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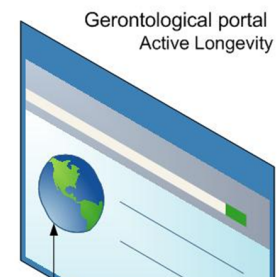
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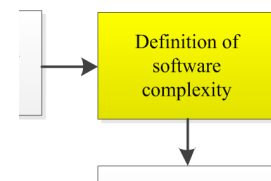
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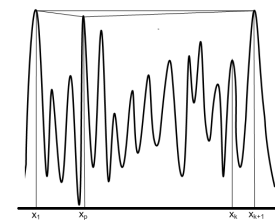
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Development portal

“Active longevity” of RK population and preliminary results

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Abstract. This paper describes the main elements of the portal and presents preliminary results of frequency occurrence analysis of cardiovascular diseases in elderly age and income level of the respondent on the basis of epidemiological screening performed on the basis of data collected on our site.

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Keywords: gerontology; Kazakhstan population; information technology; cardiovascular diseases.

Short title: Development portal.

Introduction

Increasing the duration of active life is one of the most important problems in modern gerontology in the world, including Kazakhstan [1]. The solution of these problems is associated with using information and communication technologies (ICT) [2-5]. Gerontological RK portal, which has no analogues in the countries of the former USSR, will include information on major aspects of the aging in RK. Portal will be a platform for exchange of experiences, publishing the research results, getting generalized and personalized information.

1. Work actuality

Gerontological researches in the world are associated with the rapid aging of the population in developed countries. This process is caused not only by decreasing the birth rate, but also by the increase in life expectancy. For example, according to European experts in 2060 one third of the Europe’s population will reach age 80 and elder. At the same time there is a great number of single people and people who need intensive medical care in a described group of large population.

In this regard, the main tasks set forth by the scientific and medical community of developed countries are to prevent the social isolation of the senior citizens, creating conditions for maintaining an active lifestyle for elder people and their participation in the labor market.

To achieve these ambitious goals the world community makes a range of initiatives of medical, social and techno-

logical types by widely using all modern information and communication technologies. It is not just proper measures to maintain health, but also the initiatives in the field of business, for employment, using of ICT to reduce the costs of health care and care for elderly patients. As a result of these efforts during the period from years 2010 to 2013 only in Europe, public and private investment for research and innovation to improve lives of elder people will reach more than 1 billion €.

Kazakhstan is a developing country with country’s population also aging. In Kazakhstan, in January 1, 2010 the number of people aged 65 years and older was 7.14% of the total population of the country. UN experts consider Kazakhstan as a state with accelerated aging. According to the forecast, by 2050, 25 % of the elder people are expected to make the country’s population.

Due of this, extension of active life, reducing the costs of health care, increasing demand of the elder in labor market becomes a serious issue to Kazakh society.

Improving care for elder people, comprehensive solution of their medical-biological, social and psychological aspects is one of the priorities defined by the State program “Salamatty Kazakhstan” for 2011-2015, approved by Presidential Decree of Kazakhstan for 29.11.2010, Nr.1113.

Economic analysis has shown that we need to find ways and new technologies to improve the quality of services and to reduce costs. Initiatives that are offered in different regions are usually connected with using the *Information and*

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Communication Technologies (ICT).

Although the group of elder persons is heterogeneous in the sense of education, income and type of illnesses associated with age, the elder forms the group of maximum risk and is considered to be excluded from the benefits of the Information Society. According to the recent study, more than 60% of people over 50 in Europe feel that their needs are ignored by current ICT services and equipment [4].

Policies and initiatives aimed to improve the conditions and technology for elder people in the information society can achieve a triple purpose.

1. Facilitating usage of the information society tools and services for elderly people, among other things removes barriers, making ICT tools easier for everyone and encourages people to look for the better, increasing their independence, improving health, increasing the ability to participate in working environment and be active in society.
2. ICT can help to increase the efficiency and quality of social services and health in aging society, and promote financial sustainability of these services in the future.
3. Due to the aging as global phenomenon, new ICT products and services might ensure the needs of aging society providing an opportunity in corresponding industries to become leaders and exporters in the global market.

At the same time we have to point out that the potential of ICT in gerontological market is very high: the fact is that Europeans aged 65+ own funds of over €3000 milliard. In Kazakhstan, the situation is different, but due to the increasing elderly population (1634974 people at the beginning of 2011), an increasing of Internet usage, income growth, as well as increasing number of specialists in the field of gerontology and geriatrics, the potential of ICT will also rise.

Thus, increasing duration of people active life is one of the most important problems of modern gerontology in the world, including Kazakhstan.

Solution to these problems is connected with application of ICT. The work of gerontological portal development is in progress. This portal does not have any analogue in the countries of former USSR and in neighboring countries.

2. Objectives and functions of the portal

The portal is supposed to be as an input point to “the gerontological space” of Kazakhstan, including information about major aspects of aging of Kazakhstan population. It will be as a platform for the exchange of experience, the publication of research results, for generalized and personified information reception about elder person’s health.

Based on the collected information using methods of scientific forecasting, searching patterns in the data and forecasting in processes of aging by experts in gerontology and geriatrics, expert systems on various aspects of aging process will be developed. Portal users at this stage could be determined as follow:

- i) doctors (managers for interviewers);
- ii) interviewers (persons who gather and enter questionnaires);
- iii) managers.

Portal functions at this stage include several positions:

- a) questionnaires selection according to various criteria;
- b) downloading forms data in .xls format;
- c) questionnaires input, editing, deleting;
- d) get information about interviewers;
- e) get statistics from questionnaires entered into data base.

Prospective users of the portal in the future (additional to initial portal users) are the following subjects:

- a) specialists in the gerontology;
- b) any other medical specialists, practitioners, Interns, residents, graduates;
- c) health facilities;
- d) health and rehabilitation centers;
- e) social services;
- f) elder citizen, their relatives and nurses;
- g) organizations that use volunteer work;
- h) any interested organizations and individuals, including entrepreneurs, merchants, sponsors, patrons, etc;
- i) health insurance;
- j) medical equipment, medical chemistry manufacturers and distributors.

Possible functions of portal in future could be formulated as follow:

- a) ability to self-entry questionnaire by patients or their relatives;
- b) statistical information in the questionnaires from portal database;
- c) ability to analyze;
- d) self-diagnosis;
- e) placement of scientific publications and scientific journals of the medical community;
- f) relation: patient - portal - clinic; information exchange between the patient and the portal, the patient and the hospital, the clinic and the portal;
- g) portal users forum on gerontology or other medical issues.

3. Questionnaire data gathering and storing

Personal data about health of elderly and senior patients in Kazakhstan collecting and storing is a part of the portal. That data required for the further analysis and prediction of the aging process on Kazakhstan territory - information system “questionnaire”. Fig. 1 represents the local system scheme of questionnaires gathering. The information system provides a systematic collection of personal data of patients with subsequent loading into the database.

4. Preliminary results

The results obtained during collecting and entering data allow us to get some results at this stage already.

The priorities in health and social safety at the present stage are health promotion, prevention of disease and disability, the development of rehabilitation.

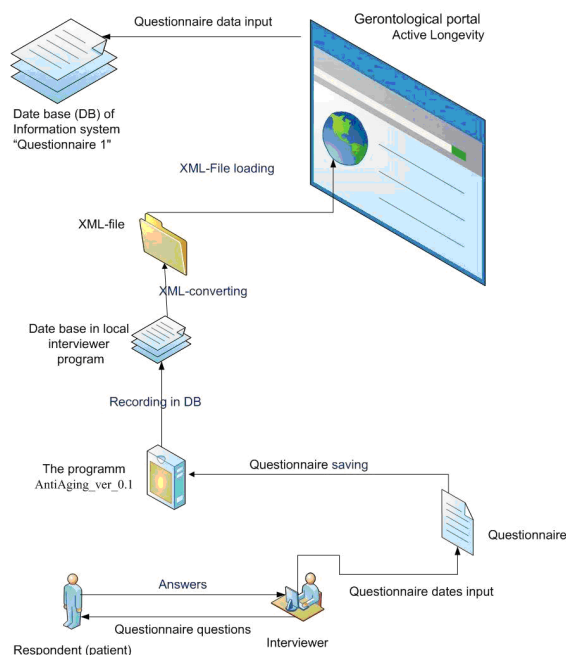


Fig. 1. Process of questionnaire data about health of elderly and senior citizens collecting and storing.

Public health is the most important indicator of society well-being and depends on many factors: the environment, labor conditions, level of satisfaction of population needs in food, clothing and other goods, social goods, leisure, etc. Therefore, to solve health problems is not enough to rely only on budget funding model of medicine. Efforts in this direction may be weakened by insufficient contribution to the health by the population.

The last may be associated with the reluctance to healthy

lifestyles, and on the other hand, the lack of such opportunities in the population, in particular financial.

Cardiovascular diseases (CVD) are considered as one of the major problems in modern world. Therefore the income influence on frequency of cardiovascular diseases was investigated in different age groups.

Income level was evaluated by questioning the respondents letting them to define the level of income, choosing an option from the list:

- “Money is hardly enough sufficient for food.”
- “Money is sufficient for food but for clothing isn’t.”
- “Money is sufficient for food, clothing and small appliances.”
- “Money is sufficient for large household appliances.”
- “Money is sufficient for everything except real estate.”
- “There are no problems with money.”

Mathematical processing of the results was performed using the software package *STATISTICA 8.0* Analysis of the interactions showed that in reality the income of the population and frequency of CVD in groups of men and women has negative correlative relationship. However, at the same time, it was found that the level of income in the studied group has an inverse correlation relationship with age - see Table 1.

Therefore, to eliminate the influence of age factor in the relationship with income and CVD frequency was examined in different age groups. This age group was formed in such a way that, firstly, the age in subgroups with cardiovascular diseases and without them did not differ, secondly, the selected age subgroups was not statistically significant in correlation with age and income. Thus, there were groups in which the incidence of cardiovascular disease and the level of income were not associated with age. The group “Men” was divided into two groups: one group consisted of men from 45 to 55, the other elder than 64 years (Table 2a, 2b).

Table 1. Relation between age, income and CVD (Spearman rank correlation coefficients) in the groups of men and woman (for women $p < 0,05$).

Group		CVD	<i>p</i>	Income	<i>p</i>
Men	Age	0,24	7,8E-10	-0,18	0,004
	CVD			-0,33	2,7E-05
Women	Age	0,26	1,1E-19	-0,17	0,002
	CVD			-0,28	4,7E-08

Table 2. The result of comparisons of income levels and age in different groups: with CVD (group1) and without CVD (group2): a) group of 45-56 year-olds men; b) men over 65; c) women elder 55.

Group		Ranges sum of group1	Ranges sum of group2	<i>p</i> -level	Valid <i>N</i> group1	Valid <i>N</i> group2	Median group1	Median group2
men 45-56	Age	696,0	2154,0	0,10	15	60	50,5	49
	Income	104,0	1436,0	0,004	8	47	2,5	5
men over 65	Age	3097,000	3119,000	0,4	50	49	73	72
	Income	2929,000	1922,000	0,01	44	46	2	3
women elder 55	Age	17195,50	23274,50	0,63	123	161	70	67
	Income	14629,50	12166,50	0,00003	108	123	2	3

Table 3. Frequency of occurrence of cardiovascular diseases in groups with different income levels (expected number are in brackets):
 a) among men elder than 45-55; b) men elder than 65 years;
 c) women elder than 55; d) women elder than 55; e) women elder than 55.

Group	Income level	There are CVD	There are not CVD
a) men elder 45-55	“Money is hardly enough sufficient for food” (1 unit.)	4	1
	The level is higher then “Money is hardly enough sufficient for food”	4	36
b) men elder 65	“Money is hardly enough sufficient for food” (1 unit.)	14	5
	The level is higher then “Money is hardly enough sufficient for food”	35	42
c) women elder 55	“Money is hardly enough sufficient for food”	36,6 % (45)	10,2% (11)
	“Money is sufficient for food and for clothing isn’t”	24,4% (30)	26,9% (29)
	“Money is sufficient for food, clothing and small appliances”	19,5% (24)	30,6% (33)
	“Money is sufficient for large household appliances” +		
	“Money is sufficient for all except estate”	3,2% (4)	5,6% (6)
	“There are no problems with money”	16,3% (20)	26,9% (29)
	Total in group	100% (123)	100% (108)
d) women elder 55	“Money is hardly enough sufficient for food”	24,2% (29,82)	24,2% (26,18)
	“Money is sufficient for food and for clothing isn’t”	25,5% (31,42)	25,5% (27,58)
	“Money is sufficient for food, clothing and small appliances”	24,7% (30,35)	24,7% (26,65)
	“Money is sufficient for large household appliances” +		
	“Money is sufficient for everything except real estate”	4,3% (5,32)	4,3% (4,68)
	“There are no problems with money”	21,2% (26,09)	21,2% (22,91)
Total in group	100% (123)	100% (108)	
e) women elder 55	“Money is hardly enough sufficient for food”	45 (29,82)	11 (26,18)
	The level is higher then “Money is hardly enough sufficient for food”	78 (93,18)	97 (81,82)

Rank criterion of Mann-Whitney was used as a criterion for identifying differences in characteristics levels in sub groups.

Among women only one subgroup followed specified conditions. It included women elder than 55. In the subgroup of women younger than 55 years any statistically significant relationship between the frequency CVD occurrence, age and income was noticed.

Analysis of CVD frequency at different income levels using two-tailed Fisher’s Exact Test revealed statistically significant association between these parameters in groups of men of 45-55 ($p=0,002$) and over 65 years ($p=0,04$). (Table 3a, 3b). In the analysis due to lack of data after checking for homogeneity were combined the data about income, which was higher than “money is hardly enough sufficient for food”.

In the group of women elder than 55 was found correlation between the CVD frequency and income using the criterion χ^2 ($\chi^2 = 23,3, p=0,007$) (Table 3c, 3d).

Using the criterion χ^2 , it was shown that data of income higher than the “money is hardly enough sufficient for food” can be combined ($\chi^2 = 1,44, p=0,98$). Table of dimension 2x2 was the result - see Table 3e.

Analysis of these data showed (Yates correct $\chi^2=20,41, p<0,0001$), that CVD are significantly frequent in a group of women over 55 with incomes lower than “money is hardly enough sufficient for food” than in the group with higher incomes. At the same time there are significantly more women who do not suffer from cardiovascular diseases in the groups with higher incomes.

The analysis of results has shown that for men, as well as for women, frequency of Cardiovascular diseases is significantly higher in groups that evaluate their income as “money is hardly enough sufficient for food”.

All people bring great economic damage. The data of this study has shown that for the normal economic development it is possible and necessary to determine that minimum household income, which will bring less damage to health i.e. the residents should have more opportunities for health maintenance.

Conclusion

The increasing longevity of active life and corresponding increase in expenses in public health services is a new call to the world’s community which forces to start looking for new ways of development of public health services and maintenance of active longevity. Researches, conducted in the developed countries, show necessity of using the information-communication technologies widely, to lower expenses and to raise quality of health services and to create conditions for comfortable life and work at elderly age. New market of services for elderly citizens has large potential consumption of advanced intelligent technologies.

At this stage, the problem of development and research is creation of system for gathering, storing and editing data, obtained from questionnaires of the elderly population of Republic of Kazakhstan. In the future the functions of portal would be as follow:

- a) questionnaire input by patients or their relatives;
- b) advanced statistical information from portal database questionnaires;
- c) ability to analyze;
- d) placement of scientific publications;
- e) scientific journals of the medical community;
- f) information exchange between patients, the portal and clinics, forum for portal users on gerontology or other medical issues.

The preliminary analysis shows possibility of getting serious analytical results at the stage of epidemiological screening. The expansion of research base with inclusion of block of clinical researches allows to expect that the portal will become serious instrument of researches in the field of gerontology in Kazakhstan.

References

1. Resolution of United Nations A/RES/37/51 containing questions of aging. – <http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/37/51&Lang=E&Area=RESOLUTION>, accessed 2012.06.10, principles of United Nations for older persons.
2. In 1991, the General Assembly (by resolution 46/91) adopted the United Nations Principles for Older Persons. – <<http://www.un.org/documents/ga/res/46/a46r091.htm>>, accessed 2012.06.10.
3. Millennium Development Goals: progress towards the health-related Millennium Development Goals. Fact sheet N290, May 2011. – <<http://www.who.int/mediacentre/factsheets/fs290/en/index.html>>, accessed 2012.06.10.
4. Overview of the European strategy in ICT for Ageing Well. September 2009 (report). – ICT for Inclusion, Directorate General for Information Society and Media, European Commission, BU31 01/66, B-1049 Brussels Belgium, <<http://ec.europa.eu/einclusion>>, accessed 2012.06.10.
5. *National Geographic* January (2010).
6. Ambient Assisted Living Roadmap. The European Ambient Assisted Living Innovation Alliance. Edited by Ger van den Broek (Philips Research Healthcare), Filippo Cavallo (Scuola Superiore Sant'Anna), Luca Odetti (Scuola Superiore Sant'Anna), Christian Wehrmann (VDI/VDE-IT). – VDI/VDE-IT AALIANCE Office, Steinplatz 1, 10623 Berlin.
7. ICT & Ageing - Final Report. Edited by Lutz Kubitschke and Kevin Cullen (WRC), January (2010). – Empirica Gesellschaft für Kommunikations- und Technologieforschung mbH, Oxfordstr. 2, 53111 Bonn, Germany.
8. Stefano Kluzer, Christine Redecker and Clara Centeno. Long-term Care Challenges in an Ageing Society: The Role of ICT and Migrants. Results from a study on England, Germany, Italy and Spain. – JRC European Commission, EUR 24382 EN (2010).

Early estimation of manhours in software development

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Abstract. To estimate the labor input of software development, an adaptive system of input estimation based on formalized specification, a model of which includes corresponding correctors that ensures system configuration for improvement of calculation accuracy, was proposed. The results of the technique based on the LFC metrics show that error of evaluation results compared with the actual data is relatively small (at least for one module). The maximum error value is equal to 20%, the average is around 9% to be compared to the actual data.

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Keywords: software engineering; labor effort estimation; formal specification; labor input estimation metrics; estimation methods.

Short title: Estimation of manhours.

Introduction

In order to estimate the effort put into software development various models are used, which are basically based on some form of analysis specification of customer requirements or technical project. In particular, *Function Point* (FP) metrics allow to estimate the effort based on the numbers of the function points has been widely known [1,2].

In our opinion, adaptive evaluation system based on formalized specifications of a customer can be used in established system of development (elaboration). This evaluation system can be named as “early”, since it does not include the in-depth analysis methods of the projected system. This system of effort estimation should be based on some important parameters of formalized specifications and additional parameters, which include, for example, qualification of software developer, type of module and etc.

For the assessment of basic applicability of formalized specification the analysis based on actual data was performed. The quantity of words and characters were used as the metrics of formalized specification (LFC).

1. Estimation of labor input of software development

The results of the technique based on the LFC metrics show that error of evaluation results compared with the actual data is relatively small (at least for one module). The maximum

error value is equal to 20%, the average is around 9% to be compared to the actual data.

Estimation of labor input of software development is one of the difficult tasks in software engineering. It is solved by different methods [1-5]: expert estimation as well as estimation using models.

1. *Expert estimation.* The method is designed for project estimation with an emphasis on the expert’s knowledge and experience. The estimation is conducted for the whole project or its separate parts by the experts.

2. *Estimation using models.* This technique is designed for project estimation with the help of specific models. *Estimation using models* technique has the following types: estimation by analogy; use Case Points (UCP); function points (FP); fast Function Points (ffp); early Function Points (EFP).

2.1. *Estimation by analogy.* Project estimation on the basis of historical data. In fact, it is an automated version of expert estimation method. Project estimation based on its “measurement” of forms, reports, subsystems, essence and etc. Conversion of measurement results to labor effort according to accumulated statistics.

2.2. *Use Case Points* (UCP). The method is designed to evaluate the projects, for which requirements definition is applied with the help of use cases (or precedents). The main point of this technique is to determine “actors” and use cases (precedents) and to estimate (evaluate) its complexity.

2.3. *Function Points* (FP). The method is designed to evaluate the project on the base of a concept called “function

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point”. Its essence is presented as follows:

- a) identification of all information objects and all operations on data exchange between the system and “actors” (users, other systems) and estimation of its complexity;
- b) correction of the results - account of non-functional requirements;
- c) using the result (in FP) in a COCOMO (Constructive Cost Model) calculator (conversion to labor effort with the partition according to project phases and processes) or conversion to code size, and further to labor efforts.

2.4. *Early Function Points* (EFP). Variety of a Function Points method allowing application in the absence of detailed requirements. The main point of this technique could be formulated as follow:

- a) identification of all information objects and all operations on data exchange between the system and “actors”;
- b) correction of the results - account of non functional requirements.

2.5 *Fast Function Points* (ffP). Variety of a Function Points method allowing application in the absence of detailed requirements. The essence is as follows: - Identification of all information objects and all operations on data exchange between the system and “actors” (users, other systems) without estimation of their complexity (an average value is used) In the case of the established software development process estimation of labor input can be conducted using the statistics based on the results of the previous tasks. Particularly, in this regard, size-oriented metrics has worked well. The given approach described in Ref. [1] is based on LOC (lines of code) estimation by analogy with COCOMO.

Software development input estimation on the basis of formal specification The techniques considered above are not easy to implement, and in some cases, for example, when modifying system modules, their application can be redundant.

Here comes the question: is it possible to move away from the given techniques for input estimation and replace them with the simplified method that allows performing immediate estimation of software development input at an early stage, the stage of task formulation? We assume that, in some ca-

ses, in the well-organized development process, in “conservative” environment, where specific statistics of software development is given and the groups of developers are stable, it is possible to use formal specification of software development (*FC* - formal specification) for calculation of labor input (*WD* - work days) in man-days.

$$FC \Rightarrow WD \tag{1}$$

In other words, it can be assumed that formal specification can be sufficient for relatively accurate labor input calculations of software development.

In this case, the task is to find a function *fwc*

$$WD = fwc(FC, P), \tag{2}$$

where *P* is a vector of additional parameters, including, for example, a developer’s qualification, a type of the designed module and etc. It is supposed that in some instances it is possible to perform convolution of *P* vector to the correction factor that depends on the specified parameters.

The general model of a customizable (adaptive) system of input estimation is shown in Fig. 1. Block 1 is a block for definition of significant parameters of formal specification, block 2 is a block for definition of a vector of additional parameters, block 3 is a module for definition of *fwc* function, block 4 is used for calculation of predicted input, block 5 performs a comparison of actual indicators of labor input with the calculated ones, *Kfc*, *Kp*, *Kfwc* are corresponding correctors that ensures the system configuration to improve an accuracy of input calculations. The factor analysis, clustering and pattern recognition algorithms, and also algorithms for semantic analysis can be applied in order to construct the correctors.

The experiments with an actual data were conducted in order to verify the possibility of using formal specification for software development input calculations. At the same time, the number of words and symbols (which, in this case, plays the role of significant parameters) is used as a simple metrics of formal specification.

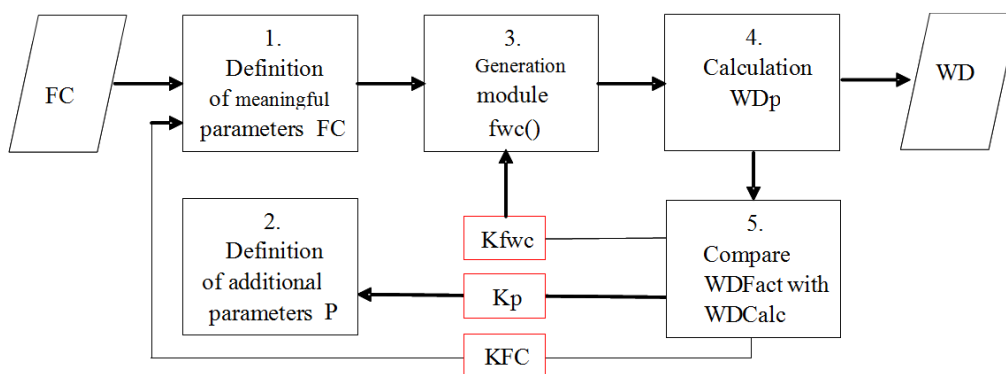


Fig. 1. The generalized model of adjusted (adaptive) system of an assessment of labour input.

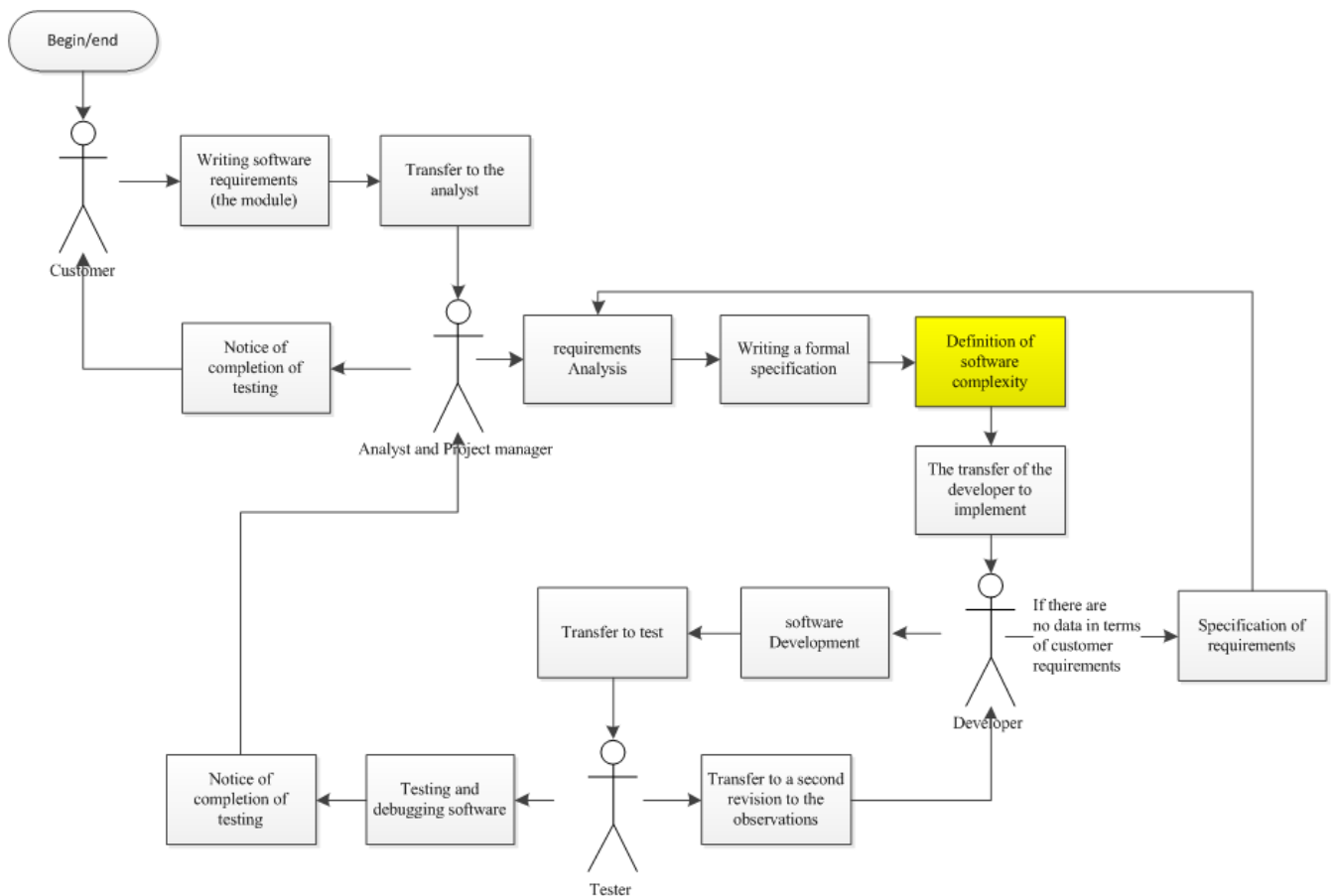


Fig. 2. The development and modification of software in the organization of “HB”.

In this instance, the expression (1) can be converted to the following form:

$$WD = LFC(w, c) * p, \tag{3}$$

where LFC is a function depending on the number of words w and symbols c in formal specification, p is a correction factor. In this case, a correction factor is a convolution of P vector.

At first glance, the described approach looks very formal, independent of the semantic content of specification to a software product. However, it can be recalled that the structure of formal specification developed by an expert gives necessary substantial sense to the whole technique.

An example of LFC metrics and formal specifications application for estimation of software development labor input

The applicability analysis of LFC metrics and formal specifications was conducted based on the data accumulated in an organization with an “HB” label. In this organization software development and modification is done as follows - see Fig. 2.

At first, an application form written by a customer in a free form and related to the specific module of a system comes to an analyst.

Based on this application the analyst writes formal specification and passes it to the developer.

At this point, on the basis of the given specification the developer in the “HB” organization estimates his/her labor input. The calculation of labor effort is not formalized and based on expert estimation. But, as shown in Fig.2, it is proposed to calculate efforts at an analysis stage, without bringing up an application to the developer. To formalize the process of effort calculation empirically dependence

$$LFC = f(w, c) \tag{4}$$

was found in the following form where $w1$ and $w2$ are the number of words in the application of the customer and analyst, respectively; $c1$ and $c2$ are the number of symbols in the application of the customer and analyst, respectively.

As a result formula (2) has the following form

$$WD = LFC * p, \tag{5}$$

In order to get the p factor, data about WD accumulated in the development process can be used. In other words, for each application

$$P_i = \frac{WD_i}{LFC_i}, \tag{6}$$

where WD_i is the developer’s labor effort for i -th application, LFC_i is LFC calculation using formula (3) for i -th application.

Table 1. Quantitative characteristics of applications for the module “Credits”.

CA - Customer Application; AA - Analyst Application; w_1, w_2 - number of words, c_1, c_2 - number of characters.

S/n	Name of application	WD_i fact.	CA w_1	CA c_1	AA w_2	AA c_2
1.	Unblock	11	612	6685	568	4917
2.	Stepped rate	15	853	7657	1058	7208
3.	Calculation of the duration	5	240	1715	292	2564
4.	Cancellation of deposit	13	688	6518	764	6087
5.	Changes mortgage	4	234	1981	319	2722
6.	Delivery of documents	4	127	1114	418	3372
7.	Calculation of the homogeneity	9	130	1146	812	8205

Table 2. The results of calculations of labor input required for application processing by the developer according to the module “Credits”.

S/n	Name of application	LFC	P_i	P	WD_i (per.-min)	WD_i (per.-day)
1.	Unblock	12782	0,38	0,44	5624,08	11,72
2.	Stepped rate	16776	0,43	0,44	7381,44	15,38
3.	Calculation of the duration	4811	0,60	0,44	2116,84	4,41
4.	Cancellation of deposit	14057	0,68	0,44	6185,08	12,89
5.	Changes mortgage	5256	0,27	0,44	2312,64	4,82
6.	Delivery of documents	5031	0,48	0,44	2213,64	4,61
7.	Calculation of the homogeneity	10293	0,23	0,44	4528,92	9,44

Table 3. The comparison of actual and calculated data of labor input required for applications processing by the developer.

S/n	Name of application	Module	WD_i (per.-day) fact.	WD_i (per.-day) calc.	$\Delta(WD_i)$ (per.-day)	$\varepsilon(WD_i)$ %
1.	Unblock	Credits	11	11,72	0,72	6,55
2.	Stepped rate	Credits	15	15,38	0,38	2,53
3.	Calculation of the duration	Credits	5	4,41	-0,59	11,8
4.	Cancellation of deposit	Credits	13	12,89	-0,11	0,85
5.	Changes mortgage	Credits	4	4,82	0,82	20,5
6.	Delivery of documents	Credits	4	4,61	0,61	15,25
7.	Calculation of the homogeneity	Credits	9	9,44	0,44	4,89

The generalized factor P is calculated as an average for all P_i .

Let us consider the application of the given technique in the “HB” organization when modifying modules in one system.

Formal specification for software development (modification) was designed for the use of the technique. Formal specification is based on GOST34 [8].

Table 1 contains the source data for calculation (w_1, c_1, w_2, c_2)

According to the data given in Table 1, the following results are derived:

Based on the first application “Unblock” $LFC = 612+6685+568+4917 = 12782$

$$P_i = \frac{WD_i}{LFC_i} = \frac{11 * 60 * 8}{12782} = 0.41. \quad (7)$$

where 11 is a runtime of the application in man-days. For ac-

curacy improvement, calculations are done in minutes with account of 8-hour workday.

An average value of a correction factor for the module “Credits” calculated according to 7 applications is $P=0.44$.

Using the values of p and data from Table 1, the developer’s labor effort (WD_i) is calculated according to 7 applications (Table 2).

Table 3 presents the data that allows comparing the results of actual input required for application processing with the calculated data. The absolute error of labor input required for application processing is calculated by the formula:

$$\Delta(WD_i) = |(WD_i^{actual.}) - (WD_i^{calc.})| \quad (8)$$

The relative error of labor input:

$$\varepsilon(WD_i) = \frac{\Delta(WD_i)}{WD_i^{actual.}}. \quad (9)$$

The error between actual $WD_i^{actual.}$ and calculated $WD_i^{calc.}$ is insignificant as shown in Table 3.

The results of using the technique based on LFC metrics show that the error of the results of input estimation compared to actual data is relatively small (at least for one module).

Let us note that the attempts of using the specified approach for labor input estimation required for applications processing that affect multiple modules have not been successful. Therefore, the described technique can be applied only in case of severe restrictions on the subject area and in the presence of reliable data about actual labor input of software development.

Conclusion

To estimate the labor input of software development, an adaptive system of input estimation based on formalized specification, a model of which includes corresponding correctors that ensures system configuration for improvement of calculation accuracy, was proposed.

The analysis based on the actual data was conducted in order to evaluate principal applicability of formal specification. At the same time, the quantity of words and symbols were

used as the metrics of formal specification (LFC).

The results of using the method based on LFC metrics show that the error of results of labor input estimation compared to the actual data is relatively small (at least for one module). The maximum value of the error is 20%, the medium is about 9%.

The attempts of using the specified approach for labor input estimation required for applications processing that affect multiple modules have not been successful. Therefore, the described technique can be applied only in case of severe restrictions on the subject area and in the presence of reliable data about actual labor input of software development.

Let us note that although the proposed metrics is formal, it can be recalled that the structure of formal specification developed by an expert gives necessary substantial sense to the whole technique.

Further development of the approach can be a system that computes the correction factor p by the actual results of design and self-defining type of function fwc . The possible approaches can be the factor analysis, clustering and pattern recognition algorithms, and also algorithms for semantic analysis.

References

1. Lipaev V.V. Software Engineering. Methodological Foundations. – Moscow: TEIS, 2006. - 680 p.
2. Orlov S.A. Technologies of development of the software. – St. Petersburg: Piter, 2004. - 527 p.
3. Lipaev V.V. Debugging complex software: Methods, tools, technology. – Moscow: Energoatomizdat, 1993.
4. Boehm B.W. Software Engineering. – Moscow: Radio and Communications, 1985.
5. B. Boehm and R. Turner. Using Risk to Balance Agile and Plan-Driven Methods. – *Computer*, June 2003, 57-66.
6. A. Abran and P.N. Robillard. Function Points Analysis: An Empirical Study of its Measurement Processes. – *IEEE Transactions on Software Engineering* 22 (1996) 895-909.
7. S. Arkhipenkov. Lecture N6. Evaluation complexity and timing of software development, 2009. – <http://citforum.ru/SE/project/arkhipenkov_lectures/11.shtml>, accessed 2012 03 05.
8. Development of documentation in accordance with GOST. – <http://www.rugost.com/index.php?option=com_content&task=category§ionid=7&id=25&Itemid=62>, accessed 2012 03 05.

On the polynomials of optimal shape generating maximum number of period annuli

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Abstract. The nonlinear differential equation $x'' + g(x) = 0$ is being considered, where $g(x)$ is a polynomial that allows the equation to have multiple period annuli. It is shown how the respective optimal polynomials can be constructed in case, when a primitive of the function $g(x)$ is a polynomial of an arbitrary selected even degree.

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Short title: On the polynomials.

Introduction

Lets consider the second order nonlinear autonomous differential equation

$$x'' + g(x) = 0 \quad (1)$$

where $g(x)$ is a polynomial of odd degree with simple zeros only and the highest degree of polynomial with a negative coefficient. Zero z is called simple if $g(z) = 0$ and $g'(z) \neq 0$. In these points function $G(x)$ which is a primitive of the function $g(x)$ has an alternate local maxima and minima points.

$$G(x) = \int_0^x g(s) ds \quad (2)$$

Note that a critical point is a center, if it has a punctured neighborhood covered with nontrivial cycles. Period annuli looks like a domain filled with closed trajectories. Every connected region on a phase plane covered with nontrivial concentric closed curves is called a period annulus. We will call a period annulus associated with a central region by a trivial period annulus.

Periodic trajectories of a trivial period annulus encircle exactly one critical point of the type center. Period annuli enclosing several (more than one) critical points are called nontrivial period annuli. According to previous notes in Ref. [1-3], we are interested mostly in presence of nontrivial period annuli.

1. Methods

Definition 1. Points x_i and x_j of local maxima of the function $G(x)$ are called non-neighbouring, if there exists at least one point of local maxima of the function $G(x)$ in the interval (x_i, x_j) .

Definition 2. Two non-neighboring points of maxima x_i and x_j of $G(x)$ will be called a regular pair if $G(x) < \min(G(x_i), G(x_j))$ at any other point of maximum lying in the interval (x_i, x_j) .

The theorem of existence of periodic annuli is formulated according to Ref. [1]. If $g(x)$ is a polynomial of odd degree with simple zeros only, $G(x)$ is a primitive of the function $g(x)$, two points of maxima x_i and x_j of the function $G(x)$ form a regular pair, then the equation $x'' + g(x) = 0$ has a nontrivial period annulus associated with the pair x_i, x_j .

The theorem of the maximum number of periodic annuli is formulated according to Ref. [2]. If $g(x)$ is a polynomial of odd degree with simple zeros only and the highest degree of polynomial with a negative coefficient, $G(x)$ is a primitive of the function $g(x)$, n is the number of points of local maxima of the function $G(x)$, then the maximal possible number of regular pairs for $G(x)$ is equal to $(n - 2)$.

Proof. Let $n = 3$. The following $G(x)$ combinations are possible at three points of maxima as presented in Fig. 1.

A regular pair exists in the unique case presented in Fig. 1b, therefore, the maximal number of regular pairs is equal to one.

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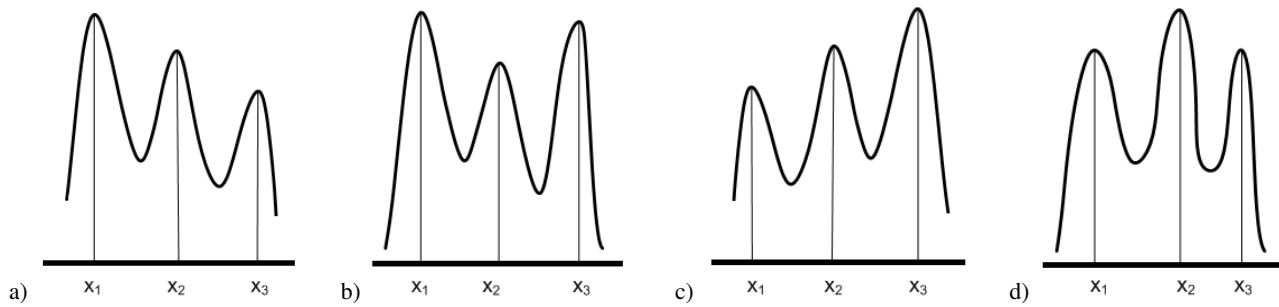


Fig. 1. $G(x)$ combinations at three maxima points.

- a) $G(x_1) \geq G(x_2) \geq G(x_3)$, b) $G(x_2) < G(x_1), \quad G(x_2) < G(x_3)$,
 c) $G(x_1) \leq G(x_2) \leq G(x_3)$, d) $G(x_2) \geq G(x_1), \quad G(x_2) \geq G(x_3)$.

Suppose that for any sequence of k consecutive points of maxima of $G(x) (k \geq 3)$ the maximal number of regular pairs is equal to $(k - 2)$. Without the loss of generality let us add to the right side the additional maximum point of the function $G(x)$. We get a sequence of $(k + 1)$ consecutive points of maximum of the function $G(x) : x_1, x_2, \dots, x_k, x_{k+1}$, when $x_1 < x_2 < \dots < x_k < x_{k+1}$.

Let us prove that the maximal number of regular pairs is equal to $(k - 1)$.

Let x_p , when $2 \leq p \leq k$, be one of the maxima points of $G(x)$ in which the function $G(x)$ has the largest value. Now cut the segment $[x_1, x_{k+1}]$ into two parts: $[x_1, x_p]$ and $[x_p, x_{k+1}]$.

Number of the points of maxima on the segment $[x_1, x_p]$ is equal to p and the maximal possible number of regular pairs is equal to $(p - 2)$. Number of the points of maxima on the segment $[x_p, x_{k+1}]$ is equal to

$$k + 1 - (p - 1) = k - p + 2 \leq k \tag{3}$$

and the maximal possible number of regular pairs is equal to $(k - p)$. Number of the maxima points on the segment $[x_1, x_{k+1}]$ is equal to $(k + 1)$. Maximal possible number of regular pairs is equal to

$$(p - 2) + (k - p) + 1 = k - 1, \quad \text{if } G(x_p) < G(x_1) \text{ and } G(x_p) < G(x_{k+1}), \text{ and}$$

(see Fig. 2)

$$(p - 2) + (k - p) = k - 2, \quad \text{if } G(x_p) \geq G(x_1) \text{ or } G(x_p) \geq G(x_{k+1}), \text{ and}$$

the additional regular pair does not appear. In a particular case (see Fig. 3) $G(x_1) > G(x_k)$ and

$$G(x_2) < G(x_3) < \dots < G(x_k) < G(x_{k+1}), \tag{4}$$

the following regular pairs emerge, namely x_1 and x_3, x_1 and x_4, \dots, x_1 and x_k, x_1 and x_{k+1} , in total $(k - 1)$ pairs.

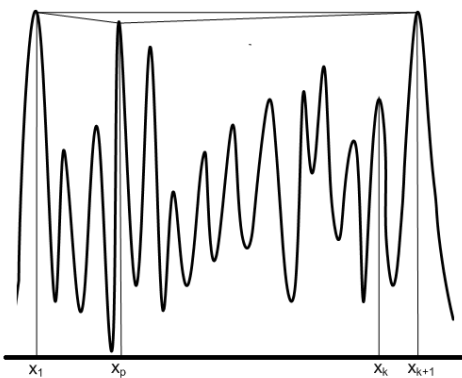


Fig. 2. Case of $G(x_p) < G(x_1)$ and $G(x_p) < G(x_{k+1})$, where one additional regular pair appears.

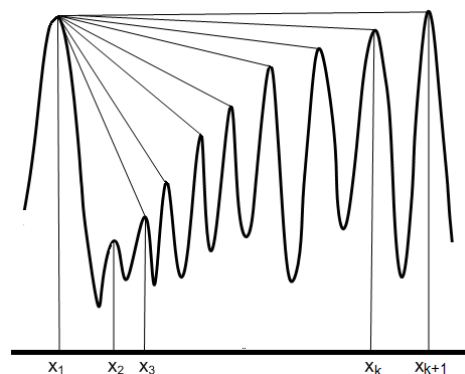


Fig. 3. Particular case with exactly $(k - 1)$ regular pairs.

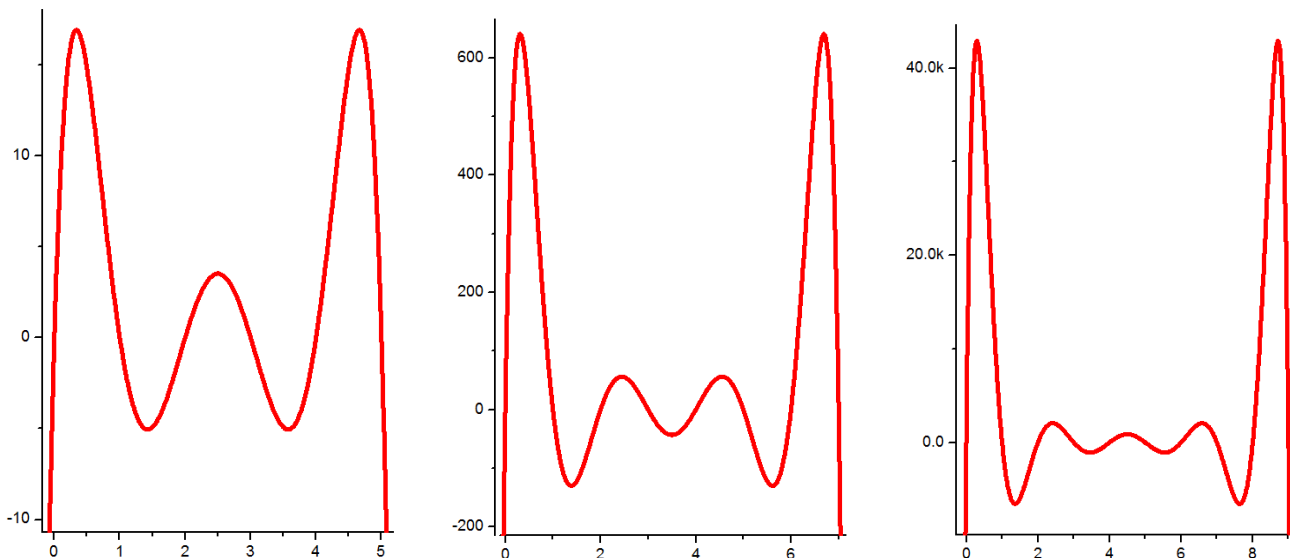


Fig. 4. Polynomial $P_{2n}(x)$ in cases, when $n = 3$ (left), $n = 4$ (center), $n = 5$ (right).

Proposition 1. Graph of the polynomial

$$P_{2n}(x) = -x(x - 1)(x - 2) \dots (x - (2n - 1)) \tag{5}$$

is symmetrical relative to the straight line $x = n - \frac{1}{2}$ (see Fig. 4).

Proof. Lets provide the parallel shift of coordinate system

$$\begin{cases} x - \left(n - \frac{1}{2}\right) = x' \\ y = y' \end{cases} \tag{6}$$

to the point $O'(n - \frac{1}{2}, 0)$. In that case the polynomial $P_{2n}(x)$ is transformed to new one as follows:

$$P_{2n}(x') = -\left(x'^2 - \left(\frac{1}{2}\right)^2\right) \left(x'^2 - \left(\frac{3}{2}\right)^2\right) \dots \left(x'^2 - \left(n - \frac{1}{2}\right)^2\right). \tag{7}$$

$P_{2n}(x')$ is an even function, i.e., a graph is symmetrical to axis $O'Y'$.

Proposition 2. The polynomial

$$P_{2n}(x) = -x(x - 1)(x - 2) \dots (x - (2n - 1)) \tag{8}$$

has n maxima points x_1, x_2, \dots, x_n , where $x_i \in (2i - 2; 2i - 1), i = 1, 2, \dots, n$, and

$$P_{2n}(x_1) = P_{2n}(x_n) > P_{2n}(x_2) = P_{2n}(x_{n-1}) > \dots > P_{2n}(x_{\frac{n}{2}}) = P_{2n}(x_{\frac{(n+2)}{2}}), \tag{9}$$

if n is even,

$$P_{2n}(x_1) = P_{2n}(x_n) > P_{2n}(x_2) = P_{2n}(x_{n-1}) > \dots > P_{2n}(x_{\frac{(n+1)}{2}}), \tag{10}$$

if n is odd.

2. Proof for $P_{2n}(x)$ where $n = 2$.

Proof. Let us consider polynomial $P_{2n}(x)$ where $n = 2$ and polinomial $P'_4(x)$ as the derivative of $P_4(x)$:

$$P_4(x) = -x(x - 1)(x - 2)(x - 3), \tag{11}$$

$$P'_4(x) = -(4x^3 - 18x^2 + 22x - 6) = -2(2x - 3)(x^2 - 3x + 1). \tag{12}$$

The polynomial $P_4(x)$ has two maxima points x_1 and x_2 related using expression: $P_4(x_1) = P_4(x_2)$:

$$x_1 = \frac{(3 - \sqrt{5})}{2} \in (0; 1); \quad x_2 = \frac{(3 + \sqrt{5})}{2} \in (2; 3), \tag{13}$$

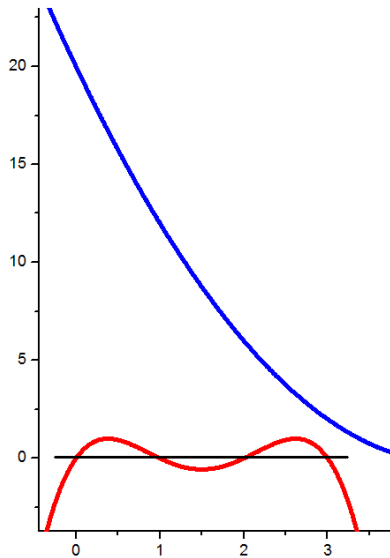


Fig. 5. $P_4(x) = -x(x - 1)(x - 2)(x - 3)$ at bottom and $Q_2(x) = (x - 4)(x - 5)$ at top.

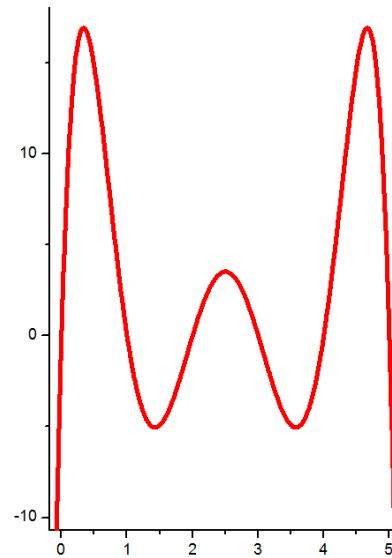


Fig. 6. Polynomial $P_6(x) = P_4(x) \cdot Q_2(x)$
 $P_6(x) = -x(x - 1)(x - 2)(x - 3)(x - 4)(x - 5)$

Polynomial $P_6(x)$ (see Fig. 5, Fig. 6) will be formed using the polynomial $P_4(x)$ and quadratic trinomial $Q_2(x)$:

$$Q_2(x) = (x - 4)(x - 5) : \tag{14}$$

$$P_6(x) = -x(x - 1)(x - 2)(x - 3)(x - 4)(x - 5) = P_4(x) \cdot Q_2(x). \tag{15}$$

Function $P_6(x)$ has two maxima points on segment $[0; 3]$ belonging to the different intervals: $x'_1 \in (0; 1)$ and $x'_2 \in (2; 3)$, and derivatives of $P_6(x)$ at fixed points could be expressed as follow:

$$P_6(x'_1) = \max_{x \in (0;1)} P_6(x) \geq P_6(x_1) = P_4(x_1) \cdot Q_2(x_1) > P_4(x_1) \cdot Q_2(1) = 12 \cdot P_4(x_1), \tag{16}$$

$$P_6(x'_2) = P_4(x'_2) \cdot Q_2(x'_2) \leq \max_{x \in (2;3)} P_4(x) \cdot Q_2(x'_2) < P_4(x_2) \cdot Q_2(2) = 6 \cdot P_4(x_2). \tag{17}$$

We obtain

$$P_6(x'_1) > 12 \cdot P_4(x_1) > 6 \cdot P_4(x_2) > P_6(x'_2) \tag{18}$$

On every segment between zeros of the polynomial $P_6(x)$ this polynomial has only one extremum point, because $P'_6(x)$ is a polynomial of the 5th degree, and can not have more than 5 zeros.

By symmetry of the graph of the polynomial $P_6(x)$ with respect to the line $= \frac{5}{2}$, the second point of maxima is $x'_2 = \frac{5}{2}$, the third point of maxima is $x'_3 \in (4; 5)$, and $P_6(x'_3) = P_6(x'_1)$.

3. Proof for $P_{2n}(x)$ where $n = 3$.

Let us consider polynomial $P_{2n}(x)$ where $n = 3$. Polynomial $P_8(x)$ (see Fig. 7, Fig. 8) will be formed using the polynomial $P_6(x)$ and quadratic trinomial $Q_2(x)$:

$$P_6(x) = -x(x - 1)(x - 2)(x - 3)(x - 4)(x - 5), \tag{19}$$

$$Q_2(x) = (x - 6)(x - 7), \tag{20}$$

$$P_8(x) = -x(x - 1)(x - 2)(x - 3)(x - 4)(x - 5)(x - 6)(x - 7) = P_6(x) \cdot Q_2(x). \tag{21}$$

On segment $[0; 3; 5]$ the function $P_8(x)$ has two points of maxima $x''_1 \in (0; 1)$ and $x''_2 \in (2; 3)$, and

$$P_8(x''_1) = \max_{x \in (0;1)} P_8(x) \geq P_8(x'_1) = P_6(x'_1) \cdot Q_2(x'_1) > P_6(x'_1) \cdot Q_2(1) = 30 \cdot P_6(x'_1), \tag{22}$$

$$P_8(x''_2) = P_6(x''_2) \cdot Q_2(x''_2) \leq \max_{x \in (2;3)} P_6(x) \cdot Q_2(x''_2) < P_6(x'_2) \cdot Q_2(2) = 20 \cdot P_6(x'_2). \tag{23}$$

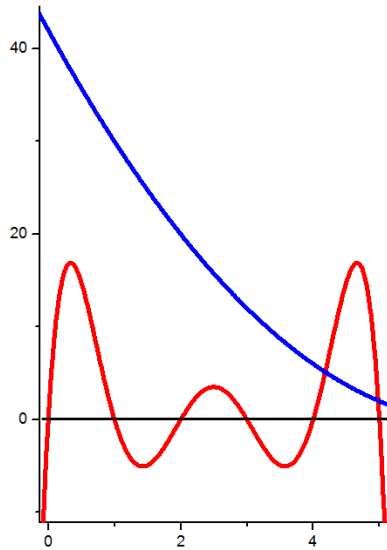


Fig. 7. Polynomial $P_6(x)$ at bottom
 $P_6(x) = -x(x-1)(x-2)(x-3)(x-4)(x-5)$
 and quadratic trinomial $Q_2(x) = (x-6)(x-7)$ at top.

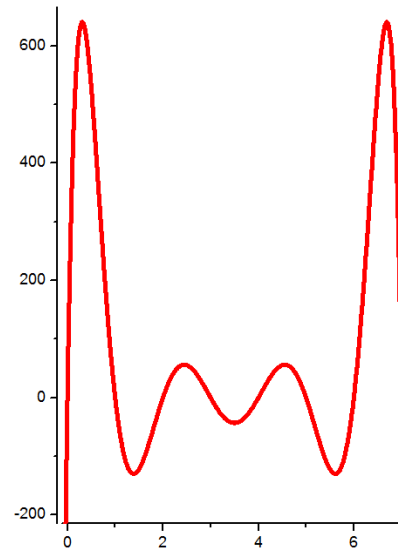


Fig. 8. Polynomial $P_8(x) = P_6(x) \cdot Q_2(x)$
 $P_8(x) = -x(x-1)(x-2)(x-3)(x-4)(x-5)(x-6)(x-7)$

We obtain

$$P_8(x''_1) > 30 \cdot P_6(x'_1) > 20 \cdot P_6(x'_2) > P_8(x''_2). \tag{24}$$

Polynomial $P_8(x)$ has two more points of maxima: $x''_3 \in (4; 5)$ and $x''_4 \in (6; 7)$.

By symmetry of the graph of the polynomial with respect to the line $x = \frac{7}{2}$, following expressions take place:

$$P_8(x''_3) = P_8(x''_2) \tag{25}$$

$$P_8(x''_4) = P_8(x''_1) \tag{26}$$

4. Proof for $P_{2n}(x)$ where $n = k + 1$.

Suppose that the proposition 2 is true, if $n = k$, i.e., $P_{2k}(x)$ has k points of maxima x_1, x_2, \dots, x_k , where $x_i \in (2i-2; 2i-1), i = 1, 2, \dots, k$, and

$$P_{2k}(x_1) = P_{2k}(x_k) > P_{2k}(x_2) = P_{2k}(x_{k-1}) > \dots > P_{2k}(x_{\frac{k}{2}}) = P_{2k}(x_{\frac{k+2}{2}}), \tag{27}$$

if k is even, and

$$P_{2k}(x_1) = P_{2k}(x_k) > P_{2k}(x_2) = P_{2k}(x_{k-1}) > \dots > P_{2k}(x_{\frac{k+1}{2}}), \tag{28}$$

if k is odd.

Let us show now that the proposition 2 is true if $n = k + 1$, i.e., for the points of maxima $x'_1, x'_2, \dots, x'_{k+1}$ of the polynomial

$$P_{2(k+1)}(x) = -x(x-1)(x-2) \dots (x-(2k+1)), \tag{29}$$

where $x'_i \in (2i-2; 2i-1), i = 1, 2, \dots, k+1$, the following relation takes place:

$$P_{2(k+1)}(x'_1) = P_{2(k+1)}(x'_{k+1}) > P_{2(k+1)}(x'_2) = P_{2(k+1)}(x'_k) > \dots > P_{2(k+1)}(x'_{\frac{k+2}{2}}), \tag{30}$$

if k is even, and

$$P_{2(k+1)}(x'_1) = P_{2(k+1)}(x'_{k+1}) > P_{2(k+1)}(x'_2) = P_{2(k+1)}(x'_k) > \dots > P_{2(k+1)}(x'_{\frac{k+2}{2}}) = P_{2(k+1)}(x'_{\frac{k+3}{2}}), \tag{31}$$

if k is odd.

Let us represent the polynomial $P_{2(k+1)}(x)$ as a complex polynomial:

$$P_{2(k+1)}(x) = P_{2k}(x) \cdot Q_2(x), \quad (32)$$

$$Q_2(x) = (x - 2k)(x - (2k + 1)) \quad (33)$$

where $Q_2(x)$ on the segment $(-\infty; 2k + \frac{1}{2})$ is a monotonically decreasing function. Now compare values of the polynomial $P_{2(k+1)}(x)$ in the neighbouring points of maxima $x'_i \in (2i - 2; 2i - 1)$ and $x'_{i+1} \in (2i; 2i + 1)$ ($i = 1, 2, \dots, \frac{k}{2}$, if k is even, and $i = 1, 2, \dots, \frac{(k-1)}{2}$, if k is odd):

$$P_{2(k+1)}(x'_i) = \max_{x \in (2i-2; 2i-1)} P_{2(k+1)}(x) \geq P_{2(k+1)}(x_i) = P_{2k}(x_i) \cdot Q_2(x_i) > P_{2k}(x_i) \cdot Q_2(2i - 1), \quad (34)$$

$$P_{2(k+1)}(x'_{i+1}) = P_{2k}(x'_{i+1}) \cdot Q_2(x'_{i+1}) \leq \max_{x \in (2i; 2i+1)} P_{2k}(x) \cdot Q_2(x'_{i+1}) = P_{2k}(x_{i+1}) \cdot Q_2(x'_{i+1}) < P_{2k}(x_{i+1}) \cdot Q_2(2i). \quad (35)$$

We obtain

$$P_{2(k+1)}(x'_i) > P_{2k}(x_i) \cdot Q_2(2i - 1) > P_{2k}(x_{i+1}) \cdot Q_2(2i) \geq P_{2(k+1)}(x'_{i+1}), \quad (36)$$

i.e.,

$$P_{2(k+1)}(x'_i) > P_{2(k+1)}(x'_{i+1}), \quad (37)$$

where $i = 1, 2, \dots, \frac{k}{2}$, if k is even, and $i = 1, 2, \dots, \frac{(k-1)}{2}$, if k is odd.

By symmetry of the graph of the function with respect to the line $x = k + \frac{1}{2}$, in other points of maxima of the polynomial $P_{2(k+1)}(x)$ we obtain necessary correlation.

We would like to get now a polynomial $Q_{2n}(x)$ with optimal distribution of maxima.

Let us change one of zeros of the polynomial $P_{2n}(x)$ to sufficiently small ε :

$$Q_{2n}(x) = -x(x - 1)(x - 2) \dots (x - (n - 1 + (-1)^n \varepsilon)) \dots (x - (2n - 1)). \quad (38)$$

Sign of the difference

$$Q_{2n}(x) - P_{2n}(x) = (-1)^n \varepsilon x(x - 1)(x - 2) \dots (x - (n - 2))(x - n) \dots (x - (2n - 1)) \quad (39)$$

on the segments between zeros $0, 1, 2, \dots, n - 2, n, \dots, 2n - 1$ of this difference will alternate increasing the value of the polynomial $Q_{2n}(x)$ comparing to the values of the polynomial $P_{2n}(x)$ in points of maxima on one side of the line $x = n - \frac{1}{2}$, and decreasing on the other.

Proposition 3.

The polynomial

$$Q_{2n}(x) = -x(x - 1)(x - 2) \dots (x - (n - 1 + (-1)^n \varepsilon)) \dots (x - (2n - 1)) \quad (40)$$

an arbitrary selected even degree $2n$ using condition $n \geq 3$, where $\varepsilon > 0$ is sufficiently small, has n points of maxima $x'_1, x'_2, \dots, x'_n, x'_i \in (2i - 2; 2i - 1), i = 1, 2, \dots, n$, and

$$Q_{2n}(x'_1) > Q_{2n}(x'_n) > Q_{2n}(x'_2) > Q_{2n}(x'_{n-1}) > \dots > Q_{2n}(x'_{n/2}) > Q_{2n}(x'_{(n+2)/2}), \quad (41)$$

if n is even, and respectively

$$Q_{2n}(x'_1) > Q_{2n}(x'_n) > Q_{2n}(x'_2) > Q_{2n}(x'_{n-1}) > \dots > Q_{2n}(x'_{(n+1)/2}), \quad (42)$$

if n is odd.

Conclusion

We consider the acquired polynomial $Q_{2n}(x)$ as a function $G(x) = \int_0^x g(s)ds$, which is a primitive of the function $g(x)$. There exist exactly $(n - 2)$ regular pairs of maxima points of the function $G(x)$, and, consequently, $(n - 2)$ nontrivial period annuli of differential equation $x'' + g(x) = 0$.

References

1. S. Atslega, F. Sadyrbaev. Period annuli in the Lienard type equation. – *Intern. J. of Pure and Applied Mathematics* 44(1) (2008) 117-123.
2. Y. Kozmina, F. Sadyrbaev. On a Maximal Number of Period Annuli. – *Abstract and Applied Analysis* Vol. 2011 (2011), Article ID 393875, 8 pages, doi:10.1155/2011/393875.
3. Y. Kozmina. Profiles of primitive functions and application to nonlinear differential equations. – *Information Technologies, Management and Society* 3(1) (2010) 64-67.

Financial investment market of Lithuania

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Abstract. This article discusses the main notion about international standard of financial instruments and tries to explain theory using transaction cost financial method. Particularly how precision, which is one of the three most important attributes for characterizing theoretical base, can effect financial investment, investor's choice and investment fees in a setting when customers/suppliers, as the stockholders of the firm, are included. Therefore, this article is focused on the improvement of theoretical basis of financial instrument to stimulate the development of private and small business. According to the aim and logic of the article the following tasks, based on the study of foreign experience of investment in liaison with the foreign and domestic scientists and mass media, some international standards are observed: what is convergence and whether there is any possibility of convergence between Central Asian and European financial organizations. Recommendations on introducing foreign experience in the Lithuanian investment market are discussed on the basis of analysis of experience in developed countries.

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JEL: D53; M40; P33.

Short title: Financial market.

Introduction

One of the most important investment decisions that an investor encounters is the allocation of funds among the wide range of Financial Instruments (FIs). According to the acknowledgement in recent literature, financial instruments play a crucial role in economic development.

Common-stock market spans the length and breadth (width) of the financial spectrum, from a new start-up company to a mature conglomerate, from a so called *mom-and-pop* shop to an international giant, from a domestic corporation to a foreign company. All of them want to become attractive to the investments. This is a way for a company to raise the capital.

Literally, it is selling shares to the public [1]. That decision requires understanding of the investment characteristics of all asset classes. The market of financial instruments, also called securities market, is a constituent part of economy, which allows redistribution of financial resources between separate economic entities. As a result, the companies can accumulate necessary financial resources, whereas households and other economic entities have a possibility to invest and expect a return on investment.

Information acquisition costs create incentives for financial intermediaries to emerge [2,3]. The ability to acquire and process information may have important growth implications. Because many firms and entrepreneurs will solicit capital, financial intermediaries and markets that are better at selecting the most promising firms and managers will induce a more efficient allocation of capital and faster growth. The behaviour of financial markets makes it possible to understand the general economic status of a country:

- a) the rising share prices show positive investor expectations and possible economic growth;
- b) the falling share prices mark poor activity or prospects for a company or the whole national economy.

Economic processes, which are related to the market of financial instruments, not only influence trade inside the country, but also attract foreign and institutional investors, whose capital contributes much to the creation of economic welfare, and increases the liquidity and global competitiveness of the market of financial instruments.

Basic stakeholders (such as accountants, regulators, preparers etc) argue on many issues regarding setting standards related to financial instruments. This is because financial instruments continue to be an important and contentious account-

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ting topic. The argument runs round the issue of disclosure, measurement and remeasurement, recognition and valuation. Stakeholders' arguments are usually about the effect the standards and their prescriptions would likely have on their economic interests.

For example, a central issue that links issues in relation to disclosure, valuation and recognition is accounting for financial instruments at fair value, which is a major heading in IAS 32 and 39 and therefore will be discussed here.

1. Financial instruments: classification and evaluation

The term *financial instrument* has a variety of definitions. According to Dubil [4], financial instruments are classified into such categories: fixed income securities, equities, derivatives (futures, swaps, options, exchange-traded funds, ect). Other authors according to Ref. [5] classify financial instruments into securities (shares), derivatives, short-term and long-term Debt securities.

Financial instruments can be classified by the type of claim that the holder has on the issuer. When the claim is for a fixed dollar amount, the financial instrument is said to be a debt instrument. In contrast to a debt obligation, an equity instrument obligates the issuer of the financial instrument to pay the holder an amount based on earnings, if any, after the holders of debt instruments have been paid. Common stock is an example of an equity claim.

Financial instruments (FIs) make a major part of *actives* and obligations of many organizations, in particular the credit organizations. FIs play the leading part in the maintenance of effective function in the financial markets. During the last three decades the market of financial instruments has significantly grown in both aspects: quantitative and qualitative; its progress was accompanied by occurrence all of new types of FIs, including derivative tools.

Nowdays banks and companies are not limited to use the traditional primary tools, resorting to complex tools of management of risks where they are actively applied as the interconnected financial instruments. Financial instrument - means any contract that gives rise to a financial asset of one entity and a financial liability or equity instrument - from another company. Some securities fall into both categories in terms of their attributes. Preferred stock, for example, is an equity instrument that entitles the investor to receive a fixed amount. This payment is contingent, however, and due only after payments to debt instrument holders have been made. Other "combination" instrument is a convertible bond, which allows the investor to convert debt into equity under certain circumstances. Both debt instruments and preferred stock that pay fixed dollar amounts are called fixed-income instruments.

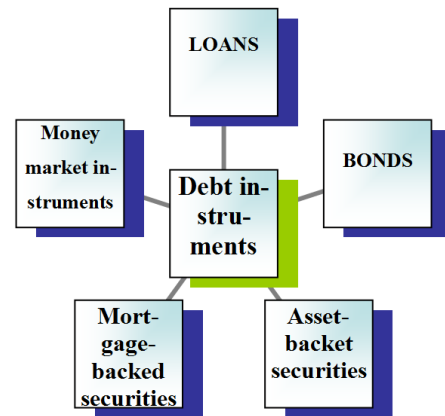


Fig. 1. Debt instruments.

As it has become obvious, there is a good number of debt instruments available to investors. Debt instruments include loans, money market instruments, bonds, mortgage-backed securities, and asset-bucket securities [6]. Fig. 1 represents the schema of debt instruments. In the chapters that follow, each will be described. There are features of debt instruments that are common to all debt instruments and they are described below. In later chapters, there will be a further discussion of these features.

The abbreviated definition provided in the Republic of Lithuania Law on Markets in Financial Instruments: a financial instrument means any of the following instruments: transferable securities; money market instruments; securities of collective investment undertakings; options; futures; swaps; forward rate agreements. Any other derivative are also included which contract relating to securities, currencies, interest rates or yields, or other derivatives instruments, financial indices or options, futures, swaps, forward rate agreements and any other derivative contracts relating to commodities, and financial contracts for differences [7].

Only equities have been preserved as the "original" financial instruments in the present day Lithuanian financial market, whereas debt financial instruments often have the features of derivatives (e.g. Lithuanian bank bonds are linked with the raw materials price index). The CFI (Classification of Financial Instruments) code based on ISO-10962 (2001) standard defines the nature of financial instruments most precisely. Thus, the following breakdown of the financial instruments based on that standard is used (see Ref. [8].)

- E - Equities;
- D - Debt instruments;
- R - Entitlements or rights;
- O - Options;
- F - Futures;
- M - Others or Miscellaneous.

Although different terminology is used, the financial instruments are classified into three main groups [9]: equities, debt instruments and derivatives. Fig. 2 represents the groups of financial instruments currently used in Lithuania.

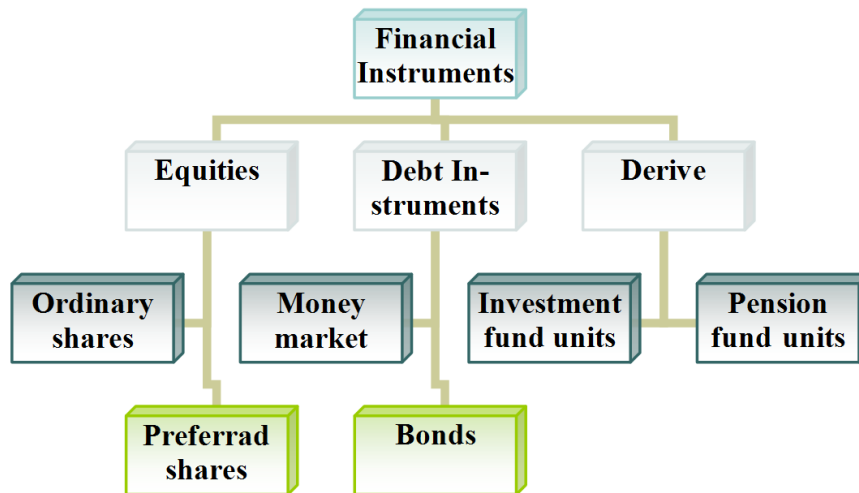


Fig. 2. The groups of financial instruments currently used in Lithuania.

The financial intermediaries licensed in Lithuania can offer, from the range mentioned above, all financial instruments traded on and off the regulated Lithuanian market and can act as intermediaries almost in all financial markets of the world.

2. Money market

The development and regulation of stock markets play a key role in the financial system architecture in transition economies [10].

There were no stock markets in Central Asia during the 40-70 years of socialism era. Nowadays, the fast expansion of stock markets is seen as an important component of the development of the financial sector in these economies. Stock market development and other aspects of financial market development take place simultaneously and complement each other. A crucial question, however, is to what extent and under which conditions stock market development may contribute to a process of long-term economic growth.

For example, Levine and Zervos strongly suggest that stock markets contribute positively to economic growth. Moreover, they do not find any evidence of a negative effect of stock price volatility or capital market integration on economic growth. However, there are others who argue that stock markets do not play an important role since only a small part of corporate investment is financed by means of equity. Stephen Ryan is a well-known opponent of the view that stock markets are crucial for long-term economic growth [11].

Fair value accounting for financial instruments is increasingly feasible for two reasons.

1. The markets for financial instruments have become much richer over time. For example, risky assets that previously were difficult to trade, such as commercial loans, how can be securitized.

2. Financial theory, such as options pricing, has developed and been applied successfully in many contexts by practitioners. See Ref. [11].

Investment in money market is done through money market instruments. Money market instrument meets short term requirements of the borrowers and provides liquidity to the lenders. Fig. 3 represents the schema of Instruments of Common Money Market according to Ref. [12].

To decide how much and where to invest in money market an investor will refer to the *Money Market Index*. It provides information about the prevailing market rates. There are various methods of identifying Money Market Index.

Smart Money Market Index. It is a composite index based on intra day price pattern of the money market instruments.

Salomon Smith Barney's World Money Market Index. Money market instruments are evaluated in various world currencies and a weighted average is calculated. This helps in determining the index.

Banker's Acceptance Rate. As discussed above, Banker's Acceptance is a money market instrument. The prevailing market rate of this instrument i.e. the rate at which the banker's acceptance is traded in secondary market, is also used as a money market index.

LIBOR/MIBOR. London Inter Bank Offered Rate/ Mumbai Inter Bank Offered Rate also serves as good money market index. This is the interest rate at which banks borrow funds from other banks.

As the world interest rate rises relative to the Lithuanian interest rate, investors move capital overseas to enjoy a higher rate of return and reduce the demand for Lithuanian stocks and stock prices. On the other hand, a higher world interest rate causes the foreign currency to appreciate, makes Lithuanian-made products cheaper, helps raise net exports, and increases businesses and stock prices.

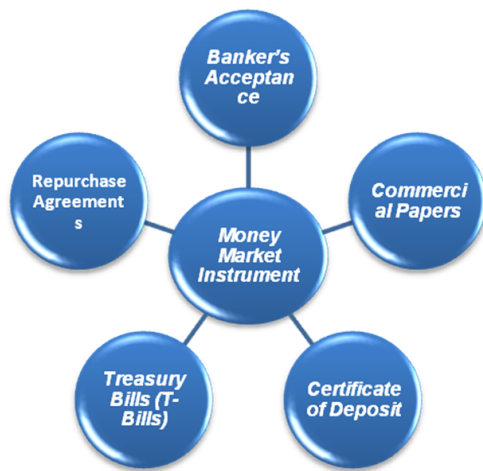


Fig. 3. Instruments of money market.
Adapted according to the Ref. [12]

The contagion effect suggests that Lithuania’s stock market is linked to and affected by the world stock market. Thus, Lithuania’s stock market index responds positively (negatively) to an increase (a decrease) in the US and other major stock market indexes.

3. Use of International Financial Reporting Standards around the world

In 2005, thousands of companies around the world (particularly in Europe and the Asia-Pacific area) switched from their national accounting standards to International Financial Reporting Standards (IFRSs). This "big bang" adoption took a lot of hard work on the part of the preparers of financial statements, their auditors and others. Early indications are that the effort was well worthwhile from the perspective of investors, lenders and fund managers, who acknowledge that IFRSs have provided valuable new insights into companies’ financial condition and performance. And since financial markets attract seekers and providers of capital across political borders, the financial statement comparability that IFRSs provide is another major benefit from the perspective of the user of financial statements. Table 1 represents the usage of IFRSs for domestic reporting by listed companies as of February 2006 according to data presented in Ref. [13].

In Australia, Brazil, India and Holland and other countries, international standards are used as a basis for developing their own standards, and in countries which decided not to develop its own standards (Cyprus, Malaysia, Nigeria, Fiji, Sri Lanka, etc.) international standards can be fully utilized as national. In most developed countries with their specific national auditing standards (Canada, UK, Ireland, USA), international standards simply takes note of the professional organizations. Growing numbers of countries are adopting IFRS. The historic 2002 Norwalk Agreement (between the US standard

setter, FASB and the IASB) called for "convergence" of the respective sets of standards, and indeed a number of revisions of either US GAAP or IFRS have already taken place to implement this commitment, with more changes expected in the immediate future. The aim of the Boards was to complete the milestone projects of the Memorandum of Understanding (MOU) by the end of June 2011. These milestone projects include the following categories.

1. Financial Instruments.
2. Consolidations.
3. Derecognition.
4. Fair value measurement.
5. Revenue recognition.
6. Leases.
7. Financial Instruments with characteristics of equity.
8. Other MOU projects.
9. Other joint projects, see Ref. [14].

4.1. International standards: what is convergence and whether there is any likelihood of convergence between Asian and European financial organizations

The development of financial reporting rules for financial instruments just described has provided users of financial reports with substantial new information about how firms generate or destroy value using these instruments.

Lithuania has not fully adopted IFRS [15]. However, it is trying to converge to an extent with IFRS. In 1998, there has been an accounting reform in Lithuania for the development of a series of the first National Accounting Standards that were based upon IAS [16]. Some of these standards were first drafted in 1997, but a few of them were approved in 1998 by the Ministry of Finance. At present, there are 21 standards effective in Lithuania [17]. Each standard is based on the relevant international standard, but there are differences between respective local and international standards. In essence, Uzbekistan is in the first stage of the adoption process of IFRS.

IFRS is required for all commercial banks. IFRS and IFRS for SMEs are prohibited for other companies’ statutory filings. However, other entities can also use IFRS together with statutory rules, since there is no restriction in use of IFRS for any type of entities (foreign entities or joint ventures, etc). The local standard setting body has not announced any adoption plans; however, there is a step by step convergence plan of local GAAP with IFRS.

The debate surrounding the adoption of IFRS in Europe initially focused on the merits of adopting IFRS, such as whether the benefits of the expected increased capital flows would outweigh the costs of implementation and lost diversity in domestic accounting standards.

Table 1. Use of IFRSs around the world.

Location	IFRS not permitted	IFRS permitted	Required for some domestic listed companies	Required for all domestic listed companies
Lithuania				X(a)
China			X	
Estonia				X(a)
Finland				X(a)
France				X(a)
Germany				X(a)
Hong Kong				X(c)
India	X			
Japan	X			
Kazakhstan			X(e)	
Korea (South)	X			
Kyrgyzstan				X(a)
Latvia				X(a)
New Zealand				X(b)
Russian Federation			X	X(f)
Switzerland		X		
Tajikistan				X
United States	X			
Uruguay	X(d)			

a) audit report refers to IFRSs as adopted by the EU;
b) compliance with IFRS is stated in a note, starting from 2007;
c) IFRSs adopted virtually in full as national GAAP;
d) by law, all companies must follow IFRSs existing at 19 May 2004; auditors report refers to conformity with Uruguayan GAAP.
e) banks only;
f) starting 2006.

The debate later centered on IAS 39 Financial Instruments: Recognition and Measurement and, to a lesser extent, on IAS 32 Financial Instruments: Disclosure and Presentation. The provisions in these two standards, particularly IAS 39, had the potential to materially affect financial statement amounts for firms with a large number of financial instruments, notably banks. The debate regarding IAS 39 ultimately led to the modification of IAS 39 for adoption in Europe. Modifications to IAS 39, or any other IASB standard, undermine the EU's goal of adopting global standards.

4.2. The practice of international standards

The *International Accounting Standards/International Financial Reporting Standards* (IAS/IFRS) consist of a set of international accounting principles, the adoption of which aims at establishing clear rules within the European Union to draw up comparable and transparent annual reports and financial statements. Their adoption represents an essential element to obtain an integrated, competitive and attractive European capital market, which has impelled the European Commission to introduce this set of uniform accounting standards for listed EU companies.

Financial reporting for financial instruments and institutions is undergoing a period of unprecedented change and re-

laxance for financial analysis. In the past decade, the *Financial Accounting Standards Board* (FASB) has issued major standards on derivatives and hedging, transfers of financial Instruments including securitizations servicing of financial assets, consolidation of special purpose interest entities, hybrid financial instruments, financial guarantees, and fair value measurements.

4.3. Financial market of Lithuania

Accordingly, a lot of companies with participation of foreign capital have been establishing lately. So, under these circumstances there is a need for proper organization of business activity of joint ventures and companies with foreign investments. The financial intermediaries licensed in Lithuania can offer from the range mentioned above all financial instruments traded on and off the regulated Lithuanian market and can act as intermediaries almost in all financial markets of the world.

The restored financial market of Lithuania is quite young, it has moved to only the third decade. Its establishment gave rise to the need to thoroughly analyse the ongoing processes, make analysis, and statistical calculations. The complex analysis is needed both with regard to investor and the issuer of the financial instrument for the Bank of Lithuania, the Central

Securities Depository of Lithuania, and the Securities Commission of the Republic of Lithuania. Following the Council Regulation (EC) No 2223/96 of 25 June 1996 on the European system of national and regional accounts in the Community, the institutions mentioned above have prepared the *Rule on the Submission of Information on the Owners of Securities, Balances of Securities and Financial Flows (2005)*. Drafting of the *Rule* was based on the May 16, 2001 Decision No 569 of the Government of the Republic of Lithuania on the Implementation of the European System of National and Regional Accounts (ESA'95). According to the Rule the owners of financial instruments, also called securities, are grouped into Lithuanian residents, European Union residents, except for the Republic of Lithuania, and non-residents.

Lithuanian financial system is dominated by the banking sector with only a minority of assets held by other types of firms (capital market, insurance, leasing of credit unions). As well as the whole economy, financial system has suffered from the losses in the period of the recession. Banking sector has maintained its stability and no major disturbances in the market occurred even though the situation was tough. Today the financial sector is on its way for a rebound. Its path will depend on the general state of Lithuanian economy which is still subject to risks from the foreign markets. However, many areas of Lithuanian financial services are underdeveloped compared to the Western economies, thus the long term potential is yet to be unveiled.

In general for transition economies the following barriers for derivatives markets can be presented according to notes in Ref. [18]:

- a) awareness and understanding of derivatives;
- b) domestic laws and regulations inhibiting such investments;
- c) limits on access to brokerage services;
- d) cost of entering a new market;
- e) increased risks;
- f) lack of adequate infrastructure;
- g) lack of customers.

In developed countries derivatives markets fulfil important roles of price discovery and hedging opportunities. There-

fore, I see the future of the derivatives market in transition economies in general and in Uzbekistan in particular, as at least a long-run prospect.

Conclusion

New forms of businesses in international activities of Lithuania result in occurrence of new problems. Selection of a partner in the international market, on which the future collaboration depends, is one of the problems. The methods of efficiency analysis of enterprises applied abroad are different from the ones in Lithuania. New economic relations linked with gradual transfer of the economy to the usage of market mechanisms, create new problems in organization and methodology of financial system. Development of market economy does not tolerate insularity of national economy, but on the opposite, it allows free movement of goods, capital and workforce. Broad international relations also include expanding foreign investments into the economy of Lithuania.

This is stipulated by the development of world economy, requiring between companies operating in the international market. On the other hand, restructuring of the theoretical basis in Lithuania requires profound understanding of the essence of international standards and the opportunity of their application in practice. These letters contain errors and omissions noted, and recommendations for corrections. Development of financial system in Lithuania requires immediate solution to the following issues, presented below.

1. Usage of the methodologies based on international standards for grouping financial instruments and investors.
2. Enhancing international integration of trade and settlement systems and promote creation of new high technologies in this sphere in Lithuania.
3. Encouraging the arrival of new issuers into the market.
4. Developing the education of investors.
5. Developing the financial standards and norms considering international experience and peculiarities of the national accounting standards.
6. Developing the recommendations on generally accepted forms of investors opinion and programmes.

References

1. David M. Weiss. Financial Instruments: Equities, Debt, Derivatives, and Alternative. – 2009 07 23 – 396.
2. Diamond D. Financial Intermediation and Delegated Monitoring. – *Review of Economic Studies* 51(3) (1984) 393-414. <<http://dx.doi.org/10.2307/2297430>>, accessed 2012 11 04.
3. Deacon, M.; Derry, A.; Mirfendereski, D. Inflation-Indexed Securities: Bonds, Swaps, and Other Derivatives. – Chichester: Wiley, 2004. – ISBN 0-470-86812-0.
4. Dubil, R. An arbitrage guide to financial market. – John Wiley & Sons LTD, 2004 – 8-310.
5. Fabozzi, F. J.; Peterson, P. P. Financial Management and Analysis. – John Wiley & Sons Inc, 2003 – 27 - 533.
6. Farbozzi, F. J. The handbook financial instruments. – John Wiley & Sons Inc, 2002 – 67-805.
7. Law on markets financial instruments [interactive]. – <<http://www.vpk.lt>>, accessed 2010 10 23.
8. International Standard. Securities and related financial instruments. – Classification of Financial Instruments (CFI code) ISO 10962:2001E, 2001.

9. Information containing Law on Markets in Financial Instruments (Republic of Lithuania), systematized by author.
10. Hunsen, M. H.; Hurwitz, W. N.; Madow, W. G. Sample Survey Methods and Theory. – John Wiley & Sons, Inc., 2000. ISBN: 978-0-471-00628-2 – 1016 p.
11. Stephen G. Ryan. Financial Instruments and Institutions: Accounting and Disclosure Rules. – HF5681, 2007. – 657-dc22.
12. Understanding Financial Markets & Instruments. – Online book.
13. Deloitte, Touche, Tohmatsu. IFRS in Your Pocket. Fifth edition. – April 2006, <<http://www.iasplus.com/dttpubs/pocket>>, accessed 2012 11 04.
14. Bruce Mackenzie, Danie Coetsee, Tapiwa Njikizana. Interpretation and Application of International Financial Reporting Standards, – Wiley, 2012 – p3-1081.
15. Deloitte & Touche.(2003). IFRS: Of Growing Importance for US Companies. 2003, P4. – <<http://www.iasplus.com/pastnews/2003may.html>>, accessed 2008 12 01.
16. Narayan, F.; Reid, B. Financial Management and Governance Issues in the Republic of Uzbekistan. Asian Development Bank [online]. – 2000, P37. – <<http://www.adb.org/Documents/>>, accessed 2010 01 02.
17. Balchenko, S. The Eurasian Landscape: IAS Gap Analysis. Organisation for Economic Cooperation and Development. – (2001) <<http://www.oecd.org/dataoecd/60/0/2354837.pdf>>, accessed 2010 01 02.
18. Mackenzie, B.; Coetsee, D.; Njikizana, T.; Chamboko, R. Interpretation and Application of International Financial Reporting Standards. – London: Wiley, 2010.

