

JOURNAL   
of Applied Economic Sciences



Volume VIII  
Issue 4(26)

Winter 2013

**I.S.S.N. 1843-6110**

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ISSN 1843-6110

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# A PRAGMATIC STUDY ON WAITING LINE STRATEGIES OF AN INDIAN PRIVATE SECTOR BANK

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## Abstract:

*In today's fast-paced society, waiting is not something most people tolerate well. As people work for longer hours, individuals have less leisure and families have fewer hours together, the pressure on people's time is greater than ever. In this environment, customers are looking for efficient, quick service with no wait. Organizations that make customers wait take the chance that they will lose business or at the very least that customers will be dissatisfied. Waiting lines, namely, queues occur whenever the number of arrivals at the facility exceeds the capacity of the system to process them. Queues are the symptom of unresolved capacity management problems. Customers can be more or less satisfied depending on how the wait is handled by the organization. The actual length of wait will affect how customers feel about their service experience. The type of wait namely, the standard queue versus a wait due to delay of service can also influence how customers will react. The study was made by collecting data from the customers of ICICI Bank Ltd., Tirchirappalli District and it resulted in a very small degree of dissatisfaction among the customers.*

**Key words:** customer satisfaction, waiting time, location, queue and service delivery.

**JEL Classification:** G21, M31.

## 1. Introduction

An organization should always consider customers as their foundation for the business. A customer should be considered empathetically and treated as they are the part of their business. As the customers are considered as one of the stakeholders, the service providers should maintain a very cordial relationship with them. The intermediaries should recognize that their remuneration depends on the number of customers they gain for the employer. The ultimate in customer satisfaction is giving customers exactly what they want. The organization should satisfy the customers to make repeated purchases with them. This will result in the increased cash flow of the organization. Satisfaction = Perception – Expectation.

If the perception exceeds the expectations of the customers, the service provider gets a satisfied customer and vice-versa. Rarely, the perception will be equal to the expectation of the customers. The service manager has to manage and concentrate always on the perception, expectation and the actual service rendered to their customers.

Customers consider waiting time as frustrating and they think that they can do many things while waiting. To minimize the waiting time, any organization must design their service process properly which is practically difficult.

## 2. Scope of the study

In Forbes Global 2000 ranking the companies for the year 2012, out of top eleven leading Indian companies, ICICI Bank (world rank 301) is the first private sector banking company in the Indian banking sector. ICICI Bank has increased their business based on the franchise (Direct Sales Agents) model for small enterprise segment. ICICI Bank is the second largest bank in India by assets (US\$ 93 billion as on March 31, 2012) and third largest by market capitalization. It has a network of 2,907 branches and 10,088 ATM's in India. It has its presence in 19 countries including

India. It has profit after tax of US\$1.271 billion as on March 31, 2012. It has a total equity of US\$ 12.62 billion and 81,254 employees as on March 2012. ICICI Bank is the first bank in India to offer one-of-its kind “Your Bank Account” App, which allows access to bank account information on Facebook officially.

The success of the bank over the period is based on the service quality which has resulted in customer satisfaction and loyalty towards the bank. This formed the basis for the selection of this bank for measuring the customer satisfaction. Though there are e-banking facilities available, there exists a need for personal touch for the issue of debit cards, pin number for debit cards, pay orders, cheques, demand drafts and the like. This calls for the personal interaction between the bank and the customers. This paved way for the study to analyse the customer satisfaction towards the waiting line strategy of ICICI bank.

### **3. Objectives of the study**

To study about the waiting time of the customers for receiving service and the means of reducing waiting time using ANOVA, Weighted ANOVA and queuing model.

#### *3.1. Sampling design*

Stratified random sampling method is dividing the population into homogenous sub groups and administering random sampling within the sub groups. Stratified random sampling method is adopted for the collection of the data from the customers of ICICI Bank. ICICI Bank operations are divided into four divisional offices in India, specifically, North, South, West and East. The South Division comprises four states Karnataka, Andhra Pradesh, Kerala, and Tamilnadu are called zonal offices. In Tamilnadu zonal office, the regional offices are carried on in metropolitan cities namely, Chennai, Coimbatore, Tiruchirappalli and Madurai. Under the regional offices, they have area operations and branch in charges depending on the volume of operations and productivity. Under the Tiruchirappalli region, half of the total branches have been selected within 100 kilometre radius and thirty questionnaires are distributed per branch and 20 branches are detailed in the following table.

**Table 1** Area of sampling

Place of branch	No. of branches	No. of branches selected
Tiruchy	6	4
Pudukkottai	26	7
Karur	2	1
Ariyalur	1	1
Perambalur	2	1
Dindugal	5	3
Thanjavur	3	2
Kumbakonam	1	1
<b>TOTAL</b>	<b>46</b>	<b>20</b>

Primary data is collected by personally administering questionnaires to the branches of ICICI Bank as mentioned in the Table 1. Out of 600 (20 branches x 30) questionnaires, 127 are found incomplete and 473 are fully complete with 78.8% of response rate. The analysis is based on the opinion collected from 473 customers of ICICI Bank.

The sum of squares of variations within sample and sum of squares of variations among sample could not be easily calculated manually because of the large size of the data collected. For this purpose, statistical inferential techniques are used with the help of the software NCSS package. Thus ANOVA for the data was performed to study the significant variation between and among the variables involved. Weighted ANOVA was performed to rank the variables according

to their order of importance as perceived by the respondents. QUEUEING Model is formulated to analyse the waiting time of the respondents and to compare with the standards of the bank.

#### 4. Review of literature

Amudha, Surulivel and Vijaya Banu (2012) have stated that customer satisfaction is considered as a yardstick for measuring the service quality and the effectiveness of service delivery process is decided by excellent customer service provided by the bank. Vimi and Mohd (2008) have stated that the performance of the banks depend on perception of the customers towards service provided by the organization. Byun, 2007 have stated that value of the customer was determined by their perceived benefit and the value is considered as the predictor of customers' intention to use the technology. Chiung-Ju Liang, Wen-Hung Wang, (2006) suggested that perceived relationship has an impact on the satisfaction towards the service quality. Parasuraman (2000) stated that the continued market success can be attained only because of the perfect mixing of conventional marketing with better customer service.

Sasser *et al.*, (1979) have provided examples for balancing the perception and expectation of waiting times. They have given an example of hotel for managing perception of waiting times. The hotel received complaints from their customers regarding the waiting time for elevators. The hotel group installed a mirror near the elevator as it is the human tendency to check them. This has considerably reduced the complaints even though waiting time was the same as before. Regarding the expectation of the waiting time, they have given an example of a hotel which informs the length of waiting time which may exceed the expected time. As the customers are already pleased with their service, they accept the length of waiting time.

Waiting is frustrating because one has to do many things during that time. In a business, a customer hates waiting. To try to overcome this, an organization must properly design the service to minimize the waiting time which is practically difficult.

The waiting time of the respondents at the time of obtaining service have a major impact on their behaviour. Every company must implement a waiting line strategy to satisfy their customers. To maintain a present customer and to acquire a new customer, every organization must utilize the waiting time of the customers in a useful way. The customers should not feel that they have wasted their time in waiting in the organization for the service. If the customers are satisfied that they have waited for the service with the minimum of time, they decide to have repeated purchases and have an encouraging word-of-mouth to others. If the customers are dissatisfied regarding the time of wait, they decide to drop their business and shift them to best available competitors. They also spread negative word-of-mouth to others and don't recommend to others. This will result in losing a particular existing and potential customers. This will also result in decrease of volume of transactions in future.

#### 6. Analysis and discussion

The primary data collected for waiting time are analysed under six major dimensions namely, location and number, information about waiting time, modifying the place and time of delivery, inventorying of demands, special treatment and impact as follows:

##### *Location and number*

Provision of excellent service to the customers is difficult to attain than to reach excellent product quality. Organizations will always strive for the methods to satisfy a customer as a never ending process even though they do not complain. Increasing the capacity by adding more tellers is one of the strategies used to reduce the wait times. But, this can be done only when the customer satisfaction is balanced with cost considerations. The bank managers should also consider the redesigning of queuing system and also the process to reduce the time of each transaction and manage the consumer's behaviour and their perceptions of wait. Queue configurations refer to the number of queues in the bank, their locations, their spatial requirement and their impact on customer satisfaction. Therefore, when queues become necessary, the service provider should decide how to configure the queue.



*The information about waiting time*

The information regarding the relative position in the queue, length of waiting time, upcoming services and reason for waiting time will be useful for customers, as it let them to decide whether to wait a present or ought to response later. It also helps them to plan the utilization of their waiting time. Michael K. Hui and David K. Tse (1996) suggested that it may be more fruitful if the customers know how their position in the queue is changed rather than how much time it will take for serving. They conclude that people prefer to see or sense that the line is moving rather than to watch the clock.

*Modify the place and time of delivery*

Adjusting or flexing the resources like time, people, equipment and facilities is the best strategy adopted by many service firms to match the demand with the supply. Many service firms respond to market needs by amending the time and place of delivery rather than to amend the demand for a service. Modification can be done by providing adequate spatial requirements and spreading demand over periods. The service organizations can vary by extending the time when the service is available during the peak seasons. They can also offer the service to customers at a new location and take the service to the customers rather than necessitate them to visit fixed-site locations. Banks use the ATM facility as a strategy to control both the timing and the location of the delivery of their services. U.S Banks use “rolling bank branches” and portable ATMs to capture the demand for financial services. U.S. bank also operates a bank mobile to cover the areas in which population is very thin to justify the construction of a permanent bank branch. Mobile bank units are also useful for reaching the elderly and disabled populations who cannot physically travel to the bank themselves. Monthly costs of operation are also much less than a traditional branch.

*Inventorizing of demands*

Demand for services cannot be inventoried because of its' perishable nature and simultaneous production and consumption. But service demand can be stored by requesting the customers to wait on a first-come-first-served basis or by providing them a service through a reservation facility. Reservation process should guarantee the service at the time of booking and shift the demand to less desirable periods. The service firms also face the type of customers who do not show up for their reserved time. In this situation, booking in excess of their service capacity on the basis of earlier period records of no-show percentages is the best solution. This will be fruitful if the predictions are accurate. If the prediction goes wrong, the customers still have to wait or they may not be served at all. The victims of overbooking may be compensated for their inconvenience. To avoid this no-show problem, some firms charge the customers who fail to show up or cancel their reservations within a specific time.

*Special treatment*

All the customers need to wait the same length of time for service. The urgency of the needs of the customers is considered to decide about their waiting time by the service provider. This is called as queue discipline and first come first served basis is generally followed in the queue. The queuing systems can be altered and designed based on market segmentation. This is possible by designing queuing systems to set special treatment to different types of customers. Provision of break up areas for queuing based on special service area, meeting urgent needs, shorter service jobs and paying a premium price that is extra fee. Customers who are very important personalities or are frequent customers, whose business is especially valued, may be given special treatment. Customers are prepared to pay an extra fee for a known or trusted brand name. Customers who pay an additional amount are quite often given importance in express systems and they become everlasting customers.

*Impact*

People habitually believe that they have waited for a long time for a service though they have really done so. Jay R. Chernow (1981) state that the travellers in public transportation use perceive time spent waiting for a bus or train as passing one and a half to seven times more slowly than the time spent traveling in the vehicle. Ana B. Casado Diaz and Francisco J. Mas Ruiz (2002)

say that people do not like wasting their time on unproductive activities any more than they like wasting money. The impediments in receiving service will normally stimulate anger with emotions and results in customer dissatisfaction. Influence of waiting time over the buying behaviour, the opinion of the respondents about the duration of waiting time as fair and equitable.

Aaltonen-Gaudet, (2004) suggested that technology satisfaction results in does customer satisfaction and loyalty. They also suggest that demographics do not influence overall customer satisfaction or loyalty. The relationship that exists between the demographic variables namely, occupational pattern and the annual income as the most important variables influencing the level of customer satisfaction have been studied in this study. Quality of service provided by the ICICI Bank to the customers is taken as a yard stick to measure the customer satisfaction in this study.

A hypothesis is set to study the impact of occupational pattern and annual income of the respondents towards the waiting line strategies of ICICI Bank. Sub-hypotheses are framed to study the impact of occupational pattern and annual income of the respondents over the waiting time in receiving the service for the six variables namely, location, information, modification of place and time of delivery, spreading of demand, special treatment and the impact on satisfaction

H.1 Occupational pattern of the respondents do not have significant difference over the waiting time in receiving the service.

**Table 2** Comparative table showing the impact of occupational pattern of the respondents on waiting line strategies - ANOVA *single factor*

Waiting line strategies	Occupational pattern	Calculated value
Location and Number	Accepted	0.440621
Information about waiting time	Rejected	4.006402
Modify the place and time of delivery	Rejected	12.99215
Inventorying of demands	Rejected	4.682095
Special treatment	Rejected	5.496292
Impact	Accepted	2.795919
Overall opinion	Rejected	6.445776

Source: Primary data  
Table value = 3.014904.

H.2 Annual incomes of the respondents do not have significant difference over the waiting time in receiving the service.

**Table 3** Comparative table showing the impact of annual income of the respondents on waiting line strategies- ANOVA *single factor*

Waiting line strategies	Annual income	Calculated value
Location and Number	Accepted	0.455599
Information about waiting time	Accepted	2.687271
Modify the place and time of delivery	Rejected	7.962081
Inventorying of demands	Accepted	1.445899
Special treatment	Accepted	2.221014
Impact	Rejected	5.764737
Overall opinion	Rejected	3.591746

Source: Primary data      Table value = 3.014904.

From the above Table 2 and Table 3, it is clear that the occupational pattern of the respondents does not have an influence towards the Location and number and Impact. The occupational pattern of the respondents has the influence towards the information about waiting time, modification of the place and time of delivery, spreading of demands and special treatment. The annual income of the respondents has an influence towards the reduction of time and impact. The annual income of the respondents does not have an influence towards the location and number, Information about waiting time, spreading of demands and special treatment. The overall opinion of the respondents reveals that the occupational pattern and the annual income have an influence of waiting time over their purchasing decisions. These results are arrived taking into consideration the table value of 3.014904. When the calculated value is less than the table value, the hypothesis is accepted and vice versa. If it is accepted, it implies that the occupational pattern or the annual income does not influence the variables.

The facilities provided by the ICICI Bank takes the form of increase in the number of counters and thereby increasing the number of queues to reduce the waiting time providing information about the relative position in the queue, the probable length of waiting time, upcoming services and reasons for waiting time. ICICI Bank provides the number of service points and the number of queues to all customers irrespective of the income and occupational pattern. The customers of different occupations know the timings of ICICI Bank because of their regular dealings and they do not find any difference as far as the income level is concerned.

Adequate spatial requirements and spreading demand over periods to reduce the waiting time of the customer. The customers are satisfied that the service points namely, ATMs and branches are within their access. The ICICI Bank have also extended the business hours and differentiates the customers when the deposit of cash is more or less than Rs.50,000. This saves the waiting time of the customers resulting in satisfactory level.

Guaranteeing the service at the time of booking and shifting the demand to less desirable periods is made by ICICI Bank. The customers of different occupations are very much specific about the guaranteeing of service and shifting of demand because of the significance of the time factor involved in it. Whatever may be the amount of transaction, the customers perceive it as a single transaction. Therefore, the annual incomes do not influence the inventorying of demands.

ICICI Bank provides special area, meets urgent needs and extends the shorter service jobs with extra fee. Customers are who ready to pay an extra amount for a popular or trusted brand name and the annual income of the respondents do not have any impact on the same. Because of the importance of the time factor involved in a transaction, the occupational pattern influences the level of satisfaction. Irrespective of the amount, the customers treat the transaction as a single transaction.

Duration of waiting time is fair and equitable and the annual income of the respondents had an influence towards the same. The customers of various occupations are expressing their level of satisfaction and most of the businessmen and professionals are trying to shift their demand to other competitors. This should be taken care of by ICICI Bank to retain its customers.

The following Table 4 shows the comparative ranking of the respondents for the services rendered by ICICI Bank Ltd., Tiruchirapalli District to reduce the waiting time by fixing standards. The ranks are obtained by applying Weighted ANOVA.

**Table 4** Comparative table showing the ranking of the respondents  
– weighted ANOVA

PARTICULARS	Weighted ANOVA Scale	RANK
Does the bank identify different locations to reduce waiting time?	165.10	1
Does the bank increase the number of queues to reduce waiting time?	158.40	2
Do you feel that waiting time at ICICI Bank is fair and equitable?	149.00	3
Does the bank provide priority to the customers paying extra fee?	144.63	4
Does the bank provide added benefit of potentially shifting the demand to less desirable time periods?	141.38	5

PARTICULARS	Weighted ANOVA Scale	RANK
Does the bank provide information about the length of waiting time?	137.75	6
Does the bank provide information about the relative position in the queue?	137.25	7
Does the bank provide information about the upcoming services?	136.88	8
Does the bank provide information about the reason for the waiting time?	135.63	9
Does the bank provide adequate spatial requirement to reduce waiting time?	134.63	10
Does the bank provide priority to the customers with the most urgent need?	132.00	11
Does the waiting time influence your buying behaviour?	126.50	12
Does the bank provide special waiting area for frequent customers and customers who spend large amount of transactions with the bank?	122.50	13
Does the bank provide priority to the customers with the shorter service jobs?	120.63	14
Does the bank guarantee the availability of service when the customer arrives at times of advance booking?	114.50	15
Does the bank spread demand over periods to reduce waiting time?	102.75	16

Source: Primary data

From the above table it is evident that the respondents are satisfied that the ICICI Bank provides different locations to reduce waiting time and they rank this service as the first, following this the respondents also accept that the bank has increased the number of queues to reduce waiting time by opening more than one counter in any one branch. They also feel that the waiting time is fair and reasonable and they are given importance when they pay extra fee. The bank also shifts the demand from the peak periods to less desirable time periods. The respondents rank the services of the bank in providing information regarding the length of waiting time, relative position in the queue, upcoming services, providing reasons for waiting time from six to nine respectively.

The respondents are of the opinion that bank provides adequate spatial requirements to reduce waiting time and gives priority to the persons who are in most urgent need. The last five ranks are given by the respondents by less importance to the influence of waiting time over purchasing decision, provision of spatial waiting area for customers who make frequent visit and customers who spend large amount of transactions with the bank, provision of priority to customers with shorter service jobs, guaranteeing the customers about the availability of service to the customers at times of advance booking and spreading of demand over periods to reduce waiting time.

The respondents are of the opinion that they are satisfied about the services provided by the bank to reduce the waiting time. The bank provides comfortable seating arrangements in the waiting area. They also provide a minimum of three and a maximum of ten counters in one particular branch depending upon the volume of transactions and the number of customers. The bank has also set the standards for its services that are extended to the customers to assess their service quality. If the waiting time is above the normal, the bank provides reasons for the waiting time. By issuing and depicting the token number in the bank, it reveals the relative position in the queue. When the customers enter into the bank, they are being aware with the information about the services to be provided by the bank.

An organization should communicate the quality of service to its customers. The customers will always expect the same level of information from advertisements and in the real service received by them. By proper communication methods like toll-free numbers, automated voice recorded system; any organization should try to build a level of trust among the customers. Through market research, the organization must try to gain new customers which will result in increased sales.

Queuing Model

Queuing theory is applied in this study to understand the system standards followed by the bank for the receiving cash, issue of demand draft and pay orders, the probability of waiting for the service is found through queuing model. Since both the arrival and departure rates are dependent on service channels, the model was presumed to be Poisson queuing. The best fit for the arrival of the customers to the counters is studied by trying Binomial distribution, Weibull distribution and Poisson distribution and the results for the accuracy of arrival rate is summarized in the Table 3. To validate the model, the underlying assumptions of Poisson distribution are enumerated below:

- the variable is discrete and the trials are independent;
- $n$ , the number of trials is finite and large;
- $p$ , the probability of success is very small;
- $np = m$ , is the mean of the distribution and is finite and moderate;
- $p$  or  $q$  is very close to zero or unity. If  $p$  is close to zero, the distribution will be  $J$ - shaped and unimodal;
- there are only two possible outcomes of the trial;
- Poisson is entirely known if the arithmetic mean is known,
- if  $n$  is very large and  $p$  is very small, Poisson gives a close approximation to the binomial.

Most of the data collected falls in the line of the above mentioned general assumptions. The best fit of arrival rate of the customers under Binomial distribution, Weibull distribution and Poisson distribution is shown in Table 5.

**Table 5** Best fit of arrival rate of respondents

Transactions	Binomial distribution	Weibull distribution	Poisson distribution
Receipt of cash below Rs.50,000	65.8%	90%	92.9%
Receipt of cash above Rs.50,000	84.4%	85.8%	94.5%
Issue of Pay order/Demand draft	88%	83.8%	94.6%

Source: Primary data

Sum of the probabilities obtained from fitting the data for receipt of cash less than Rs.50,000 to the Poisson distribution is found to be 92.9% , for cash receipt for more than Rs.50,000 is 94.5% and for issue of demand draft and pay order is 94.8%. It clearly exhibits that 7.1%, 5.5% and 5.2% data for cash receipt less than Rs.50,000 cash receipt more than Rs.50,000 and demand draft and pay order respectively belong to misclassified category. When the data is compared by experts in ICICI Bank Ltd., with the available data base of the bank, it clearly indicates that the misclassified data is normally distributed. It is fortunate that more than 90% belong to Poisson domain for all the three categories.

As customer dissatisfaction level corresponds to this misclassified data and it is found that from records, these percentages are normal; much attention has not been paid to categorizing this class of data.

A single/double counter service with Poisson arrival and exponential service time distribution, when both the arrival and service rates are independent of number of customers in the waiting line is taken up for the study. Arrivals are handled on *first come - first service* basis and the arrival rate  $\lambda$  is less than the service rate  $\mu$ .

System represents the number of customers waiting in the line plus number of customers who are getting service.

$$P[\text{waiting time} \geq 5 \text{ min}] = \int_5^{\infty} \frac{\lambda}{\mu} (\mu - \lambda) e^{-(\mu - \lambda)t} dt ,$$

when the number of service counter = 1.

Primary data has been collected to obtain queue parameters. The ways of acquisition of data are as under:

- cash receipt of less than Rs.50, 000 as multi server model of having two counters serving on an average 100 to 120 customers per hour;
- cash receipt of more than Rs.50, 000 as multi server model of having two counters serving average of 70 to 100 customers per hour;
- issue of demand draft and pay order as single server model of having one counter serving average of 30 to 40 customers per hour.

Waiting time of the customers is summed up in Table 6.

**Table 6** Waiting time for the service of the respondents

Transactions	Average expected waiting time (minutes)	Probability of waiting for service for more than the standard time
Receipt of cash below Rs.50,000	8.010	0.028804
Receipt of cash above Rs.50,000	16.385	0.033873
Issue of Pay order/Demand draft	6.1024	0.154095

**Source:** Primary data

The average waiting time for the receipt of cash below Rs.50, 000 is 8.010 minutes and it happens to be equal to the standard time of 8 minutes. This results in the satisfaction of the service and therefore it is ranked as third among thirty one ranks. The probability of waiting for the service for more than the standard time of 8 minutes is 0.028804, which constitutes only 2%. The average waiting time for the receipt of cash above Rs.50, 000 is 16.385 minutes and it happens to be slightly more than the standard time of 15 minutes. This results in the less satisfaction of the service and therefore it is ranked as 20 among thirty one ranks. The probability of waiting for the service for more than the standard time of 15 minutes is 0.033873, which constitutes only 3%. The average waiting time for the issue of Pay order and demand draft is 6.1024 minutes and it happens to be more than the standard time of 6 minutes. This results in the less satisfaction of the service and therefore it is ranked as 10 for pay order and ranked as 13 for demand draft among thirty one ranks. The probability of waiting for the service for more than the standard time of 6 minutes is 0.154095, which constitutes 15%.

*Ways of reduction of waiting time*

- Entertain and Distract: Physically the customers should be involved by installing distractions like music, Mirrors near elevators, Televisions, magazines in hospitals and Electronic News Bulletins in banks;
- Get customers out of line and/or into the process: By providing alternative like telephone and internet banking, the customers will feel part of the process even when they wait in the alternative process;
- Inform customers about waits: If there is a reason for longer than usual waits, customers need to know it;
- Keep non-active resources out of sight: There is nothing more frustrating for a bank customer than to see tellers chatting on the phone behind the tellers’ desks;
- Segment customers according to their willingness to wait;
- Never underestimate the power of a friendly attendant to reconcile the customer tired of waiting and effect a strong recovery;
- Keep signage simple, visible and intuitive and the signs must make sense, like green light means to go and red light means to stop in case of traffic signals;
- Teach the customers the rules “before” they become part of the system. Don’t wait for customers to muck up the process before the organization communicates with them;

- Understand that customer expectations will be set by industry standards. Avoid being too fancy to customers as customers may get confused;
- Learn to read customers because many will simply leave the service disappointed and frustrated rather than ask for help. Customer service staff should pick up on body language and provide assistance before they lose a potential customer and use sound observation often.

The ICICI Bank reduces the waiting time by identifying different locations and increasing the number of queues in a line. The ICICI Bank informs customers about the relative position in the queue to ascertain the length of waiting time. The ICICI Bank also provides adequate information and reason for making a customer to wait in a queue. He is also informed about the upcoming services he is supposed to receive in near future and this will reduce his mental fatigue of waiting in a line. Customers will be having their own mental expectations about the services to be received and they are provided with adequate spatial requirements to make them feel comfortable. This will not result in mental irritation and avoid the drop-out of the transactions.

The ICICI Bank also tries to spread the demands over the periods to avoid huge accumulation of demand at any one point of time. This will also result in reduction of waiting time. When the demands are spread over, the ICICI Bank also guarantees that it will provide the services in future without any hindrance, if it is booked in advance. Thus, the advance booking help the ICICI Bank to shift the potential demand to less desirable time periods.

### **Conclusion**

The waiting time can be reduced by identifying different locations and increasing the number of queues in a line. The customers must be informed about the relative position in the queue to ascertain the length of waiting time. The bank should also provide adequate information and reason for making a customer to wait in a queue. He should also be informed about the upcoming services he is supposed to receive in near future. This will reduce his mental fatigue of waiting in a line. He will be having his own mental expectations about the services to be received. They should also be provided with adequate spatial requirements to make them feel comfortable. This will not result in mental irritation and avoid the drop-out of the transactions.

The bank should also try to spread the demands over the periods to avoid huge accumulation of demand at any one point of time. This will also result in reduction of waiting time. When the demands are spread over, the bank should also guarantee that it will provide the services in future without any hindrance, if it is booked in advance. Thus, the advance booking help the bank to shift the potential demand to less desirable time periods.

Regarding the waiting time for receiving the service, the customers opines that the intermediaries of the ICICI Bank show difference among them based on occupational pattern and the income level. Therefore, the bank must instruct its intermediaries to extend the same level of service to them. As the customers are dissatisfied with the service of receiving cash above Rs.50,000, issuing demand draft and pay order, the bank should take initiative to improve the services up to the standard norms as prescribed by the bank.

Amudha Ramachandran and Vijayabanu Chidambaram (2012) have stated that attraction, retention and enhancement of the customer relationships are essential to maintain a base of delighted and committed customers who form the basis for the sustainable competitive position of the bank. So, the bank should educate the employees regarding the priority order of service delivery performance. The bank should create confidence in the minds of the customers that they are properly taken care of their business and emphasize the courteous behaviour of the intermediaries of the bank towards the customers.

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# **META-ANALYSIS COMBINING CLUSTER ANALYSIS AND MULTIDIMENSIONAL SCALING – CATEGORISATION OF SIGNS OF THE EUROPEAN UNION COUNTRIES' INSOLVENCY**

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## **Abstract:**

*Insolvency belongs to the basic indicators representing financial situation of practically all enterprises. In spite of the fact that promising development of several macroeconomic indicators suggests that economy as a whole have overcome the economic crisis and since 2010 its recovery clearly occurs, the increase of unpaid liabilities still persists. In this paper we performed the analysis of data indicating insolvency of the EU countries for year 2012. Within our statistical meta-analysis, we compare multiple methodological approaches: variants of agglomerative hierarchical cluster analysis; outputs of method k-means; k-medoids; and fuzzy c-means. The obtained results are qualitatively compliant with multidimensional scaling. Following the structure of their insolvency indicators, the countries were divided into three basic groups. The obtained classification is quantitatively compliant with current macroeconomic idea about gravity of debt crisis in various EU countries. .*

**Keywords:** indebtedness, insolvency, receivables, delayed payments, private sector, cluster analysis, multidimensional scaling, macroeconomic consequences

**JEL Classification:** C32 E43, E52.

## **1. Introduction**

The terms insolvency and bankruptcy are as ancient as enterprising itself. In general, it means that it is a situation in which entrepreneurs are not able to pay liabilities by their due dates. The practice shows, and literature confirms, that insolvent are those, who have more than one creditor - more than one liability - that exceeded 30 days after its payment due, while those liabilities are not covered by their assets Borovský (2001). In Europe, each and every day, dozens of small and medium enterprises bankrupt due to their unpaid bills. Very often the firms have a huge amount of their money „drowned“ into unpaid invoices; and thus are not able to pay their own liabilities. The current situation is serious. Several facts point to the need to solve this situation and to introduce measures in this specific domain. In fact, near to the half of enterprises in the EU doesn't attain the fifth year of their existence. In Europe, 200,000 enterprises bankrupt per year in average. This directly leads to the loss of 1,7 millions of working opportunities. Approximately 50,000 enterprises (1% out of 5 millions) per year become debtor, and at least twice the number of them are creditors abroad. The European Union has responded to this situation with a set of measures submitted in December 2012, with aim to modernize the rules of insolvency proceedings European Commission (2011). Modernization of the EU rules concerning insolvency targets mainly the ease of doing business and providing second chance to entrepreneurs at risk. This modernization was identified as the key measure for improvement the functioning of local but also foreign markets. Because the conditions and possibilities of enterprising are different depending on countries, it is thus important, after analysing their common signs, to classify them into several groups. For this classification, we used cluster analysis. We also made qualitative comparison of these results with those of multidimensional scaling.

The paper is divided into five parts. In the second part we explain the methodological procedures and present the basic information about our data structure. The third part attends to present literature review on the subject and to define its key terms. In the fourth part, we analyse the results, as well as some specific details of the data analysis. In the fifth part, we compare the results of cluster analyses with results of the multidimensional scaling; as well as we present there our concluding remarks.

## 2. Research objectives and methodology

Main target of this paper is to create an economically transparent and effective categorization of the EU countries, by taking into account several specific aspects – indicators of insolvency of these countries. The categorization has been realized by means of a number of methodological approaches to data analysis that are based on the concept of the Euclidian metric. It is important to mention that here, the term Meta means that it concerns synthesis of multiple statistical approaches. These methods are used to be mentioned mainly in the context of issue of the so called manifold learning Rosman, Bronstlin, Bronstein and Kimmel (2010). We mainly address to the traditional hierarchical cluster analysis with Ward's linkage, as well as to application of the methods such as: k-means; k-medoids; and fuzzy c-means. The obtained information about the clusters' structure is completed with multidimensional scaling. It is known that the concept of metric is the common denominator of the mentioned methods, which are however significantly different in terms of their historical origins, targets, as well as proceedings. The method of hierarchical clustering is traditional method, which is well known within economic community, and thus doesn't require any deeper explanation. For use of these methods, we have chosen the implementation in the R environment. For hierarchical clustering, it was the standard routine *hclust()* R CORE TEAM (2013); for k-means, we used the routine *kmeans()*. Its extension is fuzzy logical variant c-means implemented by means of the routine *cmeans()*. Dimensional scaling (also called principal coordinates analysis) has been realized by means of the routine *cmdscale()* Venables and Ripley (2002).

This analysis has been performed in the EU countries, for year 2012, following chosen indicators of insolvency - with exception of Malta and Luxemburg, which is due to missing data. The data are sourced from the annual report EPI 2012, and from *Doing business* (2012). We focused on the following chosen indicators, creating six components of clustering vectors:

- ratio of unpaid receivables/ (share of outstanding claims) over 90 days, in %;
- average duration of payments in B-2 sector, in days;
- differ/(late) payments in B-2 sector, in days;
- time required for debt settlement/ (time required for recovery of claims), in years;
- cost of recovery of the claim/ (cost of recovery procedures), in % of value of insolvency assets;
- degree of compensation of creditors (in cents to 1 dollar invested).

Each indicator gave highly different results. This is why we first decided to normalize all data through conversion to z-scores. We have displayed those in one of the tools of multidimensional scaling by means of the procedure *cmdscale()*. We assessed whether these data have signs of potential clustering. Subsequently, we processed the transformed data by means of selected methods of cluster analyses – Ward's single linkage clustering, k-means, and k-medoids. For testing the quality of clustering, the interpretation and validation of clusters, we used the silhouette method Rousseeuw (1987). Finally, we used the method fuzzy c-means, in which the object (country) belongs, to some extent to all clusters at the same time, while this extent is determined by the membership function.

## 3. Literature review

In 2011, the second wave of economic crises appeared. This was due to a high indebtedness of economies. In order to support the European economy, it would be necessary to deal with the impact of late payments that cause severe issues to entrepreneurs, and subsequently to the whole economy. Entrepreneurs require legislative amendments, targeting higher effectiveness of the system of debt recovery, as well as an increase in law attainment Bánociová (2007). In several EU countries, indeed, including Slovakia, the average time lapse of late payments is of longer nature in public sector than in private sector, and this situation has tendency to worsen in time. In fact, the payment discipline represents a weakness not only for the private, but also for the public sector.

Solvency of an enterprise means that it has enough of call money available to cover its liabilities on time Kubranová, Sochor (2009), Režňáková (2010) suggested that the basic

precondition for preservation of solvency is an overtime consistency of available financial resources (their maturity) and of the notice period of assets. In order to manage the insolvency issues, it is important to understand its causes first. However, the insolvency issue is, first of all, to be managed by the entrepreneur himself. A similar issue from macroeconomic point of view has been analysed by Siničáková and Gazda (2011). They mention that insolvency can be caused or by enterprise itself, either by its customers that don't pay their liabilities properly and on time. Based on character of its causes, we distinguish two types of insolvency:

- primary insolvency;
- secondary insolvency.

#### *Primary insolvency*

Primary insolvency means exceeding of liabilities after their payment due over receivables after their payment due. This type of insolvency is mainly caused by the intern factors within enterprise that is consequently unable to create cash surpluses in due time and in due volume. Primary insolvency is considered as an integral part of natural market development. It is a signal of bankruptcy of enterprises that haven't found any adaptation strategy needed for their further development

#### *Secondary insolvency*

Secondary insolvency is the totality of liabilities after due payment that is lower or equal to the totality of receivables after payment due. It concerns that part of insolvency that is caused by insolvable customers. It is considered that the cause of total insolvency is the primary insolvency, while the secondary insolvency is a phenomenon caused by underdeveloped institutional framework of markets. This concerns obstructions for payments within banks and rigidity of their lending policies.

This is why European Union targets, within their set of measures, putting an end to late payments. As was mentioned in the introduction, the EU adopted a directive 2011/7/EU combating late payment in commercial transactions, in which it is stated that such payments have negative impact on liquidity and complicate financial management of enterprises. They also affect competitiveness and profitability of enterprises, because due to late payments, creditor has to acquire financial means from external sources. The risk of these negative effects can increase significantly in period of economic decline, when the access to financing is more complicated. This amendment to the Act is supposed to solve mainly the issue of secondary insolvency of enterprises. The member States have to incorporate the refined directive about late payments into their domestic legal system by end of the year 2013.

The new rules dictate the following:

- public authority must pay for goods and services that have been provided to them up to 30 days, or in case of very special occasions, up to 60 days;
- contractual freedom in commercial transactions between enterprises – enterprises should pay their invoices up to 60 days, under condition that they have agreed so and it is not significantly disadvantageous for the creditor;
- enterprises have, in case of late payment, the right to automatically require interests from this late payment, and they also can automatically acquire a lump up of at least 40 Euros as compensation for expenses linked to the exaction;
- the amount of the statutory rate of interest for the late payment increases to the amount that is at least 8 percentage points over the reference rate of the European Central Bank. Public authorities cannot set a lower interest rate on the late payments;
- creditor and debtor can agree on a longer maturity period than these 60 days however this agreement cannot be significantly disproportionate to the rights and obligations of their contractual relationship.

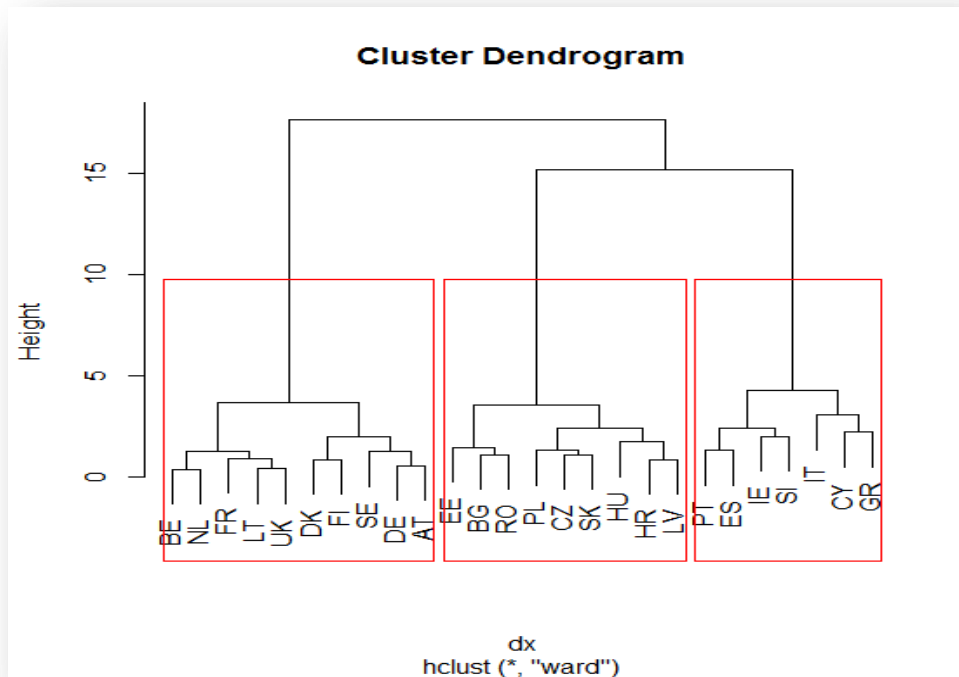
#### **4. Hierarchical cluster analyses of insolvency**

The data were, first of all, processed by means of multidimensional scaling see Figure 3. On the basis of this analysis, we decided to study consequences of the classification into three groups. This targeted number of groups seemed to be rational for economic reasons, as well as for practical reasons. After this visual assessment, we analysed the transformed data to z-cores by

means of chosen methods of cluster analyses – which are Ward’s method and single linkage clustering, as well as methods k-means and k-medoids. Each of the methods has led to creation of three clusters, which is in line with preliminary estimate. The contents of clusters have been compared subsequently. There have been found clusters that are common for all of the mentioned methods. This is the core of the mentioned meta-analyses of the issue. The indexes of clusters have repeatedly been implemented into the output of multidimensional scaling and assessed in terms of mutual distribution of countries.

4.1 Analysis by the Ward’s method

Preference for this method is, within economic community, most probably of experiential nature. A number of authors might have found more suitable economic interpretation for outputs of this method. It is important to mention that this long term experience has been confirmed in our analyses too. The result of Ward’s method and single linkage clustering is Figure1 that was divided into three clusters. The first cluster contains the following States: Belgium, Finland, Denmark, Sweden, France, Lithuania, Netherlands, Austria, Germany, and United Kingdom. The second cluster includes countries such as: Bulgaria, Croatia, Czech Republic, Estonia, Latvia, Slovakia, Hungary, Poland, and Rumania. The third cluster contains countries such as: Cyprus, Greece, Ireland, Portugal, Spain, Slovenia, and Italy.



Source: output of the programme R

Figure 1 Dendrogram designed by Ward’s method. Three clusters obtained by command cutree().

As we can see from Figure 1, the cluster 1 contains countries with the best level of payment discipline in the EU. The clustering of countries shows that these countries are characterized by the lowest share of outstanding claims; the lowest late payments; the lowest time required for recovery of the claims; the lowest cost of recovery procedures; as well as the highest degree of compensation of creditors in cents to 1 dollar invested. To this group belong the following countries: Belgium, Finland, Denmark, Sweden, France, Lithuania, Netherlands, Austria, Germany, and United Kingdom. The V4 countries are, along with other smaller economies (Estonia, Bulgaria, Rumania, Croatia, and Latvia), classified into the second cluster. This cluster is composed of average countries, which don’t belong neither to the group of the most

insolvent counties, not to the group of the least insolvent ones. The third cluster is composed of Portugal, Spain, Ireland, Slovenia, Italy, Cyprus, and Greece. These countries are the so called PIGS countries Dianotto (2006). They have the highest share of outstanding claims; and the highest rate of late payments in B-2-B sector. The Ward’s method has thus confirmed the position of the economies with better and with worst payment discipline.

*4.2 Analysis by the method k-means*

Within the application of k-means, we first defined the number of centroids; and thus the number of clusters that are supposed to be generated from the individual objects. Classification of countries is illustrated in Table 1.

**Table 1.** Meta-analyses by methods: Ward’s, k-means, and k-medoids.

Cluster 1	Cluster 2	Cluster 3
Belgium	Bulgaria	Cyprus
Netherlands	Croatia	Greece
Finland	Czech Republic	Ireland
France	Estonia	Portugal*
Holland	Latvia*	Spain
Lithuania	Hungary	Italy
Germany	Poland	Slovenia
Austria	Rumania	
United Kingdom*	Slovak Republic	
Sweden		
Slovenia**		

Source: own processing of outputs from programme R

Remark: \* demarcation of the country that is the centre of the specific cluster defined by means of method k-medoids.

\*\* demarcation of the country that belongs to the cluster only with the method k-means.

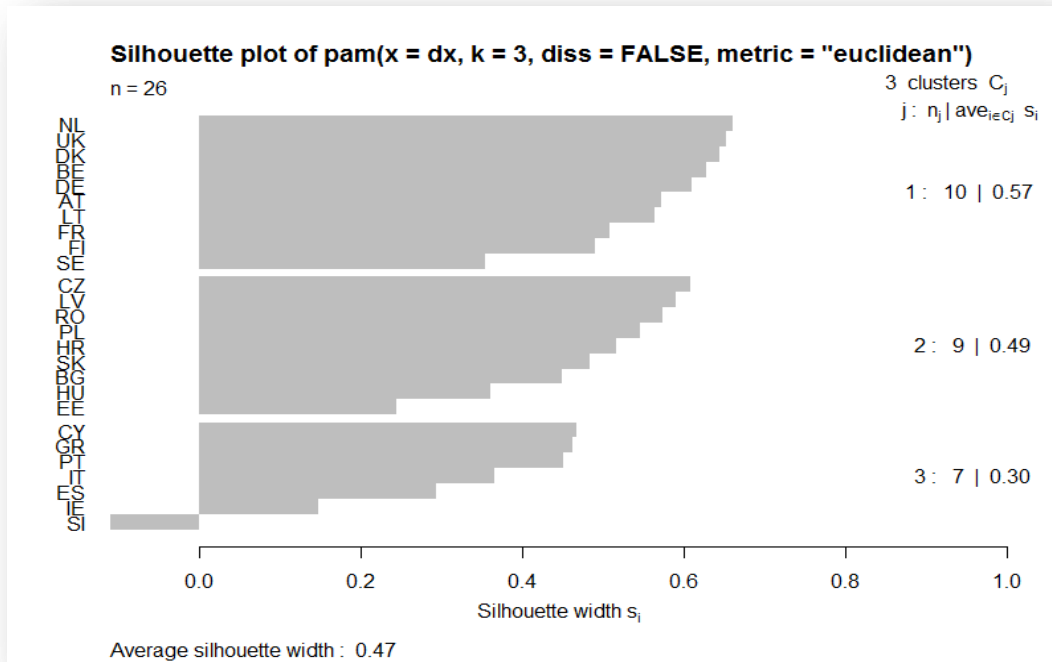
In accordance with our requirement, also when using k-means method, we assumed the distribution of countries into three clusters. The method subsequently identified number of objects in the clusters, which is: 11, 9, and 6. As the name of the method evokes itself, to each cluster belong average characteristics of financial discipline – centers of mass (centroids). The first cluster represents countries with the best solvency within EU countries, and the third cluster is formed by countries that are the most concerned by the economic crises. These are mainly countries that attain higher rate of unpaid receivables, but also the highest cost for their recovery. To these countries belong Greece, Portugal, Italy, Spain, Cyprus, and Ireland. The only country that has been reclassified from the 3rd cluster by the Ward’s method to the 1<sup>st</sup> cluster when method used was k-means, is Slovenia.

*4.3 Analysis by the method k-medoids*

Within the framework of this method, the distance between objects and clusters is determined given the value of object that is the closest to the average value (median). In Table 1 we can observe the distribution. The centre of the first cluster is United Kingdom. The centre of the second cluster is Lithuania, and the centre of the third cluster is Portugal. This means that these countries are, in the given cluster, the closest to the average value of the specific cluster. The results of each method show concordance of the methods, with exception of Slovenia that belongs to the group of so called „uncertain countries“. As was mentioned earlier, this country was classified via the Ward’s and k-medoids methods as belonging to the third cluster, while the k-means method classified this country as belonging to the first cluster.

Testing by the method Silhouette

Results of application of the method k-medoids have been subject to analyses by means of the function *silhouette()* implemented in R environment (see Figure 2). This has led us to conclusion that the first cluster - that is characterized by the value average silhouette width 0,57 - represents the average structure of the cluster (in accordance with the standard interpretation of the outputs of this method). The second and the third cluster are labelled, by this method, as weak structures.



Source: output of programme R

Figure 2 Graphic illustration of validation of data clustering.

Complementary study by the method fuzzy c-means

The method fuzzy c-means enables the object – country – to belong to all three clusters at the same time. This method was used to determine the so called „uncertain countries“ or „unclassifiable countries“. The uncertain countries are those countries, of which share is almost equal in each and every cluster (100% in total). Certain countries, or in other word well classified countries, are those, of which share in a specific cluster represents more than 50% (Table 2).

On the basis of the k-means method application, we can say that beside Ireland, even Slovenia becomes the so called uncertain country. Ireland has the highest rate of affiliation (37.32%) to the third cluster, and Slovenia 41.34% to the second cluster. It is interesting that Ireland is on the first place from EU countries in terms of the time to settle debt – 0.4 days *Doing business* (2013). This is why this country was labelled as uncertain country. Otherwise we could say that Ireland belongs to the PIGS countries, mainly due to its major problems in the area of corporate insolvency. Its affiliation to the third cluster was however not unequivocal, because Ireland is significantly different from these countries in terms of time to settle debt – this country is even better in terms of this indicator than countries of the first cluster. In the first cluster, indeed, the time to settle debt moves between 0.9 days (Belgium and Finland) to 2 days (Sweden). In this area is Ireland the best performer, not only among the EU countries, but also worldwide. This means that one of the steps to get the countries out of the third cluster to the first (or at least to the second) is to lower the time to settle debt. Beside Ireland, there is also Slovenia, of which affiliation to specific clusters is

almost equally distributed. We classified Slovenia as belonging to the third cluster by the methods Ward's and k-medoids, and to the first cluster by the method k-means Doing business (2013). The primacy belongs to Slovenia in terms of costs associated with collecting debts (4.0% of insolvency assets). This is why Slovenia has been classified between countries like Belgium, Finland, Denmark, Holland, and other countries from the first cluster.

Table 2. EU countries membership (in percent) in clusters determined by the Fuzzy c-means method.

Country	Affiliation to cluster in %		
	1	2	3
Belgium	5,52	91,91*	2,57
Bulgaria	80,18*	13,92	5,9
Croatia	82,87*	8,18	8,95
Cyprus	5,18	3,65	91,17*
Czech Republic	91,09*	5,39	3,52
Denmark	5,26	92,57*	2,17
Estonia	66,8*	27,48	5,72
Finland	16,83	75,15*	8,02
France	11,03	85,29*	3,68
Greece	6,09	4,31	89,6*
Holland	3,6	94,9*	1,5
Ireland**	28,28**	34,4**	37,32**
Lithuania	8,87	87,9*	3,23
Latvia	91,09*	5,38	3,53
Hungary	76,29*	17,88	5,83
Germany	7,52	89,9*	2,58
Poland	89,75*	6,99	3,26
Portugal	9,88	6,6	83,52
Austria	7,45	90,39*	2,16
Rumania	90,93*	6,11	2,96
Slovak Republic	73,56	12,19	14,25
Slovenia **	35,95**	41,34**	22,71**
Spain	26,77	18,6	54,63*
United Kingdom	3,9	94,61*	1,49
Sweden	23,67	70,58*	5,75
Italy	10,55	6,49	82,96*

*Source:* own proceeding following the outputs from programme R.

For better understanding of the terms, we introduce the following classification:

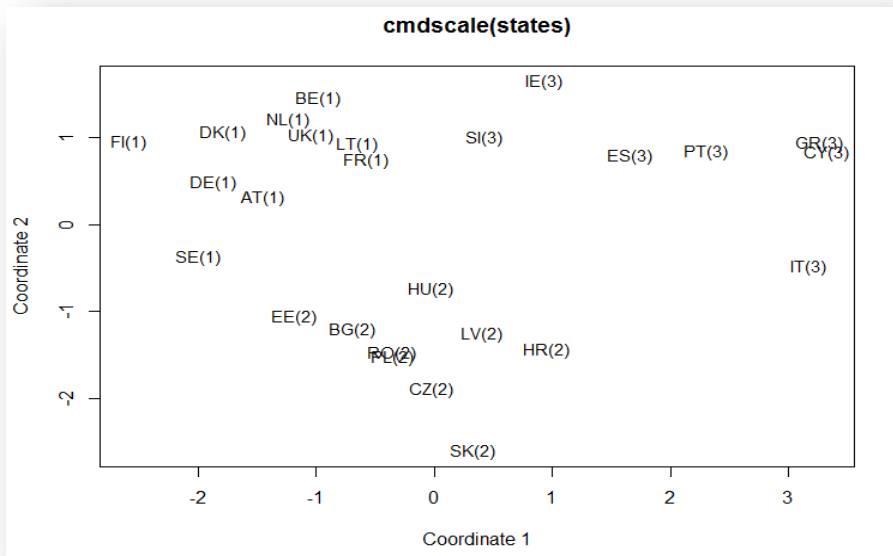
\* certain countries (more than 50% in a specific cluster);

\*\* uncertain countries (less than 50% in every cluster).

## 5. Comparison of results of the cluster analyses and of multidimensional scaling

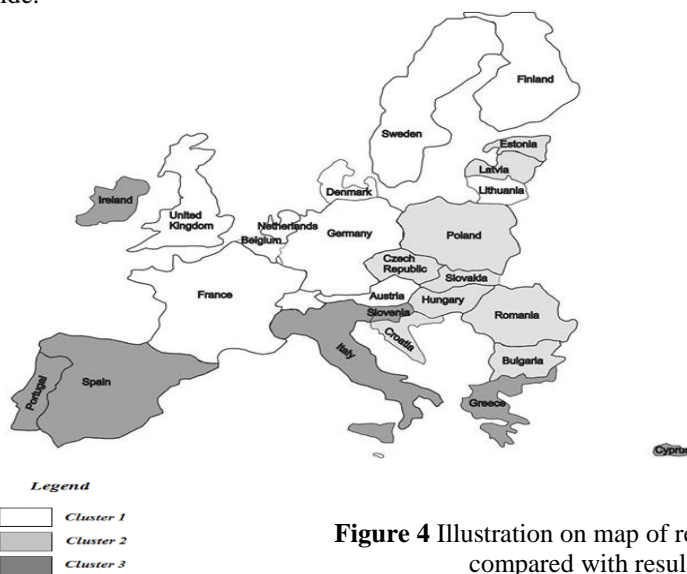
After having performed the cluster analyses, we compared the results obtained by multidimensional scaling with those obtained by cluster analyses, in order to assess to what extent these results correspond. After obtaining two-dimensional plot by means of the function *cmdscale()*, we completed its respective points (with names of countries) with results of the previous cluster analyses (see Figure 3). To the indicator of countries, we added the identification

number of respective cluster; and we found that distribution in the first cluster is visually justified. All of the countries from the first cluster converge, only Finland and Sweden are little more distant from the centre. The second cluster seems to be relatively compatible with visual observation, even if it has been identified as weak structure by the function *silhouette()*. The third cluster has higher dispersion due to the outliers - Ireland and Slovenia – that are close to the first cluster. Based on the spatial distribution of countries and on the affiliation to clusters, we see that the qualitative match of the two methods is reasonable. The method of multidimensional scaling shows the best why the affiliation of Ireland and Slovenia was problematic. It was due to their outstanding location. This means that these countries could be base for the fourth separate cluster. Figure 4 highlights very interesting fact that clusters are formed by the geographic neighbour countries. It means that geographic proximity and amounts of debt correlate.



**Figure 3** Alignment of the results of multidimensional scaling with the results of cluster analyses.

Remark: In the 2<sup>nd</sup> cluster, Poland and Romania collide; and in the 3<sup>rd</sup> cluster Greece and Cyprus collide.



**Figure 4** Illustration on map of results of multidimensional scaling compared with results of cluster analyses.



## Conclusion

Late payments cause a set of issues; starting with corporate insolvency, through bankruptcy, to lowered State budget revenues and slowing of economic growth. Paradox remains however that governments deepen the issue by their own lack in payment discipline, instead of fighting this phenomenon. In majority of the EU countries, the delay in payment of the public sector is higher than the one of the private sector. The causes are not of economic nature. The lack of payment discipline depends, in each country, on local culture, compliance with ethical rules, and administrative effectiveness of State institutions. The EU is aware of negative consequences of the late payments, and this is why it stated, in its directive about late payment, that due of the invoiced in public sector shouldn't be over 30 days, and between enterprises over 60 days.

Nowadays, following the directive, only three countries fulfil the requirement of the directive, which is to pay its liabilities within 30 days (but only in the private sector), and these countries are: Bulgaria, Estonia (both from 2<sup>nd</sup> cluster), and Finland (1<sup>st</sup> cluster). When it comes to the time period for payment of invoices in the private sector, in 2012, this requirement was not respected by 5 EU countries from the third cluster: Cyprus, Greece, Portugal, Spain, and Italy. All of the other countries met the requirement. The new European directive is a step forward in acquiring a better payment ethic in the whole Europe; and thus enables entrepreneurs to help lead Europe towards a solid economic recovery. The methods combined in the paper consistently show that microeconomic indicators used can be translated into a depth situation of countries on macroeconomic level. It is thus possible to suppose that increased tensions to improve payment discipline of the third cluster (Cyprus, Greece, Ireland, Portugal, Slovenia, Spain, and Italy) on microeconomic level could significantly influence the resolution of the debt crises in future. By means of the meta-analysis method proposed here, the countries were divided into the so called uncertain countries, of whose affiliation to clusters was highly similar. At the same time, this classification could serve as a recommendation for directing foreign investments into countries with improving or average payment discipline. From the data visualization by multidimensional scaling, it is possible to better determine countries with similar payment conditions. In the future we would like to deal with methodology for design of the index of payment discipline, which would be based on the classification by using the using approaches introduced here. Let us mention briefly also the future challenging task we face - that for suitable time series macroeconomic data (of similar structure as studied here) there will be an opportunity to apply the original distance-based methodology that has been recently developed by Horváth, Šulíková, Gazda, and Siničáková (2013).

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## INTEREST RATE TRANSMISSION MECHANISM IN V4 COUNTRIES

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### **Abstract:**

*The paper focuses on analysis of monetary policy transmission mechanism in V4 countries and EMU12. The aim of analysis is to verify the reaction of endogenous variables in case of monetary policy shocks with an emphasis on transmission through interest rate channel and its impact on inflation, nominal effective exchange rate and gross domestic product. The effects of interest rate shocks on selected variables were identified by estimating VAR model that uses Cholesky decomposition of innovations.*

**Keywords:** interest rate channel, monetary policy shock, V4 countries, VAR model.

**JEL Classification:** C32 E43, E52.

### **1. Introduction**

The four central European countries, Slovak Republic, Czech Republic, Hungary and Poland, are often referred to as the Vysehrad countries, or briefly V4 countries. When we look closer at their macroeconomic policies and the evolution of their economies over the last two decades, it is possible to find many similar features. Each of these countries had to overcome the so-called transformational depression that was followed by a fall of GDP growth rates, a considerable rise in consumer prices as well as in unemployment rates. V4's central bankers opted for traditional monetary anchors such as monetary or exchange rate targets. However, the on-going process of liberalization shifted the focus of monetary policies towards "new strategies" based on direct or indirect targeting of the inflation rates and exchange rate regimes were modified to less strict forms, such as the managed floating. The constantly changing macroeconomic environment together with a high degree of openness and strong foreign trade links still intensify the impact of foreign factors what consequently reduces the autonomy of national monetary policy.

This paper will focus on analysis of the transmission process of monetary policy in V4 countries as well as for the EMU12 ("first, original" members: Austria, Belgium, Finland, France, Germany, Greece, Italy, Ireland, Luxembourg, Netherlands, Portugal, and Spain). Group of V4 countries consist of one EMU member (Slovakia) and three non-EMU members that can still use their own national monetary policies. Therefore we decided to verify the similarity of individual responses to monetary policy shocks of V4 countries and EMU12. By comparing these responses we would be able to assess the impacts of the economic and financial crisis on the transmission process of monetary policy in these countries. The transmission process will be observed via traditional channel of the interest rate with the use of vector autoregression (VAR) model. VAR model allows computing impulse-response functions for estimation of interest rate pass-through to macroeconomic variables. The paper is structured as follows. Firstly, an overview of the literature is presented. The next section explains the VAR model which is followed by the section with data and results. The last part offers conclusions of presented analysis.

### **2. Overview of the literature**

Most central banks use their key interest rates to indicate the changes in their monetary stance. Even though there have been many important shifts in monetary policy strategies over the years, key interest rates remain the most important instrument. Modifications in key short-term interest rate are transmitted to money market rates and consequently to banking sector and the real

economies. This way, central bankers are able to influence the expectations of the market subjects and direct them towards a desired level of inflation. (Raisová, Bánociová, 2012) The macroeconomic theory suggests that a monetary contraction is followed by a fall in output as well as in the prices and the exchange rate is expected to appreciate shortly after.

Monetary transmission processes are often analysed using vector autoregression models (VAR or VEC model). The standard VAR approach assumes that the dynamics of the economy can be described by a set of macroeconomic variables. Even though some authors argue that this approach cannot be considered realistic, VAR model remains one of the most often used in modelling of monetary transmission processes. A vector autoregression approach enables to study impacts of monetary shocks on selected variables and allows a cross country comparison.

Naturally, monetary conditions and thus transmission processes may be different in various countries; the studies show that these differences were not significant in 1990s. (Gerlach and Smets, 1995; Baran, Coudert and Mojon, 1996) The results of Angeloni *et al.* (Angeloni, Mojon, Kashyap and Terlizzese, 2003) show that the interest rate channel is the most important for monetary policy transmission in the euro area as it enables the direct pass-through of monetary shocks (such as a monetary policy tightening or loosening). According to their findings, the effects of the monetary policy on the output and the prices of the euro area aggregate are consistent with the effects of monetary policy shocks identified within each country. The reaction of the output to an unexpected increase in the short-term interest rate is only temporal and the response of prices is delayed up to four quarters.

In case of V4 countries, analyses confirm the importance of the interest rate channel in comparison with other transmission channels. (Crespo-Cuaresma, Reininger, 2007) E.g. Hurník and Arnoštová (Hurník and Arnoštová, 2005) used vector autoregression approach in order to analyze transmission mechanism in case of Czech Republic over the period 1994-2004. Their results show that the unexpected tightening of the monetary policy led to a fall in output, whereas the prices remained persistent for a certain time and started to fall after approximately two quarters. The exchange rate reacted by immediate appreciation.

The interest in analysing transmission processes of monetary policy has increased in recent years especially with regards to recent financial and debt crises. For example Lyziak (Lyziak, 2011) and Demchuk (Demchuk, 2012) used the VAR approach to test the impacts of the crisis on the effectiveness of transmission of monetary policy in case of Poland. One of the most important findings is the fact that the traditional, interest rate, channel can be considered as the most affected by the crisis. Effects of financial crisis on interest rates pass-through are also analysed in IMF's Global Financial Stability report (IMF, 2012). The report compares the interest rate pass-through to the short-term interest rates as well as to the long-term interest rates in case of euro area and the United States. According this report, the financial crisis marked the transition from the short-term interest rates to the long-term interest rates in both the United States and the euro area.

Similar results were obtained by other authors with regards to impacts of crisis on the effectiveness of monetary rules. (Sinicakova, Pavlickova, 2011) The main problem seems to be the effectiveness of the short-term interest rate in the times of the crisis when these rates were reduced to levels close to zero. As a result, the transmission to real macroeconomic variables has proved to be relatively insignificant. Even before crisis; some authors stressed the possibility of the problems and lower effectiveness of the interest rate channel using short-term interest rate. They suggested the use of long-term interest rate. (Rudebusch, McGough, Williams, 2005; Mankiw, 2011)

We tried to apply the vector autoregression approach to monitor the transmission via interest rate transmission channel in case of EMU12 as well as the V4 countries (three EMU candidate countries and one EMU17 member country). As for the selected variables of the model we chose gross domestic product, inflation and exchange rate, i.e. the variables that central banks typically use within their monetary rules. The main objective is to verify whether these variables reacted as suggested by macroeconomic theory, whether their reactions were lagged or even

inverse (so-called “price or exchange rate puzzles”<sup>1</sup>). (Hurník and Arnoštová, 2005; Popescu, 2012; Castelnuovo and Surico, 2006)

## 2. Econometric model

In order to analyse the transmission of the interest rate shocks, we will use the Vector Autoregression approach. The vector autoregression model is an approach commonly used for modelling the effects of monetary policy on the set of endogenous variables over the sample period of time. For our analysis we estimated the following model:

$$CY_t = A(L)Y_{t-1} + u_t \quad (1)$$

where: -  $Y_t = [ir_t, y_t, p_t, e_t]$  is a  $N \times 1$  vector of the contemporaneous endogenous variables with  $ir_t$  corresponding to interest rate,  $y_t$  corresponding to GDP,  $e_t$  representing nominal effective exchange rate (NEER) and  $p_t$  denoting consumer price index. This ordering of endogenous variables reflects the transmission of monetary policy impulse from key interest rate to other variables.

-  $C$  is a  $N \times N$  matrix that includes all the coefficients describing the simultaneous relations among endogenous variables of the model,  $A(L)$  corresponds to a  $N \times N$  polynomial with coefficients representing relationships among endogenous variables on lagged values. Shocks are represented by  $u_t$ , - a  $N \times 1$  normalized vector of shocks to the model.

Contrary to standard VAR models used to identify monetary shocks we did not include money aggregates in the model. The tested contractionary monetary policy shock is commonly followed by a fall in money for most of the countries. What is more, analyses of other authors indicate that the inclusion or omission of money aggregate in a model did not affect the impact of the short-term interest rate shock on output and prices. (For more see Mojon and Peersman, 2001)

By multiplying equation (1) by an inverse matrix  $C^{-1}$  we obtained the reduced form of the VAR model (this adjustment is necessary because the model represented by the equation (1) is not directly observable and structural shocks cannot be correctly identified). Thus the VAR model described by the equation (1) can be rewritten to following representation:

$$Y_t = C^{-1}A(L)Y_{t-1} + C^{-1}u_t = B(L)Y_{t-1} + e_t \quad (2)$$

$$\text{where: } - B = C^{-1}A \quad (3)$$

$$- e_t = C^{-1}u_t \quad (4)$$

-  $B(L)$  is a matrix describing the relationship among variables on lagged values and  $e_t$  is a  $N \times 1$  vector of serially uncorrelated errors of the model.

To verify the soundness and accuracy of our results, we estimated and compared two Vector Autoregression models. Models were identified through the restriction resulting from the recursive Cholesky decomposition of the residuals for each of the analyzed countries. Final causal impacts of unexpected shocks on the examined variables were summarized in the impulse response functions (IRF functions).

Before starting analysis, it was necessary to test selected time series for stationarity as well as to verify the existence of long-run equilibrium. It was also important to test the model for residual autocorrelation, heteroscedasticity and normality.

## 3. Data and results

For the purpose of estimating the effect of the interest rate exogenous shocks on economies of V4 countries and overall EMU12 we have used the quarterly data from 2002Q1 to 2012Q4 (44 observations). Data covered the evolution of following macroeconomic indicators, namely interest

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<sup>1</sup> Unusual behaviour of exchange rate and prices when the monetary contraction leads to immediate depreciation (instead of appreciation) of the exchange rate and increase in prices (instead of decrease).

rates (key and inter-bank), gross domestic product, inflation (measured by domestic consumer price index) and nominal effective exchange rate for each analysed country (group of countries). Time series for the gross domestic product were seasonally adjusted in order to eliminate possible seasonal factors.

Data used in our model were obtained from the International Financial Statistics of the International Monetary Fund, databases of national Central Banks and Bank for International Settlements as well as from the European Central Bank database.

We estimated two models (A and B) corresponding to various time periods: model A (2002-2007), model B (2002-2012). By applying same method on time periods of various lengths we were able to analyse possible impacts of the economic and financial crisis on the transmission process of monetary policy. V4 countries, unlike EMU members, still have a possibility to carry on their own monetary policies even though it may be limited to some extent by their high levels of openness. In case of Slovak Republic the last years of the analysed period (from 2009 onward), the country has been a member of EMU and National Bank of Slovakia has been integrated to Euro-system.

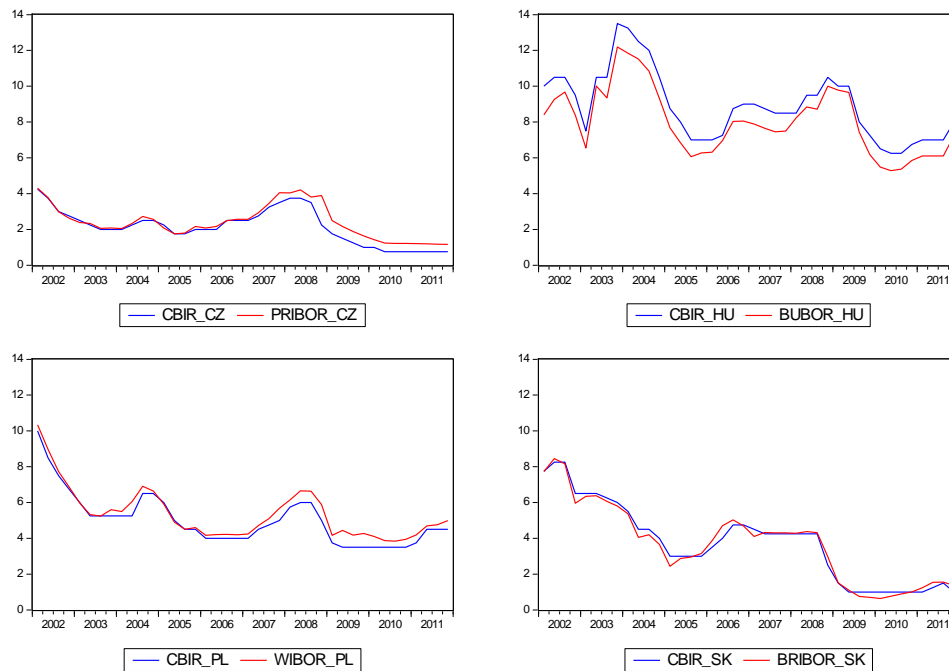
### *3.1 Endogenous variables*

For all analysed countries, we started with an assumption that each change of key interest rates represents also a change in monetary policy stance. Consequently, the changes in key interest rates are transmitted to market interest rates and later on, they equally affect macroeconomic variables.

Central banks of V4 countries usually use 2-week interest rate for main refinancing operations as a key interest rate. Changes in its setting affect short-term money market rates, such as 3-month rates, in particular PRIBOR in Czech Republic, BUBOR in Hungary, WIBOR in Poland and BRIBOR in Slovakia (BRIBOR was replaced by EURIBOR rate for the period of 2009-2012 as Slovakia entered a monetary union). As for the EMU12, key interest rate is represented by 2-week interest rate for main refinancing operations. Its changes are equally transmitted to market interest rates, such as e.g. 3-month EURIBOR rate that we have chosen for our analysis.

When compared (Figure 1, Figure 2), the 3-month interest rates show high level of correlation to 2-week key interest rates of selected central banks. Therefore we assumed that the evolution of 3-month rates can be used as an estimation of the evolution of monetary policy decisions without posing any problem for the analysis.

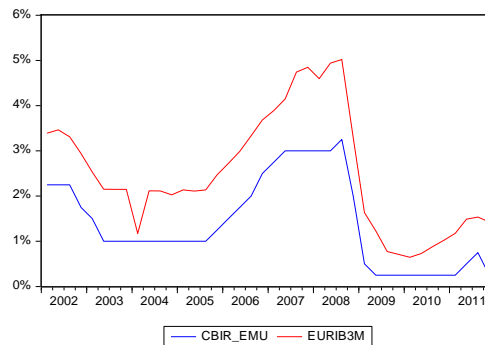
Following graphs (Figure 1) illustrate the evolution of previously mentioned interest rates for V4 countries. However, these figures do not indicate a same evolution for all four countries. There is a discernible downward trend in case of Slovakia and to some extent also in Poland and Czech Republic. The evolution of interest rates in Hungary was the most volatile with two important peaks. Nevertheless, we can find two common characteristics almost in all four graphs: there was a decrease of interest rates at the beginning of the observed period that ended around 2004-2005. In years of economic crisis interest rates increased and reached their maximums around 2008. After this year they were adjusted to lower levels in order to stimulate economic activity. However, the case of Hungary is a bit specific. We can see two “peaks” in the evolution of interest rates, i.e. 2003 and 2008. While the second can be connected to economic crisis, the first one is specific only for this country. A soaring in interest rate was a response of Hungarian central bank to previous speculative attack of investors.



Source: national central banks, ECB

Figure 1 - Interest rates

The Figure 2 shows the evolution of interest rates in EMU12. It indicates that base interest rate reached the highest level right before the economic crisis. Year 2009 brought about the reversal in the character of monetary policy, changing the focus of European Central Bank from decelerating inflation rates to stimulation of economy of euro area countries. That is why ECB adopted rather expansionary policy with interest rate close to zero.

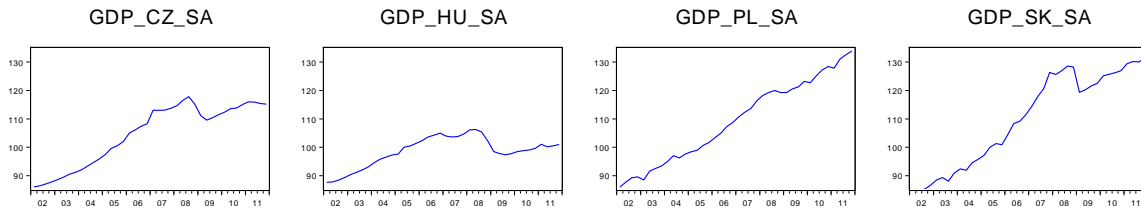


Source: ECB

Figure 2 - Interest rates

As for the evolution of three analysed variables in V4 over 2002-2012, it was marked with considerable volatility and in some cases we cannot find a common trend for all four countries.

Firstly we looked at the evolution of gross domestic product (Figure 3). We can see that the highest growth occurred in case of Slovakia and Poland, followed by Czech Republic. The economy of Hungary was similar to other three countries in the first half of the observed period even though the growth was less pronounced. In 2008, GDP slumped and the next years brought only a slight recovery. In 2011 the GDP was still at lower level than it was before crisis. The crisis marked GDP growth also in Slovakia and Czech Republic leaving Poland as the only “unaffected” country. In this case, the GDP growth was only slowed down and Poland was the only European Union country that managed to avoid a recession.



Source: IMF

Figure 3 - The evolution of GDP in V4 countries (2005=100%)

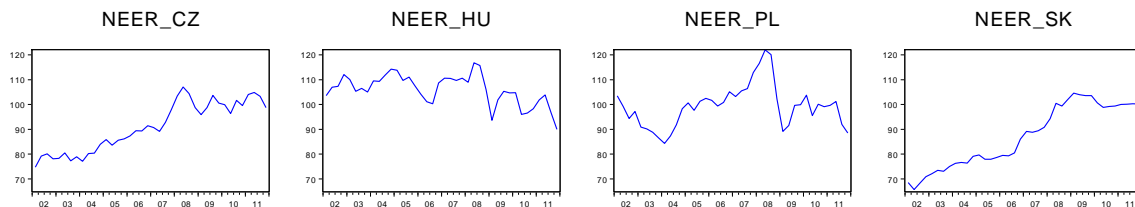
Comparison of basic descriptive statistics (minimum, maximum, mean, median and standard deviation) also confirms that the evolution in GDP may have been similar but there were also some differences. (Table 2) We see that the maximum level of GDP ranged from 106.24 in Hungary to 133.81 in case of Poland even though the lowest levels of GDP for these countries are rather similar (from 83.75 in Slovakia to 87.71 for Hungary). Logically, the standard deviation is ranged from 5.28 for Hungary (the lowest one) to 16.44 for Slovakia (the highest one).

Table 2 – Descriptive statistics table – GDP, V4

V4	GDP_CZ_SA	GDP_HU_SA	GDP_PL_SA	GDP_SK_SA
Mean	104.6613	98.63885	109.2910	110.0495
Median	108.8985	99.37303	109.7585	112.9271
Max.	117.8267	106.2404	133.8124	131.3902
Min.	86.11624	87.71031	86.00884	83.74988
Std. Dev.	10.71558	5.277239	14.54205	16.44134

Source: own calculations

Nominal exchange rate was the next analysed variable (Figure 4). A similar evolution of NEER can be observed for two countries, namely Czech Republic and Slovakia. In these two cases, NEER appreciated continually until 2008. Since then the evolution of NEER can be described as a rather volatile. Nevertheless, the appreciation that appeared after 2008 was not as strong as before 2008 and the exchange rate did not surpass its levels from before crisis. After 2008, Slovakia saw its nominal effective exchange rate depreciate. Later on it was followed by only a very slight appreciation. Evolution of NEER in Hungary was marked by several appreciations and depreciations. However, the overall trend over the analysed period can be described more as a depreciating than an appreciating. Here again, we can observe a most significant slump in the evolution of NEER in the time of economic crisis. Following years brought some amelioration but the NEER was still “weaker” than before the crisis. As for the evolution of Poland, we can distinguish two important periods. Firstly there is a period of 2004-2008 which can be described by strong appreciation. This trend was reversed by crisis; NEER fell to its levels 4 years prior. Similarly to Hungary, since 2008, there were periods of appreciations and depreciations without any clear upward or downward trend.



Source: BIS

Figure 4 - The evolution of NEER in V4 counties (index)

We also compared basic descriptive statistics for this variable. (Table 3) Compared to GDP, it becomes obvious that the evolution was even less similar and more volatile than in case of



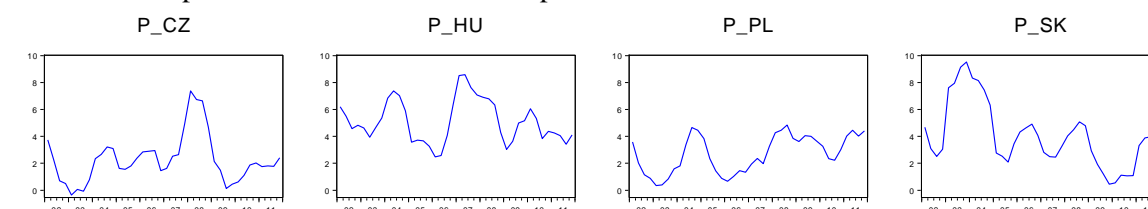
GDP (minimum and maximum values). Nevertheless, the interval for standard deviation is smaller than it was for GDP: 6.09 (HU) -12.50 (SK) for NEER to 5.28 (HU) - 16.44 (SK) for GDP.

**Table 3** – Descriptive statistics table - NEER, V4

V4	NEER_CZ	NEER_HU	NEER_PL	NEER_SK
Mean	90.98350	106.0235	99.26525	87.09325
Median	90.05000	106.7150	99.67000	87.43500
Max.	107.0300	116.8300	122.0900	104.5600
Min.	74.76000	90.00000	84.29000	65.73000
Std. Dev.	9.909198	6.088595	8.604332	12.50470

**Source:** own calculations

Evolution of price levels in these countries was the most volatile out of all analysed variables. It was marked by repeated increases and decreases. This volatility can be connected to continuing process of price deregulation and to various administrative measures especially at the beginning of the observed period. The impact of the economic crisis was visible mostly at the end of the period. Generally, we can say that crisis brought a turnabout in evolution of price level for all countries as we can observe a common feature - more or less prominent slumps in prices (Figure 5). It is visible especially in case of Czech Republic, Hungary and Slovakia. However, prices fell the most significantly in Czech Republic. Evolution of price level in Hungary was marked with an increase before crisis and a slump in the following years. Slovakia recorded an important increase at the beginning of the observed period. This evolution was influenced predominantly by domestic factors, especially by administrative measures (increase in excise taxes as well as TVA) and price deregulations that explain up to 75% of price level increase. Other important turnabout came after the crisis. Prices fell considerably but after few quarters they returned to pre-crisis level. And lastly, in case of Poland the increase of price level did not exceed 5% and the impact of the crisis was the least prominent.



**Source:** IMF

**Figure 5** - The evolution of prices in V4 countries (%)

Despite the high volatility of this variable (the highest of selected variables), results presented in the Table 4 confirm that this volatility was limited to certain boundaries, predetermined by countries' central banks and their monetary policies and inflation targets. As a result the variation of price levels was not as important as it was for GDP or NEER. This is also confirmed by the lowest standard deviations, ranged from 1.395 for Poland to 2.399 for Slovakia.

**Table 4** – Descriptive statistics table – Prices, V4

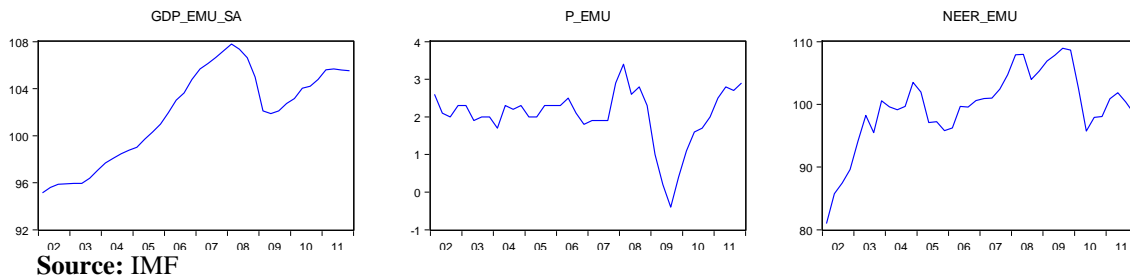
V4	P_CZ	P_HU	P_PL	P_SK
Mean	2.278500	5.121000	2.700750	4.048500
Median	1.950000	4.745000	2.685000	3.665000
Max.	7.380000	8.580000	4.840000	9.530000
Min.	-0.360000	2.480000	0.340000	0.450000
Std. Dev.	1.783558	1.594844	1.394984	2.399239

**Source:** own calculations

The next section monitors the evolution of endogenous variables for EMU12. Until 2007, GDP of EMU12 globally grew. In certain countries (such as e.g. Luxembourg or Finland) we can follow a stronger growth, in others (e.g. such as France or Germany), the growth was slower. In 2008, the growth of GDP was stopped by the crisis and GDP slumped considerably. Some countries registered even a decline of GDP compared to 2007 which was reflected also in the evolution of EMU12's GDP. The overall economic situation worsened and many macroeconomic variables recorded unfavourable development. E.g. unemployment rates increased considerably over the last few years (with some of the countries seeing their rates to triple). General government debt increased as well. However, these variables were not included in our model. GDP growth re-established its growing trend after 2008 and stopped again as new problems appeared (debt crisis).

Behaviour of inflation in the euro area over the period 2002 - 2007 can be described as relatively stable. Since the end of 2007 to the end of the reporting period the development of inflation has been more volatile with sharp decrease connected to crisis as well as a significant increase that followed up. EMU members are no longer able to employ a proper monetary policy that could help in case of situation such as the economic downturn. Even though European Central Bank still uses one key interest rate as a basic instrument for overall EMU, this policy may be too strict or inversely too loose for a particular country with regards to existing differences between member countries. Nevertheless, this paper will not focus on the analysing whether the monetary measures adopted by ECB were appropriate or did bring expected results.

The last surveyed variable was a nominal effective exchange rate. Based on the Figure 6, we can follow the evolution of NEER for EMU12. Generally, we can observe a trend of gradual appreciation with the shorter periods when NEER depreciated, then resumed its previous course. As expected, the years of economic crisis are marked with the most prominent depreciation of the surveyed period of 2002-2012.



Source: IMF

Figure 6 - The evolution of prices in EMU12 (%)

Table 5 shows again minimum, maximum and average values as well as standard deviation of values for GDP, NEER and prices in case of EMU12. As we can see, the variation of values over the analysed

period is less important. E.g. in case of GDP a standard deviation is 3.99 (EMU12) while the variance of GDP values for V4 countries is ranged from 6.09 to 12.50. A lower standard deviation was also confirmed for prices: 0.736 for EMU12 compared to an interval of 1.395 - 2.399 for V4 countries. However, NEER results show that standard deviation of EMU12 falls within the interval of V4 countries (5.28 - 16.44).

Table 5 – Descriptive statistics table – GDP, NEER, prices, EMU12

EMU12	GDP_EMU_SA	NEER_EMU	P_EMU
Mean	101.8526	99.62125	2.030000
Median	102.4263	100.0250	2.100000
Max.	107.8026	108.9400	3.400000
Min.	95.13468	80.97000	-0.400000
Std. Dev.	3.990727	6.098090	0.735614

Source: own calculations

4.3 Results of the tests

Before we can estimate our model it is necessary to test time series of selected variables for stationarity and cointegration. In order to verify the stationarity of time series we used unit roots test - Augmented Dickey-Fuller Test and Phillips – Perron. In case of V4 countries, ADF and PP tests indicated that only some of the series were stationary at the values. Testing on the first differences showed the stationarity of time series. We can conclude that the variables are (Table 6):

**Table 6** - Results of the unit root tests, V4

V4		IR (3m) ADF	PP	GDP ADF	PP
CZ	level	-1.900416	-2.086908	-1.676031	-1.753671
	1 <sup>st</sup> diff.	-4.147079*	-4.127920*	-3.753081*	-3.695753*
HU	level	-2.059239	-2.132583	-3.120515**	-2.097672
	1 <sup>st</sup> diff.	-5.778706*	-5.775436*	-3.120515**	-3.206547**
PL	level	-3.279173**	-3.991206	0.122162	0.122162
	1 <sup>st</sup> diff.	-3.625562*	-3.502639**	-6.709337*	-6.712962*
SK	level	-2.302531	-1.603150	-0.965763	-0.957064
	1 <sup>st</sup> diff.	-5.044862*	-5.058568*	-5.382526*	-5.367136*
		NEER ADF	PP	INF ADF	PP
CZ	level	-1.520625	-1.491732	-1.759866	-2.519334
	1 <sup>st</sup> diff.	-5.256253*	-6.893745*	-5.589619*	-3.966264*
HU	level	-1.520625	-1.491732	-1.759866	-2.519334
	1 <sup>st</sup> diff.	-5.256253*	-6.893745*	-5.589619*	-3.966264*
PL	level	-1.782970	-1.802298	-3.832310*	-2.420608
	1 <sup>st</sup> diff.	-5.157588*	-6.218456*	-4.299772*	-3.240775**
SK	level	-2.553088	-2.086649	-2.762881	-2.145945
	1 <sup>st</sup> diff.	-4.634968*	-4.505182*	-3.942391*	-3.972840*

Note: Data represent results of t-statistics. Null hypothesis cannot be rejected at 1% significance level (\*), at 5% significance level (\*\*), at 10% significance level (\*\*\*)

Source: own calculations

We obtained the same results for EMU12 variables, i.e. stationarity at the values only for some variables. Variables were therefore tested also on the first differences. In this case the tests indicated stationarity for all variables.

**Table 7** - Results of the unit root tests, EMU12

EMU12	IR(3m) ADF	PP	GDP ADF	PP
Level	-1.836	-1.679	-1.667	-1.467
1 <sup>st</sup> diff.	-4.029*	-4.055*	-2.697***	-2.773***
	NEER ADF	PP	INF ADF	PP
Level	-2.886***	-3.465**	-2.789***	-2.351
1 <sup>st</sup> diff.	-5.161*	-5.106*	-4.455*	-4.479*

EMU12	IR(3m)	GDP		
	ADF	PP	ADF	PP
<i>Note:</i> Data represent results of t-statistics. Null hypothesis cannot be rejected at 1% significance level (*), at 5% significance level (**), at 10% significance level (***)				

Source: own calculations

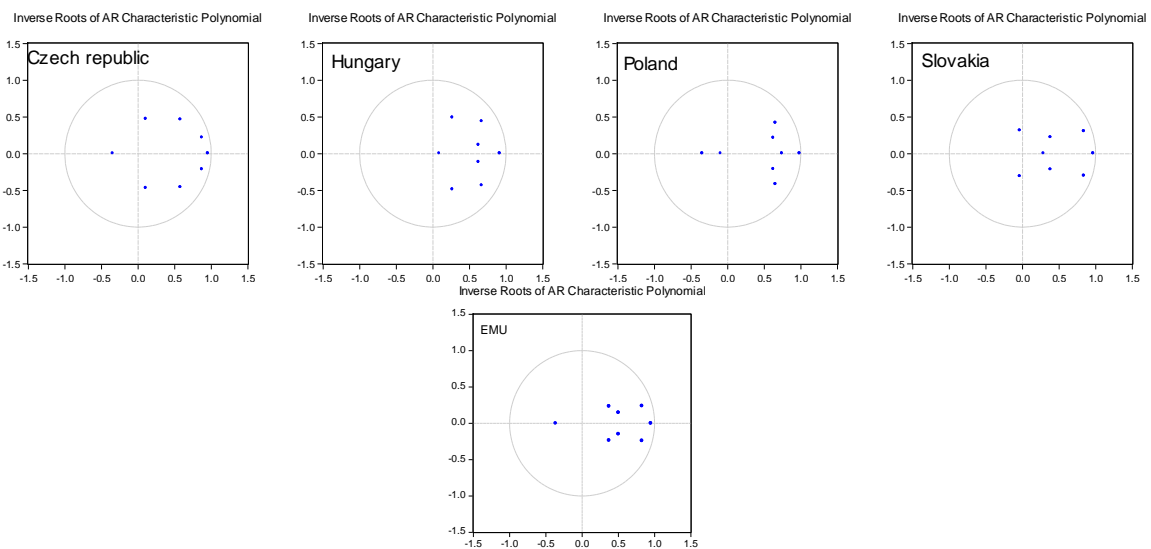
As most of the endogenous variables were not stationary on the values (and had the unit root), it was necessary to test these series for cointegration. The existence of the cointegration between variables was verified by Johansen cointegration test (using two lags as recommended by the Akaike Information Criterion and Schwarz Information Criterion). The results of the cointegration tests by both Trace and Maximum Eigenvalue statistics indicated in almost all cases no cointegration among the endogenous variables of the model (Table 8).

Table 8 - Results of the cointegration tests, V4 and EMU12

	Number of equations	Trace Statistics	0.05 Critical Value	Eigenvalue	0.05 Critical Value
CZ	None	61.26312	54.07904	28.22967	28.58808
	at most 1	33.03345	35.19275		
HU	None	47.10558	47.85613	24.70808	27.58434
PL	None	40.28425	47.85613	17.05212	27.58434
SK	None	62.77215	47.85613	33.16675	27.58434
	at most 1	29.60540	29.79707	16.95593	21.13162
EMU	None	46.99179	47.85613	25.29037	27.58434

Source: own calculations

In order to verify the stability of the model we used the AR roots test. The graphs (Figure 5) show that none of the points exceeds the circle, thus the estimated VAR models for each of V4 countries were considered stable. The same can be applied to EMU12



Source: own calculations

Figure 5 - AR roots test, V4 and EMU12

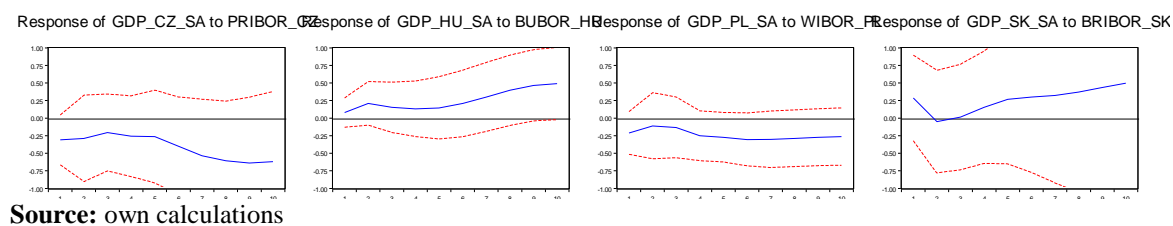
4.4 Impulse response functions

Estimated vector autoregression models for V4 countries as well as for EMU12 enabled to analyse impulse response functions for selected endogenous variables firstly for shorter period (model A) and then for longer period (model B). The results are grouped by variables in order to simplify the comparison of the responses for each country. We focused solely on the response of endogenous variables to changes in interest rate. The estimated response of variables to a monetary policy shock is observed over the period of 10 quarters after initial shocks.

As mentioned previously, in case of unexpected monetary tightening (monetary policy shock in the form of sudden increase of interest rate) the theory suggests: an output decline, a price level decline (with possible time lags) and the appreciation of the country's exchange rate.

Model A – reaction of GDP, period of 2002- 2007

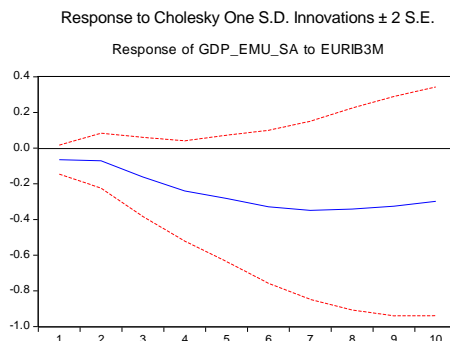
The Figure 6 shows that the response of endogenous variables to sudden fluctuations in short-term interest rate was sensitive. Despite positive shock in interest rate the reaction of GDP is only slightly positive in case of Hungary and Slovakia. This behaviour may be related to the fact that GDP growth in Slovakia is largely determined by other factors. High trade openness and connection to other countries as well as domestic fiscal policy played also an important role. In the case of Hungary, monetary policy faced several unfavourable events that tested its efficiency. We can mention for example a speculative attack on domestic currency as one of the most significant. Central bank had to choose between the stability of price level and the stability of Forint. As a result, transmission of monetary policy measures to real economic variables such as GDP might have been weakened as indicates next graph.



Source: own calculations

Figure 6 - IRF function for GDP, V4, 2002-2007

When we compare the response of the GDP in EMU12 and V4 countries, we can see there are some differences. While the reactions were lagged in case of some V4 countries, these results confirm that the tightening of the monetary policy in EMU12 did constrict the GDP growth and can be considered as being effective over the surveyed period. (Figure 7) Out of four V4 countries only Czech Republic seems to have a reaction that is similar to that of EMU12.



Source: own calculations

Figure 7 - IRF function for GDP, EMU12, 2002-2007

Model B – reaction of GDP, period of 2002- 2012

Over the longer period of 2002 – 2012 GDP responded, as expected, by a decrease in all monitored countries. For Czech Republic and especially Poland and Slovakia, this reaction was not immediate but with time lags of around three quarters (Figure 19).

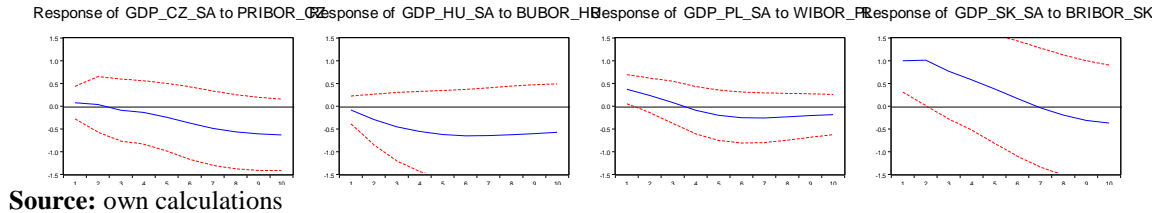


Figure 8 - IRF function for GDP, V4 2002-2012

We also tested the response of EMU12’s GDP over the longer period so as to compare whether this reaction would indicate an impact of economic crisis. Contrary to a period of 2002-2007 (Figure 7), the reaction is lagged. When we compare the responses of GDP for V4 countries and for EMU12, here we see a much higher similarity in a reaction of these countries and EMU12. All graphs (Figure 8) show firstly an initial increase in GDP that is replaced by its decline after approximately two quarters.

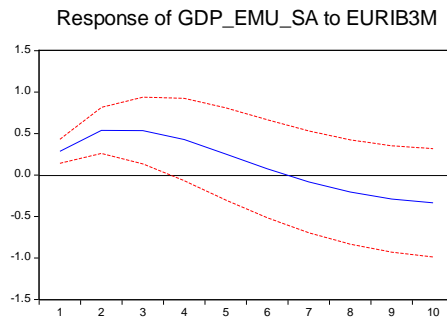


Figure 9 - IRF function for GDP, EMU12, 2002-2012

Model A – reaction of prices, period of 2002- 2007

For a reaction of prices, the theory indicates that the increase of interest rate should slow down the increase of prices causing the inflation rate to drop down. However, as explained previously, sometimes an unusual behavior in the form of sluggish or even positive response of prices can appear after an unexpected monetary tightening (“price puzzle”).

The Figure 10 depicts the impulse-response function for price levels in V4 countries over the period of 2002- 2007. We can see that the expected downward trend appears but not immediately and not in all analyzed countries. In most cases, the reaction is lagged by 4 quarters and in the case of Poland and Slovakia the reaction is less sensitive.

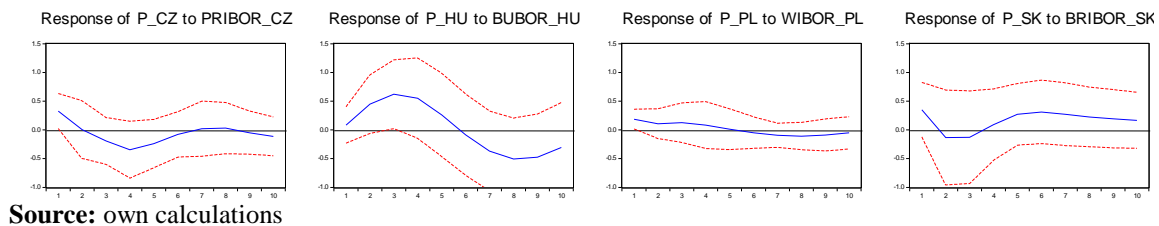
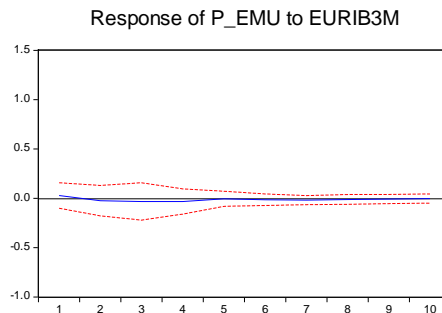


Figure 10 - IRF function for prices, V4, 2002-2007

The following Figure (Figure 11) depicts the impulse-response functions for price level in EMU12 for a shorter period. We can see that the reaction is relatively weak. The expected downward trend appears after first quarter but lasts only several quarters. When we compare the responses for V4 countries with this response, we can conclude that the trend is the same. However, the intensity of the reaction is more significant in V4 countries.

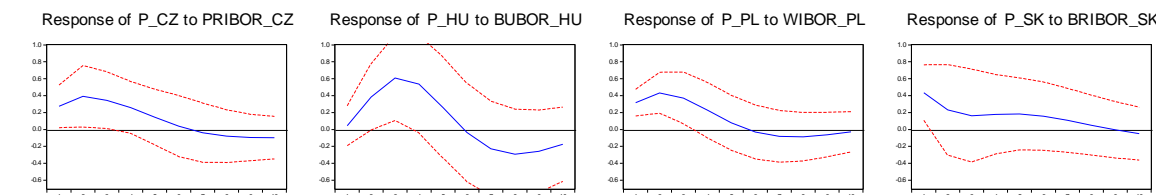


Source: own calculations

**Figure 11** - IRF function for prices, EMU12, 2002-2007

*Model B – reaction of prices, period of 2002- 2012*

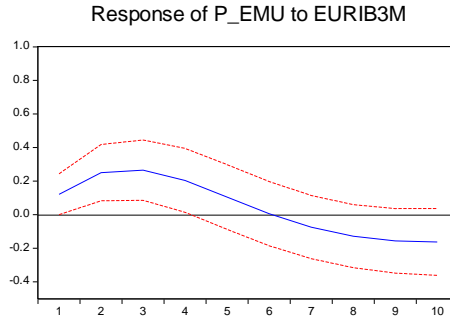
Model B shows the reaction of prices over a longer period. We can see that in V4 countries prices reacted positively (not as the theory would suggest) to a shock in the short-term interest rates. This could be explained by the fact that within this period the inflation in V4 countries varied substantially. There were periods of higher inflation even during monetary policy tightening. Similarly, declines in interest rates during crisis (2008-2010) did not result in the growth of the price level but reduced inflation rates. During this period inflation was still strongly influenced by many reforms, such as changes in taxes and price deregulations. High openness of these countries (notably Czech Republic, Hungary and Slovakia) and the impact of the imported commodities prices (ex. oil prices) equally affected the evolution of the inflation. All these factors reduce the possibility of monetary policy to influence price developments in these countries.



Source: own calculations

**Figure 12** - IRF function for prices, V4, 2002-2012

Figure 13 represents the reaction of EMU12's prices over the longer period. Here we can observe a stronger response of prices in comparison with shorter period. In this case we expected that monetary tightening will cause a decline in price level. This reaction appears with the lag of approximately three quarters. When we compare graphs of V4 countries (Figure 12) with the response of EMU12 (Figure 13) it is obvious that the reactions are rather similar (trend as well as the intensity). The higher similarity of the reaction in the longer period suggests that the differences between countries are getting less prominent in the long-run.



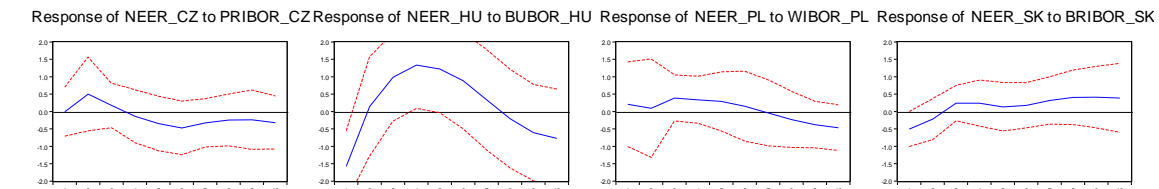
Source: own calculations

Figure 13 - IRF function for prices, EMU12, 2002-2012

*Model A – reaction of NEER, period of 2002- 2007*

The exchange rate was the last variable tested for impulse-response functions. Here the theory indicates that the increase of interest rate should be accompanied by the inflows of foreign capital causing the appreciation of country’s exchange rate.

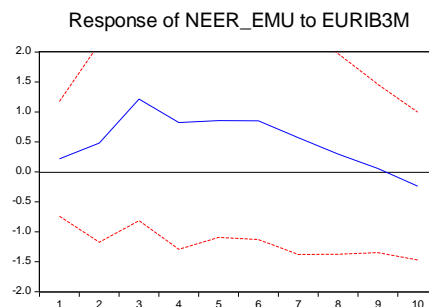
Based on the Figure 14, we can follow the evolution of NEER after the positive interest rate shock in V4 countries. In all cases the appreciation of the exchange rate is lagged by several quarters. What is more, the reactions differ in their volume. The weakest reaction was observed for Czech Republic, Poland and Slovak Republic.



Source: own calculations

Figure 14 - IRF function for NEER, V4, 2002-2007

The development of NEER for EMU12 corresponds with expected positive reaction of NEER. The intensity of the initial reaction increases even more after 2 quarters. Impulse is lost after 9 quarters. With the exception of Slovak Republic, the responses of NEER in other three countries can be considered similar to some extent to that of EMU12.



Source: own calculations

Figure 15 - IRF function for NEER, EMU12, 2002-2007

*Model B – reaction of NEER, period of 2002- 2012*

Model B monitors the reaction of NEER to the interest rate shock in the longer period of 2002-2012. As mentioned before, the increase in short-term interest rate is supposed to cause an appreciation of exchange rate that is represented by an increase of NEER. Even though this expected appreciation appears, it is not directly after the initial impulse. In the case of Hungary and Slovakia it appears after 2 quarters. However, we must also point out that the intensity of the reaction is not identical for all monitored countries. The NEER responds to positive interest rate



shock by its depreciation in the case of Czech Republic which may be related to higher volatility of bilateral Czech Crown exchange rate against foreign currencies since 2008 (Figure 4).

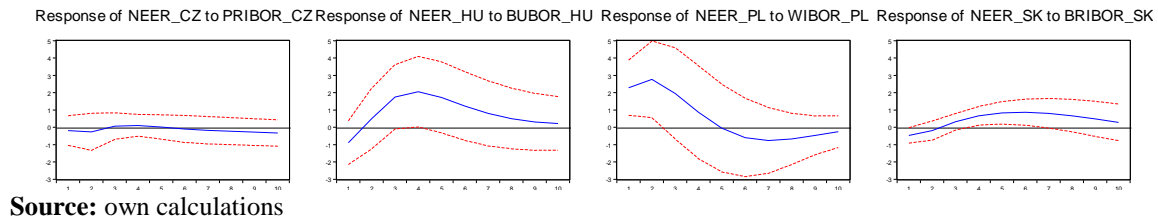


Figure 16 - IRF function for NEER, V4, 2002-2012

Figure 17 monitors the reaction of NEER to the interest rate shock for EMU12. The increase of NEER (appreciation) appears but not directly after the initial impulse. It is delayed by almost three quarters. When we compare the responses in models A and B, we can see that the intensity of reaction is a little bit less prominent in longer period. As for the comparison of NEER's response in V4 countries and EMU12, we can find similarities only in case of Slovak Republic where the reaction as well as its intensity are almost identical.

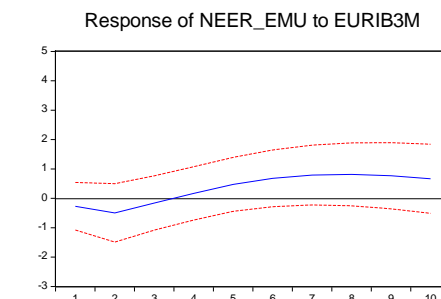


Figure 17 - IRF function for NEER, EMU12, 2002-2012

The majority of tested variables reacted not immediately or their responses were not exactly as expected based on macroeconomic theory. The reactions were often lagged, or very weak even in the shorter period of 2002-2007. So we continue our analysis with the variance decomposition.

#### 4.5 Decomposition of variation – endogenous variables

Based on the estimated model it is possible to continue with a decomposition of variance of endogenous variables. Table 9 shows contributions of changing interest rate (PRIBOR, BUBOR, WIBOR, BRIBOR and EURIBOR) to the variability of GDP, price level and nominal effective exchange rate for Czech Republic, Hungary, Poland, Slovakia and EMU12. The results for shorter period i.e. that is until 2007 indicate that variations of interbank interest rates had a significant impact on variability of GDP in Hungary (39%), Czech Republic (24%) at the end of analysed period. This reaction was lower in case of Poland (24%) and rather weak in case of Slovakia (3.9%). Comparing the sensibility of the EMU12's GDP (36%) to sensibility of other variables in EMU12, it is possible to conclude it was the most significant from all tested variables. The same results (the strongest sensibility of GDP) were obtained only for Czech Republic.

For price level, it is possible to observe a stronger reaction at the beginning of the analysed period for Czech Republic (19%) and Poland (19%). The most significant reaction was observed in Hungary (34%) nearing the end of the period. Results for Slovakia indicate again the least significant impact (9.5%). The sensibility of reaction of price level in EMU12 was very weak (3.2%) what can be explained by the relatively stable behaviour and low rate of inflation in the euro area over the period 2002 – 2007.

**Table 9** - Decomposition of variation of endogenous variables (2002-2007)

CZ	GDP_SA	P	NEER	HU	GDP_SA	P	NEER
1	13.00653	19.06483	0.002192	1	2.540472	1.284213	35.77179
3	14.68488	12.62680	7.312109	3	9.824570	25.83959	31.46820
6	14.17493	19.68635	11.45182	6	10.77226	28.57453	42.75172
12	24.82843	17.74028	15.92685	12	39.31527	34.73937	43.20111
PL	GDP_SA	P	NEER	SK	GDP_SA	P	NEER
1	8.371598	19.31147	0.531479	1	3.933223	9.535905	16.82455
3	5.154862	7.750705	2.001080	3	1.755614	3.083910	13.64358
6	12.77357	4.931009	2.782869	6	2.256321	5.956170	8.119885
12	15.44656	5.420584	6.271231	12	3.436915	9.208415	7.819380
EMU	GDP_SA	P	NEER				
1	10.76932	0.850188	0.935507				
3	14.98055	1.914235	10.00401				
6	36.11129	2.850700	17.77033				
12	35.96022	3.273967	19.88475				
Cholesky ordering: EURIB3M, GDP_SA, P, NEER							

**Source:** own calculations

Out of all observed variables, the reaction of nominal effective exchange rate was a most prominent one. It could be observed especially for Hungary (43%). However, the impact for three remaining countries was significantly weaker and intensified only with passing time. The result for EMU12 (19.8%) shows the important but not the most significant impact of interest rate shock.

Based on these results we could conclude that the contributions of changing interest rates to variability of GDP, price level and NEER were lower in the period of 2002-2007 (especially in case of Poland and Slovak Republic). We could therefore assume that there were also other channels that played an important role in the transmission of monetary policy measures. With the regards to high level of openness of analysed countries and the selected monetary strategy (predominantly a targeting of inflation) we can assume an important position of other transmission channels, that is an exchange rate channel and a channel of inflation expectations. Their combined functioning can mean that the transmission via the interest rate is weakened.

The decomposition of variations carried for the longer period of 2002-2012 (Table 9) that covers also the years of economic crisis showed certain differences. For some of the variables or the countries the reaction got stronger for others it weakened. The most visible difference was observed for GDP in case of Slovakia (from 4% to 19.7%). It was similar for the price level (from 9.5% to 17%). We can therefore conclude that the effectiveness of the analysed transmission channel of interest rate improved over the longer period that covered also the years of crisis as well as adoption of common European currency.

However, the similar conclusion cannot be drawn for Hungary where the results indicate an opposite trend – a weakening of reactions of analysed variables to interest rate shock. The most important change could be observed for NEER (from 43% to 27%) and also for GDP (from 39% to 26%). Very similar conclusions could be also drawn for Czech Republic where all analysed variables reacted less strongly to sudden changes in interbank interest rates.

Results for Poland show stronger impact on variability of price level (change from 19% to 40%) and NEER (change from 6% to 21%). The reaction of GDP intensified only slightly and only at the beginning of the analysed period. Overall, we could assume a higher effectiveness of monetary policy in this longer period, similarly as in the case of Slovak Republic.

Over the longer period, the differences appear also in the case of EMU12. The sensibility of reaction of price level on interest rate shock increased significantly (from 3.2% to 44%); contrariwise to the slightly weaker reactions monitored for GDP (from 36% to 33%) and NEER (from 19.8% to 17.9%) The comparison did not identify the similar behaviour with V4 countries.

**Table 10** - Decomposition of variation of endogenous variables (2002-2012)

CZ	GDP_SA	P	NEER	HU	GDP_SA	P	NEER
1	0.484235	11.65681	0.536140	1	0.803205	0.391505	5.136175
3	0.252917	18.39445	0.870319	3	5.864276	21.23768	11.67055
6	1.864567	14.32080	0.771068	6	14.48187	25.70894	26.00751
12	12.28084	13.22661	2.985048	12	26.66135	28.99200	27.42196
PL	GDP_SA	P	NEER	SK	GDP_SA	P	NEER
1	13.24544	35.39376	19.54685	1	19.74425	17.13064	10.82820
3	8.146368	40.00032	21.70215	3	18.14342	7.388900	9.702790
6	6.879981	32.41762	19.48854	6	11.64131	8.967516	23.93522
12	7.788567	27.77474	19.37068	12	9.433910	9.373209	15.45078
EMU	GDP_SA	P	NEER				
1	33.88845	9.987223	1.173817				
3	34.95727	33.59046	2.893923				
6	22.30419	36.55599	7.307510				
12	26.25392	44.09607	17.95679				
Cholesky ordering: EURIB3M GDP_SA, P, NEER							

**Source:** own calculations

Results of variance decomposition for V4 countries point out that the reactions of variables to interest rate shock for individual countries are not entirely identic. In all cases it was confirmed that other transmission channels of monetary policy played an important role. Two interesting tendencies could be equally observed: a stronger reaction to interest rate shock in shorter period in case of Hungary and Czech Republic. For these countries the influence of interest rate weakens with the passing time. An opposite trend, a stronger impact in the longer period could be seen in case of Slovakia and Poland. In these two countries, especially in Poland there were no important changes in reactions of analysed variables over longer period.

### Conclusion

The interest in exploring transmission mechanisms of the monetary policy has increased in recent years. Many authors have noted that out of the various transmission channels the traditional interest rate channel was the most affected by the financial and debt crisis. The crisis has also restarted a debate on the EMU accession and the advantages of own monetary policy as macroeconomic and anti-shock tool. A question that remains is whether it is now possible to talk about independent monetary policy in the condition of EU member country. Recent negative developments after 2008 still verify the ability of monetary policy to mitigate its impacts. In EMU, it can be seen in the case of the effects of single monetary policy and the deepening of the asymmetries between member countries. It is now possible to evaluate the monetary policy independence of small and open non-member country and its influence on macroeconomic developments. In current situation, central bank authorities of the countries such as Czech Republic, Hungary or Poland still consider important to preserve an independent monetary policy.

The analysis focused on the monetary policy efficiency through interest rate transmission channel. The basic variables of the model were GDP, inflation and exchange rate, i.e. variables that are generally used in the central bank monetary rules. The aim of the analysis was to evaluate the efficiency of the interest rate channel in EMU12 in general as well as in V4 countries. Our analysis was based on several expectations. We assumed that negative developments related to the crisis can distort the transmission of monetary policy effects on macroeconomic variables and that the impact of monetary policy changes are transmitted to the economic variables only partially or significantly lagged. The estimations were made using the vector autoregression model with the Cholesky decomposition of innovations.

The results for whole EMU12 and for V4 countries are not entirely identic. Especially in shorter period of 2002-2007 the differences are more visible. The longer period of 2002-2012 shows the negative influence of crisis on the results of all monitored countries; the responses of variables on interest rate shock in EMU12 and V4 countries have become more similar. In all cases it was confirmed that other transmission channels of monetary policy played an important role. In regard to the high level of openness and monetary strategy applied in economies of V4 countries, it is possible to assume the important role of exchange rate and inflationary expectations channel what may weaken the transmission through the interest rate channel.

### Acknowledgement

This paper was written within the scientific project VEGA no. 1/0973/11. Financial support from this Ministry of Education's scheme is also gratefully acknowledged.

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## REPRESENTATION OF STRUCTURED FORMS FOR THE SAME PATH

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**Abstract:**

*The concept of labelled graph and the term of structured path were introduced in ([1]). Using the definition for the term of structured element and elementary structured element for a path in a labelled graph, the information contained in a labelled graph can be transposed into a representation of labelled tree type. In the present paper we try to explain the case of several structured form for the same path, are needed.*

**Keywords:** structured element, elementary structured element, accepted set, structured form.

### 1. Introduction

An important concept in the field of Artificial Intelligence was named Knowledge Representation and Reasoning System (KRRS). Such a system is a collection of components cooperating between them and the whole system is able to reason in order to give the answer of an interrogation (Wagner, 1994). Among these components, the knowledge base and the answer function are considered as main components. Each knowledge base uses a knowledge representation method (Popîrlan, Ştefănescu, Ştefănescu, 2011). One of the most known methods for knowledge representation is the graph-based representation of knowledge.

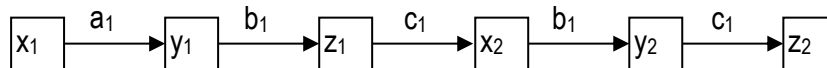
In a graph-based representation an entity is given by a pair of nodes and a link between them. In this kind of knowledge representation, a node is an object characterized by a set of attributes and the link between two nodes is specified by the relation parent-child. An overview of these methods of knowledge representation can be found in (Way, 1991). The semantic is given by specifying the concrete meaning of this notational convention.

The basic concept used in this paper is that of labelled graph denoted by  $G = (S, L_0, T_0, f_0)$ . The elements of  $G$  are defined as:  $S$  is a finite set of node;  $L_0$  is a set of elements named labels;  $T_0$  is a set of binary relations on  $S$  and  $f_0: L_0 \rightarrow T_0$  is a surjective function.

### 2. A formalism to specify structured path

We consider a labelled graph  $G$  and a path  $d = ([x_1, \dots, x_{n+1}], [a_1, \dots, a_n])$  in  $G$ . Let us consider the partial path of  $d$  represented in Figure 1 and the following set of structured elements:

$$X(d) = \{((x_1, y_1), [1, 2, 5]), ((y_1, z_1), [1]), ((z_1, x_2), [1, 2, 3]), ((x_2, y_2), [1]), ((y_2, z_2), [1])\}.$$



**Figure 1.** Partial path of  $d$

To explain the case of several structured forms for the same path, we will use the notations and demonstrations of ([2]).

First, to show that the set  $X(d)$  of structured elements is an accepted set, we have to check the satisfaction of two condition.

We have length  $(d) = 5$  and the first condition is satisfied. For  $d$  we have:

$$a) ((x_1, y_1), [1, 2, 5]) = \{((x_1, y_1), [1]), ((x_1, y_1), [2]), ((x_1, y_1), [5])\}$$

$$\text{succ}^{(2)}(x_1) = z_1$$

$$\text{succ}^{(5)}(x_1) = z_2$$

$$\begin{aligned} \text{b) } ((z_1, x_2), [1, 2, 3]) &= \{((z_1, x_2), [1]), ((z_1, x_2), [2]), ((z_1, x_2), [3])\} \\ \text{succ}^{(2)}(z_1) &= y_2 \\ \text{succ}^{(3)}(z_1) &= z_2 \end{aligned}$$

The second condition is also verified as it results from the following specifications:

- a) For  $((x_1, y_1), [2])$  we take  $k = 1$ :  
 $((x_1, y_1), [1]) \in_c X(d)$   
 $((\text{succ}^{(1)}(x_1), \text{succ}^{(1)}(y_1)), [2-1]) = ((y_1, z_1), [1]) \in_c X(d)$
- b) For  $((z_1, x_2), [2])$  we take  $k = 1$ :  
 $((z_1, x_2), [1]) \in_c X(d)$   
 $((\text{succ}^{(1)}(z_1), \text{succ}^{(1)}(x_2)), [2-1]) = ((x_2, y_2), [1]) \in_c X(d)$
- c) For  $((z_1, x_2), [3])$  we take  $k = 2$ :  
 $((z_1, x_2), [2]) \in_c X(d)$   
 $((\text{succ}^{(2)}(z_1), \text{succ}^{(2)}(x_2)), [3-2]) = ((y_2, z_2), [1]) \in_c X(d)$
- d) For  $((x_1, y_1), [5])$  we take  $k = 2$ :  
 $((x_1, y_1), [2]) \in_c X(d)$   
 $((\text{succ}^{(2)}(x_1), \text{succ}^{(2)}(y_1)), [5-2]) = ((z_1, x_2), [3]) \in_c X(d).$

In the following figure (Figure 2), the dash line showing the fact that  $(x, y)$  is the first arc belonging to a path of length  $s$ . The dash line is draw from the node  $x$  to  $\text{succ}^{(s)}(x)$ .

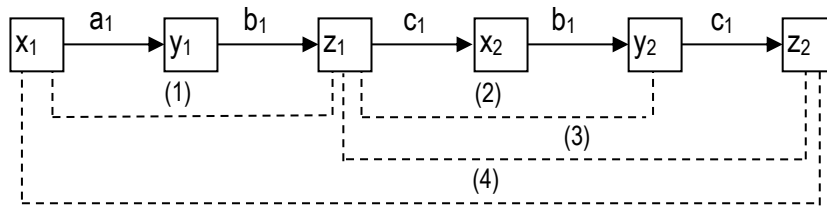


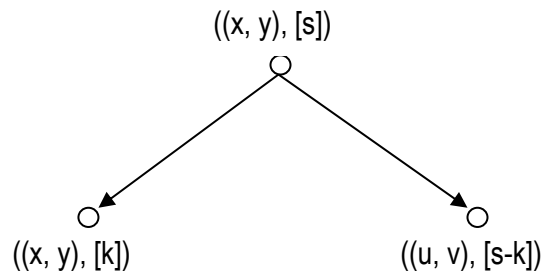
Figure 2. Intuitive representation for example

From the condition (a) of the previous verification we draw a dash line (1); from (b) we draw a dash line (2); from (c) we draw a dash line (3); from (d) we draw a dash line (4).

Each elementary structured element  $((x, y), [s]) \in_c X$  are two direct descendants  $((x, y), [k]) \in_c X$  and  $((u, v), [s-k]) \in_c X$ , uniquely determined, such that  $u = \text{succ}^{(k)}(x)$  and  $v = \text{succ}^{(k)}(y)$ . The uniqueness of these elements allows us to represent this property by means of a particular tree such that:

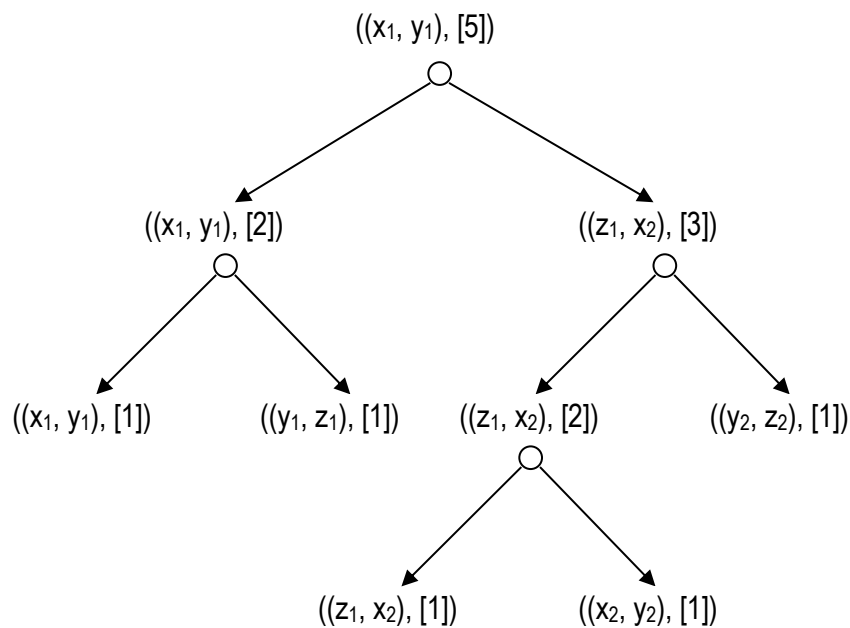
- the root is labelled by  $((x, y), [s])$  and the root has two direct descendants;
- the left direct descendant is labelled by  $((x, y), [k])$ ;
- the right direct descendant is labelled by  $((u, v), [s-k])$ .

This tree is drawn in Figure 3. We can repeat this procedure for the direct descendants until the leaves are elements of the form  $((\alpha, \beta), [1])$ . We denote by  $TREE(X)$  the set of all trees over  $X$  such that their leaves are labelled by elements of the form  $((\alpha, \beta), [1])$ .



**Figure 3.** A general representation for a tree

For example considered, the tree corresponding to this elementary structured element is represented in Figure 4.



**Figure 4.** TREE(X)

Using the  $h$  mapping, we obtain for the elementary structured elements of index 1:

$$h((x_1, y_1), [1]) = a_1$$

$$h((y_1, z_1), [1]) = b_1$$

$$h((z_1, x_2), [1]) = c_1$$

$$h((x_2, y_2), [1]) = b_1$$

$$h((y_2, z_2), [1]) = c_1$$

For the elementary structured elements of index 2, 3 and 5, we obtain successively:

$$h((z_1, x_2), [2]) = [c_1, b_1]$$

$$h((x_1, y_1), [2]) = [a_1, b_1]$$

$$h((z_1, x_2), [3]) = [[c_1, b_1], c_1]$$

$$h((x_1, y_1), [5]) = [[a_1, b_1], [c_1, b_1], c_1]$$

Substituting the relations obtained above in the labels of Figure 4, we can draw the Figure 5 of a labelled tree:

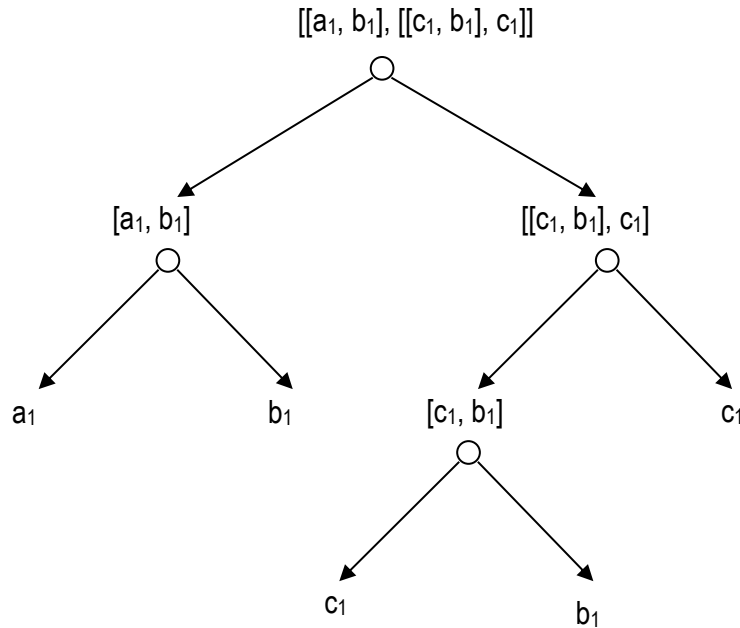


Figure 5. A labeled tree

### 3. The case of several structured forms for the same path

In this section we present the case when two or more structured forms for  $d$  are needed. First, we consider the path  $d$  represented in Figure 6. We observe several dash lines such that each of them can be identified by a proper number. We suppose the lines (1), (2), (3) and (4) define intuitively some structured form  $S_1$  of the path  $d$ . The other lines ((5), (6), (7) and (8)) define the structured form  $S_2$  for the same path  $d$ . We observe that the sequence  $(y_1, z_1)(z_1, x_2)$  can appear in  $S_2$  but not in  $S_1$ . We denote by  $B_+$  the “common” part of  $S_1$  and  $S_2$ . This means that  $B_+$  contains the directed arcs of  $d$  and in addition, the information concerning the fact that the direct arc  $(x_1, y_1)$  is the initial arc for a path of length 5. The last information is specified by introducing the elementary structured element  $((x_1, y_1), \text{in } B_+, \text{see also } (\text{T\candareanu, Dinc\candea}, 2012))$ .

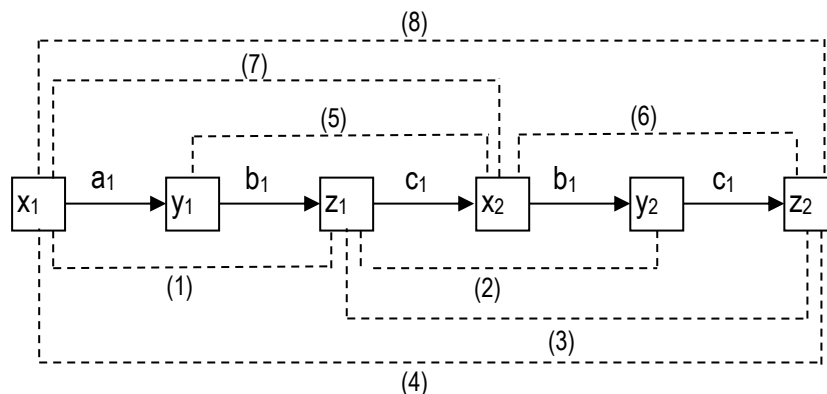


Figure 6. Intuitive representation of X

$$B_+ = \{((x_1, y_1), [1, 5]), ((y_1, z_1), [1]), ((z_1, x_2), [1]), ((x_2, y_2), [1]), ((y_2, z_2), [1])\}$$

The specific information for  $S_1$  will be introduced into the following set:

$$C_1 = \{((x_1, y_1), [2]), ((z_1, x_2), [2, 3])\} \text{ and similarly we obtain } C_2 \text{ for } S_2:$$



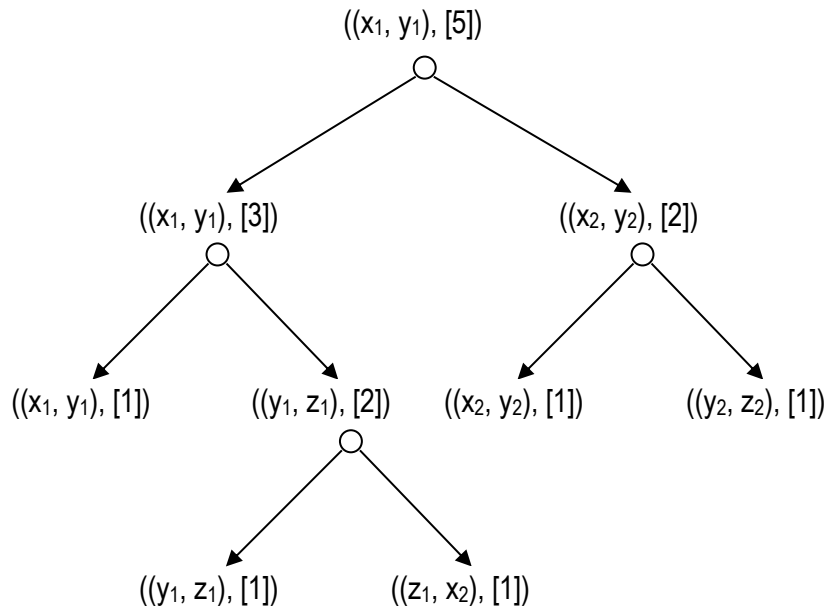
$$C_2 = \{((x_1, y_1), [3]), ((y_1, z_1), [2]), ((x_2, y_2), [2])\}$$

We observe that the dash lines (4) and (8) are introduced in  $B_+$ , the lines (1), (2) and (3) in  $C_1$ , (5), (6) and (7) in  $C_2$ .

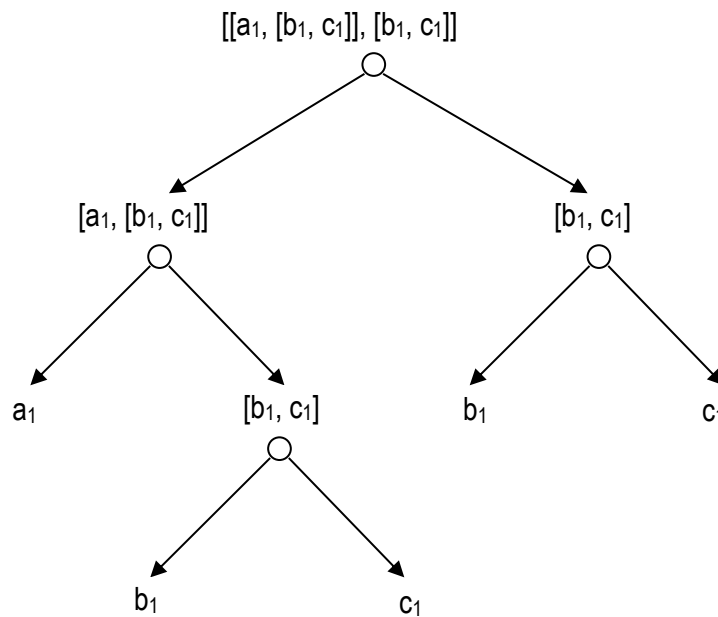
Moreover,

$$X_1 = B_+ \cup C_1$$

$X_2 = B_+ \cup C_2$  are accepted sets for  $d$  and they generate the trees  $t_1$  from Figure 4 and  $t_2$  from Figure 7 respectively. Now, the tree  $t_1$  is transposed by  $h$  in the tree from Figure 5 and  $t_2$  in Figure 8.



**Figure 7.** The tree  $t_2$



**Figure 8.** The tree  $t_2$

As a result of this computation the following structured forms for  $d$  are obtained:

$$d_{X_1} = ([x_1, y_1, z_1, x_2, y_2, z_2], [[a_1, b_1], [[c_1, b_1], c_1]])$$

$$d_{X_2} = ([x_1, y_1, z_1, x_2, y_2, z_2], [[a_1, [b_1, c_1]], [b_1, c_1]])$$

### Conclusions

In general, in order to specify  $k$  structured forms for a path  $d = ([x_1, \dots, x_{n+1}], [a_1, \dots, a_n])$  we consider the set  $B_+$  containing the common information such that  $((x_i, x_{i+1}), [1]) \in B_+$  for  $i \in \{1, \dots, n\}$ , the element  $((x_1, x_2), [n]) \in B_+$  and other information concerning common structured form of the partial paths in  $d$ . Then, for each  $j \in \{1, \dots, k\}$  we define the set  $C_j$  including the “specific” information for the  $j^{\text{th}}$  structured form of  $d$ . We obtain a complete description if and only if  $X_j = B_+ \cup C_j$  is an accepted set for  $d, j \in \{1, \dots, k\}$ .

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# COUNTRY RISK MODELLING USING TIME-VARYING FUNDAMENTAL BETA APPROACH: A VISEGRAD GROUP COUNTRIES AND ROMANIA PERSPECTIVE

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## **Abstract:**

*Financial instability is a recurring, macroeconomic phenomenon which has been manifesting itself in form of the Great Recession since 2007. The paper pursues the question of how financial instability affects the risk of a country. We discuss the relation of the risk of a particular country to international investment activities and refer to unique risk faced by foreign investors when investing that country. In the study we intend to identify the relationship between country risk indicators, local and global, and so called fundamental beta coefficient from the capital asset pricing model. As we have found out, the global risk factors have greater influence on their betas than local factors. Betas are sensitive to the consequences of economic development like recent economic crisis. In almost all of observed cases the Betas reached their maximum in the period of 2008-2009. Furthermore a rapid increase of betas in Hungary and Romania corresponds to the time of official request for the financial assistance and can be used as case of Beta sensitivities.*

**Keywords:** systematic risk, time-varying beta, risk factors, Visegrad group countries, Romania, Equity Markets

**JEL Classification:** C51, C52, G12, G32

## **1. Introduction**

Since beginning of the 1990s, the world economy has been characterized by its intensifying globalization. As a consequence, the structure and size of the international capital flows has been changed rapidly. The rapid change has already highlighted the importance of global risk factors for the management of firms and organizations, as well as for the sustainable socio-economic development of countries. Country risk analysis has evolved as a major research topic within the fields of economics and finance during the past three decades.

The significance of the country risk analysis is also highlighted through last development in the global environment, where many developed and emerging countries have been hit hard by the crisis. Also Visegrad countries and Romania have been affected, but in deferent manner. We provide an evidence of the three Visegrad countries and Romania. These four countries have been selected and analysed using specific fundamental Beta approach.

All of them are the EU member state countries and currently are not a part of the Euro area countries - Czech Republic, Hungary, Poland, and Romania. Two of them were hit hard in the 2008-2009 by the global economic downturn, Hungary and Romania. In the case of Hungary, at the end of 2008, the Emergency Financing Mechanism of the International Monetary Fund was used to help provide financing because the country faced an exceptional situation that threatens its financial stability. Affecting with the global economic downturn, Romania received in February 2009 a loan by the IMF in the amount of 17.1 billion USD.

The paper is organized as follows: The first section shortly describe the country risk term and the theoretical background and genesis of the time-varying fundamental Beta approach. In the second section we employ time-varying fundamental Beta technique using the time series and multiple linear regression analysis to analyse and model Beta in each country. In the third section we discuss achieved results in context of other researches and we make a summary of them.

## 2. Country risk and capital asset pricing model

Generally accepted definition on country risk offered Panras Nagy in Euro-money. According Nagy, 1984 country risk is the exposure to a loss in cross-border lending caused by events in a particular country which are, at least to some extent, under the control of the government but definitely not under the control of a private enterprise or individual. Cosset et al., 1992 defined country risk as the probability that a country will fail to generate enough foreign exchange in order to pay its obligation toward the foreign creditors. Other researchers have emphasized the necessity of defining country risk in a broader context that better represents the multidimensional character of country risk. As discussed in Kosmidou *et al.*, 2004 country risk may be prompted by a number of country specific factors or events. Indeed three types of event can cause country risk, namely political events, economic factors, and social factors. Country risk therefore means the exposure to a loss in cross-border lending (of different types) due to events more or less under the control of the government.

As Bouchet *et al.*, 2003 discuss there is not a consensus about a comprehensive definition of “country risk”. In the literature dealing with the risk of international investment, the two terms most frequently encountered are “country risk” and “political risk”. Also references to “cross-border risk” or “sovereign risk” can be found. Gangemi *et al.*, 2000 suggest that the country risk is a function of the country’s exposure to the world markets. Verma and Soydemir, 2006 or Verbenik *et al.* (2011) discuss the relation of the risk of a particular country to international investment activities and refer to unique risk faced by foreign investors when investing in that country.

In the early 1970s was introduced a series of scientific papers on the capital asset pricing model (CAPM). This standard form of the general equilibrium relationship for asset returns, also known as the Sharpe-Lintner-Mossin mean-variance equilibrium model, builds on the theoretical works of Harry Max Markowitz, 1959. Beta in the model is a risk measure that arises from the relationship between the return on an investment and the return on the market. One of the earliest attempts to relate the Beta of an investment to fundamental variables was performed by Beaver et al., 1970, where the relationship between seven firm variables and the Beta of a company’s stock has been used. In this fundamental Beta model a static form of the CAPM was performed, where the ordinary least squares estimation technique has been used to estimate Beta.

However one of the first attempts to relate this technique to the country risk came from Harvey, 1991. He introduced a Beta market model as a method based on the CAPM. The innovation was the time-varying Beta as a function of a number of independent economic and financial variables. Erb *et al.*, 1996 used this method and concluded the returns in individual stock markets show a strong relation to the risk faced of countries under consideration. Gangemi et al., 2000 employed the model proposed by Harvey in analysis of the negative influence of increasing foreign debt in Australia. Verma and Soydemir, 2006 estimate the risk of selected countries in Latin America and show how the inflation in G7 countries, interest rates and specific local factors impact on Beta coefficients in these countries. In Glova, 2013 the exponential smoothing technique has been applied to analyze the country systematic risk of Visegrad countries.

## 3. Data and methodology

The fall of communism has fundamentally changed the economies of the former communist states of Central and Eastern Europe (CEE). These former East Bloc countries have become more visible for the global investors, who have increased interest in equity markets of these countries. In the previous two decades these markets recorded high returns as well as heavy losses in relatively unstable economic environment. Through the EU enlargement process many of the post-communist states in the Central and Eastern Europe have become new EU member states.

Therefore particular Visegrad Group countries and Romania have been selected and analysed. Specifically all of them currently are not a part of the Euro area countries. Two of them were hit hard in the 2008 and 2009 by the global economic downturn, Hungary and Romania, as discussed in Mirdala, 2013. In this section we apply the technique proposed in Harvey, 1991 to analyse the country risk of these selected CEE countries using time-varying fundamental Beta approach.

The selected data set contains observations on 11 variables (see the global and local variables' description summarized in Table 1) for a multiple entity of the four CEE countries - Czech Republic, Hungary, Poland, and Romania for 88 time periods, months. The observations in this data set begin in the January of 2006, and end in the April of 2013.

We employ the aforementioned fundamental Beta approach proposed by Beaver *et al.*, 1970 and extensively improved in the time-varying form by Harvey, 1991 as shown in equation

$$\beta_i = \beta_0 + \sum_{j=1}^n \beta_{j,i} \gamma_{j,i} + e_i \tag{1}$$

Standard form of the general equilibrium relationship for asset returns was derived in several forms involving different degrees of rigor and mathematical complexity. As mentioned in Elton *et al.*, 2006 the equilibrium CAPM model can be written in the form

$$R_i = R_f + (R_m - R_f) \beta_i \tag{2}$$

The basic model (2) can be rearranged to the time series model where the excess return of asset ( $R_{i,t} - R_{f,t}$ ) is explained through the excess return of market portfolio ( $R_{m,t} - R_{f,t}$ )

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{it} (R_{m,t} - R_{f,t}) + e_{i,t} \tag{3}$$

**Table 2** Variables and their description

VARIABLE	DESCRIPTION
<b>Global risk factors</b>	
ER_EU	Monthly rate of returns calculated from average monthly values of Euronext global index – share price index (rebased). Also used as a proxy for stock market index (Eurostat)
BRENT	Average monthly oil prices - Europe Brent Spot Price FOB per Barrel (US Energy Information Administration)
IR12_EU	Average monthly data of Euro yield curves with 12 months maturity (Eurostat)
IR3M_EU	Money market interest rates - monthly data with 3 months maturity (Eurostat) Euro area - EA11-2000, EA12-2006, EA13-2007, EA15-2008, EA16-2010, EA17 (Eurostat)
HICP_EU	Harmonised consumer price index of Euro Area (Eurostat)
XR_EU	Average monthly USD/Euro exchange rates (Eurostat)
<b>Local risk factors</b>	
ER	Monthly rate of returns calculated from average monthly values of national stock exchange index – share price index (rebased). Also used as a proxy for stock market index (Eurostat)
IR1M	Average monthly data of Money market interest rate with 1 month maturity (Eurostat)
HICP	Harmonised consumer price index of the particular country (Eurostat)
VOL	Volume index of production - Industry production index - monthly data - (2005 = 100) acc. to NACE Rev.2 (Eurostat)
XR	Average monthly exchange rates of the national currency to Euro (Eurostat)

**Sources:** Eurostat, US Energy Information Administration

According to Gangemi *et al.*, 2000 in an efficient financial market, we would only expect stock market reaction to the unanticipated component of the macroeconomic variables. We find the unanticipated components as the residuals from ARIMA models fitted to the macroeconomic data.

Based on our aforementioned equations and discussion we propose a time-varying model of country systematic risk as follows

$$\beta_{i,t} = b_{0,i} + \sum_{j=1}^n b_{j,i} \gamma_{j,it} + u_{i,t} , \tag{4}$$

where all variables are defined as their unanticipated components. Due to the fact that one is unable to directly observe beta  $\beta_{i,t}$  in equation (4), we cannot estimate the model directly. However, we could postulate a general beta market model from equation (3). Within this framework we can now substitute equation (4) for  $\beta_{i,t}$  into equation (3). Thus the specific time-varying beta market model of a selected country is estimated through

$$(R_{i,t} - R_{f,t}) = \alpha_i + b_{0,i} + \sum_{j=1}^n b_{j,i}Y_{j,it} + \vartheta_{i,t} \tag{5}$$

Now we can indirectly determine the values for the parameters in equation (4) by estimation of equation (5).

**4. Model fitting and diagnostic**

According to the description in the model specification we should fit appropriate ARIMA or SARIMA models to estimate expect stock market reaction to the unanticipated component of the local and global variables. However many time series in finance are non-stationary, i.e. statistical properties such as mean, variance, autocorrelation are not all constant over time or whose joint probability distribution does not change when shifted in time or space. Statistical tests of the null hypothesis that a time series is non-stationary versus the alternative it is stationary are called unit root tests. We apply two different unit root tests - augmented Dickey-Fuller (ADF) test and Phillips-Perron test. In regard to very low power to discriminate between alternative hypotheses (especially when the data have jumps and structural breaks) of ADF test we use less restrictive assumptions on the errors in the form of the Phillips-Perron tests, which are generally favoured for financial data analysis.

**Table 3** Fitted ARIMA/SARIMA models for the particular local variables

Country	ARIMA (p, d, q) or ARIMA (p, d, q) × (P, D, Q) [S] model			
	IRIM	HICP	VOL	XR
Czech Republic (CZE)	(1,1,0)	(1,1,1) × (2,0,0)[12]	(2,1,0) × (2,0,0)[12]	(0,1,0)
Hungary (HUN)	(0,1,0)	(2,1,0) × (2,0,1)[12] <i>with drift</i>	(1,1,0)	(0,1,0)
Poland (POL)	(1,1,0)	(1,1,0) × (2,0,0)[12] <i>with drift</i>	(1,1,0) × (0,0,2)[12] <i>with drift</i>	(0,1,1)
Romania (ROM)	(0,1,0)	(0,1,0) × (0,0,1)[12] <i>with drift</i>	(0,1,0) × (0,0,1)[12] <i>with drift</i>	(1,1,0)

**Source:** own calculations

The next step in time series analysis is to specification of an appropriate model and its parameter estimation. We could use plots of empirical autocorrelation function (ACF) and partial autocorrelation function (PACF), which provide effective tools for identifying pure AR (p) or MA (q) models. However, for a mixed ARMA model, its theoretical ACF and PACF have infinitely many nonzero values, making it difficult to identify mixed models from the sample ACF and PACF. There are many graphical and computational methods based on information criterions, e.g. extended autocorrelation method EACF or ARMA-subsets specification. In our analysis we used a tool of the forecast package in software R – auto.arima, developed and described by Hyndman and Khandakar, 2008 to estimate the appropriate sets of models. We have fixed the order of differentiation in the auto.arima tool and detected several appropriate models for each variable. Thereafter we used model diagnostic in form of the residual analysis to inspect the model adequacy. We inspect plots of the residuals over time, QQ (quantile-quantile) plots for assessing normality of residuals, and the independence of the noise terms in the model. Using this methodology for time series analysis we have fitted the most appropriate model for each of the relevant variables. The relevant models are listed in Table 2 and 3.

**Table 4** Fitted ARIMA/SARIMA models for the particular global variables.

ARIMA (p, d, q) or ARIMA (p, d, q) × (P, D, Q) [S] model					
Global	BRENT	IR12_EU	IR3M_EU	HICP_EU	XR_EU
	(1,1,0)	(1,1,0)	(1,1,0)	(1,1,0) × (0,1,1)[12]	(0,1,0)

Source: own calculations

In accordance with (5) we obtain new time series explanatory variables, which are created by the market excess returns and residuals from ARIMA/SARIMA models quantified for each of the local and global variables. We use these new variables for model specification and parameters estimation of the multiple linear regressions as denoted in (5). A potential problem with multiple linear regressions is that explanatory variables may have a high degree of correlation between themselves – multicollinearity. We used variance inflation factor or VIF to detect the presence of potential multicollinearity. If necessary we have dropped the least significant of the collinear variables until multicollinearity was no longer a problem. The next step in multiple linear regression analysis was diagnostic of the residuals, where the assumptions of normality, autocorrelation and heteroscedasticity have been inspected. We employed Durbin-Watson (DW) test for autocorrelation, Breusch-Pagan (PB) test for heteroscedasticity detection, and Jarque-Bera (JB) test for the normality of the residuals. The statistics are listed in Table 4. Not all results are reported, but are available on request from author.

### 5. Analytical results

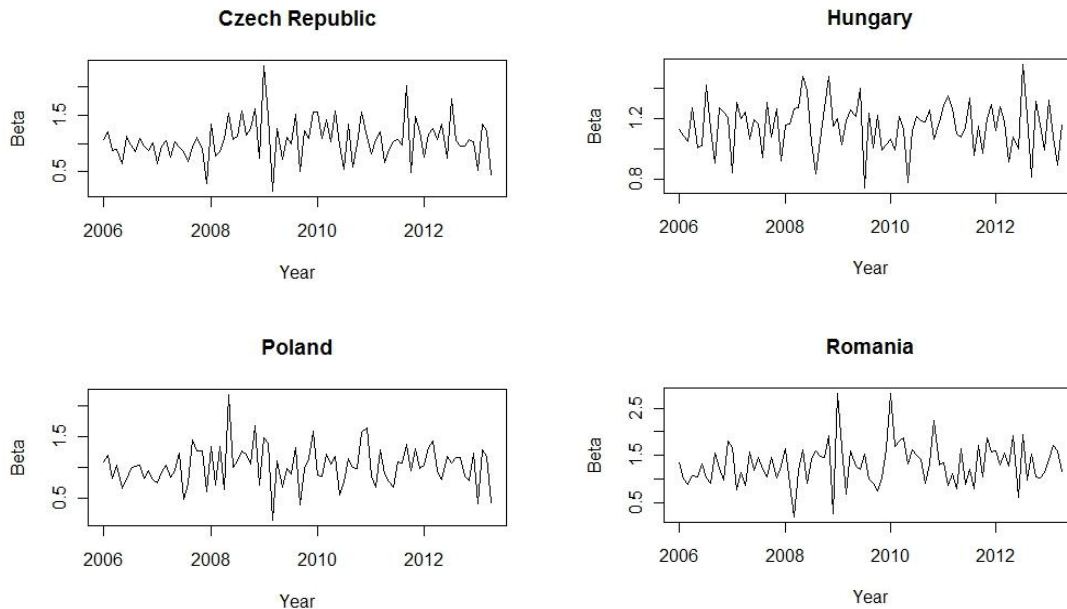
The results depicted in Table 4 are quite similar to the results of Gangemi *et al.*, 2000, and Verma and Soydemir, 2006 who suggest a high influence by global risk factor (at 1 percentage level) of excess return on global stock index (ER\_EU). These results may provide the evidence for a strong integration of local and global stock markets. There is a small impact of local interest rates (ER\_IR1M), whereby consumer prices (ER\_HICP) are also not statistically significant. Exchange rate of Euro/USD (ER\_XR\_EU) has an impact on Betas of three countries. Interest rate with maturity of 3 months is not statistically significant for any country. In our research we cannot prove a significant impact of exchange rate on Beta for all countries as can be found in Bilson *et al.*, 2001.

**Table 5** Selected results of the multi linear regression.

Statistics	Czech Republic	Hungary	Poland	Romania
ER_EU	1,067***	1,146***	1,026***	1,311***
ER_BRENT	0.012	0.023		
ER_IR3M_EU	-0.670	-0.175	-0.675	-0.779
ER_HICP_EU	0.637	-0.152	1.068**	
ER_XR_EU	-6.110***	-0.354	-2.788*	-9.079**
ER_IR1M	-0,857	0,179	-0,142	-0,244*
ER_HICP	-0,218	-0,088	0,196	0,374
ER_VOL	-0,014	-0,017	-0,096*	0,101
ER_XR	0,011	-0,005	-0,183	
R <sup>2</sup>	0,793	0,697	0,7418	0,6185
F test	33,25	19,94	28,37	21,89
JB test	7,81	1,61	1,63	0,37
BP test	10,245	11,356	8,1545	4,4975
DW test	1,7579	1,8221	1,996	1,6032

Source: own calculations

As the next step of our analysis we calculated time-varying fundamental Betas for the selected countries that are depicted in Figure 1. Average and maximum values of Betas vary from 1,06/2,38 in the Czech Republic, through 1,14/1,56 in Hungary, 1,02/2,19 in Poland, up to 1,32/2,82 in case of Romania.



**Figure 1** Time-varying beta coefficients of the analyzed countries

Examining Figure 1, there is visible a different reaction of the Betas between markets. There is a dominant peak in 2008-2009 in case of Czech Republic, Poland and Romania. Furthermore some of the countries, as Hungary and Romania requested financial assistance through the Emergency Financing Mechanism of the International Monetary Fund during the 2008-2009. Increase of Betas in Hungary (in November 2008) to 1,475 and Romania (in January 2009) to 2,821 corresponds to the time of official request for the financial assistance. In the case of Hungary, at the end of 2008 (November), the Emergency Financing Mechanism of the International Monetary Fund (IMF) was used to help provide financing because the country faced an exceptional situation that threatens its financial stability. Romania received the assistance in February 2009 through a loan by the IMF.

**Conclusion**

Between 2000 and 2007, the CEE countries were one of the fastest growing regions in the world. But in 2008-2009 almost all of them have been affected hard by the crisis. In our research, four CEE countries have been selected and analysed using specific fundamental beta approach - Czech Republic, Hungary, Poland, and Romania. Two of them were hit very hard in the 2009 by the global economic downturn, Hungary and Romania.

We have shown the global risk factors have greater influence on their Betas than local factors. We have also shown Betas are sensitive to the consequences of economic development like recent economic crisis. In almost all of observed cases the Betas reached their maximum in the period of 2008-2009. Furthermore increase of Betas in Hungary to 1,475 and Romania to 2,821 corresponds to the time of official request for the financial assistance and can be used as case of Beta sensitivities.

**Acknowledgements**

The work was supported by the Ministry of Education of the Slovak Republic under grant VEGA No. 1/0799/13.



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# A COMPARATIVE ANALYSE ON AMERICAN, JAPANESE AND KOREAN MANAGEMENT FROM THE POINT OF VIEW OF INTERNATIONAL BUSINESS

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**Abstract**

*After the rapid economic ascension on international level of South Korea or the "quiet morning's country" they questioned whether the Korean management system is unique and different from other management systems such as the Japanese and American one. The answer is both "yes" and "no."*

**Keywords:** international business, management, economy, company, employee, traditional values.

**JEL Classification:** F23

## 1. Introduction

All management systems have a common feature: they make efforts to increase the performance of an organization in the most effective way. From this point of view the Korean management shares this characteristic with the other management systems. From this perspective, we can say that all management systems operate based on the universally valid principles of planning, organization, control, management and motivation. However, Korean management is unique in its traditional values and a business approach, and it endeavours to improve the performance of their organizations in the most efficient way but in the context of traditional Korean culture (Chang Chan, Chang Nahn Joo, 1994).

Also, Japanese and American management styles are unique because they operate according to their own cultures. The Japanese and American management were chosen for comparison just because these two systems have significantly influenced the Korean management.

## 2. General aspects and theoretical analysis

During the Japanese occupation, from 1910 to the end of the Second World War, the Japanese implemented in Korea the western, modern management system. The current Japanese management is just a mixture of their traditional management with elements belonging to the western one.

Even nowadays, the hierarchy inside an organization is approximately identical in both systems: the Korean and Japanese one. All levels of an organization are expressed by the same Chinese characters but each country pronounces them differently (Chang Chan, Chang Nahn Joo, 1994).

Position	Japan	South Korea
Chairman	shacho	sachang
Executive Director	senmu	jeonmu
Manager	riji	eesah
Head of Department	bucho	puchang
Deputy Head of Department	jicho	chachang
Head of Branch	kacho	kwachang
Deputy Head of Branch	dairi	daerhee
Ganger	kakaricho	kaychang
Ordinary employee	shain	sawon

With the end of the Second World War, American culture has started to make its presence felt in all aspects of South Korean culture and Korean management system was not an exception.

Korean managers tried to adjust several American concepts to their own management system, since until then the American system had been a symbol of management effectiveness. New terms such as "marketing" have also been adopted from the American system of management, but they barely found suitable representations in the Korean vocabulary.

Despite the infusion of American concepts of management, the Korean system differed from the American one due to the influence of culture upon the management practices. It is only by comparing the three management systems that one can emphasize the common and distinctive features.

The Japanese management system has the following features:

- decision-making is based on consensus;
- life employment;
- team spirit;
- great loyalty towards the employer and organization;
- patriarchal leadership of the company;
- personal approach to problems;
- close cooperation between government and business;
- satisfactory relationship between workers and management;
- confucian work ethic;
- its motto is human harmony;
- management system dominated by men.

In the Japanese management system no decision is taken until everyone involved reached an agreement. Hence, it follows that any unilateral decision is invalid. This process is known as the "*ringi system*". A Japanese company grants its new employees a job until they retire at the age of 55, although retirement at the age of 60 has become a growing trend. As a result of this type of employment the following concepts arose: seniority, promotion, remuneration, immobility.

Thus, promotions are based on seniority and rarely are the cases where subordinates compete for top positions with their superiors. Remuneration is also based on seniority and not on merits. However, the longer an employee works in a company, the more he or she earns. Since an employer has a long life commitment, theoretically, he or she cannot move from one company to another and vacancies are granted to the company staff.

In the Japanese management system team spirit or group consciousness is more important than individualism (Furstenberg, 1974). Individual aspirations must be subjugated to team efforts to maintain the spirit of the group.

Employees' loyalty is also very deeply rooted in the Japanese system of management the employee is expected to show complete attachment to his betters and organization. In Japanese society, complete loyalty to superiors and country is considered the highest virtue. At the same time, employers should always satisfy the employees' needs by introducing benefits programs and superiors must treat their subordinates as their children.

The patriarchal system well-structured supports a personal approach to employees' motivation (Kleining, 1983). Employees are encouraged to actively participate in the affairs of the company, to talk freely with the superiors and the organization tries to provide an open environment.

The relationship between government and business is exceptionally cooperative in Japan, the first protecting companies from foreign competition through protective policies. Business community in Japan advocates a so-called government policy guidance through which many government officials advise companies. This cooperation between government and business has resulted in the phrase "Japan, Inc."

Japanese management guides itself by Confucian rules and that is why society dominated by men considers women useful for only household, child education and serving man (Ouchi, 1993).

In order to maintain its global competitiveness the Japanese management system is currently going through a change from stability and loyalty oriented one to one oriented towards entrepreneurship and creativity.

The Japanese and Korean management systems have a lot of common, both countries being under the influence of Chinese culture and philosophy and for almost 40 years when South Korea was under Japanese occupation, the Japanese management system was implemented in the former country. Korean management traits may be classified as follows:

- decision-making is based on consensus between qualified persons;
- lifelong employment, with some qualifying conditions;
- individualism within the groups;
- loyalty;
- mobility inside organization;
- leadership patriarchal on the grounds of qualification;
- close relationship between government and business, with qualifications;
- Confucian work ethics;
- harmony and solidarity.

Making decisions by consensus is a practice that is reflected by Korean management, called "*pumui system*". But, unlike the Japanese, in the Korean management system decisions are taken by consensus at a certain level.

*For example*, the Korean entrepreneurs make decisions without consulting their assistants or employees and decision by consensus is only a formal expression for the top management decisions (Yang, 2006). Korean companies also practice employment until the age of retirement. However, unlike the Japanese employers, the Koreans can lay off their employees both in times of economic difficulties, such as recessions, and also as a generally accepted practice.

The concept of life employment is limited in the Korean management because it is often ignored by highly skilled employees (Patterson, 2002). Thus, they may change their jobs if this entails their career development. Mobility inside organization is a much more common practice in Korean corporations than in Japanese ones, where it has not yet been formally implemented. The individualism within a group, in case of the Korean management, is accepted to the extent that individual actions bring advantages to organization, for the common good, consequently.

Promotion is very important in Korean management because it is a crucial criterion in assessing the value of an employee. If an employee observes that he lacks promotion opportunities within the company he will look for another one appropriate to his qualifications (Lee, 1989). As long as in Korea an employer's promotion is a matter of family pride and prestige, its importance is crucial. The top managers of some major chaebols lead their organizations by delegation of authority and decentralization of decision making but, largely, they apply an autocratic and patriarchal leadership style (Kleining, 1983). In the case of Korean management there is a relationship between government and enterprises, but this is conditioned by the relations businessmen develop with leading political leaders, and government officials (Lee, 2000).

Unlike the Japanese, to Koreans the group spirit is a means to achieve their own ends. Throughout the tumultuous history they have learned to treasure that fact that individual aspirations are the most outstanding. As selfish as it sounds, these individual aspirations always serve the society's purpose, so subsequent the common good. Unlike the two management systems in Asia, the American one has the following features:

- rationality;
- individualism;
- impersonality;
- profit oriented;
- mobility and orientation towards short term objectives;
- decrease of seniority system;
- protestant work ethics;
- profit as motivation.

The American system is based on rationality, which means efficiency, as well as on other American rules that are frankness, openness, justice and civic sense (England, 1980). While

Americans are more interested in objectivity, Asian countries are more interested in emotional subjectivity. American system encourages individualism inside companies, although conflicts started between individual objectives and the objectives of the organization. Within the American management system, employees have clearly defined the difference between official and unofficial people. If an employee has a qualification, he will be employed by a company without any conditions.

Max Weber invented the concept of bureaucracy, where major, rationality, professionalism, impersonality, autonomy and stability are fundamental principles and this concept still remains predominant in the American management system (Weber, 1904).

Even if money is not a main motivating factor of both employer and employee it must be admitted that they are one of the most important elements of the American leadership. The prestige and social status of an employee are influenced largely by income, as the prestige of corporation leaders is measured in their compensatory packages.

The American system of management has successfully promoted the reward systems for effective performance promotion (Ouchi, 1993). Under this system inter-organizational mobility is encouraged. Unlike the Asian systems, if a manager remains in an organization until retirement he might not be rated as being an efficient and capable leader. Throughout his career, an employee is encouraged to experience inter-organizational mobility for five or six times.

Seniority is not as appreciated in the U.S. system as inside the Asian systems, that because the remuneration of the beginners shall be decided by market, not by the company's remuneration policy. An entry-level employee may earn as much as senior members, whose earnings increases with only a few percent each year for 10 or 20 years after salary packages were agreed upon (Chang Chan, Chang Nahn Joo, 1994). Also, if a beginner employee makes a significant contribution to organization betterment, compensations will be rewarding irrespective of seniority.

Work ethic of American employees and managers is based on Protestant principles, according to which the hard work is considered the greatest virtue and it is assimilated to Judaeo - Christian doctrines. Americans consider that their successes are normal outcomes of their work (Weber, 1904).

Even if they face several social responsibilities, getting profit remains the greatest responsibility of the managers of the American corporations. Even if one normally might declare that this principle does not apply to non-profit organizations, one must admit that their managers must generate enough profit to go on with offering services to customers.

Inside the profit-oriented organizations, managers explicitly show the importance of being profitable while Japanese counterparts refrain from mentioning openly the need of getting profit. In the last decades Korean management has undergone rapid change, the inflexible traditional structure being affected, but with a present tendency toward decentralization and improving horizontal cooperation.

The Korean vision of the universe and the social relationships have influenced by the indigenous shamanistic religion and also by China's religion and philosophical traditions (Kim, 2005). That is why the Buddhism, Confucianism and Taoism have played important roles in the formation of Korean culture and the foundation of social relationships. Confucianism is the current that most strongly influenced Korean culture. In a typical Korean community, the concept of "neighborhood" was limited to the nearest village. This has led to the development of a closed community and directly proportional to strengthening intra-communitarian relations. Confucianism regards each individual as a member of a group, not as an independent and autonomous human being. That is why, common agrarian society under the influence of Confucianism has developed a cooperative spirit and social organization such as "doore" (cooperative groups of farmers), "kye" (association for mutual assistance) and "hyangyak" (village code) (Song, Meek, 1998).

In a collective society, progress is obtained through the joint efforts of the group. Skilful individual as well as the aggressive ones, who do subordinate to collective interests, cannot be accepted because they disturb the harmony of the group, and they are considered as *paria*. Collectivist perceptions are noticeable even nowadays within the Korean society and implicitly within an organization. The personal pronoun "I" and the possessive pronoun "my", turn into "us" and "our". If an individual uses the pronoun "I" instead of the plural "we" he will be considered

self-centered and selfish. Confucianism does not see the individuals as independent beings with equal abilities. In the light of Confucianism, all human relationships are vertical.

That is why the company and its bodies require the betters to be moral and the inferiors to be obedient and loyal. It is from here that the employees' loyalty towards the company comes from.

The company, its management implicitly protects the worker who is subject in the frame of employment relationship and who will be loyal to the company for the rest of his life. Even the forms of address in Korean reflect the social status of interlocutors, the language having particular suffixes for each class and hierarchical level. In the traditional Korean social structure, family members were asked to follow their patriarchs and masses were bound to follow nobility to complete the relations between them (Kleining, 1983).

This entailed great authoritarianism and patriarhism and the company' members will accept ideas and principles of the people positioned on top of hierarchy without much criticism, because they truly believe that their superiors or seniors are wise and omniscience.

Many Korean companies, especially those highly developed, are run as families are, with strong authority, the decision power and responsibility being concentrated in the hands of top management while the rest is delegated in a pyramidal way, from top to bottom.

The authoritarian leadership style imprinted by the Confucian ideal of hierarchical order is not necessarily despotic. That's because there is also a strong devotion towards harmony between people of different ranks, derived from the Confucian ideals of loyalty towards parents, elders and authoritative figures.

Managers have an obligation to care for the needs of employees in professional and personal life, and employees are obliged towards the elders, towards their seniority and experience (Yang, 2006). When corporate companies were observed, they noticed the importance of their symbols which include corporate values and beliefs.

Organizational symbols, such as the *company motto and songs* identify the ideals towards which the company aspires and their main role is to evoke collective feelings (Alvesson, 1991). In particular, the values and beliefs of management delimit organizational actions and serve as a motivating force when they are shared. As for understanding the behaviour of an individual one needs to understand his personal values and beliefs, in order to understand an organization's behaviour of must know the values and beliefs of management of that organization. A company's motto and song a does not necessarily reflect only its values and beliefs, but one should also understand their motivating role inside the company whose representation they are.

To understand the significance of these elements an insight into the history of the company's motto (*sahoon*) is necessary. As most Korean companies have a *sahoon*, most Korean families have a *kahoon*. This term refers to teachings to be transmitted to family members and their descendants concerning social attitudes, appropriate behaviour, and proper management of the house, distinguishes good from evil for complete harmony in family and society. There is also a traditional element to be transmitted from generation to generation. In other words, *kahoon* is a traditional concept by which a healthy, harmonious environment inside a family is settled (Song, Meek, 1998).

Following the example of the traditional family, the company, regarded as the extension of a family, has a *sahoon* and a *sap-oong* (literally - the company's tradition), which is similar to the concept of organizational culture. For example, a managing director of a company indicated as the "*kap-oong*" of the company's founder or president, has a very important role in shaping the corporate culture, especially in companies that are family businesses (Song, Meek, 1998). For marriage, even in today's Korean families, family history is a critical factor in the choice of a husband as it relates to "*kap-oong*" (culture implemented in that particular family). Many Koreans still believe that "*kap-oong*" plays a strong role in shaping the character of an individual.

Since the majority of Korean corporations are family businesses, one can assume the relationship existing between '*kap-oong*' and corporate culture. To understand the way in which national culture is reflected within Korean firms, it is also necessary to study managerial values presented in mottos and slogans. Of course, a company's motto does not always reflect a strict corporate culture in daily practices. That's because "*sahoons*" can indicate only the ideals of the

management founder. As the Patriarchs used "*kahoon*" to instruct their family members and descendants, so the company founders use "*sahoon*" to guide their company and employees.

"*Sahoon*" is assimilated to motto in Western companies and it is similar to fundamental values (*core values*) or commitments in American companies. As a rule, the "*sahoon*" of a company reflects the personal values and commitments of the founder of top management functioning as guiding line for company and employees. It is also an important instrument in the formation of character and attitude in the period of new employees' socialization during training programs as well as throughout their career within the organization. In contrast to Western companies, which tend to concentrate on the technical and practical aspects of the job, trainings for new peers or co-workers are focused, in a Korean company, on the managerial values and ideals, aiming to turn them into "*their man*" (i.e. Daewoo man, Samsung man) (Alvesson, 1991).

"*Sahoon*" usually contains a few words or a short phrase with an emotional charge enough to inspire employees to devote every effort for the good of the company, to make them proud that they are part of the company. Harmony and unity, sincerity and diligence, creativity and development are the values most commonly used in corporate mottos. In order to maintain a good interpersonal relationship and build fruitful inter-social relationship trust (*shin* in Korean) is essential. Through "*sahoon*" the values and beliefs of management are articulated, which corresponds to the fundamental values of harmony and unity, vertical community and social relations.

The Great Korean corporations also tend to have their own song "*saga*", although many small and medium enterprises lack one. Like the company motto its song appears on company brochures, training texts and journals.

This is sung in the morning, before starting work, at monthly conferences, social meetings or at the company's anniversaries in order to bring unity and harmony within the company (Deal, Kennedy, 2000). As the case stands with "*sahoon*" the Korean values and principles that consist of core values of community, unity and harmony are expressed through song. In general, Korean employees are motivated by extrinsic factors such as working conditions, job security and salary, but they are well-known for enduring many hours of extra work just because of the strong work ethic and sense of duty towards the company.

The typical Korean companies' employees can be divided into three categories: fundamentals, permanent employees and temporary employees. Salaries are generally based on seniority but bonuses are often based on performance. The decisions for promotion typically involve top management. Because an employee's loyalty is directed to an individual, they often change position with his superior. Even if influenced by Confucianism, at present managers have tried to improve their relations with subordinates overlooking rigor to maintain a harmonious workplace.

After the Korean War Armistice in 1953, the main objectives to be fulfilled by Koreans, ordinary citizens and leaders, was not only to rebuild economy shaken by the war, but to create institutions to encourage the development of a strong, self-sustaining and internationally competitive economy (Patterson, 2002). This was possible through a development of the economic structure where the State controlled the access to financial resources, which were unequal distributed towards Korea's industrial conglomerates, called *chaebol*.

The Korean term can be translated as "business group" or "trust". The Korean entrepreneurial class, relatively low, encouraged by decades of Japanese occupation as well as by the presence of a large number of farmers, less educated in terms of industrialization found *chaebols* the best way to development (Patterson, 2002). *Chaebol* had the opportunity to develop due to the following factors: foreign loans and special favors. Also, the access to foreign technology was a catalyst in their development over the 1980s. Under the name of "guided capitalism", the government has selected companies that could subcontract projects and receive funding from foreign loans. Government guarantee if a company failed to pay the loan for this, thus, making available loans from domestic banks, if a company failed to pay the loan. Towards the end of 80s, corporate companies dominated industrial sector and were very well represented in production, trade and heavy industry.

The great development of the corporations which began in the 60s was connected to the development of South Korea's exports. This development resulted from production and export of a diversified range of goods in exchange for a basic product (Gongol, 2001). Innovation was a critical factor in the development of new production lines. Thus, the early '60s corporations were oriented to textiles manufacture, starting with the 70s and 80s heavy industry, defence and chemical industry become prevalent.

These continued their supremacy until the 90s, when they were dethroned by the electronics and high technology industry (Patterson, 2002). Corporations continued their extraordinary development on export markets in the 80s. In the 90s they begun to produce for domestic market, so as to become financially independent, eliminate the need for governmental support and assistance for foreign loans.

After the Asian crisis in 1997, there started the strong chaebols reform. Korean corporations characterized by absolute concentration of power in the hands of the members of founder's family as well as the diversified business structures were considered the main pawns of the Asian crisis (Lee, 2000). Reforms were initiated by destruction of the traditional features of corporations and building an Anglo-American system of corporations' governance.

The plan initiated by government initially pursued (Yanagimachi, 2004):

- to draw attention to corporate managers upon performance management;
- to improve management transparency;
- to improve the financial health of the Korean economy;
- focus on core business;
- elimination of guaranteed loans between subsidiaries of a corporation.

These guidelines were joined in August 1999 as follows:

- prohibiting financial domination by industrial capital;
- suppressing circular investment and disadvantageous transactions between subsidiaries of corporations;
- prevention of providing facilities and gifts to corporate heirs.

All these eight principles of the reform were the foundation of corporations restructuring. Through their instrumentality the corporations' management, financial transparency and financial stability were considerably improved.

For example, the obligation to appoint directors from outside the structure was instituted for large corporations and since 2001 this obligation was imposed to the subsidiaries of large corporations, too. However, the most important issue was whether these outside directors had the power to monitor the absolute control of corporate directors. The system of imposition external director was just a first step. The rapid growth of foreign investors became one of the most important problems after the Asian crisis. Qualifications and rules pertaining to the outside directors were very strict so that in all important branches of the corporations it was mandatory to create a committee to recommend a position of external director (Yanagimachi, 2004). Changes brought by government reforms caused many chaebols to disappear, partly due to the lack of global competitiveness. Chaebols are powerful independent entities which act in economics and politics, which cooperate with Government in areas such as scheduling and innovation.

To defend the right to leadership became a serious issue for Korean corporations and it seems very difficult for an Anglo-American management to infiltrate the Korean economy, strongly characterized by the lack of equitable division of shares between stockholders (Yanagimachi, 2004).

## **Conclusion**

However, after the Asian crisis, the influence of foreign capital in the Korean economy grew significantly. The presence of foreign capital had a decisive influence upon the development of the Korean economy (Lee, 2000). Several explanations were given for what was called the "Asian miracle" and as a result, it is difficult to structure all these solutions in a precise way.

Despite the multitude of explanations, we can say that the answer to the rapid industrialization of the East Asian countries is the unique way in which they adapted differently to western invasion, to Western model of development. Sundry factors are assumed to have



influenced this unique way of development, but the most important seems to be the strong state involvement in the processes of industrialization and economic development, due to the nationalist desire to catch up and even exceed other nations in developed of the world.

In the process of developing different policies were applied by Asian countries and because of the fact that these countries had experimented rapid economic growth in the post-war period, their evaluation was universally positive. Positive evaluations of these countries pointed out that they have entailed a unique approach of management in the development process - the so-called "Asian Model".

This approach was the subject of much debate between 80s and 90s, and they even talked about the *school of Asian management* concept (Chang Chan, Chang Nahn Joo, 1994). However, there are joint components of these countries in the development process that had a decisive impact on economy. Among these there are the worker - management relations, especially long-term employment (lifetime employment) and the involvement of as many employees in decision-making in the company as well as other components that relate directly to the manufacturing process, such as quality control and inventory management at the last moment (just-in-time inventory management).

In addition to these traits there can be identified others related to the Asian style of management, such as the fact that Asian managers tend to be specialized in technical sciences and engineering, unlike those of Western firms (Hattori, 1997). There are many characteristics which describe this unique behaviour of Asian companies, but the most important are related to the corporate profitability and management from the perspective of time. Many treaties tackle the fact that Asiatic management allows managers to focus on long term objectives such as: the increase of stock shares and of value on market, while American firms manager focus on short term objectives: increasing profit. The reason for this difference seems to be the different structure of the two typologies of firms as well as the employees' different style of work.

Asian companies have a tendency to increase employees' loyalty as members of their community dedicate their life to the firm, thus allowing management to make forecasts and schedule on long term. On the other hand, Western companies treats employees as resources that can be replaced at any time, thus discouraging long-term loyalty to the firm and forcing managers to establish and achieve short term goals. These characteristics were considered the basis of the process of Asian countries economic renaissance.

Without being a general conclusion, Korean management is rooted in the Asian type, being not necessarily implemented in schools and courses, but originating in the Asian culture of Confucianism, of the hierarchy and respect for the elderly and the wise (Song, Meek, 1998).

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## EXCHANGE RATE PASS-THROUGH TO DOMESTIC PRICES UNDER DIFFERENT EXCHANGE RATE REGIMES

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### **Abstract:**

*Responsiveness of exchange rates to external price shocks as well as their ability to serve as a traditional vehicle for a transmission of these shocks to domestic prices is affected by exchange rate arrangement adopted by monetary authorities. As a result, exchange rate volatility determines the overall dynamics of pass-through effects and associated absorption capability of exchange rate. Ability of exchange rates to transmit external (price) shocks to the national economy represents one of the most discussed areas relating to the current stage of the monetary integration in the European single market. The problem is even more crucial when examining crisis related redistributive effects.*

*In the paper we analyze exchange rate pass-through to domestic prices in the European transition economies. We estimate VAR model to investigate (1) responsiveness of exchange rate to the exogenous price shock to examine the dynamics (volatility) in the exchange rate leading path followed by the unexpected oil price shock and (2) effects of the unexpected exchange rate shift to domestic price indexes to examine its distribution along the internal pricing chain. To provide more rigorous insight into the problem of exchange rate pass-through to the domestic prices in countries with different exchange rate arrangements we estimate models for two subsequent periods 2000-2007 and 2000-2012. Our results suggest that there are different patterns of exchange rate pass-through to domestic prices according to the baseline period as well as the exchange rate regime diversity.*

**Keywords:** exchange rate pass-through, inflation, Cholesky decomposition, impulse-response function

**JEL Classification:** C32, E31, F41

### **1. Introduction**

Ability of the exchange rate to transfer external shocks to the national economy remains one of the most discussed areas relating to the current stage of the monetary integration process in the European single market. New European Union (EU) member countries that accepted the obligation to adopt euro have to consider many positive and negative aspects of the euro adoption especially in the view of time they need for the implementation of all necessary actions to be ready to give up their monetary sovereignty. We do not want to speculate about the approximate date of the future European Monetary Union (EMU) enlargement especially due to increased uncertainty of the economy agents in the time of the global financial and economic crisis that also worsen the macroeconomic stability in the EMU candidate countries as well as their ability to meet the Maastricht convergence criteria. On the other hand it is still convenient to analyze the wide spectrum of effects related to giving up the relative flexibility of the national exchange rates after the euro adoption. While the exchange rates of majority of the EMU candidate countries are strongly affected by the euro exchange rate development on the international markets there is still room for them to float partially reflecting changes in the domestic economic development.

Among many of impulses that the exchange rate transmits from the external environment to the national economy we highlight the price effects of changes in the foreign import prices on the domestic price indexes. The degree of exchange rate pass-through to the domestic prices emphasizes its role as the external price shocks absorber especially in the situation when the exchange rate development is less vulnerable to changes in the foreign nominal variables.

In the paper we analyse exchange rate pass-through to domestic prices in the European transition economies. Approach we employed consists of two stages. In the first stage we investigate the responsiveness of exchange rate to the exogenous price shock to examine the dynamics (volatility) in the exchange rate leading path followed by the unexpected oil price shock. By doing so we investigate a capability of exchange rate to transmit or absorb the external inflation pressure to domestic prices. In the second stage we investigate effects of the unexpected exchange rate shift to domestic price indexes to examine its distribution along the internal pricing chain. Our results contribute to understand the key features of the exchange rate transmission of the external

price shifts based inflation pressures across different domestic price measures. We estimate vector autoregression (VAR) model. True shocks are identified by the Cholesky decomposition of innovations. From employed VAR model we estimate (1) responses of exchange rates in each individual country to the positive one standard deviation oil price shock and (2) responses of different domestic price indexes to the positive one standard deviation exchange rate shock. To provide more rigorous insight into the problem of exchange rate pass-through to the domestic prices in countries with different exchange rate arrangements 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 be helpful to examine specific features of external inflation pressures transmission to the domestic prices according to the differences in the exchange rate commitments of monetary authorities. We suggest that comparison of results for models with different time period is crucial to understand spurious effects of the economic crisis in both exchange rate responsiveness to the external price shocks as well as pass-through effects to different domestic price measures.

Following the introduction, in Section 2 we provide brief overview of exchange rate pass-through effect. The topic is then discussed from the prospective of the fixed versus flexible exchange rate dilemma to highlight its specific features under fixed and flexible exchange rate arrangements. In Section 3 we provide an overview of the exchange rate regime evolution in the European transition economies during the period of last two decades. In Section 4 we summarize the current empirical evidence about exchange rate pass-through. While the empirical evidence about exchange rate pass-through seems to be reach, comparison of relevant studies provides results for individual countries or group of countries that we can conventionally divide in three groups - advanced, advancing and emerging markets. However, recent studies provide mixed results according to the exchange rate regimes as a crucial initial assumption or are not even taken into the account. In Section 5 we provide a brief overview of the VAR model (recursive Cholesky decomposition is applied to identify structural shocks) that we employ to examine exchange rate pass-through to domestic prices in two stages. In Section 6 we discuss main results.

## **2. Exchange rate pass-through under different exchange rate arrangements**

Responsiveness of exchange rates to external price shocks as well as their ability to serve as a traditional vehicle for a transmission of these shocks to domestic prices is affected by exchange rate arrangement adopted by monetary authorities. As a result, exchange rate volatility determines the overall dynamics of pass-through effects to domestic prices and associated absorption capability of exchange rate. Ability of exchange rates to transmit external (price) shocks to the national economy represents one of the most discussed areas relating to the current stage of the monetary integration in the European single market. The problem is even more crucial when examining crisis related redistributive effects associated with relative price changes.

Effects of the exchange rate volatility on inflation, as a part of the fixed versus flexible exchange rates dilemma, refer to relative changes in prices of exports and imports and associated price effects on the aggregate price level. Under fixed exchange rate arrangement, credible nominal anchor (i.e. sound foreign currency of a country with a low and stable inflation) provides very efficient tool in fighting high inflation while helping to stabilize inflation expectations. As a result, country with fixed exchange rate should experience successful periods of disinflation (provided that a decision to adopt fixed exchange rate originated from high inflation pressures). Ability of the country to achieve price stability (and maintain low inflation differentials) within a reasonable period of time seems to be crucial for fixed exchange rate sustainability. It seems that stable inflation expectations anchored by fixed exchange rate to credible foreign currency represent a crucial role for understanding price effects of the sudden exchange rate shifts. Exchange rate volatility under fixed exchange rate arrangement originated in anchoring foreign currency instability may cause domestic price level to adjust accordingly in the short period, though persisting inflation or disinflation pressures are not expected. It is especially due to positive effects of stable inflation expectations that (we suggest) do not seem to be affected for longer period.

On the other hand, price stability in countries with flexible exchange rate arrangement obviously suffers even more in the short period due to absence of credible nominal anchor

provided that the monetary policy strategy of the central bank is based on either inflation targeting or interest rate transmission channel. Low levels of inflation targeted by the monetary authority are obviously more sensitive to exogenous price shocks originated in the sudden and unexpected exchange rate shifts. Price effects of exchange rate volatility in countries with flexible exchange rate arrangements may be even strengthened by corresponding effects of real output or its components to unexpected movements of exchange rate on domestic price level as a part of the exchange rate adjustment process. As a result, exchange rate fluctuations in countries with flexible exchange rate arrangements are usually associated with more intensive a durable adjustment in price level.

Quite specific seems to be a situation in countries with fixed exchange rate arrangement and anchoring currency that serves as a local or global currency widely used in foreign transactions. Price effects of volatility in reference currency leading path may be reduced provided that a large number of trading partners are also fixing their exchange rate against same reference currency (membership of countries in currency union with our reference currency as common currency seems to have the same effect). Even when the large portion of foreign transactions in country with fixed exchange rate against such anchoring currency were immune to the reference currency volatility, remaining transactions are still exposed to the reference currency exchange rate unexpected shifts. On the other hand, real exchange rate sudden shifts are not exclusively caused by the nominal exchange rate volatility. Increased intensity of price adjustments associated with crisis related effects on real output are usually followed by accelerated deviations of real exchange rates from their equilibrium leading path especially in the short period.

Effects of exchange rate volatility on the price level in countries with different exchange rate regime may be even strengthened during the crisis period. Excessive price adjustments due to uncertainty and lower predictability of the exchange rate leading path under flexible exchange rate arrangement, regardless of the sources and intensity of exchange rate instability, reflects the absence of a nominal anchor to stabilize inflation expectations. At the same time, inflation expectations anchored by the credible foreign currency, provides more fundamentally appropriate framework to preserve and sustain price stability.

Exchange rate flexibility (i.e. exchange rate depreciation as a result of economic growth cool down) serves as a convenient vehicle for exchange rate based recovery (i.e. automatic adjustment process) through increased competitiveness of domestic production on markets home and abroad provided there are flexible adjustments to price incentives on the markets. On the other hand, exchange rates shifts (under fixed exchange rate regime) associated with volatility of main reference currency serving as the nominal anchor are usually not originated by changes in domestic economy (i.e. real output fluctuations during the business cycle turnovers in country with fixed exchange rate) and thus may act as unexpected and destabilizing shock reducing its price effects on demand. As a result we suggest that the exchange rate downward flexibility may provide wide range of incentives stimulating overall demand and thus accelerate economic growth in the recession. Exchange rate rigidity under fixed exchange rate arrangement may stabilize exchange rate expectations with positive contributions to the overall macroeconomic stability. Sudden shifts in exchange rate of the reference currency may cause a fixed exchange rate of domestic currency to become volatile. Moreover, exchange rate based adjustments of real output will not work provided that price incentives may be associated with false signals and spurious effects on expected short-term exchange rate leading path.

### **3. Overview of exchange rate regime evolution in the European transition economies**

Macroeconomic stability, fast recovery from deep and sudden transition shock and real output growth stimulation represents one of the most challenging objectives for the European transition economies in the early 1990s. Consistent choice as well as flexible adjustments of monetary policy framework and exchange rate regime accompanied key crucial economic policy decisions in this process. Associated changes in monetary-policy strategy reflected wide range of macroeconomic aspects underlying sustainability of appropriate exchange rate regime choice.

Among key determinants of the exchange rate regime choice in the European transition economies at the beginning of the 1990s we may consider an effort to regain macroeconomic

stability, foreign exchange reserves requirements and availability, overall external economic (trade and financial) openness, etc. At the later stages of transition process we emphasize the role of massive foreign capital inflows, sustainability of real economic growth, institutional adjustments according to perspectives of ERM2 entry.

Initial transition shock followed by the sharp real output decline associated with intensive inflation pressures (caused by rapid exchange rate devaluations, price liberalization and deregulation, tax reforms, fiscal imbalances, etc.) emphasized a crucial importance of strong nominal anchor for monetary authorities in restoring a macroeconomic stability and confidence as well as positive expectations of economic agents. However immediate exchange rate based stabilization became an appropriate strategy only for countries with adequate foreign exchange reserves while being able to significantly reduce inflation pressures in adequate (short) time period to prevent undesired rapid overvaluation. As a result it seems to be convenient to divide the European transition economies in two groups (so called “peggers” and “floaters”) considering initial exchange rate regime framework.

Relative diversity in exchange rate regimes in the European transition economies revealed uncertain and spurious conclusions about the exchange rate regime choice during last two decades. Moreover, Eurozone membership perspective (de jure pegging to euro) realizes uncertain consequences of exchange rate regime switching especially in the group of large “floaters”.

Successful anti-inflationary policy associated with stabilization of inflation expectations in the European transition economies at the end of 1990s significantly increased the role of short-term interest rates in the monetary policy strategies. At the same time, so called qualitative approach to the monetary policy decision-making performed in the low inflation environment, gradually enhanced the role of real interest rates expectations in the process of nominal interest rates determination. However, economic crisis increased uncertainty on the markets and thus worsen expectations (inflation expectations including) of agents.

Eurozone member countries as well as global economy are currently exposed to the negative effects of the economic and debt crisis. To alleviate recession and support economic recovery, monetary authorities dramatically reduced key interest rates. Low interest rates together with quantitative easing, however, should not necessarily increase supply of loans due to prudential credit policy of commercial banks reflecting increased uncertainty on the markets. As a result, policy of low interest rates seems to be inefficient.

Exchange rate policy evolution represents one of the key parts of crucial economic policy decisions at the beginning of the transition process in countries from the region of Central and Eastern Europe in the early 1990s. Despite its complexity and particularity there seems to be some similar features at the starting point of transition process in all European transition economies such as recession followed by initial transition shock and common vision of European union and Economic and Monetary union membership.

Macroeconomic stability as one of the primary objectives in the initial phase of the transition process affected exchange rate regime choice in the European transition economies. However, low credibility of monetary institutions, lack of foreign exchange reserves and high inflation differentials represented real constraints and difficulties related to the sustainability of pegged exchange rate regimes. Brief overview of the exchange rate regimes evolution in the European transition economies provides Table 1.

It seems to be clear that the European transition economies did not follow common practice in the process of the exchange rate regime choice at the beginning of the 1990s. Small Baltic countries adopted currency board regime (Estonia and Lithuania) eventually conventional fixed peg regime (Latvia). Hungary adopted crawling peg regime (after few years of adjustable peg in place) together with Poland. Czech Republic and Slovak Republic adopted pegged regime with horizontal bands. Despite high inflation rates Bulgaria, Romania and Slovenia adopted floating exchange rate regime due to low level of reserves and lack of credibility though Bulgaria switched to currency board after 1996-97 financial crisis. It seems to be clear that most of the European transition economies enjoyed disinflationary and credibility benefits of so called hard or soft exchange rate regimes. Fixed exchange rates as the nominal anchor significantly contributed to the successful disinflationary process at the end of the 1990s.

**Table 1.** Exchange Rate Regimes in the European Transition Economies

	exchange rate regime																							
<b>Bulgaria</b>		managed floating					currency board																	
<b>Czech Republic</b>	peg with horizontal bands					managed floating																		
<b>Estonia</b>		currency board					ERM2			Eurozone														
<b>Hungary</b>	adjustable peg			crawling peg			peg with horizontal bands				managed floating													
<b>Latvia</b>		floating	conventional fixed peg					ERM2																
<b>Lithuania</b>		floating	currency board					ERM2																
<b>Poland</b>		crawling peg					free floating																	
<b>Romania</b>	free floating					managed floating																		
<b>Slovak Republic</b>	peg with horizontal bands					managed floating				ERM2		Eurozone												
<b>Slovenia</b>		managed floating					crawling band		ERM2		Eurozone													
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013

*Note:* Exchange rate regime evolution in the European transition economies: Bulgaria - since 1991 floating (pegged exchange rate regime undesirable due to possible low credibility), currency board since 1997 (after 1996-1997 financial crisis (public debt, bad commercial banks loans)). Czech Republic - exchange rate pegged to currency basket with narrow but continuously widen horizontal bands, since May 1997 after currency attacks switch to managed floating with no predetermined path for the exchange rate with DEM (EUR) as reference currency. Estonia - currency board since 1992 till 2011 (euro adoption), plan to adopt in 2008 but delayed due high inflation, since 2011 Eurozone membership. Hungary - managed floating till February 1995, since March 1995 till the end of 1999 crawling peg with continuously decreased rate of periodical devaluation and widen horizontal bands, since January 2000 exchange rate pegged to euro combined with wide horizontal bands (since May 2001), since May 2008 managed floating with EUR as reference currency. Latvia - since February 1994 exchange rate pegged to SDR (fixing the exchange rate to a basket of currencies (SDR) .

instead of a single currency serves to promote long-term stability) (since January 2005 pegged to EUR), since 2014 Eurozone membership. Lithuania - since April 1994 currency board (exchange rate pegged to USD, in February 2002 pegging switched to EUR). Poland - since the end of 1991 crawling peg with continuously decreased rate of periodical devaluation and widen horizontal bands, since April 2000 free floating. Romania - free floating, since 1998 exchange rate arrangement reclassified as managed floating. Slovak Republic - exchange rate pegged to currency basket with narrow but continuously widen horizontal bands, since October 1998 after currency attacks switch to managed floating with no predetermined path for the exchange rate with DEM (EUR) as reference currency, since 2009 Eurozone membership. Slovenia - managed floating with no predetermined path for the exchange rate (since February 2002 crawling band - the monetary authority manages the float of the domestic currency within certain fluctuating margins around a depreciating path - a heavily-managed crawling band with pragmatic monetary, real, external and financial indicators).

ERM2 - June 2004 - Estonia (left in January 2011 after euro adoption), Lithuania, Slovenia (left in January 2007 after euro adoption)

- May 2005 – Latvia (leaves in January 2014 after euro adoption)

- November 2005 - Slovak Republic (left in January 2009 after euro adoption)

Source: IMF AREAER 1990-2011, author's processing

Till the end of the decade many countries from the group switched to more flexible exchange rate regimes (Czech Republic in 1997, Slovak Republic in 1998 and Poland in 2000). Similarly Hungary switched to intermediate regime by widening horizontal bands. Although Hungary stacked to exchange rate pegged to euro, by employing wide horizontal bands de facto followed the same trend as previous group of countries.

Exchange rate regime choice also affected corresponding monetary policy strategy framework. Countries with exchange rate as nominal anchor (hard pegs or soft pegs with narrow horizontal bands) successfully implemented exchange rate targeting. Countries with soft pegs (pegs with wide horizontal bands or crawling pegs) and floating regimes employed monetary targets as intermediate criteria of monetary policy (monetary targeting).

Overall success of disinflationary process represents one of the key milestones on the road to stable macroeconomic environment with crucial role of low and stable inflation expectations. Low inflation combined with stable inflation expectations is considered to be a substantial condition for switching from quantitative (money supply) to qualitative (interest rates) approach in monetary policy decision-making. This adjustment in monetary policy strategies seems to be obvious in the European transition economies since the end of 1990s as a part of prevailing trend in weakening of relationship between money and inflation. Increased role of inflation expectations together with raising credibility of monetary authorities resulted in adoption of direct (explicit) inflation targeting strategy in many European transition economies - Czech Republic (1998), Poland (1999), Hungary (2001), Slovenia (2002), Romania (2005) and Slovak Republic (2005).

European transition economies challenged a decision of a euro adoption and Eurozone membership several years before the economic crisis arises. Disputable policy implications of sacrificing monetary sovereignty rose as a crucial assumption affecting main features as well as durability of preparation phase timetable in countries with flexible exchange rate regimes (Czech Republic, Poland, Romania, Slovak Republic and Slovenia). Among a variety of determinants and aspects we emphasize the role of decisions inevitably associated with “right” scheduling of the Eurozone entry. Some countries from the group of the European transition economies already joined the Eurozone (Estonia (2011), Slovak Republic (2009), Slovenia (2007)) followed by participation of their currencies in ERM2 (Estonia (June 2004), Slovak Republic (November 2005), Slovenia (June 2004)). On the other hand currencies of Lithuania and Latvia are still participating on ERM2 (Latvia's currency leaves in January 2014 after euro adoption).

The loss from sacrificing exchange rates flexibility in the Eurozone candidate countries became directly confronted with benefits related to exchange rate stability associated with sacrificing monetary autonomy. Despite plausible advantages of pegging exchange rates of candidate countries to euro followed by the euro adoption it seems to be clear that risks associated with potential effects of breakdown in mutual interconnections between macroeconomic



development and flexible exchange rates leading path seem to be of a minor interest in current empirical literature.

Economic theory provides clear suggestions in fixed versus flexible exchange rates dilemma in fighting high inflation pressures. At the same time exchange rate based enhancement of external competitiveness may provide a convenient framework to foster economic growth even when domestic economy is cooling down. On the other hand, incentives to increase external demand during the crisis period may start unfavourable spiral of competitive devaluations. Central banks and governments may tend to devalue currencies (internal devaluation) especially in times when low interest rates policy associated with quantitative easing doesn't provide correct and sufficient incentives to foster domestic demand. Internal devaluation causing real exchange rate to depreciate became highly discussed nowadays, in the time of economic and debt crisis in Eurozone, when inability of low performing economies to increase foreign competitiveness of their production forces authorities to experiment with internal devaluation considering all adjustments are made by prices, wages (and associated costs of production) and assets values falling.

#### **4. Overview of the literature**

Vulnerability of the exchange rates to the exogenous shocks came to the center of an academic discussion shortly after a break-down of a Bretton Woods system of fixed exchange rates at the beginning of the 1970s. Uncertainty on the foreign exchange markets together with higher volatility of exchange rates increased a sensitivity of domestic economies to the foreign partners' economic development as well as to the world leading economies' exchange rate movements. Exchange rate pass-through as the relationship between exchange rate movement and price adjustments of traded goods came to the center in academic and policy circles (Lian, 2007). Toshitaka (2006) estimated exchange rate pass-through of six major industrial countries using a time-varying parameter with stochastic volatility model. Author divided an analysis into impacts of exchange rate fluctuations to import prices and those of import price movements to consumer prices. Takatoshi *et al.* (2005) examined the pass-through effects of exchange rate changes on the domestic prices among the East Asian countries using the conventional pass-through equation and a VAR analysis. In order to identify the VAR model authors used a Cholesky decomposition to identify structural shocks and to examine the pass-through of the exchange rate shock to the domestic price inflation. They conclude that while the degree of exchange rate pass-through to import prices is quite high in the crisis-hit countries, the pass-through to CPI is generally low. Takatoshi and Kiyotaka (2006) estimated five and seven variable VAR model (including all three price variables to check the robustness and to investigate directly the pass-through effect across the prices.) in order to examine the pass-through effects of exchange rate changes on the domestic prices. Cortinhas (2007) also tested the sensitivity of results from the VAR models using several alternative ordering of the variables with mixed results. Ca' Zorzi *et al.* (2007) on the sample 12 emerging markets in Asia, Latin America, and Central and Eastern Europe investigated that exchange rate pass-through declines across the pricing chain, i.e. it is lower on consumer prices than on import prices. Choudhri and Hakura (2012) analysed exchange rate pass-through to import prices and export prices employing both regression- and VAR-based estimates considering local currency pricing and producer currency pricing assumptions. Authors suggest that exchange rate pass-through to import prices for a large number of countries is incomplete and larger than the pass-through to export prices. McCarthy (2007) investigated the impact of exchange rates and import prices on the domestic PPI and CPI in selected industrialized economies by employing VAR model. His Impulse-response analysis indicates that exchange rates have a modest effect on domestic price inflation while import prices have a stronger effect. He suggests that pass-through is larger in countries with a larger import share and more persistent exchange rates and import prices. Bussière and Peltonen (2008) estimated export and import price equations for a large number of countries. Their results indicate, inter alia, that exchange rate pass-through to import prices in advanced countries is falling over time indicating the increased role of emerging economies in the world economy. Campa, Goldberg and González-Mínguez (2005) analysed the transmission rates from exchange rates movements to import prices, across countries and product

categories, in the euro area during 1990s. Their results show that the transmission of exchange rate changes to import prices in the short run is high, although incomplete, and that it differs across industries and countries; in the long run, exchange rate pass-through is higher and close to one. Anderton (2003) employed both time series and panel estimation techniques to investigate exchange rate pass-through for euro. His results points to the relatively high degree of the pass-through changes in the effective exchange rate of the euro to the price of extra-euro area imports of manufacturers. Bergin and Feenstra (2007) studied how a rise in China's share of U.S. imports could lower pass-through of exchange rates to U.S. import prices. Barhoumi (2006) investigated exchange rate pass-through into import prices in a sample of 24 developing countries over the period from 1980 to 2003. His analysis revealed differences in exchange rate pass-through in his sample of developing countries explained by three macroeconomics determinants: exchange rate regimes, trade distortions and inflation regimes. Shambaugh (2008) examined the relationship between exchange rates and prices. He employed long-run restrictions VAR to identify shocks and explore the way domestic prices, import prices and exchange rates react to a variety of shocks. He suggests that consumer price pass-through is nearly complete in response to some shocks, but low in response to others. Alternatively, import prices and exchange rates typically respond in the same direction, and pass-through seems quick.

## 5. Econometric model

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  $\varepsilon_t$  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. However, restrictions based on the theoretical assumptions employed in both identifying schemes should be empirically tested to avoid shocks identification bias and imprecisions associated with endogenous variables responses to the shocks.

We employ a VAR methodology to investigate exchange rate pass-through to domestic prices in the European transition economies. Cholesky decomposition of variance-covariance matrix of reduced-form VAR residuals is implemented to examine responsiveness of (1) exchange rate to the unexpected oil price shock followed by (2) investigation of responses of different domestic price indexes to the unexpected exchange rate shock.

First stage in exchange rate pass-through reveals ability of exchange rate to absorb or accelerate the transmission of external price shock (positive one standard deviation oil price shock). The overall dynamics in the exchange rates response patterns provide crucial information about the exposure of exchange rate to the price related external shock in each particular country from the group. At the same time it reveals vital features of the exchange rate leading path toward pre-shock equilibrium and associated volatility patterns followed by the initial exogenous price shock.

Second stage in exchange rate pass-through highlights effects of the unexpected exchange rate shifts (positive one standard deviation exchange rate shock) on domestic price indexes and thus reveals the responsiveness of prices at different stages of the pricing chain (import prices, producer prices, consumer prices). At the same time it allows to investigate a distribution channel of the external price shock along the internal pricing chain. This approach is helpful for

understanding the responsiveness patterns of domestic price indexes following principles of the pricing chain mechanism across different price measures.

Examination of the two stage exchange rate pass-through employing a multivariate VAR for each individual country from the group of the European transition economies follows the side objective of the paper to investigate possible implications of different exchange rate arrangements on estimated results and thus to contribute to the fixed versus flexible exchange rates dilemma from the prospective of the transmission of the external inflation pressures to the domestic price inflation associated with the exchange rate conditional variability.

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

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

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,  $\varepsilon_t$  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):

$$E(\varepsilon_t) = 0, \quad E(\varepsilon_t\varepsilon_t') = \Sigma_\varepsilon = I, \quad E(\varepsilon_t\varepsilon_s') = [0] \quad \forall t \neq s \quad (2)$$

Vector  $X_t$  in our baseline model similar to those by Takatoshi and Liyotaka (2006) consists of five endogenous variables - oil prices ( $p_{oil,t}$ ), nominal exchange rate ( $er_{n,t}$ ), money supply ( $m_t$ ), real output ( $y_{r,t}$ ), domestic price index ( $p_t$ ). In the five-variable VAR model ( $X_t = [p_{oil,t}, er_{n,t}, m_t, y_{r,t}, p_t]$ ) we assume five exogenous shocks that contemporaneously affect endogenous variables - external (oil) price shock ( $\varepsilon_{y,t}$ ), nominal exchange rate shock ( $\varepsilon_{er_{n,t}}$ ), liquidity shock ( $\varepsilon_{m,t}$ ), demand shock ( $\varepsilon_{y_d,t}$ ) and internal price shock ( $\varepsilon_{er_{r,t}}$ ).

Structural exogenous shocks from equation (1) are not directly observable due to the complexity of information included in true form VAR residuals. As a result, structural shocks cannot be correctly identified. It is then necessary to transform true model into following reduced form

$$X_t = C(L)Y_{t-1} + e_t \quad (3)$$

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 (shocks in the reduced form can be contemporaneously correlated with each other):

$$E(e_t) = 0, \quad \Sigma_u = E(e_t e_t') = A_0 E(\varepsilon_t \varepsilon_t') A_0' = A_0 A_0', \quad E(e_t e_s') = [0] \quad \forall t \neq s \quad (4)$$

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

$$e_t = A_0 \varepsilon_t \quad (5)$$

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 the 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 (5) can be rewritten as follows:

$$\begin{bmatrix} e_{p_{oil},t} \\ e_{er_n,t} \\ e_{m,t} \\ e_{y_r,t} \\ e_{p,t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} \mathcal{E}_{p_{oil},t} \\ \mathcal{E}_{er_n,t} \\ \mathcal{E}_{m,t} \\ \mathcal{E}_{y_r,t} \\ \mathcal{E}_{p,t} \end{bmatrix} \quad (6)$$

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

- Oil prices do not contemporaneously respond to the shock from any other endogenous variable of the model.
- Exchange rate doesn't contemporaneously respond to liquidity, demand and internal price shocks, while it is contemporaneously affected only by the external price shock.
- Money supply doesn't contemporaneously respond to demand and internal price shocks, while it is contemporaneously affected by external price and exchange rate shocks.
- Real output doesn't contemporaneously respond to the internal price shock, while it is contemporaneously affected by external price, exchange rate and liquidity shocks.
- Domestic price index 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.

Ordering of variables is crucial not only for a correct identification of structural shocks but also to reveal a convenient transmission mechanism of the external price shock into the domestic price level as well as a suitable distribution chain of the price effect across various domestic price indexes. However, the overall accuracy and robustness of the empirical results may be tested by examining the effects of the changed ordering of endogenous variables to exchange rate pass-through to the domestic prices.

To investigate the pass-through effect of the exchange rate shock to domestic price indexes at particular stages of distribution we include three different types of domestic prices (import prices, producer prices, consumer prices). All three types of internal price indexes are included in one model to examine a distribution channel of the external price shock along the internal pricing chain. As a result, the equation (6) is rewritten as follows:

$$\begin{bmatrix} e_{p_{oil},t} \\ e_{er_n,t} \\ e_{m,t} \\ e_{y_r,t} \\ e_{p_{imp},t} \\ e_{p_{ppi},t} \\ e_{p_{cpi},t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{bmatrix} \begin{bmatrix} \mathcal{E}_{p_{oil},t} \\ \mathcal{E}_{er_n,t} \\ \mathcal{E}_{m,t} \\ \mathcal{E}_{y_r,t} \\ \mathcal{E}_{p_{imp},t} \\ \mathcal{E}_{p_{ppi},t} \\ \mathcal{E}_{p_{cpi},t} \end{bmatrix} \quad (7)$$

Following theoretical assumptions as well as empirical results we expect that the highest degree of exchange rate pass-through would be identified for import prices and lowest for consumer prices. We suggest that the initial effect of the external price shock will be reduced during its transmission along the internal price distribution channel.

Estimated VAR model is employed to compute impulse response functions to analyze (1) the responses of the exchange rate to the positive one standard deviation external (oil) price shock and (2) responses of particular internal price indexes to the positive one standard deviation exchange rate 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 and thus employing different identifying restrictions resulting from the recursive Cholesky decomposition of the reduced form VAR residuals:

- model A1, B1 ( $X_t = [p_{oil,t}, er_{n,t}, m_t, y_{r,t}, p_{imp,t}, p_{ppi,t}, p_{cpi,t}]$ )
- model A2, B2 ( $X_t = [p_{oil,t}, m_t, er_{n,t}, y_{r,t}, p_{imp,t}, p_{ppi,t}, p_{cpi,t}]$ )
- model A3, B3 ( $X_t = [p_{oil,t}, y_{r,t}, er_{n,t}, m_t, p_{imp,t}, p_{ppi,t}, p_{cpi,t}]$ )

Different ordering of variables enables us to examine exchange rate pass-through via alternative distribution channels of external inflation pressures transmission to the domestic prices assuming that different ordering of variables follows the economic logic of the chain of pricing and the structure of the economy. It also allows us to compare results with those of other studies. Additionally, if estimated results from the impulse-response analysis confirm the model is not very sensitive to the endogenous variables ordering than the Cholesky decomposition of the reduced-form VAR residuals with the initial ordering of variables provides significant and robust results.

Following the main objective of the paper we also estimate VAR models employing time series for two different periods (pre-crisis period - model A (2000M1-2007M12) and extended period - model B (2000M1-2012M12)) to examine effects of the crisis period on exchange rate pass-through to the different domestic price indexes in the European transition economies.

Investigation of the exchange rate responsiveness to the unexpected exogenous price shock in countries with different exchange rate arrangements (“peggers” versus “floaters”) reveals substantial implications of exchange rate anchoring as well as rigorous commitment of monetary authority to maintain fixed exchange rate according to the exchange rate external shock absorption capabilities. Limited exchange rate volatility thus clearly reduces exchange rate exposure to the external price shock while it clearly simplifies its transmission to the domestic prices. At the same time, external price shocks under flexible exchange rate arrangements should be followed by exchange rate appreciation. Exchange rate flexibility thus increases exchange rate exposure to the unexpected external shocks. Flexible adjustment in the exchange rate leading path thereby serves as shock absorber provided that it is associated with corresponding improvement (decrease) in the domestic price level and thus eliminates the negative effect of the external price shock. However, while the overall effect of the external price shock to the domestic prices may be neutralized, relative prices remain changed.

## 6. Data and results

To investigate exchange rate pass-through to domestic prices in the European transition economies we employed monthly data for period 2000M1-2007M12 (model A) consisting of 96 observations and for period 2000M1-2012M12 (model B) consisting of 156 observations for the following endogenous variables - oil prices, nominal exchange rate (nominal effective exchange rate), money supply (monetary aggregate M2), industrial production<sup>2</sup> (nominal volume of the industrial product deflated by averaged PPI) and inflation (index of import prices, producer price index and consumer price index) (Figure 1).

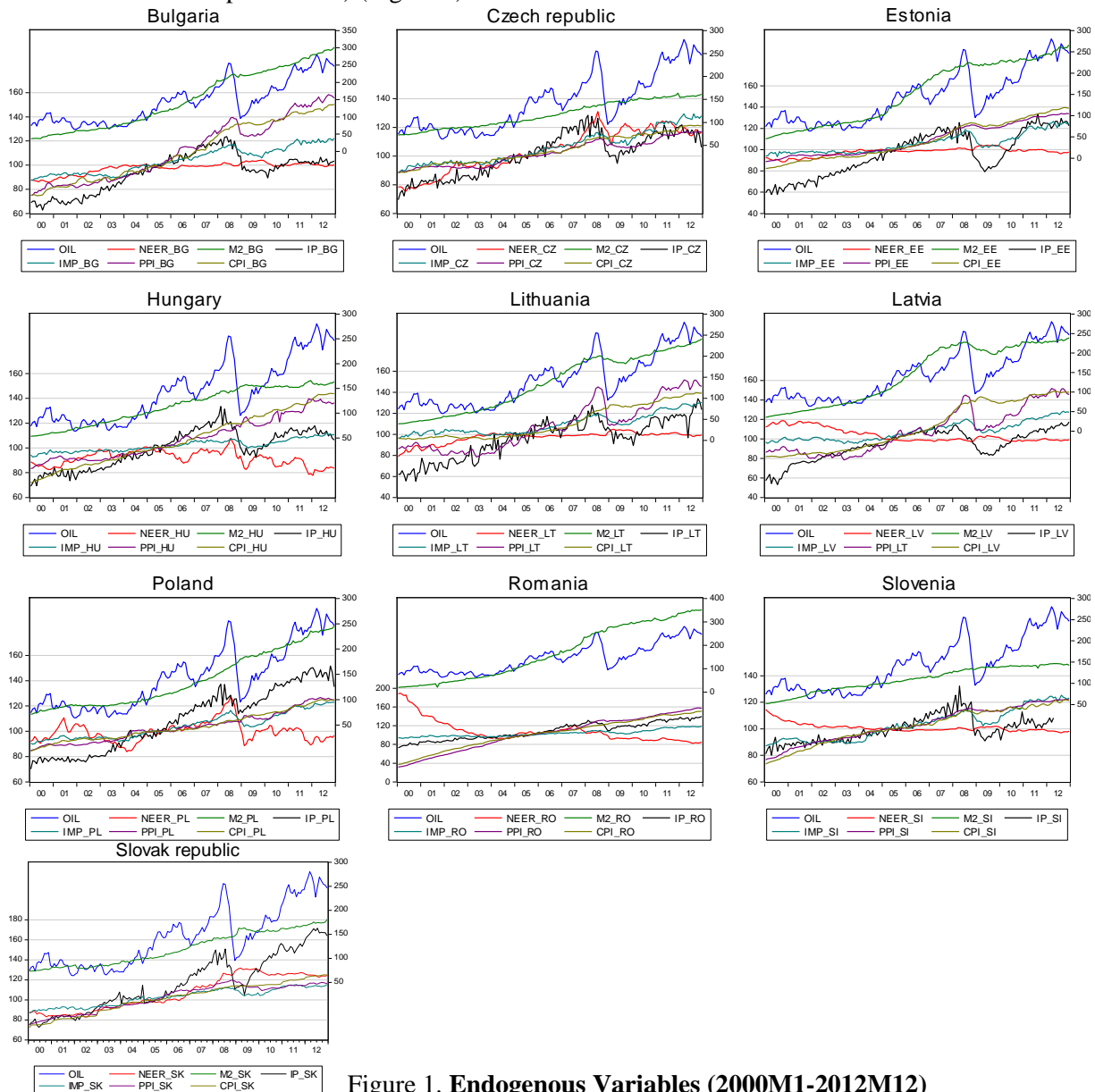


Figure 1. Endogenous Variables (2000M1-2012M12)

*Note:* Endogenous variables - nominal effective exchange rate (NEER), industrial production (IP), import prices (IMP), producer prices (PPI) and consumer prices (CPI) are expressed as indexes (left axis in figures) (2005 = 100). Oil price (OIL) and money supply (M2), are expressed as indexes (right axis in figures) (2005 = 100).

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

<sup>2</sup> Time series for monthly industrial production were employed due to absence of data on the same basis for real output (GDP).

## **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.

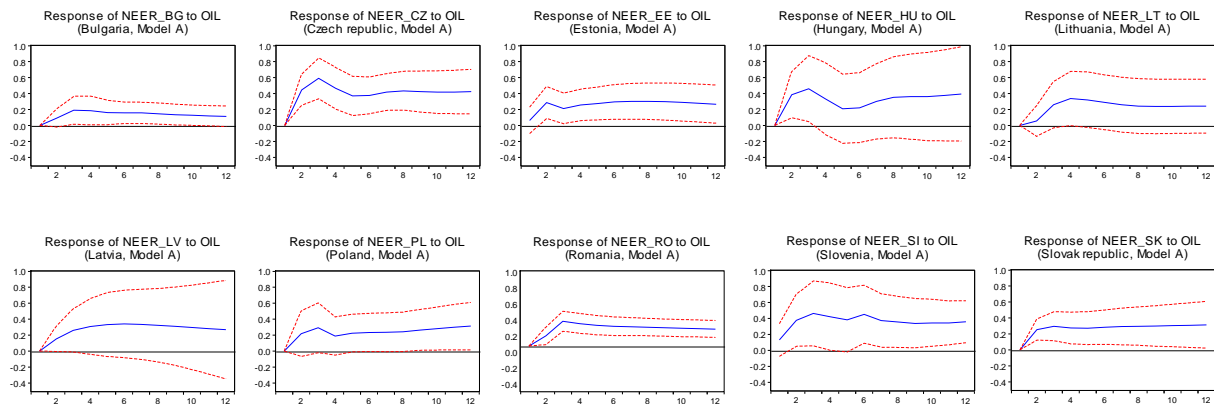
Following results of the unit root and cointegration tests we estimated the model using variables in first differences so that we can calculate impulse-response functions for all ten European transition economies. Following the main objective of the paper we focus on interpretation of responses of the (1) exchange rate to the positive one standard deviation oil price shock and (2) domestic price indexes (import prices, producer prices and consumer prices) to the positive one standard deviation exchange rate shock.

We also observe effects of the crisis period on the both exchange rate responses to oil price shock and domestic prices responses to the exchange rate shock in the European transition economies by comparing results for estimated models using time series for two different periods - model A (2000M1-2007M12) and model B (2000M1-2012M12). 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).

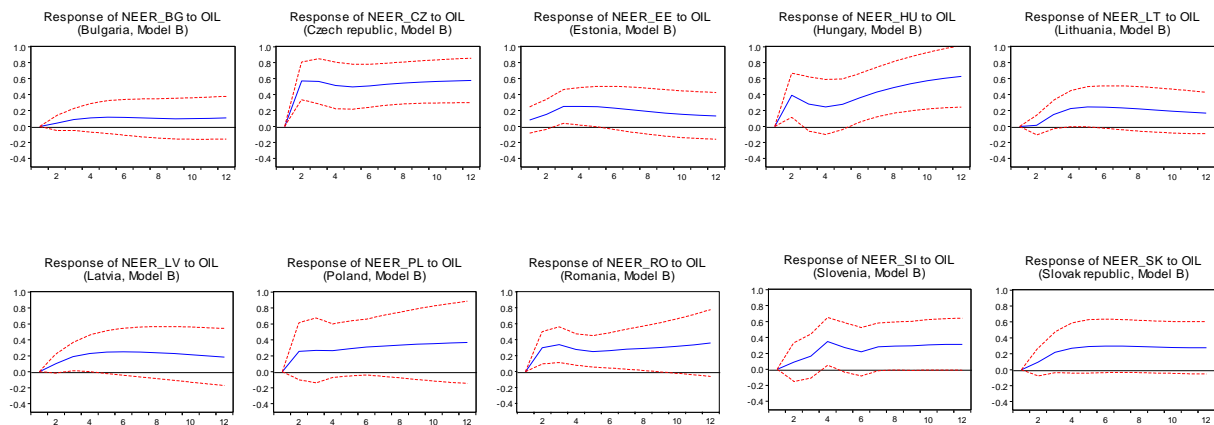
## **B. Impulse-response functions**

Investigation of the first stage in exchange rate pass-through includes estimation of exchange rates responses to the positive one standard deviation oil price shock employing monthly data for two subsequent periods 2000-2007 (model A) and 2000-2012 (model B). Results seem to be sensitive to the exchange rate arrangements diversity in individual countries.

**(Model A) (2000M1-2007M12)**



**(Model B) (2000M1-2012M12)**



**Figure 2.** Responses of Exchange Rates to Oil Price Shock

**Note:** Curves represent responses of exchange rates (NEER) to the positive one standard deviation oil price (OIL) shock in each country from the group of the European transition economies.  
**Source:** Author's calculation.

In the figure 2 we summarize results of impulse-response functions of the exchange rate to the positive (increase in) oil price shocks in both models in the European transition economies. Estimates of the exchange rate responsiveness to the Cholesky positive one standard deviation oil price shock revealed interesting implications of the exchange rate regime choice as well as particular role of the size of the economy in the model with time series for a pre-crisis period. Unexpected increase in the oil price was followed by the exchange rate appreciation in all countries from the group. However, we have observed different patterns in the exchange rate responsiveness among countries. Oil price shock caused a moderate and less dynamic increase in the exchange rate in countries (“peggers”) with rigid exchange rate regimes. Positive effect of the shock culminated within first four months and then steadily died out. As a result, an exchange rate increase seems to be just a temporary and the overall effect of the oil price shock is neutral in the long-run period (its effect died out completely till the end of the third year since the shock).

Responses of exchange rates in countries (“floaters”) with flexible exchange rate arrangements followed slightly different patterns. We observed more dynamic immediate response of exchange rates. Appreciation of exchange rates seems to be also more persisting over time. As a result, the overall dynamics of the exchange rate response leading path in countries from the group of “floaters” was generally higher. At the same time, the positive effect of the oil price shock seems to be persisting and thus permanent in the long run (however, we found no long-run cointegrating relationship between both variables).



Exchange rate responsiveness to the external price (oil) shock in countries with large and less opened economies (Poland and Romania) seems to be less dynamic in comparison with the rest of countries from the group of “floaters”.

Summary of results for exchange rate responses followed by the oil price shock in the model A revealed interesting implications of the exchange rate regime relevancy for examination of the first stage in exchange rate pass-through in the European transition economies. Our results confirmed expected lower vulnerability of exchange rates in countries with nominal exchange rate anchoring to the external price shocks.

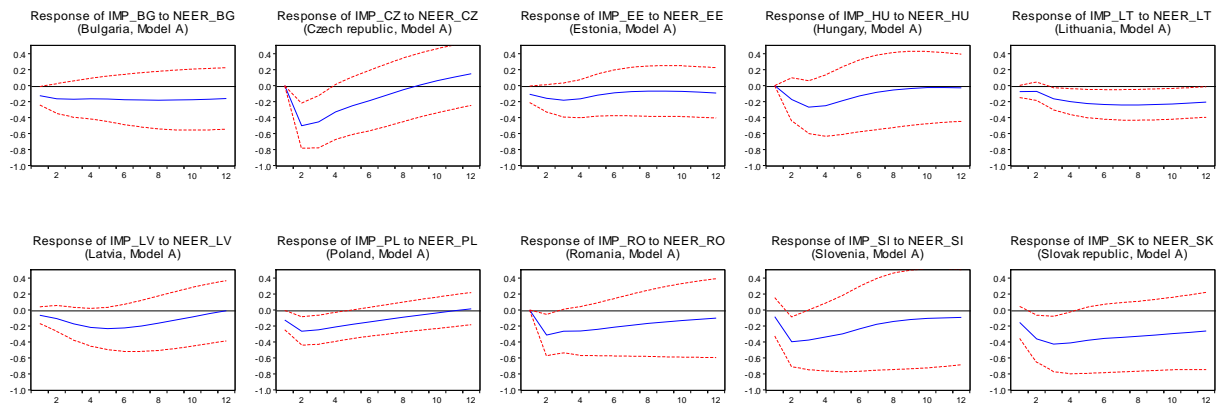
Lower exposure of the exchange rate to the oil price shock reduces its absorption capabilities. We expect that this feature of exchange rates will be crucial consideration in examining the second stage in exchange rate pass-through. Reduced exchange rate responsiveness to the external price shocks increases the transmission of the price effect to the domestic prices. As a result, exchange rates in countries with reduced exchange rate flexibility operate more as an external price shock transmitters. Imported inflation is clear implication of the exchange rate rigidity in such cases and it is also a contrary example to the traditional views emphasizing positive effects of the (fixed) exchange rate based stabilization economic policies. On the other hand, higher and durable responsiveness of exchange rates to the oil price shock in countries with flexible exchange rate arrangements reduces the transmission of the price effect to the domestic prices and thus contributes to offset the expected inflation pressures originated in the negative external price shock. As a result, exchange rates in countries with exchange rate flexibility operate more as an external price shock absorber. Assumptions about expected transmission or absorption capabilities of exchange rates under different exchange rate arrangements will be comprehensively evaluated by assessing the second stage in exchange rate pass-through the various domestic price indexes.

Crisis period affected short-term responsiveness of exchange rates to the positive one standard deviation oil price shock in both groups of countries. Examination of the loading phase in the exchange rate responses revealed slightly reduced immediate and short-term dynamics in the response patterns of exchange rates in countries with nominal exchange rate anchoring. Overall durability of the exchange rate appreciation followed by the oil price shock decreased too. It seems that the overall exposure of exchange rates in countries from the group of “peggers” to the unexpected external price shocks decreased during the crisis period. Reduced vulnerability of rigid exchange rate to the oil price shock intensifies the transmission of the inflation pressure to domestic prices.

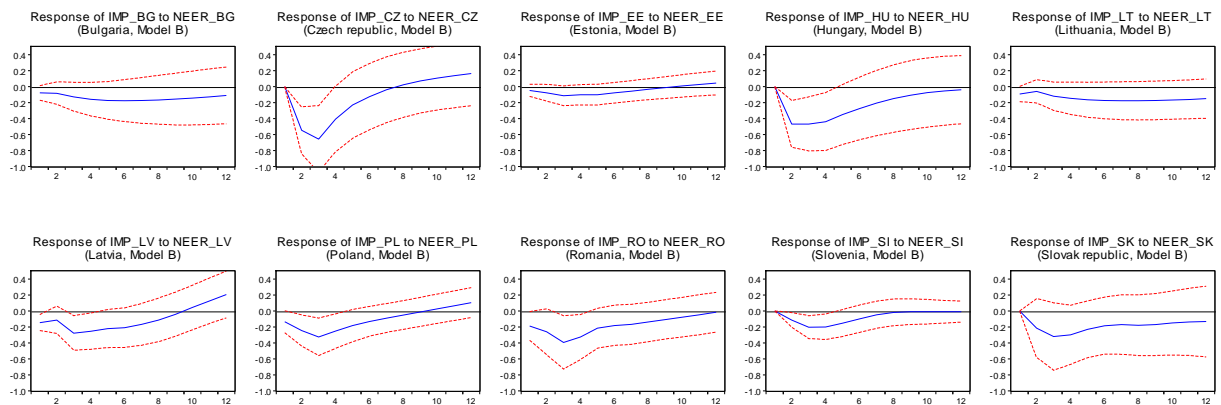
Response patterns of exchange rates to oil price shock during the crisis period also changed in countries with flexible exchange rate arrangements. We observed a slight increase in the immediate exchange rate response in this group of countries. Permanent effect of the oil price shock to the long-run exchange rate leading path was also slightly intensified. However, we investigated a moderate decrease in immediate as well as long-term responsiveness of exchange rates in the Slovak republic and Slovenia. Both countries enjoyed effects of the euro adoption during the crisis period that seems to affect their nominal effective exchange rate responsiveness to the external price shock. As a result, the crisis period generally increased the overall exposure of exchange rates to the oil price shocks in countries from the group of “floaters”. Ability of flexible exchange rate to offset external inflation pressure originated in the oil price shock during the crisis period rose suggesting its increased absorption capabilities. However, euro adoption in countries with former flexible exchange rate arrangements (the Slovak republic and Slovenia) clearly reduced exchange rate absorption capabilities revealing negative implications of the nominal exchange rate rigidity associated with the external inflation pressure transmission to the domestic prices.

Investigation of the second stage in exchange rate pass-through includes estimation of (a) import prices responses to the positive one standard deviation exchange rate shock employing monthly data for two subsequent periods 2000-2007 (model A) and 2000-2012 (model B). Results seem to be sensitive to the exchange rate arrangements diversity in individual countries.

**(Model A) (2000M1-2007M12)**



**(Model B) (2000M1-2012M12)**



**Figure 3.** Responses of import prices to exchange rate shock

*Note:* Curves represent responses of import prices (IMP) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the European transition economies.

*Source:* Author’s calculation.

In the figure 3 we summarize results of impulse-response functions of the import prices to the positive (increase in) exchange rate shocks in both models in the European transition economies. Unexpected exchange rate appreciation was followed by the drop in import prices though we have observed some different response patterns among individual countries. It seems that results are also sensitive to the exchange rate regime choice. In countries with pegged exchange rate regimes we have observed only moderate decrease in import prices followed by the positive one standard deviation exchange rate shock. At the same time, the initial loading phase of the import price divergence was fairly gradual though with a different intensity in each individual country. While the effect of the shock culminated within first four-six months in all countries from the group, its durability seems to be quite different. The length of the import prices path toward the pre-shock equilibrium lasted from eleven months (Latvia) till twenty months (Estonia) and nearly twenty four months (Bulgaria and Lithuania). In general, the overall effect of the exchange rate shock to the import prices was just a temporary, revealing its long-run neutrality in countries from the group of “peggers”.

On the other hand, the leading path of import prices resulted from the positive one standard deviation exchange rate shock followed different response patterns in countries with flexible exchange rate arrangements. Immediate response of import prices in the group of “floaters” was clearly more dynamic in comparison with previous group of countries. Import prices response culminated within first three months since the shock. However, the dynamics of

the convergence process of import prices toward the pre-shock equilibrium notably differs among countries. Due to observed differences in adjustment processes the overall effect of the exchange rate shock died out within eleventh and twentieth month since the shock revealing its long-run neutrality in the group of floaters too.

Summary of results for import prices responses followed by the oil price shock in the model A revealed interesting implications of the exchange rate regime relevancy for examination of the second stage in exchange rate pass-through in the European transition economies. Our results confirmed expected lower dynamics of the exchange rates pass-through effect to import prices in countries with rigid exchange rate regimes. At the same time it seems that exchange flexibility is a crucial assumption for more dynamic exchange rate pass-through to import prices.

Higher responsiveness of import prices to the exchange rate shock in countries with flexible exchange rate regimes reveals more dynamic exchange rate pass-through under volatile exchange rates. High degree of exchange rate pass-through to import prices contributes to offset inflationary effects of the external price shock provided high exchange rate vulnerability to this shock (see our results for the first stage in exchange rate pass-through). Volatility of exchange rate increases its price related absorption capabilities against negative inflationary effects originated in sudden external price shifts. On the other hand, low vulnerability of import prices to the exchange rate shock reduces absorption capabilities of exchange rate in situations when exchange rate volatility is caused by external price shocks.

Finally, the degree of the exchange rate pass-through and its price related effects to domestic price indexes should be examined according to the source of exchange rate volatility. Low exchange rate exposure to the external shocks under rigid (flexible) exchange rate arrangements contributes to domestic price (in)stability by reducing (accelerating) inflationary or disinflationary effects on domestic prices provided that the external source of the exchange rate volatility has non-price related origin (i.e. external supply or demand shocks). However, when the exchange rate volatility is caused by external price shocks (i.e. oil price shock) then the low (high) exchange rate exposure contributes to the transmission (absorption) of external price shock to import prices.

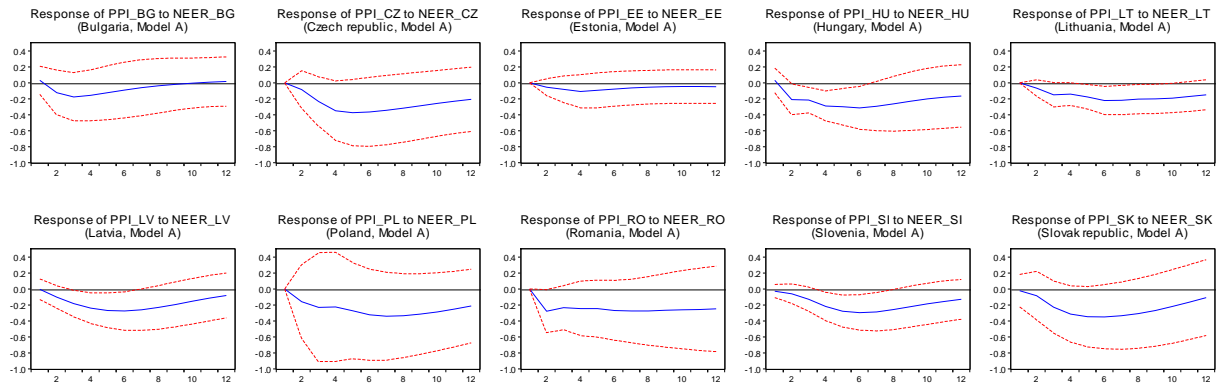
Crisis period affected responsiveness of import prices to the positive one standard deviation exchange rate shock in all countries. In general, the overall durability of the import prices convergence path toward the pre-shock equilibrium was reduced in all countries but Hungary while we observed some differences in the short-term vulnerability of import prices and associated dynamics in the import-prices responsiveness to the unexpected exchange rate shock. Immediate response of import prices in countries with pegged exchange rate arrangements was reduced in all countries but Latvia (effect of the exchange rate shock in Latvia culminated earlier though its dynamics in the peak was comparable with pre-crisis levels). As a result, crisis period clearly reduced exchange rate pass-through in countries with nominal exchange rate anchoring and thus increased transmission of external price shock to import prices.

On the other hand, we observed an increase in the overall dynamics of the short-term response patterns of import prices in countries with flexible exchange rate arrangements. Increased responsiveness of import prices is clear especially in countries with higher external (trade) openness (Czech republic and Hungary). However, reduced exchange rate flexibility (due to euro adoption) decreased exposure of import prices to the unexpected exchange rate shock in the Slovak republic and Slovenia. Exchange rate flexibility seems to be a convenient vehicle to reduce distortionary effects of external price shock to import prices through the intensified pass-through effect. It seems that exchange rate regime shift toward pegged exchange rate (i.e. euro adoption) may have negative impact on the price stability when sudden shifts in exogenously determined exchange rate originates in negative external price shock that is easily transmitted into import prices due to reduced absorption capabilities of exchange rate. However, reduced transmission of external price shock (i.e. drop in oil prices) under flexible exchange rates in bad times (crisis period) may reduce its disinflationary effects and associated price related incentives for a demand driven recovery.

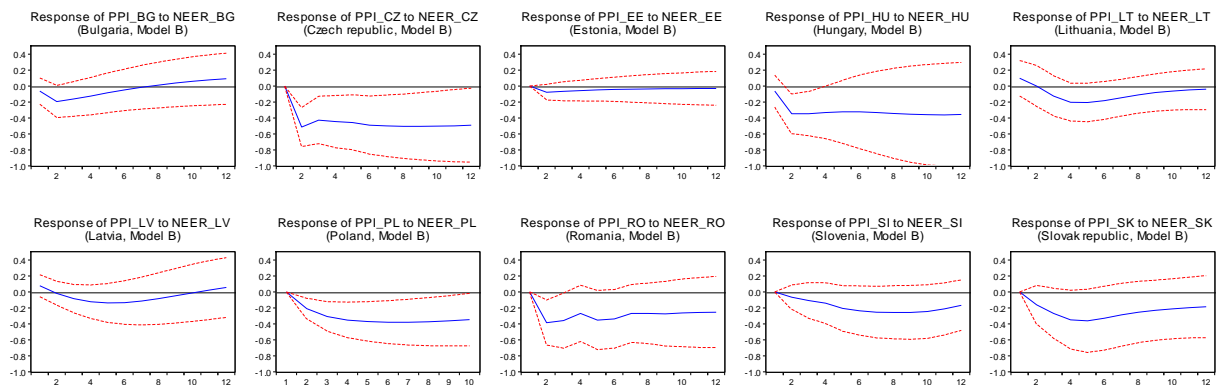
Investigation of the second stage in exchange rate pass-through includes estimation of (b) producer prices responses to the positive one standard deviation exchange rate shock employing

monthly data for two subsequent periods 2000-2007 (model A) and 2000-2012 (model B). Results seem to be sensitive to the exchange rate arrangements diversity in individual countries.

**(Model A) (2000M1-2007M12)**



**(Model B) (2000M1-2012M12)**



**Figure 4.** Responses of Producer Prices to Exchange Rate Shock

*Note:* Curves represent responses of producer prices (PPI) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the European transition economies.  
*Source:* Author’s calculation.

In the figure 4 we summarize results of impulse-response functions of the producer prices to the positive (increase in) exchange rate shocks in both models in the European transition economies. Exchange rate appreciation caused decrease in producer prices in all countries though we observed some differences in the response patterns between both groups of “peggers” and “floaters”. Similarly to our results of the import prices responsiveness, responses of producer prices seem to be sensitive to the exchange rate regime diversity. Positive exchange rate shock was followed by a moderate decrease in producer prices in countries with nominal exchange rate anchoring. However, leading phase and dynamics of the producer prices immediate response seems to vary across individual countries. Least dynamic response of producer prices was observed in Estonia (effect of the shock culminated during the third month) while producer prices reacted with most dynamics in Latvia (effect of the shock culminated during the sixth month). Similarly different was the overall durability of the producer prices decrease followed by the exchange rate shock though the overall effect was just a temporary and thus neutral in the long run.

Leading path of producer prices followed by the exchange rate shock in countries with flexible exchange rate regimes followed different response patterns. General decreasing trend in the producer prices response seems to be more dynamic and culminated within first six months since the shock. In comparison with previous group of countries it seems that a decrease in producer prices was more durable though the overall effect of the exchange rate shock was generally neutral in the long-run.

Summary of results for producer prices responses followed by the exchange rate shock in the model for pre-crisis period revealed interesting implications of the exchange rate regime diversity for examination of the second stage in exchange rate pass-through along its pricing chain in the European transition economies. Our results confirmed expected lower dynamics of the exchange rates pass-through effect from import prices to producer prices in countries with nominal exchange rate anchoring. At the same time it seems that countries with flexible exchange rate arrangements experienced more dynamic and durable exchange rate pass-through to producer prices.

Crisis period affected responsiveness of producer prices to the positive one standard deviation exchange rate shock in all countries. In countries with pegged exchange rate regimes we observed a slight reduction in the loading phase as well as the overall dynamics of the producer prices responses. At the same time, the overall durability of the producer prices convergence path toward the pre-shock equilibrium was reduced in all countries from the group. As a result, crisis period reduced producer prices exposure to the exchange rate shock in the group of “peggers” that is why we suggest that the exchange rate pass-through in countries with nominal exchange rate anchoring decreased as well and thus increased transmission of external price shock to producer prices.

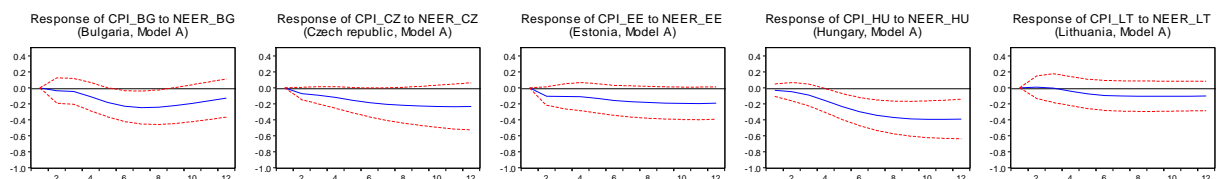
Response patterns of producer prices in countries with flexible exchange rate arrangements seem to be also affected by the crisis period. We observed increased dynamics in the initial load of the producer prices responses in most countries (especially in those with smaller and more opened economies). Moreover, the overall durability of the producer prices response path not only increased but the producer prices decrease became even permanent. However, we observed different response patterns of producer prices in countries from the group of “floaters” with reduced exchange rate flexibility during the crisis period. We suggest that euro adoption reduced durability of the producer prices response in the Slovak republic and the dynamics of the initial response in Slovenia. In both countries the overall effect of the exchange rate shock on producer prices seems to be just a temporary.

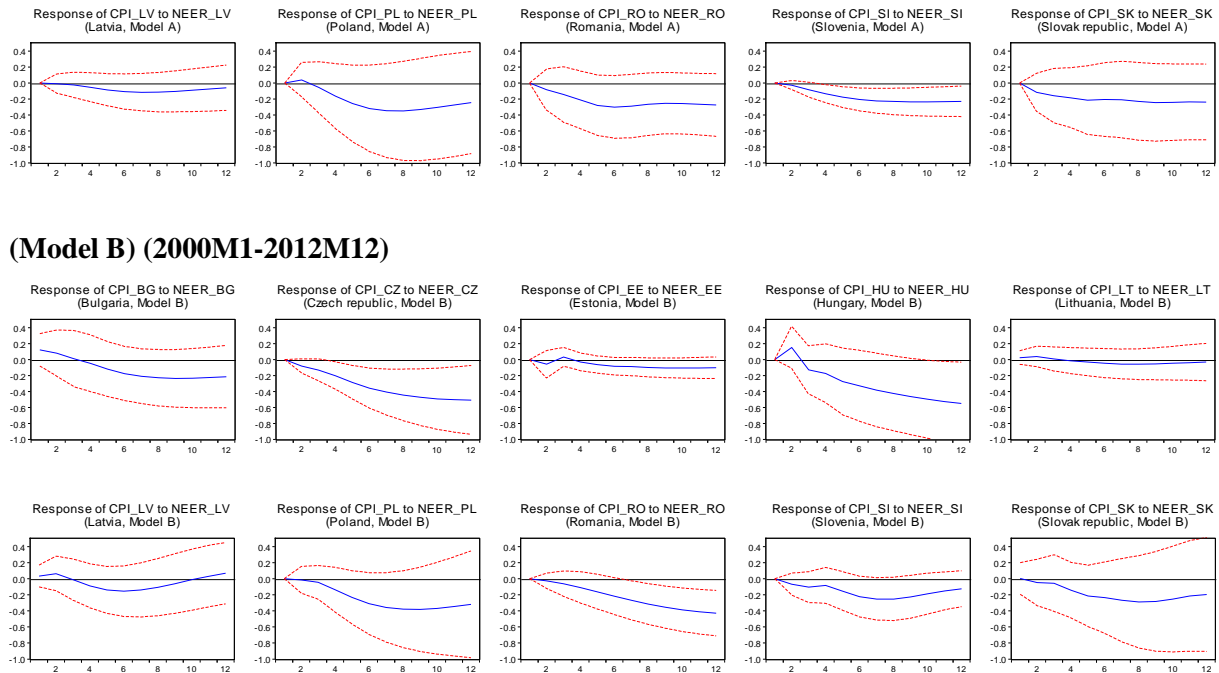
Examination of the exchange rate pass-through along the internal pricing chain in the group of “peggers” revealed slightly reduced extent of transmission of the exchange rate shock from import prices to producer prices. Initial load, intensity as well as durability of the producer prices response to the exchange rate shock were generally reduced. Crisis period clearly reduced the extent of transmission of exchange rate shock across these price indexes. As a results, decrease in the exchange rate pass-through reduced absorption capabilities of exchange rates in countries with rigid exchange rate arrangements.

Investigation of the exchange rate pass-through along the internal pricing chain in the group of “floaters” revealed reduced immediate intensity of price effect transmission from import prices to producer prices though the overall dynamics of the response remained mostly unchanged and the durability of the price effect clearly increased. Crisis period even identified key patterns in the internal pricing chain of the pass-through effect. Despite reduced immediate responsiveness, our results suggest an increasing dynamics in the medium-term exchange rate pass-through revealing (from import prices to producer prices) increased absorption capabilities of exchange rates in countries with flexible exchange rate arrangements.

Investigation of the second stage in exchange rate pass-through includes estimation of (c) consumer prices responses to the positive one standard deviation exchange rate shock employing monthly data for two subsequent periods 2000-2007 (model A) and 2000-2012 (model B). Results seem to be sensitive to the exchange rate arrangements diversity in individual countries.

**(Model A) (2000M1-2007M12)**





**Figure 5.** Responses of consumer prices to exchange rate shock

*Note:* Curves represent responses of consumer prices (CPI) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the European transition economies.

*Source:* Author's calculation.

In the figure 5 we summarize results of impulse-response functions of the consumer prices to the positive (increase in) exchange rate shocks in both models in the European transition economies. Similarly to our results from the figure 4 we observed that the exchange rate appreciation was followed by a decrease in consumer prices in all countries though we observed some differences in the response patterns between both groups of “peggers” and “floaters”. Here again we investigated some crucial implications of the exchange rate arrangement diversity on the consumer prices responsiveness. Positive exchange rate shock was followed by mostly lagged decrease in consumer prices in all countries though the length of the lag differs among individual countries. The overall dynamics as well as durability (from twelve to twenty months) of the consumer prices response in countries with pegged exchange rate regimes was generally lower.

Responsiveness of consumer prices to the unexpected exchange rate shock in countries from the group of “floaters” followed different patterns according to the dynamics and durability. While generally lagged, consumer prices response to the exchange rate shock in this group of countries was clearly more dynamic revealing higher medium-term exposure of consumer prices to the unexpected exchange rate shifts. At the same time, in most countries we observed permanent effect of the exchange rate shock to the consumer prices response path.

Summary of results for consumer prices responses followed by the exchange rate shock in the model for pre-crisis period revealed interesting implications of the exchange rate regime diversity for examination of the second stage in exchange rate pass-through along its pricing chain in the European transition economies. However, our results did not confirm expected decreasing trend in the exchange rates pass-through effect along the pricing chain (from producer prices to consumer prices) in both groups of countries. While a decrease in consumer prices followed by the exchange rate shock clearly lagged behind the drop in producer prices, its dynamics was higher in Bulgaria, Estonia and all countries from the group of “floaters” but lower in Lithuania and Latvia. At the same time, countries from both groups experienced more durable exchange rate pass-through to producer prices in comparison with producer prices.

Crisis period affected responsiveness of consumer prices to the positive one standard deviation exchange rate shock in countries from both groups. In countries with rigid exchange rate

arrangements we observed a slight increase in the lag length of the consumer prices response as well as its reduced dynamics. Overall durability of the consumer prices convergence path toward the pre-shock equilibrium during the crisis period was reduced in all countries from the group of “peggers” but Bulgaria. As a result, crisis period reduced consumer prices vulnerability to the exchange rate shock in this group of countries that is why we suggest that the exchange rate pass-through in countries with nominal exchange rate anchoring decreased as well (with the exception of Bulgaria) and thus increased transmission of external (oil) price shock to consumer prices.

Response patterns of consumer prices in countries with flexible exchange rate regimes were also affected by the crisis period. While the length of the initial lag of the consumer prices response loading phase did not significantly change, we investigated clear increase in their medium-term responsiveness. Similarly we observed an increase in the durability of the consumer prices response path. However, similarly to our results from the figure 4 (impulse-response functions for producer prices) we observed different response patterns of consumer prices in countries from the group of “floaters” with reduced exchange rate flexibility during the crisis period. We suggest that euro adoption reduced durability of the consumer prices response in the Slovak republic and Slovenia. In both countries the overall effect of the exchange rate shock on producer prices seems to be just a temporary.

Investigation of the exchange rate pass-through along the internal pricing chain in the group of “peggers” provided mixed results. Despite generally lagged response of consumer prices to the unexpected exchange rate shock, its dynamics was higher in Bulgaria and Estonia but lower in Lithuania and Latvia. Exchange rate pass-through to consumer prices in first two countries was intensified but in the last two countries reduced. Our results thus provide biased information about absorption capabilities of exchange rates in countries with rigid exchange rate arrangements according to the exchange rate pass-through to consumer prices.

Investigation of the exchange rate pass-through along the internal pricing chain in the group of “floaters” revealed lagged though generally more dynamic transmission of price effect from producer prices to consumer prices while the overall durability of the price effect clearly increased. Crisis period even identified crucial patterns in the internal pricing chain of the pass-through effect. Despite lagged overall responsiveness, our results highlight an increasing dynamics in the medium-term exchange rate pass-through (from producer prices to consumer prices) revealing increased absorption capabilities of exchange rates in countries with flexible exchange rate arrangements.

## **Conclusion**

In the paper we have analysed exchange rate pass-through to domestic prices in the European transition economies. We have employed a multivariate VAR model for each individual country to investigate possible implications of different exchange rate arrangements on estimated results and thus to contribute to the fixed versus flexible exchange rates dilemma from the prospective of the transmission of the external inflation pressures to the domestic price inflation associated with the exchange rate conditional variability. To meet the objective we have analysed (1) a capability of exchange rate to transmit or absorb the external inflation pressure originated in the oil price shock to domestic prices followed by examination of (2) effects of the unexpected exchange rate shift to domestic price indexes to examine its distribution along the internal pricing chain. We suggest that our results contribute to understand the key features of the exchange rate transmission of the external price shifts based inflation pressures across different domestic price measures.

Our results confirmed expected lower vulnerability of exchange rates in countries with nominal exchange rate anchoring (“peggers”) to the external price shocks (this effect was even strengthened during the crisis period). Reduced exchange rate responsiveness to the external price shocks increased the transmission of the price effect to the domestic prices. This idea was supported by investigated lower dynamics of the exchange rates pass-through effect to import prices and producer prices (though not to consumer prices) in countries with pegged exchange rate regimes in comparison with “floaters” (results for the crisis period mostly highlighted empirical results from the pre-crisis period). Intensity of the price effect along the internal pricing chain

revealed its reduction from import prices to producer prices though results for consumer prices were mixed. As a result, exchange rates in countries with reduced exchange rate flexibility operated more as the external price shock transmitters.

On the other hand, higher and durable responsiveness of exchange rates to the oil price shock in countries with flexible exchange rate arrangements (this effect was even strengthened during the crisis period) reduced the transmission of the price effect to the domestic prices and thus contributes to offset the expected inflation pressures originated in the negative external price shock. This idea was supported by investigated higher dynamics of the exchange rates pass-through effect to import prices, producer prices as well as consumer prices in countries with flexible exchange rate regimes in comparison with “peggers” (results for the crisis period mostly highlighted empirical results from the pre-crisis period). Intensity of the price effect along the internal pricing chain revealed its reduction from import prices to producer prices though results for consumer prices revealed its increase. As a result, exchange rates in countries with exchange rate flexibility operated more as the external price shock absorber.

Low exchange rate exposure to the external shocks under rigid (flexible) exchange rate arrangements contributes to domestic price (in)stability by reducing (accelerating) inflationary or disinflationary effects on domestic prices provided that the external source of the exchange rate volatility has non-price related origin (i.e. external supply or demand shocks). However, when exchange rate volatility is caused by external price shocks (i.e. oil price shock) then the low (high) degree of exchange rate pass-through to import prices/producer prices/consumer prices contributes to the transmission (absorption) of external price shock to import prices/producer prices/consumer prices following the price shock distribution along the internal pricing chain.

#### **Acknowledgement**

This paper was written in connection with scientific project VEGA no. 1/0892/13. Financial support from this Ministry of Education’s scheme is also gratefully acknowledged.

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## DEVELOPMENT OF COMPUTER APPLICATION FOR RISKS ANALYSIS IN CRISIS SITUATIONS

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### **Abstract:**

*Leading an organization in a crisis time is a risky and extremely requiring action, not only for the leaders, but also for the employees. The leader needs an independent clarity and self-confidence that can be insured only by the risk management.*

*This work has as object the creation of a risk management system, at a project level, though it can realize an efficient administration of risks, thus the decision structures adapt themselves and respond in crisis regarding the critical infrastructural dysfunctions.*

**Keywords:** informatics structures, informatics system interrogations, informatics basis, risks factors, residual risk, inherent risk, RAMV (Risk Adjusted Monetary Value).

**JEL Classification:** M15

### **1. Introduction**

Leading an organization in a crisis time is a risky and extremely requiring action, not only for the leaders, but also for the employees. In order to maintain the fragile balance between necessary and possible, between what he is asking and what he is offering to his people, the leader needs an independent clarity and self-confidence that can be insured only is the risk management.

Given that the present decisions are taken considering the future events, the benefits can be enormous: to anticipating the market conditions to competitive advantage, from understanding the internal and external background of the enterprise activity to anticipating the crisis situations or avoiding the frauds.

The costs of a risk management system implementation in a company depend on the administration methods of unpredictable events. Depending on the organization profile, we can talk about risks on a project or product level, about risks that require different approaches and a different training.

The subject of this work is: the risks on a project level, as the projects are the means by which an organization fulfils its strategic plan or exercise its mission. A large number of organizations and institutes spend a lot of time and resources to develop and improve standards and methodologies for project risk management. Among these, the most common are:

- AS/NZS 4360:2004, The Australian and New Zealand Standard on risk management, developed by Broadleaf Capital International PTY LTD<sup>3</sup>;
- IRM Standard, jointly developed by The Institute of Risk Management (IRM) [10], The Association of Insurance and Risk Managers (AIRMIC) and by ALARM The National Forum for Risk Management in the Public Sector (widespread in the United Kingdom)– adopted by the Federation of European Risk Management Associates (FERMA);
- PMBOK Guide developed Project Management Institute (widespread in the U.S.A);
- PRAM (Project Risk Analysis and Management) Guide developed by Association for Project Management<sup>4</sup> (widespread in United Kingdom).

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<sup>3</sup> [http://www.ucop.edu/riskmgt/erm/documents/asnz4360\\_2004\\_tut\\_notes.pdf](http://www.ucop.edu/riskmgt/erm/documents/asnz4360_2004_tut_notes.pdf).

<sup>4</sup> <http://www.apm.org.uk/>

The risk management on a project level is not only an exercise of risk identification, but also: the planning of the minimizing measures for the risk apparition and impact probability, including those measures in the project plan (as activities and costs) for those cases when the prevention measures are failing, nominating the ones in charge with the monitoring of every single risk, the permanent monitoring, risk recalculation and escalation in case a risk is activating.

**2. The risk specific in a company activity**

The risk represents an uncertain future event, capable of producing but with an incalculable apparition. It is a future event as its apparition cannot be related on a specific future period. It is uncertain because we don't know for sure when if, when and how it is going to appear. Its apparition can be quantified under different forms by probability (Hillson 2007)

The risk must be evaluated as a factors combination: the *probability* that a risky event produces and the impact or the dimension of the consequences if this risky event is going to happen (Cendrowski et al 2009)

Accordingly, the estimation of the identified risks is made upon two indicators:

- the risk materialization *probability*, meaning the possibility of a risky event measured by the rate between the number of that event apparition and the number of total events. The probability can be also expressed by the risk event production frequency, meaning the event apparition number in a certain period of time.
- the risk *impact*, respectively the effect or the consequences that can reside from a risk materialization, in term of costs, time planning, quality and other effects on the objectives achievement.

A project element, *a*, can be considered a risk element when the following two conditions are simultaneously happening:

$$0 < P(a) < 1 \tag{1}$$

$$L(a) = \emptyset \tag{2}$$

where: P (a) - the probability that an event (a) produces;  
 E (a) - the event effect on the project;  
 L (a) - the monetary evaluation of E(a).

**3. The risk analysis phases**

Project risk analysis includes assessment of the likelihood and impact of the identified risks. Phases of the risk analysis (Damodaran, 2008):

- a) the identification/listing of the auditable operations/activities, respectively of the auditable objects. In this phase, we are analysing and identifying the activities/operations, and also the interdependencies between those, which establish the analysis perimeter;
- b) the identification of the threats/opportunities-inherent risks associated to each operation/activity;
- c) the establishment of the risk analysis criteria. The criteria utilization recommended: the apparition probability and the impact;
- d) a score setting for each criteria, on a value scale of 3 or 5 levels, which is multiplied with the weight given to the respective criteria;
- e) the total score establishment for every identified risk (T) by summing the points of each criteria.

The total risk score will be calculated by using the formula:

$$T(i) = \sum P(i) \times N(i) \quad \text{where: } P(i) \text{ - the risk weight for each criteria;} \\ N(i) \text{ - the risk level for each used criteria.}$$

or

$$T = N1 \times N2 \times N3 \times \dots \times N(i)$$

- g) the risk classification, based on the total scores previously realized in: small, medium and high risks;
- h) the estimate of the total risk of the operation/activity by summing all the identified risks scores for the audited operation/activity which is analysed;
- i) the hierarchy of the operations/activities that are to be audited, respectively the elaboration of the chart for the strong and weak points.

**4. The risk analysis realization**

The risk analysis is an important phase and its goals are ( Simion *et al.* 2008):

- the identification of the threats at the achievement of the audited entity/structure objectives or the opportunities it can benefit upon,
- the evaluation of the audited entity/structure internal control system capability to prevent, eliminate or minimize the threats and explore the opportunities.

The projects will be selected to be checked based on the risk matrix elaborated after the identification of the variables and risk factors. The risk matrix must consider the verifications/checks that were made (*see* Figure1)

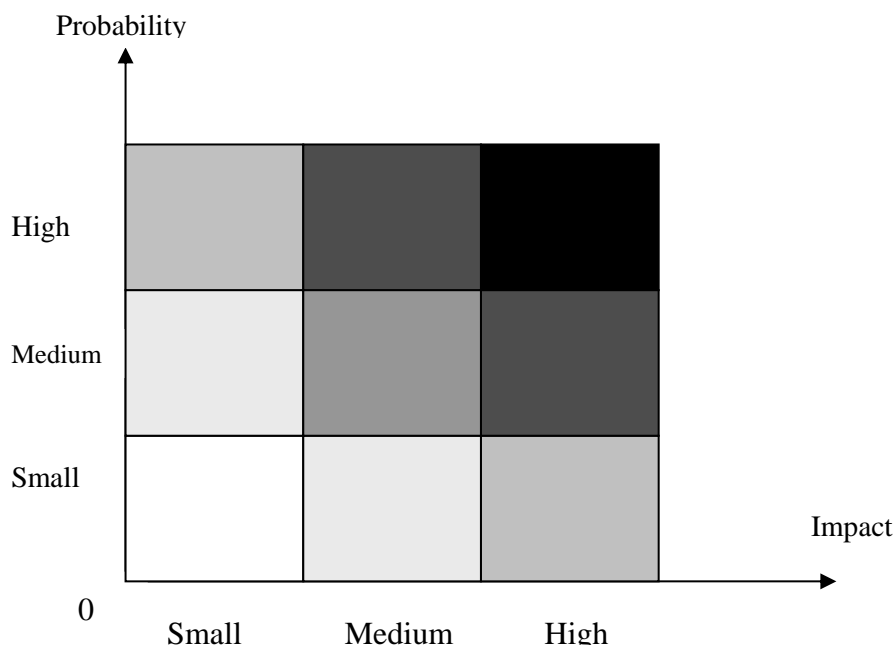


Figure 1 The risk matrix

There is no absolute standard for the risks matrix, but we can use the following score guide for the two criteria of risks analysis, as we describes below:

- The probability evaluation (*see* Table 1) - Probability is the chance that an event or an operation takes place.

Table 1: The probability evaluation

Score	The evaluation	The agreed acceptance
5	Almost certain (>95%)	The risk has already appeared or its apparition is inevitably
4	Possible (75-95 %)	The risk apparition probability is based on clear evidence
3	Probable (25-75 %)	The risk apparition probability is based on a few evidence
2	Improbable (5-25 %)	The risk apparition is practically possible, although there are a few concrete cases
1	Seldom (0-5 %)	The risk apparition is practically impossible.

- The impact evaluation (*see* Table 2) - The impact is the effect that risk materialization would have on the objectives achievement of the audited entity/structure. Most times, the impact is evaluated in financial terms.

Table 2: The impact evaluation

The score	The quality evaluation	The agreed acceptance
5	Major	If the risk appears, it is not possible to achieve certain objectives
4	Considerable	If the risk appears, the activities are significantly disturbed and considerable additional resources are needed in order to achieve the objectives.
3	Moderate	If the risk appears, the activities are not significantly disturbed, but additional resources are needed in order to achieve the objectives.
2	Minor	If the risk appears, the activities are insignificantly disturbed which does not affect the objectives achievement.
1	Insignificant	If the risk appears, the activities taking place and those planned are not disturbed and the objectives achievement is not affected.

In the elaboration/use of the risk matrix a “score” (Baloi *et al.* 2001) is assigned in order to express the risk level and to allow the calculation of the Risk Adjusted Monetary Value. The score can vary from 1 (the risk level is considered to be low) to 3 or 5 (the risk level is considered to be high).

The score assign process is a quality assessment that depends on the experience project manager and on the level of information available on the moment of selection (Farahmand *et al.* 2005).

The score assignment on the given risk factors can be:

a) The business environment

Public Administration	1
Education Establishment	2
Non government organization	3
Intercommunity developing association	3
Worship unities	4
Commercial Society	5

b) The project nature/ the complexity of the project operations

The Infrastructure	
- new buildings	2
- renovation/ rehabilitation/consolidation	2
- adaptation/ repartitioning	2
- purchase	1
A material/ equipment purchase	3
Studies and non materials works	5

c) Budget changes/reallocations to the project – values between 1(low) and 5(high)

d) Previously reported abnormalities- values between 1 (low) and 5 (high)

e) Previous surveys

Entities unchecked yet	5
Previous survey(low quality)	3-4
Previous survey( medium quality)	2
Previous survey( corresponding)	1

Some risk factors have a greater impact on the general risk than others, for example an error/ abnormality incidence previously reported.

The total of the risk factors scores is 25, for that you can see Table 3 This number is transformed into a percentage by dividing the total obtained score to the maximum possible score (if every factor would have received the High score).

Table 3 - The total of the five risk factors allocation

The business environment	B – 1 -5
The project nature and complexity	P – 1-5
Budget modifications	MB – 1-5
Abnormalities/errors previously reported	I – 1-5
Previous surveys	CA – 1-5
Total	Total – 5...25

For every project, the following risk factors will be determined:

- The Risk Adjusted Monetary Value (RAMV);
- the refunded expenses (payments) value report to the beneficiary/ the project total eligible value that is agreed in the financing contract, expressed in percentages.

For example, we will calculate the risk level associated to some risk factors. We will use 3 risk factors: the total value, the project stage and the evaluation score (see Tabel 4).

Table 4 – Calculation risk level associated to some risk factors

RISK	LOW	MEDIUM	HIGH
Risk level	1	2	3
Project Value	< Maximum Level - A low risk	Maximum level- low risk– maximum level medium risk	> Maximum Level Medium Risk
Project stage	Contracted without request, reimbursement, or terminated	Request contracted, reimbursement	Completed
Evaluation Score	> 5	4 - 5	< = 4

where: the Maximum Level Low Risk and Maximum Level Medium Risk will be calculated according to the algorithm presented in Tabel5:

Table 5 – Algorithm for calculating risk level

1	Maximum project value	MAX
2	Minimum project value	MIN
3	Risk estimation interval determination. [(rd. 1-rd.2):3]	(MAX-MIN)/3
4	Maximum level for screening as a low risk (rd 2+ rd3)	MIN+(MAX-MIN)/3
5	Maximum level for screening as a medium risk (rd4+rd. 3)	MIN+2 x (MAX-MIN)/3

For every factor we will assign a score from 1 to 3: S1, S2 and S3. We will sum up the risk factors, so the final score will be:

$$SF = S1 + S2 + S3$$

Next, we will calculate the percentage risk from the report between the final score to the maximum possible score (risk factors number x possible maximum score, respectively 3 or 5):

$$RP = SF / (n \times 3)$$

We will determine the risk adjusted monetary value RAMV by multiplying the eligible value to the percentage risk:

$$VMAR = VE * RP \text{ (see Table 6).}$$

Table 6 Calculation for the Risk Adjusted Monetary Value

1	Maximum RAMV	MAX
2	Minimum RAMV	MIN
3	Risk estimation interval determination. [(row 1- row 2):3]	(MAX-MIN)/3
4	Maximum level for screening as a low risk (row 2+ row 3)	MIN+(MAX-MIN)/3
5	Maximum level for screening as a medium risk (row 4+row 3)	MIN+2 x (MAX-MIN)/3

Depending on the RAMV value we will calculate the final risk (risk score) according to the dates in the Table 7.

Table 7 - Calculation for the final risk based on RAMV

1	Maximum RAMV	MAX
2	Minimum RAMV	MIN
3	Risk estimation interval determination. [(row 1- row 2):3]	(MAX-MIN)/3
4	Maximum level for screening as a low risk (row 2+ row 3)	MIN+(MAX-MIN)/3
5	Maximum level for screening as a medium risk (row 4+row 3)	MIN+2 x (MAX-MIN)/3
<b>Final Risk</b>	<b>Screening Conditions</b>	
<b>Low risk</b>	$VMAR \leq VMAR_{min} + (VMAR_{max} - VMAR_{min})/3$	
<b>Medium risk</b>	$VMAR_{min} + (VMAR_{max} - VMAR_{min})/3 < VMAR \leq VMAR_{min} + 2x(VMAR_{max} - VMAR_{min})/3$	
<b>High risk</b>	$VMAR > VMAR_{min} + 2x(VMAR_{max} - VMAR_{min})/3$	

### 5. The general architecture of computer applications

For the data basis management I have chosen the MS Access, a strong environment that has a very accessible programming language, Visual Basic, a complex system of charging/update/data basis interrogation (Rotaru *et al.*, 2005)

The tuples emphasis as a logical unity of selection, stocking, recovery, transmission and automatic data processing was done by defining the data collection, and also by reporting it to the information volume and content from the primary documents.

The informatics entries and the output situations were set up into the following permanent data (see Figure 2):

- Charts for the primary data introduction;
- Interrogations achieved from charts by using the dates accordingly or by processing it;
- Reports for printing the output situations;



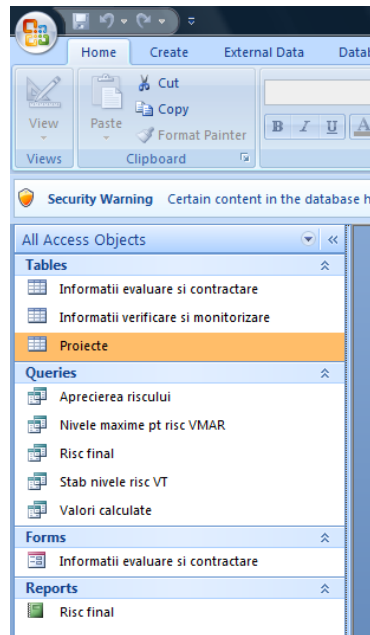


Figure 2. The database components

Maximum levels of RAMV risk where we calculate the maximum values for the risk score setting based on the risk adjusted monetary value. This interrogation structure is shown in Figure 3:

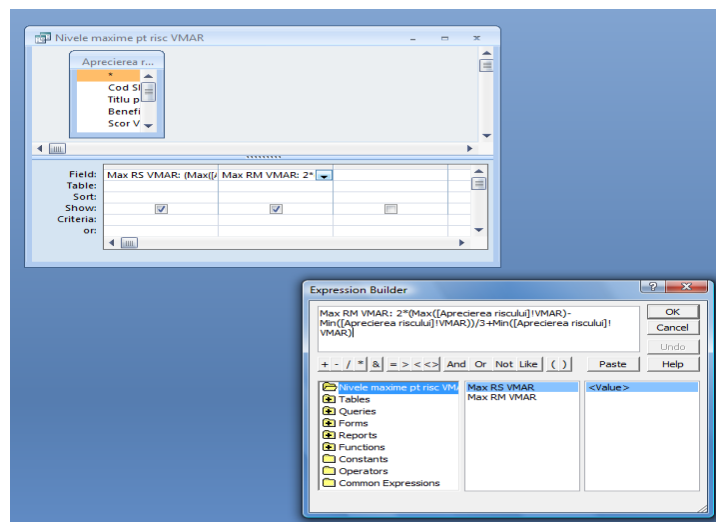


Figure 3. The interrogation structure. Maximum levels for RAMV risk

-The final risk- the calculation of the final risk and the project arrangement based on the associated risk. This structure is shown in Figure 4:

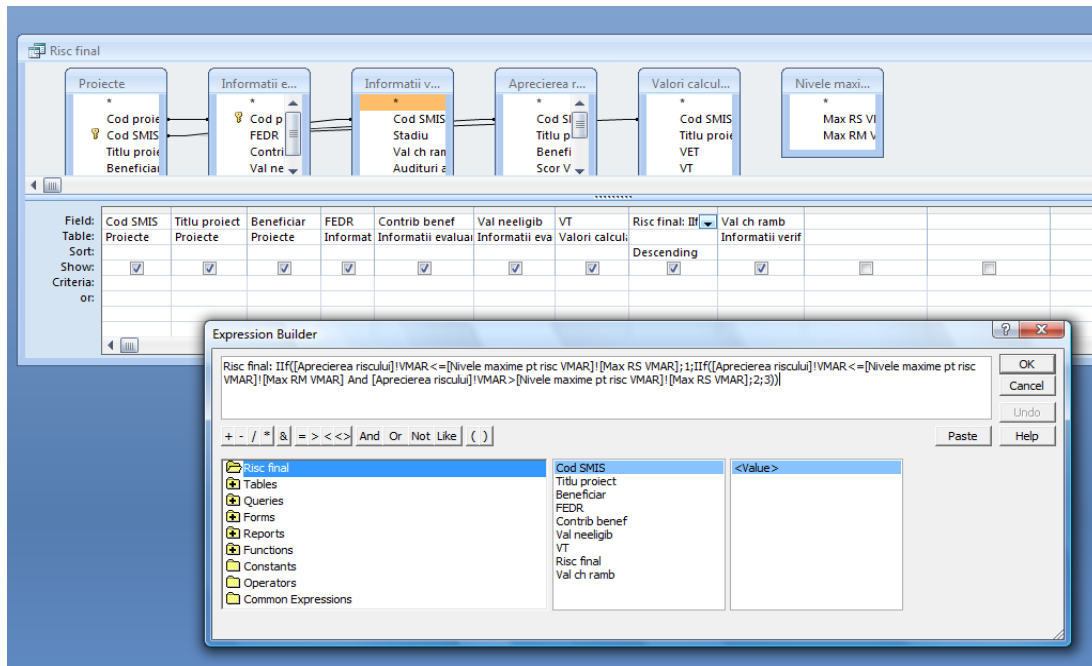


Figure 4. The Final risk Interrogation structure

Reports - I have created here a report on the Final risk interrogation basis which presents the data into a more attractive form than the classical chart resulted after the interrogation. (Figure 5)

Cod SMI	Titlu proiect	Beneficia	Finantare neran	Contributie proprii	Valoare neeligibila inc	Valoare t	Risc final	Valc
4580	Dezvoltarea SC Gama SRL	Alfa SRL	600000	600000	300000	1500000	3	
6584	Dotarea atelier auto	Alfa SRL	450000	450000	300000	1200000	2	
3535	Dezvoltare infrastructura IT	Alfa SRL	800000	200000	300000	1300000	2	
8975	Achizitie aparatura modern	Alfa SRL	200000	200000	35000	435000	1	
8970	Modernizare linie productie	Alfa SRL	500000	200000	150000	850000	1	
5455	Formare continua	Alfa SRL	350000	150000	30000	530000	1	

Figure 5. The final risk report

### Conclusions

The risk analysis, with the informatics tools, has as object the identification of all the factors that can threaten the functional or non-functional constraints obedience. A correct risk identification and management can avoid causing effects in the late development phases and assures a predictable controlled evolution of the project.

The project risks are identified and analysed, a Risk Management Plan is prepared, by illustrating how those risks will be reduced or avoided. If the risks are inevitable and their impact is significant, special plans will be developed for them.

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# TRANSMISSION OF INFLATION AND ECONOMIC GROWTH IN THE EURO AREA IN THE RESPECT TO A SINGLE MONETARY RULE

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## Abstract:

*The objective of the research is to investigate inflation and economic transmission among the Visegrad countries (Czech Republic, Hungary, Poland and Slovakia) and the euro area. Narrow external trade and integration relations suppose significant level of transmission within the observed countries. Level of (a) symmetry among inflation and economic growth shocks can be crucial for a single monetary rule application. Importance of this issue is not relevant only for Slovakia, the euro area member since 2009, but for the Czech Republic, Hungary and Poland, too, as the future euro area member. Estimation of inflation and economic growth transmission is based on the vector error correction model. Variance decomposition enables us to observe these interdependences among particular countries throughout several horizons. Dominance of the euro area is more obvious in the case of economic growth. Therefore, from the perspective of the Visegrad countries, a potential single monetary rule should put more weight on economic growth than inflation. However, due to an endogenous argument, level of these interdependences should increase gradually in time. The paper was elaborated within the project VEGA 1/0973/11.*

**Keywords:** inflation transmission, economic growth transmission, the euro area, the Visegrad countries, monetary rules.

**JEL Classification:** F15, F42, E52.

## 1. Introduction

Monetary rules versus discretionary monetary strategies are often discussed in connection with the time inconsistency problem of monetary policy. The time inconsistency issue is essentially based on the contributions by Kydland and Prescott (1977) and Barro and Gordon (1983). Their conclusions stress macroeconomic advantages of monetary rules comparing with discretionary approach. According to their findings monetary rules help to reduce inflation without economic output decrease.

However, the role of monetary rules can be questionable in terms of economic crisis and monetary integration. Consequently, a unique monetary policy e.g. under the form of a unique monetary rule can be problematic. The aim of the paper is to consider implementation of a single monetary rule from the perspective of the Visegrad countries (V4), i.e. future euro area member states (the Czech Republic, Hungary and Poland) and actual euro area member (Slovakia). The Visegrad region consists of countries with quite similar economic background and integration process. The countries have experienced transition process since 1989 and they joined the European Union in 2004. Slovakia adopted euro in 2009 as the first country from the Visegrad group. Other three countries should be its followers in the coming years. On the one hand, recent economic evolution has been similar in these countries. On the other hand, their particularities, e.g. at the level of external openness, production structure diversification, etc. can lead us to different results. Is there interdependence among output and inflation evolution in the mentioned countries and the European Monetary Union? Would be a unique monetary rule or central bank reaction function based on inflation and output indicators convenient for the Visegrad countries as future or actual members of the European Monetary Union?

The aim of the paper is to evaluate cointegration of inflation and output in the Visegrad countries and the euro area. These two indicators are crucial in the most of monetary rules as well as in the Taylor rule - one of the best known rules (Taylor, 1993).

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However, the role of monetary rules has been contested by certain economists (Belke, Klose, 2011) due to economic crisis. Others (Taylor, 2009) claim that negative impacts of economic crisis would be weaker under monetary rules application.

The implementation of monetary rules in the European Monetary Union is even more questionable as several authors (Bucur, Ancuba, 2012) have doubts about the euro area optimality because of inflation and output shocks asymmetry. Others (Liapis, 2012) suggest fiscal integration in the euro area to avoid future financial and debt crises. Consequently, this research takes into account period of economic crisis and monetary integration, too.

## **2. Literature background**

Until the 19th century, the discretionary strategy was preferred by most of the countries in the world. No precise monetary rules were applied by monetary authorities except the “gold standard” and the exchange rate stability (Lewis, 2010). However, during the last hundred years, monetary rules have found their followers.

Wicksell (1989) brought a very simple rule, yet it was not widely spread. It was based on the principle that the interest rate in the economy was only influenced by one parameter - price stability. On the other hand, Friedman’s k-percent rule is world known (Friedman, 1968). Friedman claimed that the rate of growth of money supply should be equal to the rate of growth of real GDP in economy. This rule supposes a stable velocity of money.

Even more significant increase in the number of monetary rule followers came in the 1970s and the 1980s. It was the case of Kydland and Prescott (1977) for instance. They pointed out the problem of time inconsistency. According to their findings, monetary rules should reduce the time inconsistency occurrence.

Brennan and Buchanan (1981) defended policy rules, too. They were convinced that discretionary policy enables a central bank to generate inflation above its optimal level. Barro and Gordon (1983) expanded this theory in the 1980s and claimed that monetary authority will always have propensity to lower the unemployment at the expense of higher inflation.

McCallum suggested a rule today known as the McCallum one (1988). The author focused on monetary base as a central bank’s target. This parameter is influenced by inflation rate, real GDP growth and growth of velocity of money. McCallum claims the US economy would have achieved better results if it had followed his rule, especially in 1930s and 1970s.

In 1993 Taylor presented a monetary rule which became very popular thanks to its simplicity and accountability. The rule was suggested as an efficient tool for monetary policy decision making process. In general, the Taylor rule is considered to be a supplement monetary tool to inflation targeting. The rule focuses on achieving the inflation target in a middle-run. Moreover, it reacts to the GDP evolution that is closely connected to the inflation. The rule enables to quantify short-term nominal interest rates set by a central bank in response to inflation and output gap evolution.

Svensson (2003) criticizes the rule because of small number of parameters determining the monetary policy. Consequently, the rule does not take into account other parameters.

It seems that the current economic crisis has contested the reliability of the Taylor rule. Results of Rudebusch (2009) have shown that the interest rate in the U.S. should reach the values of about -5% during 2009 according to the Taylor rule. It is, of course, impossible to implement in practice. As current federal funds interest rate is 0%, the difference between calculated and real value is significant, i.e. 5%. On the other hand, except the current crisis, the Taylor rule results corresponded quite well to reality from 1988 to 2008 (Rudebush, 2009).

Nevertheless, Taylor defends his rules against the criticism. He claims that if the FED respected original version of his rule, the results would be convenient even during the crisis.

Several authors suggested the Taylor rule or the Taylor type rules for the European Monetary Union. Gerlach and Schnabel (1999), Gerlach and Smets (1999) found out that interest rate in the euro area given by Taylor was moving very closely to the interest rate in a real economy. Exceptions were only in years 1992 and 1993. That period was characterized by disturbances on exchange market and currency crises in Europe e.g. in Great Britain and Sweden. Adema (2004) researched the Taylor rule application in the euro area, as well. In order to compare

the results based on various data, she decided to analyse the situation both with ex-post and actual data. Finally, she recommended using of actual data available in the period when a monetary authority decides about the height of interest rate. Belke and Cui (2009) applied the Vector Error Correction Model (VECM) methodology to verify interdependence between the U.S. and European interest rates in terms of the Taylor rule. They confirmed this interdependence by their general VECM and found out that the European Central Bank followed the Fed's strategy during 1999 - 2006. Eleftheriou, Gerdesmeier and Roffia (2006) analysed the possibility of the Taylor rule application in the pre-European Monetary Union era. They concluded that convenient rules were distinct for each country. Gerlach-Kristen (2003) presented an alternative policy rule for the euro area, i.e. a reaction function which takes the non-stationarity of the data into account. His estimated interest rate rule is stable and forecasts well. He applied cointegration analysis. Ullrich (2005) estimated linear equations with the OLS method to the central bank's reaction function within the EMU countries and the U.S. She applied her research for the period before and after 1999, i.e. before and after creation of the EMU. She described significant differences between the central bank's reaction functions before and after 1999 and between the EMU countries and the U.S. Altavilla (2003) appreciates performance of monetary rules in the EMU and he recommends forward-looking approach in the rules.

Application of a unique monetary policy and eventually of a single monetary rule has to deal with asymmetry problems between countries. This imbalance can be linked to different economic cycles and inflation bias in particular countries. The unevenness is significantly influenced by various shocks (supply, demand, inflation, etc.). The problem of shock asymmetry in the European Union was researched by several authors, e.g. Horváth (2003). According to his findings asymmetry of shocks in the euro area seemed to be quite important during first decade of monetary integration. However, it is possible to expect improving of the situation e.g. due to the endogenous argument (Frankel, 2009). Frankel explained that monetary integration would lead to gradual symmetry among business cycles and economic fundamentals in general. Business cycles in the Visegrad countries have been recently studied by Tkáčová and Bánociová (2013) using composite leading and cyclical indicators. Business cycles symmetries among countries can be significantly implied also by eventual application of the Balance Scorecard system in enterprises and their respective Balance Scorecard function as explained by Gavurová (2012) or Gavurová (2011). Economic growth and consequent business cycles in particular countries are implied by many other factors present in financial markets as researched e.g. by Úžik and Šoltés (2009).

### 3. Research method and data

Research methodology of the paper is based on the vector error correction model estimation. This procedure enables us to determine long and short term equilibrium among inflation and output in the Visegrad countries.

The vector error correction model analyses interdependence of observed time series taking into account lagged values. This fact enables us to research links among variables more comprehensively. Nevertheless, this type of models requires stationarity testing. Generally speaking, non-stationarity (presence of a unit root) is typical for economic time series. Non-stationarity of level values can be eliminated e.g. by first or second differences. 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:

$$y_t = \beta_0 + y_{t-1} + u_t$$

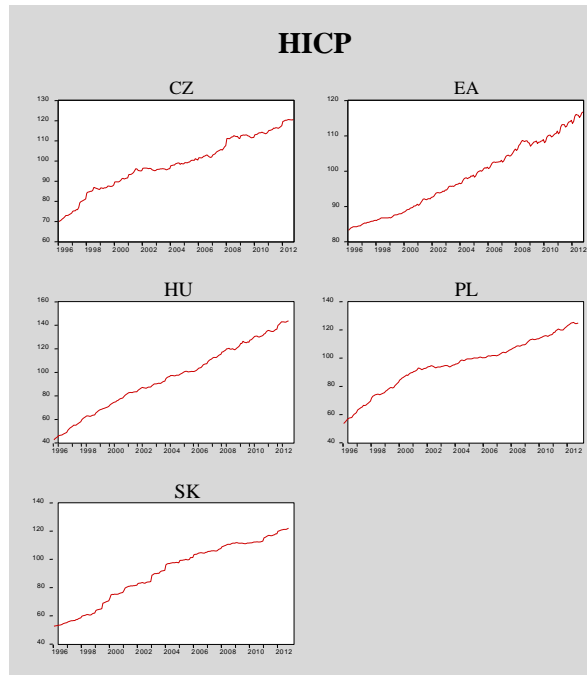
can become stationary after first difference calculation:

$$\Delta y_t = y_t - y_{t-1} = (1 - L)y_t = \beta_0 + u_t$$

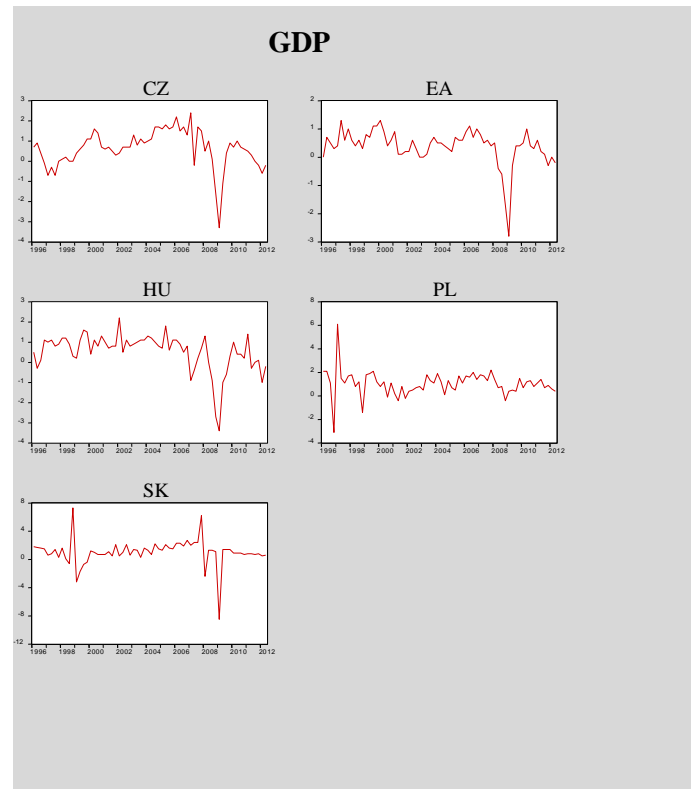
where  $L$  is a lag operator. If  $y_t$  comprises one unit root (order 1), first differences will eliminate non-stationarity problem. If  $y_t$  comprises two unit roots (order 2), second difference are needed:

$$(1 - L)^2 y_t = \Delta y_t - \Delta y_{t-1} = \Delta^2 y_t = u_t \Rightarrow y_t \sim I(2), \Delta y_t \sim I(1), \Delta^2 y_t \sim I(0).$$

Unit root testing can be realized using several approaches, e.g. the Augmented Dickey Fuller (ADF), Elliot-Rothenberg-Stock DF-GLS or Phillips-Perron tests. A standard Augmented Dickey Fuller test is 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 Trace test determines number of equilibrium cointegration equations and eventual presence of trends and/or constants.



HICP - harmonised indices of consumer prices (fixed based index, 2005 = 100)  
GDP - gross domestic product, seasonally adjusted;  
CZ – the Czech Republic;  
EA – the Euro Area;  
HU – Hungary;  
PL – Poland;  
SK – Slovakia;



Source: according to the Eurostat

**Figure 1** HICP and GDP in the V4 Countries and the Euro Area, 1996 – 2012

Finally, the vector error correction model is applied to reveal the structural shocks from the residuals. The Cholesky decomposition was chosen to display the residual variance-covariance matrix where the correct ordering of the variables is crucial.

As a shock on the later ordered variable in the system does not contemporaneously affect the previous ones, we choose the order based on the size of economies: euro area, Poland, Hungary, Czech Republic and Slovakia. As inflation and output are two main explaining variables of the monetary policy rules, e.g. the Taylor rule, harmonized indices of consumer prices and gross domestic product were chosen for the purpose of our analysis. Data, covering the period from 1996 to 2012, are seasonally adjusted and were retrieved from the Eurostat. As we are focusing on the problematic in the respect to the euro area, harmonised indices of consumer prices (HICP) seem to be the most appropriate indicator of inflation. HICP are fixed based indices to year 2005 (2005 = 100). HICP capture monthly and gross domestic product (GDP) quarterly data. HICP cover 202 and GDP 66 observations. A relatively small number of GDP observations may sometimes influence significance of the model results. Nevertheless, such practice is in line with other authors (*see Narayan et al., 2008*).

Evolution of HICP and GDP in the particular Visegrad countries and the euro area in average is displayed in Figure 1. We can observe similar evolution of HICP and GDP from 1996 to 2012 which is in line with transition and integration process of the V4 group. Impact of recent financial and economic crisis is obvious in all observed countries apart from Poland which is relatively the least open economy and consequently the least sensitive to shocks from other countries.

Descriptive statistics of the data are presented in Table 1. Evolution of HICP has the lowest standard deviation in the euro area. Extreme values of GDP explained by kurtosis are the least frequent in the Czech Republic. The highest average economic growth is in Slovakia and Poland, the lowest one is in the euro area.



**Table 1** Descriptive Statistics of HICP and GDP in the V4 Countries and the Euro Area

HICP	EURO AREA	POLAND	HUNGARY	CZECH REPUBLIC	SLOVAKIA
Mean	98.26970	95.53812	95.32322	98.62228	90.76233
Median	97.94500	98.10000	96.89500	98.45000	97.37500
Maximum	116.7800	125.3000	143.5200	120.7000	122.0600
Minimum	83.22000	53.60000	42.49000	70.00000	52.64000
Std. Dev.	9.793462	17.96139	27.80943	13.09254	21.37227
Skewness	0.159423	-0.460196	-0.067984	-0.252243	-0.377244
Kurtosis	1.745488	2.532822	1.975434	2.321185	1.793036
Jarque-Bera	14.10183***	8.966912**	8.990881**	6.020406**	17.05229***
Sum	19850.48	19298.70	19255.29	19921.70	18333.99
Sum Sq. Dev.	19278.29	64844.90	155446.2	34454.31	91811.58
Observations	202	202	202	202	202
GDP	EURO AREA	POLAND	HUNGARY	CZECH REPUBLIC	SLOVAKIA
Mean	0.3818	1.0469	0.5333	0.6197	1.0287
Median	0.5000	1.1000	0.8000	0.7000	1.1500
Maximum	1.3000	6.1000	2.2000	2.4000	7.3000
Minimum	-2.8000	-3.1000	-3.4000	-3.3000	-8.5000
Std. Dev.	0.6194	1.0664	0.9254	0.9187	1.8657
Skewness	-2.5853	0.5175	-1.9174	-1.2665	-1.4522
Kurtosis	13.3982	12.1807	8.2641	6.8101	14.2697
Jarque-Bera	370.8622***	234.7326***	116.6480***	57.5662***	372.4729***
Sum	25.2000	69.1000	35.2000	40.9000	67.9000
Sum Sq. Dev.	24.9381	73.9243	55.6666	54.8644	226.2753
Observations	66	66	66	66	66

HICP - harmonised indices of consumer prices (fixed based index, 2005=100)

GDP - gross domestic product, seasonally adjusted

**Table 2** Correlation Matrix of HICP and GDP in the V4 Countries and the Euro Area

HICP	Euro Area	Poland	Hungary	Czech Republic	Slovakia
Euro Area	1.000000	0.957854	0.990366	0.972266	0.974162
Poland		1.000000	0.986281	0.990838	0.975488
Hungary			1.000000	0.991685	0.983570
Czech Rep.				1.000000	0.971599
Slovakia					1.000000
GDP	Euro Area	Poland	Hungary	Czech Republic	Slovakia
Euro Area	1.000000	0.477880	0.424577	0.395579	0.067523
Poland		1.000000	0.149859	0.250694	0.058020
Hungary			1.000000	0.273776	-0.163157
Czech Rep.				1.000000	0.398227
Slovakia					1.000000

Pearson correlations

Correlation matrix in Table 2 displays Pearson correlations among analysed countries as for their HICP and GDP. Correlations within HICP are statistically very significant, unlike GDP evolution. These findings seem to be in line with intuitive observation of Figure 1. However, the

vector error correction model and the consequent variance decomposition will lead us to more relevant conclusions as it takes into account lagged values, too.

**4. Research method and data**

As it is typical for economic time series, level values are non-stationary (see Table 3). First differences permit us to reach required stationarity. The Augmented Dickey-Fuller testing was applied in this research. Test results indicate that all-time series are integrated of order one, which is crucial to perform the cointegration analysis.

**Table 3** Augmented Dickey-Fuller stationarity testing

HICP	Level values		First differences		GDP	Level values		First differences	
	C, T, L	t-stat	C, T, L	t-stat		C, T, L	t-stat	C, T, L	t-stat
Czech Rep.	C, T, L=0	-2.8318	C, L=13	-3.5731**	Czech Rep.	C, T, L=0	-3.2439	C, L=0	-9.3871***
Hungary	C, T, L=14	2.5325	C, L=13	-3.4684***	Hungary	C, T, L=0	-3.1031	C, L=0	-9.5624***
Poland	C, T, L=1	3.1156	C, T, L=0	-8.6495**	Poland	C, T, L=0	-3.1165	C, L=1	11.1274***
Slovakia	C, T, L=0	0.8908	C, L=0	-12.6541**	Slovakia	C, T, L=0	-2.7174	C, L=2	-8.9804***
Euro Area	C, T, L=13	3.2491	C, L=13	-3.2384**	Euro Area	C, T, L=0	-3.0682	C, L=0	-8.8397***

C = constant (intercept), T = trend, L = number of lags;

\*, \*\*, \*\*\* indicates statistical significance at different 1, 5, 10 % level;

5 % level was chosen to be a decisive criterion to reject/accept the alternative hypothesis

It is obvious from Table 4 that the Johansen Trace test determines one equilibrium cointegration equation for HICP as well as GDP. Trend and constant are found out in case of HICP. GDP cointegration equation includes only constant (see Table 5).

**Table 4** Unrestricted Cointegration rank test (Trace)

Hypothesized	HICP				GDP				
	No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value
None *	0.1987	95.7104	88.8038	0.0145	None *	0.4550	80.1219	69.8188	0.0060
At most 1	0.1184	52.0472	63.8761	0.3275	At most 1	0.2166	41.8804	47.8561	0.1621
At most 2	0.0654	27.2191	42.9152	0.6684	At most 2	0.1839	26.4969	29.7970	0.1145
At most 3	0.0434	13.8830	25.8721	0.6672	At most 3	0.1265	13.6920	15.4947	0.0918

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level;

\*, \*\*, \*\*\* indicates statistical significance at different 1, 5, 10 % level;

5 % level was chosen to be a decisive criterion to reject/accept the alternative hypothesis; MacKinnon-Haug-Michelis (1999) p-values;

The opposite signs of the estimated cointegration coefficients  $\beta$  in Table 5 between the euro area and the V4 group confirm the idea of the euro area dominance in the Central European region in long term. The opposite signs indicate positive relationship. Increase of HICP and GDP in the euro area leads to rise of these indicators in the V4 countries in long-run.

**Table 5** Cointegration

	Euro Area	Poland	Hungary	Czech Rep.	Slovakia	trend	constant
Estimation for HICP							
Cointegration vector $\beta$	1.000	-0.5505 [-2.4268]	-2.6011 [4.5773]	-1.1452 [-4.1214]	-0.1004 [1.9984]	-1.0011 [-5.0003]	-89.8288
Error correction vector $\alpha$	-0.0078 [-1.0152]	0.0146 [1.9698]	-0.0472 [-3.6245]	0.0104 [ 2.1232]	-0.0188 [-2.1413]	-	-

	Euro Area	Poland	Hungary	Czech Rep.	Slovakia	trend	constant
<b>Estimation for GDP</b>							
Cointegration vector $\beta$	1.000	-0.2364 [-1.9868]	-0.5451 [-4.0706]	-0.8947 [-5.7569]	-0.3762 [3.5585]	-	0.5958
Error correction vector $\alpha$	0.0487 [0.4151]	-0.1127 [-0.7041]	0.4070 [ 2.1605]	1.1109 [ 4.2467]	-1.4576 [-3.1835]	-	-

$\alpha$  - error correction vector,  $\beta$  - cointegration vector

On the other hand, the short term euro area impact on the V4 economies expressed by error correction vector  $\alpha$  is not so obvious. The long term impact is evident in case of HICP and GDP, too.

Variance decomposition based on the vector error correction model captures mutual impacts and transmissions among observed countries as for their HICP or GDP respectively. Table 6 expresses HICP forecast variance decomposition with lags corresponding to 1, 3, 6, 12 and 24 months. Cumulative impacts of shocks are calculated from the perspective of the V4 (eventually V3 remaining countries) and foreign countries (including the euro area).

**Table 6** HICP Forecast Variance Decomposition

explained country	period (month)	euro area	Poland	Hungary	Czech Republic	Slovakia	V4	foreign countries
Euro Area	1	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	3	84.8288	9.4763	3.7775	1.2359	0.6813	15.1710	15.1710
	6	78.1902	15.5314	3.6386	1.4964	1.1431	21.8095	21.8095
	12	80.9099	13.0831	2.6903	1.2144	2.1021	19.0899	19.0899
	24	81.8550	11.7053	2.7377	1.4465	2.2552	18.1447	18.1447
Variance Decomposition of HICP in Poland								
explained country	period (month)	euro area	Poland	Hungary	Czech Republic	Slovakia	V3	foreign countries
Poland	1	2.8375	97.1624	0.0000	0.0000	0.0000	0.0000	2.8375
	3	2.7240	95.2910	0.1807	1.1994	0.6046	1.9847	4.7087
	6	1.9760	90.7257	2.4133	4.2808	0.6041	7.2982	9.2742
	12	1.0100	84.9096	4.2543	8.5354	1.2905	14.0802	15.0902
	24	0.5161	76.3570	9.6993	11.4350	1.9924	23.1267	23.6428
Variance Decomposition of HICP in Hungary								
explained country	period (month)	euro area	Poland	Hungary	Czech Republic	Slovakia	V3	foreign countries
Hungary	1	6.1749	20.5133	73.3116	0.0000	0.0000	20.5133	26.6882
	3	1.7906	31.1190	64.3810	2.6100	0.0991	33.8281	35.6187
	6	4.8226	32.2874	49.4007	13.4343	0.0547	45.7764	50.5990
	12	6.8625	22.5868	38.7503	30.4213	1.3789	54.3870	61.2495
	24	7.1569	18.6252	36.6343	34.9931	2.5903	56.2086	63.3655
Variance Decomposition of HICP in the Czech Republic								
explained country	period (month)	euro area	Poland	Hungary	Czech Republic	Slovakia	V3	foreign countries
Czech Republic	1	0.0038	11.9049	23.7137	64.3774	0.0000	35.6186	35.6224
	3	0.7626	14.0593	21.1551	63.8158	0.2072	35.4216	36.1842
	6	2.1916	14.8533	15.7591	64.2681	2.9307	33.5431	35.7347
	12	1.9876	8.6572	16.0521	65.8691	7.4337	32.1430	34.1306
	24	2.5136	8.4594	25.2246	55.8378	7.9644	41.6484	44.1620
Variance Decomposition of HICP in Slovakia								
explained country	period (month)	euro area	Poland	Hungary	Czech Republic	Slovakia	V3	foreign countries
Slovakia	1	1.4424	0.0391	5.4445	11.6780	81.3957	17.1616	18.6040
	3	1.1455	0.0737	2.8091	11.9133	84.0582	14.7961	15.9416
	6	0.8105	2.1042	1.4961	7.8996	87.6894	11.4999	12.3104
	12	0.5428	2.8198	0.7584	3.6804	92.1983	7.2586	7.8014
	24	0.4150	2.7681	0.4967	2.2874	94.0326	5.5522	5.9672

Cholesky ordering: the euro area, Poland, Hungary, the Czech Republic, Slovakia

As expected the impact of inflation in the V4 countries on the euro area inflation is quite weak, i.e. maximally 21.8% in 6-month period with decreasing tendency in the following months. However, impact of the euro area on particular V4 countries is smaller than supposed (maximally at the level of 7.2% in the case of Hungary). Mutual influence of the V4 countries is more important. Economic and trade interdependence within the V4 group seems to have higher importance. It can also correspond to territorial structure of their external trade. Besides trade with Germany, the V4 business transactions have the most important volume in these countries.

While HICP in Poland can be explained by more than 23% by HICP in the other V3 countries in the 24-month horizon, the euro area HICP influences Polish HICP by less than 3% in short term with diminishing tendency in longer horizon. Impact of the V3 partners on Hungarian and Czech HICP is even more important (up to 56.2% or 41.6% respectively in long run).

**Table 7** GDP forecast variance decomposition

explained country	period (trimester)	euro area	Poland	Hungary	Czech Republic	Slovakia	V4	foreign countries
<b>Euro Area</b>	1	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	94.4406	1.6680	3.2667	0.0224	0.6021	5.5592	5.5592
	4	93.4585	1.3011	3.7602	0.2026	1.2774	6.5413	6.5413
	6	94.1662	1.1199	3.4801	0.2404	0.9932	5.8336	5.8336
	8	94.7141	0.9124	3.2962	0.2356	0.8414	5.2856	5.2856
Variance Decomposition of GDP in Poland								
explained country	period (trimester)	euro area	Poland	Hungary	Czech Republic	Slovakia	V3	foreign countries
<b>Poland</b>	1	7.2068	89.1489	3.2054	0.4387	0.0000	3.6441	10.8509
	2	11.0047	82.4904	3.3783	0.4841	2.6422	6.5046	17.5093
	4	17.9378	66.1207	7.6843	0.5670	7.6900	15.9413	33.8791
	6	22.0026	60.8788	7.0961	0.8640	9.1583	17.1184	39.1210
	8	25.6537	55.3283	6.9329	0.8330	11.2519	19.0178	44.6715
Variance Decomposition of GDP in Hungary								
explained country	period (trimester)	euro area	Poland	Hungary	Czech Republic	Slovakia	V3	foreign countries
<b>Hungary</b>	1	38.0309	0.9827	60.9862	0.0000	0.0000	0.9827	39.0136
	2	47.3604	2.0945	49.7302	0.3617	0.4529	2.9091	50.2695
	4	54.8386	1.5881	38.0040	4.7820	0.7871	7.1572	61.9958
	6	57.5964	1.3762	35.5640	4.8794	0.5838	6.8177	64.4141
	8	58.6527	1.3545	34.3456	5.1658	0.4811	7.0014	65.6541
Variance Decomposition of GDP in the Czech Republic								
explained country	period (trimester)	euro area	Poland	Hungary	Czech Republic	Slovakia	V3	foreign countries
<b>Czech Republic</b>	1	30.4570	0.0000	0.0000	69.5429	0.0000	0.0000	30.4570
	2	53.2492	0.4032	2.8285	42.0329	1.4859	4.7176	57.9668
	4	59.3454	0.2388	2.8417	35.6466	1.9271	5.0076	64.3530
	6	62.5068	0.2818	2.5572	32.9984	1.6556	4.4946	67.0014
	8	63.8001	0.2216	2.5561	31.8022	1.6198	4.3975	68.1976
Variance Decomposition of GDP in Slovakia								
explained country	period (trimester)	euro area	Poland	Hungary	Czech Republic	Slovakia	V3	foreign countries
<b>Slovakia</b>	1	4.4735	3.8292	0.3108	5.9475	85.4388	10.0875	14.5610
	2	20.8446	5.4140	0.8810	8.8060	64.0542	15.1010	35.9456
	4	20.8117	6.3661	3.9033	10.5456	58.3731	20.8150	41.6267
	6	25.7889	5.3303	4.8980	10.6175	53.3651	21.6290	47.4179
	8	27.8470	5.1326	5.5709	10.9255	50.5238	21.6290	49.4760

Cholesky ordering: the euro area, Poland, Hungary, the Czech Republic, Slovakia

Slovak HICP seems to be least dependent from the V3 (maximally 17.2%) and the euro area HICP (maximally 1.4%). These findings can be quite surprising as Slovakia is very small and open economy with very narrow business and trade links with observed countries including the euro area. However, this result can be explained by Slovak membership in the European Exchange

Rate Mechanism II since 2005 and consequent euro adoption. Thus, Slovakia had to maintain low and stable inflation resistant to external shocks.

Table 7 captures GDP forecast variance decomposition with lags corresponding to 1, 2, 4, 6 and 8 trimesters. Impact of the V4 GDP on the euro area growth is even weaker than in the case of HICP. Unlike previous case, GDP transmission from the euro area to the V4 is more obvious than within the V4 group itself. Polish, Hungarian and Czech GDP is explained by 25.6%, 58.7% or 63.8% respectively by the euro area GDP in 2-year horizon. The impact corresponds to the openness of economy. Polish economy is the least open and largest economy from the V4 countries, thus the GDP transmission is the lowest. Slovakia represents again an exception. Impact of foreign GDP on Slovak growth is relatively small (comparing with the Czech Republic and Hungary) which can be caused by above mentioned euro adoption preparations, consequent economic policy measurements, and important reforms during last decade (e.g. tax reform).

## **Conclusions**

In conclusion, HICP transmission process between the euro area and the V4 countries on the other hand is much weaker than HICP transmission within the V4 countries. As for GDP, the opposite seems to be true. Mutual interdependence of HICP evolution in the V4 countries can stem from similar disinflation and transition process in 1990s as well as almost equivalent purchasing power. Significant impact of the euro area economic growth on the V4 growth is caused by the V4 dependence on the euro area trade, demand and investments. Nevertheless, Slovakia represents an exception due to its recent integration to the European Monetary Union.

Application of a single monetary rule seems to be ambiguous. While economic growth shocks are relatively symmetrically transmitted from the euro area to the V4 countries, inflation shocks are transmitted mostly only within the V4. This interdependence is obvious also during current financial and economic crisis. Therefore, in respect to the observed countries, a common monetary rule should put more weight rather on GDP or output gap than on inflation gap. Yet, in line with endogenous argument this situation should change in the future. We can expect that inflation shocks will evolve more symmetrically also due to increasing purchasing power in the V4 countries.

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## DECISION-MAKING PROCESS AND CONSENSUS FORMATION

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### Abstract

*The aim of the paper is to draw up a model of consensus formation on problem solving in a group in relation to the decision-making process. The model will help to enhance our understanding of group behaviour. First, the main elements and relations of the system are identified and described and a mathematical model is created using mathematical equations. Second, impact of the changes of independent variables on dependent variables is tested and compared to our experience. Some conclusions resulting from the proposed model and its testing are also interpreted.*

**Keywords:** model, problem solving, work group, consensus, decision-making.

**JEL Classification:** M12, M54, J53

### 1. Introduction

Human resources are the key factor in searching for increased productivity of the organization (Stverkova *et al.* 2012). It is also well known that the evolution of the “classic management model” towards ever greater specialization of labour, centralized decision-making and labour fragmentation resulting in a thicket of collaborative relationships has created growing problems in addition to rising profits. For this reason, management models aimed at boosting the integrated efforts of all employees in the organization toward eliminating these issues are fervently sought. In small and microenterprises, the cognitive phase of the management cycle is exclusively within the purview of the person at the top of the organizational hierarchy – the owner, entrepreneur, director, CEO or authorized representative. The same is true of managerial decision-making, often including the intervention phase, where the task is to implement the decisions adopted (Adair 2013). By contrast, in larger organizations, a greater number of persons normally participate in the activities and procedures which make up the managerial cycle. It is only a slight simplification to denote this process as group- or team-based decision-making.

### 2. Intragroup interaction and decision-making process

Intragroup interaction, interpersonal communication, understanding and collaboration between decision-makers play a key role in achieving synergistic effects in group decision-making (Forsyth, 2010). This is true both during the joint preparation of decisions and during the joint act of decision-making itself and, subsequently, during the intervention and implementation phase of the managerial cycle. These group activity variables depend upon the nature of the decision-making context and are particularly sensitive to the personality of each member participating in the decision-making group’s preparation and adoption of the decision.

Key ingredients in the fitness of group decision-makers, which serve as the basis for effective group decision-making, include not just their skills, knowledge and familiarity with the realities of the situation, but also personal characteristics needed for group activities such as openness, friendliness, a willingness to cooperate, responsibility, toleration, respect and positive relationships toward colleagues and their cognitive styles, along with insight into the motives of others, respect for their ideas, empathy for their frame of mind and the ability to communicate.

To approach the group decision-making process, the impact of communication on the formation of consensus on a problem under discussion by primary and secondary working groups in a particular organization will first be discussed. A problem and its relationship to the decision-making process will be understood as follows:

- the problem will be understood to consist in the lack of certain means for achieving the organization's desired objectives. The means to deal with the problem may be either tangible or intangible – e.g., lack of methods or knowledge.
- or the reverse may be the case: the problem may lie in the formulation of goals which correspond to the means at the organization's disposal.

Problems are resolved via the decision-making process. The purpose of the decision is to eliminate the problem (existing or potential). Increasing problems in an organization usually point to decreasing efficiency on the part of the organization's management (Prince, 2012).

Organizations can only deal with problems within the framework of a defined set of changes in the circumstances of their existence. The purpose-driven components which make up the organization have their own defined problem areas. Effective consensus formation processes play a significant role in the successful functioning of the organization.

This article attempts to arrive at a specific model based upon what is known about communication processes within employee groups during the decision-making process. It is based upon empirical research. Its practical employment in management and in the decision-making process is multifaceted, both as affects the rank-and-file employees of the organization who implement decisions taken by others outside their group, and by managers who are ever increasingly deciding as a group.

### 3. Designation of variables for the model of consensus formation in decision-making process

The first fundamental component consists in the objective *significance of the problem* for the group and the potential to do something about it. Other input variables which must be included in this model are the *perceived difference in a group members' opinions* at time  $t$  concerning the problem at issue and its resolution, and group cohesion, understood as the level of motivational unity of the group members.

A variable defined as the difference between the opinions of group members at time  $t$  concerning the problem at issue must be taken into account, since the objective of the decision-making process is to issue a decision constituting an optimal solution for the problem. It is desirable that differences in opinion between group members on how the problem is to be resolved be reduced or eliminated.

A “group cohesion” variable must be considered because good results in implementing the decision will depend both upon its quality and on the motivation to carry it out. This motivation is proportional to the level of group cohesion in terms of the joint interest of all its members to implement the decision.

The input and output variables in the model of “consensus formation in group-based problem solving in the decision-making process” will therefore be the perceived difference between the opinions of group members at time  $t$  concerning the problem at issue and its solution, and the level of group cohesion. The logic behind transforming the changing levels of these variables over time (from input to output variables) is the subject of our interest. So that the decision-making process can take place in a group, its members must exchange information on the problem and its solution. This leads to a reduction in differences of opinion on the problem at issue and its resolution, along with increasing the group cohesion.

If, for example, the information exchange between group members takes place in such a way that one member of a group forces his solution upon the two remaining members and they simply accept it formally as the final word on resolving the problem, it is very likely that the member who “won” will be strongly motivated to carry out the solution in a quality way but the motivation of the remaining two will not be adequate. In this way, group cohesion is reduced both as regards implementing the decision and in terms of the future activity of group members in exchanging information to find optimum solutions to problems in their organization. This means that the variables which will impact the change in the output variable values, i.e., the perceived difference in the group members' opinions and group cohesion will be identical to those impacting the course and efficiency of the information exchange process between group members.

The designation of individual variables influencing the information exchange process between individual members of the group and their causal ties is based on some conclusions of



Clarkson and Simon (1960) and Festinger *et al.* (1950, 1951, 1999) which have been critically re-evaluated and modified in terms of their theoretical basis and in light of the author's own research. In this context, it should be noted that this approach is only one of several possible for research on this issue.

The basic hypotheses of the model may be formulated as follows:

- Pressure on the information exchange between group members to eliminate differences of opinion on the problem – the bigger the difference of opinion, the greater the pressure applied.
- The greater the degree of the problem's significance for the group's activity, the greater the pressure.
- The greater the group cohesion, the greater the pressure.
- The greater the rate of change in the opinions of individual group members as a result of obtaining information from other group members, the greater the pressure to form an opinion consensus between group members.
- The rate of change of group members' opinions on resolving the problem rises in tandem with pressure to reduce differences of opinion as the result of information exchange between group members, if the recipient of the information is well integrated into the group.

Using the above, the individual variables, which influence the information exchange process between group members, the consensus of group opinions concerning the solution of the problem and the level of motivation among all group members, can be introduced. These variables include *pressure to exchange information (pressure to communicate) between group members at time t*, *pressure on the group to achieve a consensus of opinions for the problem and its solution at time t (pressure to achieve consensus)*, *pressure to reduce differences of opinion on the problem in question and its solution* as a result of the information exchange between members at time *t*. The variables and hypotheses defined above may be used to create a model system of "consensus formation in group-based problem solving in the decision-making process", and to describe its structure and behaviour.

#### *Kinematic depiction of the model and transformation equations*

The kinematic depiction of the model indicated in Figure 1 shows the system structure of the model, defining mutual ties between its elements. The model transformation equations also describe the structure of the system contained in the model. They will be employed to analyse and describe model behaviour using either partial transfers or the end result information transfer depicting the state of individual variables (elements) in the "consensus formation in group-based problem solving in the decision-making process" model at a given time *t*. (System elements are circled in the kinematic diagram — e.g., information on variables as follows:  $V_R(t)$ ,  $T_j(t)$ , etc.).

Individual variables (information):

- $V_R(t)$  - the perceived difference in group members' opinions on the problem in question and its solution at time *t*,
- $T_k(t)$  - pressure for communication between group members at time *t*,
- $M_k(t)$  - pressure to seek and find suitable opportunities for informational ties between group members at time *t*,
- $T_z(t)$  - pressure to reduce differences of opinion concerning the problem at issue as a result of the information exchange between the group members at time *t*,
- $D(t)$  - the significance of the problem for the group at time *t*,
- $S_v(t)$  - ability and willingness of group members to perceive the influencing of their opinion on the problem and its solution as a result of information exchange with other members of the group at time *t*,
- $T_j(t)$  - pressure felt by the group to achieve a consensus of opinions on the problem at issue and its solution at time (pressure to achieve consensus),
- $S_s(t)$  - group cohesion at time *t*,

-  $t$  - duration of the implementation of the decision-making process in interval  $t \in \langle t_0, t + 1 \rangle$ , while  $t_0$  is the time at which the decision-making process is initiated and  $t+1$  is the time at which the decision-making process is completed when a decision is arrived at.

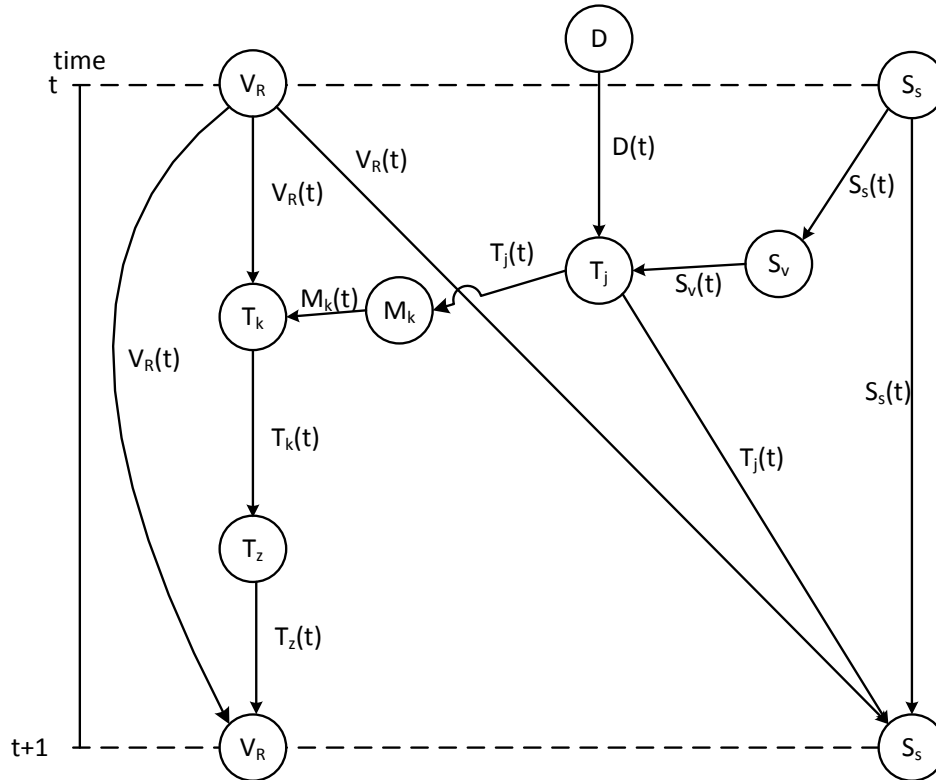


Figure 1 - Model of ties between individual variables

*Model transformation equations*

The transformation equations describe the allocation of input and output information which characterizes the state of individual system elements of the model. They are set up using the hypothesized ties between model variables indicated above.

$$T_k(t) = T_k(V_R(t); M_k(t)) \tag{3.1}$$

$$T_j(t) = T_j(D(t); S_v(t)) \tag{3.2}$$

$$S_v(t) = S_v(S_s(t)) \tag{3.3}$$

$$M_k(t) = M_k(T_j(t)) \tag{3.4}$$

$$T_z(t) = T_z(T_k(t)) \tag{3.5}$$

The change over time in the difference in opinions on the problem at issue and its solution during the decision-making process will be described using transformation equation (3.6).

$$\frac{dV_R(t)}{dt} = f(T_z(t); V_R(t)) \tag{3.6}$$

The change in group cohesion over time during the decision-making process  $v$  will be described by means of transformation equation (3.7).

$$\frac{dS_s(t)}{dt} = h(S_s(t); T_j(t); V_R(t)) \tag{3.7}$$

We will assume that  $\Delta V_R(t) = V_R(t + 1) - V_R(t)$ , yielding  $dV_R$  for  $dt$  in differential form; and that  $\Delta S_s(t) = S_s(t + 1) - S_s(t)$ , giving  $dS_s$  for  $dt$  in differential form.

As noted above, changes in  $V_R$  and  $S_s$  over time are keys for evaluating the efficiency of the decision-making process. Values of the model variables will be assumed to represent an average or sum for group members. To examine model's behaviour, we must thus assume that the magnitude of every variable at time  $t$  may be expressed as a real number.

#### **4. Determining quantitative values for the model variables**

As a general rule, social characteristics are only amenable to indirect measurement via changes in the quantitative values of phenomena directly related to the characteristic in question. This principle must also be applied in determining the quantitative level of variables in the model described here.

##### *Measuring the $V_R$ variable*

Differences of opinion within the group on a particular problem may be measured in terms of information and analysed using a form which allows the characteristics of the problem to be depicted in a uniform manner, along with proposals for its resolution. Group members may utilize it to express their opinions on a problem, characterize it and express their opinions on its solution during the initial consensus formation process and then repeated after a certain period of time has elapsed. This process may be done several times. Frequency differences between differing characteristics for the same problem, as noted on the form at varying times, allow conclusions to be drawn about the magnitude of differences of opinion concerning the problem in question.

*Sample Form.* Problem specification form:

- Problem formulation;
- Detailed specification of the problem;
- Person responsible for resolving it: a) Foreman; b) Head of the workshop; c) Head of the facility;
- How fast must it be solved: a) As soon as possible; b) After thorough consideration; c) In the future;
- How long has the problem been present: a) A very long time (probably longer than 5 years); b) A long time (probably 2 to 5 years); c) A shorter period of time (no more than around 2 years);
- Severity of the problem: a) Critical importance; b) Very serious; c) Less serious;
- Problem solving: a) The problem has been solved but reoccurs repeatedly; b) The problem has not been resolved.

*Form for specification of problem solving proposals:*

- Proposal formulation;
- Detailed specification of the proposal;
- Degree of proposal sophistication: a) Thought through in great detail – we are convinced it is going to be successfully implemented; b) It will need to be confronted using other solution variants, the best of which must be selected; c) It is only a proposal requiring further thought;
- How quickly must the proposal be implemented: a) As soon as possible; b) After thorough consideration; c) In the future;
- Origin of the proposal: a) The proposal is not new, it only must be implemented; b) I am not sure whether those responsible are sufficiently acquainted with it; c) The responsible persons are probably not acquainted with it.

##### *Measuring the $T_k$ Variable*

This variable may be measured by the frequency and duration of personal contacts between group members. If the number of meetings and the amount of time spent in discussion between group members increase, this is undoubtedly testimony to the fact that there is increasing pressure for communication between group members. Both the frequency and time spent on this communication may be measured either by auto-time-frame estimator or retrospectively using questionnaires, observations, etc.

*Measurement of the  $M_k$  variable*

One prerequisite for mutual understanding is that people must “speak the same language”. In this sense, the pressure to seek out suitable forms of communication is indirectly measurable by studying the time devoted by group members to clarifying and understanding the different opinions of other group members, acquiring different terminology, approach methods, the specifics of a professional outlook on the problem in question, etc. Primarily, then, the focus is on the amount of time devoted to preparing an effective discussion from a content standpoint. Also noteworthy is the effort to seek out suitable means of communication – where, how and when to communicate. Measurement of this variable faces special obstacles. However, it may be measured in a manner similar to what was done with the  $T_k$  variable, using an overall estimate of time devoted to the preparation of group discussions.

*Measurement of the  $T_z$  variable*

Pressure to seek out and locate potentially suitable information connections and frequencies, along with a time for communication to take place, need not be directly proportional to pressure for reducing differences of opinion on the problem. This is testified to by the results of evaluations of the communication level achieved at staff meetings. Several surveys have discovered that, if group discussions which are always or usually useful take place, this is closely tied to an excellent or good evaluation of work performance and initiative on the part of one’s colleagues, a positive evaluation by superiors, the selection of mostly identical co-workers, a desire to remain in the group, etc. This fact also generates pressure to reduce differences of opinion among group members on the solution of the problem in question as part of the decision-making process. If by contrast such discussions do not take place, the situation is opposite. The level of the  $T_z$  variable may therefore be measured, for example, using the frequency and evaluation of the communication level achieved in group discussions (manufacturing discussions, staff meetings). If the frequency of responses viewing the discussions as lost time diminishes, this may be seen as a sign of increased pressure to reduce differences of opinion as the result of information exchange between group members at time t and vice versa.

*Measurement of the  $S_v$  variable*

The ability and willingness to perceive other group members' influence on opinions depends upon the composition of the group. It directly correlates with group cohesion and the mutual respect shown between group members. The ability for such perception is a function of the particular qualification prerequisites. The willingness to perceive depends upon the interest (need) of group members to participate in resolving the problem at issue (Snapka and Kasik, 2012). Both are subject to measure: ability, by comparing an ideal (or normed) state with reality; and subsequently willingness, by looking at the level of mutual evaluations of other group co-workers.

*Measurement of the  $T_j$  variable*

The pressure to achieve opinion consent on the problem at issue within the group is conditioned upon awareness of the severity of the problem for the group and awareness of the need for a joint approach to its solution. This variable may therefore be measured as the sum of the severity values determined for the problem (in the form – see the measurement of  $V_R$ ) and the group cohesion value.

*Measurement of the  $S_s$  Variable*

Indirectly, this variable may be measured by the frequency of answers by group members to questions like the following:

- Do you wish to remain in the group?
- Are all group members unified in their actions?
- Do group members help each other?
- Are your friends mostly within or outside the circle of group members?

But it is also possible to measure using the fluctuations in group members not due to an objective cause, the equality of degree to which individual tasks are fulfilled, etc. The overall

situation in the organization with respect to determining quantitative values for the model variables may be obtained, e.g., using questionnaire (Horvathova and Mikusova, 2012) with questions focused on the approach to decision-making, interpersonal communication, difference of opinions among the decision-makers, team roles (Belbin 1985, 1993), etc.

*Partial and end information transfers*

Behavioural research under the model will be carried out on the basis of information transfers describing the behaviour of individual system elements and the entire system as a whole. The transfer is understood to be the ratio of information output to information input. Then the transfer concerns both the input and output information as part of the individual system elements or the entire system itself. The transfer will determine what changes occur in output variable values depicted by the information output by the model. To express the quantitative values of variables and their changes no notice is necessary of whether the influence of particular pieces of information input and cohesion  $S_s$  increase or decrease in the group on the basis of a precisely quantifiable analytical function. For many transfers, this is impossible to determine. The focus is put on the direction of the dependence, i.e., in what direction a transformation from input to output information occurs.

The research focus, then, is on whether there is an increase or decrease in the quantitative level of output information by the transfer of quantitatively different level of input information. In what follows, the term input or output information will only be used to describe information processes in the system modelled. The term transfer will be understood to mean the ratio of information output to information input. To determine the transfer, the partial derivatives of functions expressed by the transformation equations describing the system structure will be used to characterize the direction of transfer. We shall thus make use of the partial derivative of a function which actually characterizes information output on the basis of a variable which characterizes information input, thereby obtaining the ratio which has been labelled "transfer" above. Knowledge of the signs of the individual partial derivatives of the functions, i.e., transfers, will allow us to determine the resultant transfers using the system structure.

**5. Creation of partial and total transfers of information describing system model behaviour**

In analysing the efficiency of the course of the decision-making process aimed at arriving at the optimum resolution of the problem at issue and the required level of motivation needed to inspire group members to implement the decision in practice, we will focus on the character of the final system transfer. This transfer is understood to consist of the progression of changes in  $V_R$  as its value diminishes and  $S_s$  as it maintains the required group cohesion or improves cohesion at the conclusion of the decision-making process. As part of the system behaviour examined, chains of partial transfers must be determined which describe the behaviour of individual system elements and the character of these transfers. This is because the end transfer reflecting the character of changes in system output variables ( $V_R$ ,  $S_s$ ) depends upon the mutual ties between partial transfers and their nature.

When we determine the partial transfer chains, we actually determine which system elements must be activated in time and how the input and output information values describing the behaviour of these elements must change over time if the system is to show the behaviour required by the goals of the decision-making process. The nature of the particular transfers as shown by the sign of the partial derivative used to depict them, will be determined either using the above noted hypotheses about work group communication processes, or via calculations based upon knowledge of the nature of the final transfer and of partial transfers organized in a chain of partial transfers. These determine the end transfer examined in a manner such that the composition of the signs of the partial transfers of individual system elements achieves the required sign of the partial derivative – the transfer which determines the nature of the end transfer.

The character of a particular transfer may be interpreted using the signs of the partial derivative as follows: if the sign of the transfer is positive ( $>0$ ), the change in output information value is directly proportional to the change in the input information value over time. If the sign is negative for the transfer ( $<0$ ), the change is indirectly proportionate.

*Examining system behavior for changes in  $V_R$*

As emphasized above,  $V_R$  is the first result variable whose change over time influences the course of the decision-making process and its objective of finding an optimum solution. Because of this, an analysis of potential change in this variable over time must first be carried out and the conditions, i.e., the behavior at which the system must arrive to reduce or eliminate any differences of opinion as to how the problem is to be resolved must be designated.

The change over time in  $V_R$  is defined by equation (3.6), i.e.:

$$\frac{dV_R}{dt} = f(T_z(t); V_R(t)), \quad \text{where: } T_z(t) = T_z(T_k(t))$$

If  $T_z(t) = T_z(T_k(t))$  is substituted into differential equation (3.6), then we get:

$$\frac{dV_R(t)}{dt} = f[T_z(T_k(t)); V_R(t)] \tag{5.1}$$

This equation may be used to determine the transfer ( $F_1$ ) of a portion of the system as the ratio of changes in the output information value to changes in the input information value, where the output information will reflect the rate of change in  $V_R$  over time and the input information will reflect the value of  $T_k$  over time. This transfer will be examined provided there is a certain level of difference in group members' opinions on resolving the problem at issue. Transfer  $F_1$  will thus be as follows:

$$F_1 = \frac{\partial f}{\partial T_k(t)} = \frac{\partial f}{\partial T_z(t)} \cdot \frac{\partial T_z}{\partial T_k(t)} \tag{5.2}$$

Given hypotheses no. 1, 2, 4 and 5 and the requirements placed by the effectiveness of the decision-making process, it must hold true that  $F_1 < 0$ , which means that the *speed of group member consensus formation, i.e., movement in the direction of reducing the difference in group members' opinions on problem solution will grow in tandem with the pressure to achieve communication*. Given the purpose of the decision-making process and hypothesis no. 5, it must hold true of the nature of the transfer  $\frac{\partial f}{\partial T_z(t)}$ , that: the partial transfer value must be less than zero; given the sign of the  $F_1$  transfer, it must be true that the transfer  $\frac{\partial T_z}{\partial T_k(t)}$  must take on values greater than zero for a decision to be made in the decision-making process on the basis of a consensus of all or a majority of group members. This is one of the demands placed on an effective decision-making process.

In this sense, the  $T_k$  variable is a key or "node" variable whose value changes over time in tandem with changes in  $T_z$ . This is important, since changes in the frequency of information change between individual members of the group, i.e., an increased frequency of such exchanges, results in heightened potential for growth in pressure  $T_z$ . This pressure forms the basis for reducing differences of opinion on resolving the problem, i.e., arriving at an optimum decision.

To achieve this, any transfer of that portion of the system in which  $T_k$  is the output variable must be designated via chains which include individual system element transfers; these, after being activated (together with the nature of the information transfer) induce changes in the value of  $T_k$ .  $D$  is the first input variable whose own changes impact on the value of  $T_k$  over time. Any change in the value of this variable impacts the change in the value of  $T_k$  via activating the system element in the chain in question, from the  $D$  element up to the  $T_k$  element. The system's behaviour in the context of the change in  $T_k$  as  $D$  varies over time are described via a transfer  $F_2 = \frac{\partial T_k(t)}{\partial D(t)}$ . Because of the nature of this transfer, i.e., its sign, in keeping with hypothesis no. 2 and the requirements placed upon decision-making effectiveness, the  $F_2$  transfer must be greater than zero. This is due to the fact that decreasing opinion differences between group members on the problem and its solution, as well as arriving at an optimal decision, is conditioned upon increasing pressure for achieving communication. The  $F_2$  transfer, then, will be as follows:

$$F_2 = \frac{\partial T_k(t)}{\partial D(t)} > 0 \tag{5.3}$$

In keeping with hypothesis No. 2, the partial transfer  $\frac{\partial T_j}{\partial D(t)}$ , must be greater than zero and the nature of the two remaining partial transfers,  $\frac{\partial T_k}{\partial M_k(t)}$  and  $\frac{\partial M_k}{\partial T_j(t)}$ , may be determined by considering the sign of the  $F_2$  transfer. *The sign of the two partial transfers must be positive, i.e., greater than zero, or negative.* In any event, based upon empirical findings, the growth of significance of a problem brings pressure to achieve uniformity ( $T_j$ ) while maintaining a certain level of group cohesion ( $S_s$ ). If the signs of  $\frac{\partial M_k}{\partial T_j(t)}$  and  $\frac{\partial T_k}{\partial M_k(t)}$  are positive and  $T_j$  is increasing, growth in the value of  $T_k$  will be conditioned upon the growth of  $M_k$  over time. If the signs of the partial transfers are negative, there is intensive growth in the value of  $T_k$  due to the increased frequency of information exchange between group members aimed at reducing differences of opinion on the problem at issue and its solution, at the same time that the frequency of individual meetings, staff meetings, etc., involving group members is decreased. The nature of the problem and its degree of severity have been clarified by group members to such an extent that no further opportunities for information exchange are necessary to clarify the problem at issue.

$S_s$  is the other input variable whose own changes in value over time impact upon the values of  $T_k$ . The changes in value of this variable influence changes in the value of  $T_k$  by activating the system elements in a particular chain, i.e., from the  $S_s$  element up to  $T_k$ . System behaviour with regard to changes in the  $T_k$  variable arrived at as a result of changes in the  $S_s$  variable over time will be described by means of a transfer  $F_3 = \frac{\partial T_k(t)}{\partial S_s(t)}$ .

The sign of this transfer value (in keeping with hypothesis no. 3 and the requirements placed upon the efficiency of the decision-making process aimed at forming group consensus) *must always be greater than zero.* This conclusion follows from the fact that increasing group cohesion brings pressure for communication between group members. This is because if there is growth in the motivation level of all group members to find an optimum solution to the problem at issue – the optimal decision – and its successful implementation in practice, group members will try to exchange information as frequently as possible to arrive at the optimum decision. The  $F_3$  transfer will then be as follows:

$$F_3 = \frac{\partial T_k(t)}{\partial S_s(t)} > 0, \tag{5.4}$$

$$\text{where: } \frac{\partial T_k(t)}{\partial S_s(t)} = \frac{\partial T_k}{\partial M_k(t)} \cdot \frac{\partial M_k}{\partial T(t)} \cdot \frac{\partial T}{\partial S_v(t)} \cdot \frac{\partial S_v}{\partial S_s(t)} \tag{5.5}$$

The sign of the partial transfers  $\frac{\partial T_k}{\partial M_k(t)}$  and  $\frac{\partial M_k}{\partial T_j(t)}$  with growth  $T_j(t)$  - was discussed in examining the  $F_2$  transfer.

To achieve efficiency in the decision-making process we require the value of  $S_s$  to grow over time. Per the initial hypotheses, growth in  $S_s$  brings growth in  $T_j$ . Based upon these prerequisites – the sign of the  $F_3$  transfer and the potential signs of partial transfers  $\frac{\partial T_k}{\partial M_k(t)}$  and  $\frac{\partial M_k}{\partial T_j(t)}$  – the  $\frac{\partial T_j}{\partial S_v(t)}$  and  $\frac{\partial S_v}{\partial S_s(t)}$  transfers must be either greater than zero or less than zero.

If the sign of these partial transfers is positive, growth in  $T_j$ , with growing values of  $S_s$ , is conditioned upon growth in  $S_v$ . All the members are not only *willing*, which is a condition, but also *capable of* fully participating in seeking out an optimal solution to the problem at issue. If the sign of the partial transfers  $\frac{\partial T_j}{\partial S_v(t)}$  and  $\frac{\partial S_v}{\partial S_s(t)}$  is negative, growing values of  $S_s$  and  $T_j$  lead to declines over time in  $S_v$ . This is so because group members, even if *willing* to exchange information with other group members, are not all *capable of* sharing information at a particular level of exchange but

place complete "trust" in individuals or a limited subgroup to come up with a solution to the problem.

The final entry variable which influences changes in the value of  $T_k$  is  $V_R$  as an initial value. System behaviour with regard to changes in the  $T_k$  variable arrived at as a result of changes in the  $S_s$  variable over time may be described by means of the transfer:

$$F_4 = \frac{T_k(t)}{V_R(t)} \quad (5.6)$$

In keeping with hypothesis 1, this transfer's sign must be positive, *i.e.*:

$$F_4 = \frac{T_k(t)}{V_R(t)} > 0 \quad (5.7)$$

Based upon an analysis of the transfers above, we have defined the behaviour determined by one requirement influencing the effectiveness of the decision-making process. This requirement is the reduction of differences of opinion among group members as to how to solve the problem at issue and how to implement the solution in practice.

*An examination of the nature of consensus formation in group-based problem solving in the decision-making process in the context of the demand placed by the  $S_s$  variable upon the decision-making process*

The second resultant variable for which a change in value influences the course of the decision-making process and the motivation of members to implement the decision in practice is the  $S_s$  variable. In view of this, the following section of this article undertakes an analysis of the nature of the system in question. We will determine the conditions under which the cohesion level decreases in a group, *i.e.*, what kind of behaviour must be achieved within the system so as to prevent a loss of cohesion at the end of the decision-making process when the decision has been reached. We will thus analyse how  $S_s$  must change over time for the system to regain a dynamic, balance state with regard to  $S_s$  at the end of the decision-making process, *i.e.*, so that  $dS_s = 0$ . If this is true, the transition of the system from one equilibrium to another will not reduce group cohesion.

The system is thrown into disequilibrium due to a problem the group must solve and differences of opinion among group members as to its solution.

The new equilibrium will be attained by terminating the decision-making process, *i.e.*, when a decision is made serving as a basis for solving the problem in the organization in question. Considering the requirement for an effective decision-making process, meaning that a decision must be arrived at whose nature will allow the highest motivation possible on the part of group members to implement it in practice, a decrease in group cohesion must not occur during the decision-making process, *i.e.*, the transfer of the system from one equilibrium to another. Within the new system equilibrium, the  $S_s$  must attain a value which allows successful implementation of the decision made in practice.

The change over time in group cohesion during the decision-making process is defined by equation (5.7):

$$\frac{dS_s(t)}{dt} = h(S_s(t); T_j(t); V_R(t)).$$

If we assume the  $h(S_s(t); T_j(t); V_R(t))$  function is differentiable or that it has an equilibrium point (a total differential) at a particular point ( $S_{sp}; T_{jp}; V_{Rp}$ ), then the change in  $S_s$  during the decision-making process, *i.e.*,  $dS_s$ , may be determined via the total differential of the  $h(S_s(t); T_j(t); V_R(t))$  function. This total differential will be as follows:

$$dS_s = \frac{\partial h}{\partial V_{Rp}} \cdot dV_{Rp} + \frac{\partial h}{\partial T_{jp}} \cdot dT_{jp} + \frac{\partial h}{\partial S_s(t)} \cdot dS_{sp}, \quad (5.8)$$



With regard to the demand placed on the value of  $S_s$  when the equilibrium is achieved, it must hold true that:  $dS_s=0$ .

*The significance of the  $dS_{sp}$ ,  $dV_{Rp}$  a  $dT_{jp}$  differentials:*

- $dS_{sp}$  - the required change in the value of  $S_s$  at the start of system transfer from one equilibrium to another, ensuring successful implementation of the decision made in practice by attaining adequate motivation for all group members to implement the decision;
- $dV_{Rp}$  - the change in the value of  $V_R$  at the end of the decision-making process, i.e., at the time of the new system equilibrium;
- $dT_{jp}$  - the change in the value of  $T_j$  at the end of the decision-making process, i.e., at the time of the new equilibrium.

Equation (5.7) shows that the rate of change of group cohesion is influenced by changes in the values of  $T_j$ ,  $V_R$  and  $S_s$  for a particular time. A decrease in the group cohesion level during the decision-making process may occur if the corresponding changes of variable values in the system influenced by the changes in  $S_s(V_R$  a  $T_j)$  do not occur. It is for this reason that the system equilibrium will be examined and the nature of the transfer required so that group cohesion does not decrease – i.e.,  $dS_s = 0$  – will be determined.

If the required change in the value of  $V_R$  does not occur to form a consensus on the problem and its solution during the decision-making process, i.e.,  $dV_R = 0$ , then the condition for equilibrium, taking  $S_s$  into account, will be as follows:

$$\frac{\partial h}{\partial T_j(t)} \cdot dT_{jp} + \frac{\partial h}{\partial S_s(t)} \cdot dS_{sp} = 0, \quad (5.9)$$

and the transfer of the system describing behaviour in terms of necessary changes in the values of  $S_s$  if there is a change in value of  $T_j$  and if  $dV_{Rp} = 0$ , will be as follows:

$$F_5 = \frac{dS_{sp}}{dT_{jp}} = - \frac{\frac{\partial h}{\partial T_j(t)}}{\frac{\partial h}{\partial S_s(t)}}. \quad (5.10)$$

If the requirement for effective progress of the decision-making process is to be fulfilled along with the initial hypothesis and the condition for system equilibrium, then the transfer value must be positive, i.e.,  $F_5 > 0$ , because with the growth in change of  $T_j$  induced by the problem significance level, the value of the change required in  $S_s$  must grow – this being group member motivation to implement the decision taken even though there is no change in differences of opinion among group members on solving the problem.

Also, under this condition, the rate of change of  $S_s$  must grow over time with growing values of  $T_j$ . (This means  $\frac{\partial h}{\partial T_j(t)} > 0$ , so that there is no decrease in the level of  $S_s$  at the end of the decision-making process when a decision is made and accepted by the group's environment – for example, based upon external pressure from the group environment or pressure exerted by an individual within the group).

The growth in group cohesion over time must be implemented based upon intensive Impact by other information exchanges between the group members which are focused in directions other than solving the problem at issue. These may include information exchanges based upon friendships, etc.

Taking into account the sign of the resulting transfer  $F_5$ , i.e.,  $F_5 > 0$  and the nature of the transfer  $\frac{\partial h}{\partial T_j(t)} > 0$ , to achieve equilibrium in the system of “consensus formation in group-based problem solving in the decision-making process”, it must be true the  $\frac{\partial h}{\partial S_s(t)}$  transfer is less than 0, i.e.,  $\frac{\partial h}{\partial S_s(t)} < 0$ . This condition is based upon the speculation that the greater the change is on the group cohesion level at time  $t$ , the smaller the rate of change for this variable may be in subsequent

time intervals during the decision-making process in contrast to  $t$ , taking into account the system equilibrium conditions and limitations on the change required for  $S_s$  to achieve equilibrium.

If the value of  $T_j$  decreases during the decision-making process (for example, because the problem's significance decreases), the nature of the transfers will be maintained. There will only be a change in the requirements placed on the nature of the output variables from the transfer in question – with their value decreasing over time to achieve equilibrium for transfers  $F_5$  and  $\frac{\partial h}{\partial T_j(t)}$ .

If the value of  $T_j$  does not change during the decision-making process, i.e.,  $dT_{jp} = 0$  during the transfer from one equilibrium to another, then the conditions for systemic equilibrium, taking the  $S_s$  variable into account, will be expressed as follows:

$$\frac{\partial h}{\partial V_R(t)} \cdot dV_{Rp} + \frac{\partial h}{\partial S_s(t)} \cdot dS_{sp} = 0, \tag{5.11}$$

and the transfer of the system describing behaviour in terms of necessary changes in the values of  $S_s$  if there is a change in  $V_R$  with  $dT_{jp} = 0$  will be as follows:

$$F_6 = \frac{dS_{sp}}{dV_{Rp}} = - \frac{\frac{\partial h}{\partial V_R(t)}}{\frac{\partial h}{\partial S_s(t)}}. \tag{5.12}$$

If the requirement for effective progress in the decision-making process is to be fulfilled along with the initial hypotheses and the condition for system equilibrium, then the  $F_6$  transfer value must be *positive*, i.e.,  $F_6 > 0$ , because with growing changes in  $V_R$  during the decision-making process (conditioned upon the existence of inadequate pressure for opinion consensus if the value of the  $T_j$  variable does not change during the decision-making process), the required change in  $S_s$  – motivation of group members to implement the decision made – must grow.

A constant level of pressure for opinion consensus may be caused, for example, by the fact that some group members do not consider the problem in question as important as other members. Also, under this condition, the rate of change of  $S_s$  must grow over time, i.e.,  $\frac{\partial h}{\partial V_R(t)} > 0$ , so that there is no decrease in the value of  $S_s$  at the end of the decision-making process.

Considering the sign of the resulting transfer  $F_6$ , i.e.,  $F_6 > 0$ , its shape and the character of transfer  $\frac{\partial h}{\partial V_R(t)} > 0$ , to achieve equilibrium  $\frac{\partial h}{\partial S_s(t)}$  must be less than 0, i.e.,  $\frac{\partial h}{\partial S_s(t)} < 0$ . Just as with the prior analysis, this condition is based upon the speculation that the greater the change is on group cohesion at time  $t$ , the lower the rate of change may be for this variable during subsequent time intervals in the decision-making process, taking into account the system's equilibrium conditions and limitations on the change required for  $S_s$  to achieve equilibrium.

If the value of  $V_R$  decreases during the decision-making process (there is sufficient initial pressure to attain uniformity), the nature of the transfers will be maintained. There will only be a change in the requirements placed on the nature of the output variables from the transfer in question – with their value decreasing over time to achieve equilibrium for transfers  $F_6$  and  $\frac{\partial h}{\partial V_R(t)}$ .

The aforementioned analysis of the end transfer and partial transfers describing the nature of “consensus formation in group-based problem solving in the decision-making process”, taking the required state of  $S_s$  into account when moving from one equilibrium to another, was used to determine the nature of these transfers, i.e., what behaviour the system must demonstrate so that the required changes in  $S_s$  during the decision-making process are achieved.

**Conclusion**

By way of conclusion, the individual transfers analysed and used to describe the nature of the introduced model are included in Table 1.

This provides a clearly laid-out overview of how a particular element (variable) must be activated so that the decision-making process taking place in practice and being analysed may be evaluated as a rational process and so that it becomes possible (on the basis of empirical

knowledge obtained from the analysis) to use comparison and determine where in the organization’s decision-making processes corrections must take place to allow processes to attain the requisite quality.

**Table 1** - Transfers describing the nature of the “consensus formation in group-based problem solving in the decision-making process” system

Resulting transfer	Partial transfers creating the resulting transfer
$F_1 = \frac{\partial f}{\partial T_k(t)} < 0$	$\frac{\partial f}{\partial T_z(t)} < 0; \frac{\partial T_z}{\partial T_k(t)} > 0$
$F_2 = \frac{\partial T_k(t)}{\partial D(t)} > 0$	$\frac{\partial T_j}{\partial D(t)} > 0; \left( \frac{\partial M_k}{\partial T_j(t)} > 0 \wedge \frac{\partial T_k}{\partial M_k(t)} > 0 \right) \vee \left( \frac{\partial M_k}{\partial T_j(t)} < 0 \wedge \frac{\partial T_k}{\partial M_k(t)} < 0 \right)$
$F_3 = \frac{\partial T_k(t)}{\partial S_s(t)} > 0$	$\left( \frac{\partial M_k}{\partial T_j(t)} > 0 \wedge \frac{\partial T_k}{\partial M_k(t)} > 0 \right) \vee \left( \frac{\partial M_k}{\partial T_j(t)} < 0 \wedge \frac{\partial T_k}{\partial M_k(t)} < 0 \right);$ $\left( \frac{\partial T_j}{\partial S_v(t)} > 0 \wedge \frac{\partial S_v}{\partial S_s(t)} > 0 \right) \vee \left( \frac{\partial T_j}{\partial S_v(t)} < 0 \wedge \frac{\partial S_v}{\partial S_s(t)} < 0 \right)$
$F_4 = \frac{T_k(t)}{V_R(t)} > 0$	
$F_5 = \frac{dS_{sp}}{dT_{jp}}$	$\frac{\partial h}{\partial T_j(t)} < 0; \frac{\partial h}{\partial S_s(t)} < 0$
$F_6 = \frac{dS_{sp}}{dV_{Rp}}$	$\frac{\partial h}{\partial V_R(t)} > 0; \frac{\partial h}{\partial S_s(t)} < 0$

**Acknowledgement**

The research was supported by the European Social Fund within the project CZ.1.07/2.3.00/20.0296.

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## OPERATIONAL RISK IN CONTEXT OF SLOVAK BANKING SECTOR

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### **Abstract:**

*The article deals with the analysis of operational risk in commercial banking in Slovakia. The importance of operational risk has increased due to Basel II including capital requirements for operational risk in new concept of capital adequacy. The aim of this paper is to quantify the relationship between operational risk and selected variables in terms of commercial banks in Slovakia. First part analyses the Slovak banking sector in terms of capital adequacy and capital requirement for operational risk. In analytical part we examine with help of regression models the relationship between operational risk and selected variables, to find out what are the key factors affecting operating losses in commercial banks.*

**Keywords:** operational risk, banks, Basel II, Slovak Republic, statistics.

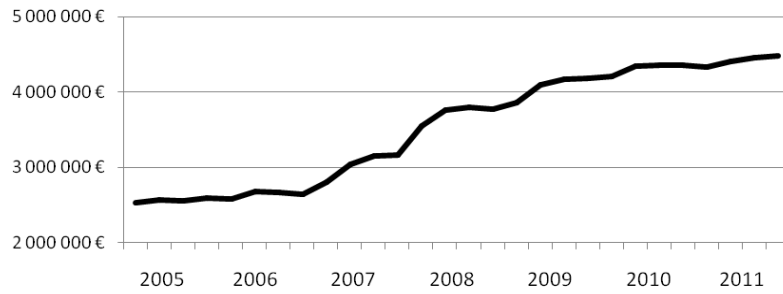
**JEL Classification:** E50

### **1. Introduction**

Developments in the field of operational risk are really quick, but banks usually lack reliable long-time series of data on operational losses, that could help them in strategy development (Vejačka and Vincová, 2009). Currently, there are several databases monitoring certain banking sector areas (ORX, RiskBusiness), but the problem is that data provided are not fully comparable with each other. As McAleer *et al.* (2009) demonstrated, procedures for choosing a model to measure market risks have changed after the impact of financial crisis in years 2008 - 2009. Authors focused on optimal model selection for measuring market risk in banks, considering a combination of conservative and aggressive risk management strategies and recovered impact of Basel II on banks' risk management. Using Standard and Poor's 500 index authors modelled impact of Basel II on risk management during financial crisis. The situation is similar for models for estimating operational risk that are currently available. Lot of banks is using only basic indicator approach or standardized method and advanced models are still being evolved. At the present, there is still no proven largely used that could and would be incorporated into the first pillar of Basel II. In next section we analyze Slovak banking sector from point of view of capital adequacy and own resources with attention to operational risk. Relationship between gross income and variable expressing the size of the bank is identified and a detailed analysis of a particular commercial bank operating in the country is carried out.

### **2. Sector analysis**

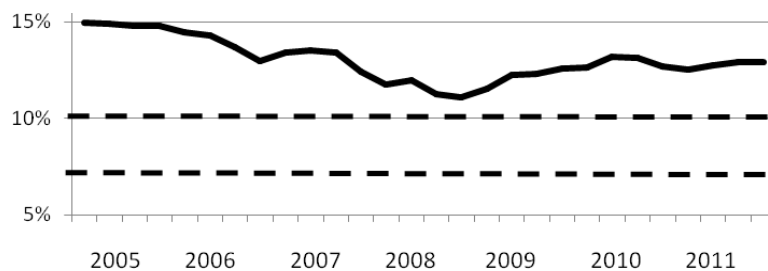
By 1.1.2012 in Slovakia, there were 14 banks with residence in territory of Slovak Republic and 15 foreign banks branches (nbs.sk). Banks and branches of foreign banks were included into analysis. The observed period is defined: beginning of 2005 (Q1) till end of 2011 (Q4). Data used in this section are from NBS statistics.



Source: (Own research based on NBS data)

Figure 1 –Amount of own funds (thousands)

During crisis, which is most visible at the end of 2008, banks on global market had to worry about actual trust between each other and trust in banking sector as a whole. Therefore, there has been an increase of amount of own funds in many banks to maintain their adequacy and finally, confidence among clients increased too. The crisis came to Slovakia with a lag, so Slovak banks had enough time to prepare. In Figure 1, we can observe an increase in volume of own funds in 2008 and continued moderate growth in 2009. In next season there is no such significant growth. Proportion of Tier 1 on own funds, to which as key component of the capital, is placed the greatest emphasis, reached during all monitored periods values from 88 % to 95 %. Figure 2 demonstrates development of capital adequacy in Slovak banking sector.

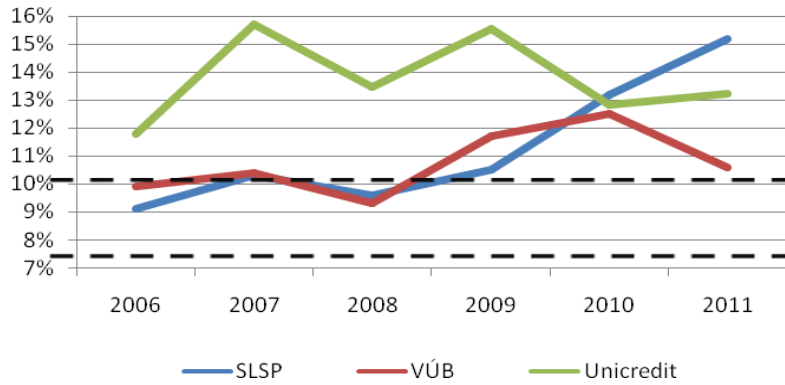


Source: (Own research based on NBS data)

Figure 2 - Capital adequacy in sector

Capital adequacy (Capital to Risk Weighted Assets Ratio) has stable values throughout the period and is in zone between 11% and 15%. First dashed line indicates value 8% specified by Basel II. Second dashed line represents the value of 10.5%, which is suggested by Basel III after capital increase of conservative pillow. The value of capital adequacy during the period does not fall below 8% or below 10.5%.

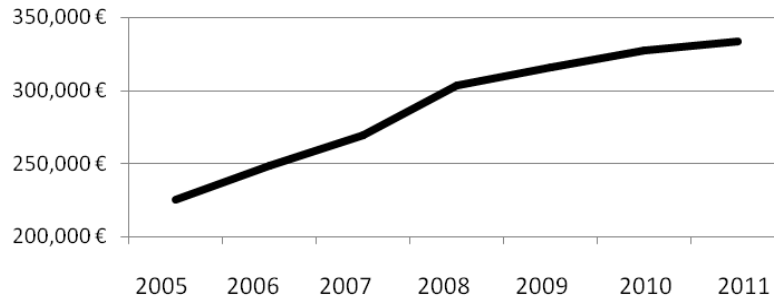
Figure 3 shows the evolution of banks capital adequacy, which currently use AMA methods to quantify capital requirement for operational risk in period from 2006 to 2011. These are banks - Slovenská Sporiteľňa (SLSP), Všeobecná úverová banka (VÚB) and Unicredit Bank. Lower dashed line as in previous case, marks amount of 8% fixed by Basel II, upper dashed line represents proposed value 10.5% of new Basel III framework. At the beginning of reporting period in 2006, capital adequacy of VUB and SLSP was in range between 9% and 10%. Unicredit Bank's capital adequacy reached 12% and higher values than SLSP and VUB maintained until 2010. After approval of Basel III framework by leaders of G20 summit in Seoul in November 2010, capital adequacy of banks got over desired value 10.5% of new Basel agreement. It remained there also following year 2011 and capital adequacy of SLSP increased to value above 15%.



Source: Own research based on annual reports of banks (annual data)

Figure 3 - Capital adequacy of selected banks in Slovakia

Figure 4 shows development of capital requirement for operational risk in Slovak banking sector, calculated according to approach of basic indicator BIA.



Source: (Own research based on NBS data)

Figure 4 - The capital requirement for operational risk in sector calculated using BIA (in thousands)

After 2008, is visible a growing trend with a slight slowdown. Low volatility and almost linear trend is caused by BIA calculation method. Calculation is defined by Basel II framework, in which is important average for the past three years, which smoothed time series (three-year average was introduced just to reduce volatility). Volume of capital requirement for operational risk in Slovak banking sector calculated according to basic indicator approach in 2005 was 225 million EUR, and got up to 333 million EUR in 2011. Fluctuations in the volume of capital requirements for not only operational risks could be also the result of usage of several hedging Instruments (Šoltés and Rusnáková, 2013)

## 2. Testing the relationship of operational risk and bank size by correlation analysis

Basel II assumes in BIA and TSA methods linear relationship between operational losses and bank size. In next section we proceed to test this assumption and establish whether nature of this relationship can be expressed otherwise as a linear. As source data NBS statistics with monthly frequency during 2005 to 2011 will be used.

First, we empirically examined the correlation (Rimarčík, 2007) of operational loss amount and bank size. Correlation coefficient measures the strength of statistical dependence between two variables. Correlation coefficient values are in range from -1 to 1, with values close to 0 represent no dependence and absolute values close to 1 a strong relationship. Positive values indicate that variables change in same direction, negatives opposite direction. As mentioned, *Price Water House Coopers* study in 2000 revealed that bank size is only a very small part of operational

losses variability ( $R = 5\%$ ). As variables reflecting bank size in study performed: income, total assets and number of employees.

Most banks located in Slovakia (11 of 14 banks) uses BIA or TSA methods, therefore, first part of analysis deals mainly with relationship of variables to gross income (GI). The aim was to find out what is dependency ratio between gross income and monitored variables.

Gross yield acts as a variable expressing the size of operational risk (calculated according to NBS definition). For variables reflecting bank size, we selected total assets, loans and other assets, number of branches, number of employees, information technology costs, and personnel costs.

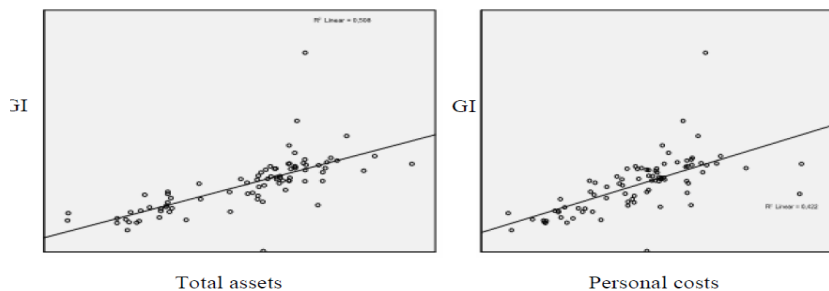
We started by calculating correlations (Pearson's  $r$ ) between gross income (GI) and variables that represent bank size. When interpreting correlation coefficients we will use intervals created by Cohen (1988) to interpret correlation coefficients in psychological and sociological research: correlation less than 0.1 is significant, from 0.1 to 0.3 small, 0.3 to 0.5 middle and more than 0.5 high.

**Table 1** - Values of correlation coefficients between GI and variables

	Total assets	Loans and receivables	Branches	Employees	IT costs	Personnel costs
Correlation coefficient	0.712774	0.631147	0.555915	-0.096628	0.588863	0.649400
Significance	0,000	0,000	0,010	0,075	0,000	0,000

Source: Own research

We found that all variables except number of employees are highly correlated with gross income. The strongest positive linear relationship is observed with total assets, where correlation coefficient reaches to 0.71 and personnel costs with correlation coefficient of 0.65, which reflects a very strong positive linear relationship. Only correlation with number of employees showed insignificant dependence. In study (Shih, Samad-Khan and Medapa, 2000) they observed strong dependence of number of employees, but operational risk was quantified using real recorded operational losses, not only their gross revenue.



Source: Own research

**Figure 5** – Correlation GI and Total Assets (left) and Personal costs (right)

Graphic representation of correlation observed is in Figures 5. Visual inspection of correlogram is required to verify that any remote measurements (outliers) do not affect the height of correlation coefficient. Correlation is high, if it can be measured if we can place a line in plane by method of least squares. Graphical representation is consistent with previous findings and highest correlation show gross income with total assets and personnel costs.

Next step was to calculate correlation coefficients of variables after logarithmic transformation, to compare if dependence is stronger, which would suggest that relationship between bank size and operating loss is not linear and would be better described by exponential function. Thus bank of two-time size in average would not suffer by double losses (Shih *et.al.*



2000). The study assumes a concave exponential function, and thus with growing size of banks decrease operating losses gains. Correlation coefficients of logarithmed variables capture Table 2.

**Table 2** - Correlation coefficients of logarithmed GI values and variables

	Total assets	Loans and receivables	Branches	Employees	IT costs	Personnel costs
Correlation coefficient	0.747693	0.660924	0.568239	-0.111874	0.671063	0.689657
Significance	0,000	0,000	0,000	0,2	0,000	0,000

Source: Own research

We observed that variables after logarithmic transformation showed stronger relationship to losses than in the first case with original variables. But it was a very slight increase in range of a few hundredths. This indicated that relationship is not better expressed by exponential function what supports previous research.

**3. Testing the relationship of operational risk and the bank size by regression analysis**

In following part we continued with inclusion of variables in a linear regression model. The linear regression model has general form (Lejnarová, Ráčková, Zouhar, 2009):

$$y_t = \beta_0 + \beta_1 x_{t1} + \dots + \beta_k x_{tk} + u_t \tag{1}$$

for (1,2, ..., n), where:  $y_t$  – explaining variable;  
 $\beta_0$  – absolute member of regression;  
 $\beta_0, \dots, \beta_k$  – model parameters;  
 $x_{t1}, \dots, x_{tk}$  – explanatory variables;  
 $u_t$  – random component;  
 n – number of observations.

For n number of observations we get n equations with n unknown numbers. From this system we can calculate estimated parameters  $\beta_0, \beta_1, \dots, \beta_k$ .

Also, a linear model can be written as:

$$y = X\beta + u, \tag{2}$$

$$y = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix}, X = \begin{pmatrix} 1 & x_{11} & \dots & x_{1k} \\ 1 & x_{21} & \dots & x_{2k} \\ \vdots & \vdots & \ddots & \vdots \\ 1 & x_{n1} & \dots & x_{nk} \end{pmatrix}, \beta = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{pmatrix}, u = \begin{pmatrix} u_1 \\ u_2 \\ \vdots \\ u_n \end{pmatrix} \tag{3}$$

If we mark statistical parameter estimates  $\beta_0, \beta_1, \dots, \beta_k$ . and estimated theoretical value of explained variable  $\hat{y}$ , then:

$$\hat{y}_t = \beta_0 + \beta_1 x_{t1} + \dots + \beta_k x_{tk} \quad \text{for } t \quad (1, 2, \dots, n) \tag{4}$$

Value y is given by:

$$y = \beta_0 + \beta_1 x_{t1} + \dots + \beta_k x_{tk} + e_t \quad \text{for } t \quad (1, 2, \dots, n) \tag{5}$$

of above equations, we see that:

$$\hat{y}_t = y + e_t \quad \text{for } t \quad (1, 2, \dots, n) \tag{6}$$

Statistical evaluation and conclusions can be deduced from linear model only if certain conditions of variables in model are met. They are called the Gauss-Mark assumptions (Lejnarová, Ráčková, Zouhar, 2009):

- mean value of random variable must be at each of  $n$  observations equal to zero;
- random component variance is constant for all observations - homoskedasticity assumption;
- random variables are uncorrelated, have zero covariance;
- explanatory variables  $x_i$  are not random variables, nor stochastic, independent from random variables;
- random variables are from the normal distribution.

Request of random components normality distribution is often neglected in definition of linear regression model (in this case, leaving only requirement of zero mean, constant variance and independence of random component values) (Fedorčáková, 2011). But normality is required for construction of interval estimates and statistical hypothesis testing.

In case of Gauss-Markov assumptions validity, we can determine by method of least squares optimal estimation properties. If latter condition is true (random variables are from normal distribution), estimate  $\tilde{\beta}$  is best possible unbiased estimate (Hatrák, 2007).

Basic assumptions of linear regression model are mutually uncorrelated random components. This means that random component of any two observations need to be independent. Not fulfilling this condition is called autocorrelation (Hatrák, 2007). Autocorrelation is tested by Durbin-Watson test, hypotheses are formulated:

$H_0$ : in model autocorrelation of random components is not present

$H_1$ : in model autocorrelation of random components is present

If  $p > \alpha$ , we do not reject  $H_0$  and autocorrelation of random components is not present. To remove autocorrelation from model can be used for example method of first differences, Cochrane - Orcutt method or Hildreth-Lu method (Hatrák, 2007).

To additional prerequisite of linear model belongs homoscedasticity. Same values of random component variances for different values of explanatory variable are marked as homoscedasticity. If values of variances are not the same, there is no fulfilling of homoscedasticity and a phenomenon known as heteroscedasticity occurs. To detect heteroscedasticity we use Breusch-Pagan test with following hypotheses formulated.

$H_0$ : in model heteroscedasticity is not present

$H_1$ : in model heteroscedasticity is present

If  $p > \alpha$ , we do not reject  $H_0$  and Breusch-Pagans test proves no heteroskedasticity present. Multicollinearity is a phenomenon that occurs, when there is mutual linear dependence between explanatory variables. The presence of multicollinearity in model causes a reduction in accuracy of estimate of regression coefficients. Multicollinearity detected by the variation-inflation factor (vif). If value of vif is greater than 5, multicollinearity is present in model. It can be removed from model using method of first differences, omitting variables, using a priori information, combination of cross-sectional and time data (Hatrák, 2007).

Request of normality levels distribution does not belong to Gauss-Markov assumption of linear regression model, but it is necessary for statistical hypothesis testing. We assume that residuals (random components) in linear econometric model are derived from normal distribution. To verify assumption of normality of residues can be used as Jarque-Bera test (JB test). In JB test we formulate hypotheses:

$H_0$ : residuals are from normal distribution

$H_1$ : residuals are not from normal distribution

Result of testing is test statistic p-value that is compared with alpha (level of significance). If  $p > \alpha$ , we accept hypothesis  $H_0$ , if  $p < \alpha$ , hypothesis  $H_1$  is accepted.

To test model specification errors, by which we find out whether the model chosen is correctly specified, we use testing by Ramsay - Reset test of specification errors, we formulate following hypotheses:

$H_0$ : model is correctly specified

$H_1$ : model is not correctly specified

If  $p > \alpha$ ,  $H_0$  is not rejected and model is specified correctly.

Most banks located in Slovakia use BIA or TSA method, so next part of analysis deals mainly with selected variables relationship to gross income, by which is quantified capital requirement in both approaches. We focused on identifying variables that affect gross income, and level of dependence between gross yield and observed variables.

In linear regression model we used monthly data of Slovak banking sector since beginning of 2005 until end of 2011. Testing was realized at 5% significance level  $\alpha = 0.05$ , which means 95% probability that test will be relevant. Decision to test hypothesis may not always be correct. First type error occurs when hypothesis is rejected even though it is valid. Second kind error is when hypothesis is not rejected, although is not valid. Process and description of tests, by which we verified correctness of model is characterized in next section of text.

Dependent variable representing size of operational risk is gross revenue (in thousands EUR). As independent variables in model are:

- TA - Total assets - (in thousands of EUR);
- LA - Loans and advances to customers - (in thousands of EUR);
- DEP - Deposits received from customers - (in thousands of EUR);
- NI - Net income - (in thousands of EUR);
- HM - Property and equipment - (in thousands of EUR);
- IA - Intangible assets - (in thousands of EUR);
- FIM - Financial instruments held to maturity - (in thousands of EUR);
- FIS - Financial instruments available for sale - (in thousands of EUR);
- PE - Personal expenses - (in thousands of EUR);
- AC – Advertising costs - (in thousands of EUR);
- IT – IT cost - (EUR thousand).

Proposed model can be defined as:

$$GI = \beta_0 + \beta_1 * AC + \beta_2 * PvK + \beta_3 * VaUPoK + \beta_4 * CZ + \beta_5 * HM + \beta_6 * NM + \beta_7 * HM + \beta_8 * FNDdS + \beta_9 * FNnP + \beta_{10} * ON + \beta_{11} * NnP + \beta_{12} * NnSIP + \varepsilon \quad (7)$$

where:  $\varepsilon$  – random component.

When preparing model it is necessary to verify the stationarity of time series. Most economic time series exhibits nonstationarity. Non-stationary time series can be transformed to stationary for example by their differentiation. By first or second differentiation, third differences are practically unused because of complex or economically impossible interpretation. By multiple time series differentiation we obtain stationarity, but also lose a bit of information about long-term relationships between economic time series (Hatrák, 2007). Other model approach could be used for future research as proposed in work of Bálint, Bucko and Vejačka (2012).

The use of non-stationary data (eg. time series showing trend) in models often leads to false regression (or spurious regression). To test the stationarity of time series in our case, we use ADF unit root test (Augmented Dickey-Fuller).

$H_0$ : time series has not a unit root

$H_1$ : time series has a unit root

The presence of a unit root indicates that time series is not stationary. Testing showed nonstationarity of time series on 95% confidence level (except time series net profit and personal costs, which were stationary), so we began differencing them. After first difference all the time series were stationary already at level of significance. Results of Augmented Dickey-Fuller after first difference of time-series captures following table.

**Table 3 - Augmented Dickey–Fuller test results after first differention (p-value)**

	dif(GI)	dif(TA)	dif(LA)	dif(CL)	dif(NB)	dif(HM)
ADF	0,0001	0,0000	0,0000	0,0182	0,0001	0,0000
	dif(IA)	dif(FI)	dif(FIS)	dif(ON)	dif(AC)	dif(IT)
ADF	0,0000	0,0000	0,0000	0,0000	0,0032	0,0001

Source: Own research

This was followed by testing of residue normality distribution using Jarque-Bera test and then test of Gauss-Markov assumptions are shown in following Tables 4 and 5 Testing minimum and maximum values with David, Hartley and Pearson test in original sample showed few outliers. By gradual removal of five outliers David, Hartley and Pearson test did not showed minimal or maximal outlier. Continuous testing of normality by Jarque-Bera test captures following Table 4.

**Table 4 - Testing residues normality distribution**

	1. outlier	2. outlier	3. outlier	4. outlier	5. outlier
Jarque-Bera	2,2e-16	0,747	0,69	0,088	0,462

Source: Own research

In our case, p-value of Jarque-Bera test is greater than selected level of significance, so null hypothesis is not rejected, so we can actually assume normality of residues distribution. Final model after withdrawal of five outliers is then tested for presence of heteroscedasticity, autocorrelation and multicollinearity. Results of Gauss-Markov assumptions tests captures following table.

**Table 5 - Gauss-Markov model assumptions**

Assumption	Heteroscedasticity	Autocorrelation	Multicollinearity
Test	Breusch-Pagan	Durbin-Watson	vif
Results	value = 3,019 p-value = 0,388 not present	value = 2,663 p-value = 0,99 not present	< 2 viable

Source: Own research

Since p-value of Breusch-Pagan test is higher than specified level of significance, we can say that we could not reject the null hypothesis about the absence of heteroscedasticity, so we can assume homoscedasticity in data. P-value of Durbin-Watson test is higher than specified level of significance; we do not reject the null hypothesis of uncorrelance of residues, by what from thin point of view model can be considered as a suitable. Value of variation-inflation factor (vif) is for variables in model less than 2, multicollinearity in model is viable.

After testing Gauss-Markov assumptions, we proceeded to Backstep regression using qs-STAT statistical software, where on 95% confidence level from model were gradually removed insignificant variables. Resulting values of regression coefficients, interval in which regression

coefficients for a given level of significance may be present, t-statistics, p-value test and vif are shown in Table 6.

**Table 6 - Estimated model parameters diff(GI)**

	x	b	b (...)	t	p	VIF
	const.	12 294	(-75574,100162)	0,279	0,781	-
diff(ON)	x1	1,331	(0,474, 2,188)	3,093**	0,00278	1,132
diff(IT)	x2	1,405	(0,377, 2,434)	2,723**	0,00805	1,309
diff(NB)	x3	0,135	(0,038, 0,231)	2,778**	0,00691	1,240

**Source:** Own research

From us selected variables, which entered into model as statistically significant variables at given significance level showed: diff (PC), diff (IT) and diff (NB). Adjusted determination coefficient (adjusted R2) reaches 20.99%, i.e. variables entering into model explain only 20.99% diff (GI) variability. This means that 79% of diff (GI) variance is caused by other, exogenous factors, which were not incorporated into model.

**Table 7 - Diff(GI) model significance**

R	R*
24,037 %	20,999 %

**Source:** Own research

Reset test value showed that it is properly specified. After substituting estimated values of constant-level value and regression coefficients can be our linear regression model of gross income (GI) be written in form:

$$diff(GI) = 12\,294 + 1,331\,diff(PC) + 1,405\,diff(IT) + 0,135\,diff(NP) \tag{8}$$

### Conclusion

Most banks located in Slovakia uses BIA or TSA methods for operational risk measurement. Basel II assumes in these two methods linear relationship between operational losses and bank size. Gross income acts as a variable expressing the size of operational risk. Therefore aim of the article was to find out what is dependency ratio between gross income and monitored variables.

Based on performed analysis we come to conclusion that a change in personnel costs increase (PC) of 1 unit causes increase of gross income (GI) of 1.331 units. The biggest impact on change of gross income has increase of IT cost), which will cause gross income (GI) increase change of 1.405 units and net profit (NP) increase change by 1. Therefore it is necessary for operational risk management to pay attention to these factors.

### Acknowledgement

We would like to express thanks for the support of the projects SGS-2012-063 titled “*Integrated design of manufacturing system as metaproduct with a multidisciplinary approach and with using elements of virtual reality*“ dealt with in Internal Grant Agency of University of West Bohemia and project NEXLIZ – CZ.1.07/2.3.00/30.0038, which is co-financed by the European Social Fund and the state budget of the Czech Republic.

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# MACROECONOMIC ANALYSIS OF LABOUR MARKET PERFORMANCE: THE CASE OF THE SLOVAK REPUBLIC

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## **Abstract:**

*The paper deals with development of economic and labor market performance in the Slovak Republic. Consequences of the economic crisis on the labor market, respectively on unemployment are also discussed in the paper. During the crisis, real gross domestic product decreased in the Slovak Republic. Massive drop of gross domestic product led to increase in the unemployment rate. We also compared Slovak economy with another EU New Member States.*

*The main question is if this process was also seen at regional level. The unemployment rate differed significantly among the Slovak NUTS 3 regions during the period between 2005 and 2012. According to previous studies high unemployment is caused by drop in economic performance or by some structural problems in the region. During economic growth the unemployment rate was decreasing and during economic downturn it was increasing. We used monthly seasonally adjusted data during the observed period between the years 2005 and 2012. In total, we had 96 observations. We also applied the Hodrick-Prescott filter for estimating the natural rate of unemployment. This method is often used for estimating the potential output and is possible to use in the case of unemployment. Our empirical results show that in most regions the real unemployment rate was lower than the natural rate of unemployment during the pre-crisis period. In other words, it means that the Slovak labour market was in positive unemployment gap. However, this gap was not the same in all regions.*

**Keywords:** Hodrick-Prescott filter, natural rate of unemployment, NUTS 3, regional disparities, Slovakia.

**JEL Classification:** E01, E24.

## **1. Introduction**

One of the key macroeconomic indicators is the unemployment rate which shows labour market performance. The traditional understanding means that if this indicator is increasing, labour market performance is worsening and vice versa. In addition, labour market development is closely associated with the economic cycle and we can say that economic performance influences the situation on the labour market. A deterioration of labour market performance could be also associated with a widespread expansion of the informal economy (Gomes and da Silva, 2009). Moreover, sufficient labour market performance is subject to a corresponding economic performance. The past economic crisis has hit the European Union Member States' labour markets especially hard. Unemployment has been a recurrent problem in most European Union Member States including the Slovak Republic for the last decades and it has become a major concern among not only policymakers but also the society as a whole.

The aim of this paper is to compare labor market development in the Slovak NUTS 3 regions in the period between the years 2005 and 2012. We also compare development of the registered unemployment rate in comparison with the natural rate of unemployment. For this purpose, we applied the Hodrick-Prescott filter as the method how to estimate the natural rate of unemployment. The paper is structured as follows: the introductory section deals with methodological-theoretical aspects of the natural rate of unemployment and its relationship with the real unemployment rate and economic performance. In the second part, we described the method (the Hodrick-Prescott filter) used in the paper and in the third, empirical, section, we compared labour market development among the Slovak NUTS 3 regions and the last part concludes.

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## 2. Theoretical background

The concept of the natural rate of unemployment (NRU) represents the hypothetical unemployment rate consistent with aggregate production being at the "long-run" level. This level is consistent with aggregate production in the absence of various temporary frictions such as incomplete price adjustment in labour and goods markets. The natural rate of unemployment therefore corresponds to the unemployment rate prevailing under a classical view of determination of activity. It is mainly determined by the economy's supply side, and hence production possibilities and economic institutions. If these institutional features involve permanent mismatches in the labour market or real wage rigidities, the natural rate of unemployment may feature involuntary unemployment.

Romer (2005) argues that the development of the theory of the natural rate of unemployment came in the 1960s where economists observed that the Phillips-curve relationship between inflation and unemployment began to break down. Until then, it was widely believed that a stable negative relation between inflation and unemployment existed. This belief had the policy implication that unemployment could be permanently reduced by expansive demand policy and thus higher inflation. Nevertheless, if we look at the original Friedman's paper Friedman (1968) we do not find a clear, well-defined characterization of this concept, but rather description of some features that it should have. This resulted in the hysteresis hypothesis, which states that cyclical fluctuations in the labour market might affect the unemployment rate permanently and might lead to a long-term persistence. This means that the unemployment should be an integrated process (Gomes and da Silva, 2009).

According to Weiner (1993) when the economy is at the natural rate of unemployment, inflation tends to be constant from one year to the next. Individuals come to expect this inflation rate and base their decisions on it. Any attempt to use monetary or fiscal policy to reduce unemployment below the natural rate of unemployment ultimately results in higher inflation. Under such a scenario, aggregate demand increases, prices rise, but wages initially lag behind. As a result, firms have an incentive to hire more workers to produce more output and the unemployment rate declines. The decline in unemployment is temporary, however, because workers eventually demand higher wages. The increase in inflation, in contrast, is permanent. The central bank can set the inflation or the economic cycle. If the central bank follows the inflation variability, the society must tolerate the output gap variability. On the other side central bank can set the economic cycle goal. It means the central bank minimises the output gap variability (for more detailed analysis see Kotlán (2001)).

The OECD distinguishes between a long-run structural rate of unemployment (NRU), corresponding to Friedman's original natural rate, determined by economic fundamentals, and the non-accelerating inflation rate of unemployment (NAIRU) as a short-run phenomenon. The latter may differ from the NRU, when structural or demand shocks occur. In general, the NAIRU is considered an extension of Friedman's natural rate when labour markets are not competitive and most of the literature overlaps the two concepts (Chiarini and Piselli, 2001).

## 3. Methodology

Based on Němec (2008), Tasci (2012), Tuleja and Tvrđon (2011) and da Silvia Filho (2010) we applied the Hodrick-Prescott filter (HP filter) for estimation natural rate of unemployment (NRU). This method is quite frequently used to filter the trend and the cyclical time series. To estimate the natural rate of unemployment, it is necessary to have just the time series of the unemployment rate – in our case the registered one. The only input parameter for the optimal filter, we have to specify, is an appropriate smoothing constant  $\lambda$ . It is defined as the ratio of dispersion of shock causing cyclical fluctuations and shocks affecting the growth trend Hlouchek and Polanský (2007).

The filter is characterized by this formula Hájek and Bezděk (2001):

$$\text{Min} \left\{ \sum_{t=1}^T (\ln U_t - \ln U_t^*)^2 + \lambda \sum_{t=2}^{T-1} [(\ln U_{t+1}^* - \ln U_t^*) - (\ln U_t^* - \ln U_{t-1}^*)]^2 \right\} \quad (1)$$

where: U denotes the registered unemployment rate;

U\* is the natural rate of unemployment;

$\lambda$  is a parameter determining the smoothness of the trend smoothing.



For  $\lambda = 0$  the natural rate of unemployment is equal to the real unemployment rate, for  $\lambda \rightarrow \infty$  the trend will be a straight line. When choosing a value of smoothing constant  $\lambda$ , we then drew on generally accepted recommendations – experts consider optimal value 14400 for monthly data, 1600 for quarterly data and 100 for annual data (Rozmahel (2011), Gerlach and Yiu (2004), Zimkova and Barochovský (2007) or Hájek and Bezděk (2001)).

Monthly national and regional (NUTS 3 level) unemployment rate between the years 2005 and 2012 obtained from Ministry of Labour, Social Affairs and Family of the Slovak Republic database were applied. The standard ANOVA (analysis of variance) was carried out in order to determine the presence of monthly seasonality in the unemployment rates series. Unemployment rates usually exhibit significant seasonality. There are several methods and techniques to adjust time series, e.g. Census X12 and TRAMO/SEATS. The first program is produced and widely used by the US Census Bureau.

TRAMO (Time series regression with ARIMA noise missing observations and outliers) and SEATS (Signal extraction in ARIMA time series), was developed by Gómez and Maravall (1996). For more details to seasonal adjustment and TRAMO/SEATS method see Gómez and Maravall (1998). TRAMO preadjust the series to be adjusted by SEATS (Maravall and Sánchez, 2000). Both of them are officially used by Eurostat. Hence this method was applied to seasonal adjustment.

#### **4. Empirical results**

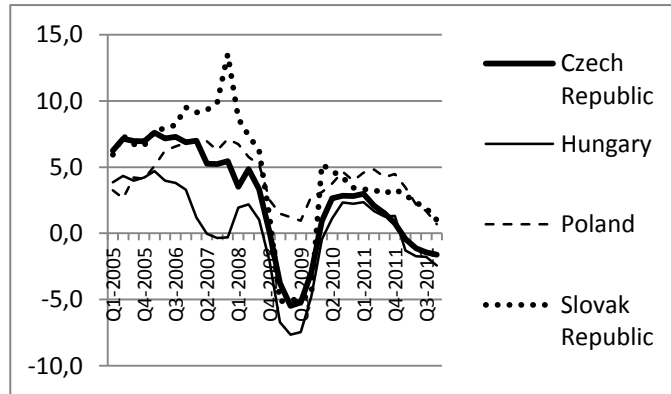
Economic transition in the Slovak Republic ran into difficulties in the late 1990s with a banking crisis, currency problems and an economic recession. However, during the years 2004-2008, the Slovak economy grew steadily and rapidly, and its growth rate was more than twice higher compared with Eurozone' Member States. Significant growth was based on increasing exports and improving labour productivity. Large foreign direct investment (FDI) inflows fostered trade integration, underpinning an export-led expansion. All these factors created conditions for real convergence of the Slovak economy or for so called the catch-up effect. Despite the good macroeconomic performance and the stable banking sector, the Slovak economy has been impacted by spill over effects from the global crisis (mainly through decline in foreign demand). Heavy dependence on industry, which is most affected, caused that industry' performance drop pulls down the whole economy. Global financial and economic crisis erupted in full force in 2008 and first signs of the coming economic crisis, we could see already later than in other western European countries, in the last quarter of 2008, where GDP growth over the same period last year, reached only 0.5%. Although the Slovak Republic is not among the countries most affected by the crisis, it still faced with substantial year on year decline in real GDP in every quarter of 2009 (according to data released by the OECD, real GDP fell by 4.9 percent year-on-year, 5.1 percent in 1Q 2009 respectively). The downturn was largely driven by a sharp contraction in investment, as companies scaled down their production capacities in view of low access to financing and uncertainty about future prospects. Private consumption held up better. It was supported by modest inflation, stable wages, and still largely robust labour markets. Large declines in domestic demand led to increasing net exports.

Looking at performance of the Visegrad group countries for the past fourteen years these economies kept relatively good pace of growth between the years 2005–2010. Hungarian economy grew at the slowest rate in the observed period; the average real GDP growth reached 0.4%. The Hungarian economy was followed by the Czech economy with average real GDP growth rate of 2.6%. Much faster growing economies were Poland and Slovakia with the average of 4.2%, 4.5% respectively. As the result, e.g. the volume of the Czech GDP increased by one third. According to Vintrová (2008) the main reasons of this development can be seen in accession into the EU and cultivation of the institutional framework which made these countries more attractive for foreign capital. Massive inflows of foreign direct investment have accelerated trade integration within the EU and promoted export-oriented economic growth.

As already written above, remarkable slower economic growth was reached in Hungary. This development was caused by unstable finances, large fiscal imbalances and high government debt. Given the size of fiscal imbalances, government had to raise state budget's revenues, e.g. hikes in employee social contributions, value-added tax and business taxation. The resulting squeeze on households' disposable incomes and businesses was damping demand (OECD, 2007).

According to OECD (2008) main factors of significant economic growth in Poland were labour productivity and labour resource utilization. Labour market productivity has been underpinned by strong investment growth, financed in large part by foreign capital inflows.

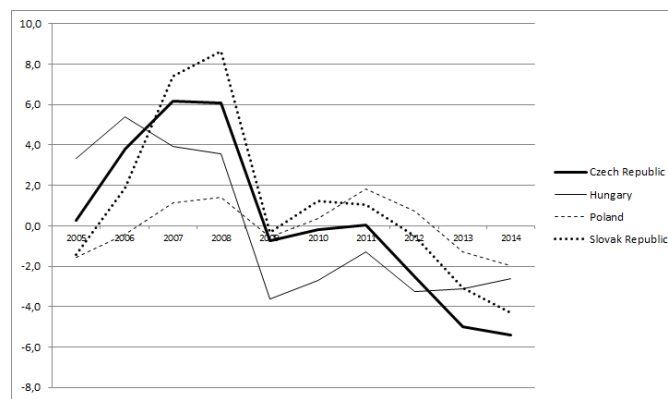
Although these countries have made progress in closing the income gap and its GDP per capita relative to the EU-27 average, the difference with EU income levels remains wide.



Source: OECD

Figure 1. Quarterly Growth Rates of real GDP, change over previous quarter

The Slovak economy experienced a dynamic economic growth before the economic crisis. Massive growth was a result of economic reforms that attracted foreign direct investment and improved the functioning of the labor market. Horvath and Rusnak (2008) conclude that the fluctuations in Slovak output are mainly due to domestic factors and contribute to about 70% in the variation. This may reflect the positive role that Slovak economic reforms, which aimed to increase product and labor market flexibility, played for domestic economic growth. According to Konuki (2008) output gaps estimated by conventional methods show a large positive swing during 2006-2007. However, few signs of economic overheating have been observed yet.

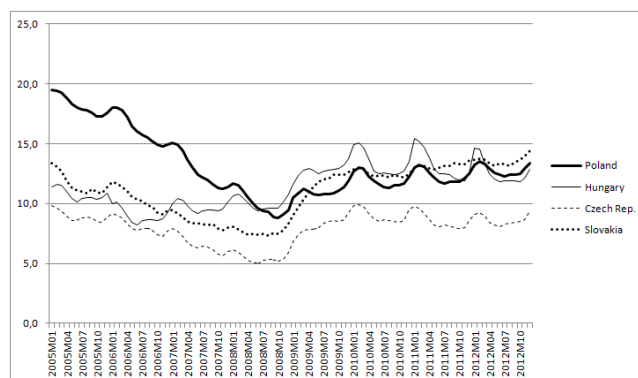


Source: OECD

Figure 2. Output gaps: deviations of actual GDP from potential GDP as % of potential GDP

Figure 3 shows development of the unemployment rate at the national level in Visegrad group. The global recession resulted in a severe shock to the Visegrad Group countries. Moreover, both Czech and Slovakia economy got even beyond its potential in the first half of 2008, which in conjunction with a public finance reform caused inter alia by a rise of the inflation rate. The recession's consequences were: the number of unemployed rose, employment declined and many employees are working fewer hours than before the crisis. However, unemployment rate development in the observed countries was different. While the unemployment rate was decreasing until the beginning of the economic crisis Poland, Czech Republic and Slovakia, in Hungary, the

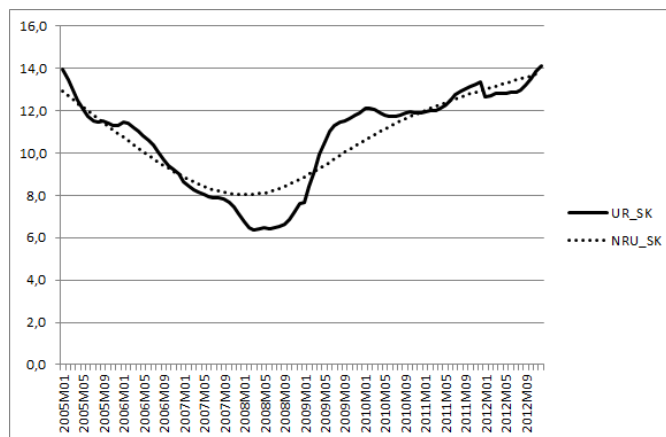
unemployment rate was stagnating - Hungary was in serious macroeconomic problems of a fiscal nature in this period, which had a great influence on the catching up process which was accompanied by a process of rapid catch-up growth in regional imbalances.



Source: National labour market authorities

**Figure 3.** Development of the national unemployment rate in the Visegrad group, monthly data 2005-2012

Figure 4 shows development of the real unemployment rate and the estimated natural rate of unemployment at the national level. As seen from figure, the real unemployment rate was below the natural rate of unemployment in the pre-crisis period (from January 2007 till February 2009). We can also say that the labour market reacted on lower economic performance with some delay. However, the unemployment rate increased sharply at the beginning of the crisis. The period from March 2009 till February 2010 can be characterized as the economic crisis with relatively high national unemployment rate which was higher compared to the estimated natural rate of unemployment. Signs of recovery started during the year 2010 when the real unemployment rate was close to the level of the natural one. Nevertheless, the both the real unemployment rate and the natural rate of unemployment were higher in the comparison with the pre-crisis period. Moreover, we can say that the levels of both rates were still growing.



Source: Ministry of Labour, Social Affairs and Family of the Slovak Republic

**Figure 4.** Slovakia natural and real unemployment rate, national monthly data, 2005-2012

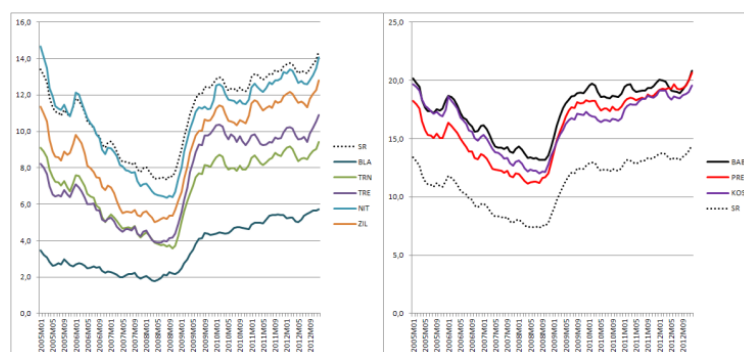
The deep recession in all EU Member States has led to a marked deterioration of labour market performance. Unemployment generally fluctuates depending on a phase of the economic cycle - it tends to increase during the economic crisis and tends to decline during economic growth. In the context of the global recession, thank to labour and product market reforms, in the majority of countries, the impact of the crisis on long-term and structural unemployment is likely to be more moderate than in past severe downturns.

The global recession resulted in a severe shock to the Visegrad Group countries. Moreover, both Czech and Slovakia economy got even beyond its potential in the first half of 2008, which in conjunction with a public finance reform caused inter alia by a rise of the inflation rate. The recession's consequences are: the number of unemployed rose, employment declined and many employees are working fewer hours than before the crisis.

However, if we look at some other indicators, moreover in a longer time period, than we find out that labour market performance in these countries was not so good (even before economic crisis) as it could seem at the first sight. Development of some indicators as a number of job applicants or available jobs was insufficient; they even lead to doubts concerning optimal development of unemployment in comparison with the most used indicators (e.g. the unemployment rate). As an alternative viewpoint it can be used more detailed analysis of total unemployment, if we split unemployed into groups by duration. OECD uses five basic categories – a) unemployment shorter than one month; b) unemployment longer than one month but shorter than three months; c) unemployment longer than three months but shorter than six months; d) unemployment longer than six months but shorter than 12 months and the last category is represented by e) unemployment longer than 12 months (so-called long-term unemployment). For outlining situation in the labour market in these countries division of unemployment based on its duration into two groups is sufficient, when we merge all the shorter forms of unemployment (a+b+c+d) into unemployment, which duration does not exceed 12 months and we mark it generally as short term unemployment. The other category is long-term unemployment, thus unemployment longer than 12 months. In general, it is valid that the longer is duration of unemployment the more serious problem it represents, namely from the viewpoint of unemployed as well as from the viewpoint of potential employers and after all even from a viewpoint of a government.

A general trend of rising unemployment was accompanied by rising percentage share of long-term unemployment (12 months or more) in total unemployment before the crisis. Growth of a long-term unemployment share was recorded in all countries in the period 2000 to 2006.

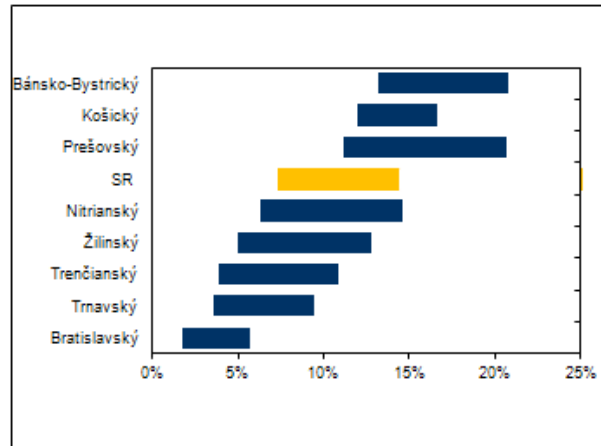
Unemployment in general, but especially long-term unemployment tends to significantly adverse consequences for those with relatively low levels of education, just as in the EU and in V-4 countries with increasing levels of education, both overall and long-term unemployment declining. Unemployment is heavily concentrated among less educated workers in the V-4 countries. Generally, the unemployment rate is the higher the lower is the educational level. Unemployment rates among workers with primary and lower secondary education tend to be extremely high, usually well close to or even above 20 %. For example, in the case of Slovakia the unemployment rate reached its maximum (53.4 %) for a group of low educated workers (with primary education) in 2005. Such level of unemployment was more than double compared with other V-4 countries. Moreover, we have also reported large variations in the unemployment rates in this group and data confirm generally known correlation between educational attainment and a position of this group in the labour market. The rate of unemployment was much more sensitive to cyclical fluctuations in the economy than other groups in the labour market, especially when it declined. We discuss causes of these relations in individual V-4 countries later in the article.



Source: Ministry of Labour, Social Affairs and Family of the Slovak Republic

Figure 5. Development of the national unemployment rate in the Visegrad group, monthly data 2005-2012

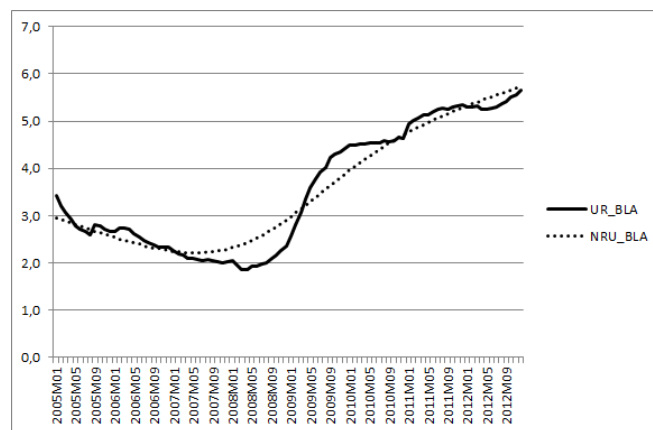
Labour market development in Slovakia (see Figure 5) – the lowest unemployment in comparison with the national level existed in the Bratislavský region. In addition, we can find more regions with lower unemployment rate – Trenčianský, Trnavský, Nitrianský and Žilinský region. On the other hand, there were three regions with significant problems associated with labour market performance. These problems are reflected in particular by the fact that the highest unemployment was reached within the Visegrad group’s regions. Moreover, last data indicate that the situation might get worse. If we look at a range between reached minimum and maximum, the situation is the same as in the Czech Republic. The only difference lies in the fact that the values are shifted to the right; in other words it means that the values are higher.



Source: Ministry of Labour, Social Affairs and Family of the Slovak Republic

**Figure 6.** The minimum and maximum range of regional unemployment rate in Slovakia

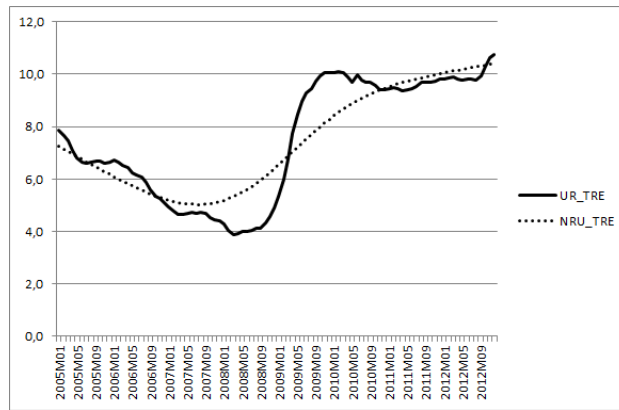
Firstly, we have chosen region with the lowest unemployment rate (Bratislavský kraj). Both the real unemployment rate and the estimated natural rate of unemployment were significantly lower than in the rest of regions. This is mainly due to the position of the capital city which is the heart of Slovak economy. Its position is similar to which has Prague in the Czech Republic.



Source: Ministry of Labour, Social Affairs and Family of the Slovak Republic

**Figure 7.** Natural and real unemployment rate in Bratislavský kraj, national monthly data, 2005-2012

Economic of this region is mainly focused on the tertiary sector which consists of sectors with higher added value. Moreover, the labour force in the Bratislava region is significantly higher qualified in comparison with other regions (together with traditional skills and abilities of professional flexibility).



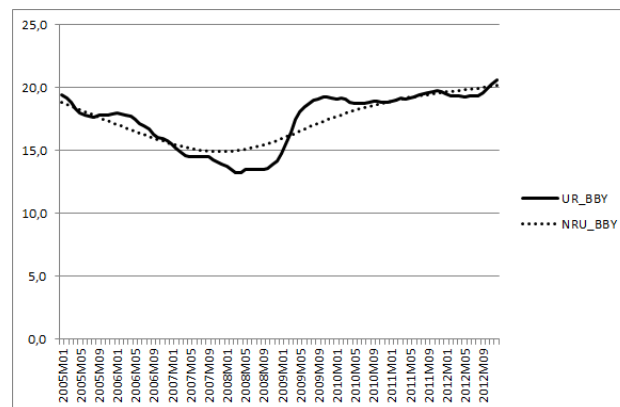
Source: Ministry of Labour, Social Affairs and Family of the Slovak Republic

**Figure 8.** Natural and real unemployment rate in Trenčianský kraj, national monthly data, 2005-2012

The situation in the rest of the regions was similar – the real unemployment rate was remarkably lower than the natural rate of unemployment in the pre-crisis period. After the outbreak of the crisis in the real economy, the unemployment rate increased rapidly and was higher during the crisis compared with the natural rate of unemployment.

We can find four regions that had similar development of labour market performance – Trenčianský (see figure 7), Trnavský, Nitrianský and Žilianský kraj. The real unemployment rate attacked very low level (5 %) on the peak of economic growth. However, labour market performance deteriorated very quickly and the both the real unemployment rate and the estimated natural rate of unemployment reached levels at the beginning of the observed period and even they were higher.

In addition, these regions have an advantage that is based on its position which is closed to the capital city. Moreover, e.g. Žilinský region is also attractive for direct foreign investment. Lower unemployment rate in comparison with other regions is mainly determined by the strong position of the automotive industry in this region.



Source: Ministry of Labour, Social Affairs and Family of the Slovak Republic

**Figure 9.** Natural and real unemployment rate in Banskobystrický kraj, national monthly data, 2005-2012

Figure 9 illustrates situation in the most problematic region – Banskobystrický. The similar situation was also in Prešovský and Košický regions. Economic transition and restructuring of production after 1989 (loss of some traditional industries and sectors – especially mining and quarrying, metallurgy and some engineering fields, construction and chemical industry), among other things led to extensive changes in industry structure and changes in the distribution of economic activities of the regions’ economic base. Firstly, both the real unemployment rate and the natural rate of unemployment were significantly higher than in other regions during the observed period.

However, deterioration of labour market performance did not have so dynamic development. Secondly, an interesting fact is that levels of both rates did not differ remarkably, especially in the pre-crisis period. It means that some structural problem still existed in these regions.

## Conclusions

The aim of this paper was to examine development of labour market performance, especially in the regions during the period 2005–2012. We compared development of the registered unemployment rate and the estimated natural rate of unemployment. We applied the Hodrick-Prescott filter (HP filter) for estimation the natural rate of unemployment. This method is quite frequently used to filter the trend and the cyclical time series. Research in this study is based on regional monthly data between the years 2005 and 2012 (registered unemployment rate) which were published by Ministry of Labour, Social Affairs and Family of the Slovak Republic. As is evident from the analysis the Slovak labour market was in a relatively strong positive unemployment gap before the crisis of the real economy.

We argue that the decline of labour market performance during the crisis was the first step to return to a state of long-term equilibrium. This argumentation may seem at least controversial, but if we look at the situation before the outbreak of the economic crisis, then we can see that the Slovak economy was in a relatively strong expansion. This resulted in usage the production factors (especially labour) with the too much intensity in the Slovak Republic, and it was untenable in the long-run view. We found out the difference between the estimated natural rate of unemployment and the unemployment differed among the regions. We found that the positive unemployment gap was lower in the problematic regions like the Banskobystrický, Košický and Prešovský region.

These findings suggest that these regions still have to face some structural problems and the labour market is not as flexible as in the rest of regions. In addition, we also found that the natural rate of unemployment has shifted permanently higher in comparison with the pre-crisis period.

## Acknowledgment

This research was financially supported by the Student Grant Competition SU within the project SGS/7/2012 “The influence of regional disparities on the business environment”.

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