JOURNAL OF ENTREPRENEURSHIP MANAGEMENT AND INNOVATION

No 7
2011

WYŻSZA SZKOŁA BIZNESU
NATIONAL-LOUIS UNIVERSITY

Journal of Entrepreneurship, Management and Innovation (JEMI) is a scientific journal ([p] ISSN 1734-1590; [e] ISSN 1734-283X) published annually by Wyższa Szkoła Biznesu – National Louis University, Zielona 27, 33-300 Nowy Sącz, Poland.
The journal is primarily published on-line at http://www.jemi.edu.pl.

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THE TRANSFORMATION OF BASIC RESEARCH INTO COMMERCIAL VALUE: ECONOMICS ASPECTS AND PRACTICAL ISSUES

Haim V. Levy[1]

Abstract

Basic research may be considered as the first step in the knowledge generation or innovation process. Knowledge is probably recognized as the most important factor in the development of national economies. Governments therefore have a role in ensuring and subsidizing the basic science to generate knowledge aimed to improve social welfare.

Since basic research is conducted mainly at universities nowadays, they should set to support all aspects of knowledge generation and transfer - from basic research (invention) to innovation and ultimately, to commercialization. The transformation of knowledge or innovation into commercial value depends primarily on efficient pathway(s) of technology transfer by universities' technology transfer organizations. Ideally, universities should seek to transfer technology to the private sector in order to capture the benefits of commercialization of their innovation. However, in circumstances where the innovation is at an early or premature stage, consequently far from materializing to a product, licensing to industrial enterprises is not (always) plausible, hence feasible alternatives should be sought. In this short review, we argue possible modi operandi to achieve these goals.

Key words*: Basic Research; Knowledge; Innovation; IP; Technology Transfer; Licensing; Spin-off companies.*

Introduction

The purpose of this paper is to briefly discuss the potential contribution of universities applicable research to the achievement of economic growth. This paper is by no means an exhaustive review but rather aimed at bringing about a discussion on practicable avenues to commercially exploit scientific achievements and technological innovation from academia.

The rapid pace of technological advancement that has led many national economies forward for the past two centuries is not self evident. Indubitably, the growth of economies in industrialized countries has been driven mainly by the pursuit of scientific research, the implementation of innovative engineering solutions and a constant flow of technological innovation. It is now apparent that the knowledge base of modern economies has steadily increased, and the ability of a society to produce and commercialize knowledge is critical for sustained economic growth and improved quality of life.

Medical (and biomedical) research, for example, has certainly brought economic benefit and welfare. The increase in life expectancy in the twentieth century is generally attributed to improved drugs, vaccines, antibiotics, advanced diagnostic methods and other medical treatment breakthroughs. Silverstein et al. (Silverstein, Garrison, & Heinig, 1995) compiled data on cost savings from medical research. Following are few arbitrarily selected examples: polio vaccine saves $2 billion per year in the US; hip-fracture prevention in postmenopausal women at risk for osteoporosis saves $333 million annually. Kidney

[1] Dr. Haim V. Levy is the founder of two Biomed companies and currently serves as Chairman of NanoDerma Ltd. (Israel). He lectures on Entrepreneurship at Ben Gurion University and is a business adviser and a counsel to Hi-Tech transactions. hlevydr@netvision.net.il

transplantation, improved efficacy and safety, save between 360-480 million per annum in reduced treatment costs and lost earnings. Treatment for testicular cancer has resulted in annual savings of 134.0-178.7 million from improved survival and reduced premature mortality.

The power of research is demonstrated not only by single innovations but by the ability to create entire new industries, such as *molecular biology* (genetic engineering), which in turn has led, among others, to new therapeutic modalities and the enormous growth of the biotechnology industry. The potential of these developments for healthcare is only beginning to be realized.

It is evident that universities have become more important players and scientists, researchers and engineers have played a critical role in driving technological progress. In order for the benefits of university research to be expressed in the economy, the universities have to find the way to effectively liaise with the industrial domain and explore efficient mechanisms for the transfer of technology to industry.

In this review we argue the role of basic research to generate knowledge which can be transformed into economic value. We discuss, among others, the common process and methodologies currently applied to the transfer of applicable scientific research and innovation from universities to the industry.

The Role of Basic Research in Generating Innovation

Basic research is conducted at universities and research institutions, and is primarily directed for the advancement of knowledge and scientific discoveries. Scientists often endeavor to solve scholarly problems without immediate expectations (or even interest) to utility implication. Consequently, basic research may produce results of vast scientific value, but not necessarily with plausible economical significance, if at all. Incontestably, universities' main goals are, *and should remain to be*, the discovery and dissemination of new knowledge, on one hand, and higher education teaching[2], on the other hand.

The increased importance of basic research is also the emergence of certain new technologies and knowledge (such as *biotechnology*, discussed hereinafter) which depends on and requires very basic research that might eventually materialize to marketable products.

From the laboratory bench to the market place

A remarkable contemporaneous example to illustrate the long journey *'from the laboratory bench to the market place'* is the development of Copaxone®[3], among the most unique of modern drug discoveries, initiated at the Weizmann Institute of Science in Rehovot, Israel (WIS). It is a notable example of basic research with vast impact on human health and economic benefit. The roots of this drug are to be found in the research of Ephraim Katchalski Katzir[4], who, back in the 1940s, prepared synthetic polypeptides—long molecules resembling proteins. Ten years later, Katzir's student, Michael Sela, discovered that these synthetic polypeptides could activate the immune system. A decade later, Sela, together with his student Ruth Arnon and Dvora Teitelbaum were working to determine the minimum chemical

2 A rather important effect of basic research is the training that graduate students receive, which later enable them to engage in innovative firms. The movement of trained personnel into industry can be a powerful mechanism for the dissemination of scientific research thus affecting the efficiency of R&D – 'Human Capital'.

3 Copaxone®, Teva's (see Footnote 5) first major innovative drug, is the leading multiple sclerosis treatment. Multiple sclerosis (MS) is a chronic disease of the central nervous system. Worldwide, MS is thought to affect more than 2.5 million people.

4 Eminent scientist and the fourth President of the State of Israel (1973-1978)

constituents necessary to make a molecule immunogenic, that is, to give it the ability to elicit antibodies in an animal. Later, they began to examine possible applications for such molecules with interest in the immunology of lipids. They have made a serendipitous discovery of a drug (or 'therapeutic vaccine') for the exacerbating-remitting form of multiple sclerosis. The pathway of the drug discovery is vividly summarized in Michael Sela's presentation at the Plenary Session of the Pontifical Academy of Sciences on 'Paths of Discovery' which was held in November 2004 in the Vatican (Sela, 2006). These experiments eventually led to the development of Copaxone®. The active molecule was patented and licensed to Teva Pharmaceutical Industries (Teva)[5]. Clinical trials carried out by Teva showed its efficacy in treating MS. At the end of the process, in 1996, Copaxone® became the first original Israeli drug to be approved by the US Food and Drug Administration (FDA). Today, following fifteen years of active sales in the U.S. and 40 countries around the world, Copaxone® has made a significant contribution to the Israeli economy and to patients' wellbeing. Global market sales of Copaxone® reached a record $3,316 million in 2010[6]. The development of Copaxone® is not a single example whereby basic research has evolved to commercial products.

The role of basic research in 'knowledge-based economies'

It is generally accepted that basic research may be considered as the first step in the process of knowledge generation that might lead to discoveries and inventions that have a significant impact on society. To this end, scientific knowledge[7], resulting from basic research and inventions thereof has been long recognized to have characteristics of a pure public good (see for example, (Nelson, 1959) (Arrow, 1962)). Knowledge is accordingly recognized as a critical determinant of economic growth and standard of living. The role it plays in the process of innovation and economic growth has become even more central since the emergence of the so-called 'knowledge-based economies' - economies which are directly based on the production, distribution and use of knowledge (OECD, 1996). In fact, the science system carries out key functions in the knowledge-based economy, including knowledge production, transmission and transfer.

The characteristic of the knowledge-based economy has emerged with changes to the linear model of innovation (Figure 1: Linear Model of Innovation). This theory held that innovation is a linear process which begins with new scientific research, progresses sequentially through stages of product development, production and marketing, and terminates with the successful sale of new products, processes or services. However, innovation can assume many forms, including incremental improvements to existing products, applications of technology to new markets and uses of new technology to serve an existing market (see also Footnote 5). Therefore, it is argued now that the process is not completely linear, it rather requires extensive communication among the different players (OECD, 1996).

5 Teva Pharmaceutical Industries Ltd. is a global pharmaceutical company, based in Israel, specializing in the development, production and marketing of generic and proprietary branded pharmaceuticals as well as active pharmaceutical ingredients.

6 Teva Annual Report 2010 (FORM 20-F (US Security and exchange Commission - SEC).

7 Knowledge in general, disregarding to its origin or the way is generated, is considered as a public good.

Figure 1: Linear Model of innovation

It should be further noted that knowledge can be non-excludable since, once it is made public, in the absence of clearly defined and protected property rights (e.g. patented), users cannot be prohibited from using it. Some forms of knowledge are (or can be made) excludable. For instance, it may be possible to keep new knowledge secret ('trade secret'), thereby excluding use by others. The most common way of excluding knowledge is by seeking protection through patents. Nonetheless, certain advances in basic knowledge, such as mathematical theorems, are not patentable despite their importance and their potential practical applications.

The Funding of Basic Research

Academia has traditionally been considered the primary producer of new knowledge, largely through publicly funded basic research at universities and academic institutions. Funding of university research, particularly applied research, by the private sector and industry is also considerable; however it will not be discussed in this paper. Justification for the public funding of basic research has been largely discussed in the literature; see for example (Scott, Steyn, Geuna, Stefano, & Steinmueller, 2001). It has been advocated that it should be governments' interest in funding basic research because of the potential benefits that it is perceived to bring to society. The justifications for funding basic research can be generally classified as instrumental, which often refers to direct or indirect economic benefits. To this end, Salter and Martin have classified six types of benefits: increasing the stock of knowledge; skilled graduates; new instrumentation and methodologies; networks and social interaction; technological problem-solving and creation of new firms. Consequently, they reasoned that no simple model of the economic benefits from basic research is possible (Salter & Martin, 2001). Though measuring rates of return to basic research may be particularly challenging, nonetheless, it is evident that the contribution of basic research to society is indisputable.

Another strong argument that public funds are needed to support the scientific research is the 'public good' argument, according to which there is a 'market failure' if the production of scientific knowledge is left to the private sector alone (Nelson, 1959; Arrow, 1962). This argument is increasingly being challenged and it is beyond the scope of this paper to further discuss it. We are, however, witnessing new arguments concerning the importance of science in the so-called '*knowledge-based economy*' used to justify the public support of basic research. This term emerged from recognizing the place of knowledge and technology in modern western countries economies. It became apparent that in the past few decades economies are more dependent on the production, distribution and use of knowledge than in previous times. In the knowledge-based economy, the science system contributes to knowledge production; knowledge transmission (i.e. educating and developing human resources); and knowledge transfer (i.e. disseminating knowledge). The government therefore has a role, or rather a duty, in ensuring and subsidizing the basic science to generate knowledge aimed to improve social welfare. Governments should therefore adapt their mechanisms and priorities for financing research.

It should be pointed out that research evaluation has emerged as a key science policy issue in most industrialized countries. Quantitative measures of the output of academic research seldom go beyond counts of research papers, patents, and royalty income, none of which directly correlates with the impact on industry[8]. Many countries have introduced procedures for the evaluation of university research (OECD, 1997). Challenges for the future include greater pressure from governments for demonstrable merit of the basic research it supports.

Most industrialized countries have publicly funded research-grant programs that attempt to channel public resources directly into R&D projects that are anticipated to have particularly large social benefits (Figure 2: Civilian R7D Expenditure as Percentage of GDP 2009). For instance, the US National Institutes of Health (NIH) invests over $31.2billion annually in medical research. More than 80% of the NIH's funding is awarded through almost 50,000 competitive grants to more than 325,000 researchers at over 3,000 universities, medical schools, and other research institutions in every state and around the world (NIH Budget, 2011). The EU's Seventh Framework Program for Research is the largest in the world with a budget of more than €50.5billion (excluding EURATOM), for 2007-2013 (EU Memo, 2010).

The necessity for and the significance of public funding is particularly relevant to biotechnology[9], which is an emerging field that remarkably illustrates a potential high return. It is incontrovertible that biotechnology is a vital key to enabling technology for the 21st century. The biological sciences have been adding value to an array of products and services, bringing forth the "*Bioeconomy*" and offering the potential to make major socio-economic contributions (Konde, 2002) , (JRC Reference Reports, 2007), (OECD, 2009) and (Levy, 2011). The bioeconomy will be influenced, among others, by public research support, regulations and intellectual property rights.

The biotechnology industry has emerged as a major growth area in the global healthcare industry. Since its emergence in the 1970s, the biotechnology market has shown tremendous growth, reaching approximately $128 billion in 2009 (Biotechnology Industry Yearbook, 2010). Today, there are more than 250 biopharmaceuticals and vaccines, with hundreds more in the pipeline. In 2009, 14 million farmers in 25 countries planted 134 million hectares of transgenic plants. Industrial biotechnology supports a growing US$2.9 billion global market for industrial enzymes (Greenwood, 2010).

The biotechnology industry survived tough times to a large extent because of the remarkable value it adds to society health, renewable energy sources and sustainable industrial processes and providing crops.

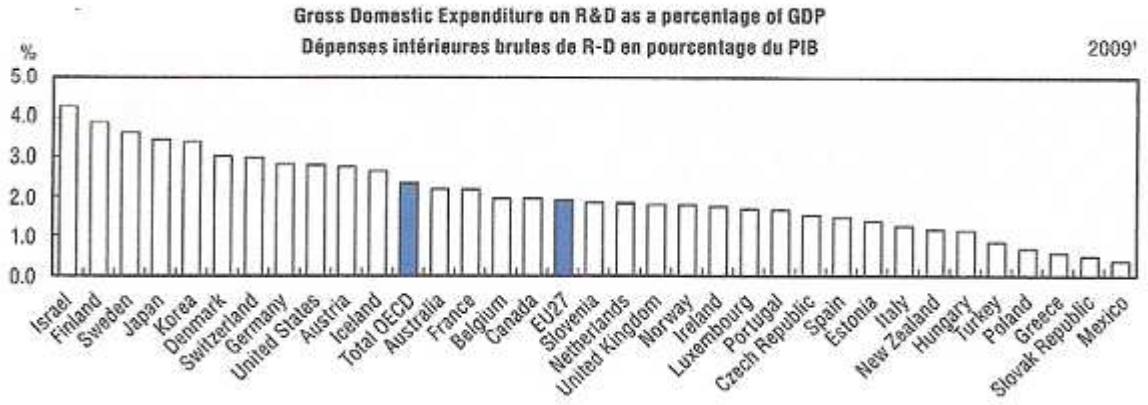
Further indicators for economical impact and valuation of biotechnology industry include the NASDAQ Biotechnology Index (see Figure 3, Endnote[i]) and the industry's collective market cap of $405 billion, as of July 2011 (Burrill & Company, 2011).

In summary, we should bear in mind that biotechnology requires a strong academic environment and must be nurtured carefully by an often long, laborious and costly basic research. The later development and implementation is also an extensive and expensive process (see discussion hereinafter). The public sector is, and should remain to be, a major player in nurturing biotechnology and accounts for a notable share of research.

8 While industrial performance can be measured by shareholder value, employment growth, market share, technical advances and other factors.

9 Modern biotechnology applications are mainly related to the following areas: human and animal, primary production/agro-food, industrial processes and environment and energy. The term BioMed is also used with respect to life sciences and medical devices medical devices.

Figure 2: Civilian R&D Expenditure as Percentage of GDP (2009)



Source: OECD© (2011), "Gross domestic expenditure on R&D", Science and Technology: Key Tables from OECD, No. 1.

Commercialization of Innovation – Mechanisms of Transfer from Academia to industry

Technology transfer may be generally described as the mobility of knowledge or technology from one entity to another, including private firms, government agencies, government laboratories, universities and even entire nations. More practically, it is defined as the process by which a developer of technological innovation and owner of IP right (IPR) avails it to a business partner for commercial exploitation. In this paper we limit the scope of our discussion to the transfer of university-based innovation to the industrial sector.

A solid foundation of academic excellence and cutting-edge basic and applicable research, in conjunction with appropriate funding, are a fundamental prerequisite for beneficial commercial exploitation of universities and research institutes innovation. Ideally, university structures should be able to support all aspects from basic research (invention) to innovation and eventually to commercialization. In order to capture the benefits of commercialization, universities should seek to transfer their technology to the business sector. That can be achieved via a number of different mechanisms, as discussed hereinafter.

The Role of TTO

Strong technology transfer organizations[10] (TTO) combined with a solid IPR protection capacity is crucial for successful consummation of technology transfer transactions. TTOs are thus considered to be a valuable instrument for screening and assessing innovative applicable research projects in-campus, on one hand, and connecting researchers with the industry, on the other hand. A diligent evaluation process is essential for the selection of the most appropriate projects representing a significant commercial potential and commercialization opportunity. Basic criteria determining the viability of the outcome of applicable basic research include, among others: (i) market potential; (ii) competitiveness and (iii) patentability of the results/invention. The latter is of particular significance in view of the costs involved and the importance of creating a strong IPR position, which is a vital factor for decision making by licensees. Moreover, the most efficient and pertinent way of commercialization of each particular innovation (project) should be determined specifically for and in accordance with the case, as it may be.

[10] TTO also refers to technology transfer offices or technology transfer companies. Not to be confused with 'brokerage' activity.

We reason that in order to achieve these goals, each university (or such other academic institution) should establish its own TTO designated to commercialize its innovation. The TTO should be an independent, yet controlled by the university, legal entity or agent, engaged exclusively with the commercialization of the university's inventions and authorized to conclude technology transfer transactions, aiming at generating revenue to support further research and education[11].

It is therefore advisable that TTOs recruit experienced people, possessing international business experience, and retain competent consultants to proficiently carry out the assessment process. Strong IPR protection should be duly obtained for elected inventions which demonstrate high commercialization potential. An appropriate patent application policy (taking into consideration that it is a vast financial burden) should be therefore determined and applied by the TTO.

Ownership of IP

Ownership of the IPR presents an additional material issue which should be addressed. It is now a common policy and practice in developed countries that universities claim and retain title to inventions made by their faculty scientists during the course of their research. This is implemented either by legislation or contractually (i.e. employment contracts). In the US, for example, the Bayh-Dole Act[12] created a uniform patent policy among the many federal agencies that fund research, enabling also universities, to retain title to inventions made under federally-funded research programs. In our opinion, a more general strategy should be endorsed, according to which the ownership of IPR should neither depend on the source of funding (e.g. governmental) nor on the nature of the employer (e.g. public, NGO's etc.), but rather should be determined by and depend on the employer-employee labor relations in general. Such policy is implemented, for instance, in the Israel Patent Law[13] and the UK Patent Act[14]. In accordance with Section 132 (Chapter Eight, Service Inventions) of the Israel patent Law, an employee must notify his employer of any invention which he made in consequence of his service or during the period of his service, as soon as possible after he invented it. An invention made by an employee, arrived at in consequence of his service and during the period of his service (designated as '*Service Invention'*) shall, in the absence of an agreement to the contrary between him and his employer, become the employer's property, unless the employer waives the ownership to the invention[15].

In absence of appropriate legislation, universities may contractually stipulate title to so-called 'Service Inventions' in the employment agreement.

Incentives to Scientists

Scientists are unlikely to be experts in legal and business domains and therefore their cooperation with the TTO officers may facilitate the commercialization of their inventions. TTOs must seek scientists' cooperation in order to successful commercialize their inventions. Such cooperation will mainly depend on trusting the competence and performance of the TTO officers. To achieve this goal, *ex ante* incentives for scientists to disclose their inventions and *ex post* incentives upon the beneficial commercialization of their innovation, should be sincerely considered. We propose possible *modi operandi*, which are based on our experience

11 It is anticipated that the academic institutes provide initial finance to the TTO and later on the TTO should obtain certain management fees.

12 P.L. 96-517, Patent and Trademark Act Amendments of 1980.

13 The Israel Patents Law (5727-1967)

14 See, among others, also The UK Patents Act (1977).

15 Section 132 in Chapter eight: Service Inventions of the Israel patent Law (5727-1967), as amended.

in Israel. Award of compensation to the inventors should be such as will secure a fair share of the benefit which the university has derived. We believe that the award should be allocated mainly to the inventor(s)[16] himself, however part of the award should be allotted to support the scientist ongoing research. Under appropriate circumstances[17], TTOs should consider offering licensing the IP to the inventors themselves or in certain cases even assigning the IPR to pertinent scientists, who can demonstrate the competence to effectively commercialize it[18]. That should be in return for sharing future proceeds (i.e. by way of royalties) and/or equity shares in the Spin-off Company established by such scientists.

Technology Transfer Transactions – Licensing vs. Spin-Off companies

For universities, technology transfer by way of licensing out can successfully and effectively bring their innovation through to the market place. The license is a permission granted to licensee by licensor to use the patent(s) for the development, manufacturing and sale of the 'licensed product', in return for royalties (a certain percent) of revenues from sales of the licensed product. Royalties can be considerable and reach millions of dollars per year. According to the Association of University Technology Managers, universities' total royalty income on patents in the US has exceeded $1 billion per year. Interestingly, much of that income is from biomedical patents (AUTM, 2005). To this end, some remarkable licensing instances of basic research in the medical field from academia in Israel to industry are shown in Table 1: List of Licensed Innovative Drugs from Universities in Israel.

TTO's should seek to license their IP to appropriate commercial entities, which are financially, technologically and operationally competent to develop, manufacture and market the university innovations. However, in circumstances where the innovation is at an early stage and far from materializing to a product, licensing is not (always) plausible; TTO's should therefore explore alternative avenues. This is particularly applicable to new drug discovery (see below) and innovation in biomedical area. For illustration purpose (and interest) we will contemplate the pharmaceutical domain.

Applicable basic research results in medical sciences may be regarded as the "discovery stage" (early stage) of a potentially new drug or medical technology. It is a common knowledge that the development of new drugs (and medical innovations in general) requires massive long term investments in R&D, expertise in pharmaceuticals development, obtaining regulatory approval, production and marketing capacities. On average, developing an innovative new drug takes about 12 years. A recent estimate of the average cost of developing an innovative new drug is over $800 million, including expenditures on failed projects and the value of forgone alternative investments (DiMasi, Hansen, & Grabowski, 2003). Hence, due to the unpredictability of innovative biomedical developments, pharmaceutical companies diverse R&D to divide risk across many projects. Large pharmaceutical companies find viable innovation to be much more difficult to accomplish internally (Christensen, 1997). The challenges, including, among others, lack of in house basic research set-up and activities, encourage large Pharmaceutical firms to pursue collaborative alliances. Pharmaceutical executives seem to recognize that collaborative arrangements provide a vital mechanism enabling to expand product pipeline. Nonetheless, most of the pharmaceutical companies (and to a certain extent, medical device companies) tend to refrain from engagement in an early stage of the discovery, namely in the basic research stage. Often they are willing to become involved after preclinical and toxicology

16 The practice in Israel is that universities share royalties received at least 60:40 with the scientists/inventors.
17 i.e. in the event of establishing a spin-off company.
18 The author of this paper was personally engaged in the two instances.

studies have been satisfactory[19]. Indubitably, preclinical and toxicology studies, which are costly and may require expertise unavailable on university campus, are not within the scope of academic research and therefore are not presumed to be carried out at universities. We surmise that under these circumstances, licensing to third parties (e.g. pharmaceutical companies) would be impractical, and that the formation, by the TTOs or otherwise, of independent new spin-off entities, that would be dedicated and focused on the completion of preclinical and toxicology studies[20], would be a more proper technology transfer avenue.

Successful technology transfer by universities to spin-off companies depends, among others, on cutting edge innovation, a strong IPR position, entrepreneurial spirit, competent management, appropriate long term financing, significant competitive edge and market growth, a supportive board of directors and a viable business strategy. The role of spin-offs to economy growth, in general and for the benefits of universities, in particular, is addressed by the author elsewhere (Levy, 2011).

Table 1: List of Licensed innovative Drugs from Universities in Israel

Product	Indication	License	Sales in 2009 (in millions)	Licensor
Copaxone	Multiple Sclerosis	Teva	$2,826	Weizmann Institute (WIS)
Rebif	Multiple Sclerosis	Merck- Serono	€1,537	WIS
Exelon	Alzheimer	Novartis	$954	Hebrew University Jerusalem (HU)
Doxil/Caelyx	Cancer	Schering-Plough	$295	HU and Hadassah Hospital, Jerusalem
Aziltec	Parkinson	Teva	$243	Technion medical School (Haifa, Israel)
Erbitux	Cancer	Merck- Serono	€697	WIS

Sources: Companies' Annual Reports 2009

Conclusion

It is evident nowadays that basic research creates knowledge that may lead to discoveries and inventions that have a significant impact on society. Basic research may be therefore considered as the first step in the knowledge generation or innovation process. The ability of a society to produce and commercialize knowledge is critical for sustained economic growth and improved quality of life. Recent policy statements from the OECD, the World Bank, and others, clearly echo that knowledge is the most important factor in economic development. The role it plays in the process of innovation and economic growth has become even more central since the emergence of the so-called 'knowledge-based economies' - economies which are directly based on the production, distribution and use of knowledge. Governments therefore have a role in ensuring and subsidizing the basic research to generate knowledge aimed to improve social welfare.

19 This is also based on the author's personal experience.

20 In certain cases, even conclude phase I clinical studies [Phase I: researchers test an experimental drug or treatment in a small group of people for the first time to evaluate its safety, determine an appropriate dosages, traces what happens to the compound in the body, and begin to identify side effects].

The transformation of knowledge or innovation into commercial value depends primarily on successful transfer of the technology. Ideally, university structures should support all aspects from basic research (invention) to innovation, as well as commercialization. Universities should seek to transfer technology to the private sector in order to capture the benefits of commercialization of their innovation. To this end, TTOs are expected to play a crucial role and should be therefore structured and managed accordingly. For universities, technology transfer by way of licensing out can successfully and effectively bring their innovation through to the market place. However, in circumstances where the innovation is at an early stage and far from materializing to a product, licensing is not (always) plausible; TTO's should therefore explore alternative avenues, such as formation of spin-off companies. Not least, scientists (inventors) should be properly compensated for their contribution to economic profits of the universities.

In summary, successful commercialization of applicable discoveries and inventions may well serve the interests of the university, the scientific community and society in general.

Figure 3: NASDAQ BIOTECHNOLOGY INDEX*(five years, as of July 18, 2011)

Source: NASDAQ*

*The NASDAQ Biotechnology Index includes securities of Nasdaq-listed companies classified according to the Industry Classification Benchmark as either Biotechnology or

Pharmaceuticals which also meet other eligibility criteria. To be eligible for inclusion in the Index, the security must have, among others, a market capitalization of at least $200 million.

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Abstrakt

Badania podstawowe mogą być traktowane jako pierwszy krok w tworzeniu wiedzy lub procesu innowacji. Wiedza jest uznana współcześnie za najważniejszy czynnik w rozwoju krajowej gospodarki. Rządy pełnią zatem ważną rolę w zapewnianiu i dofinansowaniu badań podstawowych, których celem jest do tworzenie wiedzy w celu poprawy opieki społecznej. Badania podstawowe prowadzone są głównie na uniwersytetach, w dzisiejszych czasach, powinny one mieć wsparcie we wszystkich aspektach generacji i transferu wiedzy - od badań podstawowych (wynalazek) do innowacji i ostatecznie do komercjalizacji. Przekształcanie wiedzy i innowacji w wartość handlową zależy przede wszystkim od efektywnego transferu technologii przez organizacje transferu technologii. Uczelnie powinny dążyć do transferu technologii do sektora prywatnego w celu uzyskania korzyści z komercjalizacji ich innowacyjności. Jednak w sytuacji, gdy innowacja jest na wczesnym etapie, w konsekwencji też daleko jej do materializacji w postaci produktu, otrzymanie licencji dla przedsiębiorstw przemysłowych nie jest nierzadko możliwe.

A COHERENT MODEL OF DCF VALUATION

Wiktor Patena[1]

Abstract

Business valuation through DCF is recognized as one of the most popular valuation approaches. DCF valuation models, however, have become extremely complex. Modeling requires plenty of input data to be processed, the process is done in many stages, and the data obtained on each of the stages may be interrelated. The process then is not simply a chain of tasks. The modern models work via sophisticated mechanisms of loops being triggered whenever a new piece of information is revealed and the whole model needs updating. Technically speaking, in the spreadsheets environment, this may only be done with the use of iterations. The valuation model should also be subjected to the sensitivity analysis, which is able to quantify the impact of every single assumption made on the final company value. The analysis points out the set of critical assumptions, which have the major impact on the calculated company's value. Apart from quantifying the impact of the assumptions, the analysis runs qualitative checks on the assumptions assessing the robustness of the arguments standing behind the critical factors for valuation. Consequently, the sensitivity analysis improves the objectivity of the model and mitigates the exposure for the possible results manipulation. The sensitivity analysis reveals its critical role in the valuation process and proves that it should be considered as the standard step in every DCF valuation.

Key words: *company valuation, DCF, interactive financial planning system, sensitivity analysis, iterations.*

Model Coherence

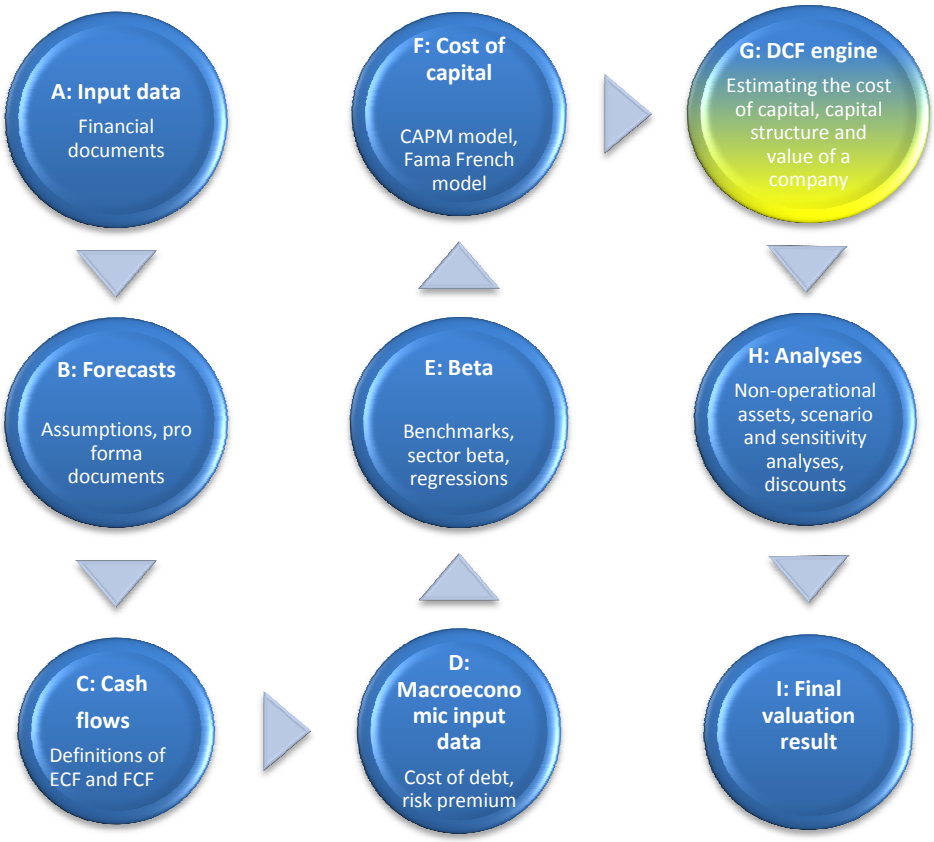
DCF valuation models have become extremely complex. Modeling requires plenty of input data to be processed, the process is done in many stages, and the data obtained on each of them may be interrelated. The process, however, is not simply a chain of tasks (Figure 1.1), where company input data (first column) and macroeconomic input data (second column) are processed in the system engine (third column). The modern models work *via* sophisticated mechanisms of loops being triggered whenever a new piece of information is revealed and the whole model is constantly updated. Technically speaking, in the spreadsheets environment, this may only be done with the use of iterations.

The objective of this paper is to demonstrate the complexity of contemporary DCF valuation models, show the interrelations within the model and present one of the solutions for maintaining the integrity of the model – iterations.

The paper is structured as follows: first, the model for creating forecasts (interactive financial planning system), then DCF model based on iterations (interactive valuation system), and finally a model of developing sensitivity analysis are presented and discussed. We deal only with a few components of the model, the ones that are crucial from the model coherence point of view.

[1] Wiktor Patena, Ph.D. in Economics, Wyzsza Szkola Biznesu – National Louis University, ul. Zielona 27, 33-300 Nowy Sacz, Poland, e-mail: patena@wsb-nlu.edu.pl

Figure 1.1. Stages of DCF valuation



Source: Patena W. (2011). *W poszukiwaniu wartości przedsiębiorstwa. Metody wyceny w praktyce*. Kraków: Oficyna Wolters Kluwer Business, p. 296.

Interactive financial planning system

Financial forecasts (including all the *pro forma* documents: balance sheets, income statements, cash flow reports, ratio analysis) are typically built on the basis of interactive financial planning system - IFPS (Shim & Siegel, 2006). The core components of the system are the formulae that refer to input data and, based on predefined assumptions, generate all the single entries of *pro forma* financial documents for a given period of time (typically 5-8 years). The whole set of net income and balance sheet equations is needed for that. A few simple examples of such formulae are presented in Figure 2. There, retained earnings must be linked to net income, interest income to the level of cash, interest payments to the level of debt, cash to the level of short term liabilities and short term debt is one of the balancing factors, to name just a few important links.

There are two approaches to build forecasts for a given company: bottom-up and top-down (Koller 2010). The starting point for any of them is analyzing macroeconomic data, a company's standing, plans designed by the company, and eventually estimating possible dynamics of sales, and then costs. Most of the entries in the balance sheet would depend on the sales dynamics. On the other hand, the main balance sheet entries may also depend on the assumptions related to turnover ratio – it is rational to assume that these should not change as long as the company stays in the same industry. The forecasts cannot ignore the fact that some industries are cyclical. It also must be decided whether the forecast is done with nominal or real prices. These issues, however, go beyond the main topic of the paper.

Figure 2.1. Formulae for the IFPS

Retained earnings^{t} = RE^{t-1} + net income^{t} * plowback ratio
Net income^{t} = max(tax rate * EBT^{t},0)
Interest income^{t} = interest rate on deposits^{t} * (cash and cash equivalents)
Interest payment^{t} = interest rate on loans^{t} * (debt)
Cash^{t} = max(10% * short term liabilities^{t-1}, total liabilities – fixed assets – inventory – AR – short term investment – pre paid expenses)

Source: author's elaboration

We tend to analyze only a technical aspect of forecasting. The key issue in financial modeling is balancing assets and liabilities. This is usually done with a debt-as-a-plug approach, meaning that any imbalance between assets and liabilities resulting from previously made and implemented assumptions finds its destination in the short-term debt entry. The formula below represents the concept which however is too complicated to be presented in a descriptive form (H cells refer to time *t*, and G cells to time *t-1*).

Figure 2.2. Formula for debt as a plug

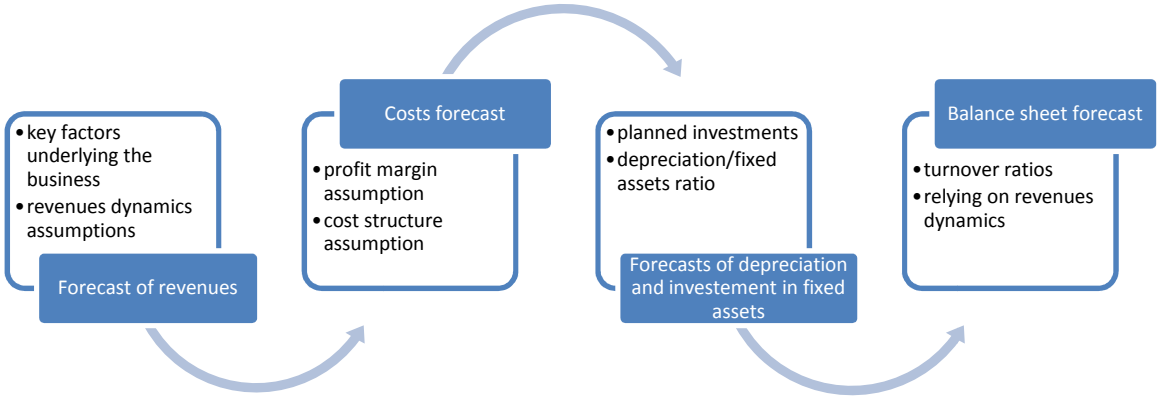
Short term debt^{t} = IF((H4^{t}+H67^{t}+H31^{t}+H37^{t}+H66^{t}+H52^{t}+H57^{t}+0.1*G100^{t-1}-H73-H85-H93-H101-H118-H119(H108+H109+H110+H113+H114+H115+H116+H117))>0; (H4+H67+H31+H37+H66+H52+H57+0.1*G100-H73-H85-H93-H101-H118-H119-(H108+H109+H110+H113+H114+H115+H116+H117));0)

Source: author's elaboration

Debt (short term debt in the example above) is a plug – it changes automatically whenever assets exceed liabilities. Similarly, cash is a plug in the assets – the level of cash is kept at least on the level that is operationally justified, but it changes whenever liabilities exceed assets.

The model creates a coherent system of financial planning. A change of a single parameter is observable, one can easily create hypothetical scenarios and simulations with changed input data. The forecast is done in stages described in Figure 4. What is most important, however, is that this stage of company valuation is linked with the other stages. For example, the cost of debt that is used to calculate the interest payments affects the net income of the company. At the same time the very same cost of debt is a part of WACC formula that is used to calculate the value of the company and equity. Thus, each change in the interest rate will, in sequence, change the value of net income, WACC, capital structure and the value of equity.

Figure 2.3. Stages of income statement and balance sheet forecasting



Source: author's elaboration

Iteration-based DCF model

When using a DCF model for company valuation one has to agree that estimating its value without looking into the future is impossible. The value of a company depends on cash flows that the company may generate in the future. The problem we are facing is then to:

- estimate future cash flows
- determine a discount factor – cost of capital.

The basic notion of the DCF method can be introduced with the following valuation formula.

$$V_0 = \frac{CF_1}{(1+k)^1} + \frac{CF_2}{(1+k)^2} + ...,$$

This is how the company's value is determined: certain cash flows are discounted with the cost of capital. There are three components involved: cash flows, cost of capital and the model (or the engine, technically speaking) explaining how the first two are related and eventually put together into a coherent system (Kruschwitz & Loffler 2006).

Once we have financial documents *pro forma*, we can calculate the free cash flows. There are two basic valuation methods, corresponding to two kinds of cash flows: ECF (equity cash flow - cash flow available for shareholders only) and FCF (firm cash flow - cash flow available for both shareholders and debt holders). The methods are called FTE (flow to equity) and FTF (flow to firm) respectively (Capinski 2008, Fernandez 2005). Whichever of the two methods is used and even if the company model is simplified to being a perpetuity, certain technical problems are bound to appear (the points below exemplify the FTF approach).

1. One has to know the cost of capital WACC (and both its components: cost of debt and cost of equity) in order to calculate the value of a company.
2. One has to know the capital structure, that is the value of debt and equity, in order to calculate the cost of capital (cost of equity or WACC).
3. One has to know the value of interest payments, which is the value of debt, in order to calculate cash flows.

The problems create a logical loop: step 1 needs step 2, but step 2 requires step 1 and 3. The issue seems technical, but as a matter of fact it is a profound shift in the way the value can be found. An analytical solution to the problem is fairly straightforward (in case of

perpetuities): we are facing the following system of equations, where *V* is the value of a company and *WACC* the cost of capital.

Figure 3.1.. System of equations – analytical solution

$$\begin{cases} V = \dfrac{FCF}{WACC} \\ WACC = k_D \times (1-T) \times \dfrac{D}{V} + k_E \times \dfrac{V - D^{\cdot}}{V} \end{cases}$$

Source: author's elaboration

The problem can also be solved numerically. We should enter the formulae for WACC and V in the appropriate cells in Excel, replacing the missing values of WACC and V with the (incomplete) results obtained in the cells. The loop is then complete and the final results are correct. The loop will work on one condition: a feedback loop must be activated in Excel (go to Excel Options/Formulae, tick Manual Calculation and Iteration boxes). The loops can be triggered by pressing the F9 key.

In a real life case, however, when one has to deal with numerous parameters and time periods, a numerical solution seems to be the only feasible approach. For example, in order to find the value *V* (for a given year *t*), one needs to know the values of *WACC*, next *E*, and then k_E. It is impossible to calculate *WACC* without *V* (the one we look for), and *E* without k_E. There appears a chain of logical loops and formulae (Figure 6) that become so integrated that the information between cash flows and cost of capital moves freely. The cost of capital "tracks" the capital structure and changes accordingly, while *ECF* is a reflection of future profits and also the level of debt in the company (Figure 7). The valuation is recursive, going backwards in time. Explaining the methodological aspects of the model is beyond the scope of the paper – we follow the theory developed by M. Capinski (Capinski 2008).

In general, the recursive method of company valuation that has been shown overcomes a fundamental problem that is often ignored by many other methods: the fact that the cost of capital depends on the financial structure. It creates additional technical problems in a form of a logical loop but this was also remedied. To conclude, calculating the value of a company without using iterations is tantamount to applying the wrong weights to *WACC* and leads to an inner contradiction (Ibragimov 2008).

Figure 3.2. Interlinked equations

$$V_{t-1} = \frac{V_t + FCF_{t-1}}{(1+WACC_{t-1})}.$$

$$\Downarrow$$

$$WACC_{t-1} = k_D \times (1-T) \times \frac{D_{t-1}}{(E_{t-1}+D_{t-1})} + k_{E,t-1} \times \frac{E_{t-1}}{(E_{t-1}+D_{t-1})}$$

$$\Downarrow$$

$$E_{t-1} = \frac{E_t + CF_{t-1}}{(1+k_{E,t-1})}$$

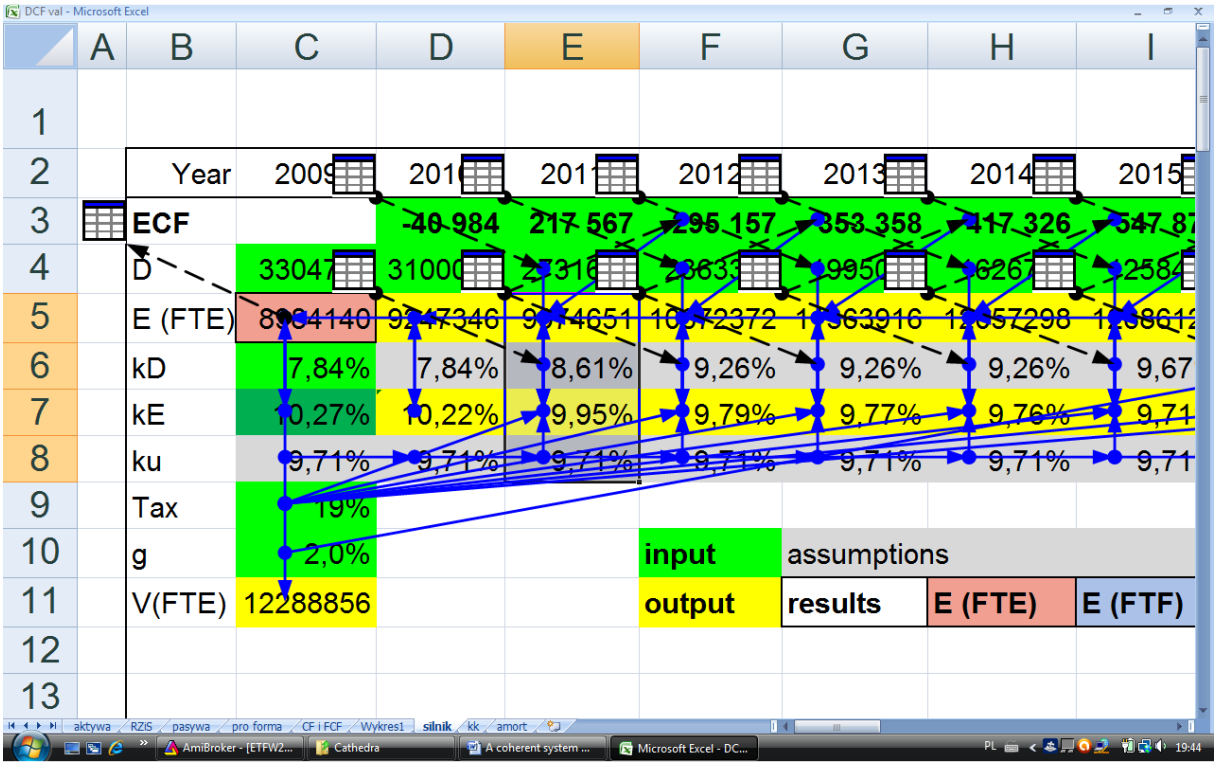
$$\Downarrow$$

$$k_{E,t-1} = k_U + (k_U - k_D) \times \frac{D_{t-1} \times (1-T)}{E_{t-1}}.$$

Source: author's elaboration

What is more, iterations enable creating a coherent valuation system. In Figure 3.3. (engine of the model) one can see how the formulae are linked. To take just one example, calculating E (FTE) for 2012 requires ECF (preceded by cash flow calculations in a separate spreadsheet and pro forma spreadsheets) for the same year, the value of equity for the previous period and the cost of equity which in turn needs k_U, capital structure (links to the value of D and E), tax rate and many more. The loops work until the model is in equilibrium. The final touch is to provide the current cost of equity (10.27% in Figure 3.3.). Then the model is complete and generates the current fair value of equity (E = 8904140 in Figure 3.3.).

Figure 3.3. System of equations – numerical solution (part of the DCF engine)



Source: author's elaboration

Sensitivity analysis

Sensitivity analysis is a *sine qua non* component of any DCF valuation. It enables:

1. identifying the assumptions that are critical in terms of the valuation model.
2. Avoiding subjectivity and manipulation by verifying the validity of the key assumptions.

In other words, this is the part of the valuation in which one tests the model's reliability and objectivity. The critical moment in DCF valuation is building pro forma financial documents that are based on a set of assumptions. This has much to do with understanding the nature of the business and then identifying the crucial variables that are value drivers of the company (Koller 2010). At the end of the valuation process one needs to verify how sensitive the model is to changes in the set of assumptions. The set is typically composed with dozens of variables, some of which refer to the valuation theory or macroeconomic situation and are not included in the sensitivity analysis (e.g. risk free rate, risk premium). The others are relevant from the sensitivity analysis point of view and typically include:

- Dynamics of revenues in the given years of the forecast,
- Wages in relation to operational costs,
- Growth factor g,
- Tax rate,
- β factor
- Cost of equity
- Cost of debt,
- Operational costs in relation to revenues,
- Depreciation in relation to fixed assets,

- AR and AP in relation to revenues,
- Inventory in relation to revenues,
- Reinvestment ratio.

Technically speaking, one can make the sensitivity analysis using the data tables feature that is available in some spreadsheets. Arranging all the data properly one can observe how the final value varies if you modify the chosen variables. You can make a single variable sensitivity analysis by selecting only one parameter, but the two variable tables are much more useful – you calculate the changes in the final value based on two parameters. Below, we present examples of the sensitivity analysis for two sets of parameters. Figure 8 shows an example of the assumed changes in the revenues dynamics: namely -5% in the years 1-2 (columns) and 0% in the years 3-5 (rows). In Figures 4.1-3 one can watch the values resulting from the changes (originally 29.95).

Figure 4.1. Sensitivity analysis – change in revenues v change in the value of company

% change in revenue in the years 1-2 (columns) and 3-5 (rows)											
29.95	-5%	-4%	-3%	-2%	-1%	0%	1%	2%	3%	4%	5%
0%	30.11	30.56	31.00	31.45	31.90	32.34	32.79	33.23	33.68	34.12	34.57
-1%	29.66	30.10	30,54	30,98	31,42	31,86	32,31	32,75	33,19	33,63	34,07
-2%	29,20	29,64	30,08	30,51	30,95	31,39	31,82	32,26	32,70	33,13	33,57
-3%	28,75	29,18	29,61	30,04	30,48	30,91	31,34	31,77	32,21	32,64	33,07
-4%	28,29	28,72	29,15	29,58	30,00	30,43	30,86	31,29	31,71	32,14	32,57
-5%	27,84	28,26	28,68	29,11	29,53	29,95	30,38	30,80	31,22	31,65	32,07
-6%	27,38	27,80	28,22	28,64	29,06	29,48	29,89	30,31	30,73	31,15	31,57
-7%	26,93	27,34	27,75	28,17	28,58	29,00	29,41	29,83	30,24	30,66	31,07
-8%	26,47	26,88	27,29	27,70	28,11	28,52	28,93	29,34	29,75	30,16	30,57
-9%	26,02	26,42	26,83	27,23	27,64	28,04	28,45	28,85	29,26	29,66	30,07
-10%	25,56	25,96	26,36	26,76	27,16	27,57	27,97	28,37	28,77	29,17	29,57

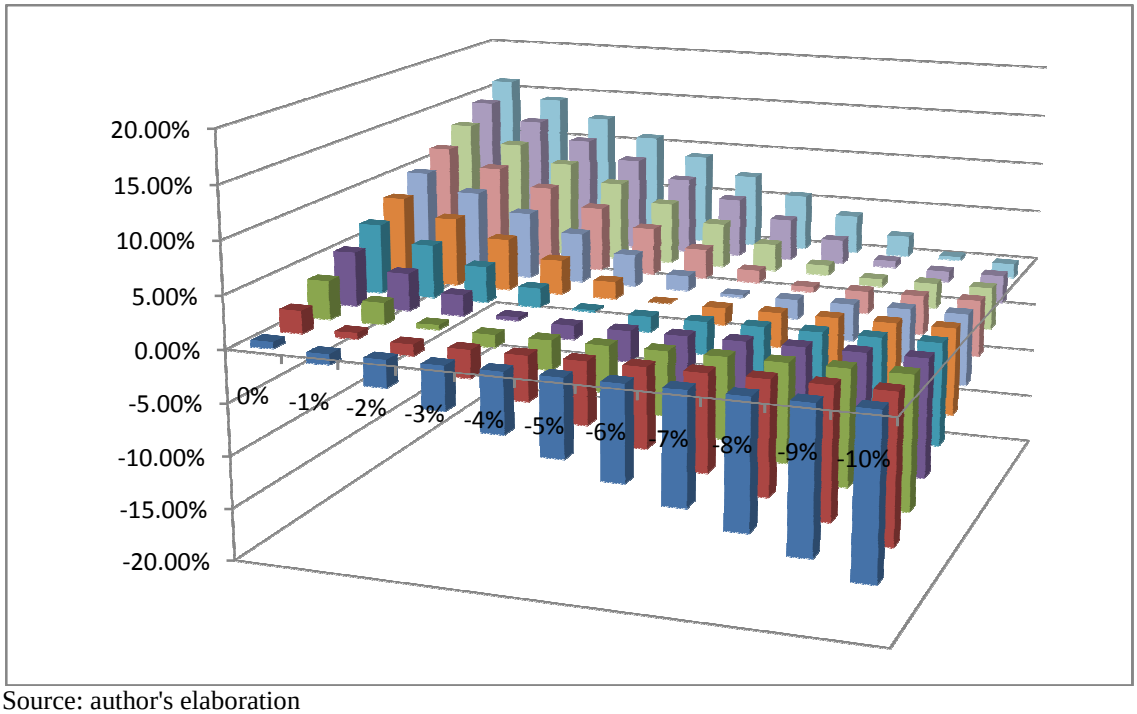
Source: Patena W. (2011). W poszukiwaniu wartości przedsiębiorstwa. Metody wyceny w praktyce. Kraków: Oficyna Wolters Kluwer Business, p. 296.

Figure 4.2. Sensitivity analysis – change in revenues v change in the value of company (%)

% change in revenue in the years 1-2 (columns) and 3-5 (rows)											
29.95	-5%	-4%	-3%	-2%	-1%	0%	1%	2%	3%	4%	5%
0%	0.53%	2.04%	3.51%	5.01%	6.51%	7.98%	9.48%	10.95%	12.45%	13.92%	15.43%
-1%	-0.97%	0.50%	1.97%	3.44%	4.91%	6.38%	7.88%	9.35%	10.82%	12.29%	13.76%
-2%	-2.50%	-1.04%	0.43%	1.87%	3.34%	4.81%	6.24%	7.71%	9.18%	10.62%	12.09%
-3%	-4.01%	-2.57%	-1.14%	0.30%	1.77%	3.21%	4.64%	6.08%	7.55%	8.98%	10.42%
-4%	-5.54%	-4.11%	-2.67%	-1.24%	0.17%	1.60%	3.04%	4.47%	5.88%	7.31%	8.75%
-5%	-7.05%	-5.64%	-4.24%	-2.80%	-1.40%	0.00%	1.44%	2.84%	4.24%	5.68%	7.08%
-6%	-8.58%	-7.18%	-5.78%	-4.37%	-2.97%	-1.57%	-0.20%	1.20%	2.60%	4.01%	5.41%
-7%	-10.08%	-8.71%	-7.35%	-5.94%	-4.57%	-3.17%	-1.80%	-0.40%	0.97%	2.37%	3.74%
-8%	-11.62%	-10.25%	-8.88%	-7.51%	-6.14%	-4.77%	-3.41%	-2.04%	-0.67%	0.70%	2.07%
-9%	-13.12%	-11.79%	-10.42%	-9.08%	-7.71%	-6.38%	-5.01%	-3.67%	-2.30%	-0.97%	0.40%
-10%	-14.66%	-13.32%	-11.99%	-10.65%	-9.32%	-7.95%	-6.61%	-5.28%	-3.94%	-2.60%	-1.27%

Source: Patena W. (2011). W poszukiwaniu wartości przedsiębiorstwa. Metody wyceny w praktyce. Kraków: Oficyna Wolters Kluwer Business, p. 296.

Figure 4.3. Sensitivity analysis – change in revenues v change in the value of company (%)



Source: author's elaboration

Another example shows how the relation of accounts receivables (AR) with regard to revenues (originally 5.3%) and inventory with regard to revenues (originally 11%) affect the final value of company (originally 29.40). The original values are based on the analysis of historical data, median or the average. The analysis shows that the change of the parameters has a weak effect on the final value: the change of 1 percentage point results in a 1.8% change of the final value. To conclude, the model is not very sensitive to changes in these parameters.

Figure 4.4. Sensitivity analysis – change in AR and inventory v change in the value of company

AR (columns) and inventory (rows) as % of revenues											
29.40	0.09	0.1	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19
0	33.41	32.86	32.31	31.76	31.21	30.67	30.12	29.57	29.02	28.47	27.92
0.003	33.24	32.70	32.15	31.60	31.05	30.50	29.95	29.40	28.86	28.31	27.76
0.013	32.70	32.15	31.60	31.05	30.50	29.95	29.40	28.86	28.31	27.76	27.21
0.023	32.15	31.60	31.05	30.50	29.95	29.40	28.86	28.31	27.76	27.21	26.66
0.033	31.60	31.05	30.50	29.95	29.40	28.86	28.31	27.76	27.21	26.66	26.11
0.043	31.05	30.50	29.95	29.40	28.86	28.31	27.76	27.21	26.66	26.11	25.57
0.053	30.50	29.95	29.40	28.86	28.31	27.76	27.21	26.66	26.11	25.57	25.02
0.063	29.95	29.40	28.86	28.31	27.76	27.21	26.66	26.11	25.57	25.02	24.47

Source: author's elaboration

Figure 4.5. Sensitivity analysis – change in AR and inventory v change in the value of company (%)

AR (columns) and inventory (rows) as % of revenues											
29.40	0.09	0.1	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19
0	13.64%	11.77%	9.90%	8.03%	6.16%	4.32%	2.45%	0.58%	-1.29%	-3.16%	-5.03%
0.003	13.06%	11.22%	9.35%	7.48%	5.61%	3.74%	1.87%	0.00%	-1.84%	-3.71%	-5.58%
0.013	11.22%	9.35%	7.48%	5.61%	3.74%	1.87%	0.00%	-1.84%	-3.71%	-5.58%	-7.45%
0.023	9.35%	7.48%	5.61%	3.74%	1.87%	0.00%	-1.84%	-3.71%	-5.58%	-7.45%	-9.32%
0.033	7.48%	5.61%	3.74%	1.87%	0.00%	-1.84%	-3.71%	-5.58%	-7.45%	-9.32%	-11.19%
0.043	5.61%	3.74%	1.87%	0.00%	-1.84%	-3.71%	-5.58%	-7.45%	-9.32%	-11.19%	-13.03%
0.053	3.74%	1.87%	0.00%	-1.84%	-3.71%	-5.58%	-7.45%	-9.32%	-11.19%	-13.03%	-14.90%
0.063	1.87%	0.00%	-1.84%	-3.71%	-5.58%	-7.45%	-9.32%	-11.19%	-13.03%	-14.90%	-16.77%

Source: author's elaboration

The sensitivity analysis is definitely recommended as a summary of any DCF valuation. The DCF models are based on many quantitative data but also dozens of assumptions whose validity needs to be double checked. The final report of the sensitivity analysis (Figure 4.6.) reveals which assumptions are prone to miscalculations and may have to be revised. The summary confirms the obvious truth that the effect of the change in a given parameter is related to its utility. No wonder that the assumption referring to a short period of time had smaller effect than those referring to longer periods (including those affecting the residual value). Another conclusion is that the assumptions related to the structure of the income statement are very sensitive to changes. As shown in Figure 4.6., the 1% change of COGS results in over 21% change in the final value.

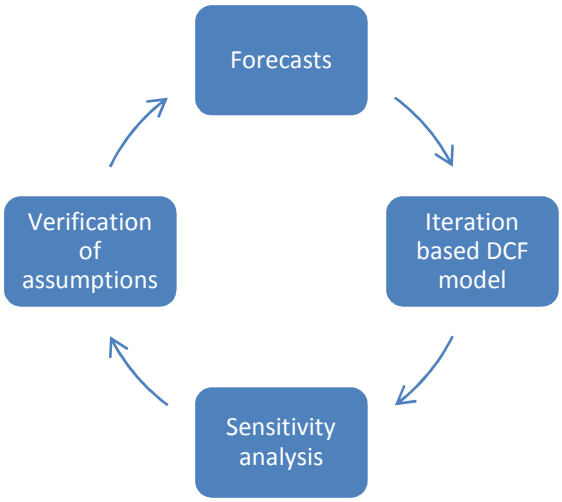
Figure 4.6. Sensitivity analysis – summary (example)

Assumption	Change of the COMPANY VALUE(%)	
	+ 1 p. p.	**- 1 p. p.**
Revenue growth in the years 1-2	1.60%	1.57%
Revenue growth in the years 3-5	1.40%	1.44%
Growth factor g	24.12%	14.36%
COGS as % of revenues	21.12%	21.15%
Depreciation as % of fixed assets	2.78%	3.06%
AR as % of revenues	1.87%	1.84%
Inventory as % of revenues	1.87%	1.84%
AP as % revenues	0.00%	3.71%
WACC in the years 1-2	0.17%	0.17%
WACC in the years 3-5	17.99%	28.13%

Source: author's elaboration

In general, a sensitivity analysis provides a picture of relative sensitivity of the model to certain changes. Some of them are justified and predictable, others may raise doubts and lead to model revisions. In particular, one should pay special attention to those assumption whose influence on the final value seems great and which were accepted as a result of not a quantitative analysis but based on data which are hard to verify. The DCF valuation model should then work in a circle: once the value is generated, the sensitivity analysis shows whether the assumptions are credible. If not, they are revised and the valuation is generated again, as shown in Figure 4.7.

Figure 4.7. Coherent model of DCF valuation



Source: author's elaboration

Conclusions

DCF valuation models have become extremely complex. Still, for the credibility of the valuation process, it is essential that the model is coherent and all the parts of the process are well integrated. Generating the final value does not finish the valuation process. With models involving dozens of variables, the real challenge is to understand the model and identify the assumptions that are critical for the valuation process.

We emphasize three parts of the valuation process that are indispensible for the integrity of DCF valuation. First, the model for creating forecasts needs to be interactive and

the generated *pro forma* financial documents must be properly linked with external (macroeconomic) and internal (historical) data. Second, the modern DCF models work *via* sophisticated mechanisms of loops being triggered whenever a new piece of information is revealed and the whole model needs updating. In the spreadsheets environment, this may be done with the use of iterations. The method of company valuation based on iterations overcomes a fundamental problem that is often ignored by many other methods: the fact that the cost of capital should depend on the financial structure. Finally, the valuation model should be subjected to the sensitivity analysis, which is able to quantify the impact of every single assumption made on the final company value. The analysis points out the set of critical assumptions which have the major impact on the calculated company's value. Apart from quantifying the impact of the assumptions, the analysis runs qualitative checks on the assumptions assessing the robustness of the arguments standing behind the critical factors for valuation. The model gains a higher level of objectivity since it is no longer pegged to the assumptions for good. These may be revised whenever the model seems oversensitive to some of them. Consequently, the sensitivity analysis improves the objectivity of the model and mitigates the exposure for the possible results of manipulation. The sensitivity analysis reveals its critical role in the valuation process and proves that it should be considered as a standard step in every DCF valuation.

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Abstrakt

Wycena przedsiębiorstw poprzez DCF jest uznawana za jedną z najbardziej popularnych metod wyceny. Modele wyceny DCF stały się jednak niezwykle skomplikowane. Modeling wymaga wiele danych wejściowych do przetworzenia, proces odbywa się w kilku etapach, a dane uzyskane w każdym z etapów mogą być ze sobą powiązane. Proces nie jest po prostu łańcuchem zadań. Nowoczesne modele pracy, poprzez zaawansowane mechanizmy pętli, jest uruchamiany zawsze, gdy nowa informacja się pojawia, i cały model wymaga aktualizacji. Technicznie rzecz biorąc, w arkuszach kalkulacyjnych, może być dokonana analiza jedynie z zastosowaniem iteracji. Modele wyceny powinny być również poddane analizie wrażliwości, która jest w stanie obliczyć wpływ każdego założenia na ostateczną wartość firmy. Analiza wskazuje na zestaw kluczowych założeń, które mają duży wpływ na obliczoną wartość firmy. Oprócz ilościowego określenia wpływu założeń, analizy jakościowe prowadzą kontrole założenia oceny niezawodności argumentów odpowiedzialne za kluczowe czynniki wyceny. W związku z tym, analiza wrażliwości poprawia obiektywność modelu i zmniejsza narażenie na manipulowanie wynikami. Analiza wrażliwości pokazuje jej kluczową rolę w procesie wyceny i udowadnia, że należy go traktować jako standardowy krok w wycenie DCF.

ASSESSING UKRAINIAN BANKING PERFORMANCE BEFORE AND AFTER THE CRISIS

Iryna Shkura[1], Barbara Peitsch[2]

Abstract

The main goal of this paper is to analyze the impact of the 2008 global financial crisis on the Ukrainian financial system, and on Ukrainian bank performance. Our analysis is based on key bank performance indicators from 2003-2011. Bank assets, liabilities and capital are analyzed, and changes in bank management are taken into consideration. Special attention is paid to changes in bank stock prices of two of the largest banks, following the crisis.

Key words*: performance, problem loans, debt provision, banking system, financial crisis, bank stock prices.*

Introduction

The strength and sustainability of a country's banking system is the basis for its economic development, especially in countries with bank-based financial systems. The performance of the banking system is always an area of interest and concern to government regulators and academic researchers. After the global financial crises in the 1990s and early 2000s, bank performance has received even more attention. The Ukrainian banking system had been characterized by rapid growth in terms of the number of banks, the number of loans extended to companies and households, and the performance of the banks until 2009. This sector was one of the most attractive for foreign investors and as a result, bank capitalization grew rapidly. New approaches to bank management were introduced in the strongest banks and the quality of banking services improved. Such large inflows of foreign capital brought some additional risks to the system, however.

The main goal of this paper is to analyze the changes in Ukrainian bank performance before, during and after the financial crisis of 2008, with special attention paid to changes in bank stock prices, rates of return, and risk. Ukrainian bank capital, assets, liabilities, and financial results will be analyzed in the overview of the Ukrainian banking system. A SWOT-analysis of foreign investment in Ukrainian banks will also be conducted. The final section of this paper will present our assessment of the impact of the 2008 global financial crisis on Ukrainian bank stock prices.

Overview of the Ukrainian banking system

The Ukrainian financial system is similar to banking systems in the Euro-zone and Japan in that it is bank-based, as opposed to capital markets-based. Financial sector development, and therefore a financial system type in a country is often based on historical and economic development and on the financial sector development in neighboring countries. The main criteria for determining a country's type of financial system is the source of capital for the enterprises and other entities. In bank-based systems, bank loans are the primary

[1] I. Shkura, Ph.D., Alfred Nobel University, Dniepropetrovsk, Ukraine, irashkura@gmail.com
[2] B. Peitsch, M.A.,M.P.P., University of Michigan Dearborn, bpeitsch@umd.umich.edu

source, while in capital markets-based systems, capital from bond issues and/or equity investments are the main source.

Economic research on the Ukrainian banking system does not classify it consistently. Moreover, the process of globalization has caused the convergence of financial systems [Hölzl, 2003, Masciandaro, 2009, Reinhard, 2001]. In the Ukrainian financial system, the banking sector developed before capital markets, the volume of banking sector assets exceeds non-banking assets by nearly ten times (see Table 1). Loans issued by banks are 80 times more than corporate bonds issued (in the year 2010).

Table 1. Ukrainian financial system assets, 2003-2010*

Banks	2003	2004	2005	2006	2007	2008	2009	2010
Bank assets share of GDP, %	30.01%	39.48%	41.00%	50.52%	65.67%	92.14%	109.66%	99.59%
Non-banking financial institutions								
Mutual fund assets share of GDP, %	No data	0.56%	1.56%	3.15%	5.66%	6.67%	9.04%	9.88%
Non-government pension fund assets share of GDP, %	No data	No data	0.01%	0.03%	0.04%	6.67%	0.09%	0.10%
Insurance company Assets share in GDP, %	3.38%	5.08%	2.80%	3.21%	No data	4.42%	4.60%	4.13%

Source: Own calculation based on the reports of State Commission of Financial Services Market Regulation, Ukrainian Investment Business Association, and State Statistics Comity of Ukraine

This situation is similar to the Japan where "prior the financial liberalization alternatives to bank finance were very limited. As equity and bond finance were restricted, most firms had to rely heavily on bank loans" (D. Weinstein, Y. Yafeh, 1998, p.635).

The development of the Ukrainian banking system commenced in March, 1991, after the adoption of the Law on the National Bank of Ukraine and the Law on Banks and Banking by the Ukrainian Parliament. Ukraine introduced a two-tiered banking system at that time, consisting of the National Bank of Ukraine and commercial banks of various types and forms of ownership including the state-owned Export-Import Bank and a specialized savings bank.

The National Bank of Ukraine serves as the country's central bank and is responsible for monetary policy and for ensuring the stability of the national currency, the Hryvnia. Commercial banks are formed primarily as joint-stock companies. Foreign ownership of Ukrainian banks is permitted. Some commercial banks are privately held, while others are publicly traded. The range of commercial banking activity includes deposit taking, lending, investing in securities, providing service products, foreign exchange operations and other services to natural persons and legal bodies.

Banks operate in accordance with the Constitution of Ukraine, the Laws of Ukraine "On the National Bank of Ukraine", "On Banks and Banking", Ukrainian legislation on joint-stock companies and other economic entities, as well as with the normative regulations of the National Bank of Ukraine and their Statutes.

As of January 2011, 176 banks have banking licenses. The number of banks with foreign participation is presented in Table 2 [Main…,2011].

Table 2. Number of banks and banks with foreign participation, 2003-2011

	01.01. 2003	01.01. 2004	01.01. 2005	01.01. 2006	01.01. 2007	01.01. 2008	01.01. 2009	01.01. 2010	01.01. 2011	01.09. 2011
Number of banks	157	158	160	165	170	175	184	182	176	176
Banks with foreign capital	20	19	19	23	35	47	53	51	55	56
Banks with 100% of foreign capital	7	7	7	9	13	17	17	18	20	21
Share of foreign capital in statutory fund, %	13.70	11.03	9.60	19.50	27.60	35.00	36.7	35.8	40.6	37.8

Source: http//bank.gov.ua

In spite of the economic contraction in Ukraine since September 2008, the main indicators of banking activity had been improving in 2003-2008. For example, bank equity grew by 71.4%, liabilities by 52.3%, and assets by 57.2%, Profits increased by 7.3 billion UAH. However, in the 1st quarter of 2009, the banking sector began to decline. Profitability shrank for the first time in more than a decade.

Analyses of Ukrainian bank assets

The period of analysis is characterized by an increase in net assets by 16 times (see table 3).

Increasing credit volumes in 2003-2008 confirm that the economy has become more market oriented. Banking credits to enterprises create the financial basis for the GDP growth this period. Individual credit, or credit to private households, exploded from 2003 to 2008, growing from 7% of total credit at the beginning of 2003 to almost 34% by the end of 2008. During the same period, the share of credit to enterprises declined from 81.7% to 59.6%. The quality of banks' credit portfolios improved markedly in the period 2003-2008, as the share of long-term loans expanded 47.5 times in the last six years. The share of long-term loans in bank portfolios was 64.1% at the beginning of 2009, compared to 22.9% at the beginning of 2003. The structure of long- term loans by borrower provides more evidence of liberal lending policies towards individuals – in 2003 only 10% of long- term loans were issued to individuals, while at the beginning of 2009, 47.6% were issued to private individuals. It should be noted that this trend is due primarily to the introduction of mortgage lending, which grew rapidly once people were allowed to own private property.

There were also positive changes in the quality of bank management in terms of credit policy, as evidenced by the sharp decline of problem credits, or bad loans, from 4.5% in 2003, to just 1.3% at the end of 2008. It should be noted, however, that the financial crisis of 2008 led to a 6% decrease in credit volume in 2009.

Bank credit policy appears to have changed after the crisis. The share of credit to enterprises as a percentage of the total loan portfolio expanded to 2007 levels. The most characteristic feature of crisis is that non-performing loans as a percentage of total loan portfolios exploded from 1.31% at the beginning of 2008 to 11.24% by the end of 2010. As a result, reserves for active bank operations grew 2.4-2.5 times in 2009-2010 before slowing down. The fact that reserves grew more quickly than credit issued confirms that there were problems with credit quality. Further evidence that credit policy changed after the crisis is

that bank lending to enterprises outpaced loans to individuals. Long-term loans were only available to enterprises after the crisis. The interesting fact is that the volume of long-term loans peaked in 2008 before dropping off dramatically.

Table 3. Assets of Ukrainian commercial banks, 2003-2011

№	Indicators	01.01. 2003	01.01. 2004	01.01. 2005	01.01. 2006	01.01. 2007	01.01. 2008	01.01. 2009	01.01. 2010	01.01. 2011	01.09. 2011
1.	**Assets, m UAH**	67774	105539	141497	223024	353086	619004	973332	1001626	1090248	1189832
	Net assets, m UAH	63896	100234	134348	213878	340179	599396	926086	880302	942088	1026073
2.	**Credit issued**	46736	73442	97197	156385	269688	485507	792384	747348	755030	807830
2.1.	including credit issued to enterprises, m UAH.	38189	57957	72875	109020	167661	276184	472584	474991	508288	564720
	share in total volume, %	81.71	78.92	74.98	69.71	62.17	56.89	59.64	63.56	67.32	69.91
2.2.	**Credit issued to individuals,** m UAH	3255	8879	14599	33156	77755	153633	268857	222538	186540	182595
	share in total volume,%	6.96	12.09	15.02	21.20	28.83	31.64	33.93	29.78	24.71	22.60
3.	**Long-term credits,** m UAH	10690	28136	45531	86227	157224	291963	507715	441778	420061	439896
	share in total volume,%	22.87	38.31	46.84	55.14	58.30	60.14	64.07	59.11	55.64	54.45
3.1.	including: long-term credits to enterprises, m UAH	9698	23239	34693	58528	90576	156355	266204	244412	262199	298027
	share in total volume of long-term assets,%	90.72	82.60	76.20	67.88	57.61	53.55	52.43	55.32	62.42	67.75
4.	Problem credits (overdue and doubtful), m UAH	2113	2500	3145	3379	4456	6357	18015	69935	84851	83147
	share in total volume,%	4.52	3.40	3.24	2.16	1.65	1.31	2.27	9.36	11.24	10.29
5.	Investments in securities, m UAH	4402	6534	8157	14338	14466	28693	40610	39335	83559	92011
6.	**Reserves (Provision) for active bank operations,** m UAH	3905	5355	7250	9370	13289	20188	48409	122433	148839	164424
	including: debt provision, m UAH	3575	4631	6367	8328	12246	18477	44502	99238	112965	122916

Source: Own calculation based on www.bank.gov.ua (15.10.2011)

Analyses of commercial bank liabilities

From the 2003 until 2009, the stability of the banking system improved. This is reflected in the growth of bank capitalization and the increase in individual and enterprise deposits in banks. The sources of bank capital are included in Table 4.

Table 4. Liabilities & equity of the Ukrainian commercial banks, 2003-2008, million UAH

№	Indicators	01.01. 2003	01.01. 2004	01.01. 2005	01.01. 2006	01.01. 2007	01.01. 2008	01.01. 2009	01.01. 2010	01.01. 2011	01.09. 2011
1.	Liabilities & equity	63896	100234	134348	213878	340179	599396	926086	880302	942088	1026073
2.	**Equity**	9983	12882	18421	25451	42566	69578	119263	115175	137725	149136
	Including: paid-in statutory fund	6003	8116	11648	16144	26266	42873	82454	119189	145857	163838
	share of capital in liabilities & equity, %	15.60	12.90	13.70	11.90	12.50	11.60	12.9	13.1%	14.6%	14.5%
3.	**Bank liabilities**	53 913	87352	115927	188427	297613	529818	806823	765127	804363	876937
3.1.	including: capital of enterprises	19 703	27987	40128	61214	76898	111995	143928	115204	144038	169144
	share in total volume of liabilities & equity,%	36.55	32.04	34.61	32.49	25.84	21.14	17.8	13.1%	15.3%	16.5%
	including: fixed-term deposits of enterprises	6161	10391	15377	26807	37675	54189	73352	50511	55276	62816
	part in total capital of enterprises, %	31.27	37.13	38.32	43.79	48.99	48.39	50.7	43.8%	38.4%	37.1%
3.2	capital of individuals	19092	32113	41207	72542	106078	163482	213219	210006	270733	303045
	share in total volume of liabilities & equity, %	35.41	36.76	35.55	38.50	35.64	30.86	26.43	23.9%	28.7%	29.5%
	Including: fixed-term deposits of individuals	14128	24861	33204	55257	81850	125625	175142	155201	206630	227067
	part in total capital of individuals, %	74.00	77.42	80.58	76.17	77.16	76.84	82.14	73.9%	76.3%	74.9%

Source: Own calculation based on www.bank.gov.ua (15.10.2011)

During the period 2003-2008, bank equity had a growth rate of 1194.7%, liabilities increased roughly 15 times, and the growth rate of individual deposits exceeded the growth rate of enterprise deposits (1116% compared with 730%) over the six year period. The analyses of bank liabilities suggests a high level of public trust in the banking system at the beginning of 2009 – 82.14% of all individual capital was fixed term.

In the 1st quarter of 2009, bank capitalization grew by 7%, but market participation and capital invested by individuals fell by 13.5% and 9.1% respectively, in spite of strong regulatory measures introduced by the National Bank of Ukraine. During the following period (2009- 3d quarter 2011) the banking system was recapitalized in order to resist the financial crisis: the growth rate of the paid-in statutory fund was as high as 144% in 2009 before dropping off [Shulik, V. Ukrainian…,2009]. It should be noted that subordinated debt became a key tool used by some foreign banks to increase capitalization. It was also used as a source of long-term capital. The amount of subordinated debt reached 30.92 billion UAH (4% of all

banking system liabilities) in 2010. Such large amounts allow banks to hedge country and currency risk. Liabilities fell in 2009 by 6% and then almost reached the level of 2008 in 2010. In the 3rd quarter of 2011 liabilities were the highest of the analyzed period.

According to the structure of the deposit portfolio, the share of capital of individuals exceeds share of enterprise capital in total volume of liabilities and equity from 2004 to the present time. However fixed term deposits, which are more desired by banks because they are a more stable source of funding, decreased from 2009, and only the data from the 3rd quartet of 2011 suggests that long-term loans funded by fixed term deposits are beginning to grow again.

Financial results of the banking system

One of the most important measures of bank health is profitability and improved effectiveness of money lent [Caruntu, 2008, p.2]. Table 5 provides key financial results of commercial banks from 2003-2011.

Table 5. Financial results of commercial banks, 2003-2011

№	Indicator	01.01. 2003	01.01. 2004	01.01. 2005	01.01. 2006	01.01. 2007	01.01. 2008	01.01. 2009	01.01. 2010	01.01. 2011	01.09. 2011
1.	Incomes, million UAH.	10470	13949	20072	27537	41645	68185	122580	142995	136848	91842
2.	Expenditures, million UAH	9785	13122	18809	25367	37501	61565	115276	181445	149875	96395
3.	**Financial results, million UAH**	685	827	1263	2170	4144	6620	7304	-38450	-13027	-4553
4.	Return on average assets (ROA), %	1.27	1.04	1.07	1.31	1.61	1.50	1.03	-4.38	-1.45	-0.69
5.	Return on average equity (ROE), %	7.97	7.61	8.43	10.39	13.52	12.67	8.51	-32.52	-10.19	-4.79
6.	Net interest margin, %	6.00	5.78	4.90	4.90	5.30	5.03	5.30	6.21	5.79	5.36
7.	Net spread, %	7.20	6.97	5.72	5.78	5.76	5.31	5.18	5.29	4.84	4.57
8	Leverage multiplier, MC (ROE/ROA)	6.28	7.32	7.88	7.93	8.40	8.45	8.26	7.42	7.03	6.94
9	The profit rate,%	6.54	5.93	6.29	7.88	9.95	9.71	5.96	-26.89	-9.52	-4.96
10	The margin of assets utilization,%	15.45	13.22	14.19	12.35	11.79	11.02	12.59	14.28	12.55	7.72

Source: Own calculation based on www.bank.gov.ua (15.10.2011)

These results clearly indicate strong growth in profitability with some volatility in 2003-2008. It should be noted, however, that from the beginning of 2009 started a decline in profitability and in the case of some banks, even losses. Maximum total losses of the banking system were 38.45 billion UAH in 2009. According to bank top management and overviews of credit agency “Credit Rating”, this was due to additional debt provisions, which are recorded as bank expenses. So this is “losses on paper”, but not yet in fact. Because net operational income exceeds total administrative expenditures in 2.2 times [Shulik, V. Ukrainian…, 2010].

The government regulation of the problems which banks had was conducted through the implementation of temporary administration, purchase of the commercial banks' stocks by government (on the sum of nearly 25.8 billion UAH) and refinancing credits to the banks (more than 120 billion UAH). However, the effectiveness of the last two measures is not satisfactory. To the beginning of 2010 commercial banks debt to the National Bank was 86.3 bill UAH with the opportunity of extension and refinancing to support liquidity. Some Commercial banks (Ukrgazbank, Rodovid Bank, Bank "Kyiv") purchased by the government now should be sold, but the way of their selling is a debatable issue because of their unattractiveness for the investors' due to great amount of losses (904.7 billion UAH as a result of 6 months of 2011) [The alternatives...,2011].

Bank performance and the perceived health of the banking system have great influence on the investment activity of enterprises. The greater availability of credit provided more investment opportunities for market participants, which resulted in the enlargement of the loan portfolios of banks - long-term credits increased to 64% of the total portfolios, on average. It should also be noted that the stability of the banking system improved for the 2003-2008 period (see Table 6). And the opposite effect also takes place: since 2009 in conditions of the restriction monetary policy and interrupting or reducing of issued credits market participants suffer from the deficit of investment resources.

Thus, the first impact of the financial crisis on the banking system began from the 3rd quarter of 2008. Due to the deficit of liquidity and the National Bank disciplining requirements, a lot of banks were limited in increasing their credit portfolios, as a result reducing profitability and changing in the development plans of some banks.

Foreign capital in the Ukrainian banking system

During the period analyzed, growing Ukrainian bank resources were provided by both internal (individuals, enterprises) and external (foreign capital) sources. One distinctive feature of the Ukrainian banking system is undoubtedly the high level of foreign investment in the sector – the share of foreign capital in the statutory funds of banks was 40.6% on 01.01.2011, compared to only 13.7% on 01.01.2003 (see Table 2). Currently, foreign investment in Ukrainian banks comes from 26 countries. The largest portion comes from Russia (24.5%), Cyprus and France (11.1% each), Sweden (10.4%), Austria (10.0%), Germany (8.0%), and the Netherlands (5.9%).

This tendency to invest in the banking systems of Central and Eastern Europe has been visible since the end of the 1980s. Foreign investors have different reasons for investing in developing markets. The main motivations for them to invest in the Ukrainian financial system were the following: 1) the low level of banking products available on the market, and the low level of bank capital concentration; and, 2) the limited amount of foreign capital invested in Ukraine compared with the other CEE countries. Certainly, this investment has influenced the Ukrainian financial sector. The results of a SWOT analysis on the reasons behind, and the impact of foreign capital flowing into the Ukrainian banking system are presented in Figure 1.

Figure 1. SWOT-analyzes of foreign investments in banking system of Ukraine

S – perspectives of Ukrainian banking sector (advantages for foreign investors)	**W – weak sides of financial system in Ukraine**
Limited availability of banking products	Lack of financial recourses with growing needs
Low concentration of banking capital	Low amount of foreign investments per capita
Small share of foreign capital	A lot of small captive banks, high level of corruption, necessity of income legalization
O – opportunities for development with the help of foreign capital	**T – threats / risks for the Ukrainian economy**
Enhancement of service (Improvement of service quality)	Loss of sovereignty in the sphere of monetary-credit policy
Improvement of using technology	Unexpected volatility of banks liquidity
Growth of financial resources	Speculative changes in demand and supply on monetary-credit market
Development of security market (due to participation of banks in the Ukrainian and foreign security markets)	Possible runoff of financial resources
Increasing of international financial rating	Strengthening of competition between banks

Source: Own elaboration

Government regulation of these processes is important in order to take full advantage of foreign investment in the banking system, and to protect against potential risks. It should be noted that after the crisis expert's evaluation of the impact of foreign investment on the Ukrainian banking system became more negative. The main threats named are the following:

- Insecure concentration of speculative capital as short- and medium-term loans on real estate, land, automobile and consumer markets (growing basic assets prices on these markets and distortion of the country's trade balance as a result);
- Dollarization of lending (and following problems with debt service because of the devaluation of the UAH).
- Rapid growth of bank external debt (39 bill USD on 01.01.2009) [Analytica…,2010]

Ukrainian banks stock market: crises impact

The financial crisis 2008 is a difficult test for the Ukrainian financial system as a whole, and for the Ukrainian banks in particular. There were existing problems with inadequate capitalization, liquidity, and quality of credit portfolios, which became more pronounced and more evident during the year 2009 and now are on a different level in appropriate phase. Actions from the regulator – The National Bank of Ukraine (NBU) confirm this: at the beginning of April 2009, bank debt to the NBU was 79.3 billion UAH (20% of all NBU assets), 86.3 billion. UAH at the beginning of 2010; temporary management was implemented in 20 banks (in 5 banks now) [Data…,2011].

The banking system is clearly more vulnerable due to the global financial crisis and this fact influences the value of bank stock prices and here we are attempting to estimate the strength of this impact.

First, it should be noted that of the 176 banks, stocks of only 5 are in the listing of PFTS Stock Exchange. The level of concentration of bank assets and capital is significant enough in only a few of the biggest traded banks, which are the ones that we have chosen to analyze. 80% of all assets belong to 24 banks, long-term trading conducts with only 2 banks stocks (see Table 6)

Table 6 Concentration of banking assets and capital in Ukraine (01.07.2011)

Name of bank	Assets, million UAH.	Share, %	Capital, million UAH.	Liabilities, million. UAH.
Total	**880836.88**	**100**	**131934.15**	**748902.73**
Privatbank	135740.84	15.41%	12683.56	123057.28
Ukreximbank	80011.47	9.08%	17622.09	62389.37
Oschadbank	72451.51	8.23%	17396.17	55055.34
Raiffeisen Bank Aval	55089.81	6.25%	6444	48645
Ukrsotsbank	39976.04	4.54%	6579.06	33396.98
VTB Bank	35869.92	4.07%	3872.22	31997.7
Prominvestbank	34590.48	3.93%	4593.18	29997.3
Alfa-Bank	28786.23	3.27%	3172.91	25613.32
Finance and credit	24410.13	2.77%	1860.3	22549.83
Otp-Bank	23225.47	2.64%	3273.75	19951.72
Nadra Bank	22485.26	2.55%	3979.84	18505.42
First Ukrainian International Bank	19505.61	2.21%	2968.3	16537.31
Brokbusinessbank	17842.05	2.03%	2390.94	15451.11
Ukrgazbank	17213.22	1.95%	1970.31	15242.91
Creditprombank	14993.12	1.70%	1855.59	13137.53
Forum Bank	13208.45	1.50%	1708.19	11500.27
Sberbank Rossii	11838.89	1.34%	1178.11	10660.78
Swedbank	11602.11	1.32%	1515.85	10086.25
Erste Bank	11200.58	1.27%	1379.83	9820.75
Joint-stock bank Pivdenny	10883.44	1.24%	1523.47	9359.96
Rodovid Bank	9563.2	1.09%	4189.77	5373.43
Ing Bank Ukraine	9393.34	1.07%	1698.21	7695.13
Unicredit Bank	8082.27	0.92%	886.26	7196.01

Source: Own calculations according the data from:
http://www.kinto.com/rus/research/marketupdate/transactions/equity/company/10/t_transactions/13/7/2008/13/7/2009.html\

We have therefore chosen to further analyze the 2 biggest banks, based on asset volume with full data about market value of stocks in the period 2005-2011.

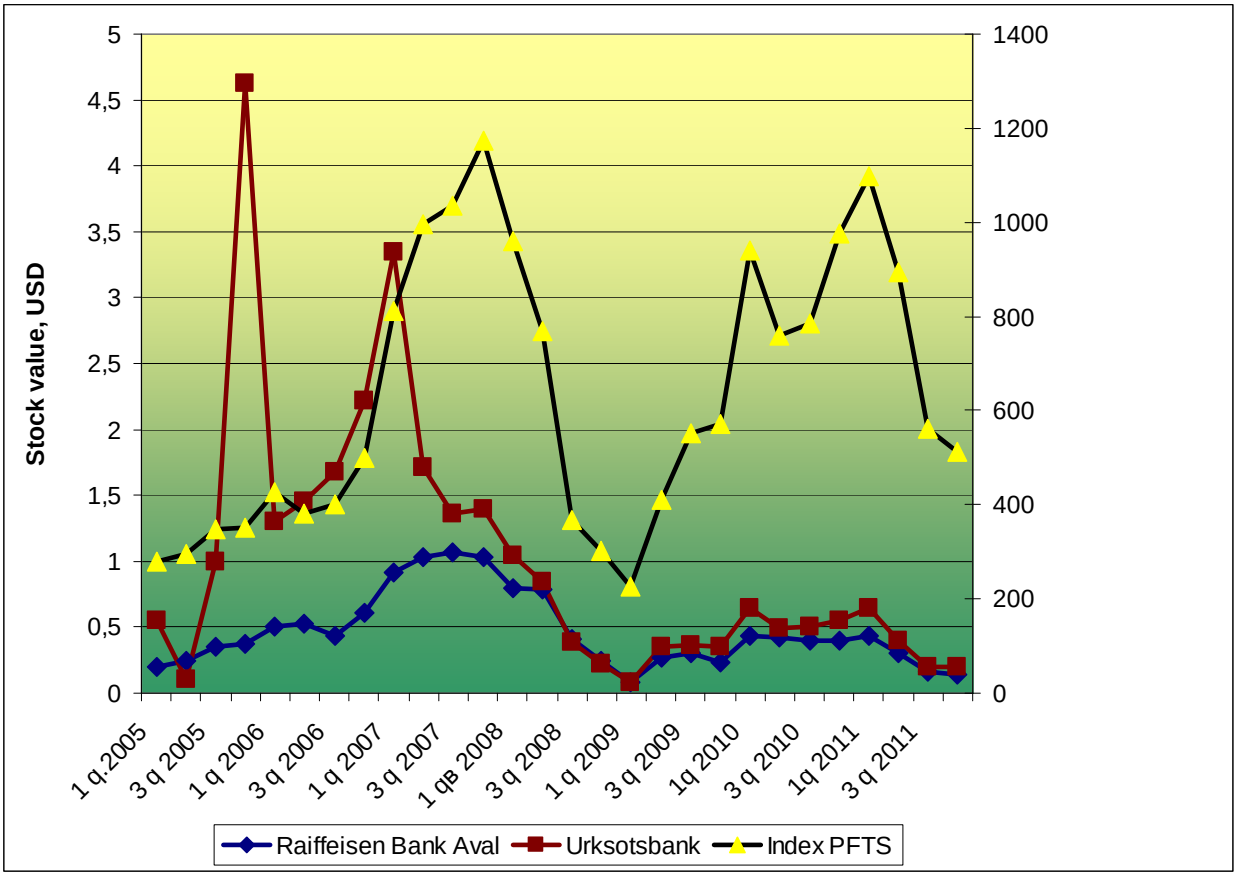
The assessment of rates of return is presented in Table 7 below.

Table 7. Value of banks stocks

	RaifeisenBank Aval		Ukrsotsbank		Market index	
	Value of stock, UAH	Rate of return, %	Value of stock, UAH	Rate of return, %	PFTS-index	Rate of return on PFTS-index
1 q.2005	0.2	-	0.55	-	278.48	-
2 q 2005	0.25	25.00%	0.1	-81.82%	297.09	6.68
3 q 2005	0.35	40.00%	1	900.00%	348.77	17.40
4 q 2005	0.37	5.71%	4.62	362.00%	352.97	1.20
1 q 2006	0.5	35.14%	1.3	-71.86%	428.29	21.34
2 q2006	0.53	6.00%	1.45	11.54%	380.24	-11.22
3 q 2006	0.44	-16.98%	1.68	15.86%	401.81	5.67
4 q 2006	0.61	38.64%	2.22	32.14%	498.86	24.15
1 q 2007	0.91	49.18%	3.35	50.90%	810.97	62.56
2 q 2007	1.03	13.19%	1.71	-48.96%	996.43	22.87
3 q 2007	1.07	3.88%	1.36	-20.47%	1034.38	3.81
4 q 2007	1.03	-3.74%	1.4	2.94%	1174.02	13.50
1 qв 2008	0.8	-22.33%	1.04	-25.71%	959.31	-18.29
2 q 2008	0.79	-1.25%	0.85	-18.27%	767.57	-19.99
3 q 2008	0.41	-48.10%	0.39	-54.12%	369.47	-51.86
4 q 2008	0.25	-39.02%	0.22	-43.59%	301.42	-18.42
1 q 2009	0.085	-66.00%	0.08	-63.64%	227.34	-24.58
2 q 2009	0.27	217.65%	0.35	337.50%	411.2	80.87
3 q 2009	0.3	11.11%	0.36	2.86%	553.29	34.55
4 q 2009	0.23	-23.33%	0.35	-2.78%	572.91	3.55
1 q 2010	0.43	86.96%	0.64	82.86%	940.22	64.11
2 q 2010	0.42	-2.33%	0.49	-23.44%	758.74	-19.30
3 q 2010	0.4	-4.76%	0.5	2.04%	784.04	3.33
4 q 2010	0.4	0.00%	0.55	10.00%	975.08	24.37
1 q 2011	0.43	7.50%	0.64	16.36%	1099.18	12.73
2 q 2011	0.31	-27.91%	0.4	-37.50%	895.01	-18.57
3 q 2011	0.17	-45.16%	0.2	-50.00%	562.32	-37.17
21/10/2011	0.14	-17.65%	0.2	0.00%	512.26	-8.90

Source: calculations according the data from
http://www.kinto.com/rus/research/marketupdate/transactions/equity/company/10/t_transactions/13/7/2008/13/7/2009.html\

Figure 3. Dynamic of stock value of the analyzed banks and market index- PFTS



Source: Own elaboration

The dynamic of stock rate of return in comparison with the dynamic of stock exchange index (here PFTS – index) allows us to evaluate the level of exposure (dependence) of stock value on the market movements and also gives the opportunity of risk valuation.

A valuation of risk (market beta) for these two publicly traded banks with foreign capital, which trade on a constant basis, was conducted, as was an estimation of the impact of the market on the bank stock prices. The results are presented in the Table 8.

Table 8. Risk valuation of bank stocks

Security name	Beta	Alpha	R-Sqr	Resid Std	Std. Err		Number of Observations
				Dev-n	Beta	Alpha	
RaiffeisenBank Aval (BAVL)	0.015	-0.012	0.71	0.29	0.002	0.056	28
Ukrsotsbank (USCB)	0.021	0.329	0.10	1.89	0.012	0.365	28

Source: Own calculations

Thus, we can draw some conclusions about these stocks: there is positive correlation between the Raiffeisen Bank Aval stocks rate of return and the rate of return of the market

with more than average range (correlation ratio equals 0.84). Volatility of rate of return of BAVL stocks depends on volatility of rate of return of the market index by 71%.

Regarding Ukrsotsbank, we should note that there is a positive correlation between the stock's rate of return and the rate of return of the market with less than average range (correlation ratio equals 0,32)

In contrast to the BAVL stocks, the volatility of the rate of return of USCB only depends on the rate of return of the market index by 10%.

Risk levels of both stocks are low and "betta" indicator confirms this statement.

Besides we can come to conclusion that during the analyzed period the BAVL stocks had less rate of return than market and USCB stocks had quite the opposite more rate of return. These statements are based on "alpha" indicators of the appropriate stocks.

Using the results of the above calculations we can build the market model for these two banks

For RaifeisenBank Aval it is:

$$r_{BAVL} = -0{,}01158 + 0{,}01455 * r_i$$

For Ukrsotsbank it is:

$$r_{USCB} = 0{,}3290 + 0{,}0208 * r_i$$

In conducting a quality analysis of the impact of the crisis on stocks prices, we should note the following: analyzed banks are bank subsidiaries of European parent banks (Raifeisen Bank Aval of Reifeisen Bank Austria, and Ukrsotsbank of UniCredit Group) and changes in the stock prices depend on the situation of the parent banks. Prior to the crisis, foreign ownership strengthened the competitiveness of these banks, but the current debt crisis in Western Europe could hurt these banks. The parent banks could even leave the Ukrainian market if things get worse [Shulik, V. Analysis…, 2010].

Besides the investors' expectations about the banks future and sustainability of financial system in Europe and Ukraine, legislative limits had significant impact on the stock price: prohibition for mutual fund to own banks stock. This restriction was adopted at the February 2011 and applied from the June, 16. As a result, mutual funds-owners of banks capital had to sell their shares.

Stock prices are very sensitive both to internal factors and international events.

The following groups of factors appear to have an impact on stock prices of Ukrainian commercial banks at present:

- investors expectations concerning the banks performance;
- politic uncertainty;
- capitalization of the banking system;
- stability of the financial system;
- news about world financial markets;
- sale of big bank shares.
- macroeconomic risk of devaluation
- financial soundness of parent banks and their further strategy.

Conclusion

Evaluations and forecasts of Ukrainian bank performance by international rating agencies and multilateral institutions, Standard & Poor's and the World Bank in particular, are

more negative. S&P experts rate the Ukrainian banking system in the weakest group (group 10) because of the high level of country risk and because the recovery of most Ukrainian banks took 2-3 years. A number of factors delayed recovery, including a deficiency of currency derivatives, a lack of long-term resources, and volatile client deposits [Shulik, V. Survey…2011]. According the *Global Competitiveness Index 2010-2011*, the soundness of Ukrainian banks (as one element of the "financial market development" assessment) ranked poorly --138th among the 139 evaluated countries [The Global…,2010, p.335].

The post crisis period was extremely difficult for the Ukrainian banking system. Many internal and external factors influenced bank performance. Additional debt provisions (the sharp increase in required reserves) are the main reason for the longer than expected poor financial results of banks. The quality of banking assets is worsening because of unstable borrowers' activity.

The volume of non-performing loans is falling at present, and there appears to be a chance for asset recovery. As a result, it is possible that bank performance will be significantly stronger in 2011. However, macroeconomic performance influences bank performance, and the macroeconomic situation is still vulnerable to the European and global economic.

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Abstrakt

Głównym celem artykułu jest analiza wpływu kryzysu finansowego w 2008 roku na system finansowy Ukrainy oraz efektywność ukraińskich banków. Podstawą (fundamentem) wykonanej analizy są kluczowe wskaźniki działalności banków w latach 2003-2011. Przedstawiona (zaprezentowana) analiza dotyczy: aktywów, zobowiązań i kapitału oraz zmian w zarządzaniu bankami. Szczególną uwagę zwrócono na zmianę wartości akcji dwóch największych banków przed i po kryzysie

DEVELOPMENT OF INTERCULTURAL LEARNING: NEW CHALLENGES FOR HIGHER EDUCATION IN UKRAINE

Irina Sikorskaya[1]

Abstract

The paper depicts the new challenges facing higher education institutions in Ukraine in the context of necessity of developing proper intercultural knowledge, skills, and competences of contemporary graduates. It also provides the background for the increasing role of higher education in respect of enhancing intercultural learning. The paper emphasizes the importance of introducing changes in curriculum design, improvement of teaching qualifications, and growing students' intercultural socialization. Finally the paper proposes some recommendations for achieving positive transformations of higher education in Ukraine in regards of addressing the challenges of modern pluralistic society.

Key words: *intercultural learning, higher education institution, student's socialization, globalized world*

Introduction

It is a generally acknowledged fact that today the role of higher education is enormous and complex. The whole range of challenges has emerged for higher education with corresponding implications on social, political, economic, and cultural spheres**.** In the present global transformation climate, higher education institutions (HEIs) may often operate within the international environment, with faculty and students from different countries. The HEIs have entered a new stage of development which involves changing goals and tasks in response to the reality of modern world. The world is becoming increasingly global and its complexity requires a better understanding of cultural diversity. The globalization is an objective and inevitable phenomenon in the world civilization, but, in addition, this is also realization of a subjective factor, activity of individuals, social groups, states, political parties and organizations. In this paper we refer to the idea that globalization provides us with an opportunity to consider and develop a new concept of a university and its role in an increasingly interconnected world society (Brown 2007, p.29). The context of globalization and interconnections of societies are to a great extent the result of the circulation of ideas and people. This process displays that multicultural coexistence is essential to ensuring world peace and security. In this respect we consider one of the most significant challenges for higher education institutions to enhance their potential in educating citizens who are prepared to understand and respect cultural diversity in a global age.

Changing situation in Ukraine

Ukraine has changed considerably in the twenty years of its independence and has become an important member of the world international community. The interest of foreign students in studying in Ukraine is growing, the international cooperation of businessmen, scientists, art workers and public servants has been also greater than ever. Nowadays the Ukrainian government promotes the consolidation and development of the Ukrainian nation,

[1] Prof. Irina Sikorskaya, PhD, Associate Professor of the Department of Sociology of Management, Donetsk State University of Management, Ukraine

of its historical consciousness, traditions and culture, and also the development of the ethnic, cultural, linguistic and religious identity of all indigenous peoples and national minorities of Ukraine. But despite the existence of progressive legislation, Ukraine's ethnic minorities continue to face discrimination in the workplace and their personal lives, and in some areas ethnic minorities are underrepresented in politics, educational organizations, and the media. The adoption of Ukrainian as the official language of Ukraine continues to be a highly contentious issue for native speakers of Russian or other minority languages. This situation needs to be under special concern of lawmakers, politicians, NGOs and especially of academic society. Development of intercultural awareness and intercultural competence is to go through educational methods and it needs to concern itself with knowledge, feelings, attitudes, and behaviors.

Although higher school reform has been implemented world-wide, it has not yet led to significant changes outside the school. We can observe the actions which discriminate against foreigners, we can read reports about someone's failure to adapt abroad (Hapgood and Fennes, 1997). Thus, today it is an urgent necessity for school to educate a multicultural person who can see a reality from a variety of perspectives.

The intercultural frameworks for the role of higher education in Ukraine

Ukraine has inherited from the soviet regime a well-built, comprehensive higher education system. Since its independence in 1991, one of the top priorities of the young state has been to diminish Russian influence in public life and to promote the Ukrainian language and culture. And today globalization and integration processes force the government to search the ways of reforming the education system directed at addressing the needs of local, regional, national, and international labor markets.

During the post-independence period higher education institutions have made a significant contribution to national human development due to the demands of the new market economy in Ukraine. New specialties were open, new disciplines were introduced into the study programs. The new intellectual community is being created in response to the challenges of new social-economic life. In the context of intensive transnational moving and interethnic contact, migratory processes, changes of ideological and political vectors of the development intercultural interactions get new specificity.

It should be fairly stated that the issues of cross-cultural interaction were extensively studied in the Soviet historical sciences. At that time those studies were rigidly adhered to "Communist party directives". They were clearly delineated by propaganda character and usage of ideological terminology such as "strengthening historic ties", "fraternal cooperation", "proletarian internationalism", "fraternal nations", "class solidarity", "friendship of peoples", etc. In late 1980s in the Soviet Union the concept of "dialogue of cultures" became popular in various disciplines according to many researchers.

Since then the significant changes have occurred in the interpretation by historians of the content of intercultural relations - due to the consideration of the latter in the context of ethnic and national processes, development of national consciousness, formation of a national idea. The corresponding terminology has acquired an appropriate scientific description: "relations", "contacts", "conflicts", "ethnic conflicts", "stereotypes", "mentality", "resistance to cultural influences", etc.

After falling in 1991of the Soviet regime, the study of the problems of intercultural interaction, especially those of its levels as interethnic and interethnic acquired a new impetus within historical research. Processes of democratization, nation-building process, identity crisis, the expansion of cultural space actualized the problem of updating the historical sciences. This update is manifested in a consistent de-ideologization of historical science, the

search for alternative schemes, and methodological approaches, expanding databases, address to the discovery of other social sciences and humanities.

The formation of intercultural communication skills was one of the key learning outcomes at the lessons of foreign languages. Nowadays this tradition still prevails: studying foreign languages is also considered as the grounds for raising awareness and understanding the differences between native and foreign cultures, the cross-cultural literacy and readiness for dialogues of cultures, as well as acquiring intercultural communication skills. Besides, such disciplines as political sciences, psychology, pedagogy, sociology, and cultural sciences focus on teaching cultural diversity and national-cultural peculiarities of different countries, bringing up a tolerant attitude towards representatives of other culture, and decreasing the level of ethnocentrism.

The necessity to study intercultural communication aspects in the post-Soviet space and in Ukraine in particular have been justified mainly by pragmatic and didactic motives. However some issues were left underestimated especially in the field of intercultural training. Obviously, the general theoretical training of students in the field of cultural studies does not meet the requirements of modern life. Globalization, migration processes, development of mass media, business, and tourism requires a focused "intercultural learning". The latter involves study of mental features, customs of other cultures, norms, rules and styles of intercultural communication; acquisition of intercultural skills, formation of personal readiness to interact. Even so, in most cases teaching about other cultures is frequently mistaken for a pedagogy of intercultural learning, and the following problematic issues remain vital:

- Lack of conceptualization
- Diffuseness of the conceptual-categorical apparatus
- Insufficient adaptability of Western cross-cultural achievements
- Dominance of traditional sectored nature of research over interdisciplinary
- Eclecticism (multiple theories, ideas)

Nowadays in Ukraine there are around 900 HEIs and 290 of them offer the programs in Management in different fields of Economics. The new disciplines like Intercultural Communication, Cross-Cultural Management, International Negotiation Skills and other have been introduced in the curriculum of the International Management programs. These disciplines have become an integral part of preparation undergraduate and graduate students majoring in international and general management. This is conditioned by the importance of introducing proper international culture behavior as a crucial factor of increasing business competition, which requires from the management staff not to remain static but to develop new approaches and practices for being successful in international business.

The Ukrainian government initiatives on reforming higher education system focus mostly on the national needs. Institutional initiatives to address global problems have been so far quite limited. There is a need for new types of higher education institutions to capable to tackle global issues. The most promising approach here is to introduce intercultural learning at all level of education and to be open to changing curriculum and pedagogy. The essential part of this movement has been implemented through the internationalization of higher education (Kehm and Wit, 2005).On the other hand, it is impossible to become instantly multicultural. Learning how to understand cultural differences does not mean simply to learn about culture. One can distinguishes it clearly between “learning about culture” and “understanding a culture” (Varner and Beamer, 2005). Therefore the approaches require a

conscious choice of methods that link learners, teachers and the subject. And more important is to research the outcomes of intercultural learning, and to trace the demands of society.
Ukraine's accession to the Bologna process, constant broadening contacts with foreign universities, development of academic and professional mobility prove the necessity of forming scientific approach to the questions of international education, internationalization of study courses. By observing best practices of European universities Ukrainian HEIs develop programs of multicultural orientation based on a learner-centered approach followed by educating a specialist who possesses not only professional knowledge, but also definite skills of effective intercultural interaction and observance of human rights in a modern multicultural society.

It has become a good practice for many national higher education institutions which are interested to operate at the international education market to implement actively the policy of internationalization of education process, sign agreements about collaboration with foreign institutions, elaborate programs of double-degree diplomas with European universities, develop degree-programs taught in the English language, create appropriate environment for training and accommodating international students.

In this respect higher education system in Ukraine is able to use a positive foreign experience, to transform the accumulated for many years its own experience and come forward at the international market of educational services with new interesting suggestions. These could be the following:

- Enhancement of pedagogy by applying new research and teaching methodologies and tools. This work will significantly improve the content, depth, and effectiveness of intercultural learning provided in Ukraine,
- Raising students' and faculty's awareness of the multinational nature of society in which they live and their attitude towards foreigners,
- Providing the academic community with the compact information about the significance and role of intercultural dialogue in security and stability issues.

The ongoing Bologna process is a tool for harmonization of higher education systems and can be mutually beneficial way of forming a common European market of highly skilled labor. Ukraine's participation in this process will ensure strengthening position of national higher education establishments at the international education market. Taking into account the modern tendencies of development of higher education of Ukraine in the context of globalization processes, it has become an urgent necessity to introduce the principles of intercultural dialogue, to form a new understanding of social problems in society, and to promote a wide circulation of values of tolerance and multiculturalism at all levels of the education system.

Research is considered to be a crucial part of the role of HEIs. However, there is a growing need to question the relationship between research carried out by Ukrainian HEIs in the sphere of intercultural learning and its application in a society. Unfortunately, there is a certain range of constraints, including poor infrastructure and material resources, a lack of human resources, an academic environment that is not adequate for the research, and assumptions about the processes by which knowledge is generated.
In general it should be pointed out that new policy measures in Ukraine are engaged, but they rely on a poor understanding of consequences of underestimating of education of citizens in respect of intercultural awareness and competence.

Challenge for educators

Almost in all Ukrainian HEIs educators of intercultural issues are underprivileged due to the lack of their intercultural personal experience. In most cases they are equipped only with theoretical knowledge. The American researcher J. Mestenhauser (2000) pointed out the similar problem in his local academic environment by stressing the need for formation of the international competences of teachers, because very often they try to build students' skills, which they do not possess themselves. He raises the related question: "how to teach the teachers" and "how to integrate international and intercultural knowledge in interdisciplinary". Teachers can not develop and train for internationalized curriculum, if they are not internationalized. They create the content and teach courses, and so their development is essential in achieving the successful internationalization of higher education in the content of the universities. Therefore, development of international competence of higher school teachers is a key component in the transformation of curricula and teaching methods for better training students for their future work in a diverse global environment. Certain number of the international scientists (Teekens, 2003; Otten, 2003; Paige, 2003; Mestenhauser, 2000; Whalley, 1997; Knight, 2004; Maidstone, 1996, Crichton, Papademetre, and Scarino, 2004) explored the world of internationalized curriculum integration with the development of international competence of teachers. They all underline the crucial point of acquiring of the international competences of teachers in the internationalization of higher education content, and try to find the effective instrument for creating an internationalized curriculum, which will combine intercultural competence and international expertise perspectives.

Education that is multicultural provides an environment that values diversity and portrays it positively (Gollnick and Chinn, 2002). Effective teaching strategies should be implemented in the curriculum and help students think critically about cultural differences. In most Ukrainian universities the students' audience is homogeneous that is why it is difficult for educators to develop students' skills solely on the basis of their similar group membership. For this purpose there should be elaborated solid scientific and educational-methodological resources helpful to assist students to aware cultural diversity of modern pluralistic society and apply this knowledge effectively in private and social life. It is also important to sustain the education process as a ground for intercultural environment with high investment in staff training, intercultural curriculum developing, cooperative learning models creating as well as establishing the twinning links with monoculture schools in foreign countries.

Intercultural socialization of students

The reality of multicultural coexistence to our opinion must be especially taken into account when educating young generation. Each day young people may encounter this international world in a variety of ways. Contemporary students must be familiar with and understand the interconnected ways of life in the 21st century. The necessity of reformation of the higher education system of Ukraine in this respect, its enhancement has become an important socio-cultural problem, which is to a great extent stipulated by the international flow of knowledge and by the necessity of forming positive conditions of development of any person, his/her socialization and self-realization in a modern globalized world.

In today's socio-economic, institutional, communicative changes the problems of intercultural socialization of students has become the issue for research, largely due to the rapidly expanding information space with an increasingly strong characteristic of cross-cultural communication. It is obvious that Ukraine's future largely depends on the level of socio-cultural and professional capacity of today's young generation, on the extent of their knowledge and skills for productive activities.

Universities have traditionally maintained a central role in promoting international relations, improved solidarity and intercultural understanding. Mobility of faculty and

students in higher education institutions encourage to develop intercultural dialogue within academic society, to experience different cultural values, and to confront and deal with stereotypes and prejudice. As a result of exchange programs students become more open-minded, and tolerant; they can develop wide social networks abroad. Students are included in the new information reality, characterized by significantly increased access to a variety of knowledge and information. Under the conditions of transformation of society, and drastic change of the system of values, norms and attitudes it is necessary to create an adequate model of the socialization of students in general and in the field of intercultural communication in particular. Socio-cultural and professional socialization of students appropriate to modern realities is possible by means of communication of different cultural forms, which enrich the consciousness of students, reveal and activate their potential of effective socialization. In the process of cross-cultural communication the formation of a new international educational environment is occurred, where the national interests of its existing members could be implemented by more effective forms and a joint search for solutions of the problems of socio-professional development of students can be conducted (Gudkow, 2000).

The system of obtaining and transmitting knowledge about the world, codes of conduct and the ways of adaptations to the surrounding social environment depends entirely on the development of cross-cultural communication processes, information flows, communication channels. In the process of cross-cultural communication the refraction of social norms and values occur through the prism of human consciousness that leads to real social consequences based on reflecting and understanding the information received.

Nowadays students are undoubtedly considered as the most mobile social group. Common orientation to travel abroad is strongly observed among modern students all over the world. They tend to dynamically use all the new opportunities to travel abroad for studies, internships, and temporary work. Students' international migration, as any movement has its tasks, motives and resources. Analysis of the motivational structure of contemporary university students showed that their motifs for cross-cultural interactions are closely associated with the most significant values (success, freedom, self-improvement, interesting work in the future) and are dominant in the process of socialization (Kargopoltseva, 2002). Students independently and voluntarily take the path of academic and professional mobility.

Participation in programs of cultural exchange students is one of the most accessible means of implementing cross-cultural communication needs of modern students of Ukraine. Participation in mobility programs allow students to broaden their horizons, raise their cultural level, to become stress-resistant and tolerant to others. In consequence, at the beginning of the professional activities they can apply their skills and abilities into practice and succeed in the professional development.

In establishing general concept of cross-cultural communications and individual programs of academic mobility, the main point is the issue of developing a unified state policy in education, science, innovation and economic development, and international cooperation must be one of the most important instruments for its implementation.

At the present stage of development of Ukrainian society there is need for a formation the general policy of development of international student exchange programs. In this case, it is possible to build advanced short- and long-term programs of international cooperation in the implementation of cross-cultural needs of students at the fundamentally new level, as part of agreements on economic, cultural and social cooperation between Ukraine and foreign states as complex networking projects. This will lead to a qualitative change in the forms and methods of international cooperation of students, which will require implementation of the

strategy of modernizing the management of international activities in higher education in Ukraine.

Conclusions

Development of the principles of intercultural dialogue, training practical skills of the intercultural communications becomes today the international tendency at all levels of higher education system. The reality that accelerating globalization process creates for operation of higher education institutions is whether they can adapt to modern reality or can be left behind. They must accept that they need to change as the labor market has changed enormously. The new role for higher education today is to train a specialist with an intercultural expertise.

New social-economic environment in Ukraine is a solid challenge for higher education system. The economic and socio-political changes in society inevitably require the other approach to the development of higher education system. The government has been conducted gradually a policy of a deregulation of higher education system, providing to it more authority and autonomy. New requirements of labor market compel the institutions of higher education to line up the conceptions of competitive advantages and to determine the strategy which will provide steady harmonious development. It is impossible to develop, to move forward and to remain as an immobile academic structure, irresponsive to a changing world.

Under the modern tendencies of development of higher education in Ukraine, it has become an urgent necessity to introduce the principles of intercultural dialogue, to form a new understanding of social problems in a society, and to promote a wide circulation of values of tolerance and multiculturalism at all levels of an education system.

The following could be recommendations for the higher education institutions willing to prepare inter-culturally educated specialists:

- to review current principles and practices of intercultural learning in the system of higher education in Ukraine
- to contribute to the conceptual development of intercultural learning in HEIs
- to overcome structural barriers to introduction of innovative disciplines into the study programs in the HEIs
- to promote curriculum reforms that focus on the intercultural learning
- to start intercultural awareness activities inside the institutions and facilitate the international cooperation including students and faculty mobility
- to enhance teaching-learning intercultural opportunities for students and faculty
- to adapt to the situation of globalization and multiculturalism, taking into account the fact that contemporary graduates will live and work in global environment.
- to contact with partner universities for similar experience and promote joint activities in this field.

In respect of the future role for higher education system in intercultural learning in Ukraine, the main demand is that higher education should give answers and recommend policies in order to foster human rights through elaborating adequate responses to cultural diversity.

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Abstrakt

Dokument przedstawia nowe wyzwania stojące przed instytucjami szkolnictwa wyższego na Ukrainie w kontekście konieczności stworzenia międzykulturowej wiedzy, umiejętności i kompetencji współczesnych absolwentów. Jest również tłem dla rosnącej roli szkolnictwa wyższego w odniesieniu do poprawy edukacji międzykulturowej. W artykule podkreśla się znaczenie wprowadzenia zmian w projekcie programu nauczania, podnoszenia kwalifikacji dydaktycznych i rozwijania międzykulturowej socjalizacji uczniów. Wreszcie artykuł proponuje pewne zalecenia dla osiągnięcia pozytywnych przemian szkolnictwa wyższego na Ukrainie w odniesieniu do wyzwań współczesnego społeczeństwa pluralistycznego.

FROM PROBLEM CONCEPTUALIZATION TO SIMULATION. THE APPLICATION OF THE SYSTEMS DYNAMICS TO WATER MANAGEMENT PROBLEM

Kazimierz Śliwa[1]

Abstrakt

The article continues previous text published in "Management Business Innovation" (no. 6, 2010) under the title Stock-And-Flow Thinking In Decision Making. Towards Systemic Procedure of Problem Solving. The methodology presented there is shown in the practical context of water supply management problem in one of the largest cities in Mexico. Basic methodological implications for computer supported problem modeling and simulation are shown, beginning with the Partitioning&Tearing Method, causal diagram of the problem as well as the computer simulation model structure drawn with the Vensim™ software.

Key words: *problem simulation, system dynamics, water management problem*

Introduction

There is an extensive number of different approaches to the modeling process and models (Wolstenholme 1994; Morecroft, Sterman 1994, 2000). Most of them emphasize internal nature of models and type of variables they involve. Others are based on physical features of means used in modeling process. In this study we use a different perspective. This text is a continuation to the one published under the title “Stock-and-Flow Thinking in Decision Making. Towards Systemic Procedure of Problem Solving” (see: Management Business Innovation, No 6, 2010). System methodology of problem solving is presented in two layers here: theory and practical application. This text is devoted to the latter stream.

Modeling is not only a means for predicting future but it could also be a powerful instrument for understanding the nature of the problem and learning from and about the problem. In fact, learning through testing difficult problems structures and behavior is a major advantage of problem solving process.

Common tradition in modeling practice is to acquire ready-to-go models from experts in the field and use them for selected problems. It seems that it has become dominant in the field of professional education; instead of learning "how to learn" we provide decision makers with the knowledge of "where to look for". Research works at the Tavistock Institute (Winnicott 1971 and Trygvar 1985) show that there is a remarkable relationship between playing, learning, and problem solving. Modeling contains all these activities; imported models can be replaced by authors' own experimental vision of the problem which can be then changed, re-arranged, and re-interpreted. While playing with the problem and its variables we acquire knowledge of the problem, verify learning through our intuitive process of evaluating its future behavior, and see into possible solutions. We can do that using formal approach

[1] dr hab. Kazimierz Śliwa, Krakowska Akademia im. Frycza Modrzewskiego, Uniwersytet Rzeszowski w Rzeszowie; ksliwa@afm.edu.pl.

consisting of a structured methodology imposing order upon our creativity and friendly computer simulation testing our understanding of a problem.

The paper presents such methodology, beginning with the problem conceptualization phase and ending with the construction of the problem's formal, computer-supported model. It is not only a theoretical essay; the paper results from many years of hands-on experience in modeling and simulation of real problems of which dynamic complexity was a trigger for accepting them as the analysis topic. Some of them were presented at international conferences, in many cases work results were adopted as official guidance for policing those problems. An incomplete list of those problems includes solid waste management, water management and policy, urban development, air pollution, urban logistics, and others.

It seems that proposed hereafter methodology and technology is of special importance in public administration. Most problems, especially in public administration, are solved on a very superficial and lineal knowledge base and emerging solutions results from existing budgetary constraints rather than from problems structure contents; frequently, reached solutions usually become counter-productive and short run fixes.

Cycle of Problem Structuring, Modeling, and Simulation

Problem modeling occurs in a broader intellectual setting which can be called problem solving. We always attempt to model a problem in order to understand and solve it. The term "model" and "modeling" refers, in this context, to a cycle of intellectual activities aiming at discovering problem structure, its codification in accepted language and symbols, and understanding present and future behavior of the problem and its variables. That cycle, therefore, is much more than a problem statement and simple algorithmic approach to its solving. For this reason we depart from the concept of problem solving, interpreting it as a sequence of three phases: structuring, modeling, and simulation. Each phase contributes to our problem knowledge and is linked with problem solving through some specific mental instruments. The exploration and use of those instruments is another objective of this study.

Problem Structuring

Problem structuring is oriented toward ordering of all internal elements contained within a problem. Problem exploration (such name assigned to this stage of problem solving M. Mazur - we follow his terminology hereafter - 1980) begins thus with a precise definition of problem boundaries; this separates the problem from its environment and defines its variables as controllable or independent. Exploration is intimately related with problem classification; we cannot define problem boundaries unless we possess the knowledge of the variables constituting that problem – to classify a problem means to make a list of all variables within and outside the analyzed problem relevant for its solution.

Problem structuring is aimed at specifying problem variables and their distribution in their logical space (which variable affects which other), physical space (spatial distribution), and time. Thus, a structured problem must contain:

- its boundaries (exploration),
- all involved variables (classification),
- relationships existing among variables (problem explanation).

Brainstorming is only one of many thinking tools we can use for this phase. If a problem remains in our domain, brainstorming allows us to make a preliminary list of variables. In most cases, however, the knowledge of a problem requires accessing information and knowledge depositories belonging to other parties and we need to seek relevant

information. We can assist brainstorming with some simple instruments, like Variables Inventory List, Double-Q-Diagram (Fish-Bone Diagram) or similar.

It is also very helpful in the Structuring phase to think of the variables in terms of what type of behavior they may present (dynamic properties of variables). While analyzing possible behavior of a variable over time, only three distinguishable behavior patterns can be detected:

- variables with present states depending on their previous states; those variable show the accumulation or depletion of certain resources (tangible and/or intangible) important for the problem. Those variables are called stock, state or level variables: level variables represent resources within a problem,
- variables that take in the conversion of resources; level variables change over time according to a certain transformation rules contained in another variable, linked with level variable; those variables are called flow or rate variables and they directly increase or deplete resources level, thus absorbing their dynamics,
- variables that are neither level nor rate variables; they usually intervene between level and rate variables and/or between a problem and its environment; as those variables convert internal or external influences into a language understandable for level and state variables, they will be called conversion variables (converters).

The importance of attributing one of mentioned behavior patterns to problem variables stems from different contribution that level, rate, and conversion variables make to the problem structure and behavior. A link between structure and behavior is perhaps most important paradigm of the Systems Dynamics (Senge 1990). Any problem has a structure and the problem behavior is not dominated by its variables alone but it depends on a set of relationships existing among them. Therefore, the problem structure must be analyzed as a whole entity paying special attention to feedback loops existing among variables in the structure. Thus, it is not variables themselves but what occurs in and among variables that determines problem behavior (symptoms) and possible solutions of that problem. In other words, solving a problem implies our intervention in its structure, particularly in its feedback elements. No problem can be solved without purposefully changing its structure.

Another assistance to structuring a problem can be obtained from Dynamic Thinking. Dynamic Thinking attempts to identify all feedback loops included in a problem structure. We can perform it by drawing Causal Loop Diagrams or using more formal algorithm, e. g. Partitioning Method.

It is easy to draw Causal Loop Diagram in the case of simple problems. It becomes more challenging if the problem complexity increases. In such cases we may use the Partitioning Algorithm. The Partitioning Method, invented by Gerald Kron in 1963, was initially used to structuring (partition) complex and large equation systems. It allows us to group all problem variables into blocks where a block contains variables linked with a feedback and where there are no feedback loops between blocks. That means the Partitioning Algorithm locks in all feedback loops into structures called blocks, interpreting the block as a variable or set of variables not connected to other variables (other blocks) with the feedback links. Thus, feedback can exist only within a block (unless block contains one single variable) and never between them.

This phase of problem structuring moves us closer to dynamic properties of the problem and its variables. To get an insight into dynamic behavior of the problem variables, we can use other tools, e. g. Behavior Over Time Diagram and Graphical Function Diagram. Behavior Over Time Diagram presents changes in variable values over time, taking into account any inter-relatedness in their behavior. This gives us a reference mode for capturing relationships between variables in a more detailed way (Graphical Function Diagram).

Problem Modeling

Problem modeling is interpreted here as the conversion of our visual version of a problem into a formal model enabling us to simulate a problem. During problem structuring, central focus is on information available from our knowledge and other information sources and we try to determine most probable behavior of problem variables. This is only the beginning of the modeling process. As problem structure influences upon its behavior, we must adjust problem structure to behavior requirements and to facilitate our interaction with the problem structure and behavior.

We can use for that purpose Basic Feedback Loop and Policy Structure Diagrams accompanied by the analysis of available systems archetypes. Systems archetypes are common patterns persisting in many problems; they are recurring structures that lead to similar behaviors. That similarity of distant structures and behaviors (thus similarity of otherwise distant problems) is a very interesting feature. If we possess some basic knowledge of archetypes and of feedback-based behavior, the modeling task is not that difficult. Once a problem structure is determined, we can make many interesting observations regarding its behavior, we do not need any practical knowledge of that problem but rather information of all feedback loops underpinning its structure. Systemic analysis and inference substitutes empirical observation.

Based on this we are now able to design a model of the problem containing all feedback loops. Feedback loops can also be considered basic decision making loops. They contain, at least, one stock variable and one flow variable, though in most real cases they are accompanied by a number of conversion variables. Having such a picture of the problem, we can pass to the next phase of the process.

Simulation

Simulation is an invaluable tool for problem solving. Its history has been marked by decreasing cost, increasing availability and applicability. Decades ago it was a sophisticated instrument accessible only to selected and trained specialists, now it is a common tool used in "soft" sciences and for solving less tangible social problems. With computer tools that have recently become available, we can model, understand, and re-interpret many important concepts that habitually have had descriptive form. Simulation has been losing its traditionally "hard" predictive rationale and it becomes a way of modeling and playing with problems. This is fundamentally due to new, emerging kind of computer software. Though called "simulation software", it is more a "thinking tool" than computational technique for predicting future states of the problem. We refer here to packages like STELLA®, ithink® , POWERSIM®, or VENSIM®.

Computer Simulation is becoming a learning framework where problems can be tested, variables can be altered or eliminated, and the simulation process, through experimentation with the problem, leads to qualitatively new insight and reflection on the problem under analysis. Presented approach, in addition to its technical efficiency and effectiveness, is an easy to understand and attractive to accept platform for all people involved in problem solving processes; curiosity and interest of people not familiar with this way of modeling and solving problems is a typical and highly motivated reaction.

Having completed the process of problem structuring and modeling, it is easy to translate the model of the problem into a language understandable for each of previously mentioned simulation environments (software). In the next part of the paper we will show briefly the application of presented "in-use" methodology to a concrete problem. We select water management problem in a city of approximately 2 million inhabitants, located in central plateau in Mexico where the author was involved in water policy design in mid 1990's.

Water Management. Problem Structuring in Practice

We will go through all phases of the problem solving process presented in the first part of the paper. We start with the Exploration Stage requiring problem boundaries to be defined. There could be many motives of dealing with a problem. It is critical, however, to know exactly why people are willing to solve it. In our case, we detected a number of different justifications, beginning with "care about citizens" through "budgetary and political reasons". After a careful investigation we came to a conclusion that real motives of people responsible for water problem in the city were:

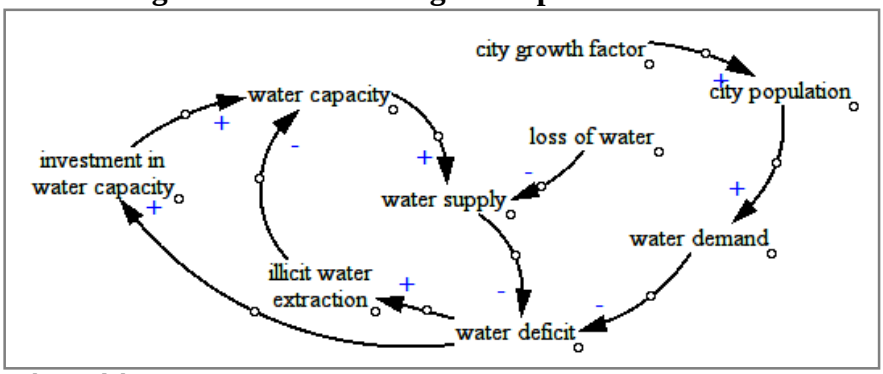
- responsibility for water supply to inhabitants, provoking (in some cases) unfavorable social reactions and political consequences,
- budget constraints resulting in perceived impossibility to solve water problem, thus leading to high costs for the city hall,
- recent decision on water supply privatization and uncertainty caused by this.
- Therefore, we had to mount into the problem all variables related with the cash flow caused by water service. In addition, given claimed rationale for water supply privatization, the problem has to include variables corresponding to its present state (with future extrapolation) and to it future states (what would happen, if we do not privatize but modify existing water policy).

Brainstorming and more formal investigation of the problem components led the research team to constructing the list of involved variables:

- Water Availability (Wav)
- Water Demand (Wdem)
- Water Planned Demand (Wpd)
- Demand Error (Der)
- City Growth (Cg)
- Population Growth (Pg)
- Water Deficit (Wdef)
- Illegal Extraction (Iextr)
- Water Loss (Wl)
- * Water Capacity (Wcap)
- Water lnvestment (Winv)
- Water Provided (Wpr)
- Water Income (Winc)
- Water Recuperation (Wrec)
- Water Extraction (Wextr)

Various sessions with specialists and groups of citizen led to the elaboration of a basic causal diagram representing overall structure of the water management problem (Fig. 1). It became clear that two feedback loops were embedded into its structure: first, beginning with the water supply and leading through water supply and water deficit to the increase (social and political pressure) in water capacity investment which – in turn – increase the city water capacity; second loop also begins with the water capacity and supply – insufficient supply results in common practice of extracting illicitly water from existing water supply aqueducts. Both feedback loops follow water demand increasing in function of the city growth and population size.

Fig. 1. Causal diagram of water management problem



Source: author's elaboration

These 15 initial variables of the water management problem were gathered through internal discussion in the research team and external consultation with water management professionals grouped in the City Council as well as groups of water system customers. According to presented methodology, variables inventory is only the first step towards problem structuring and modeling enabling us to design the initial structure of the problem (obtained through the Partitioning Method - see: Tab. 1).

With Partitioning algorithm we moved from a chaotic, initial list of problem variables towards its structural representation. We can now re-read the problem semantics and verify the viability of previous hypotheses on internal relationships of the problem. We can get closer to feedback loops within blocks and analyze their dynamics. Internal dynamics of blocks containing two or more variables is a critical factor for the dynamics of the problem as a whole and for thinking of its solutions. Even if we stop modeling process and decide to analyze the problem intuitively, our intuition will be assisted with more solid fundament helping to understand the problem. Initial structure, however, is a cornerstone for further work and the construction of the simulation model of the problem.

Tab. 1. Water Management Problem (initial and final matrix)

PROBLEM VARIABLES	Water Availability	Water Loss	Water Demand	Water Capacity	Water Planned Demand	Water Investment	Water Provided	City Growth	Water Income	Population Growth	Water Recuperation	Water Deficit	Illegal extraction	Water Extraction
Water Availability				X							X			
Water Loss				X		X					X			
Water Demand										X				
Water Capacity						X					X			
Water Planned										X				
Water Investment												X		
Water Provided		X											X	
City Growth														
Water Income							X							
Population Growth								X						
Water						X								
Water Deficit														
Illegal Extraction												X		
Water Extraction			X	X										

PROBLEM VARIABLES	City Growth	Illegal extraction	Population Growth	Water Demand	Water Planned Demand	Water Investment	Water Recuperation	Water Deficit	Water Capacity	Water Availability	Water Loss	Water Extraction	Water Provided	Water Income
City Growth														
Illegal extraction														
Population Growth	X													
Water Demand			X											
Water Planned Demand			X											
Water Investment								X						
Water Recuperation						X								
Water Deficit							X		X					
Water Capacity						X	X				X			
Water Availability													X	
Water Loss						X	X	X				X		
Water Extraction														
Water Provided											X	X		
Water Income													X	

Note: a rectangle in final matrix shows block of feedback variables
Source: author's elaboration.

Water Management. Problem Modeling

To solve a problem implies to control it. The advantage of the Partitioning Method is the division of problem structure in blocks of variables between which no feedback loops exist. In that perspective we can see the water management problem as "linear" in form and subject to cause-effect relationship existing between (author's underline) blocks. Therefore:

1) if we control Population and City Growth,
2) we control Water Demand and can easily plan it;
3) by controlling Water Demand we are able to determine the scope of water supply with its all variables (large block in the matrix).

The scope of the water supply is yet much more complicated. Figure 3 shows what form analyzed problem takes while converting its structure into a formal, computer model (Vensim^{TM} was used). We call its diagram “policy structure” as it allows to discover structures influencing possible policies for solving water management problem. Reading through the model we can discern. The city growth represented by its population is not depending upon assumed policy and should be considered independent variable (changeable only in a very long run). It affects water demand and open three large feedback loops.

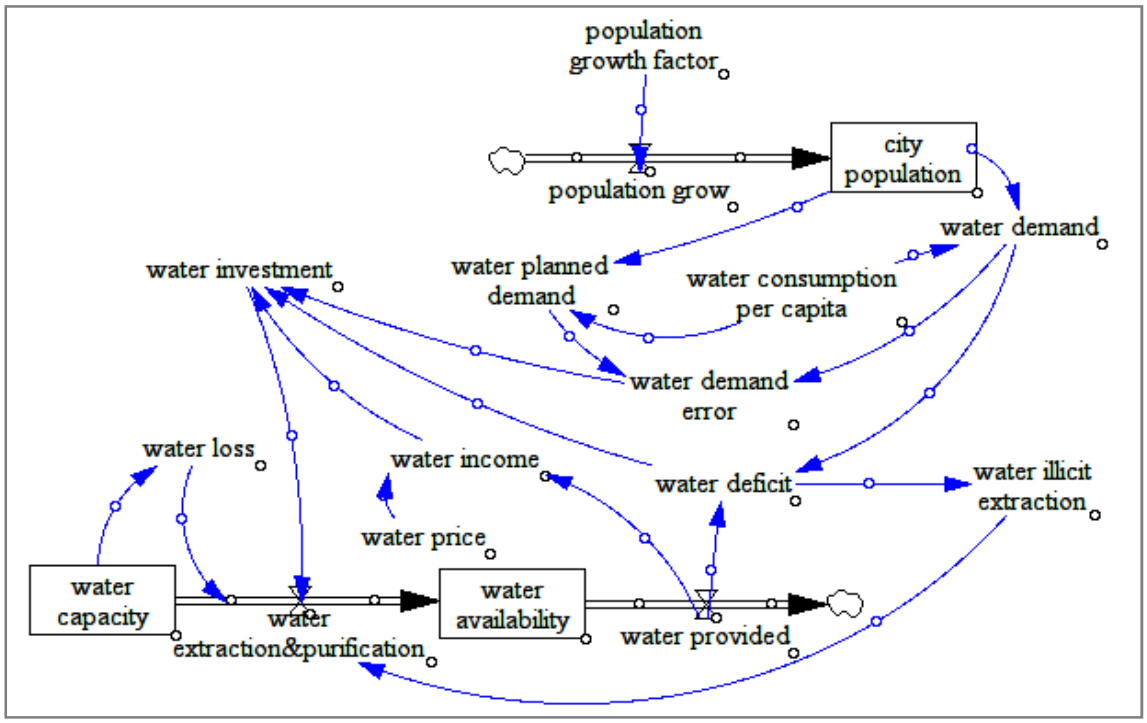
All those loops begin with “Water extraction&purification”. The first loop leads to “Water availability”, then to “Water provided”, “Water income”, and “Water investment”, closing the loop again in “Water extraction&purification”. This part of the problem structure reflects simple fact that water provided to households affects funds devoted to enhancements and improvements in the city water system. The loop is positive (strengthening).

The other two feedback loops point to the variable “Water deficit” linking both into a vicious part of the problem structure. First, when the amount of water is not sufficient (“Water deficit”), pressure towards increasing water supply raises, increasing the perception of urgency in “Water investment” and pressure towards receiving external (federal) funding.

This loop is also strengthening and it closes in “Water extraction&purification”).

Third loop is quite different. When water deficit takes place, illicit water extraction by under-served households perplexes the city water supply system, decreasing the extraction and purification of water that – in turn – activates the first two positive feedback loops.

Fig. 2. Policy Structure Diagram for Water Management Problem



Source: author's elaboration (in Vensim™)

Each of involved variables has a positive reactivity (increase/decrease in affecting variable causes increase/decrease in affected variable, respectively). Whenever all relationships existing between variables have positive reactivities, then the whole block must also possess positive reactivity. Its value may either increase or decrease but increase and decrease cannot happen at the same time. Any reaction causes another reaction in the same direction. Therefore, if we can control any variable of this block, we control the whole block.
Modeling, as a stage preceding computer simulation, requires a careful consideration of each block and its internal dynamics. Understanding blocks is fundamental for converting initial structure of the problem into Policy Structure Diagram. As it was mentioned, Policy Structure Diagram presents decision-making properties of the problem and emphasizes the role of variables reaction to the behavior of other linked variables. Although nothing can substitute our systemic intuition, it is possible to use some rules of thumb:

- within each block there must be at one level variable and one rate variable,
- number of rate variables cannot be lower than a total number of level variables.

Water management. Problem simulation

The Policy Structure Diagram is a good starting point for developing it into a plain simulation model. A specific model of the water management problem is not important here, however. The purpose of this paper is to present a road leading from the initial, intuition-based vision of the problem to its more formal representation and, at the final stage of system approach to problem solving, to testing problem policies through a friendly, computer-based

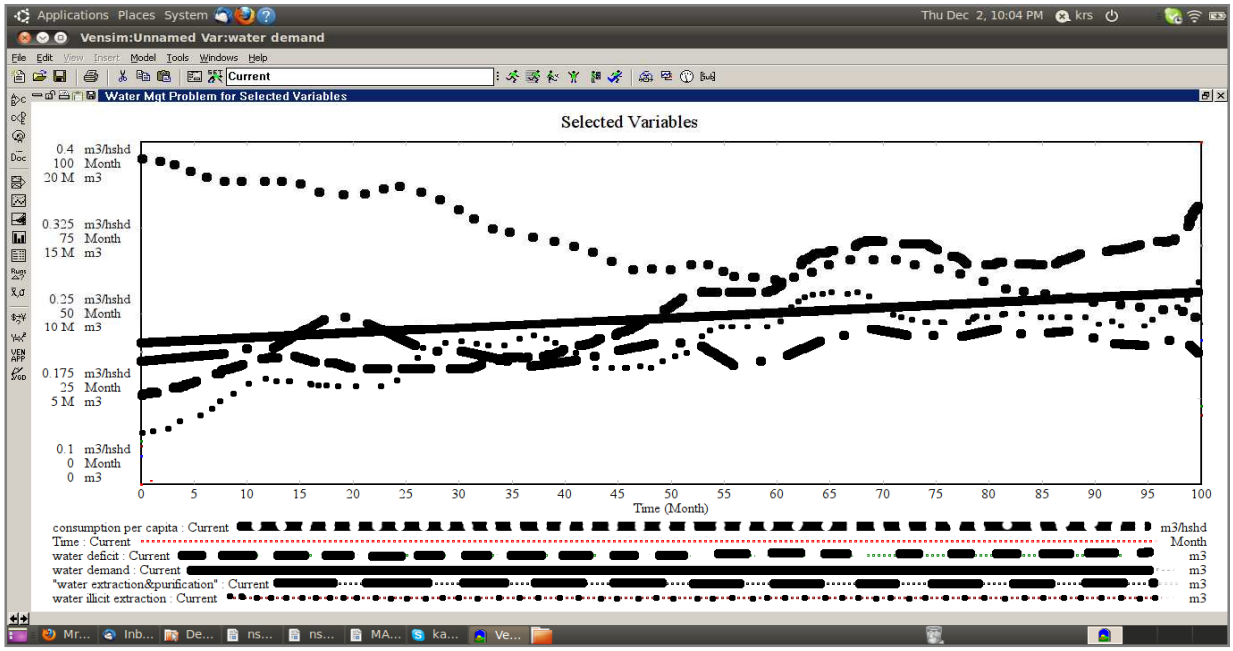
simulation. What was in the past the domain of few versed specialists, now is becoming a tool accessible for decision-makers, enhancing their intellectual potential.

Contrary to classical justification of computer simulation, system procedure of problem solving sees computer simulation as an instrument for learning, particularly learning about systemic (dynamic) structures of social problems. These problems possess some peculiar characteristics that arise due to the nonlinear behavior of stock variables, dynamics of flow variables, and feedback structures included in their structure. Among these characteristics we have:

- symptoms of a problem are often separated from it in time and space;
- they often behave contrary to human intuition;
- our intervention in those problems frequently yields short-term successes but long-term failure, or vice versa;
- feedback loops in their internal structure often counteract external policy intervention;
- it is better to see problem structure to absorb and withstand uncertain external shocks than to predict those shocks;
- real-world dynamic problems are not in equilibrium but rather are continually changing.

System Dynamics offers several tools for accessing problem structure through computer simulation. Some of them rely in using simple mathematical methods for presenting and interpreting internal relationships. Behavior over Time Diagrams (BOT) and Graphical Function Diagram (GFD) are good examples of them. BOT Diagram is a simple graphical presentation of a variable behavior over time. “X” axis denotes “time” and “Y” axis is reserved to a variable in consideration. BOT is especially important in building computer simulation models; if a model is to mimic a real problem, then its structure must generate behavior of problem variable that is equivalent or close to its real behavior (validity of initial model structure). BOT is also an invaluable tool for the analysis of possible relationships existing between variables that otherwise could be considered separated from each other. In this case we use BOT diagram for showing behavior of several variables and the diagram suggests further analysis of variables behavior in connection to each other. Figure 3 presents the BOT diagram for water management problem (note: original variables' behavior graphs have been replicated due to printing color policy).

Fig. 3. BOT Diagram for water management problem (selected variables)



Source: author's elaboration

Presented BOT diagram of selected variables shows surprising relationship between "Water Extraction & Purification" and "Water Illicit Extraction". Contrary to common sense, when water extraction (city supply of households) grows, the illicit water extraction also grows. That is only one of four unexpected outcomes in used city water supply policy. As our aim is not to propose a solution to analyzed problem, so that no implications of those counterintuitive relations will be shown here. Nevertheless, it is worth mentioning how discovered feedback pattern affected the understanding of the problem. The variable "Water Extraction & Purification" represents mainly territorial expansion of the city water supply system, giving more opportunities to the households willing to illegally connect to that system. Such a vicious mechanism works until the city supplies all households with required amount of water – mission that was and is impossible.

Conclusions

The argument that most of public management policy makers (and implementers) are distant from understanding the dynamic nature of problems being solved by them is supported by many empirical researches. Problems having dynamic, feedback based structure require quite a different approach. In this study we have attempted to prove that we can assist complex problem solving with computer modeling and simulation; there are tools and methodologies showing us how to handle dynamic problems and convert them into simpler ones without losing their systemic properties. Proper modeling leads to problem solution.

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Abstrakt

Artykuł przedstawia systemową metodologię rozwiązywania problemów i podejmowania decyzji rozwinietą w poprzednim tekście (Stock-And-Flow Thinking In Decision Making. Towards Systemic Procedure Of Problem Solving) zamieszczonym w poprzednim numerze "Management Business Innovation" (no. 6, 2010). Metodologia ta, przedstawiona w zarysie w cytowanym artykule, jest tu uzupełniona przez praktyczne przedstawienie jej zastosowania w rozwiązaniu bardzo złożonego problemu zarządzania systemem zaopatrzenia w wodę w jednym z 5 głównych miast w Meksyku. Artykuł dyskutuje podstawowe zasady systemowego rozwiązywania problemów i przedstawia ich praktyczne implikacje.

Below is a list of reviewers cooperating with us:

Marek Capiński
Andrzej Cwynar
Wiktor Cwynar
Arne Dag Sti
Michał Drożdż
Ken Nielsen
Piotr Kawa
Tadeusz Rostworowski
Iryna Shkura
Piotr Staliński
Ryszard Stocki
Aleksandra Tokarz
Zenon Uchnast