher for CAPB deteriorating episodes. Responsiveness of the current account is slightly higher during deteriorating episodes that in our sample of countries occurred typically at the beginning of the crisis period. Deterioration in overall demand (for domestic as well as foreign goods) together with accelerated negative trend in CAPB intensified contrary trends in current account and fiscal balances. CAPB large changes were associated with contrary adjustments in SPIP balances. As a result, private savings offset around 32 percent of CAPB changes (fiscal impulse) for episodes of CAPB improvements and around 48 percent of CAPB changes for episodes of CAPB deteriorations. Offsetting effects are clearly visible in most countries during initial load of effects of the crisis period.

6. Econometric model specification

VAR models represent dynamic systems of equations in which the current level of each variable depends on past movements of that variable and all other variables involved in the system. Residuals of vector ε_t represent unexplained movements in variables (effects of exogenous shocks hitting the model); however as complex functions of structural shocks effects they have no economic interpretation. Structural shocks can be still recovered using transformation of the true form representation into the reduced-form by imposing a number of identifying restrictions. Applied restrictions should reflect some general assumptions about the underlying structure of the economy and they are obviously derived from economic theory. There are two general (most used) approaches to identify VAR models. (I) Cholesky decomposition of innovations implies the contemporaneous interactions between exogenous shocks and the endogenous variables are characterized by a Wald causal chain. Ordering of endogenous variables then reflects expected particular economy structure following general economic theory assumptions. However, the lack of reasonable guidance for appropriate ordering led to the development of more sophisticated and flexible identification methods - (II) structural VAR (SVAR) models. Identifying restrictions implemented in SVAR models reflect theoretical assumptions about the economy structure more precisely.

---

[9] However, authors covered period 1970-2007 in their study avoiding effects of the crisis period to the fiscal balances.

We employ a VAR methodology to analyze effects of CAPB changes on current account adjustments in the European transition economies. Cholesky decomposition of variance-covariance matrix of reduced-form VAR residuals is implemented to estimate effects of CAPB deterioration on current accounts responses.

True model is represented by the following infinite moving average representation:

$$X_t = A_0 \varepsilon_t + A_1 \varepsilon_{t-1} + A_2 \varepsilon_{t-2} + \ldots = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i} = \sum_{i=0}^{\infty} A_i L^i \varepsilon_t = A(L)\varepsilon_t \qquad (6.1)$$

where X_t represents $n \times 1$ a vector including endogenous variables of the model, $A(L)$ is a $n \times n$ polynomial consisting of the matrices of coefficients to be estimated in the lag operator L representing the relationship among variables on the lagged values, ε_t is $n \times 1$ vector of identically normally distributed, serially uncorrelated and mutually orthogonal errors (white noise disturbances that represent the unexplained movements in the variables, reflecting the influence of exogenous shocks):

$$E(\varepsilon_t) = 0, \quad E(\varepsilon_t \varepsilon_t') = \Sigma_\varepsilon = I, \quad E(\varepsilon_t \varepsilon_s') = [0] \quad \forall t \neq s \qquad (6.2)$$

Vector X_t consists of six endogenous variables - real output $(y_{r,t})$, government budgetary stance $(g_{b,t})$, current account (cu_t), short-term nominal interest rates $(ir_{n,t})$ and real exchange rate $(er_{r,t})$. In the five-variable VAR model $(X_t = [y_{r,t}, g_{b,t}, cu_t, ir_{n,t}, er_{r,t}])$ we assume five exogenous shocks that contemporaneously affect endogenous variables - demand shock $(\varepsilon_{y,t})$, fiscal shock $(\varepsilon_{g_b,t})$, current account shock $(\varepsilon_{cu_n,t})$, monetary policy shock $(\varepsilon_{ir_n,t})$ and real exchange rate shock $(\varepsilon_{er_r,t})$.

Structural exogenous shocks from equation (6.1) are not directly observable due to the complexity of information included in true form VAR residuals. As a result, structural shocks cannot by correctly identified. It is then necessary to transform true model into following reduced form

$$X_t = C(L)Y_{t-1} + e_t \qquad (6.3)$$

where $C(L)$ is the polynomial of matrices with coefficients representing the relationship among variables on lagged values and e_t is a $n \times 1$ vector of normally distributed errors (shocks in reduced form) that are serially uncorrelated but not necessarily orthogonal:

$$E(e_t) = 0, \quad \Sigma_u = E(e_t e_t') = A_0 E(\varepsilon_t \varepsilon_t') A_0' = A_0 A_0', \quad E(e_t e_s') = [0] \quad \forall t \neq s \qquad (6.4)$$

Relationship between reduced-form VAR residuals (e_t) and structural shocks (ε_t) can be expressed as follows:

$$e_t = A_0 \varepsilon_t \qquad (6.5)$$

As we have already noted at the beginning of the section we implement a Cholesky identification scheme to correctly identify structural shocks. In order to identify our model there must be exactly $n^2 - [(n^2 - n)/2]$ relationships among endogenous variables of the model, where n represents a number of variables. We have to impose $(n^2 - n)/2$ restrictions on the matrix A_0 based

on the Cholesky decomposition of the reduced-form VAR residual matrix that define matrix A_0 as a lower triangular matrix. The lower triangularity of A_0 (all elements above the diagonal are zero) implies a recursive scheme (structural shocks are identified through reduced-form VAR residuals) among variables (the Wald chain scheme) that has clear economic implications and has to be empirically tested as any other relationship. Identification scheme of the matrix A_0 implies that particular contemporaneous interactions between some exogenous shocks and some endogenous variables are restricted reflecting causal (distribution) chain of interaction transmission. It is clear that the Wald causal chain is incorporated via convenient ordering of variables.

Considering lower triangularity of a matrix A_0 the equation (6.5) can be rewritten as follows:

$$\begin{bmatrix} e_{y_r,t} \\ e_{g_b,t} \\ e_{cu,t} \\ e_{ir_n,t} \\ e_{er_r,t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{y_r,t} \\ \varepsilon_{g_b,t} \\ \varepsilon_{cu,t} \\ \varepsilon_{ir_n,t} \\ \varepsilon_{er_r,t} \end{bmatrix} \qquad (6.6)$$

Correct identification of exogenous structural shocks reflecting Cholesky ordering of variables denotes following assumptions:

- Real output doesn't contemporaneously respond to the shock from any other endogenous variable of the model;
- Government budgetary stance doesn't contemporaneously respond to current account, interest rates and exchange rate shocks, while it is contemporaneously affected only by the real output shock;
- Current account doesn't contemporaneously respond to interest rates and exchange rate shocks, while it is contemporaneously affected by real output and government budgetary stance shocks;
- Interest rates don't contemporaneously respond to the current account shock, while it is contemporaneously affected by real output, government budgetary stance and current account and inflation shocks;
- Exchange rate is contemporaneously affected by the shocks from all of the endogenous variables of the model.

After initial period endogenous variables may interact freely without any restrictions. Estimated VAR model is used to compute impulse response functions to analyze responses of the current account to the negative one standard deviation CAPB shock in the European transition economies. To check the robustness of empirical results we estimate the model considering different ordering of the endogenous variables in models with time series for two different periods (pre-crisis period - model A (2000Q1-2007Q4) and extended period - model B (2000Q1-2012Q4)):

- model A1, B1 $\left(X_t = \begin{bmatrix} y_{r,t}, g_{b,t}, cu_t, ir_{n,t}, er_{r,t} \end{bmatrix} \right)$;
- model A2, B2 $\left(X_t = \begin{bmatrix} y_{r,t}, er_{r,t}, g_{b,t}, ir_{n,t}, cu_t \end{bmatrix} \right)$;
- model A3, B3 $\left(X_t = \begin{bmatrix} y_{r,t}, g_{b,t}, ir_{n,t}, er_{r,t}, cu_t \end{bmatrix} \right)$.

Investigation of the current account responses to the CAPB changes reveals importance of discretionary changes to the cyclically adjusted budgetary components and their cross-country redistributive effects (through the current account adjustments).

7. Data and results

To estimate effects of CAPB changes on current account adjustments in the European transition economies we employed quarterly data for period 2000Q1-2007Q4 (model A) consisting of 32 observations and for period 2000Q1-2012Q4 (model B) consisting of 52 observations for the following endogenous variables - real output (nominal GDP deflated by GDP deflator), CAPB (see

sections 5.2 and 5.3 for methodology), current account of the balance of payments, short-term interest rates (interbank offered rates with 3 months maturity[10]), real exchange rate (CPI based real effective exchange rate) (Figure 7).
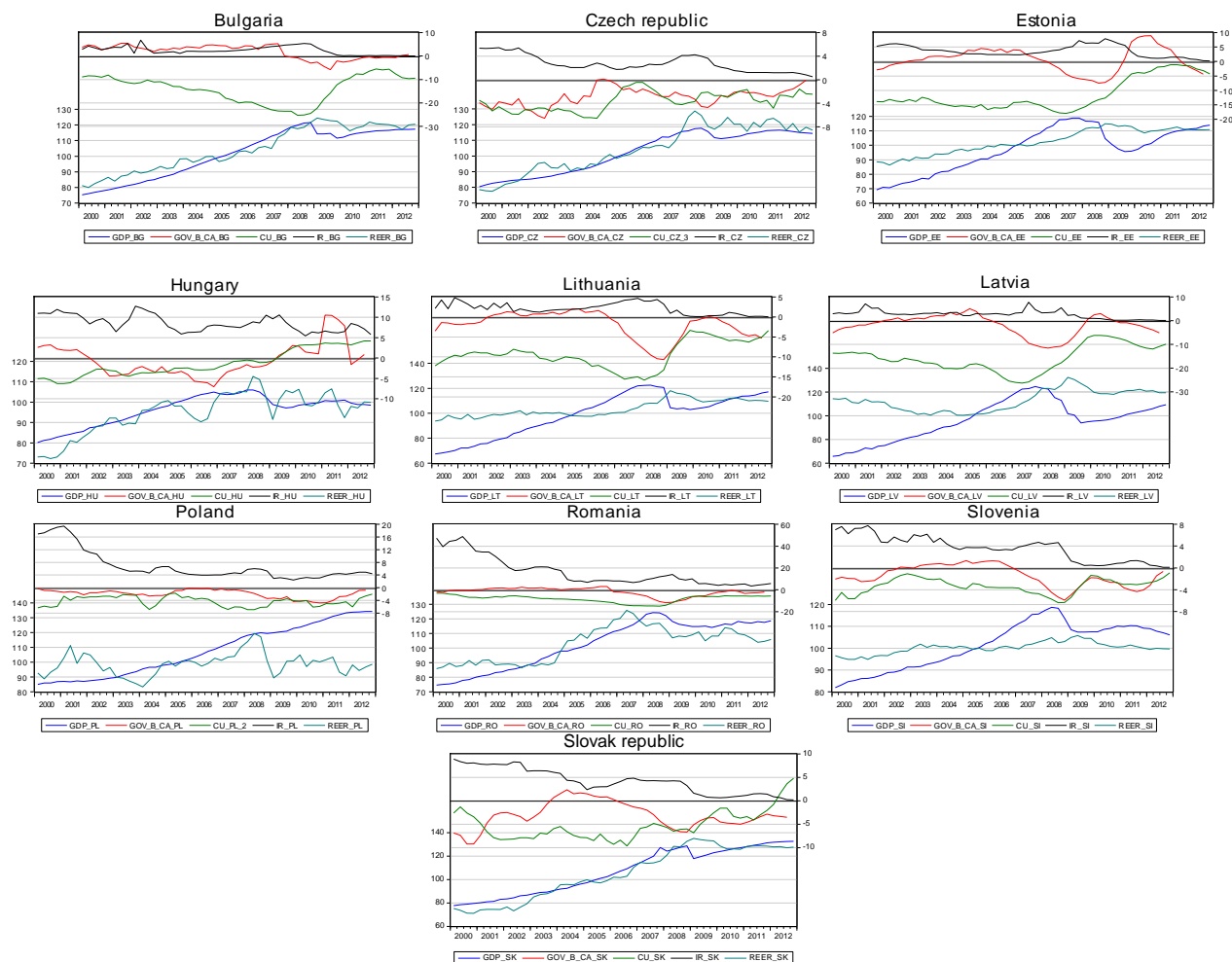
Figure 7. Real output, cyclically adjusted primary balance, current account, interest rates, real effective exchange rates (2000Q1-2012Q4)

Note: Endogenous variables - real output (GDP) and real effective exchange rate (REER) are expressed as indexes (left axis in figures) (2005 = 100). Cyclically adjusted primary balance (CAPB), current account (CU) and interest rates (IR) are expressed in percentage (right axis in figures).

Source: Compiled by author based on data taken from IMF - International Financial Statistics (September 2013).

　　　Estimation of two models is in line with the primary objective of the paper to reveal a relationship CAPB changes and current account adjustments considering possible implications of the crisis period on estimated results. Time series for endogenous variables were drawn from Eurostat - Government Finance Statistics (September 2013) and IMF database - International Financial Statistics (September 2013). Time series for real output and current account were seasonally adjusted.

　　　To correctly identify exogenous shocks hitting the model as well as to compute impulse-response functions it is necessary VAR model to be stationary. To check stationarity of the model it is necessary to test the time series for unit roots and cointegration.

---

[10] Short-term interest rates in Estonia, Slovak republic and Slovenia we replaced by EURIBOR after euro adoption in each particular country (2007, 2009 and 2011).

A.Testing procedures

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were computed to test endogenous variables for the unit roots presence. Both ADF and PP tests indicate that most of variables are non-stationary on values so that the null hypothesis of a unit root presence cannot be rejected for any of time series. Testing variables on first differences indicates that time series are stationary. We may conclude that variables are integrated of order 1 I(1).

Because there are endogenous variables with a unit root on values it is necessary to test time series for cointegration using the Johansen and Juselius cointegration test (we found reasonable to include variables I(0) for testing purposes following economic logic of expected results). The test for the cointegration was computed using three lags as recommended by the AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion).

Results of Johansen cointegration tests confirmed our results of unit root tests. Both trace statistics and maximum eigenvalue statistics (both at 0.05 level) indicate that there is no cointegration among endogenous variables of the model.

To test the stability of VAR models we also employed a number of diagnostic tests. We found no evidence of serial correlation, heteroskedasticity and autoregressive conditional heteroskedasticity effect in disturbances. The model also passes the Jarque-Bera normality test, so that errors seem to be normally distributed. VAR models seem to be stable also because inverted roots of the model for each country lie inside the unit circle. Detailed results of time series testing procedures are not reported here to save space. Like any other results, they are available upon request from the author.

Following results of the unit root and cointegration tests we estimated the model using variables in first differences so that we can calculate impulse-response functions for all ten European transition economies. Following the main objective of the paper we focus on interpretation of responses of the current account to the negative one standard deviation CAPB (decrease in CAPB) shock.

We also observe effects of the crisis period on the current account responses to the CAPB shock in the European transition economies by comparing results for estimated models using time series for two different periods - model A (2000Q1-2007Q4) and model B (2000Q1-2012Q4). Changed ordering of variables didn't seem to affect results of the analysis. Considering that impulse-response functions are not very sensitive to the ordering of endogenous variables we present results of both models (model A1 and B1) with default ordering of endogenous variables (detailed results for models A2, A3, B2, B3 are available upon request from the author).

B. Regression results

Table 3 provides an overview of estimated regression results with CAPB as proxy for the discrete fiscal policy stance in the European transition economies since 2000 for two different periods 2000-2007 (model A) and 2000-2012 (model B).

Table 3. Regression results of current account on cyclically adjusted primary balance

	(1) CAPB (Model A)	(2) CAPB (Model B)
Bulgaria	-0.1047** [0.0504]	-0.0938** [0.0787]
Czech republic	-0.1742** [0.1257]	-0.1140** [0.1452]
Estonia	-0.2332** [0.1251]	-0.1937*** [0.2133]
Hungary	-0.1907** [0.1138]	-0.1557* [0.1687]
Lithuania	-0.2633** [0.1353]	-0.2051** [0.2299]
Latvia	-0.2213** [0.127]	-0.1779** [0.1839]

	(1) **CAPB (Model A)**	(2) **CAPB (Model B)**
Poland	-0.0519** [0.0348]	-0.0436** [0.0492]
Romania	-0.0810* [0.0549]	-0.0653** [0.0937]
Slovak republic	-0.1579** [0.0786]	-0.0977*** [0.0921]
Slovenia	-0.1499** [0.0703]	-0.0792** [0.1085]

Note: Standard errors in square brackets. * denotes significance at 1%, ** at 5% and *** at 10%.

Source: Author's calculation.

Results of both regressions revealed that effects of deteriorating CAPBs on the current account balance are significant mostly at 5 percent level. CAPB deterioration is followed by the current account deterioration though with a different intensity in each particular country from the group. Effects of CAPB changes also vary according to the baseline period. On average, a decrease in CAPB at 1 percent point caused current account deterioration at a range of 0.05-0.26 percent points for model A and 0.07-0.2 percent points for model B. Countries with large (Poland) and weak (Bulgaria and Romania) performing economies (experienced generally lower deteriorating effect on their current accounts (0.05-0.10 percent points). In countries with pegged exchange rates ("peggers") we observed regression coefficients (0.22-0.26 percent points) that seem to be higher than in countries with flexible exchange rate arrangements (0.14-0.19 percent points). However, the size of the economy seems to be more crucial for estimated results because Poland and Romania are clearly out of the range revealed for "floaters". Our results confirm general theoretical expectations about higher sensitivity of external equilibrium to fiscal incentives under fixed exchange rates. Large discrete changes and associated CAPB adjustments in these countries are more likely to interact with current account dynamics.

Crisis period reduced exposure of external imbalances to CAPB initiated adjustments in internal imbalances in all countries from the group. Estimated regression coefficients ranged from 0.04 to 0.21 percent points. However, this effect is significantly smaller in a group of three large or weak performing economies. On the other hand, more significant decrease was investigated in the group of "floaters" with Hungary near the results for "peggers" with less intensive decrease in regression coefficients. Despite euro adoption in Slovenia (2007) and Slovak republic (2009), regression results for a model B (2000-2012) do not provide any empirical evidence about similar patterns in regression coefficients comparable with the results for countries in the group of "peggers".

Intensified co-movements of fiscal and current account imbalances during the crisis period resulted in accelerated redistributive effects of the crisis on cross-country expenditure shifting associated with increased volatility in current account balances that seems to be less affected or exposed to the large CAPB changes (as indicated by decreased regression coefficients in all countries in model for an extended period). This suggestion is also supported by higher standard deviations of estimated regression coefficients in all countries from the group (the most significant in the Baltic countries).

C. Impulse-response functions

An investigation of CAPB effects on current account adjustments in the European transition economies includes estimation of current account responses to the negative one standard deviation CAPB shock employing quarterly data for two subsequent periods 2000-2007 (model A) and 2000-2012 (model B). Results seem to be sensitive to the exchange rate arrangement as well as the size of the economy.
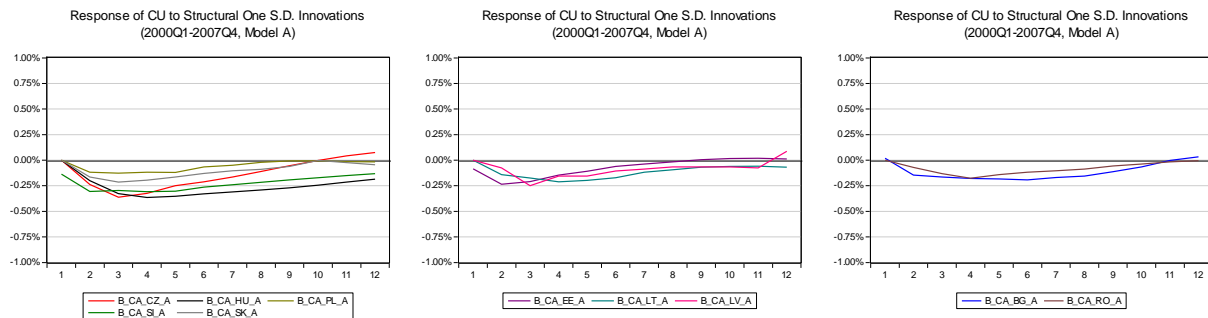
Source: Author's calculation.

Note: Curves represent responses of current accounts (CU) to the negative one standard deviation cyclically adjusted primary balance (CAPB) shock in each country from the group of the European transition economies.

Figure 8. Responses of current account to CAPB shocks (2000Q1-2007Q4) (Model A)

In the Figure 8 we summarize results of impulse-response functions of current account balances to the negative (decrease in) CAPB shocks in the model with time series for the pre-crisis period (model A1) in the European transition economies. Estimates of current account responsiveness to the Cholesky negative one standard deviation CAPB shock reveals interesting implications of exchange rate regime choice as well as particular role of the size of the economy in model with time series for a pre-crisis period. Unexpected change in the fiscal stance (CAPB deterioration) was followed by the current account deterioration in all countries from the group. However, we have observed some different patterns in the current account responsiveness among countries. CAPB shock caused slow current account deterioration in Bulgaria and Romania. Negative effect of the shock culminated during the second year since the shock while it has died out within the fourth year. While the response pattern (intensity of the shock) in another big economy, Poland, is quite similar, it is a durability of the deteriorating effect that seems to be reduced (effect of the shock was neutralized at the beginning of the third year). Negative response of the current account to the CAPB shock seems to be the most significant in countries from the group of "floaters". Moreover, a negative effect culminated till the end of the first year after the shock though its durability seems to differ in each individual country. Current account deterioration after the CAPB shock in the group of "peggers" seems to be slightly reduced in comparison with previous group of countries. Finally, negative CAPB shock deteriorated current accounts in all countries from the group just temporarily. Effect of the shock seems to be neutral in the long run.
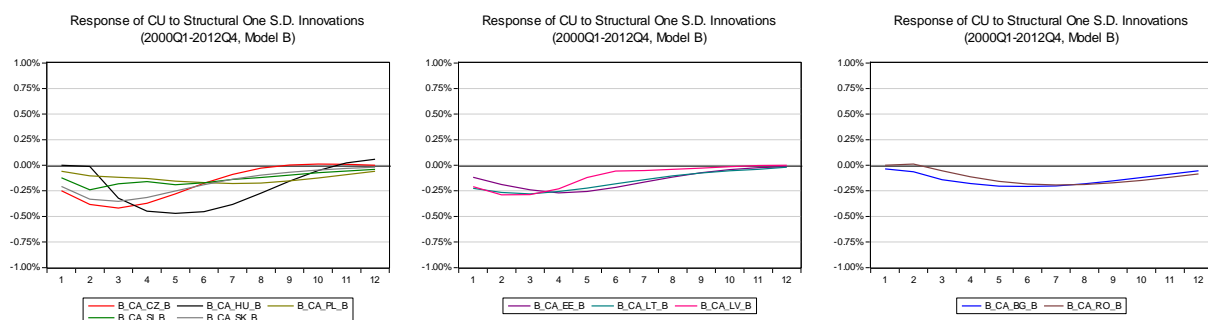
Source: Author's calculation.

Note: Curves represent responses of current accounts (CU) to the negative one standard deviation cyclically adjusted primary balance (CAPB) shock in each country from the group of the European transition economies.

Figure 9. Responses of current account to CAPB shocks (2000Q1-2012Q4) (Model B)

In the Figure 9 we summarize results of impulse-response functions of current account balances to the negative (decrease in) CAPB shocks in the model with time series for the extended period (model B1) in the European transition economies. It seems that crisis period affected short-term responsiveness of the current account to the CAPB shock in each individual country. In Baltic

countries ("peggers") current accounts deteriorated immediately after the negative CAPB shock. While intensity of the response remained generally unchanged it seems that a load time of the effect as well as its durability slightly reduced. In the group of "floaters" we examined few different patterns of changes in the current account responses. Despite generally reduced lag (except for Hungary and Slovenia) in the current account negative response, its immediate (or short-term) dynamics seems to be increased (Hungary, Czech republic, Slovak republic). Clearly reduced durability of the current account deterioration was observed in all countries but Poland with response pattern much more similar to the one revealed in the countries with big or weak performing economies. Except for a slightly increased lag in the current account response in Hungary, its short-term dynamics clearly increased though the effect of the shock culminated with a one year lag in comparison with a whole group of "floaters". Countries with big or weak performing economies experienced slightly lagged loading phase in the current account deterioration in comparison with the pre-crisis period. Negative effect culminated at the end of the second year while its durability slightly increased.

8. Conclusion

Current account adjustments revealed crucial implications of the continuously rising international economic and financial integration of this group of countries (increased indebtedness, lacking competitiveness, fiscal imbalances, foreign capital inflows, etc.), there seems to be still enough room to investigate partial effects of dynamic changes in key current account determinants to observe associated current account adjustments.

Changes in the fiscal policy stance associated with changes in CAPB affected current accounts in the European transition economies. Despite some differences, we have observed similar trend in the leading paths of current accounts and savings-investments gaps clearly following main outcomes of an intertemporal approach. However, expenditure shifting effects associated with current account imbalances in each individual country do not seem to be determined solely by internal balance between savings and investments. Countries from the group of "peggers" experienced periods with generally higher discrepancies in CAPB and current account balances. However, the beginning of the crisis period clearly reduced these misalignments. In the group of "floaters" we examined persisting negative SI imbalances originated in excessive fiscal deficits.

Occurrence of episodes of large CAPB changes seems to be uniformly distributed across the whole period. Durability of continuous CAPB improvements is clearly higher in Baltic countries (with rigorous exchange rate anchoring) highlighting a commitment to conduct prudential fiscal policies necessary to maintain a sustainability of tough exchange rate arrangement. In countries with flexible exchange rate arrangements ("floaters") we observed some sort of alteration in episodes of CAPB improvement and deterioration in the medium term period. All countries (except for Hungary) experienced large deteriorating episode at the beginning of the crisis period followed by improving episode (except for Poland) with differing lag revealing a crucial need of a fiscal consolidation. Large CAPB improvements and deteriorations revealed significant responsiveness of large current account adjustments to the fiscal incentives (0.65+) in the whole group of countries. The ratio is slightly higher for CAPB deteriorating episodes.

Regression results indicate that a decrease in CAPB at 1 percent point caused current account deterioration at a range of 0.05-0.26 percent points for model A (2000-2007) and 0.07-0.2 percent points for model B (2000-2012). However, the current account interference to CAPB changes seems to be lowest in big and low performing countries, followed by the group of "floaters" and then "peggers". Crisis period reduced exposure of external imbalances to CAPB changes resulted in decreased regression coefficients in all countries.

Results of impulse-response functions revealed some differences in responses of current accounts in each country to the negative one standard deviation CAPB shock. While big and low performing economies experienced slow and less intensive current account deterioration, "peggers" experienced less dynamic current account deterioration low smaller durability and "floaters" experienced more dynamic and more durable current account deterioration. Crisis period slightly changed short-term response patterns in all countries. Durability of the current account deterioration in big and low performing economies together with "peggers" slightly increased while immediate response increased in both groups of countries with pegged and flexible exchange rate arrangements. Despite euro adoption in Slovenia (2007) and Slovak republic (2009), regression results as well as

impulse-response functions do not provide any empirical evidence about similar patterns comparable with the results for countries in the group of "peggers" in model for extended period.

Acknowledgement

References

[1] Abbas, S.M. Ali, Bouhga-Hagbe, J., Fatás, A., Mauro, P., Velloso, R.C. (2011). Fiscal policy and the current account, *IMF Economic Review* 59(4): 603-629.

[2] Arghyrou, M.G., Chortareas, G. (2008). Current account imbalances and real exchange rates in the Euro area, *Review of International Economics*, 9(5): 747-764.

[3] Bouthevillain et al (2001). Cyclically adjusted budget balances: An alternative approach, European Central Bank Working Paper No. 77, Frankfurt am Main, European Central Bank, 73 p.

[4] Bussiere, M., Fratzscher, M., Muller, G.J. (2004). Current Account Dynamics in OECD and EU acceding countries - An intertemporal approach, European Central Bank, Working Paper, No. 311, Frankfurt, European Central Bank, 38 p.

[5] Caldara, D. - Camps, C. (2008). What are the effects of fiscal policy shocks, *European Central Bank Working Paper* No. 877, Frankfurt am Main, European Central Bank, 47 p.

[6] Corsetti, G., Gernot, J.M., (2006). Budget deficits and current accounts: Openness and fiscal persistence, *Economic Policy*, 21(48): 597-638.

[7] Corsetti, G., Müller, G. (2006). Twin deficits: squaring theory, evidence and common sense. *Economic Policy* 48: 597-638.

[8] Fidrmuc, J. (2002). Twin deficits: Implications of current account and fiscal imbalances for the accession countries, *Focus on Transition*, 2: 72-83.

[9] Glick, R., Rogoff, K. (1995). Global versus country-specific productivity shocks and the current account, *Journal of Monetary Economics*, 35(1): 159-192.

[10] Gruber, J.W., Kamin, S. (2005). Explaining the global pattern of current account imbalances, board of governors of the Federal Reserve System, *International Finance Discussion Papers* 846, 2005.

[11] Hassan, M. (2004). Budget deficits and the current account balance: New evidence from panel data, *Journal of Economics and Finance*, 28(1): 39-45.

[12] Chinn, M.D., Prasad, E.S. (2003). Medium-term determinants of current accounts in industrial and developing countries: An empirical exploration, *Journal of International Economics*, 59(1): 47-76.

[13] Javid, A.Y., Javid, M., Arif, U. (2010). Fiscal policy and current account dynamics in case of Pakistan, *The Pakistan Development Review*, 49(4): 577-592.

[14] Kim, S., Roubini, N. (2008). Twin Deficit or Twin Divergence? Fiscal policy, current account and real exchange rate in the US, *Journal of International Economics* 74: 362-383.

[15] Kumhof, M., Laxton, D. (2009). Fiscal deficits and current account deficits, International Monetary Fund, Working Paper, No. 237, Washington, International Monetary Fund, 35 p.

[16] Lane, P. R. (2010). External imbalances and fiscal policy, institute for international integration studies, Working Paper, No. 314, Dublin, Trinity College Dublin and CEPR, 24 p.

[17] Lee, J., Chinn, M.D. (2006). Current account and real exchange rate dynamics in the G7 countries, *Journal of International Money and Finance*, 25: 257-274.

[18] Mirdala, R. (2013a). Lessons Learned from Tax versus Expenditure Based Fiscal Consolidation in the European transition economies, *Journal of Applied Economic Sciences*, 8(1): 73-98.

[19] Mirdala, R. (2013b). Current account adjustments and real exchange rates in the European Transition economies, *Journal of Applied Economic Sciences*, 8(2): 210-227.

[20] Obstfeld, M., Rogoff, K.S. (2005). Global current account imbalances and exchange rate adjustments, *Brookings Papers on Economic Activity*, 36(1): 67-123.

[21] Obstfeld, M., Rogoff, K. (1995). The intertemporal approach to the current account, [National Bureau of Economic Research Working Paper No. 4893, New York, *National Bureau of Economic Research,* 75 p.

[22] Roubini, N. (1988). Current account and budget deficits in an intertemporal model of consumption and taxation smoothing. A solution to the Feldstein-Horioka puzzle? National Bureau of Economic Research Working Paper No. 2773, New York, *National Bureau of Economic Research*, 52 p.

[23] Rusek, A. (2013). The competitiveness dynamics in the Eurozone, *Global Journal of Management and Business Research Finance*, 13(5): 33-38.

[24] Schnabl, G., Wollmershäuser, T. (2012). Fiscal divergence and current account imbalances in Europe, CESifo, *Working Paper* No. 4108, Munich, CESifo, 38 p.

[25] Sek, S.K., Chuah, C.L. (2013). The dynamic of the current account in emerging East-Asian: Does exchange rate matter? *International Journal of Trade, Economics and Finance*, 2(4): 293-299.

[26] Soyoung, K., Roubini, N. (2008). Twin deficit and twin divergence? Fiscal policy, current account, and real exchange rate in the US, *Journal of Economic Literature*, 74: 362-383.

[27] Stavárek, R. (2013). Cyclical relationship between exchange rates and macro-fundamentals in Central and Eastern Europe, *Economic Research* (*Ekonomska istraživanja*), 26(2): 83-98.

[28] Uroševic, B. (2012). Jackknife model averaging of the current account determinants, *Panoeconomicus*, 59(3): 267-281.

OPTIMIZATION OF TAX LOADING ON THE ECONOMY AS THE MAIN DIRECTION OF TAX POLICY IMPROVEMENT OF THE COUNTRY

Lyubov SALO
Department of Finance, Lviv State Academy of Finance, **Ukraine**
luba.esina@gmail.com

Abstract:

The approaches to the definition of the concept "tax loading" have been discussed in the article. The evaluation of widely used methods of tax loading calculation on macrolevel has been performed. The level of this index throughout Ukraine and in the light of some taxes and collections has been analysed. The estimation and comparison of calculation results in accordance to social and economic development of the country have been conducted. The dynamics of this development has been analysed in comparison with the same indices of the developed countries of the world. The expediency of the optimization of tax loading level of domestic ecenomy has been argued. The main problems on the way to the optimization of tax loading and possible ways of their solution have been indicated. Special attention has been paid to the policy of tax benefits and preferences as the main direction of stimulatin of the economic development of the country.

Key words: tax loading, economic activity, tax coefficient, effective tax rate, economic entity, financial provision.

JEL Classification: E 62, H 21, H 22, H 26

1. Introduction

The development of domestic economy is impossible without formation and realization of an effective tax policy. Taxes have a strong influence on the tempos and proportions of social and economical development of the country. They stimulate business and innovative and investing activity of the country and facilitate the increase of factors of production and employment. Conducting tax policy the state should keep to the optimal level of tax loading by means of effective combination of the indices of some taxes and collections and general harmonization of the structure of tax system. Tax loading index helps to determine the real fiscal influence of tax system on the economy of the country. Nowadays we can observe the situation when exceeding tax loading has a bad influence on the economic growth of Ukraine. Tax loading facilitates the decrease of entrepreneurial activity, destroys favourable market environment, raises the shadow sector of the economy and causes crisis effects in the society. This is the reason to ground such level of tax loading which will correspond to the present-day social and economic situation in Ukraine. Thus, the importance and insufficient investigation of the problem define the choice of the theme of research and prove its actuality in present-day conditions.

2. Literature review

The works of native and foreign scientists (V. Andrushchenko, S. Barulyn (Barulin, 2011), T. Bohoslavets, O. Burbelo, H. Vasylieva, E. Haidar (Gajdar, 2005), A. Harberger, O. Hodovanets (Godovanets, 2008), Y. Drop (Drop, 2009), Y. Ivanov (Ivanov, 2009), I. Maiburov, Kh. Makhmudov, D. Melnyk, V.Oparin, V.Savchenko (Savchenko, 2011), O. Sayenko, A. Sokolovska (Sokolovska, 2008), O. Sukhoruko (Sukhoruko, 2011), V.Taranenko, T. Tkachenko, O. Fradynsky (Fradynsky, 2010), I.Tzurkan, and others) have been dedicated to the problematic aspects of tax loading and research of tax loading influence on the economic development of the state.

Most of the scientific works of these scientists are directed at the investigation of theoretical problems of the development of tax system and its components (taxes and their influence on social and economic development of the country). However, the research of tax loading level as the main criterion of taxation efficiency needs more detailed analysis. The necessity of the optimization of tax loading in accordance to the prsent-day priorities of the society development and the aims of social and economic policy of the country also require more detailed examination.

3. Modern approaches to the definition of concept "tax loading" and analysis of methods of its calculation

Nowadays there is no common opinion as to the explanation of the concept "tax loading". However, all scientists agree that it is a relative index which allows us to define a real fiscal influence of some taxes or tax system on the economy of the country. There are qualitative and quantitative approaches to the definition of this concept. The qualitative approach characterizes the essence of the concept "tax loading" and its connection with other concepts. This approach also describes the efficiency of introducing some types of tax payments. The quantitative approach needs the development of methods of "tax loading" evaluation on different organizational levels. Let us consider scientists' points of view as to the definition of the concept "tax loading" within the framework of these approaches (Table 1).

Table 1. Approaches of the authors as to the definition of the concept "tax loading"

APPROACHES	AUTHOR	ESSENCE OF THE CONCEPT "TAX LOADING"
Qualitative	A. Hodovanets	Tax loading is the index which characterizes the effectiveness of the level of state intervention by means of taxes and the activity of tax payers.
	A. Sokolovska	Tax loading consists in influence effects of tax payments on the economic sphere of the state and some tax payers that are connected with economic restrictions. These restrictions appear as a result of tax payment and distraction of the resources from other directions of their usage.
	O. Sukhoruko	Tax loading is the index which is the main criterion of the efficiency of tax system of the country. It influences the state revenues, the level of tax revenues to gross domestic product (GDP) and appropriate share of GDP per head.
Quantitative	Y. Ivanov, O. Yeskov, I. Mayburov	Tax loading is a measure, degree and level of economic restrictions which appear as a result of deduction of monetary resources for tax payment and their relocation from other directions of their usage.
	O. Fradynsky	Tax loading is a general index which defines the size of tax exclusion on macrolevel (state) and microlevel (economic entity).
	V. Savchenko, A. Los	Tax loading is the index which characterizes tax system and determines the level of re-distribution of financial resources in the country.
	S. Barulin	Tax loading is a financial concept which relatively defines the part of social product value. The part of social product value should be distributed and redistributed to the state revenue indirectly by means of taxation mechanisms.

Sources: (Barulin, 2011; Hodovanets, 2008; Ivanov, 2009; Savchenko, 2011; Sokolovska, 2008; Sukhoruko, 2011; Fradynsky, 2010)

Having investigated the existing approaches of the definition of tax loading we propose to consider it as the index which can help to evaluate the fiscal influence on social and economic development of the country in general and some economic entities in particular.

It is a common phenomenon that tax pressure constitutes no threat for an economy as it may exist in any country of the world where tax policy is implemented. At the same time the phenomenon should be adequate, effective and optimal taking into consideration the level of economic growth. Thus, nowadays the optimization of tax loading is one of the most important problems on the way to stable economic development of the state, increase of welfare and social standards of the population and strengthening of the national economy in general.

On macroeconomical level the mechanism of optimization of tax loading consists in the choice of the most effective and adequate forms and methods of taxation. This choice should be made in consideration of the peculiarities of subject of economic relations and in keeping the balance in the interests of a state and tax payers. The optimization of tax loading on microeconomic level (the level

of concrete enterprise) is the application of some measures for the purpose of maximal usage of the possibilities of tax law for decrease of tax payments.

A. Sokolovska states that nowadays the introduction of tax system which would combine the principles of economic efficiency and social fairness is the most actual. However, the optimization should be based on the achievement of the balance of intercompeting purposes. The purposes are not identical and constant for all states (Sokolovska, 2010). Therefore, different forms and methods of taxation which will be optimal for different countries are preferable.

Having analyzed the opinions of scientists it should be indicated that the problem of introduction of optimal level of tax loading has been discussed for centuries. At the end of the 19th century French economist P. Lerua-Boye stated that the taxes which made up 5-6% of GDP were optimal and efficient for the economy of the state; while taxes which exceeded 12% slowed down the economic development and constituted a threat for the security of the state in general (Gajdar, 2005). A. Laffert considers that the state should conduct moderate tax policy by means of introducing optimal tax payments. Limiting rates of the tax payments should not exceed 30% of income. Tax collections which make up 40-50%, lead to negative results in the economy as savings of people reduce and motivation of people to invest money decreases. In this situation tax evasion also takes place (Savchenko, 2011). The scientist considers that the increase of tax loading is possible only due to the increasing the number of tax payers and extension of tax base.

Recently the conception of "excess tax loading" became very popular among scientists. The conception is formed in the conditions of market economy of perfect competition with optimal resources distribution (according to Pareto). The conception of "excess tax loading" led to the fulfilment of principle of "taxation neutrality" as the introduction of equal conditions of taxation for all tax payers is expected (Kuzmin, 2010).

The scientists have different opinions as to the calculation of this index. Nevertheless, most of the scientists consider tax rates, tax level per one employee and per head as a significant measure of tax loading. Share of taxes in proceeds from the realization of products and share of net taxes (income and property taxes, tax on salary, goods, production and import) in gross domestic product are also important measures of tax loading (Drop, 2009). Most countries of the European Union determine the level of tax loading by means of the calculation of efficient tax rates. The method lies in the distribution of taxes according to economic functions: labour, capital and consumption.

Thus, taxes on labour include income tax of physical persons (employees) and insurance payments of employees and employers to the out of budget funds.

The group of taxes on capital incomes includes tax on enterprise income, property taxes, taxes on winnings in lotteries and gambling games, local taxes and collections and other income taxes. The group of taxes on consumption includes domestic taxes on goods and services (value-added tax, excise tax on goods liable to duty produced in Ukraine, excise tax on imported to Ukraine goods), taxes on international trade and foreign operations (import and export duties), taxes on specific services and other indirect taxes.

Thus, the studied methods allow us to evaluate the level of tax loading in the country. The eveluation should be conducted taking into consideration present-day social and economic development. One of the conditions of the evaluation is perfect tax administration and low level of "shadow economy". Though this method, the following disadvantages: complication of taxes division depending on economic functions and their belonging to a certain tax base, had identified.

Along with the official methods of tax loading calculation there are other methods which can be described as rating methods, i. e. the methods with the aid of which you can define the position of any country as to the certain peculiarities of taxation in the rating of the countries of the world. The company "Heritage Foundation" together with Wall Street Journal suggest the method which consists in the calculation of "Index of economic freedom" which involves "Index of fiscal freedom". The rating includes 177 countries starting from the most economic free to the depressed one. According to the rating in 2013 Ukraine occupies 161 places with the index "46.3% of freedom" and belongs to the group of "depressed countries". Though these, according to the level of fiscal freedom the domestic economy occupies 95 places in the rating with index "78.2% of freedom". Under this index Ukraine takes place in the group of such developed countries as Brazil (70.3%), Canada (79.8%), Chile (77.6%), China (70.2%), Hungary (79.7%), Iceland (72.7%), Ireland (73.8%), Poland (76.0%), Turkey (76.0%) (Heritage Foundation). As we can see the calculated "Index of fiscal freedom" in Ukraine is

sufficiently high and occupies the second place among the other ten freedoms. However, there are some differences between the level of social and economic development and the level of effectiveness of financial policy realization in these countries.

4. Investigation of tax loading level in Ukraine and in the world according to the methods based on tax coefficients calculation

The method which is based on the calculation of tax coefficient is used in the country. The method consists in including tax revenues to GDP and is used with the aim of international comparison to characterize the actual level of tax loading in Ukraine. After Tax Code adoption taxes on labour (insurance payments to the out of budget funds) have been referred to non-tax revenues. Taxes on labour make up 12% of tax loading in average. Hereby, it is necessary to take into consideration the level of tax loading on labour for the calculation of general level of tax loading on the economy of Ukraine. The level of tax loading on labour should be calculated by means of the sums of aggregate insurance payments to the out of budget funds. The calculation of general tax loading on the economy of Ukraine is shown in Table 2.

Table 2. The dynamics of tax loading on the economy of Ukraine during 2008-2012

INDICES	Years				
	2008	2009	2010	2011	2012
Tax revenues to the Consolidated budget, mln. UAH.	227 164.8	208 073.2	234 447.7	334 691.9	445 454.3
Sum of the aggregate insurance payments to the out of budget funds, mln. UAH.	101 488.3	103 104.3	119 339.4	151 756.5	178 791.0
GDP, bln. UAH.	948.1	913.3	1094.6	1314	1408.8
Level of general tax loading (tax coeffitient), %	34.6	34	32.3	37	44.3

Sources: (Ministry of finance of Ukraine; State Statistics Committee of Ukraine; Authors calculations)

Thus, the general level of tax loading in Ukraine fluctuates from 32.3% to 44.3%. The calculations show that the level of tax loading has been reducing by 2010 whereas in 2012 the tax loading reached its highest level – 44.3%. This is by 7.3% more than in 2011 and by 12% more than in 2010.

It is reasonably to consider the formation of tax loading in the light of some taxes and collections to define such a tendency. The taxes and collections should be stipulated by the current legislation of Ukraine (Table 3).

Table 3. The dynamics of tax loading forming in the light of different types of taxes and collections in Ukraine during 2008-2012

INDICES	YEARS					Average
	2008	2009	2010	2011	2012	
Tax on incomes of physical persons	4.84	4.88	4.65	4.59	4.8	4.75
Tax on enterprise income	4.62	3.64	3.68	4.21	3.96	4.02
Property taxes	0	0	0	0.05	0.05	0.05
Collections and payments for special utilization of natural resources	0.29	0.35	0.52	1.12	1.45	0.74
Value-added tax	9.71	8.65	8.09	9.92	10.85	9.44
Excise duty on goods produced in Ukraine	1.08	1.96	2.18	1.99	3.03	2.05
Excise duty on imported to Ukraine goods	0.26	0.41	0.43	0.61	0.7	0.48

INDICES	YEARS					Average
Import duty	1.26	0.71	0.78	0.81	0.92	0.89
Export duty	0.04	0.03	0.03	0.09	0.02	0.74
Local taxes and collections	0.06	0.1	0.07	0.19	0.36	0.15
Other taxes and collections	1.74	1.97	1.83	2.15	5.46	2.7
Tax loading on the budget, %	23.9	22.7	21.4	25.5	31.6	25.02
Tax loading on labour, %	10.7	11.3	10.9	11.5	12.7	11.42
TOTAL tax loading, %	**34.6**	**34**	**32.3**	**37**	**44.3**	**36.44**

Source: (State treasure service of Ukraine; Author,s calculations).

Thus, table 3 demonstrates that the Tax Code adoption has not desreased the tax loading on the economy but promoted its increase. The average level of total tax loading in Ukraine during 2008-2012 makes up 36.44%. The considerable part of tax loading of domestic economy falls on labour resources. The average level of tax loading on labour resources during the analyzed period makes up 11.42%. Tax loading from domestic taxes on goods and services is 13.6%. This fact influences the level of savings and effective demand of the population that pay these taxes. Income taxes and tax on increasing market value make up 8.82% of tax loading.

To ground and determine the optimal level of tax loading in Ukraine it is necessary to make a comparative analysis of the given index with the analogous index of the countries with developed economy (Table 4).

Table 4. Tax loading in Ukraine and in the countries with developed economies during 2012

Country	Tax loading on income, %	Tax loading on labour, %	Tax loading from other tax payments, %	Total tax loading, %
Luxembourg	4.1	15.1	1.6	20.8
China	17.6	5.3	0.1	23.0
Canada	8.4	12.7	5.8	26.9
Denmark	20.2	3.6	3.7	27.5
Great Britain	23.1	11.0	3.2	37.3
Spain	1.2	36.8	0.7	38.7
Norway	24.4	15.9	1.3	41.6
Portugal	15.0	26.8	1.5	43.3
Poland	17.4	23.6	2.6	43.6
Ukraine *	*27.5*	*12.7*	*4.1*	*44.3*
Romania	10.4	31.8	2.2	44.4
USA	27.6	10.0	9.1	46.7
Germany	19.0	21.8	5.9	46.7
Sweden	15.7	35.5	1.6	52.8
Austria	15.0	34.8	3.4	53.2
Russia	7.1	41.2	5.8	54.1
Ukraine	12.2	43.3	1.6	57.1
Byelorussia	20.3	39.0	1.4	60.7
France	8.2	51.7	5.7	65.7
Italy	22.8	43.4	2.3	65.7
Brazil	22.4	40.9	3.8	67.1

Source: (Preston J. *et al.* 2011)

The data indicated in table 4 show that the calculated index of tax loading makes up 44.3% and is lower than the index calculated by the World Bank and Princewaterhouse Coopers. The data of the World Bank and Princewaterhouse Coopers indicate that the level of tax loading in Ukraine makes up 57.1%. Thus, Ukraine occupies 152 place among 183 countries which were investigated. It is in the same group with such countries as Sweden (52.8%), Austria (53.2%), Russia (54.1%). The explanation of this situation is shadow economy of Ukraine. The actual value of GDP does not take into consideration all earned financial results of economic entities and population. It is so because a lot of them conceal their real incomes and in such a manner decrease a relative importance of the social sector of economy. The extra charges to the fund of labour remuneration are also an important problem because of high level of rates. Thus, a great number of enterprises and physical persons try to conceal the real wages of their employees. They prefer pay-envelopes or payments in kind and in such a case the level of real wages is minimal.

According to some unofficial data the real level of tax loading on the economy of our state makes up 80% of aggregate income of tax payers without taking into account tax loading on labour and cost price of production (Drop, 2009).

5. Generalization of the problem of excess tax loading in Ukraine and possible directions of its optimization

The main reason of excessive tax loading in Ukraine, in the opinion of leading economists, is its dispropotrionality among tax payers. This disproportionality appears under the influence of such negative occurences as the distribution of tax loading and unreasoned machanism of tax benefits and preferences.

As the sphere of tax activities is considerably wider than a number of its payers it results in the relocaion of tax loading. In practice, a tax payer, reducing the amount of his/her expenses because of tax, removes tax pressure back on the sellers of these goods and services. The expenses for these goods and services reduce and as a result most of the taxes are payed by physical persons by adding them to the cost price or by increasing the price of goods and services (Drop, 2009). The model of the development of national tax system where indirect taxes prevail over direct taxes is considered irrational. Under such conditions the interest of taxation bodies in increasing the effectiveness of the economy of the country decreases generally.

It should be noted that nowadays enterprises of manufacturing sector carry a considerable tax loading. Whereas most enterprises of services sector and small business can legally evade from excessive tax loading due to the mechanism of simplified taxation and tax deductions. Obviously, it has a negative influence on financial activity of manufacturing enterprises because of lack of the possibilities for the further development of production.

The policy of tax benefits and preferences in Ukraine is groundless and inefficient. The disproportions of tax loading on economic entities prove it. To level the general tax pressure it is necessary to reduce a quantity of tax benefits and preferences among the payers because nowadays their stimulant effect on the state economy is unproved. However, it is necessary to pay attention to the fact that the efficient and well thought-out tax policy as to the preferential tax treatment is a significant reserve for tax potential accumulation and tax base enlargement. At the same time offering benefits and application of a method of rapid amortization allow to stimulate the innovational and investment activity. This is done by means of forming attractive regimes of taxation as to special economic zones, technoparks and territories of priority development. Thus, the list of well-grounded tax benefits is indicated in the Tax Code of Ukraine. Among the benefits are:

- the exemption from taxation on income obtained from the realization of investment project in case the investment is equal to not less than 3 million US dollars (for the subjects of small business – not less than 500 thousand US dollars) within 3 years from obtaining the first income;
- the exemption from VAT on imported to Ukraine goods (equipment and its tools which are used only for the realization of investment project) for the period of realization of investment project but not more than for 5 years;
- taxation of incomes of nonresidents of Ukraine received from the realization of investment projects (in the amount of 2/3 of a rate);

▪ taxation of dividends payed to the investor by the economic entity that realizes the investment project at the rate of 3% (Tax Code of Ukraine).

Thus, the mechanisms and regimes of preferential tax treatment are rather effective. The vital task is to attract investors to concrete regions and spheres of activity by means of these mechanisms and regimes. The current legislation provides tax deferrals and deferments in the form of nullification of fines and penalties in order to stimulate the development of real sector of the economy and activization of business activity.

The priority direction of stimulation of investment and innovational activity except special tax regimes is extension of production and power saving technologies. In particular, the Tax Code stipulates tax benefits for income taxes in the given sphere, namely exemption from taxation which makes up 80% of enterprise income from the equipment operating on non-conventional sources of energy; power saving equipment, materials and wares; means of measurement, control and management of expenses of fuel and power complex sold on the territory of Ukraine.

Applying of tax benefits for these productions is also substantiated taking into consideration the increase of demand for innovations in the sphere of power saving technologies and rapid scientific and technical development in the world.

Having analyzed the world experience it is clear that optimal level of tax loading should be defined by social and economic conditions of the state development and components of state management system. Nowadays the special attention deserves the idea that tax loading should be planned on the level of enterprise by means of tax planning. The method of tax loading optimization may allow the tax payers to reduce their tax obligations using all the possible legal means. This method consists in the fact that the enterprise chooses the most optimal way of financial and economical activity and allocates the assets to achieve the lowest level of tax obligations which arise (Prytuliak, 2009). Thus, the effective policy of tax planning at the enterprise will give the opportunity to get the highest incomes by minimizing tax liabilities.

6. Conclusions

Summarising the results of conducted investigation it should be noted that the level of tax loading in Ukraine is more moderate than in developed countries of the world while the mechanism of administration of taxes and collections is much more complicated. However, some scientists consider that a real level of tax loading is much higher and it has a bad influence on the economy of the country and causes social tension in the society. The problem of the equality and proportionality of the apportionment of tax pressure among tax payers is still unsolved.

The main task of officials, experts and scientists is to balance the tax loading level through offering benefits and preferences which would stimulate the economy of the country and will not cause aggravation of the problem of relocating tax loading from one tax payer to another. This problem can be solved by means of improving the mechanisms of tax administration since the expenses for the management of tax payments are not always grounded within the period they were spent. The solution as to the offering benefits should be taken on the account of the sphere of tax payer activity; i. e. the benefits should be given mainly to the investment and innovational enterprises to attract investors to concrete regions or branches of the economy which are not interesting for running entrepreneurial business under the regime of general system of taxation. It is necessary to emphasize that one of the most important ways of the optimization of tax pressure on payers is efficient policy of tax planning. It helps the economic entities to regulate the level of tax loading independently and legally by means of their own method of tax loading estimation and analysis of taxes which have to be paid.

The vital tasks on the way to the optimization of tax loading in Ukraine are the following:

▪ legislative improvement of the system of tax control with the aim of creating conditions which make tax and collections evasion impossible;
▪ regulation of taxation and accounting systems.

The tasks determine the urgency of the theme of investigation and emphasize the necessity of conducting further research in this direction.

References

[1] Barulin, S. (2011). *Tax management*. Dashkov I K.

[2] Gajdar, E. (2005). State Burden on Economy. *Questions Economy,* 9: 4-21.

[3] Godovatets O. (2008). Tax loading: important factor in the socio-economic strategy of the state. *Economic analysis, 3(19)*: 85-89.

[4] Drop Y., Chaban, U. (2009). Tax loading and its impact on the economy of Ukraine. *Formation of a market economy in Ukraine, 219*: 213-219.

[5] Ivanov U. (2009). Functions of taxes and tax regulation. *Formation of a market economy in Ukraine 19*: 36-43.

[6] Kuzmin, O. (2010). Forming the base budgets for companies by using the regional factors. *Regional Economics,* 1: 177-185.

[7] Preston, J., Peckman, A., Howlett, N., Claros, A., Solf, S., and Trumbic, T. (2011). *Paying Taxes 2012. The global picture*. Doing business.

[8] Prytuliak, N. (2009). On the issue of tax planning in the company. *Proceedings of the National University of State Tax service of Ukraine, 16:* 243-429.

[9] Savchenko, V., Los, A. (2011). Evaluetion the level of tax loading in Ukraine. *Economic Journal, XXI 9: 25-28.*

[10] Sokolovska, A. (2008). Metodological and methodical aspects of determining the tax loading on labour, capital and consumption. *Finance of Ukraine, 1: 65-76.*

[11] Sokolovska, A. (2010). *Fundamentals of the theory of finance*. Kondor.

[12] Sukhoruko, O. (2011). Fiscal efficiency of the tax component of budget of different levels. *Journal Berdyansk University Management 1(17):* 93-96.

[13] Fradynsky, O. (2010). The concept of the tax loading and approaches to its definition. *Journal Khmelnitsky National University, 1(1): 79-82.*

*** Tax Code of Ukraine. (2010). No. 2755-IV, http://zakon2.rada.gov.ua/laws/show/2755-17

*** Heritage Foundation. (2012). Ranking the Countries. Heritage Foundation, http://www.heritage.org/index/Ranking.

*** Ministry of finance of Ukraine. (2010). Tax revenues of the Consolidated Budget of Ukraine, http://www.minfin.gov.ua/control/uk/publish/archive/main? cat_id=77643.

*** Pension Fund of Ukraine. (2012). Admission to the extra-budgetary funds. Pension Fund of Ukraine, http://www.pfu.gov.ua/pfu/control/uk/publish/category?cat_id=95533.

*** State Statistics Committee of Ukraine, http://www.ukrstat.gov.ua

*** State treasure service of UK. (2012). Indicators of the state budget. State treasure service of UK, www.treasury.gov.ua/main/uk/publish/category/23593;jsessionid=b5b1048bf511eb6fd9565d744 1f36e1b

THE PLACE AND ROLE OF SMALL AND MEDIUM SIZE ENTERPRISE'S IN THE ROMANIAN ECONOMY. BASE FOR EFFICIENT USE OF RESOURCES

Silvia SIMIONESCU
Spiru Haret University, **Romania**
Faculty of Financial Management and Accounting Craiova
silviasimionescu@yahoo.com
Simona MOISE
Spiru Haret University, **Romania**
Faculty of Financial Management and Accounting Craiova
simonamoise01@yahoo.com

Abstract:

For large firms, SMEs are the world from which they have come and where their future competition will arise. For individuals, SMEs are often a first job, the first step in their careers. They are also a first step towards the world of entrepreneurs. For the whole economy, SMEs are launchers of new ideas and new assembly processes that accelerate growth based on a more efficient use of resources.

Firms will not be able to capitalize on the advantages arising from the internationalization will not keep within the limits of economic efficiency and default, will come out of the international economic relations. It is for this reason that, any undertaking, regardless of its size, must master the costs and revenues.

Keywords: SME, economic and financial crisis, opportunities providers, business environment, market economy.

JEL Classification: M12, M54, J53

1. Introduction

Events that occurred 20 years ago in Romania as in other Central and Eastern European countries have caused evolution of two components, namely: the transfer of ownership of enterprises from state to private persons and the emergence of new private enterprises following independent private initiatives.

The two paths of development occurred more or less simultaneously and at different speeds, both having repercussions on the labor market. Thus, while privatization has reduced the number of jobs, boosting unemployment, private sector induced an opposite effect, creating new jobs.

Analyzing characteristics of the Romanian economy, according to data provided by the NSI and Eurostat, note that they tend to approach those of a functioning market economy.

SMEs have become increasingly important in our society as providers of employment opportunities and key elements for the welfare of local and regional communities.

2. Small and medium size enterprise's as major player on the markets of Central and Eastern Europe

SMEs, although set in a major player in the markets of Central and Eastern Europe, they play the role of principal employer and the largest contributor to the Gross Domestic Product of countries in the region that had been greatly affected by the financial and economic crisis. This explains why the number of SMEs in 2009 decreased compared to 2008[11], as shown in the figure below:

---

[11] *CNIPMMR-SME - White Paper 2009*
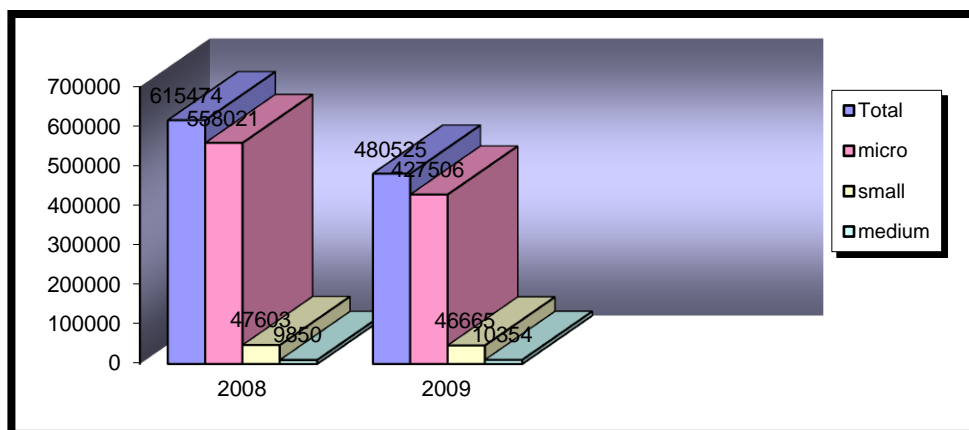
Source: National Statistical Institute and National Council of Private Small and Medium Enterprises from Romania

Figure 1. Comparation between the number of SMEs in 2008-2009

Excepting Poland, where the number of bankruptcies in 2009 remained below 1000, in all other states, the recession has brought down many SMEs. Romania is by far the most affected, given that in 2009, over 100,000 SMEs have gone bankrupt, out of 615,474 recorded as active.

In order to stay on the market, these companies have resorted to various measures to cut costs, such as layoffs, salaries cuts, and reducing administrative costs.

The loans these firms were provided with before the crisis remained only a memory now. Despite the flexibility of these companies, they do not provide the same level of safety for banks and large corporations.

However, National Council of Private Small and Medium Enterprises from Romania (NCPSMER) 12 assessed as favorable overall development of the business environment in Romania in 2008-2009, as shown in Figure 2.
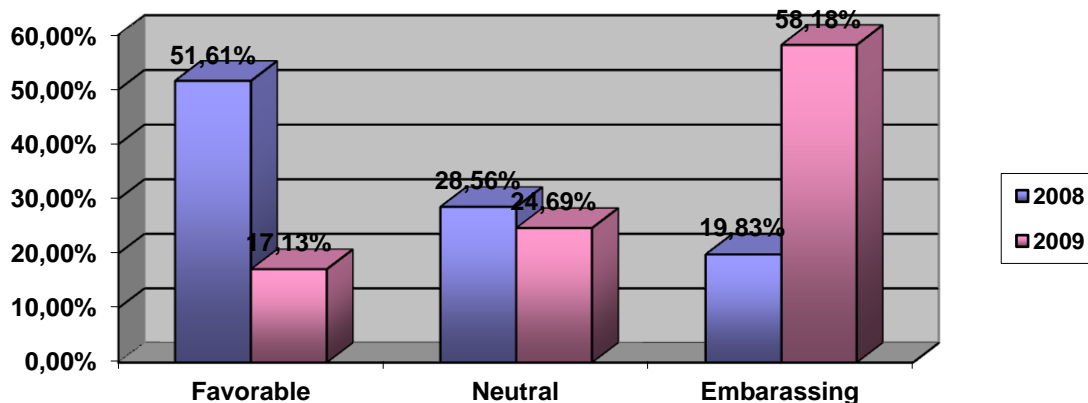
Figure 2. Global evolution of business environment in Romania

Major difficulties faced by SMEs in 2008-2009 (Figure 3) reveal that the decrease in domestic demand, excessive taxes and delays in collecting bills were the main causes that contributed to the worsening of their situation.

---

[12] CNIPMMR-SME -White Paper 2009
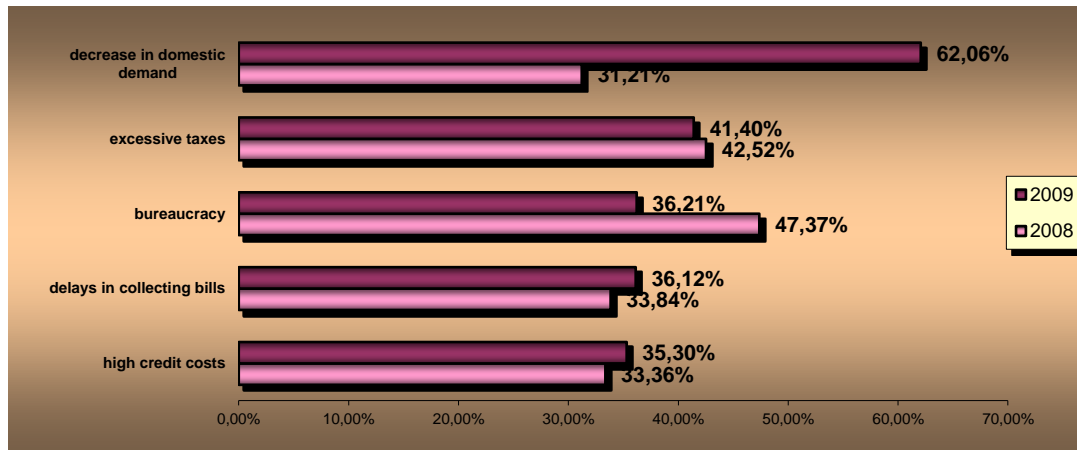
Figure 3. *Difficulties of SMEs*

Difficulties encountered by SMEs, as a consequence of the financial and economic crisis, explained the evolution of their overall performance in 2009 compared with 2008, compared to evolution in 2008 compared to 2007, as shown in Figure 4.
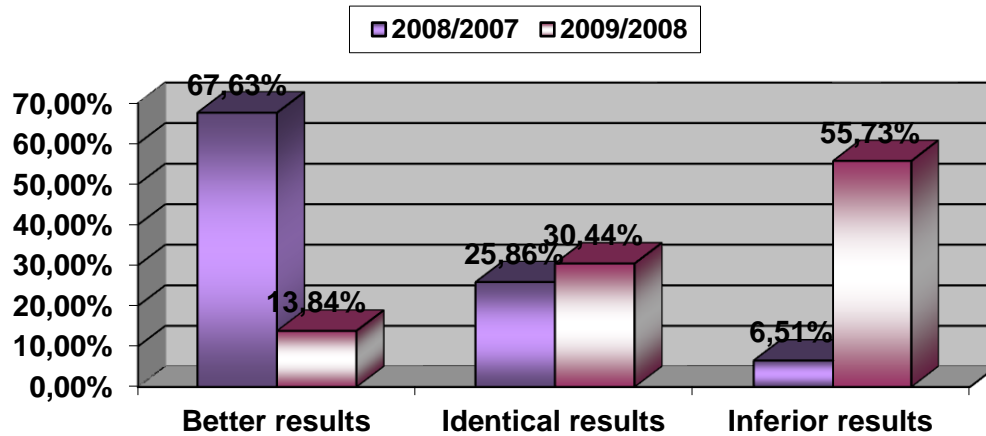
Figure 4. Evolution of SMEs performances

NCPSMER assessments presented above, consider the structure of SMEs after the outcome analyzed at the end of 2009 compared with 2008, as shown in Table 1.

Table 1. Structure of SMEs after the obtained result

Enterprise type	Profit		Loss		Null		Total
	2008	2009	2008	2009	2008	2009	
Micro	43,50	39,67	45,00	51,57	11,50	8,75	100
Small	75,40	67,77	24,30	52,17	0,03	0,06	100
Medium	78,60	73,74	21,30	26,22	0,03	0,04	100
TOTAL	46,40	42,09	43,10	49,90	10,50	8,03	X

Subjecting attention the SMEs situation in late 2009, the types of businesses and regions (Table 2), we find the following:

Table 2. *Structure of SMEs on types and regions of development, 2009*

REGION	Enterprise type				TOTAL	% Weighting	
	Micro	Small	Medium	Large		Micro in total firms	Micro in total region
1 - North East	53.013	5.692	1.191	204	60.100	12,40	88,21
2 - South East	52.673	5.656	1.231	223	59.783	12,32	88,11
3 - South	51.007	5.621	1.228	241	58.097	11,93	87,80
4 – South West	35.712	3.603	741	180	40.236	8,35	88,76
5 - West	42.306	4.855	1.105	194	48.460	9,90	87,30
6 - North West	56.832	6.511	1.453	210	65.006	13,29	87,43
7 – Center	54.677	6.592	1.474	274	63.017	12,79	86,77
8 - Bucharest	81.286	8.135	1.931	410	91.762	19,01	88,58
TOTAL	427.506	46.665	10.354	1.936	486.461	100,00	87,88

Source: Own processing of data from NSI publication „Romania in numbers 2010"

This structure is presented graphically in Figure 5.
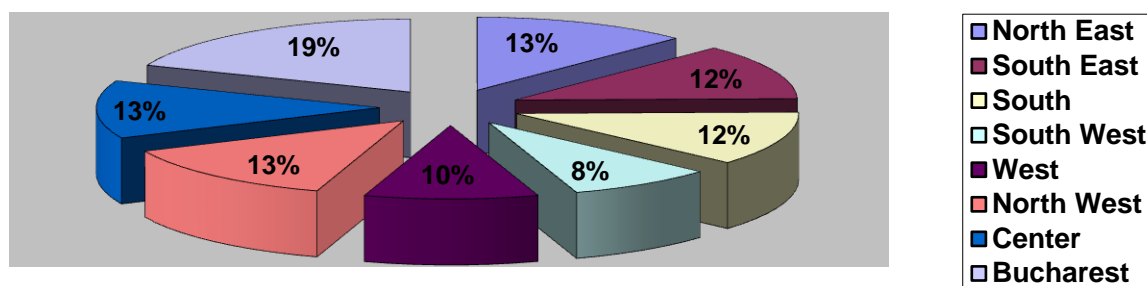
Figure 5. Structure of SMEs on developement regions

As it can be observed, small and medium enterprises in Romania with private capital have the largest share in the Romanian economy. They represent 99.6% of all companies registered in Romania in 2009, from which micro-enterprises hold 87.88% of total active enterprises, or 88.2% of total SMEs. Regarding the development regions, the least represented is Region 4 South West which holds 8.27% of total active companies and 8.35% of micro-enterprises.

A measure of displacement structure is given by the indicator proposed by A. O. Hirschman[13] by relationship:

$$C = \sqrt{\sum_{1}^{n} g_i^2} \,,$$

where g_i represents specific weights and $i = 1, ..., n$ number of populational groups. The interval of variation is:

$$\sqrt{1/n} \leq C \leq 1,$$

Proximity to limit 1 shows a strong concentration and of $1/n$ a balanced diversification. In Table 3 we present the results in the 8 regions of enterprise development, by size class for two indicators (structure by number of companies and the share of turnover in total).

---

[13] The Herfindahl index (also known as Herfindahl–Hirschman Index or HHI) is a measure of the size of firms in relation to the industry and an indicator of the amount of competition among them. Named after economists Orris C. Herfindahl and Albert O. Hirschman, it is an economic concept.

Table 3. Concentration of enterprises on development regions according to Hirschman indicator

REGION	Concentration, calculated after:	
	Weighting in total number of enterprises	Weighting in total turnover
1 - North East	0,887	0,512
2 - South East	0,886	0,529
3 - South	0,884	0,539
4 – South West	0,892	0,517
5 - West	0,879	0,511
6 - North West	0,880	0,513
7 – Center	0,874	0,520
8 – Bucharest Ilfov	0,891	0,507

Source : Own processing of data from NSI and regional statistics

As shown, size class analysis leads to the conclusion that there is a relatively high concentration of the number of enterprises and sufficiently balanced in the development regions.

Regarding the turnover the diversification is high ($\sqrt{\dfrac{1}{n}} = 0.5$), the region 8 – Bucharest Ilfov reaching the limit, which shows that businesses, regardless of size class, contribute about equally to the formation of turnover. Same significant issues we observe and if we look at the number of enterprises per 1,000 inhabitants or per square kilometer, both overall and by regions (Table 4).

Table 4. *Structure of enterprises on development regions, 2009*

Region	Number of enterprises	Population	Area (km²)	Businesses per 1,000 inhabitants	Businesses on the square kilometres
1 – Northern -East	60,100	3,823,492	36,850	15.72	1.63
2 – South- East	59,783	2,934,319	35,762	20.37	1.67
3 - South	58,097	3,465,468	34,453	16.76	1.69
4 - South West Oltenia	40,236	2,399,831	29,212	16.77	1.38
5 - West	48,460	2,041,129	32,034	23.74	1.51
6 - Northem West	65,006	2,844,042	34,159	22.86	1.90
7 - Center	63,017	2,642,242	34,100	23.85	1.85
8 – Bucharest - Ilfov	91,762	2,284,682	1,821	40.16	50.39
TOTAL	486,461	22,435,205	238,391	21.68	2.04

Source : Own processing of data from NSI publication „Romania in numbers 2010"

3. Strengths, Weaknesses, Opportunities, and Threats analysis of South West Region 4 – Oltenia

Positioning ourselves in the South West Development Region and given that the indicators analyzed set it last, we considered it useful to do a SWOT analysis of the region, noting the following (Table 5):

Table 5. SWOT analysis of South West Region 4 – Oltenia

STRENGTHS	WEAKNESSES
▪ Key transit region between Banat and Wallachia (Bucharest) situated at the intersection of the pan-European corridors IV and VII;	▪ Underdeveloped transport infrastructure; ▪ Lack of highways in the region and the lack of proper junctions; ▪ Lowest density of railways in the country; ▪ Border rail links with Yugoslavia and Bulgaria do not exist;

STRENGTHS	WEAKNESSES
▪ Largest producer of hydroelectric power (Iron Gates and Lotru-River) - about ¾ of total and heat-based power (Jiu-Motru coalfields: Rovinari and Turceni and Isalnita - Craiova) - about a quarter of the national total; ▪ The region is rich in underground resources (coal, gas, oil, mineral and thermal springs, construction stone, salt) and soil (Oltenia Sub-Carpathians and mountain regions have forest resources (beech)); ▪ The Danube is an important resource for industry, tourism, fishing, etc. ▪ Craiova is one of the most important university centers in the country (about 30,000 students); ▪ The region has diverse tourism potential, including: mountaineering and spelunking (Mehedinti, Florida and Valcea), spa (hot springs in Valcea county (Govora, Baile Olanesti, Călimăneşti-Căciulata), eco-tourism, nature parks (over 200,000 hectares of protected areas), religious (over 60 Orthodox monasteries and hermitages); ▪ The region has a total agricultural area of over 1.8 million ha, representing 12.3% of total country; ▪ Zones with modern industry: Slatina – aluminum industry with numerous international capital investments, Rm Valcea (chemistry), Turnu Severin and Craiova (mechanical engineering).	▪ Danube ports are poorly equipped with no possibility of Ro-Ro and container transhipment;Existing under-utilized airport infrastructure (Craiova); ▪ Weak utility and environmental infrastructure (water, sanitation, sewage, epuration, waste management, communications) in rural areas but also in cities, in general, the lowest density of facilities in all the regions; ▪ Because the Danube has acted in over time as a natural barrier, the region has only limited role in the transit of goods with neighbors; ▪ Low capacity to attract foreign direct investment (3.5% of the country), weak business support network, weak capacity of consultancy; ▪ With 40,056 SMEs active (2009), region South West is on the last place which explains the low share of GDP (8.27%) and gross value added (8.29%); ▪ Business support structure in early stage of development - 3 industrial parks and 5 business incubators; ▪ Insufficiency and low standard of tourism and leisure infrastructure, poor quality of tourism services; ▪ Mono-industrial areas (mining basins Motru and Rovinari - "disadvantaged areas") or non-industrialized (Mehedinti Plateau); ▪ Population density is below the national average with a relatively large number of villages and small towns; ▪ High share of employment in agriculture and low profitability of agricultural activities; (54.7% of the region's population lives in rural areas and contributes 11.62% to the regional GDP); ▪ Serious problems of rural poverty and poor social services; ▪ Acute environmental problems affecting water, air, soil and subsoil (lignite mining area in the north and around Craiova); ▪ Poor quality of health infrastructure, not only in rural areas but also in cities; ▪ Apparent discrepancy between the professions offered by the education system and labor market requirements (quality of education in rural areas is affected by weak educational infrastructure); ▪ Regional undergraduate education infrastructure is in a fairly advanced state of decay and poorly equipped; ▪ Poorly developed research-innovation infrastructure and low percent of implementation of research findings; ▪ Difficulties related to the integration of many gypsies minority (5-6% of the total population of the region);

OPPORTUNITIES	THREATS
▪ Exploitation potential of the Danube as a low-cost corridor (Corridor VII); ▪ Calafat-Vidin bridge construction (road and rail access) to Bulgaria, Greece, Turkey, Middle East (Corridor IV); ▪ Increased potential for mountain tourism, rural, spa, Danube, religious etc.;	▪ Increased inter-and intraregional disparities; ▪ Rising unemployment following the privatization of large state enterprises, industrial restructuring and economic and financial crisis;

OPPORTUNITIES	THREATS
▪ EU allocates substantial funds for environmental protection and human resources; ▪ Increased potential for organic farming and agro-tourism, particularly in the north of the region; ▪ Interest in establishing technology parks and industrial; ▪ Labor availability for retraining and skills development; ▪ Cheap hydropower resources and liquid hydrocarbons.	▪ Accumulated problems of coal mining still unsolved ▪ EU enlargement will lead to increased competition for agricultural products, may disadvantage some traditional sectors; ▪ Massive migration of young people due to lack of jobs ▪ Un-qualifying of specialists in mechanical engineering (Craiova, Balş, Turnu Severin); ▪ Failure of large industrial facilities (e.g. Chemical Plant Craiova).

If we classify enterprises by industry, according to data provided by NCPSMER then 35.60% of companies are operating in trade, 23.51% in services, 19.48% in industry, 8.88 % are working in tourism, 6.79% in construction and 5.75% are operating in transport, as observed in Figure 6.
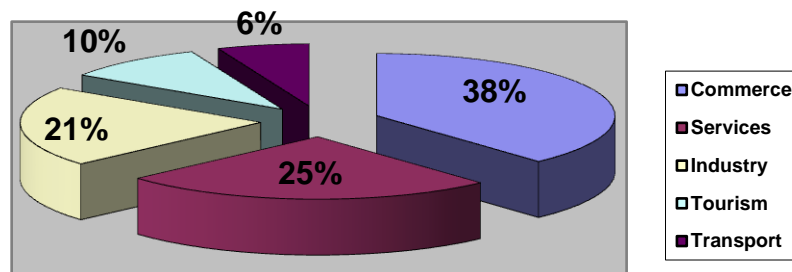
Figure 6. Structure of SMEs by industry

Note that, in the grouping of SMEs by industry was considered the main activity, ie the activity that contributes the most to the value added of the enterprise. We have mentioned this because many companies are actually covering several fields because they focus on identifying and capitalizing business opportunities and this is a basic characteristic of SMEs, both in Romania and in other countries. This feature of SMEs was the reason why our research has turned to this sector of activity which undoubtedly leaves its mark on revenue and expenditure underlying the performance evaluation activities.

In the XXVI Congress of the ICSB[14] held in Toronto, in 1999, it was stated that "twenty-first centuries will be of the small and medium-independent enterprises integrated in networks, totally different from the twentieth century, which was of the large firms, based on cost savings". A functional and competitive economy, as stated (Zaman, 1999) involves both large enterprises and SMEs. Large firms seek to control the market direction changes technologically, while SMEs have as main objective the creation of niche type markets, through a permanent redesign of products, knowledge of the markets and continue to adapt to the requirements of the consumers.

Flexible production tends to promote the growth of small and medium-sized enterprises' role, but should not be overlooked that in some industries - aerospace, electrical and thermal energy, road transport industry - small size of the organization is incompatible with the technological flow characteristics, the presence large enterprises is, in this case, absolutely necessary, being a fundamental premise of economic efficiency.

National Credit Guarantee Fund for Small and Medium Enterprises (NCGFSME), pillar supporting the SMEs sector in Romania[15], has shown a constant interest in identifying the needs of its traditional partners, representing a binder of strengthening the partnership between financial

---

[14] International Trade for Small Business is an organization whose activity is focused on the development of small and medium sized companies, the promotion of small business and entrepreneurship
[15] http://www.craiovagarantare.ro

institutions and SMEs, at the same time wanting to maintain the upward trend of its service quality development through continuous optimization, so that it can provide an adequate response to specific requirements of its partners.

NCGFSME representatives have shown that in terms of value, the volume of guarantees granted in 2012 increased by over 37% from a level of approx. 512 million EUR in 2011 to approx. 703 million EUR in 2012. In addition to its own activity, NCGFSME carried, in the name and behalf of the State, a number of government programs, whose value was in 2012 of approx. 176 million EUR.

NCGFSME announced[16] that in 2012 they granted 11,000 loans guarantees for SMEs in Romania, 12% more than in 2011. Total volume of guarantees provided NCGFSME last year was 703 million euros, up 37% compared to 2011, when the volume of guarantees was 512 million euros. Comparing the years 2012 and 2011[17], in terms of the number of SMEs benefiting from guarantees, showed an increase of approx. 12%, approx. 11,000 SMEs guaranteed in 2012, this is an evidence of the high degree of penetration and knowledge of fund activity by businesses in Romania.

According to Eurostat report on SMEs for 2012 Romania is the country with the most dramatic changes from the beginning of the crisis. It also dropped the number of employees, production and labor productivity.

In 2012 SMEs supported the EU economy, with 99.8% (20.7 million) of non-financial companies, of which, 92.2% are micro enterprises and only 1.1% fall in the middle category. All SMEs in European Union have provided 67.4% of jobs in the non-financial sector, as in 2011, but up from 2010 (66.9%). They have provided 58.1% of the GDP as gross value added (GVA), both in 2012 and in 2011, and kept almost unchanged average number of employees (4.22 employees in 2012, compared to 4.23 employees in 2011).

Table 6. Number of enterprises, employment and gross value added in the
EU 27 by classes of business in 2012[18]

Enterprises	Micro	Small	Medium	SMEs	Large	Total
Number	19.143.521	1.357.533	226.573	20.727.627	43.654	20.771.281
(%)	92,2	6,5	1,1	99,8	0,2	100
Employees	38.395.819	26.771.287	22.310.205	87.477.311	42.318.854	129.796.165
(%)	29,6	20,6	17,2	67,4	32,6	100
VAB (mil.)	1.307.360,7	1.143.935,7	1.136.243,5	3.587.540	2.591.731,5	6.179.271,4
%	21,2	18,5	18,4	58,1	41,9	100

By productivity, as measured by value added per employee, micro and small enterprises are below the national average, while medium and large companies are above average. Overall productivity of SMEs is about 15% lower than the average in the economy and that of large enterprises is 30% lower[19], as you can see in Table 7.

Table 7.

Enterprises	Small	Medium	SMEs	Large	Total
VAB/Employee	42.729,9	50.929,3	41.011,1	61.242,9	47.607,5
(%)	90	107	86	129	100

According to Eurostat 2011, compared to 2008, Germany, Austria and Malta are the countries that have improved both the real value added by SMEs and employment through them. Other three

---

[16] http://www.gds.ro/Economie/2013-03-05

[17] http://www.bankingnews.ro/fngcimm-sustine-sectorul-imm-din-romania.html

[18] htpp://cursedeguvernare.ro/wp-content/uploads/2013/03/tab1-immuri.png.

[19] htpp://cursedeguvernare.ro/wp-content/uploads/2013/03/tab1-immuri.png.

countries Belgium, Sweden and the Netherlands increased value added in the context of slight reductions of employment, by improving productivity.

Great Britain was the only country which lowered the value added and raised employment. In conclusion, in the EU there was a decrease in the value added by the SME sector and the workforce employed in this sector. However, gross value added by SMEs grew in 2010 and 2011, except for two sectors, which have decreased: in mining and construction. Ireland, Slovakia, Estonia counterbalanced the severe crisis measures that resulted in a massive decline in employment by SMEs productivity growth. Trends in different Member States are increasingly divergent and must be transmitted a positive signal in terms of employment.

In this delicate, decisive political action, designed to address factors that determine the growth of SMEs, might help. However, in most Member States, SMEs have failed so far to return to pre-crisis levels. Some Member States have recently managed to reverse this trend, their SMEs begun to create new jobs and to develop activities - heading towards a more sustainable recovery in the future.

SMEs' access to finance has deteriorated in recent months in most Member States, a significant number of them could not gain requested loans from banks. But business environment still varies significantly from one Member State to another[20].

Romania is referred to as the most obvious case of simultaneous decrease of both production and productivity, along with Spain, Greece and Latvia. In our country, almost a quarter of the SMEs with loans from banks are overdue more than three months, and 23.5% of SMEs with loans from banks have delayed payment more than 90 days, given that lending to SMEs represent 71.3% of lending to non-financial companies. In 2011 were established two times more companies than were removed and 68,589 companies have exited the market, about 3 times less than in 2010.

This year, in Romania operate 491,805 SMEs, which represent 99.7% of the Romanian companies which generate 66% of jobs in all enterprises.

However, given the tendency of transition to gray or black economy, official data reported should be taken under benefit of inventory. Romania has the lowest position in the SMEs results after three years of crisis (between 2008-2011), with a decrease by half of the value added by them, while maintaining over 90% of initial employees, based on an analysis performed by Cambridge Econometrics / Ecorys based on data from Eurostat and National Statistical Offices.

The estimate for 2012 based on currently available data is much better, as Romania passed among the 18 states that have improved both the economic outcome and employment in SMEs (only Greece and Portugal remain in the negative area on both coordinates).

Figure 7. - Annual growth rates in employment, real value added and real productivity of SMEs
in the EU 27, 2008 -2011

The estimate for 2012 based on currently available data is much better, with Romania last among the 18 states that have improved the economic outcome and employment in SMEs (only Greece and Portugal remain in the negative on both coordinates)[21].
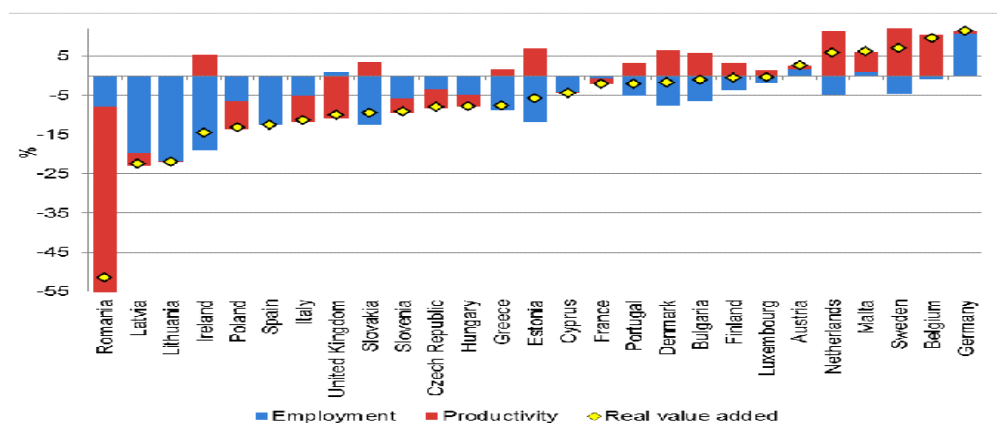
---

[20] http://ec.europa.eu/romania/news/15102012_imm_la_rascruce_ro.htm
[21] htpp://cursedeguvernare.ro/wp-content/uploads/2013/03/tab1-immuri.png

On the other hand, the impact of internationalization on economic activities of SMEs should be approached from two perspectives. These companies have access to new markets, raw materials of superior quality and are able to hire workers with a high level of training, with lower wage costs. Other opportunities from which SMEs benefit in the context of economic internationalization refers to the acquisition of new and modernized technologies, to make transfers of managerial know-how in all spheres of organizational activity (production, research-development, commercial, etc.) and the development of partnerships and strategic alliances with companies in other countries.

From the point of view of SMEs, internationalization downside is that they have to face increasingly strong competition on the international market. Companies that fail to seize the advantages arising from internationalization will not be maintained within the limits of economic efficiency and thus will get out of international economic relations stream. This is why any enterprise, regardless of its size, must control income and expenses.

In Romania, as in any market economy, SMEs have beneficial effects on the economic system, by the roles they fulfill, in the following sense:

- SMEs are important in creating jobs, thus they contribute to social stability of the area;
- SME sector is the main source for the middle class, which has a decisive role in the socio-political stability of the country. This is possible because the distribution of economic power through the small and medium enterprises leads to a favorable distribution of power in society;
- another important role is increasing competitive nature of the markets, SMEs themselves being sources of competition, thereby better meeting consumer needs;
- SMEs contribute to the supply of goods and services and, thus, to GDP, increased exports and national investments;
- ensures combination of production factors which otherwise probably would not be used: local resources, secondary products of large firms and other. With large enterprises, SMEs have cooperative relationships that in the form of either as partnership agreements (financial, technological, etc.), or as sub-contacting (capacity, specialty, etc.);
- the fact that SMEs are managed directly by the owners makes decision-making system very simple and dependent on their talent and managerial capabilities. Therefore, small and medium enterprises have great flexibility and strength in times of recession, given by the ability to adapt to market changes;
- they provide great potential for future large business development, through processes of growth and development in which will take part;
- emphasis on processes of innovation, both in technology and management is another important feature of SMEs;
- SMEs are relatively easy to integrate into a regional economic network, which contributes to the development of the region and reduce unemployment;

Their small size helps to reduce bureaucratic practices and avoid depersonalization of human relations, due to shortening of the information and documents flow within the firm. Therefore, SMEs provide superior quality in employment, in terms of performance and job satisfaction. Relations in these firms are less formalized and there is a closer link between individual and collective efforts.

4. Conclusions

In our opinion, given constant change of a changing economic environment, SMEs are flexible and possess a great capacity for adaptation, facilitated by the small size and rapid decision making process. They easily adapt to the needs and demands of consumers, being closer to the market.

Growing economies, whose demand is increasing or at least stabilized, help the SMEs to maintain or develop their business. On the other hand, increasing the real added value is a combined result of increased employment and real productivity, contribution of the first factor is clearly dominant. If an economy is strong in terms of high-tech and medium industry and services based on intensive use of knowledge, this is also a positive factor. Reducing employment in SMEs in Member States with above features was also more modest than in SMEs in other Member States.

In the same time, we note that in the economic environment in our country which is still hostile, in 2012 it has been felt a rising trend of development characterized by achieving the highest

levels of performance indicators. Although SMEs face difficulties in the current economic and financial crisis context, from the above it results that they will remain at the forefront of economic development in the future.

References

[1] Iacob C., Ionescu, I., Goagără, D. (2007). Management accounting in accordance with international practiced, Universitaria Publishing House, Craiova.

[2] Hirschman, A.O. (1964). The Paternity of an Index. The American Economic Review, American Economic Association, 54 (5): 761. http://jstor.org/stable/1818582.

[3] Zaman Ghe. (1999). The coexistence of large and small enterprises, Economic Tribune. 45, Bucharest.

*** GO nr. 99/August 29, 2000 on the marketing of products and market services, republished in the Official Gazette nr. 603/31 august 2007, approved by Law 650/December 7, 2002 published in the Official Gazette nr. 914/December 16, 2002, amended by Law 211/2008;

*** EXW – Ex Works is the most convenient delivery condition for the seller as it provides minimum requirements for it; the buyer has to bear all risks and costs involved in taking over the goods at the agreed place.

*** OMPF 1826 for approving the Specifications regarding some measures for the organization and of management of accounting management, Official Gazette 23/2004;

*** OMPF 3055/2009 for the approval of the Accounting regulations in compliance to the European Directives, Official Gazette, Part I, nr.766 of November 10, 2009.

*** http://www.contabilizat.ro/dictionar_economic_si_financiar~termen garantie_de_terminare.html

INTERBANK INTEREST RATE TRANSMISSION IN THE BALTIC COUNTRIES

Marianna SINIČÁKOVÁ
Faculty of Economics, Technical University of Košice, **Slovakia**
marianna.sinicakova@tuke.sk
Veronika ŠULIKOVÁ
Faculty of Economics, Technical University of Košice, **Slovakia**
veronika.sulikova@tuke.sk

Abstract:

Integration process, harmonisation of bank legislation and mutual economic interdependence among European countries contribute to similar evolution of several financial indicators in the European Union. Current financial and economic crisis has revealed that some indicators evolved similarly only in short run and their symmetry among countries was not justified. This was the case of e.g. bond interest rates. However, we supposed that interbank interest rates reflected mutual transmission among the Baltic countries and the European Union in long run. We wondered whether this symmetry was not shattered by the recent financial and crisis. This assumption has not been confirmed using the vector error correction model. Our results show that interbank interest rates transmission was maintained even during the crisis. In addition, this transmission in the Baltic countries was significant also due to fixed exchange rate regimes which they applied. The paper was elaborated within the project VEGA 1/0973/11.

Keywords: interbank interest rate, transmission, vector error correction model, the Baltic countries

JEL Classification: E43, G15

1. Introduction

The monetary policy is based on several transmission mechanisms by which changes in the settings of monetary policy instruments lead to targeted macroeconomic result (the most often inflation). The first step in the transmission mechanism is a change of the monetary policy instrument setting. This implies a change in the intermediary objectives, e.g. in banking markets. The change in these markets in turn leads to modifications in the field of final goals such as inflation. The transmission mechanism acts through several channels simultaneously. Here, we will focus on the interest rate channel of the transmission mechanism. An increase or decrease in a base rate leads first to an increase or decrease of interest rates in interbank markets. This in turn motivates banks to raise or lower their rates on credits and deposits. Changed interest rates will restrain or stimulate investments, aggregate demand and will finally weaken or strengthen inflation pressures. Consequently, the reaction of interbank rates to monetary policy base rate is very important for final objective result.

However, we suppose that interbank interest rates do not respond only to monetary policy measurements in a given country but react also to interbank rates in foreign countries. This interdependence among interbank rates is influenced by international synchronisation of business cycles, by integration process at macroeconomic level, by harmonisation of financial market and banking legislation, by capital interconnection of banking sector throughout the European Monetary Union and the world as a whole. Therefore we can observe certain symmetry of interest rates evolution in financial markets. However, some symmetry does not have to be justified by economic fundamentals and is rather implied by political background or other shocks (Ďurčová, 2012). This is the case of bond interest rates in the European Union. Debt and financial crisis revealed that their setting at almost the same level from 1998 to 2008 was incorrect (Micossi, 2012).

Our research takes into account interest rate theories summarised e.g. by Revenda (2005) or Polouček (2010). It respects principles of Dornbush model (Dornbush, 1976) according to which nominal variables, such as interest and exchange rates, respond more quickly to money supply than prices and wages. The relationship between interest rates is studies by several authors. Arghyrou *et al.* (2009) study real interest rate convergence in the European countries. Heryán and Stavárek (2010) observe relationship between interbank interest rates and corporate loan rates in the European Union. Applied cointegration methodology and Granger causality testing detect different relations in

particular countries. Frankel *et al.* (2004) explore impact of exchange rate regime on sensitivity of local interest rates to international ones. They apply dynamic estimation on the large sample of developing and industrialised economies during 1970-1999. In the long run they cannot reject an evident transmission of international interest rates. Their results show that interest rates of the countries with rather flexible regimes respond more slowly to changes in international rates.

Objective of the paper is to analyse behaviour of interbank interest rates in the Baltic countries (i.e. Estonia, Latvia and Lithuania), their mutual interdependence and response to the European Monetary Union interbank interest rate EURIBOR. We assume that EURIBOR has a key role in the Baltic countries due to important bank capital and external trade flows from the euro area to this region (Borys and Zemčík, 2011) and due to gradual integration process. In addition, the three Baltic economies have been applying rather fixed pegs (Nenovsky, 2009). Estonia and Lithuania have been applying currency board regime since 1992 and 1994 respectively. Estonia adopted euro in 2011. Latvia implemented fixed peg depending on SDR (special drawing rights) from 1994 to 2005. Since 2005, Latvia has been preparing to euro adoption within the ERM II (European exchange rate mechanism) which will be introduced in January 2014. According to the research carried out by Frankel *et al.* (2004), international interest rates transmission to local ones should be significant and quick in these countries due to their fixed peg regimes. Our objective is to verify this assumption through the vector error correction model, variance decomposition and impulse-response functions estimation.

2. Methodology

Research methodology of the paper is based on the vector error correction model estimation. This approach enables us to determine long and short term equilibrium among interbank interest rates in the Baltic countries and the euro area. The vector error correction model analyses interdependence of observed time series taking into account lagged values. This fact allows us to research links among variables more comprehensively. Nevertheless, this type of models requires the stationarity of endogenous variables. The vector error correction model combines two types of variables; non-stationary level (long-run) values and stationary first differences (short-run) values. A non-stationary time series, e.g. under the form of a random walk with a drift:

$$y_t = \beta_0 + y_{t-1} + u_t \tag{1}$$

can become stationary after first difference calculation:

$$\Delta y_t = y_t - y_{t-1} = (1 - L)y_t = \beta_0 + u_t \tag{2}$$

were L is a lag operator. If y_t comprises one unit root (order 1), first differences will eliminate non-stationarity problem. If y_t comprises two unit roots (order 2), second differences are needed

$$(1 - L)^2 y_t = \Delta y_t - \Delta y_{t-1} = \Delta^2 y_t = u_t \quad \rightarrow \quad y_t \sim I(2), \Delta y_t \sim I(1), \Delta^2 y_t \sim I(0) \tag{3}$$

Unit root testing can be realised using several approaches, e.g. the Augmented Dickey Fuller (ADF), Elliot-Rothenberg-Stock DF-GLS or Phillips–Perron tests. A standard Augmented Dickey Fuller and Phillips–Perron tests are performed in the research as recommended by Dolado *et al.* (1990).

Consequently, cointegration process can be carried out. Presence of cointegration among variables can be tested through Engel-Granger, Johansen or Johansen and Juselius procedures. Johansen or Johansen and Juselius concepts allow us to research several time series simultaneously. We have decided to perform Johansen Trace Test (Johansen and Juselius, 1990) which determines number of equilibrium cointegration equations and eventual presence of trends and/or constants.

Finally, the vector error correction model is applied to reveal the structural shocks from the residuals. In our case, we model:

$$c + \beta_1 IR1_t + \beta_2 IR2_t + \beta_3 IR3_t + \beta_4 IR4_t = \xi_t$$

(4)

where c is constant term, β_i are elements of the cointegration vector, ξ_t is the equilibrium error, $IR1_t – IR4_t$ denote corresponding interest rates in time t.

Thereafter, variance decomposition and impulse response functions are estimated. The Cholesky decomposition was chosen to display the residual variance-covariance matrix where the correct ordering of the variables is crucial.

3. Data

The paper evaluates mutual interdependence of interbank interest rates in the Baltic economies, i.e. RIGIBOR (Latvia), TALIBOR (Estonia) and VILIBOR (Lithuania). We suppose that evolution of these rates can be relevantly influenced by behaviour of EURIBOR (euro area). Evolution of these rates is depicted in Figure 1.
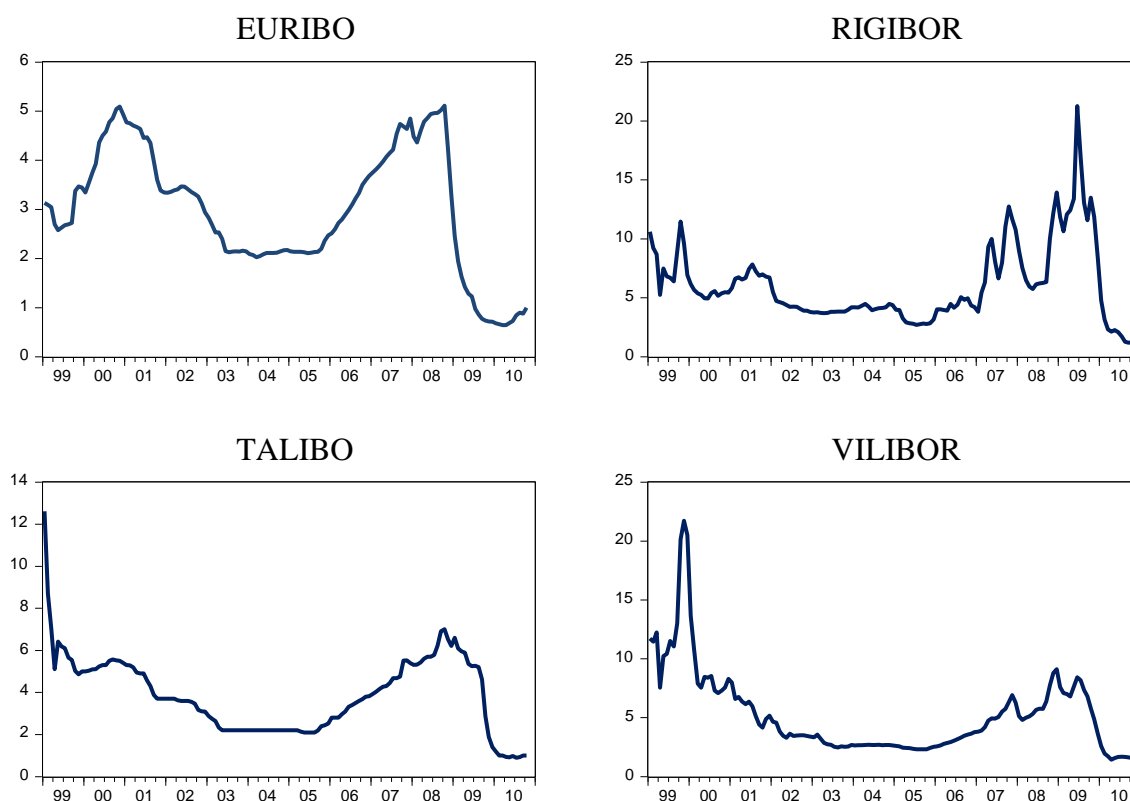
N.B.: Interbank interest rates in the euro area – EURIBOR, Latvia – RIGIBOR, Estonia – TALIBOR, Lithuania - VILIBOR

Figure 1 - Interbank interest rates evolution (1999-2010)

Monthly data are retrieved from the national central banks (Bank of Estonia, Latvia and Lithuania) and the European Central Bank (ECB) and they cover period from January 1999 to October 2010 as Estonia has stopped to quote TALIBOR after introduction of euro since 2011. Consequently, EURIBOR became its interbank interest rate. Descriptive statistics of the data based on 142 observations is captured in Table 1.

As expected, fluctuations of the Baltic rates, i.e. countries in transition, are higher than fluctuations of EURIBOR. E.g. the RIGIBOR´s minimum is 1.19 and its maximum is 21.25. Values of skewness approach to zero mostly in the case of EURIBOR, thus distribution of this rate is more symmetric than in the case of the Baltic countries.

Table 1 - Descriptive statistics of interbank interest rates

	EURIBOR	RIGIBOR	TALIBOR	VILIBOR
Mean	2.993115	6.074498	3.892312	5.265910
Median	3.016200	5.017144	3.700000	4.043913
Maximum	5.113100	21.25400	12.61111	21.72000
Minimum	0.644700	1.186818	0.900000	1.439500
Standard deviation	1.263724	3.314076	1.818539	3.558020
Skewness	-0.109629	1.498247	0.795106	2.086696
Kurtosis	2.120750	5.824609	5.307763	8.920212
Jarque-Bera [Probability]	4.858500* [0.088103]	100.3312*** [0.000000]	46.47270*** [0.000000]	310.4246*** [0.000000]

Source: Own calculations

Evolution of the rates in the countries has a similar character (see Figure 1). Therefore, we expect international transmission of interbank interest rates among the studied countries. These phenomena lead us to intention to observe mutual transmission among their interest rates.

4. Results and discussion

The vector error correction methodology enables us to realise interest rate transmission analysis more comprehensively. Our approach is based on several steps. First important step is to test stationarity of each endogenous variable using unit root tests. Here, we have applied two approaches: Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981) and Phillips-Perron test (Phillips and Perron, 1988) based on non-parametric correction of Dickey-Fuller statistics taking into account heteroscedasticity errors. The results of unit root testing are captured in Table 2. We have chosen level of 1% as a decisive criterion for acceptance or rejection of the alternative hypothesis. Maximal number of lags (i.e. 13 lags in our case) was calculated according to the Schwert criterion (Schwert, 1989). Bandwidth in Phillips-Perron test was calculated according to the Newey-West test.

Table 2 - Stationarity tests results

Augmented Dickey-Fuller (ADF) test				
	Level		First differences	
	C, T, L	t-stat	C, T, L	t-stat
EURIBOR	C, T, L=1	-2.532762	C, L=0	-7.348231***
VILIBOR	C,T,L=5	-4.506461	C,L=4	-3.021521**
RIGIBOR	C,T,L=13	-3.215866	C,L=12	-3.217328**
TALIBOR	C,T,L=3	-2.066466	C,L=2	-6.411685***

Phillips-Perron test				
	Level		First differences	
	C, T, B	t-stat	C, T, B	t-stat
EURIBOR	C,T,B=9	-2.310501	C,B=4	-7.339982***
VILIBOR	C,T,B=8	-1.090495	C,B=7	-8.991730***
RIGIBOR	C,T,B=20	-2.232532	C,B=62	-15.69330***
TALIBOR	C,T,B=8	-1.810893	C,B=8	-11.69973***

*Source***:** Own calculations

Note: C = constant (intercept), T = trend, L = number of lags, t-stat = t-statistics, B = bandwidth, */**/*** statistical significance at the level of 10 % / 5 % / 1 %.

Augmented Dickey-Fuller test and Phillips-Perron test confirm that level data are non stationary (see Table 2). This fact is not surprising as it is quite natural for economic variables such as interbank interest rates. However, the application of their first differences has ensured the stationarity of each endogenous variable. Consequently, the conditions are fulfilled and vector error correction model can be estimated. We have implemented the Johansen cointegration Trace Test (Johansen and

Juselius, 1990). The Trace Test results led to the formulation of one cointegration equation. The estimation of vector error correction model with one cointegration equation is represented in Table 3.

Table 3 – Vector error correction model estimation

Cointegration equation	VARIABLES				
	EURIBOR	**VILIBOR**	**RIGIBOR**	**TALIBOR**	**C**
β [t-statistics]	1.000000	0.927183 [6.52916]	1.066374 [7.33247]	-3.497803 [-10.7316]	-0.950890
α [t-statistics]	-0.000146 [0.03323]	-0.154778 [-6.03660]	-0.195885 [-5.70327]	-0.031658 [-4.40326]	-

Note: α - error correction vector, β - cointegration vector
Source: Own calculations

Cointegration equation confirms the existence of the long term relationship between interbank interest rates. Here, t-statistics show that all variables are statistically significant (see cointegration vector β in Table 3). According to Eq. (4), long-run cointegration equation can be expressed in the following way:

$$\beta_1 \text{EURIBOR}_t + \beta_2 \text{VILIBOR}_t + \beta_3 \text{RIGIBOR}_t + \beta_4 \text{TALIBOR}_t + c = \xi_t \tag{5}$$

$$1\,\text{EURIBOR}_t + 0.93\,\text{VILIBOR}_t + 1.07\,\text{RIGIBOR}_t - 3.50\,\text{TALIBOR}_t - 0.95 = \xi_t \tag{6}$$

Eq. (6) can be rewritten as it follows:

$$\text{EURIBOR}_t = -0.93\,\text{VILIBOR}_t - 1.07\,\text{RIGIBOR}_t + 3.50\,\text{TALIBOR}_t + 0.95 + \xi_t \tag{7}$$

Analogically, for other interbank interest rates we can write:

$$\text{VILIBOR}_t = 3.77\,\text{TALIBOR}_t - 1.08\,\text{EURIBOR}_t - 1.15\,\text{RIGIBOR}_t + 1.03 + \xi_t \tag{8}$$
$$\text{RIGIBOR}_t = 3.28\,\text{TALIBOR}_t - 0.94\,\text{EURIBOR}_t - 0.87\,\text{VILIBOR}_t + 0.89 + \xi_t \tag{9}$$
$$\text{TALIBOR}_t = 0.29\,\text{EURIBOR}_t + 0.27\,\text{VILIBOR}_t + 0.30\,\text{RIGIBOR}_t - 0.27 + \xi_t \tag{10}$$

According to these cointegration equations, we can confirm significant mutual long-term relations among interbank interest rates in the Baltic countries. The estimated vector error correction model has been tested for the presence of autocorrelation of residuals by Portmanteau and LM tests. As depicted in Table 4, autocorrelation of residuals is not present in our model.

Table 4 - Autocorrelation test results

Lags	Portmanteau test					LM test	
	Q-Stat	Prob.	Adj Q-Stat	Prob.	df	LM-Stat	Prob.
1	6.321924	NA*	6.981996	NA*	NA*	111.7968	0.0000
2	12.26949	NA*	12.99526	NA*	NA*	31.10799	0.1988
3	17.40391	NA*	18.66621	NA*	NA*	25.76710	0.4296
4	37.13324	0.7159	38.97581	0.7240	45	30.65232	0.2104
5	50.01788	0.9673	52.33766	0.9433	70	19.11833	0.7919
6	68.91139	0.9794	71.13685	0.9680	95	19.09912	0.7938
7	92.12910	0.9655	96.82917	0.9407	120	24.22238	0.4510
8	99.01917	0.9728	108.7546	0.9458	145	22.16080	0.6274
9	135.0155	0.9742	142.1847	0.9410	170	23.54947	0.4898
10	160.2847	0.9778	170.4746	0.8969	195	29.95523	0.2398
11	178.5697	0.9937	187.0629	0.9478	220	17.24068	0.9175
12	211.4424	0.9464	223.0174	0.8399	245	32.40242	0.1313

Note: Null hypothesis: No autocorrelation of residuals.
Source: Own calculations

Variance decomposition enables us to observe mutual transmission among rates throughout different periods. The approach provides us with information how many per cents of the variance of given endogenous variable is explained by another endogenous variable. Variance decomposition results, observed throughout 1, 3, 6 and 12 month lags, are presented in Table 5.

Table 5 - Variance decomposition of interbank interest rates (1999-2010)

VARIANCE DECOMPOSITION OF INTEREST RATES							
	Variance decomposition of EURIBOR						
	Month	**EURIBOR**	**VILIBOR**	**RIGIBOR**	**TALIBOR**	**BC**	**S.E.**
EURIBOR	1	100.000	0.000	0.000	0.000	0.000	0.138
	3	95.258	0.798	2.202	1.742	4.742	0.378
	6	93.614	1.743	3.425	1.218	6.386	0.706
	12	97.238	0.643	1.412	0.706	2.761	1.305
	Variance decomposition of VILIBOR						
	Month	**EURIBOR**	**VILIBOR**	**RIGIBOR**	**TALIBOR**	**BC**	**S.E.**
VILIBOR	1	20.402	75.303	3.984	0.311	4.295	0.805
	3	22.913	71.920	4.468	0.698	5.166	1.629
	6	20.979	63.832	11.383	3.805	15.188	1.934
	12	14.062	40.762	26.715	18.461	45.176	2.494
	Variance decomposition of RIGIBOR						
	Month	**EURIBOR**	**VILIBOR**	**RIGIBOR**	**TALIBOR**	**BC**	**S.E.**
RIGIBOR	1	2.348	0.000	97.651	0.000	0.000	1.078
	3	0.894	0.897	95.734	2.485	3.382	1.795
	6	2.154	8.301	68.931	20.615	28.916	2.235
	12	1.733	26.584	29.475	42.208	68.792	3.468
	Variance decomposition of TALIBOR						
	Month	**EURIBOR**	**VILIBOR**	**RIGIBOR**	**TALIBOR**	**BC**	**S.E.**
TALIBOR	1	0.205	0.000	0.000	99.795	0.000	0.226
	3	1.337	6.256	0.032	92.374	6.288	0.486
	6	6.400	10.529	1.681	81.390	12.210	0.802
	12	14.419	13.948	5.113	66.520	19.061	1.427

Note: Cholesky variance decomposition, S.E. standard error, BC – Baltic countries together
Source: Own calculations

The variance decomposition results (Table 5) show that impact of other interest rates on a chosen interest rate is increasing in time. However, as expected, EURIBOR seems to be quite independent from Baltic rates. Three Baltic rates explain together only 2.8% of EURIBOR variance in 12-month horizon. Within the Baltic countries, TALIBOR is the most independent. It is determined by itself by more than 66% in 12-months period.

Moreover, the impact of EURIBOR on TALIBOR and VILIBOR is significantly higher than on RIGIBOR. Table 5 shows that EURIBOR explains 14.1% of VILIBOR's variance, 14.4% of TABILOR's variance, but only 1.7% of RIGIBOR's variance in 12-month horizon. This is evidently implied by currency board exchange rate regime in Estonia and Lithuania unlike Latvia. Mutual relationship between RIGIBOR and VILIBOR is remarkable. RIGIBOR explains approximately 26.7% of VILIBOR's variance and VILIBOR explains 26.6% of RIGIBOR's variance (in 12-month horizon). In other words, both rates are interdependent by to the same extent in one year period. The fact can be explained by important mutual trade and capital flows between the countries. It is also interesting to note the impact of TALIBOR on RIGIBOR, as TALIBOR explains up to 42.2% of RIGIBOR's variance (in 12-month horizon). On the other hand, TALIBOR's variance is quite independent from RIGIBOR evolution.

The variance decomposition results are complemented by the impulse-response analysis depicted in Figure 2.
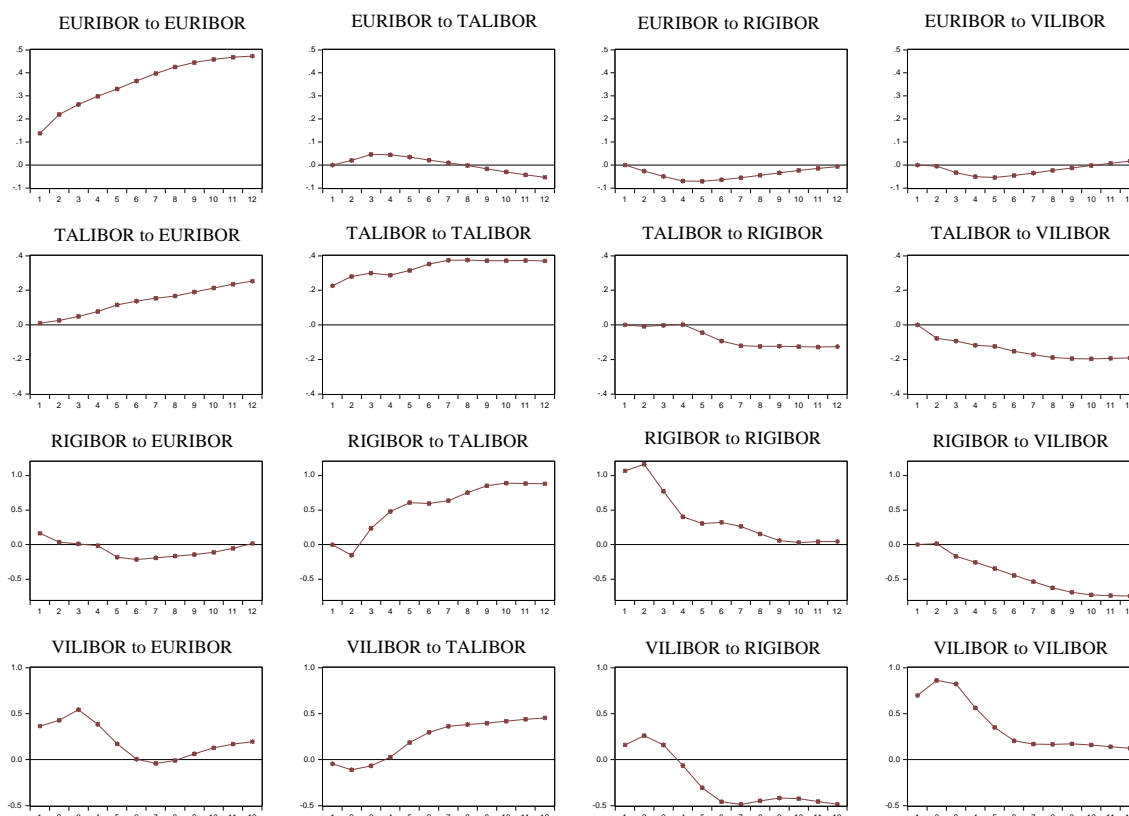
Figure 2 - Impulse-response functions

Impulse-response functions confirm the fact that EURIBOR is the most independent interbank rate within researched rates. The response of EURIBOR to Baltic interbank rates (first row, Figure 2) is negligible. Furthermore, results show that RIGIBOR loses its independence and becomes more implied by TALIBOR. Resembling evolution is in the case of VILIBOR. In general, impulse-response functions indicate the interdependence among interbank rates of all three Baltic countries (see columns 2 - 4 and corresponding rows 2 - 4, Figure 2).

Comparing to our previous research (Siničáková, Šuliková, Árvayová, 2013) and Árvayová (2013) focusing on interbank interest rate transmission in the Visegrad countries (Czech Republic, Hungary, Poland and Slovakia), interdependence in the case of the Baltic countries and the euro area seems to be more significant and quicker. Consequently, results of international interest rate transmission in the Baltic countries are in line with findings by Frankel *et al.* (2004) that local interest rates are more sensitive to international ones if fixed peg is applied. The more exchange rates are fixed, the more local interest rates are sensitive. Interest rates in Estonia (i.e. TALIBOR) and those in Lithuania (i.e. VILIBOR) reacted more flexibly to EURIBOR fluctuation as interbank rates in Latvia which has been applying less fixed regime comparing to its neighbouring countries (see Table 5 and Figure 2).

Generally speaking, similar phenomenon as in the bond interest rate market appears in interbank interest rate. Economies and their macroeconomic indicators have tendency to converge in the times of prosperity. However, many indicators have divergent trends in the period of crisis (Horváth *et al.*, 2013 and Mirdala, 2012). Our previous observations focusing on the Visegrad countries (Siničáková *et al.*, 2013 and Árvayová, 2013) are in line with these findings. The Visegrad interbank interest rates are significantly influenced by EURIBOR evolution. Relevant investors in financial markets including banking markets, take the European Union as comparatively homogeneous region during times of prosperity. Yet, during the crisis, investors and so do interest rates, behave rather independently and in respect to actual economic situation in a particular country.

Nevertheless, situation in the Baltic countries is quite different. Convergence of their interbank interest rates has not been shattered by recent financial and economic crisis. Interbank interest rate

evolution in the Baltic countries is obviously symmetric with EURIBOR. The transmission is quite strong due to fixed peg and currency board regimes in these countries. Nominal convergence has been priority of the Baltic economies as they have been planning their integration into the European Monetary Union for long time. Nominal goals were often maintained at the expense of real indicators. The three countries experienced very important fall of economic output and employment in 2009. Their remarkable economic growth of 5.4% in Estonia, 12.5% in Latvia and 9.6% in Lithuania in 2008 dropped to -1.4%, -1.6% and -3.4% in 2009 (Eurostat, 2013). However they managed to maintain exchange rate stability with euro and symmetric evolution of their interbank rates with EURIBOR.

As interbank interest rate evolution has been converging with EURIBOR at least for last decade, exchange rate is fixed to euro, the three countries are small and open economies highly dependent on the euro area trade; introduction of euro and application of EURIBOR in these countries seems to be from our point of view a reasonable solution.

5. Conclusion

Interbank interest rates evolution in the Baltic countries reflects quite significant level of mutual interdependencies. This phenomenon is obvious not only in the pre-crisis period but even during crisis. Crises, in general, stress differences and particularities among countries. Thus, evolution of economic variables such as interest rates differs in a more visible way. Nevertheless, variance decomposition approach detects rather important impact of EURIBOR on the Baltic interbank interest rates even during crisis. Effect of exchange rate regimes on interest rate transmission seems to be very significant. The Baltic countries applied fixed pegs eventually currency board regime which is also rather fixed exchange regime. Sensitivity of their interbank interest rates to international rates is therefore higher than in the case of countries with more flexible exchange rates.

References

[1] Arghyrou, M.G., Gregoriou, A., Kontonikas, A. (2009). Do Real Interest Rates Converge? Evidence from the European Union, *Journal of International Financial Markets, Institutions and Money,* 19(3): 447-460.

[2] Árvayová, S. (2013). Transmisný mechanizmus medzibankových úrokových mier vo vybraných krajinách (Interbank Interest Rates Transmission Mechanism in Chosen Countries). Diplomová práca. Technická univerzita v Košiciach, Ekonomická fakulta, p. 76.

[3] Borys, M. M., Zemčík, P. (2011). Size and Value Effects in the Visegrad Countries, *Emerging Markets Finance and Trade Journal,* 47(3): 50–68.

[4] Dickey, D., Fuller, W. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with Unit Root, *Econometrica*, 49(4): 1057-1072.

[5] Dolado J. J., Jenkinson, T., Sosvilla-Rivero, S. (1990). Cointegration and Unit Roots, *Journal of Economic Surveys,* 3: 249-273.

[6] Dornbusch, R. (1976). Expectations and exchange rate dynamics, *Journal of Political Economy,* 84(6): 1161–1176.

[7] Ďurčová, J. (2012). Macroeconomic impacts of the interest rate shocks in the selected euro area countries, *Journal of Advanced Studies in Finance*, 3(2): 140-150.

[8] Frankel, J., Schmukler, S. L., Serven, L. (2004). Global transmission of interest rates: monetary independence and currency regime, *Journal of International Money and Finance,* 23(5): 701-733.

[9] Heryán, T., Stavárek, D. (2010). How related are interbank and lending interest rates? Evidence on selected European Union countries, *European Financial and Accounting Journal,* 5(3-4): 42-55.

[10] Horváth, D., Šuliková, V., Gazda, V., Siničáková, M. (2013). *The distance-based approach to the quantification of the world convergences and imbalances - comparisons across countries and factors*. MPRA Paper, pp. 1-33.

[11] Johansen, S., Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration – with applications to the demand for money, *Oxford Bulletin of Economics and Statistics*, 52(2): 169-210.

[12] Micossi, S. (2012). *Bring the Eurozone Back from The Precipice: An agenda for the European Council*. [online]. [cit. 2013-01-17]. Available at: http://www.voxeu.org/article/bringing-eurozone-back-precipice-proposal

[13] Mirdala, R., (2012), Interest rates determination and crisis puzzle (Empirical Evidence from the European transition economies*), Journal of Applied Economic Science*, 7(4): 418-436.

[14] Nenovsky, N. (2009). Monetary Regimes in Post-Communist Countries. Some Long-Term Reflections*,* Agency for Economic Analysis and Forecasting, Working paper series 2009-1.

[15] Phillips, P., Perron, P. (1988). Testing for unit root in time series regression, *Biometrika*, 75(2): 335-346.

[16] Polouček, S. (2010). *Peniaze, banky, finančné trhy*. Iura Edition, Bratislava, pp. 89-90.

[17] Revenda, Z. (2005). *Peněžní ekonomie a bankovnictví*. 4th Ed. Management Press, Praha, p. 627.

[18] Schwert, G.W. (1989). Tests for unit roots: A Monte Carlo investigation, *Journal of Business & Economic Statistics*, 7(2): 147-59.

[19] Siničáková, M., Šuliková, V., Árvayová, S. (2013). Interbank interest rate transmission in the V4 countries*, Emerging Markets Queries in Finance and Business*, Tirgu-Mures, Romania, October, in print.

*** Bank of Estonia. (2012). Financial Sector Statistics. Talin.

*** Bank of Latvia. (2012). Annual Report of the Bank of Latvia. Riga.

*** Bank of Lithuania. (2012). Banking Statistics Yearbook. Vilnus.

*** Eurostat. (2013). GDP and main components – price indices. [online]. [cit. 2013-05-16]. Available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

FIRST STEPS OF JAVA-BASED SIMULATION FOR DECISION SUPPORT SYSTEM OF BUSINESS COMPANIES

Roman ŠPERKA
School of Business Administration in Karvina, Department of informatics
Silesian University in Opava, **Czech Republic**
sperka@opf.slu.cz
Marek SPIŠÁK
School of Business Administration in Karvina, Department of informatics
Silesian University in Opava, **Czech Republic**
spisak@opf.slu.cz

Abstract:

The motivation of this paper was to model and to implement an innovative approach to simulate the trading processes of a virtual business company. Agent-based methods together with the Java development platform are used to implement a multi-agent system to serve as a simulation framework. The framework should be a basic part of a decision support system operating in the integration with real system of a company (e.g. ERP system) to investigate and to predict chosen business metrics of a company. This will ensure the management of a company to work with the simulation possibilities of this framework and to support their decision-making processes. The paper firstly introduces some of the existing theories about consumer behavior and the types of factors influencing it. Secondly, characterizes multi-agent model of a virtual company, the agents participating in the trading processes, and the production function. Finaly, the simulation results and their validation are described. To conclude, the proposed approach to the simulation of trading processes in an agent-based model could properly contribute to better decision-making process.

Keywords: system modeling, agent, business company, multi-agent systems, negotiation, decision support, trading processes.

JEL Classification: C63; C81; C92; D12; D22

1. Introduction

In the contemporary, dynamic, global and competitive market environment, consumer behavior depends on many different types of factors, which are difficult to grasp. With personal and social factors deals e.g. Enis (1974), with physical factors deals, *e.g.* McCarthy and Perreault (1993). More complex view on the social, economic, geography and culture factors gave Keegan *et al.* (1992). Schiffman (2007) brought marketing mix and environment into the types of factors mentioned herein above. Previous discussions have so far either relied on an objectivist (complete information of customers, constant decision mechanism, constant consumer preferences) or a constructivist view (consumption discourses, consumption as a crucial aspect in the construction of identity). However, both have failed to integrate the consumers' interactions with their social behavior and physical environment as well as the materiality of consumption (Gregson *et al.* 2002, Jackson *et al.* 2006). The complexity of the factors influencing consumer behavior and their changes in the time shows relations between external stimuli, consumer's features, the course of decision-making process and reaction expressed in his choices. As a result, the investigation of consumer behavior seems to be too complicated for traditional analytical approaches (Forrester 1971, Challet and Krause, 2006).

Agent-based modeling and simulation (ABMS) provides some opportunities and benefits resulting from using multi-agent systems as a platform for simulations with the aim to investigate the consumers' behavior and trading processes (Spišák and Šperka 2011, Šperka 2012). Agent-based models are able to integrate individually differentiated types of consumer behavior. They are characterized by a distributed control and data organisation, which enables to represent complex decision processes with only few specifications. In the recent past there were published many scientific works in this area. They concern in the analysis of companies positioning and the impact on the consumer behavior (e.g. Tay and Lusch 2002, Wilkinson and Young 2002, Casti 1997). Often discussed is the reception of the product by the market (Goldenberg *et al.* 2010, Heath *et al.* 2009), innovation difussion (Rahmandad and Sterman 2008, Shaikh *et al.* 2005, Toubia *et al.* 2008). More general deliberations on the ABMS in the investigating of consumer behavior shows e.g. (Adjali *et al.* 2005, Ben 2002, Collings *et al.* 1999).

The approach introduced in this paper uses an agent-based model in the form of multi-agent system to serve as a simulation platform for the seller-customer negotiation in a virtual trading company. The overall idea comes from the research of Barnett (2003). He proposed the integration of the real system models with the management models to work together in real-time. The real system (e.g. ERP system) outputs proceed to the management system (e.g. simulation framework) to be used to investigate and to predict important company's results (metrics). Actual and simulated metrics are compared and evaluated in a management model that identifies the steps to take to respond in a manner that drives the system metrics towards their desired values. We used a generic control loop model of a company (Wolf 2006) and implemented multi-agent simulation framework, which represents the management system. This task was rather complex, therefore we took only a part of the model – trading processes and the negotiation of seller and customer.

The work described in this paper aims at proposing an approach to describe the customer behavior in the trading processes of a virtual company. Implemented simulation framework will be a basic part of a future management system simulating business metrics – key performance indicators (KPIs) of a real company's system. The paper is structured as follows. In the section 2 the multi-agent model is described. In the section 3 the seller-customer negotiation is introduced. The core of this section is the production function definition. The simulation results are presented in section 4.

2. Multi-agent model

To ensure the outputs of customer behavior simulations a simulation framework was implemented and used to trigger the simulation experiments. The framework covers business processes supporting the selling of goods by company sales representatives to the customers – seller-customer negotiation (Fig. 1). It consists of the following types of agents: sales representative agents (representing sellers, seller agents), customer agents, an informative agent (provides information about the company market share, and company volume), and manager agent (manages the communication between seller and customer). Disturbance agent is responsible for the historical trend of sold amount and uses his influence on customer agent. All the agent types are developed according to the multi-agent approach. The interaction between agents is based on the FIPA contract-net protocol (FIPA 2002).
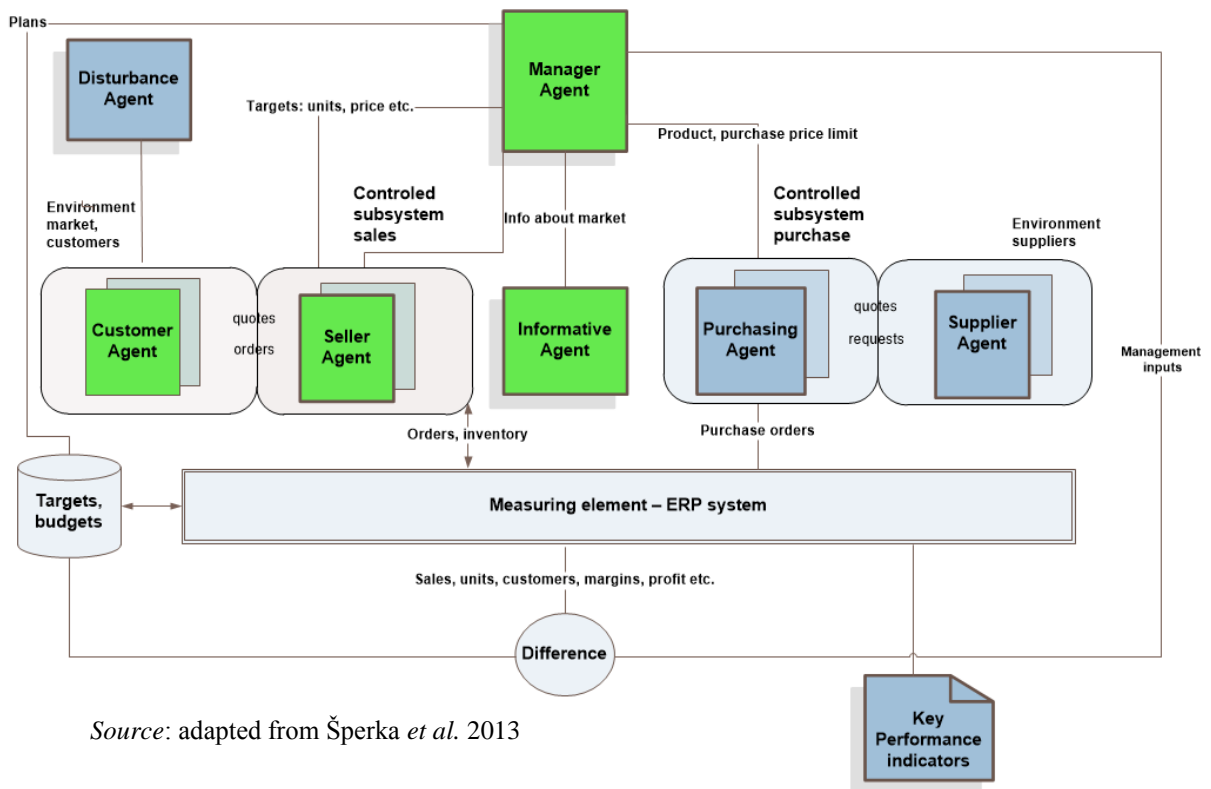
Source: adapted from Šperka *et al.* 2013

Figure 1 - Generic model of a business company.

The number of customer agents is significantly higher than the number of seller agents in the model because the reality of the market is the same. The behavior of agents is influenced by two randomly generated parameters using the normal distribution (an amount of requested goods and a sellers' ability to sell the goods). In the lack of real information about the business company, there is a possibility to randomly generate different parameters (e.g. company market share for the product, market volume for the product in local currency, or a quality parameter of the seller). The influence of randomly generated parameters on the simulation outputs while using different types of distributions was presented in (Vymetal *et al.* 2012).

3. Trading processes description

In this section, the seller-customer negotiation workflow in trading processes is described and the mathematical definition of a production function is proposed. Production function is used during the contracting phase of agents' interaction. It serves to set up the limit price of the customer agent as an internal private parameter.

Only one part of the company's generic structure, defined earlier, was implemented. This part consists of the sellers and the customers trading with stock items (e.g. tables, chairs). One stock item simplification is used in the implementation. Participants of the contracting business process in our multi-agent system are represented by the software agents - the seller and customer agents interacting in the course of the quotation, negotiation and contracting. There is an interaction between them. The behavior of the customer agent is characterized in our case by proposed customer production function (Equation 1).

At the bebinning of the simulation experiment disturbance agent analyses historical data. He calculates the averages of sold amounts in previous year as the base for the percentage calculation. Each period turn (here we assume a week), the customer agent decides whether to buy something. His decision is defined randomly. If the customer agent decides not to buy anything, his turn is over; otherwise he creates a sales request and sends it to his seller agent. The amount of items, which is being requested, is multiplied by the disturbance percentage delivered by disturbance agent. This ensures to follow real amount trend. The seller agent answers with a proposal message (a certain quote starting with his maximal price: *limit price * 1.25*). This quote can be accepted by the customer agent or not. The customer agents evaluate the quotes according to the production function. The production function was proposed to reflect the enterprise market share for the product quoted (a market share parameter), seller's ability to negotiate, total market volume for the product quoted etc. (in e.g. Vymetal and Sperka 2011). If the price quoted is lower than the customer's price obtained as a result of the production function, the quote is accepted. In the opposite case, the customer rejects the quote and a negotiation is started. The seller agent decreases the price to the average of the minimal limit price and the current price (in every iteration is getting effectively closer and closer to the minimal limit price), and resends the quote back to the customer. The message exchange repeats until there is an agreement or a reserved time passes.

The customer production function for the *m*-th seller pertaining to the *i*-th customer determines the price that the *i*-th customer accepts (adjusted according to Vymetal *et al.* 2012).

$$c_n^m = \frac{\tau_n T_n \gamma \rho_m}{O v} \tag{1}$$

c_n^m - price of *n*-th product offered by *m*-th seller,

τ_n - market share of the company for *n*-th product $0 < \tau_n < 1$,

T_n - market volume for *n*-th product in local currency,

γ - competition coefficient, lowering the success of the sale $0 < \gamma \leq 1$,

ρ_m - *m*-th sales representative ability to sell, $0.5 \leq \rho_m \leq 2$,

O – number of sales orders for the simulated time,

v_n - average quantity of the *n*-th product, ordered by *i*-th customer from *m*-th seller.

The aforementioned parameters represent global simulation parameters set for each simulation experiment. Other global simulation parameters are: lower limit sales price, number of customers, number of sales representatives, number of iterations, and mean sales request probability. The more exact parameters can be delivered by the real company, the more realistic simulation results can be obtained. In case we would not be able to use the expected number of sales orders *O* following formula (Equation 2) can be used:

$$O=ZIP \tag{2}$$

where: *Z* - number of customers;
          I - number of iterations;
          p - mean sales request probability in one iteration.

Customer agents are organized in groups and each group is being served by concrete seller agent. Their relationship is given; none of them can change the counterpart. Seller agent is responsible to the manager agent. Each turn, the manager agent gathers data from all seller agents and stores KPIs of the company. The data is the result of the simulation and serves to understand the company behavior in a time – depending on the agents' decisions and behavior. The customer agents need to know some information about the market. This information is given by the informative agent. This agent is also responsible for the turn management and represents outside or controllable phenomena from the agents' perspective.

4. Simulation results

Agent count and their parameterization were:

Table 1 - List of agents' parameters

AGENT TYPE	AGENT COUNT	PARAMETER NAME	PARAMETER VALUE
Customer Agent	500	Maximum Discussion Turns	10
		Mean Quantity	40 m
		Quantity Standard Deviation	32
Seller Agent	25	Mean Ability	0.37
		Ability Standard Deviation	0.03
		Minimal Price	0.36 €
Manager Agent	1	Purchase Price	0.17 €
Market Info	1	Item Market Share	0.15
		Item Market Volume	1 033 535 €
		Competition coefficient	0.42
		No items sold in one iteration	1 330
		Iterations count	52
Disturbance Agent	1		

Source: own

Agents were simulating one year – 52 weeks of interactions. As mentioned above – manager agent was calculating the KPIs. Total gross profit was chosen as a representative KPI. Figure 2 contains the month sums of total gross profit for real and generated data. As can be seen from this figure, the result of simulation was quite similar to the real data.

Total Absolute Gross Profit Amount
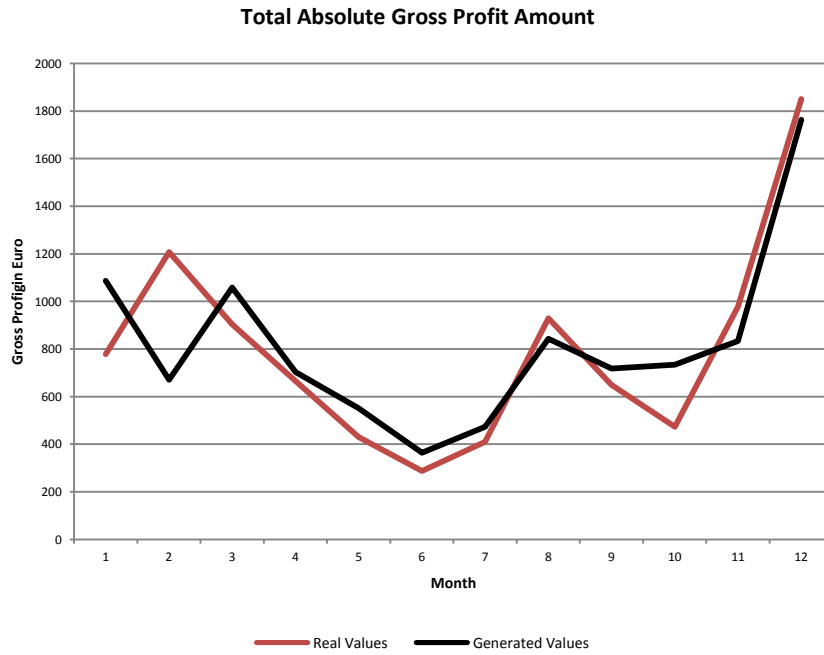
Source: own

Figure 2 - The generation values graph – monthly

To prove the relationship between the real and generated data – two instruments were chosen – Correlation Analysis to show the correlative relation between them and Chi-Square Test for Independence to show the similarity of distribution for both data series.

Correlation coeficient for total gross profit amount was 0.857, which represents very strong correlation between real and generated data. Also the Chi-Square Test for Independence has proven that the distribution of real and generated values is very similar. In Figure 3, there is a frequency histogram of gross profit for real and generated values.

Gross Profit - Frequency Histogram
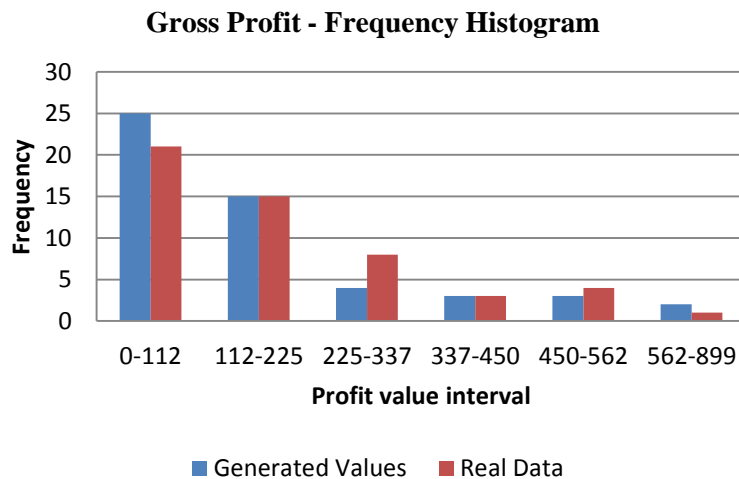
Source: own

Figure 3 - Gross Profit frequency histogram.

5. Conclusion

The basic part of simulation framework consisting of trading processes was introduced in this paper. The motivation of this partial research is to model and to implement an innovative approach of virtual business company simulation. This framework should be a part of management information

system and should provide predictive results concerning key performance indicators of a business company. This should help the management of a company to support their decision-making processes.

Introduction of disturbance agent into the simulation model to follow historical trends has caused closer distribution similarity between real and generated data. By its influence on the amounts sold in every turn (even if the price remained as a result of negotiation between seller and customer agent) strong correlation between real and generated results has appeared. This validation proves correct results of simulation experiments being done.

For the future experiments – two improvements shall be made. To make the disturbance agent more sophisticated in history analyses and also each customer agent shall be more individualistic – have its own targets, beliefs, and desires – not only to follow the production function.

Acknowledgment

References

[1] Adjali, I., Dias B., Hurling, B. (2005). Agent based modeling of consumer behavior. *Proceedings of the North American Association for Computational Social and Organizational Science Annual Conference*. University of Notre Dame. Notre Dame. Indiana.

[2] Barnett, M.W. (2003). *Modeling & Simulation in Business Process Management*. Gensym Corporation, pp. 6-7.

[3] Said, L.B., Bouron, T., Drogoul, A. (2002). *Agent-based interaction analysis of consumer behavior*. Proceedings of the First International Joint Conference on *Autonomous agents and multiagent systems:* part 1. ACM. New York, pp. 184-190.

[4] Casti, J.L. (1997). *Would-be Worlds. How simulation is changing the World of Science*. Wiley. New York, ISBN: 978-0788196768.

[5] Challet, D. and Krause, A. (2006). *What questions to ask in order to validate an agent-based model*. Report of the 56th European Study Group with Industry. pp. J1-J9. Available from: http://www.maths-in-industry.org/miis/107/1/Unilever-ABM-Report.pdf. [Accessed 28 March 2013].

[6] Collings, D.A., Reeder, I., Adjali, P., Crocker, Lyons, M. (1999). Agent based customer modelling. Computing in Economics and Finance. (1352). Available from: http://econpapers.repec.org/paper /scescecf9/1352.htm [Accessed 28 March 2013].

[7] Enis, B.M. (1974). Marketing principles: the management process. Goodyear Pub. Co. (Pacific Palisades, Calif). 608 p., ISBN 0876205503.

[8] Forrester, Jay. 1971. Planung unter dem Einfluss komplexer Sozialer Systeme. *Politische Planung in Theorie und Praxis*. Ed by. G. Schmieg. Piper Verlag. München. p. 88.

[9] Goldenberg, J., Libai B., Muller, E. (2010). The chilling effect of network externalities. *International Journal of Research in Marketing,* 27(1): 4-15.

[10] Gregson, N., Crewe, L., Brooks, K. (2002). Shopping, space, and practice, *Environment and Planning D*, 20 (5): 597–617. DOI: 10.1068/d270t.

[11] Heath, B., Raymond H., Ciarallo, F. (2009). A survey of agent-based modeling practices, *Journal of Artificial Societies and Social Simulation*, 12(4): 5-32.

[12] Jackson, P., Perez Del Aguila, R., Clarke I., Hallsworth, A., De Kervenoael, R., Kirkup, M. (2006). Retail restructuring and consumer choice 2. Understanding consumer choice at the household level, *Environment and Planning A*, 38(1): 47–67. DOI:10.1068/a37208

[13] Keegan, W.J., Moriarty, S.E., Duncan, T.R. (1992). *Marketing*. Prentice-Hall. Englewood Cliffs. New Jersey. 193 p.

[14] McCarthy, E.J., Perreault W.D. (1993). *Basic marketing: a global-managerial approach*. Irwin, 792 p., ISBN 025610509X.

[15] Rahmandad, H., Sterman, J. (2008). Heterogeneity and network structure in the dynamics of diffusion: Comparing agent-based and differential equation models, *Management Science*, 54(5): 998-1014.

[16] Shaikh, N.I., Ragaswamy, A., Balakrishnan, A. (2005). *Modelling the Diffusion of Innovations Using Small World Networks*. Working Paper, Penn State University. Philadelphia.

[17] Schiffman, L., Kanuk, L. (2007). *Purchasing Behavior*, 9th Ed. Upper Saddle River, NJ: Pearson Prentice Hall.

[18] Spišák, M., Šperka, R. (2011). Financial market simulation based on intelligent agents. Case study. *Journal of Applied Economic Sciences*, VI, 3(17): 249-256.

[19] Šperka, R. (2012). Agent-based design of business intelligence system architecture. *Journal of Applied Economic Sciences*, VII, 3(21): 326-333.

[20] Šperka, R., Vymětal D., Spišák, M. (2013). Validation of agent-based BPM simulation, Proc. Advanced Methods and Technologies for Agent and Multi-agent Systems. Frontiers in Artificial Intelligence and Applications. 7th International Conference KES-AMSTA`13, Hue city, Vietnam, 27.-29.5.2013. Amsterdam: IOS Press BV, Netherlands, 2013, Volume 252, pp. 276-283. ISBN 978-1-61499-253-0 (print), ISBN 978-61499-254-7 (online).

[21] Tay, N., Lusch. R.F. (2002). Agent-Based Modeling of Ambidextrous Organizations: Virtualizing Competitive Strategy. *IEEE Transactions on Intelligent Systems*, 22(5): 50-57.

[22] Toubia, O., Goldenberg, J., Garcia, R. (2008). A New approach to modeling the adoption of new products: Aggregated Diffusion Models. *MSI Reports: Working Papers Series.* 8(1): 65-76.

[23] Wilkinson, I., Young, L. (2002). On cooperating: Firms. Relations. Networks. *Journal of Business Research,* 55: 123-132.

[24] Wolf, P. (2006). *Úspěšný podnik na globálním trhu*. Bratislava: CS Profi-Public. ISBN 80-969546-5-2.

[25] Vymětal, D., Spišák, M., Šperka, R. (2012). *An Influence of Random Number Generation Function to Multiagent Systems*, Proc. LNAI 7327. Agent and Multi-Agent Systems. Technologies and Applications. 6th KES International Conference, KES AMSTA 2012, Dubrovnik, Croatia. Berlin Heidelberg: Springer-Verlag, Germany. pp. 340-349. DOI 10.1007/978-3-642-30946-5, http://www.springerlink.com/ content/g71k68505h76x1wx/

*** Foundation for Intelligent Physical Agents, FIPA. 2002. *FIPA Contract Net Interaction Protocol*. Available from: http://www.fipa.org/specs/fipa00029/SC00029H.pdf. [Accessed 13 June 2011].

CONSTRUCTING ABATEMENT COST CURVES FOR F-GASES

George E. HALKOS
Laboratory of Operations Research, Department of Economics
University of Thessaly, Volos, **Greece**
halkos@uth.gr

Abstract

   Scientific research on Greenhouse Gases (GHG) focuses mainly on CO_2 emissions. But non-CO_2 gases (mainly F-gases in the form of HFCs, PFCs, SF_6) are more potent at trapping heat within the atmosphere. Currently, F-gases constitute a small proportion of GHG emissions but they are extremely high Global Warming Potential gases with very high atmospheric lifetimes. They are also expected to increase massively due to expansion of some emitting industries. This study constructs the least-cost curve of F-gases control for the EU-27 and for the year 2020. It seems more cost-effective to abate SF_6 first, then PFCs and then control HFCs.

Keywords: F-gases, control methods, emissions, GWP.

JEL Classification: Q00, Q01, Q53, L52; L95.

1. Introduction

   Greenhouse gases (GHGs) include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and a number of high Global Warming Potential gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6), also known as F-gases. The Kyoto Protocol regulates all these GHGs. CO_2 emissions from the burning of fossil fuels and the change in the use of human land may be considered as the most important anthropogenic effect. The rest of the GHGs (the non-CO_2 gases) are also important. Methane and nitrous oxide are naturally present in the atmosphere while the F-gases are industrial gases. The F-gases are used as substitutes for the Ozone Depleting Substances (ODS, chlorofluorocarbons CFCs and hydrochlorofluorocarbons HCFCs) that were going to be phased out under the Montreal Protocol. They are also used and emitted from a number of industrial sources like the use of PFCs in aluminium smelting or in semiconductor manufacture or the use of SF_6 as an insulating gas in various electrical systems.

   The full set of fluorinated gases (CFC, PCFC, HFC, PFC, SF_6) comprised almost 25% of the added anthropogenic radiative forcing of the climate in 1980 and 1990 (IPCC, 1990). The main responsibility for this percentage may be attributed to the chemically related anthropogenic gases CFCs and PCFCs. Due to their depleting influence on stratospheric ozone, CFCs and PCFCs were regulated, as mentioned, by the Montreal Protocol but were not considered in the Kyoto Protocol.

   The majority of scientific research concerns CO_2 emissions, although non-CO_2 gases, especially F-gases, are more potent at trapping heat within the atmosphere. F-gases are expected to rise quickly due to the rapid expansion of some emitting industries such as semiconductor manufacture and magnesium production, and the replacement of ODSs (CFCs and HCFCs) with HFCs in various applications like air-conditioning, fire fighting, foams, refrigeration, solvents and aerosols. Moreover, the atmospheric lifetimes of PFCs and SF_6 are very long, ranging from 3200 years for SF_6 to 50000 years for CF_4 (Schaefer *et al.*, 2006). For these reasons, F-gases are considered extremely harmful for the environment, so they have been included in the Kyoto-Protocol.

   Even if F-gases constitute only a small fraction of present GHG emissions they are responsible for a more considerable amount of climate degradation, compared to other GHGs, because of their high Global Warming Potentials[1] (GWPs), which range from 140 for HFC-152a to 23900 for SF_6. The marginal costs of achieving reduction of high-GWP gases, such as F-gases, are less than achieving reductions of CO_2 gases. According to several studies, the inclusion of the abatement of non-CO_2 GHGs, reduces dramatically the overall implementation cost of the Kyoto Protocol (Reilly *et al*., 1999, 2000, 2006; Jensen and Thelle, 2001).

   The purpose of this study is the construction of the F-gases control cost curve for the year 2020 and for the EU-27. The structure is as follows. Section 2 reviews the existing relative efforts of research and academic institutions on constructing abatement cost curves for F-gases. Section 3

explains the estimation of F-gases emissions by activity and sector. Section 4 derives the stepwise abatement cost curve in the case of F-gases. The last section concludes this[22].

2. Review of existing abatement efforts

In the absence of extensive cross-country data, until recently, a few comprehensive studies examining non-CO_2 gases have been conducted (Chesnaye *et al.*, 2001). The weakness of earlier studies is that they used exogenous marginal abatement cost functions instead of incorporating non-CO_2 gases in analytic models (Hyman *et al*., 2002).

The simultaneous examination of CO_2 and non-CO_2 abatement options may have significant advantages on the so-called multi-gas control strategies. Among these advantages, we may refer to the significant cost reductions compared to a CO_2-only strategy as we may have much cheaper abatement options for several non-CO_2 GHGs (Harmelink *et al*., 2005; Blok *et al.*, 2001), while they offer a greater flexibility in the mitigation options (Lucas *et al*., 2005; Manne and Richels, 2001; Van Vuuren *et al.*, 2003; Hyman *et al.*, 2002). The Energy Modeling Forum (EMF) has performed a model comparison study on the understanding of multi-gas control strategies (EMF-21). Van Vuuren *et al.,* (2006) and Weyant and De la Chesnaye (2006) claim that on average and across models a multi-gas strategy may lead to a reduction in cost of approximately 30-60% compared to abating only CO_2 emissions.

The 21st study of Energy Modeling Forum (EMF-21) at Stanford University assembles modelling teams from around the world in order to assess the cost- effectiveness of non-CO_2 greenhouse gas abatement options and costs. Schaefer *et al*., (2006) investigate future emissions and potential reductions of F-gases. They summarize the abatement options under six categories: substitution, improved containment, recovery and recycling, modified product design, process optimization and destruction.

Following the methodology of EMF-21 study, the USA Environmental Protection Agency conducted a comprehensive report about non-CO_2 greenhouse gases and they provide a set of marginal abatement curves (MAC) which allow for improved understanding of the abatement potential of non-CO_2 GHG (USEPA, 2006a). Gallaher *et al.,* (2005) include technology development in their study, measured by changes in input costs, productivity and abatement efficiency of mitigation options and extract marginal control cost curves using EMF-21 set. Lucas *et al*., (2005) present a methodology to assess the potential long-term contributions of non-CO_2 GHGs in various control options. They rely on EMF-21 projects MAC curves and find that along with the F-gases, energy related methane emissions constitute the highest share of total non-CO_2 control potential representing a large emission source with a large potential reduction (about 90% compared to baseline in 2100).

In March 2007, the European Council decided to set an autonomous target for European climate policy, a reduction of 20% of GHG emissions until 2020, compared to 1990. IIASA developed an analytical tool, the **G**reenhouse Gas and **A**ir Pollution **In**teractions and **S**ynergies (GAINS) model, which quantifies the potential reductions and costs of six greenhouse gases, CO_2, CH_4, N_2O, HFC, PCF and SF_6, for 43 European regions (IIASA, 2008).

3. Estimation of F-gases emissions by activity and sector

To calculate the chemicals emitted from each source (ChE_p) we estimate the total annual emissions for a given chemical in each sector for each European country. The ChE_p is determined by:

$$ChE_p = \Sigma \ [PR_{ijt} \ x \ (1\text{-}AE_t) \ E_{pij} \ x \ AR_{ijtf} \tag{3.1}$$

where: i represents country; j - sector;
t - technology; f - fuel;
p – pollutant; PR stands for production levels;
AE_t - the abatement efficiency of method t; AR application rate.

---

[22] An earlier draft of this study was presented in the Workshop on Abatement Costs of Chemicals at the European Chemical Agency Conference Centre in Helsinki Finland 5-6 October 2010 organized by the European Chemicals Agency (ECHA).

For HFCs emissions, the following activities may be considered:

- *Emissions of HFC-23 gas as by-product from the production of HCFC-22.* The latter is produced both for the final use as for instance in refrigeration and air-conditioning systems and foam manufacturing or as a feedstock for the production of other fluoroorganics like PTFE. The formation of HFC-23 depends on process and manufacturing conditions adopted and may vary from 1.5% to 4% of the HCFC-22 production (Rhiemeier and Harnisch, 2009).

- *Cooling and stationary air conditioning.* To differentiate among emissions and cost differences among sources, five sub-sectors are considered. Namely, domestic small hermetic refrigerators; commercial refrigeration; refrigerated transport; industrial refrigeration; and stationary air conditioning. Commercial refrigeration is the second largest emitter due to leakages during installation, maintenance and disposal of systems. It consists of three categories of equipment: stand-alone, condensing units and centralized systems. Commercial refrigeration main control method is the leakage reductions, the regular inspections (say twice a year) and the installation of leak detectors in refrigerants over 300kg. Due to CFC ban, commercial refrigeration use HCFC-22 and HCFC blends. Since 2000, the European Regulation 2037/2000 banned HCFC in all refrigerating equipments. Industrial refrigeration applications involve food processing, heat recovery, process refrigeration and industrial heat pumps. Main refrigerants are ammonia and HFC (replacing CFC and HCFC). According to UNEP (2006), the annual leakage is approximately 8-10%. In the case of transport refrigeration a study by Schwarz and Rhiemeir (2007) showed that for the EU-27 transport emissions in the maritime and railway sectors were 447 kt CO_2 eq in 2006, reaching the level of 2.8 m t of CO_2 eq or 7% of the total HFC emissions from refrigeration and A/C sector in 2010. In stationary Air-Conditioning A/C main refrigerants used are HFC-407C, R134a and R410. Emissions take place during installation, operation and disposal.

- *Mobile air conditioning.* Mobile A/C are the major source of fluorocarbon emissions due to their increased use and their large leakages. Emissions from this activity may be calculated as a function of vehicles and the annual use of the refrigerant (approximated by the average lifetime of the vehicle). GAINS estimates the use of HFC as a function of the total of light-duty vehicles, the penetration of HFC-based air-conditioners, the vehicle lifetime (around 12 years) and the average charge of HFC per car (0.67 kg HFC-134a per vehicle) (Tohka, 2005). Currently 97 m air conditioned cars were in use in the EU-27 (Rhiemeier and Harnisch, 2009; Eurostat, 2006; IPCC/TEAP, 2005).

- *Aerosols.* HFCs may be emitted from applications where HFCs are used as propellant (aerosol propellant cans, metered dose inhalers in medical cases like the asthma inhaler).

- *Aerosol foams.* They are used in cavities joining inner fixtures in housing construction. They are also called polyurethane (PU) one component foam (OCF). Since 2008, OCFs that use HFCs is banned by EC Regulation No 842/2006. According to UNEP (2006) in Europe and in 2005 almost 85% of the propellants used were hydrocarbons like propane and butane.

- *Other foams.* They may include a number of different polyurethane foams (PU appliances, PU blocks, PU sprays, PU pipe, etc). Their end of use emissions are a function of the end of life treatment. The estimation of these emissions is very difficult. For PU foams, CO_2 alone or in combination with ethanol, hydrocarbon or water may be mainly used as blowing agents instead of extruded polystyrene (XPS). This method may have even 100% abatement efficiency.

- *Other HFC emission sources.* Here we may have fire extinguishers, specific air-conditioning and refrigerator cases, etc. PFCs comprises various substances like CF_4, C_2F_6, C_3F_8 and c-C_4F_8 and emissions come from the production of aluminium and semiconductors. Specifically:

  - *Primary aluminium production.* This is the main source of two anthropogenic types of PFCs emissions (CF_4 and C_2F_6). PFC is produced during the "anode effects", which are upset conditions taking place when the level of aluminium oxide is reduced to very low level and the electrolytic bath starts to go through electrolysis.

  - *Semiconductor industry.* This industry uses among others HFC-23, CF_4, C_2F_6, C_3F_8, SF_6, NF_3 in the production of plasma etching thin films (etch) and plasma cleaning chemical vapour deposition (CVD) tool chambers.

According to ESIA (2006), the European semiconductor industry emitted 2090 kt CO_2 eq in 2003. For the production of semiconductor devices, industry demands gaseous fluorinated compounds,

silanes and other inorganic gases. Semiconductor processes use PFCs in the form of C_2F_6, C_3F_8, CF_4 and $c\text{-}C_4F_8$ as etching gases for plasma etching or in order to perform a rapid chemical cleaning on Chemical Vapour Deposition (CVD) tool chamber (mainly C_2F_6 and CF_4). CVD chamber cleaning emissions account for 80% of semiconductor emissions (USEPA, 2006b).

For SF_6 the main sources of emissions are the following:

- *High- and mid-voltage switches.* Most of the SF_6 is stored in gas-insulated switchgears in the case of high and mid-voltage electrical networks. Emissions are a function of the age of the gas insulated switchgear (GIS).
- *Magnesium production and casting.* Production as well as casting of magnesium in primary and secondary magnesium are important sources of SF_6 emissions. SF_6 is used as gas in magnesium metalworks to sustain the molten magnesium from oxidation. That is SF_6 is used as a component to protect the surfaces of molten magnesium from igniting in the air with explosion. It may be used in casting operations at primary and secondary magnesium smelters, die casting plants and gravity casting plants.

To calculate the activity of F-gases we must include the emissions of the whole life cycle of equipment (e.g. a refrigerator). The life cycle consists of three phases: installation/manufacture, lifetime of the equipment (bank) and the end of its use (scrap). Emission during installation and manufacture are considered negligible. Emissions during lifetime are assumed as a fixed percentage of the stock (bank) of the gas under investigation, mainly HFC in our case, in the lifetime (bank) of appliances. Emissions at the end of the use of the equipment occur when the product is scrapped and their measure depends on number of appliances being scrapped in that year.

Using the emissions projections provided by Rhiemeier and Harnisch (2009) and relying on the information for F-gases emissions by sector and activity for European countries and the EU-27, Figure 1 presents F-gases emissions in 2020 for the European countries. A total projection of 137.7 m tones of CO_2 eq. was calculated.
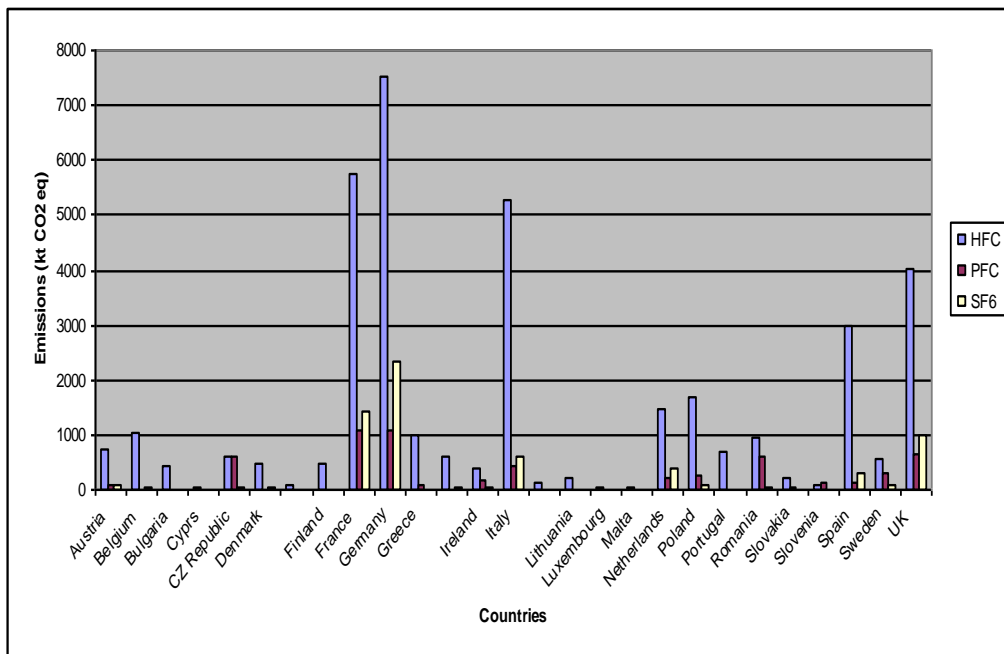

Figure 1- F-gases emissions in 2020

Let us now present an example for calculating average lifetime emissions for each of the five sub-sectors of cooling and stationary air conditioning sector. Table 1 summarizes the emission factors assumed by activity together with the emissions control methods adopted as well as the associated GWP. Similarly Table 2 presents the main parameters in estimating the average lifetime emissions. From Table 2, it can be seen that the average lifetime emissions of industrial refrigerators is 0.115 kg, representing total stock and total amount of scrapped HFC in a given year. The same explanation may be given in all other cases.

Table 1- Emission factors assumed by activity

Activity	Emission control	Emission Factor t F-gases	GWP
HCFC-22 production	Thermal oxidation	0.02	11700
Domestic end of life	Good practice	1	1300
Commercial lifetime	Good practice	0.2	2726
Commercial end of life	Process Modifications	1	2726
Transport lifetime	Good practice	0.2	2000
Transport end of life	Use of open CO_2 REF	1	2000
Industry lifetime	Good practice	0.15	2490
Industry end of life	Process Modifications	1	2490
A/C lifetime	Good practice	0.1	1627
A/C end of life	Process Modifications	1	1627
Mobile A/C lifetime	Good practice	0.1	1300
Mobile A/C end of life	HFC134a replaced by pressurized CO_2	1	1300
OC	Alternative blowing agent	1	1300
OF	Alternative blowing agents	1	815
Aero	Alternative propellants	1	1300
PFC Aluminium	Point feeder prebake PFPB	0.06	
	Centre worked prebake CWPB	0.4	
	Side Work Prebake SWPB	1.9	
	Vertical stud Söderberg VSS	0.7	
	Horizontal stud Söderberg HSS	0.7	
PFC Semiconductor	Alternatives	1	6500
SF_6			
GIS	Good practice	1	23900
Magnesium	SF_6 replaced by SO_2	1	23900
Windows	Alternatives	1	23900
SF_6 Other	Alternatives	1	23900

*Source***:** Relying on Tohka (2005).

Table 2- Parameters for calculating average lifetime emissions per sector

	Domestic	Commercial	Transport	Industry	Stationary A/C
Lifetime emission factor	0.01	0.15	0.20	0.15	0.1
End of life emission factor	1	1	1	1	1
Mean lifetime of equipment (years)	15	10	7	15	15
Average refrigerant charge (kg HFC/unit)	0.1	30 - 300	6	80	60 g/m^3
Average lifetime losses of HFC (in kg)	0.115	Small Ref 75 Big Ref 750	14.4	260	150

*Source***:** Relying on Tohka (2005). Personal calculations.

4. Deriving a stepwise marginal abatement cost curve for F-gases

Given the generic engineering capital and operating control cost functions for each efficient abatement technology, total and marginal costs of different levels of chemical reduction at each individual source and in the national (country) level can be constructed. If an abatement technology is introduced which has a lower marginal cost at some level of abatement than the technology applied before, then this technology has to be applied first. The control methods applied before are not taken into consideration. Building up the source cost functions we eliminate any technology choices which yield non-convex regions of the cost curve. National cost curves therefore will exhibit non-decreasing marginal costs and the most cost-effective techniques will be the proper abatement techniques for the national decision maker.

According to Halkos (1995, 1998), the cost of an emission abatement option is given by the total annualized cost (TAC) of this abatement option, including capital and operating cost components. Specifically:

$$TAC = \left\{(TCC)\left[r/\left(1-(1+r)^{-n}\right)\right]\right\} + VOMC + FOMC \qquad (4.1)$$

where: TCC is the total capital cost; VOMC stands for the variable operating and maintenance cost; FOMC is the fixed operating and maintenance cost; r/[1-(1+r)-n] is the capital recovery factor at real discount rate r, which converts a capital cost to an equivalent stream of equal annual future payments, considering the time value of money (represented by r). Finally, n stands for the economic life of the asset (in years).

Additional, important factors for differences among countries in average mitigation costs are due to differences in HFC compounds used in every country, unabated emission factors and load factors of annual use of equipments. Unabated emission factors may be calculated relying on the instructions given by the Intergovernmental Panel on Climate Change (IPCC).

In our study we use the methods as proposed by Schaefer *et al.*, (2006), which are depicted in the first column of table 3, and a number of abatement options for F-gases as discussed above. Data about emission sources, technologies description and emission removal efficiencies have been taken from Tohka (2005) and Total Abatement Costs are calculated by applying Halkos (1995) methodology.

Post combustion through thermal oxidation is the process of oxidizing HFC-23 to CO_2, hydrogen fluoride and water. Good practice is considered a package of measures including improved components, leak maintenance and prevention and end-of-life recollection of the refrigerant. Process modification changes the process type from ordinary to secondary loop systems and in some cases to alternative refrigerants. Modifications may require lower refrigerant charge, may have lower leak rates and allow the use of flammable or toxic refrigerants. The loss of energy efficiency is the disadvantage of secondary loop system. We may also consider the use of ammonia and hydrocarbons as alternative refrigerants for stationary cooling and stationary A/C systems. For Mobile Air-Conditioning MA/C and refrigeration transport a major alternative is pressurized CO_2.
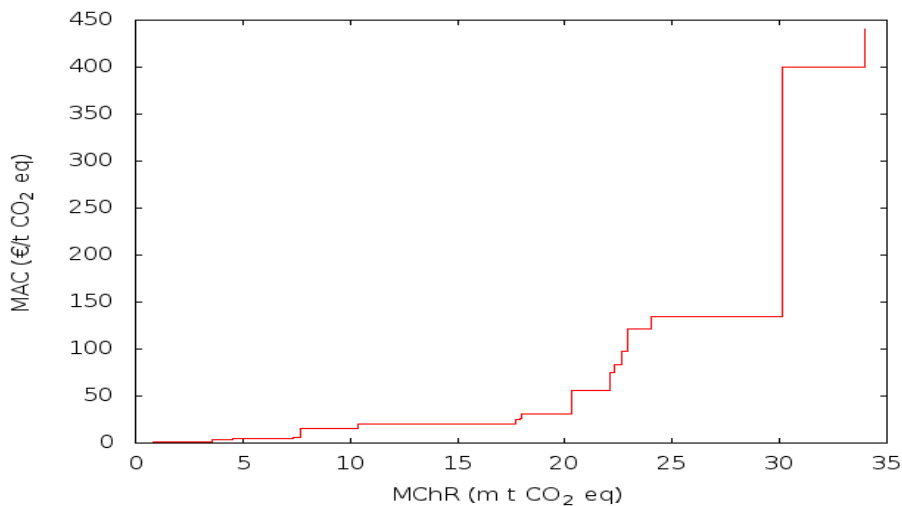

Figure 2- F-gases marginal abatement cost curve for EU-27 in 2020

Figure 2 presents the abatement cost curve for the F-gases in total for EU-27 and for the year 2020. In this Figure the order of introduction of the abatement methods is SO_2 cover gas, alternatives, incineration, alternative propellants, Side Work Prebake SWPB retrofit, alternative refrigeration lifetime and end of life, SWPB to Point feeder prebake PFPB conversion, good practice, alternative blowing agents, Vertical stud Söderberg (VSS) retrofitting, recollection, industry good practice lifetime and end of life, transport good practice lifetime and end of life, commercial good practice lifetime and end of life, mobile A/C good practice lifetime and end of life, semiconductor alternatives, alternative refrigeration

lifetime and end of life, process modification lifetime and end of life, good practice lifetime and end of life, VSS to PFPB conversion, process modification lifetime and end of life.

Table 3- Abatement options for F-gases

Method	Gas	Emission Source	Technology description	Emission removal efficiency	TAC
Substitution	HFC	Transport refrigeration (bank)	Alternative refrigerant: use of open CO_2 refrigerant system	100%	1,719
		Transport refrigeration (scarp)		100%	1,719
	PFC	Primary aluminium production	SWPB to PFPB conversion	97%	-
			VSS to PFPB conversion	92%	-
		Semiconductor manufacture	Alternative solvent: use of NF3	99%	-
	SF_6	Magnesium production and casting	Alternative protection gas: SF_6 replaced by SO2	100%	-
Improved Containment	HFC	Industrial refrigeration (bank)	Good practice: leakage control, improved components	42%	5,366
		Commercial refrigeration (bank)		33%	6,423
		Transport refrigeration (bank)		80%	6,372
		Stationary air conditioning (bank)		30%	3,786
Recovery and Recycling	HFC	Industrial refrigeration (scrap)	Good practice: end-of-life recollection	88%	5,366
		Commercial refrigeration (scarp)		80%	6,423
		Domestic hermetic refrigerators (scarp)		80%	16,459
		Transport refrigeration (scarp)		20%	6,372
		Stationary air conditioning (scarp)		88%	3,786
	SF_6	High and mid voltage switches	Good practice: leakage control and end-of-life recollection	84%	-
Modified product design	HFC	Industrial refrigeration (bank)	Process modification including alternative refrigerants	100%	12,780
		Industrial refrigeration (scrap)		100%	12,780
		Commercial refrigeration (bank)		100%	19,481
		Commercial refrigeration (scarp)		100%	19,481
		Stationary air conditioning (bank)		100%	3,786
		Stationary air conditioning (scarp)		100%	14,546
Process optimization	PFC	Primary aluminium production	SWPB retrofitting	26%	-
			VSS retrofitting	26%	-
Destruction	HFC	HCFC-22 production	Incineration: post combustion of HFC-23 emitted from production of HCFC-22	95%	4,135

In the case of HFCs, the order of introduction is alternative propelands, transport alternative refrigeration lifetime and end of life, alternative blowing agents, recollection, industry good practice lifetime and end of life, transport good practice lifetime and end of life, commercial good practice lifetime and end of life, mobile A/C good practice lifetime and end of life, mobile A/C alternative refrigeration lifetime and end of life, commercial process modification lifetime and end of life, industrial process modification lifetime and end of life, A/C good practice end of life and lifetime, A/C process modification end of life.

Similarly the order of introduction of the mitigation methods in the case of PFCs is SWPB retrofit, SWPB to PFPB conversion, VSS retrofitting, semiconductor alternatives, VSS to PFPB conversion,

while in the case of SF_6 the order of introduction is magnesium production and casting, windows lifetime, SF_6 other and good practice in gas insulated switchgear.

5. Concluding remarks and limitations

In abating F-gases, it is found as more cost-effective to start abating SF6 gases first, then moving to PFCs and then applying control methods to HFCs. Important activities emitting F-gases in 2020 are air conditioning and refrigerator sectors and aluminium industry. More than 20 abatement options to mitigate F-gases and their costs were presented. The existing results show average cost per ton CO_2 controlled using these methods to range from 0.11 to 50 €/t CO_2 eq. Half of these options have cost below 15 €/t CO_2 eq.

The policy implications are interesting. Concerning domestic refrigeration attention must be given to the improvement of recovery efficiency for old equipments containing still HFC-134a instead of isobutane (HC-600a) or propane (HC-290). Better recovery to prevent emissions at the end of life stage is necessary. In industrial refrigeration, leak detectors are important in order to reduce emissions by leakages while regular service inspections are required. Ammonia (R-717) is used as refrigerant in large installations worldwide while CO_2 can be used as a secondary refrigerant and it can also be used in applications with evaporation temperatures down to -52° C and up to 5° C (Rhiemeier and Harnisch, 2009).

In stationary A/C improvement in the design and installation of systems, maintenance and repairing of systems, refrigerant recovery during servicing, recycling of recovered refrigerants are some of the ways to reduce leakages. In mobile A/C inspections are important. For PU foams a main mitigation option is the use of hydrocarbons instead of HFCs.

In the case of sulphur hexafluoride emission abatement the main control methods are improved recovery, minimization of leakages and optimal use. In the case of the manufacture and use of GIS, the main control methods are proper design, gas recovery, re-use and training of personnel handling SF_6.

At last, it is worth mentioning that, as in any environmental problem, we may expect synergies to be present in the case of F-gases mitigation. Tohka (2005) claims that using alternative refrigerants may increase electricity use in some sectors like commercial, industry and air-conditioning. At the same time, mobile air-conditioning increases both HFCs emissions and fuel consumption leading to more emissions of other gases too. Primary aluminium production is also associated with particulate matter (PM) emissions and its abatement will also influence PM emissions (Klimont *et al.,* 2002). Finally, mitigation of PFC emissions influences also CO_2 emissions.

References

[1] Blok, K., De Jager, D. and Hendriks, C. (2001). *Economic Evaluation of Sectoral Emission Reduction Objectives for Climate Change - Summary Report for Policy Makers*. Ecofys, Utrecht, The Netherlands.

[2] Chesnaye F., Harvey R., Kruger D. and Laitner J. (2001). Cost-effective reductions of non-CO_2 greenhouse gases, *Energy Policy*, 29: 1325-1331.

[5] Gallaher, M.P., Petrusa, J.E. and Delhotal, K.C. (2005). International marginal abatement costs of non-CO_2 greenhouse gases, *Environmental Science*, 2 (2/3): 327–337.

[6] Halkos, G. (1995), Evaluation of the direct cost of sulphur abatement under the main desulfurization technologies, *Energy Sources*, 17: 391-412.

[7] Halkos, G. (1998). Evaluating the direct costs of controlling NO_X emissions in Europe, *Energy Sources*, 20(3): 223-239.

[8] Harmelink, M.G.M., Blok, K. and Ter Avest, G.H. (2005). Evaluation of non-CO_2 greenhouse gas emission reductions in The Netherlands in the period 1990–2003, *Environmental Science*, 2(2/3): 339–349.

[9] Hyman, R.C., Reilly, J.M., Babiker, M.H., De Masin, A. and Jacoby, H.D. (2002). Modeling non-CO_2 greenhouse gas abatement, *Environmental Modelling and Assessment*, 8(3): 175–186.

[13] Klimont Z., Cofala J., Berto I., Amann M., Heyes C., and Gyarfas, F. (2002). *Modelling Particulate Emissions in Europe*, IR-02-076, IIASA, Laxenburg.

[14] Jensen, J. and Thelle, M.H. (2001). *What are the gains from a multi-gas strategy?*, Fondazione Eni Enrico Mattei, Milano, Italy.

[15] Lucas, P.L., Den Elzen, M.G.J., and Van Vuuren, D.P. (2005). *Multi-gas abatement analysis of the Kyoto Protocol*, Report no. 550006001. Netherlands Environmental Assessment Agency (MNP), Bilthoven, The Netherlands.

[16] Manne, A.S., and Richels, R.G. (2001). An alternative approach to establishing trade-offs among greenhouse gasses, *Nature*, (5): 675–677.

[17] Reilly, J., Prinn, R., Harnisch, J., Fitzmaurice, J., Jacoby, H., Kicklighter, D., Melillo, J., Stone, P., Sokolov, A. and Wang, C. (1999). Multi-gas assessment of the Kyoto Protocol, *Nature*, 3: 549-555.

[18] Reilly, J., Mayer, M., and Harnisch, J. (2000). Multi gas control under the Kyoto Agreement, Report No. 58, Cambridge, MA.

[19] Reilly J., Sarofim M., Paltsev S. and Prinn R. (2006). The role of non-CO_2 GHGs in climate policy: Analysing using the MIT IGSM, *Energy Journal Special Issue*, 503-520.

[20] Rhiemeier J.M. and Harnisch, J. (2009). *F-gases (HFCs, PFCs and SF_6): Sectoral emission reduction and Economic Costs for Climate Change (SERPEC-CC)*. ECOFYS, Utrecht, The Netherlands

[21] Schaefer, O.D., Godwin, D. and Harnisch J. (2006). *Estimating Future Emissions and Potential Reductions of HFCs, PFCs, and SF_6*, *Energy Journal Multi-Greenhouse Mitigation and Climate Policy Special Issue*, pp. 63-88.

[22] Schwarz, W., Rhiemeier, J.M. (2007). *The analysis of the emissions of fluorinated greenhouse gases from refrigeration and air conditioning equipment used in the transport sector other than road transport and options for reducing these emissions*, prepared for the European Commission (DG Environment), 2 November 2007.

[23] Tohka, A. (2005). *The GAINS Model for Greenhouse Gases - Version 1.0: HFC, PFC and SF_6*, IIASA Interim Report IR-05-056, IIASA, Laxenburg..

[27] Van Vuuren, D.P., Den Elzen, M.G.J., Berk, M.M., Lucas, P.L., Eickhout, B., Eerens, H., and Oostenrijk, R. (2003). *Regional costs and benefits of alternative post-Kyoto climate regimes: comparison of variants of the multi-stage and per capita convergence regimes*. Report no. 728001025. National Institute for Public Health and the Environment, Bilthoven, The Netherlands.

[28] Van Vuuren, D.P., Weyant, J.P. and De la Chesnaye, F.C. (2006). Multigas scenarios to stabilise radiative forcing, *Energy Economics*, 28: 102–120.

[29] Weyant, J.P. and De la Chesnaye, F.C. (2006). Overview of EMF-21: multigas mitigation and climate change, *Energy Journal Multi-Greenhouse Mitigation and Climate Policy Special Issue*, pp. 1-32.

*** ESIA (2006). *European Semiconductor Industry Association: Intermediate Staus Report of the Progress towards the reduction of PFC emissions from European semiconductor manufacturing*. ESIA, Brussels.

*** Eurostat (2006). Eurostat: Passenger transport in the European Union - Issue number 9/2006, Luxembourg, September 2006. http://epp.eurostat.ec.europa.eu/cache/ITY_ OFFPUB/KS-NZ-06-009/EN/KS-NZ-06-009-EN.PDF. Accessed 11 July 2008

*** UNEP (2006), *Report of the Refrigeration, Air conditioning, and Heat Pumps Technical Options Committee*, Assessment, Nairobi, January 2007.

*** USEPA (2006a), *Global Mitigation of Non- CO_2 Greenhouse Gases*, United States Environmental Protection Agency, Washington, DC, EPA Report 430-R-06-005, http://www.epa.gov/nonco2/econ-inv/international.html

*** USEPA (2006b), *Global Emissions of Non-CO_2 Greenhouse Gases: 1990-2020*. United States Environmental Protection Agency (US-EPA), Washington, D.C., EPA Report 430-R-06-003, http://www.epa.gov/nonco2/econ-inv/international.html

The 6th Online International Conference on „Advanced Researches in Management, Finance and Accounting" Craiova, Romania, 22th November, 2013

Maintaining the tradition of annual conferences, Faculty of Financial Accounting Management and CESMAA organize this year the International Conference dedicated to the *„Advanced Researches in Management, Finance and Accounting"*. Each year, Research Center, CESMAA of Faculty of Accounting and Financial Management, Craiova provides an opportunity to meet and network with a diverse range of industry leaders and senior professionals through the academic area from the entire world of Economic Sciences.

To resolve the funding issue concerning the conference expenses, European Research Center of Managerial Studies in Business Administration will organize, in 22th November, an online session as an alternative approach for participation. Those who would attend to International online conference will be awarded with a certificate and their accepted papers will be considered for publications in Journal of Applied Economic Sciences and Journal of Applied Research in Finance.

Conference aims is to promoting research and provides an opportunity for intensive interdisciplinary interaction and debate between academics and practitioners with research interests in the field of economics, finance, accounting, business, marketing, management, and information technology. The conference has grown over the years and now attracts researchers of major institutions internationally.

CALL FOR PAPERS:

The conference provides a forum for disseminating new research findings, practices and techniques in management, finances, accounting, business, marketing, international affairs and information technology and exchanging ideas among academicians and practitioners to promote a better understanding of contemporary issues and solutions to the challenges. This conference would encourage the young generation to pursue research interests in the areas of economic sciences.
Academicians and researchers are invited to share their unpublished research findings in all areas mentioned below, but are not limited to:

- Accounting Challenges – Strategic Accounting;
- Management Control Systems;
- Creative Accounting and Earnings; Management;
- Forensic Accounting and Fraud;
- Tax Accounting and Fraud;
- Prevention of fraud and unacceptable accounting practices;
- Information security audits;
- Best Practices in Corporate Governance;
- Asset-liability management;
- Bank assurance;
- Banking crises;

- Corporate finance;
- Credit risk modelling and management;
- Financial engineering;
- Foreign exchange markets;
- Law and finance;
- Mergers and acquisitions;
- Mutual funds management;
- Portfolio management;
- Regulations of financial markets;
- Accounting and Finance;
- Accounting, Auditing and Performance; Evaluation;
- Auditing Technology;

- Organizational Reengineering;
- Efficiency and performance of
  financial institutions and bank branches;
- Financing decisions of banks;
- Investment banking;
- Management of financial institutions;
- Regulation and supervision of the
  banking industry, both nationally
  and internationally;
- Technological progress and banking;
- The role of central banks;
- Accountability;
- Accounting standards and regulations;
- Environmental accounting;
- Financial accounting;
- Management accounting;
- Risk management and internal control;
- Social accounting;
- Asset pricing;
- Bankruptcy prediction and determinants;

- Banking, Accounting and Finance;
- Behavioral Accounting and Finance;
- Corporate Governance;
- Business Intelligence;
- Economics and Accounting;
- Education Economics and Development;
- Electronic Banking;
- Electronic Finance;
- Financial Markets and Derivatives;
- Financial Services Management;
- Culture and Business Management;
- Managerial and Financial Accounting;
- Monetary Economics and Finance;
- Revenue Management;
- Strategic Engineering Asset Management;
- Applied Economic Studies;
- Complexity in Business and Economics;
- Business and Economics Engineering;
- Experimental Design and Process Optimization;
- Product Development.

Papers have to submit electronically at this e-mail address cesmaa_research@yahoo.co.uk in MS Word also in PowerPoint format (see Instructions for Authors). All papers are double peer reviewed by members of the Scientific Committee. Papers accepted will be published in official Conference eProceedings on CD, which will have assigned ISBN. Papers received after the deadline will not be included in the proceedings.

The best papers will be published in **Journal of Applied Economic Sciences** http://www.cesmaa.eu/journals/jaes/index.php which is indexed in SCOPUS, RePEc, CEEOL, Index Copernicus and EBSCO databases as well as in **Journal of Applied Research in Finance** (http://www.cesmaa.eu/journals/jarf/index)**,** also indexed**.**

Important Dates:
- 20 October, 2013 - Abstract submission deadline;
- 25 October, 2013 - Notification of acceptance/rejection;
- 5 November, 2013 - Deadline for payments and Final paper submission deadline;
- 22 November, 2013 – Conference.

Conference Fee covers conference materials, (book of abstracts, eProceedings, Certification of participate).
- **100 Euro** for foreign participants;
- **200 Lei/paper** for Romanians participants;
- **50 Lei/paper** for CESMAA members.

Payment will be to perform immediately after notification of acceptance of your paper until 2013, November 5. All fees derived by the bank transfer will be supported by the sender.
Bank: Raiffeisen Bank – Victoria Agency

IBAN ACCOUNT for EURO: RO 25RZBR0000060014384461
IBAN ACCOUNT for LEI: RO 04RZBR0000060014384451

Account holder: Spiru Haret University, Central Research Institute
Address: No.1, Tineretului *Street*, District 4, Bucharest, Romania

Please mention on the payment form that the fee is for the CESMAA Conference and your name (*e.g. CESMAAConference_2013_Smith*).
It is essential to send a copy of Payment Form (Bank Transfer):
- copy by fax: 40 251 598265;
- or a scanned copy by email to: cesmaa_research@yahoo.co.uk

For more details please visit our conference`s website at: http://www.cesmaa.eu/conferences

Call for Papers

The Editor in Chief would like to invite submissions for the 8th **Volume, Issue 4(26), Winter 2013** of the *Journal of Applied Economic Sciences (JAES).*

The primary aim of the Journal has been and remains the provision of a forum for the dissemination of a variety of international issues, empirical research and other matters of interest to researchers and practitioners in a diversity of subject areas linked to the broad theme of ~~economic, business, management, accounting, finance,~~ information technologies.

Subject areas include, but not restricted to:

- Quantitative and qualitative research methodology and practice
- Strategic, public sector and human resource management
- Entrepreneurship and Small & Medium Sized Enterprises (SME's)
- Marketing and e-business
- Economics, finance and financial management
- Organizational theory and behavior
- Supply chain management
- Information systems, technology, innovation and operations management
- Educational management and leadership

All papers will first be considered by the Editors for general relevance, originality and significance. If accepted for review, papers will then be subject to double blind peer review.

Deadline for Submission: **15th November 2013**
Expected Publication Date: **December 2013**

Web: http://www.cesmaa.eu/journals/jaes/
E-mail: jaes_journal@yahoo.com

Full author guidelines are available from:
http://www.cesmaa.eu/journals/jaes/instructions_for_authors.php