

MONTENEGRIN JOURNAL OF ECONOMICS

Volume 10
Number 2
December 2014

UDC 33 (51)
Print edition ISSN 1800-5845
Web edition ISSN 1800-6698
COBISS.CG-ID 9275920



Publisher
ELIT - *Economic Laboratory for Transition Research*
Dz. Vashington 4/5, Podgorica, Montenegro

Indexing

Papers published in journal Montenegrin Journal of Economics since September 2006 are abstracted in the **Journal of Economics Literature**, Pittsburgh, the **AEA** (American Economic Association) electronic index, involved in JEL CD, e-JEL,
<http://www.EconLit.org> and WWW.AEAweb.org
http://www.aeaweb.org/econlit/journal_list.php?full=true#M

Since April 2011 Papers are abstracted in the **EBSCO** Publishing, Inc.
<http://www.ebscohost.com>

Since December 2011 Montenegrin Journal of Economics has been included in **Index Copernicus** International S.A. database
<http://journals.indexcopernicus.com/karta.php?action=masterlist&id=7325>

Since February 2012 Montenegrin Journal of Economics has been included in databases:
Ulrich's Periodicals Directory <http://ulrichsweb.serialssolutions.com/>
RePEc <http://repec.org/>
World-Wide Web Virtual Library <http://www.e-journals.org/>
Genamics JournalSeek <http://journalseek.net>

Since **April 2012** Journal has been included in databases:
Cabell's <http://www.cabells.com>
ECONIS Datenbank <http://www.econis.eu>
NewJour <http://old.library.georgetown.edu/newjour/nj2/msg29741.html>

Since **September 2012** Journal has been included in databases:
DOAJ Directory of Open Access Journals <http://www.doaj.org>
ProQuest (ABI/Inform, Research Library, Social Sciences) <http://www.proquest.co.uk>
Scirus <http://www.scirus.com/srsapp/search?q=%22montenegrin+journal+of+economics%22+&t=all&sort=0&g=s>

Editor in Chief

Professor Veselin Draskovic University of Montenegro, Faculty of Maritime Studies Kotor, Montenegro

Associate Editors

Professor Yochanan Shachmurove The City College of the City University of New York, Department of Economics and Business, USA
 Professor Lloyd Blenman University of North Carolina-Charlotte,
 President at Midwest Finance Education Foundation, USA
 Professor Radislav Jovovic University Mediterranean, Faculty of Business Studies, Montenegro

Associate Editor and Journal Administrator

Associate Professor Oleksandr Dorokhov Kharkiv National University of Economics, Faculty of Economic Informatics, Ukraine

Advisory Board

Professor Harry M. Markowitz Nobel Laureate Rady School of Management at the University of California, USA
 Professor Oliver E. Williamson, Nobel Laureate University of California, Berkeley, USA
 Professor Shachmurove Yochanan The City College of the City University of New York, Department of Economics and Business, USA
 Professor Polterovich Victor Central Economics and Mathematics Institute, Russian Academy of Science and Moscow School of Economics / Lomonosov's Moscow State University, Russia

International Editorial Board

Professor Serguei Aivazian Central Economics and Mathematics Institute of the Russian Academy of Sciences / Lomonosov's Moscow State University, Russia
 Associate Professor István Benczes Corvinus University of Budapest, Faculty of Economics, Hungary
 Professor Bolesław Borkowski SGGW Warsaw, Faculty of Applied Informatics and Mathematics, Department of Econometrics and Statistics, Poland
 Professor Laszlo Csaba Central European University, Department of International Relations and European Studies, Budapest / Budapest University of Economic Sciences and Public Administration, Hungary
 Professor Michael Doubrovsky Odessa National Maritime University, Ukraine
 Professor Fan Gang Graduate School of Chinese Academy of Social Sciences (CASS) / China's National Economic Research Institute (NERI), China
 Professor Yuriy Gavrilec Central Economics and Mathematics Institute of the Russian Academy of Sciences, Russia
 Professor Wei Ge Bucknell University, Department of Economics, Lewisburg, USA
 Professor Balazs Hamori Corvinus University of Budapest, Hungary
 Professor Yu Hsing Southeastern Louisiana University, College of Business, Hammond, LA, USA
 Professor Wen-jen Hsieh University Road, Tainan / Art Center National Cheng Kung University, Taiwan
 Professor Svetlana Kirdina Institute of Economics Russian Academy of Sciences, Russia
 Professor George Kleiner Central Economics and Mathematics Institute of the Russian Academy of Sciences, Russia
 Professor Grzegorz Kolodko Kozminski University in Warsaw (ALK) / Director of TIGER, Poland
 Professor Valeriy Makarov Central Economics and Mathematics Institute of the Russian Academy of Sciences/ Lomonosov's Moscow State University / New Economic School, Russia
 Professor Vladimir Matveenko National Research University Higher School of Economics, St. Petersburg, Russia
 Professor Alojzy Nowak University of Warsaw, Faculty of Management, Poland
 Professor Yuriy Osipov Lomonosov's Moscow State University, Faculty of Economics, Russia
 Professor Jiancai Pi School of Business, Nanjing University, China
 Professor Evgeniy Popov Institute of Economics, Urals Branch of Russian Academy of Sciences, Ekaterinburg, Russia
 Professor Uriel Spiegel Bar-Ilan University, Faculty of Social Sciences, Ramat-Gan, Israel
 Professor Theodore Tsekeris Centre of Planning and Economic Research (KEPE), Athens, Greece
 Professor Merih Uctum The Graduate Center City University of New York, USA
 Professor Giurca Laura Vasilescu University of Craiova, Faculty of Economy and Business Administration, Romania
 Professor João Paulo Vieito Polytechnic Institute of Viana do Castelo, Portugal
 Assistant Professor Milos Vulanovic Western New England University Springfield, USA
 Assistant Professor Eric Wdoviak Farmingdale State College, New York, USA
 Professor Bagrat Yernknyan Central Economics and Mathematics Institute, Russian Academy of Science / State University of Management Moscow, Russia

Regional Editorial Board

Professor Slobodan Acimovic	University of Belgrade, Faculty of Economics, Serbia
Professor Marko Backovic	University of Belgrade, Faculty of Economics, Serbia
Associate Professor Sanja Bauk	University of Montenegro, Faculty of Maritime Studies Kotor, Montenegro
Assistant Professor Mimo Draskovic	University of Montenegro, Faculty of Maritime Studies Kotor, Montenegro
Professor Gordan Druzic	Croatian Academy of Sciences and Arts, Zagreb, Croatia
Associate Professor Nikola Fabris	University of Belgrade, Faculty of Economics, Serbia
Professor Miomir Jaksic	University of Belgrade, Faculty of Economics, Serbia
Assistant Professor Borut Jereb	University of Maribor, Faculty of Logistics Celje, Slovenia
Professor Vesna Karadzic	University of Montenegro, Faculty of Economics Podgorica, Montenegro
Associate Professor Slobodan Lakic	University of Montenegro, Faculty of Economics Podgorica, Montenegro
Associate Professor Milan Lakicevic	University of Montenegro, Faculty of Economics Podgorica, Montenegro
Associate Professor Vujica Lazović	University of Montenegro, Faculty of Economics Podgorica, Montenegro
Professor Andjelko Lojpur	University of Montenegro, Faculty of Economics Podgorica, Montenegro
Professor Tihomir Lukovic	University of Dubrovnik, Croatia
Professor Emeritus Ljubomir Madzar	Institute of strategic studies and development „Petar Karić“ of the Alfa University in Novi Beograd, Serbia
Professor Joze Mencinger	University of Ljubljana, Law School, Slovenia
Associate Professor Milivoje Radovic	University of Montenegro, Faculty of Economics Podgorica, Montenegro
Professor Ivan Ribnikar	University of Ljubljana, Faculty of Economics, Slovenia
Professor Guste Santini	University of Zagreb, Croatia
Assistant Professor Ivo Speranda	University of Dubrovnik , Department of Economics and Business Economics, Croatia
Professor Dragoljub Stojanov	University of Rijeka, Faculty of Economics, Croatia

Secretary of Editorial Boards

Associate professor Mimo Draskovic	University of Montenegro, Faculty of Maritime Studies Kotor, Montenegro
------------------------------------	---

Technical editor

Milojko Pusica, B. Sc. ing. elektrotecnics	„Tangenta“ Niksic, Montenegro
--	-------------------------------

The journal is published two times a year
Price for single copy: 30 €
Printing: 500 copy

Journal customer service:

Tel: + 382 68 688 888; + 382 68 583 622;
E-mail: veso-mimo@t-com.me
Web address: <http://www.mnje.com>

Account: **510-21341-37** (Crnogorska komercijalna banka, Podgorica, Montenegro)

Printed by : „3M Makarije“ - Podgorica

Rješenjem Ministarstva kulture i medija br. 05-962/2 od 23. maja 2005. godine
Montenegrin Journal of Economics je upisan u evidenciju medija pod rednim brojem 560.

CIP – Каталогизација у публикацији
Централна народна библиотека Црне Горе
33 (051)

MONTENEGRIN Journal of Economics /
glavni i odgovorni urednik, Editor in Chief -Veselin Drašković. – God. 1. br. 1 (2005) .
– Nikšić (Novaka Ramova 12) : “ELIT – ekonomska laboratorija za istraživanje tranzicije”,
2005 (Podgorica: 3M Makarije) . – 30 cm

Dva puta godišnje.
ISSN 1800-5845 = Montenegrin Journal of Economics
COBISS.CG-ID 9275920



Contents

CURVATURE AND THE ELASTICITY OF SUBSTITUTION: WHAT IS THE LINK? Andrei Matveenکو, and Vladimir Matveenکو	7
FACTOR ANALYSIS OF INFORMATION PRODUCTS COMPETITION Evgeny V. Popov, and Sergey V. Kulpin	21
NEOLIBERAL RHETORIC AS A METAPHOR FOR QUASI-INSTITUTIONAL MONISM Veselin Draskovic, and Milica Delibasic	33
PROGRESSIVE INCOME TAXES AND MACROECONOMIC INSTABILITY Mohanad Ismael	49
THE LONG WAVES IN THE POST-INDUSTRIAL ECONOMY Victor Ye. Dementiev	63
CRITERIA FOR MANAGING MATERIAL RESOURCES STOCK AT INDUSTRIAL ENTERPRISES Gontareva Iryna, Krokhamal Svetlana, and Dorokhov Oleksandr	71
PHRONETIC RESEARCH - METHODOLOGY THAT MATTERS TO CORPORATE GOVERNANCE RESEARCH Mirjana Kuljak	79
IDENTIFICATION AND ANALYSIS OF SPECIFIC PROBLEMS IN THE RATIONALIZATION OF MACRO-LEVEL LOGISTICS NETWORKS USING TRAVELLING SALESMAN PROBLEM Slavomir Vukmirovic, Drago Pupavac, and Mimo Draskovic	89
A REGRESSION MODEL OF INFLATION IN MONTENEGRO Vesna Karadzic.....	103
Author Guidelines	111

CURVATURE AND THE ELASTICITY OF SUBSTITUTION: WHAT IS THE LINK?*

ANDREI MATVEENKO¹, and VLADIMIR MATVEENKO²

ABSTRACT

Relation between curvature and the elasticity of substitution is the old question important for economic theory. Opinions of economists concerning presence or absence of a link between these two concepts radically diverge. Also now there is a steady trend of the use of the Arrow-Pratt coefficient of relative risk aversion and the coefficient of relative prudence as characteristics of utility functions and production functions even in non-stochastic models, and these two coefficients are also commonly interpreted as measures of curvature. The purpose of the paper is to contribute to clarification of the links between all these concepts. We suggest a simple unifying approach based on the notions of prototype functions and osculating curves. In framework of this approach we easily derive the classic geometric curvature and show the relations between the Arrow-Pratt coefficient, the prudence coefficient, the elasticity and the elasticity of substitution. As an example, demonstrating the role of such relations in economic models, we study a simple macroeconomic model with a non-homothetic production function.

KEYWORDS: *curvature, elasticity of substitution, production function, utility function, CES function, osculating function, Arrow-Pratt coefficient of relative risk aversion, relative prudence coefficient*

JEL classification: C60, D20, O40

Received: May 25, 2014 / Accepted: November 30, 2014

1. INTRODUCTION

Utility functions and production functions are basic research tools both in macroeconomics and microeconomics and, permanently, attempts are being made to develop and connect various concepts to characterize such functions. First of all, these are concepts of curvature and elasticity of substitution. These notions are often used in discussions of economic phenomena depending on parameters of production functions or utility functions.

Question of relationship between elasticity of substitution and curvature proves to be not straightforward. In different situations these two concepts seem to be close to or far from each other in their meaning.

Indeed, for the Cobb-Douglas function with constant returns to scale (CRS),

$F(K, L) = AK^\alpha L^{1-\alpha}$, where $\alpha \in (0, 1)$, elasticity of substitution is identically equal to 1. At the same time, curvature, κ , varies at different points:

$$\kappa = \frac{\alpha(1-\alpha)KL}{[\alpha^2 L^2 + (1-\alpha)^2 K^2]^{\frac{3}{2}}}.$$

* The research was supported by Grant Agency of Charles University in Prague (grant 308214) and by the Russian Foundation for Basic Research (projects 14-01-00448, 14-06-00253).

¹ CERGE-EI, a joint workplace of the Center for Economic Research and Graduate Education, Charles University, and the Economic Institute of the Academy of Sciences of the Czech Republic, PhD Student, Prague, Czech Republic, amatveen@cerge-ei.cz

² National Research University Higher School of Economics, Professor, St. Petersburg, Russia, vmatveen@hse.ru

The function $\kappa(K, L)$ is homogeneous of degree (-1) .

On the other side, it is easy to provide an example of interdependency of the elasticity of substitution and curvature. In particular, one can check that for the family of the constant elasticity of substitution (CES) functions $(\alpha K^p + (1-\alpha)L^p)^{1/p}$, where $p \in (-\infty, 0) \cup (0, 1)$, $\alpha \in (0, 1)$, at point $K=1, L=1$ the curvature is $\kappa = c(\alpha)/\sigma$, where $\sigma = 1/(1-p)$ is the elasticity of substitution, and $c(\alpha)$ is a constant which depends on parameter α .

Opinions of economists concerning presence or absence of connection between the elasticity of substitution and curvature are radically different.

Among the first who stressed presence of a link between the curvature and the elasticity of substitution was John Hicks who, in particular, wrote: "The curvature of the indifference-curve describes the same property as the "rate of increase of the marginal rate of substitution". But to take either as our measure without correction for units would be impossible – the result would have as little significance as the uncorrected *slope* of a demand curve. A measure free from this objection fortunately now lies ready to our hand. It is the *elasticity of substitution...*" (Hicks, 1934, pp. 58-59).

In today's texts on microeconomics it is also easy to find claims, without arguments, that there is a link between these two notions. Here are but some examples. "The elasticity of substitution measures the *curvature* of the isoquant" (Varian 1992, p. 13); "the *elasticity of substitution...* captures the relationship between the input ratio and the curvature of the isoquants" (Gravelle and Rees 2004, p. 29); "The elasticity of substitution $\sigma_{ij}(x^0)$ is a measure of the curvature of the $i-j$ isoquant through x^0 at x^0 " (Jehle and Reny 2011, p. 129).

Contrary, De La Grandville (1997) argues that "there is no link between curvature and the elasticity of substitution".

Probably, the authors of the microeconomic texts have in mind local differences in curvature, such as in our above example with the CES functions, in which the curvatures are compared in a fixed point. Opposite to this, De La Granville speaks about global comparisons. To give one more example, for all CES functions $(\alpha K^p + (1-\alpha)L^p)^{1/p}$ with any α and at all points (K, L) , the elasticity of substitution, under fixed parameter p is the same and equal to $\sigma = 1/(1-p)$, while curvature is different even, even under fixed α and even at points belonging the same ray $K/L = \text{const}$.

The necessity to explain conceptual links between basic concepts relates not only to the elasticity of substitution and curvature but to some other important relative concepts as well. In economic literature there is now a steady trend to use CRS utility and production functions in their intensive form, which is an increasing strictly concave function of one variable, $f(x)$, and to study models with evoking as tools such functions as

$$r_f(x) = -\frac{f''(x)x}{f'(x)},$$

and

$$r_{f'}(x) = -\frac{f'''(x)x}{f''(x)}.$$

Initially the functions $r_f(x)$ and $r_{f'}(x)$ appeared in risk analysis, where they are called, correspondingly, the *Arrow-Pratt coefficient of relative risk aversion* and the *coefficient of relative prudence* (Pratt 1964; Arrow 1965; Kimball 1990; Maggi et al. 2006; Martins 2007). However, these functions became popular also in analysis of various non-stochastic models in macroeconomics (Blanchard and Fischer 1989, Carroll and Kimball 1996), industrial organization (Zhelobodko et

al. 2012; Levine 2012), international trade (Mrázová and Neary 2013), public economics (Andersen and Bhattachary 2013).

Usually when the authors use the functions $r_f(x)$ and $r_{f'}(x)$, they interpret them as measures of curvature; however, the link of these functions with standard mathematical characteristics of the curvature is not disclosed. Moreover, the economic sense of the coefficients r_f and $r_{f'}$ often stays in shadow in situations not related to risk and uncertainty.

The purpose of our article is to contribute to clarification of the link between curvature, elasticity of substitution and such characteristics of utility function and production function as r_f and $r_{f'}$.

We suggest a simple unifying approach to different possible concepts of curvature based on the notions of prototype functions and osculating curves. In framework of this approach, we show that the classic curvature and the elasticity of substitution are, in some sense, “on different shores”: these concepts are parallel in their origin, but relate on the use of different geometric curves: circles and graphs of CES functions, correspondently. The classic curvature is obtained when the prototype function defines circles. The functions $r_f(x)$ and $r_{f'}(x)$ arise in natural way when the prototype form is the intensive form of the Cobb-Douglas function or the CES function – correspondently, the elasticity of substitution is constant in these cases and there is a relation of the elasticity of substitution, the Arrow-Pratt coefficient and the prudence coefficient.

We also obtain several previously unknown relations between the Arrow-Pratt and the prudence coefficients, the elasticity of the CES function, and its elasticity of substitution. As an example demonstrating the role of such kind of relations in economic models, we study a simple macroeconomic model with a non-homothetic production function.

The paper is organized in the following way. In Section 2 the notion of the elasticity of substitution is formulated and some of its properties are proved. In Section 3 we introduce general concepts of the prototype form and the osculating functions. By use of these concepts we easily derive the classic geometric curvature. In Section 4 we apply the same approach to the Cobb-Douglas prototype form; this leads to relations between the Arrow-Pratt coefficient, the elasticity and the prudence. In Section 5 in a similar way on basis of the CES prototype form we obtain a link of these variables with the elasticity of substitution. In Section 6 we consider an example of application of our results to a closed economy model with a non-homothetic production function. In section 7 we make a conclusion.

2. CALCULATION OF ELASTICITIES

Let us remind that if f and x are in functional relationship (possibly, through another variable)

then $\varepsilon_f = \frac{df}{dx} \frac{x}{f}$ is called *elasticity* of f with respect to x . From the properties of differentiation it

is immediately clear that the elasticities can be calculated according to very simple rules: elasticity of a product fg is equal to the sum of elasticities $\varepsilon_f + \varepsilon_g$; elasticity of a quotient f/g is equal to the difference of elasticities $\varepsilon_f - \varepsilon_g$; elasticity of a power f^α is equal to $\alpha\varepsilon_f$; elasticity of a constant is zero. Finally, multiplying a function by a constant has no effect on its elasticity (this is different from the usual differentiation).

It is obvious that the Arrow-Pratt coefficient, with a minus sign, is equal to the elasticity of the derivative of the function:

$$r_f = -\varepsilon_{f'},$$

and the coefficient of relative prudence is equal, also with a minus sign, to the elasticity of the second derivative:

$$r_{f'} = -\varepsilon_{f'}.$$

LEMMA 1. a) Elasticity of elasticity, i.e. the quantity $\varepsilon_{\varepsilon_f} = \frac{\varepsilon_f' x}{\varepsilon_f}$, equals $(-r_f + 1 - \varepsilon_f)$.

b) Elasticity of the Arrow-Pratt coefficient of relative risk aversion, i.e. the quantity $\varepsilon_{r_f} = \frac{r_f' x}{r_f}$, equals $(r_{f'} - 1 - r_f)$.

Proof. See the Appendix.

COROLLARY 1. The derivatives of the elasticity and of the Arrow-Pratt coefficient of relative risk aversion are

$$\begin{aligned}\varepsilon_f' &= (-r_f + 1 - \varepsilon_f) \cdot \frac{f'}{f}, \\ r_f' &= (r_f + 1 - r_{f'}) \cdot \frac{f''}{f'}.\end{aligned}$$

Let $F(X_1, X_2)$ be continuously differentiable function of two variables on R_+^2 . Then the quantity defined by $S_{12} = -\frac{dX_1}{dX_2} = \frac{\partial F / \partial X_2}{\partial F / \partial X_1}$ is called *marginal rate of substitution*³. The latter equality in this equation holds due to the implicit function theorem. Let us examine the ratio $x = \frac{X_1}{X_2}$. Elasticity of x with respect to S_{12} is called the *elasticity of substitution*. The standard notation for the elasticity of substitution is σ .

Let us further assume, that the function $F(X_1, X_2)$ is homogeneous of degree γ , i.e. $F(\mu X_1, \mu X_2) = \mu^\gamma F(X_1, X_2)$ for any vector $(X_1, X_2) \in R_+^2$ and for any $\mu > 0$. It is possible to express the homogeneous function as $F(X_1, X_2) = X_2^\gamma f(x)$, where $f(x) = F(x, 1)$, $x = X_1 / X_2$. Function f in this expression is called the *intensive form* and F is called the *extensive form*.

LEMMA 2. If $F(X_1, X_2)$ is homogeneous of degree γ , then the marginal rate of substitution is equal to

$$S_{12} = x \left(\frac{\gamma}{\varepsilon_f} - 1 \right). \quad (1)$$

Proof. See the Appendix.

PROPOSITION 1. If $F(X_1, X_2)$ is homogeneous of degree γ , then the elasticity of substitution is equal to

$$\sigma = \frac{\gamma - \varepsilon_f}{(1 - \gamma)\varepsilon_f + r_{f'}}.$$

Proof. See the Appendix

COROLLARY 2. If $\gamma = 1$, i.e. function f is linearly homogeneous (CRS), then

$$\sigma = \frac{1 - \varepsilon_f}{r_f}. \quad (2)$$

³ Obviously, $S_{12} = S_{21} = 1$

Equation (2) connects the Arrow-Pratt coefficient, r_f , the elasticity of the intensive form, ε_f , while the elasticity of factor substitution of the extensive form, σ .

Thus, the inequality $1 - \varepsilon_f - r_f < 0$ corresponds to the case of low substitutability for the extensive form function ($\sigma < 1$), and the inequality $1 - \varepsilon_f - r_f > 0$ corresponds to the case of high substitutability ($\sigma > 1$).

2. PROTOTYPE FORMS, OSCULATING FUNCTIONS, AND THE CURVATURE

Let function $f(x)$ be defined in a neighborhood of point $x_0 \in R_+$, n times continuously differentiable, increasing and strictly concave:

$$f'(\cdot) > 0, f''(\cdot) < 0. \quad (3)$$

It is important to note that conditions (3) introduce limitations on elasticity, $\varepsilon_f(x)$.

LEMMA 3. *If a continuous function $f(\cdot)$ is defined on R_+ , satisfies (3), and $f(0) \geq 0$, then function $f(\cdot)$ is inelastic, i.e. $\varepsilon_f(\cdot) < 1$.*

Proof: See the Appendix.

It is easily seen that the inelasticity of $f(\cdot)$ is equivalent to decrease in the ratio $f(x)/x$.

Let us assume that the form of the function $f(x)$ is unknown, however, at point x_0 the values of the function and its n derivatives are given, $f(x_0), f'(x_0), \dots, f^{(n)}(x_0)$. Or, what is more common for economic models, one can know the value $f(x_0)$ and some economic measures, such as $\varepsilon_f(x_0), r_f(x_0), r_{ff}(x_0)$. This information is equivalent, since these measures are, in their turn, based on the values of the function and its derivatives.

Let $g(x, \gamma_1, \dots, \gamma_k)$ be a class of functions with k parameters; this class will be referred as *prototype form*. Assume that the values of parameters $\bar{\gamma}_1, \dots, \bar{\gamma}_{n+1}$ can be found from the system of equations:

$$g(x_0, \bar{\gamma}_1, \dots, \bar{\gamma}_{n+1}) = f(x_0), \quad g^{(i)}(x_0, \bar{\gamma}_1, \dots, \bar{\gamma}_{n+1}) = f^{(i)}(x_0), \quad i = 1, \dots, n, \quad (4)$$

where $g^{(i)}, f^{(i)}$ are the i -th derivatives. In such case we say that functions $g(x, \bar{\gamma}_1, \dots, \bar{\gamma}_{n+1})$ and $f(x)$ are *osculating* at the point x_0 and, correspondingly, their graphs are *osculating curves*.

In the classic geometric case, function $f(x)$ at point x_0 is characterized by the value $f(x_0)$ and by two derivatives, $f'(x_0)$ and $f''(x_0)$. A two-parameter prototype form $y = g(x, a, b)$ is determined as implicit function by the equation of circle with center at a point (a, b) . It is clear that the osculating circle for $f(x)$ at point x_0 satisfies the following system of equations:

$$\left\{ \begin{array}{l} (x-a)^2 + (y-b)^2 = (x_0-a)^2 + (f(x_0)-b)^2, \\ \left. \frac{dy}{dx} \right|_{x_0} = f'(x_0), \\ \left. \frac{d^2y}{dx^2} \right|_{x_0} = f''(x_0). \end{array} \right.$$

Evidently, this system reduces to

$$\begin{cases} -\frac{x_0 - a}{f(x_0) - b} = f'(x_0), \\ -\frac{(f(x_0) - b)^2 + (x_0 - a)^2}{(f(x_0) - b)^3} = f''(x_0). \end{cases}$$

From this system, without explicit solving for parameters a, b , it is easy to obtain the expression for the radius of the osculating circle:

$$R = [(x_0 - a)^2 + (f(x_0) - b)^2]^{1/2} = \frac{[1 + (f'(x_0))^2]^{3/2}}{|f''(x_0)|}.$$

The value R is the *radius of curvature*; and the inverse value, $\kappa = 1/R$, is the *curvature* of function $f(x)$ at point x_0 .

With regard to production functions and utility functions possessing CRS, the calculation of the curvature is naturally done on the basis of extensive form. Since the curvature has no CRS, transition to intensive form would give no advantage.

As an example, we will derive the formula mentioned in Section 1. It is the formula for the curvature of an isoquant of the Cobb-Douglas production function $F(K, L) = AK^\alpha L^{1-\alpha}$, where $A > 0$, $\alpha \in (0, 1)$. On an isoquant: $K^\alpha L^{1-\alpha} = C = \text{const}$. We find

$$L = C^{\frac{1}{1-\alpha}} K^{\frac{\alpha}{\alpha-1}}, \quad L' = C^{\frac{1}{1-\alpha}} \cdot \frac{\alpha}{\alpha-1} \cdot K^{\frac{1}{\alpha-1}}, \quad L'' = C^{\frac{1}{1-\alpha}} \cdot \frac{\alpha}{(\alpha-1)^2} \cdot K^{\frac{2-\alpha}{\alpha-1}}.$$

Substituting C for $K^\alpha L^{1-\alpha}$, we get

$$L' = \frac{\alpha}{\alpha-1} \cdot \frac{L}{K}, \quad L'' = \frac{\alpha}{(\alpha-1)^2} \cdot \frac{L}{K^2}.$$

The curvature at a point (K, L) equals

$$\kappa = \frac{|L''|}{(1 + (L')^2)^{\frac{3}{2}}} = \frac{\frac{\alpha}{(1-\alpha)^2} \cdot \frac{L}{K^2}}{\left(1 + \frac{\alpha^2}{(1-\alpha)^2} \cdot \frac{L^2}{K^2}\right)^{\frac{3}{2}}} = \frac{\alpha(1-\alpha)KL}{[\alpha^2 L^2 + (1-\alpha)^2 K^2]^{\frac{3}{2}}}.$$

3. THE USAGE OF THE COBB-DOUGLAS PROTOTYPE FORM

Now let us consider a function in its intensive form, $f(x)$. Let us use as prototype form the power function $g(x, A, \alpha) = Ax^\alpha$ with two parameters, $A > 0$, $0 < \alpha < 1$. Recall that this functional form is widely used in economics as the intensive form of the Cobb-Douglas function⁴. Given $f(x_0)$, $f'(x_0)$, system (4) turns into the following system of equations with unknowns A and α :

⁴ The function Ax^α is often referred as CRRA (constant relative risk aversion) function.

$$\begin{cases} Ax^\alpha = f(x_0) \\ A\alpha x^{\alpha-1} = f'(x_0) \end{cases}.$$

Solving this system, we find $\alpha = \varepsilon_f(x_0)$, $A = f(x_0)x_0^{-\varepsilon_f(x_0)}$. Hence the osculating function generated by the prototype form g is

$$y = f(x_0) \left(\frac{x}{x_0} \right)^{\varepsilon_f(x_0)}. \quad (5)$$

Condition $\alpha < 1$ implies the inelasticity: $\varepsilon_f(x_0) < 1$ ⁵.

THEOREM 1. *Three following statements are equivalent:*

- 1) *The curvature of the osculation function (5) at point x_0 is higher (lower) than the function's f curvature;*
- 2) *Elasticity ε_f is increasing (decreasing) at point x_0 ;*
- 3) *At point x_0 the following inequality holds, which links the elasticity and the Arrow-Pratt coefficient:*

$$1 - r_f - \varepsilon_f > (<) 0. \quad (6)$$

Proof: See the Appendix.

Conditions like (6) recently appeared in economic literature. E.g., Mrázová and Neary (2013), when analyzing behavior of firms, introduce a notion of so called superconvex function which is defined in a similar way to $1 - r_f - \varepsilon_f \leq 0$. Levine (2012) in a framework of analysis of production chains defines a so called moderately concave function as satisfying the inequality similar to $1 - r_f - \varepsilon_f \geq 0$.

In case of coinciding curvatures (or second derivatives, or Arrow-Pratt coefficients) at point x_0 , the comparison of the osculating curves should be continued with usage of the third derivative⁶.

THEOREM 2. *If the curvatures of the osculating functions (5) and $f(x)$ at point x_0 are the same then the following three statements are equivalent:*

- 1) *At point x_0 the inequality for the third derivatives holds: $f''' > (<) g'''$;*
- 2) *At point x_0 the inequality which connects the Arrow-Pratt and the prudence coefficients holds:*

$$r_{f'} - r_f - 1 > (<) 0; \quad (7)$$

- 3) *At point x_0 the Arrow-Pratt coefficient r_f increases (decreases).*

Proof: See the Appendix.

⁵ A general sufficient condition for the inelasticity is provided by Lemma 3.

⁶ In geometry one uses characteristics of curves $y = f(x)$, such as the aberrancy (a measure of non-circularity of a curve), which, given x_0 , $f(x_0)$, $f'(x_0)$, $f''(x_0)$, is a monotonic function of $f'''(x_0)$ (see, e.g., Schot 1978; Gordon 2005).

4. THE USAGE OF THE CES PROTOTYPE FORM

Now let us use as prototype form the intensive form of the CES function,

$g(x, A, \alpha, p) = A(\alpha x^p + \beta)^{\frac{1}{p}}$, where $\beta = 1 - \alpha$, with three parameters:
 $A > 0, 0 < \alpha < 1, p \in (-\infty, 0) \cup (0, 1)$. Let $f(x_0), f'(x_0), f''(x_0)$ be given at point x_0 .

The system (4) turns into the system of equations with unknowns A, α and p :

$$\begin{cases} A(\alpha x_0^p + \beta)^{\frac{1}{p}} = f(x_0), \\ A(\alpha x_0^p + \beta)^{\frac{1}{p}-1} \alpha x_0^{p-1} = f'(x_0) \\ A(p-1)\alpha\beta x_0^{p-2}(\alpha x_0^p + \beta)^{\frac{1}{p}-2} = f''(x_0) \end{cases}.$$

The solution of the first two equations of the system is a set of the CES functions with various values of p and with parameter α dependent on p ⁷:

$$y = f(x_0) \left(\varepsilon_f(x_0) \left(\frac{x}{x_0} \right)^p + (1 - \varepsilon_f(x_0)) \right). \quad (8)$$

The third equation of the system is nothing else but the identity (2) for production functions possessing CRS (Corollary 2). Since for the CES function $\sigma = 1/(1-p)$, equation (2) implies

$$p = \frac{1 - \varepsilon_f - r_f}{1 - \varepsilon_f}. \quad (9)$$

The osculating function (8) with parameter p defined by (9), has at point x_0 the same values of function and its two variables (as well as the same elasticity, the curvature, and the Arrow-Price index) as function f has. Further, a comparison of the third derivatives of these functions is needed.

THEOREM 3. *If curvatures of the osculating functions f and g are equal at point x_0 , then inequalities $f''' > (<) g'''$ are equivalent to*

$$r_{f'} > (<) 1 + r_f + \left(1 - \frac{r_f}{1 - \varepsilon_f} \right) \varepsilon_f \quad (10)$$

at this point.

Proof: See the Appendix.

Theorem 3 provides a more subtle result than Theorem 2. However, note that in the case considered in Theorem 2 the osculating function has $r_f = 1 - \varepsilon_f$; thus, inequalities (10) and (7) are consistent with each other.

⁷ Such functions as (8) are known as normalized CES functions (see Klump and de La Grandville 2000; Klump et al. 2012).

5. EXAMPLE: CLOSED ECONOMY WITH A NON-HOMOTHETIC PRODUCTION FUNCTION

As an example enlightening the role of the relations between the elasticity, the Arrow-Pratt coefficient of relative risk aversion and the coefficient of relative prudence in a non-stochastic context, let us consider a simple macroeconomic model.

Production is described by the following separable production function generalizing the Cobb-Douglas function:

$$Y = F(K, L) = f(K)h(L). \quad (11)$$

Here Y is output, K is capital, L is labor; the functions $f(\cdot)$ and $h(\cdot)$ are defined and positive on some rays, $(\bar{K}, +\infty)$ and $(\bar{L}, +\infty)$; and $f'(\cdot) > 0$, $f''(\cdot) < 0$, $h'(\cdot) > 0$, $h''(\cdot) < 0$.

In a closed economy, under the assumption of perfect competition and a no-depreciation condition, all feasible bunches of production factors, (K, L) , have to satisfy the familiar balance identity

$$Y = F(K, L) = \frac{\partial F}{\partial K} K + \frac{\partial F}{\partial L} L; \quad (12)$$

and $r = \frac{\partial F}{\partial K}$, $w = \frac{\partial F}{\partial L}$ are the factor prices. If the function $F(K, L)$ is linearly homogeneous (CRS) then (12) follows automatically from the Euler theorem. In the general case (11), equation (12) is not automatically satisfied.

Equation (12) is equivalent to

$$\varepsilon_f(K) + \varepsilon_h(L) = 1, \quad (13)$$

where $\varepsilon_f(\cdot)$, $\varepsilon_h(\cdot)$ are the elasticities of functions $f(\cdot)$ and $h(\cdot)$, correspondingly. Equation (13) describes the curve such that, under perfect competition, the economy is not able to operate in any points (K, L) except the points of the curve (13)⁸.

The model allows to predict structural changes in the economy. The key question of development of the economy with production function (13) is the following: will the growth of capital be accompanied by the growth of labor because of involvement of people who previously were not in labor force or were unemployed, and because of migrants (so called *extensive growth*), or, on the contrary, the growth of capital will be accompanied by disengagement of labor (*intensive growth*)?

When the curve (13) exists, this question is reduced to the following: does this curve have a positive slope (the production factors are complements) or a negative slope (the production factors are substitutes)? The answer to this question is based on relations between the elasticities and the Arrow-Pratt relative risk aversion coefficients for functions f and h .

PROPOSITION 2. *The curve (13) has positive (negative) slope at point (K, L) , i.e. $\frac{dL}{dK} > (<) 0$, if and only if*

$$(1 - \varepsilon_f - r_f)(1 - \varepsilon_h - r_h) < (>) 0. \quad (14)$$

Proof: See the Appendix.

⁸ In some sense, it is similar to the case of Leontief technology in which the economy can operate without any losses only on a certain ray in space (K, L) .

By use of (2), the inequality (14) can be written in terms of the elasticities of substitution as

$$(\sigma_f - 1)(\sigma_h - 1) < (>) 0.$$

The other question is whether the amount of labor used in production increases or decreases when the amount of capital increases. In other words, is the curve (13) convex downwards or convex upwards?

PROPOSITION 3. *The curve (13) is convex downwards (convex upwards) at point (K, L) if and only if the following inequalities are fulfilled⁹:*

$$\begin{aligned} 2\varepsilon_f + 2r_f - 2\varepsilon_f^2 - 3\varepsilon_f r_f - r_f r_{f'} &\leq (\geq) 0, \\ 2\varepsilon_h + 2r_h - 2\varepsilon_h^2 - 3\varepsilon_h r_h - r_h r_{h'} &\leq (\geq) 0, \end{aligned}$$

Proof: See the Appendix.

As an example, let us consider the production function of type (11):

$$Y = F(K, L) = \ln K \ln L,$$

where $K > 1$, $L > 1$. It is easy to calculate $\varepsilon_f = 1/\ln K$, $\varepsilon_h = 1/\ln L$, $r_f = r_h = 1$, $r_{f'} = r_{h'} = 2$. The inequality (14) takes the form $1/(\ln K \ln L) > 0$; and the inequalities in Proposition 3 are, correspondingly, $-1/\ln K - 2/(\ln K)^2 < 0$ and $-1/\ln L - 2/(\ln L)^2 < 0$. These inequalities imply that the curve (13) has negative slope and is strictly convex downwards. Correspondingly, increase in capital is accompanied in a long run by decrease in employment. If $K \rightarrow +\infty$, then, by (13), $L \rightarrow e$. Hence, if the labor force in this economy is L_0 then the long-run unemployment rate is $(1 - e/L_0)$.

6. CONCLUSION

The concept of elasticity of substitution plays an important place in economic theory.

Many economists find useful to link this concept with the geometric concept of curvature, despite no formal relation was found. De La Grandville (1998) argues that “there is no link between curvature and the elasticity of substitution”. A new trend, which appeared in economic research recently, is the active usage of the formal constructions of the Arrow-Pratt relative risk aversion coefficient and the coefficient of relative prudence as characteristics of utility functions and production functions even in non-stochastic framework. These coefficients are also claimed to have relation to curvature.

In the present paper we clarify links between the concept of curvature and concepts of the elasticity of substitution, the elasticity, the Arrow-Pratt relative risk aversion coefficient and the coefficient of relative prudence. We show that these notions relate to the same geometric construction. To explain it we suggest a simple approach based on notions of prototype forms and osculating curves.

Different types of functions/curves can be used as prototype forms. If the prototype form corresponds to a circle, we come to the classic geometric concept of curvature. If the prototype form is the power function (what is the same as the intensive form of the Cobb-Douglas function or the CRRRA function) or the CES function then we come to expressions containing the Arrow-Pratt coefficient of relative risk aversion and the coefficient of relative prudence. The CES function in such case, naturally provides also a value of elasticity of substitution as an important characteristic closely connected with other characteristics of the production function or utility function. Equation

⁹ Similar pairs of strict inequalities provide necessary and sufficient conditions of strict convexity downwards (upwards).

(2) links the elasticity of substitution, the elasticity, and the Arrow-Pratt coefficient of relative risk aversion.

Thus, the geometric curvature and the elasticity of substitution relate to different types of prototype functions. Moreover, the curvature is calculated by use of the extensive form of function, while other concepts under consideration can be defined by use of either intensive or extensive forms.

We provide three theorems which describe precise relations between these concepts. From the works by Mrázová and Neary (2013) and Levine (2012) it is clear that such kind of relations can play an important role in economic analysis. To enlighten further this role we provide an example of simple macroeconomic model based on a separable production function which generalizes the Cobb-Douglas function.

LITERATURE

- Andersen, T.M. and Bhattachary, J. (2013), "Unfunded pensions and endogenous labor supply", *Macroeconomic Dynamics*, Vol. 17, No. 5, pp. 971-997.
- Arrow, K.J. (1965), "The theory of risk aversion", *Aspects of the Theory of Risk Bearing*, Yrjo Jahnsson Lectures. Yrjo Jahnssonin Saatio, Helsinki. Reprinted in: Arrow, K.J. (1971), *Essays in the Theory of Risk Bearing*, Markham Publishing Company, Chicago, pp. 90-109.
- Blanchard, O.J. and Fischer, S. (1989), *Lectures on macroeconomics*, MIT Press, Cambridge.
- Carroll, C.D., and Kimball, M.S. (1996), "On the concavity of the consumption function", *Econometrica*, Vol. 64, No. 4, pp. 981-992.
- Gordon, R.A. (2005), "The aberrancy of plane curves", *Mathematical Gazette*, Vol. 89, No. 516, pp. 424-436.
- Gravelle, H. and Rees, R. (2004), *Microeconomics*, 3rd ed. Pearson Education Limited, Harlow.
- Jehle G.A. and Reny, P.J. (2011), *Advanced microeconomic theory*, 3rd edn., Pearson Education Limited, Harlow.
- Hicks, J.R. (1934), "A reconsideration of the theory of value, Part I", *Economica*, New Series Vol. 1, No. 1, pp. 52-76.
- Kimball, M.S. (1990), "Precautionary saving in the small and in the large", *Econometrica*, Vol. 58, pp. 53-73.
- Klump, R. and La Grandville, O. (2000), "Economic growth and the elasticity of substitution: two theorems and some suggestions", *American Economic Review*, Vol. 90, No. 1, pp. 282-291.
- Klump, R., McAdam, P. and Willman, A. (2012), "The normalized CES production function: Theory and empirics", *Journal of Economic Surveys*, Vol. 26, No. 5, pp. 769-799.
- La Grandville, O. (1997), "Curvature and the elasticity of substitution: Straightening it out", *Journal of Economics*, Vol. 66, No. 1, pp. 23-34.
- Levine, D.K. (2012), "Production chains", *Review of Economic Dynamics* Vol. 15, No 3, pp. 271-282.
- Maggi, M., Magnani, U. and Menegatti, M. (2006), "On the relation between absolute prudence and absolute risk aversion", *Decisions in Economics and Finance*, Vol. 2, No. 2, pp. 155-160.
- Martins, A.P. (2007), "Uninsurable risks: Uncertainty in production, the value of information and price dispersion", *Annals of Economics and Finance*, Vol. 8, No. 2, pp. 341-383.
- Mrázová, M. and Neary, J.P. (2013), "Selection effects with heterogeneous firms", CEPR Discussion Paper, No. DP9288.
- Pratt, J.W.R. (1964), "Risk aversion in the small and in the large", *Econometrica*, Vol. 32, pp. 122-136.
- Schot, S.H. (1978), "Aberrancy: geometry of the third derivative", *Mathematical Magazine*, Vol. 51, No. 5, pp. 259-275.
- Takayama, A. (1993), *Analytical methods in economics*, University of Michigan Press, Ann Arbor.
- Varian, H.R. (1992), *Microeconomic analysis*, 3rd edn., Norton, New York.
- Zhelobodko, E., Kokovin, S., Parenti, M. and Thisse, J.-F. (2012), "Monopolistic competition in general equilibrium: beyond the constant elasticity of substitution", *Econometrica*, Vol. 80, No 6, pp. 2765-2784.

APPENDIX

Proof of Lemma 1. Applying to $f'x/f$ the rules for calculating the elasticity, we immediately obtain

$$\varepsilon_{f'} = \varepsilon_f + 1 - \varepsilon_f = -r_f + 1 - \varepsilon_f.$$

By applying the same rules to $-f''x/f'$, we immediately obtain

$$\varepsilon_{r_f} = -\varepsilon_{f''} - 1 + \varepsilon_{f'} = r_{f'} - 1 - r_f.$$

Q.E.D.

Proof of Lemma 2. Differentiating $F(X_1, X_2) = X_2^\gamma f(x)$, we find

$$\frac{\partial F}{\partial X_1} = X_2^{\gamma-1} f'(x), \quad \frac{\partial F}{\partial X_2} = \gamma X_2^{\gamma-1} f(x) - X_2^{\gamma-2} f'(x) X_1;$$

it follows that,

$$S_{12} = \frac{f(x) - f'(x) \cdot x}{f'(x)} = x \left(\frac{\gamma}{\varepsilon_f} - 1 \right).$$

Q.E.D.

Proof of Proposition 1. Let us consider the inverse, $1/\sigma$, i.e. the elasticity of S_{12} with respect to x . Using the rules for calculating the elasticities, according to the formula (1), we find this elasticity as a combination of elasticities of functions x , $(\gamma - \varepsilon_f)$ and ε_f with respect to x :

$$\begin{aligned} \frac{1}{\sigma} &= 1 - \frac{\varepsilon_f'}{\gamma - \varepsilon_f} x - \frac{\varepsilon_f'}{\varepsilon_f} x = \\ &= 1 - \frac{\varepsilon_f' x \gamma}{(\gamma - \varepsilon_f) \varepsilon_f} = 1 - \frac{\gamma}{\gamma - \varepsilon_f} \varepsilon_{f'}. \end{aligned}$$

Using Lemma 1, we get

$$\sigma = \frac{1}{1 - \frac{\gamma}{\gamma - \varepsilon_f} (-r_f + 1 - \varepsilon_f)} = \frac{\gamma - \varepsilon_f}{(1 - \gamma) \varepsilon_f + r_f}.$$

Q.E.D.

Proof of Lemma 3. The function $f(\cdot)$ is differentiable and strictly convex, hence (see Takayama 1994, p. 57), $f'(x_0)(x - x_0) > f(x) - f(x_0)$ for all $x, x_0 \in (0, +\infty)$, $x \neq x_0$. If $x < x_0$ then

$$f'(x_0) < \frac{f(x) - f(x_0)}{x - x_0}.$$

The R.H.S. decreases in x and converges to $f'(x_0)$ as $x \rightarrow x_0$. Hence, as $x \rightarrow 0$, the R.H.S is strictly greater than $f'(x_0)$; thus, $f'(x_0) < f(x_0)/x_0$ for each $x_0 \in (0, +\infty)$. Q.E.D.

Proof of Theorem 1. Since $f'(x_0) = g'(x_0)$, to compare the curvatures it is sufficient to compare the second derivatives $g''(x_0)$ and $f''(x_0)$. By assumption (3), $f''(x_0) < 0$. The sign of g'' is determined by $(\varepsilon_f - 1)$ which, by assumption, is negative, i.e. $g'' < 0$. Hence, function (5) has higher (lower) curvature than function $f(x)$ if and only if

$$f'' > (<) g'' . \quad (15)$$

But

$$g' = \frac{f(x_0)\varepsilon_f(x_0)}{x_0^{\varepsilon_f(x_0)}} x^{e_f(x_0)-1}, \quad g'' = \frac{f(x_0)\varepsilon_f(x_0)(\varepsilon_f(x_0)-1)}{x_0^{\varepsilon_f(x_0)}} x^{e_f(x_0)-2},$$

Hence, at point x_0 , $g'' = f'(x_0)(\varepsilon_f(x_0)-1)/x_0$, and inequalities (15) are equivalent to the following:

$$\frac{f''(x_0)x_0}{f'(x_0)} > (<) \varepsilon_f - 1$$

which is the same as (6). Thus, the statements 1) and 3) are equivalent.

Lemma 1 implies the equivalence of the statements 2) and 3). Q.E.D.

Proof of Theorem 2. Equality of curvatures means that

$$-r_f(x_0) - \varepsilon_f(x_0) + 1 = 0, \quad (16)$$

Taking (16) into account, we obtain

$$g'''(x_0) = \frac{f(x_0)\varepsilon_f(x_0)(\varepsilon_f(x_0)-1)(\varepsilon_f(x_0)-2)}{x_0^{\varepsilon_f(x_0)}} x^{\varepsilon_f(x_0)-3} = \frac{f''(x_0)}{x_0} (\varepsilon_f - 2).$$

Hence, accounting for the sign of the second derivative, inequalities $f''' > (<) g'''$ are equivalent to $f''(x_0)x_0 / f''(x_0) < (>) \varepsilon_f - 2$, which, recalling (16), is equivalent to (7); thus, the statements 1) and 2) are equivalent.

Lemma 1 implies the equivalence of the statements 2) and 3).

Q.E.D.

Proof of Theorem 3. The third derivative is

$$\begin{aligned} g'''(x_0) &= (p-1)ab[(1-2b)(ax_0^p + b)^{\frac{1}{p}-3} ax_0^{2p-3} + (ax_0^p + b)^{\frac{1}{p}-2} (p-2)x_0^{p-3}] = \\ &= \frac{g''(x_0)}{x_0} \left(-1 - \frac{pax_0^p}{ax_0^p + b} + \frac{(p-1)b}{ax_0^p + b} \right) = \frac{g''(x_0)}{x_0} \left[-1 - \left(1 - \frac{r_f(x_0)}{1 - \varepsilon_f(x_0)} \right) \varepsilon_f(x_0) - r_f(x_0) \right]. \end{aligned}$$

Thus, accounting for the sign of the second derivative, the inequalities $f''' > (<) g'''$ are equivalent to

$$\frac{f'''(x_0)x_0}{f''(x_0)} < (>) -1 - r_f - \left(1 - \frac{r_f(x_0)}{1 - \varepsilon_f(x_0)} \right) \varepsilon_f(x_0)$$

and, well then, (10). Q.E.D.

Proof of Proposition 2. Let us consider the L.H.S. of equation (13) as a function of two variables and apply the implicit function theorem: $dL/dK = -\varepsilon'_f(K)/\varepsilon'_h(L)$. The inequalities $dL/dK > (<)0$ are equivalent to

$$\varepsilon'_f(K)\varepsilon'_h(L) < (>)0; \quad (17)$$

Corollary 1 implies that (17) is equivalent to (14). Q.E.D.

Proof of Proposition 3. For the function in the L.H.S. of (13), $\varepsilon_f(K) + \varepsilon_h(L)$, the Hessian matrix is

$$\mathbf{H} = \begin{pmatrix} \varepsilon''_f(K) & 0 \\ 0 & \varepsilon''_h(L) \end{pmatrix}.$$

This matrix is positive (negative) semidefinite and, correspondingly, the curve (13) is convex downwards (convex upwards) if $\varepsilon''_f(K) \geq (\leq)0$, $\varepsilon''_h(L) \geq (\leq)0$.

By use of the expression for $\varepsilon_{f'}$ obtained in Corollary 1, we calculate

$$\varepsilon''_f(K) = \frac{(1 - r_f(K) - \varepsilon_f(K))(f''(K)f(K) - 2(f'(K))^2) + (1 - r_{f'}(K) + r_f(K))f''f}{f^2},$$

which has the same sign as

$$-\left[(1 - r_f(K) - \varepsilon_f(K)) \left(1 + 2 \frac{\varepsilon_f(K)}{r_f(L)} \right) + (1 - r_{f'}(K) + r_f(K)) \right].$$

Similarly, for $\varepsilon''_h(L)$. This leads to the assertion of the Lemma. Q.E.D.

FACTOR ANALYSIS OF INFORMATION PRODUCTS COMPETITION

EVGENY V. POPOV¹ AND SERGEY V. KULPIN²

ABSTRACT

This paper presents findings of empirical studies in assessment of competitive factors affecting information product sales in the Internet. The authors considered two types of the information product: software and videogames. The authors took data for 15 categories of software. Each category was represented by 30 software products, 15 freeware, and 15 shareware. In addition, the authors analyzed 675 videogames issued for Xbox 360 since the launch of this console in 2005 till 2013.

In case of software, study results show customs take in attention different sets of the competitive factors depending on a price category of the product. The videogames as a product have such a specific competitive factor as a brand of the game. It is realized in sequels creation. The results show the sequels are sold better than original products, but the difference is unimportant when we control for the quality of the product.

Results of this research can be useful for companies related to design and distribution of software and videogames in terms of forming better marketing campaigns for new information products.

KEYWORDS: software; videogames; competitive factors; Internet marketing; sales forecasting.

JEL classification: L81, M31

Received: May 25, 2014 / Accepted: November 30, 2014

1. INTRODUCTION

Modern world cannot exist without the variety of ways for obtaining information offered by information technology markets. Rapid development of computer gadgets, appearance of new mobile devices (communicators, tablet computers) requires IT industry to supply software products for all types of physical platform on a continuous basis.

According to Pricewaterhouse Coopers, in 2013 software product market became the driving force of technological and social innovations with turnover of 255 bln. dollars³. In 2013 turnover at international videogames market reached 93,3 bln. dollars⁴.

¹ Corresponding Member, Professor, Head of Economic Theory Center, Institute of Economics, Ural Branch of Russian Academy of Sciences; Ekaterinburg; Chair of Management Theory and Innovations, Institute of Public Administration and Entrepreneurship, Ural Federal University named after the First President of Russia B. N. Yeltsin; Ekaterinburg; Russia, E-mail:

² Teaching Assistant, Chair of Management Theory and Innovations, Institute of Public Administration and Entrepreneurship, Ural Federal University named after the First President of Russia B. N. Yeltsin; Ekaterinburg; Russia, E-mail: skulpin@yandex.ru

³ "PwC Global 100 Software Leaders: The growing importance of apps and services", available at: http://www.pwc.com/en_GX/gx/technology/publications/global-software-100-leaders/assets/pwc-global-100-software-leaders-2014.pdf (accessed 12 May 2014)

⁴ "Gartner Says Worldwide Video Game Market to Total \$93 Billion in 2013", available at: <http://www.gartner.com/newsroom/id/2614915> (accessed 12 May 2014)

Software is a complex intellectual product distributed mainly on-line via Internet. Modern position at the market is getting less and less trivial as larger share of the market goes to free software. Appearance of such goods is related both with specific features of certain companies' marketing policy and altruistic software engineers developing programs for their own needs and later spreading them in the Internet.

All software products can be subdivided into three categories based on price: paid software, freeware and shareware. The difference between the first and second type is evident: paid products have price higher than zero, free products cost zero. Shareware products are proprietary and allow users use it with some functional limitations during a fixe period (usually 30 days after installation).

Developers prefer shareware so that users can try them and then decide on purchasing. That is the main peculiarity of software market. Okina (2001) points out that information product has empiric nature: you need to try them before actually understanding their value.

Games represent another category of software. They are complex intellectual products featuring almost every type of information: audio, graphic, text, digital and video. Because of complexity, production of most popular video games is extremely expensive and successful product may stimulate its designers to create sequel. Sequel has a kind of an internal game brand – popular trademark. Another option of using brands in videogames industry is to license external brand from different sphere: music, cinema or sport.

2. MAIN EXTERNAL FACTORS INFLUENCING SOFTWARE SALES

Consumers have a set of specific external indicators helping them choose goods. In that respect software market is no different.

When analyzing consumer preferences at software market one might ask whether brand of the manufacturer has any influence on success of a program among the consumers. As Faheem Ahmed and Luiz Fernando Capretz point out, brand strategy is typical for software industry. Many software brands such as Windows, AutoCAD, MATLAB etc. have preserved a large customer audience having successfully captured largest portion of specialized market segments (Ahmed, 2007). John Sacranie (2010) says that the importance of designing software products with one brand for example in videogames sphere grows every year. The main reason behind increasing success of the brand according to Sacranie is the increasing production cost of information products.

In case of freeware and shareware, the situation is much more complicated. Stefan Koch (2005) has formulated hierarchy of users and designers of shareware and freeware. It is extremely complicated for designers to form a brand, as there are so many of them. When we speak of freeware and shareware there is a chance to form a brand of a product, but not of its designer.

Advertising remains one of the main marketing instruments of spreading information about products, including software ones. As Stephen J. Hoch and Young-Won (1986) point out, majority of consumers do not believe advertising promises but consider it useful for making purchase decisions. When we look at software designers use different advertising tools: from placing billboards in megapolices to issuing free demo-versions for users to try a program as Microsoft does. Distributers place computers in shops so that users can try a videogame at once.

Research by Stahl (2006), Maass gives example of using mobile devices for obtaining advertising information about a product right in the shop. Research has demonstrated this instrument to be the most effective at the market of digital and software products.

While looking for a software product every user would first determine which category this product belongs to, that is **software category** defines target market segment of a program.

It must be mentioned that the more experienced the user is the higher requirements he has to software functional. For example average users would not pay attention to functional differences of paid Windows and free Linux choosing the most wide spread software, that is Windows. At

the same time, network specialists prefer Linux and the like as they provide higher stability and security in working with servers.

Expert evaluation and comments from other users influencing consumer decision in purchasing software seem to be the most studies in academic literature. Research by Naveen Ambler and Tung Bui (2007) has shown that freeware with expert evaluation have 90000 downloads more than those without evaluations. The same is with users' comments: software products with comments have 76000 downloads more than those without comments.

Some researchers (Basurou 2003; Eliashberg 1997; Boatwright 2006) view the role of experts or critics from both sides: as means of predicting consumers' expectations and instrument of influencing consumers' preferences.

From the point of view of researchers analyzing **other consumers' evaluation** (Astous 1999; Zhu 2009; Duan 2008; Kowatsch 2009), in a society with growing influence of Internet on people on-line reviews by users are one of the most important sources of information for other consumers.

Network effects have a significant influence on software market dynamic. Katz и Shapiro have identified three types of external network effects: direct, indirect and post-sales service effect (Katz 1985; Popov 2013).

Network effect research is quite well presented in literature. For example, Erik Brynjolfsson and Chris F. Kemerer (1995) analyzed network effect in electronic tables processing software.

As Katz and Shapiro (1994) say, such external network effects have serious influence on the theory of market balance: it might not exist, might be not the only one, or might be quite different from the situation where network effects are absent.

Lee and Mendelson (2008) state that software market has two segments with different customer preferences and positive network effects.

We can say there are many factors influencing popularity of software. When making decision on purchasing software people consider software category, country of manufacture, expert evaluation, customer review as well as date of publication and software distributive data.

3. MAIN EXTERNAL FACTORS INFLUENCING VIDEOGAMES SALES

Genre is one of the most important elements forming consumer demand at videogames market. First, it is related to the fact that tastes differ but at different periods certain genres become sales leaders. Sacranie (2010) mentions that lately first-person shooters have become the most popular. Besides that, Sacranie says that producers can oversaturate the market with certain type of games. An example of this is a series of musical videogames «Guitar Hero», which caused significant growth of sales in musical genre in 2005 but by 2009 analogues games have virtually ended consumer interest to that genre.

Introducing innovations into sequels or games of the same genre have tremendous effect on success of a game. A vivid example of this is arcade game series «Need for speed» which starting from 1994 lead to creation of 20 sequels.

Game platform (console) is one of unique factors for video games market. Videogames designers face difficulties developing new products for several platforms. It is related to the complexity of adapting existing game to another platform. Each manufacturer has its own standards and technologies. All these factors make multi-platform game design very expensive.

Console research was conducted by Japanese scientists Maruyama and Ohkita (2011). Authors point out that increasing number of competing manufacturers and console differentiation characteristics lead to significant growth of exclusive license agreements with videogame manufacturers which in turn leads to increased demand for games fit for certain console. Using this business development strategy Nintendo managed to preserve leadership in the period from 1984 till 1994.

Critics' review is one of the best-studied factors. Most works cover cinema industry and there are virtually none devoted to videogames industry. But it must be mentioned that in terms of critical reviews cinema and videogames markets are almost equivalent. Reviews were studied by

Basurou, Chatterjee, Ravid (2003), Eliashberg and Shugan (1997), Desai and Basurou (2005), Boatwright, Basurou and Kamakura (2007). All of them agree on significant importance of critical reviews for sales of creative products.

Gamers' reviews from the point of view of researchers Feng Zhu and Xiaoquan Zhang (2010), society with rapidly growing influence of Internet on-line reviews from consumers are one of the most important sources of information for other consumers.

Yong Liu mentions that review activity from viewers is much higher during pre-release period and first post-release weeks (Liu, 2006). Viewers' opinion has prognostication type influence on first weeks box-office and total box-office. Duan (2008) states positive interrelation between viewers' opinion and sales where defining factor is not review opinion but again the number of reviews.

Brand of the game is implemented via creation of sequels. Sequel is a continuation of a game (film) based on development of the plot, use of same characters and trademark. To some extent sequel is a reflection of an already created game brand. The more popular the new game is the higher are the chances of creating its continuation in a certain period of time: an image of this series and its reputation is formed in consumers' minds. Designing a sequel is one of the most widely used methods for stimulating sales: according to the IGN.com list of most expected games of 2014 almost 82% of all expected games are sequels.

There is a set of researches aimed at sequels. As John Sacranie (2010) says the importance of designing sequels in game industry is growing every year. The main reason for it is increasing cost of designing a game: manufacturers aim at avoiding risks related to multiple failures of newly created games in recent years. Therefore manufacturers tend to create sequels which gave some guarantees in terms of successful sales. It is easier to predict commercial success of a game if you already have relevant sales data. Weak side of this instrument is related to absence of new ideas which might lead to decline of consumers' interest to this series of games.

Therefore we can name such competitive factors of videogames market as genre, game platform, critical and customer reviews and game brand.

4. MODEL

As we have stated before at software market customer can rely on external factors that fall into the following model:

$$D = f(Cr, Us, Br, Adv, Fun, Comp, S, Y) \quad (1)$$

where D – number of downloads

Cr – critical reviews,

Us – customer reviews,

Br – brand,

Adv – advertising,

Fun – functional,

$Comp$ – competition,

S – distributive scope.

Y – year of manufacture.

In order to present this model for paid and free software we can express dependence between sales (in this research downloads) and factors influencing them as two linear regression equations:

$$S = a_0 + a_1Cr + a_2Us + a_3Br + a_4Adv + a_5Fun + a_6Comp + a_7S + a_8Y + \varepsilon, \quad (2)$$

$$S = b_0 + b_1Cr + b_2Us + b_3Br + b_4Adv + b_5Fun + b_6Comp + b_7S + b_8Y + \varepsilon, \quad (3)$$

The task of this research is to prove that vector of coefficients $(a_0, a_1, \dots, a_n)$ does not equal the vector $(b_0, b_1, \dots, b_n)$. In other words when choosing paid software clients are influenced by one set of external factors and by other set when choosing free software.

To show the difference between sets of external factors we suggest that above mentioned factors have positive influence on popularity (number of downloads). Some factors cannot be tested within this research. For example, it is rather difficult to define software brand for majority of free software products which was mentioned in descriptive part of this research. It is also difficult to evaluate advertising costs product because of the lack of information.

We use similar approach when analyzing videogames. All factors influencing sales of videogames can be shown in a model where sales act as effect variable.

$$S = f(G, Pl, D, Gr, WOM, M, ESRB) \quad (4)$$

where S – sales,

G – genre of the game,

Pl – platform (number of consoles for the game)

D – designer,

Gr – critical reviews,

WOM – gamers' reviews,

M – multiplayer,

$ESRB$ – age rating.

Besides factors described above (genre, platform, designer, reviews from critics and reviews) we also use brand factor. It would be reasonable to subdivide brand into two categories: internal and external. By external brand we mean a game based on a book (for example, «Metro 2033», «The Witcher: Rise of the White Wolf» etc.), film, series or cartoon («James Cameron's Avatar: The Game», «The X-Files Game», «The Simpsons Game» etc.), comics («Lego Batman: The Videogame» etc.) etc., creative work of a singer or group («50 Cent: Blood on the Sand», «Guitar Hero: Aerosmith» etc.), sports team or competition («FIFA» series, etc.). Consumers are willing to buy such games because they have seen the film, listen to this singer or a group or support the team virtual analogue of which participates in one of the games from a sports series.

On the other hand, some customers expect continuation of already created games. This can be caused by different factors: development of a plot, high – quality gameplay (game process), etc. This is internal brand of the game.

Based on abovementioned we can see interdependence between sales and factors influencing them as a linear regression equation:

$$S = a + b_1G + b_2Pl + b_3D + b_4Gr + b_5WOM + b_6M + b_7ESRB + b_8Be + b_9Bi + \varepsilon, \quad (5)$$

where Be – external brand factor,

Bi – internal brand factor sequel),

a – absolute term,

$b_1 \dots b_9$ – coefficient,

ε – error.

5. DATA

As the basis for the research, we took data from download.cnet.com, which is a service for purchasing and downloading majority of existing software. We took data for 15 categories of software. Each category was represented by 30 software products, 15 freeware, 15 shareware. The choice was made from 15 program categories with 30 software products from each category, of which 15 were free and 15 were shareware. The choice was made from a program list from each

category sorted by date of last review or rating publication. Such method of choice allows for obtaining complete set of data on all variables present in regression model. Software included into this database is used at present which excludes outdated or unpopular programs from the analysis. Database attributes are given in the Table 1.

Table 1: Contents of database for software research

No	Variable	Description
1	software	Name of the software
2	pricetype	Type of software according to price
3	cnet_rat	Expert evaluation from cnet.com (critical evaluation)
4	user_rat	Users' evaluation
5	price	Price of software product
6	downloads	Number of downloads on 19.02.2012
7	size	Size of distributive
8	relisdate	Year of publication
9	sphere	category
10	revildownloads	Number of downloads of the closest competitor

We analyzed 675 videogames issued for Xbox 360 since the launch of this console in 2005 till 2013. Sampling includes almost all games created for this platform. The database contains variables presented in Table 2. .

Let's clarify some of them.

Dummy variable Sequel is the main variable in the research. In our case it took the value of 1 if the game fell under one of the following categories: triquel, sequel, midquel, remake, etc. English version of Wikipedia.org was used as the source of information for defining presence of internal brand.

Variable Sales demonstrates how many billions of copies had been sold according to VGCharts.com by May 2014. VGCharts Network is a network of sites devoted to videogames, including VGChartz, gamrFeed, gamrReview, gamrTV and gamrConnect. VGChartz.com is the core of this network and provides information on weekly sales of videogames in each region..

Table 2: Content of database on videogames research

No	Variable	Description
1	Sequel	Dummy variable defining whether the game is sequel (1) or not (0)
2	Sales	Sales (mln. copies of videogame)
3	ExBrand	Dummy variable defining presence of external brand of the game (1 yes, 0 no).
4	Year	Year of issue
5	Critics	Critical evaluation ranging from 0 to 100
6	Genre	Genre of the game
7	GS_amount_us	Number of evaluations from GameSpot.com
8	IGN_amount_us	Number of evaluations from IGN.com users
9	Multiplayer	Dummy variable defining presence of multiplayer: 1 yes, 0 no.
10	ESRB	Age rating
11	Publisher	Videogame publisher
12	Platform	Number of platforms compatible with the game

Variable Critics contains critical evaluation on aggregated data from MetaCritics.com. Evaluation scale is from 0 to 100. This variable is the best proxy for unobserved characteristic – quality of the game.

Variables GS_amount_us and IGN_amount_us show us the number of gamers' evaluation from Gamespot.com and IGN.com respectively. The aim of these variables is to show the level of popularity of the game among users.

Variable ESRB provides information about age rating Entertainment Software Rating Board. ESRB is an NGO engaged in defining age ratings for videogames and other entertainment software in the USA and Canada.

And finally variable *Platform* shows the number of platforms for which the game was issued. As we have mentioned earlier, we analyzed the games issued for the 7th generation of consoles.

6. ANALYSIS OF DATA AND RESULTS OF RESEARCH ON SOFTWARE

In order to test suggested hypotheses we have conducted regressive analysis individually for freeware and paid software. Let's look at several models different in terms of a set of factors included into analysis. Analysis results are given in Tables 3 and 4.

In case of paid software, the largest influence comes from reviews and critical evaluation. This is supported by many researchers mentioned in descriptive part of the article.

Reviews and evaluations from users are also important. Users' reviews can have negative influence on popularity of software.

Positive influence on popularity can also come from popularity of other programs. This supports the fact that software products market is highly competitive and consumers are oriented towards already popular products which leads to network market effects described above.

It was rather unexpected to find out that price factor does not influence customers' preferences when we use complete model. Therefore, we can say that popularity of paid products is influenced only by those factors not related to price.

Analysis demonstrates that neither the year of publication of the game nor its distribution influence its popularity.

Analysis shows that in case of freeware customers are mostly influenced by competing software popularity (networking effect). First of all users pay attention to all possible options of solving their applied problems with the help of different software products. Customers can use both freeware and paid software.

Besides popularity of competing products expert evaluations also have significant influence on the success of freeware. At the same time the influence of other customers' evaluation becomes insignificant compared to paid software.

Influence of date of issue and distributive is insignificant just like in case of paid software.

Table 3: Regression data analysis for paid software

VARIABLES	(1) logdownloads	(2) logdownloads	(3) logdownloads	(4) logdownloads	(5) logdownloads	(6) logdownloads
logprice	0.419** (0.191)	0.388** (0.188)	0.379** (0.187)	0.344* (0.190)	0.347* (0.191)	0.288 (0.190)
cnet_rat2		0.0684*** (0.0251)	0.0793*** (0.0253)	0.0762*** (0.0255)	0.0741*** (0.0259)	0.0757*** (0.0256)
user_rat2			-0.0458** (0.0207)	-0.0468** (0.0207)	-0.0475** (0.0208)	-0.0448** (0.0206)
logsize				0.0799 (0.0846)	0.0767 (0.0850)	0.0617 (0.0842)
relisdate					0.0460 (0.0892)	0.0523 (0.0883)
logrevil						0.189** (0.0789)
sphere	YES	YES	YES	YES	YES	YES
Constant	7.311*** (1.019)	6.080*** (1.100)	6.599*** (1.115)	6.710*** (1.122)	-85.72 (179.3)	-100.9 (177.4)
Observations	225	225	225	225	225	225
R-squared	0.474	0.492	0.504	0.506	0.506	0.520

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Regression data analysis for freeware

VARIABLES	(1) logdownloads	(2) logdownloads	(3) logdownloads	(4) logdownloads	(5) logdownloads
cnet_rat2	0.0455 (0.0284)	0.0553* (0.0290)	0.0544* (0.0293)	0.0540* (0.0295)	0.0525* (0.0289)
user_rat2		-0.0367 (0.0231)	-0.0360 (0.0233)	-0.0364 (0.0235)	-0.0373 (0.0230)
logsize			0.0193 (0.0829)	0.0183 (0.0833)	-0.00543 (0.0819)
relisedate				0.0182 (0.108)	0.0487 (0.106)
logrevil					0.240*** (0.0763)
sphere	YES	YES	YES	YES	YES
Constant	7.293*** (0.772)	7.710*** (0.813)	7.669*** (0.834)	-28.89 (216.6)	-93.62 (213.0)
Observations	225	225	225	225	225
R-squared	0.299	0.307	0.308	0.308	0.340

7. Data analysis and videogames research results

We used regression analysis as the research tool. Table 5 shows results of regression for several models including different set of variables starting from simplest (2 variables) to model with descriptive formula (5).

If model involves effect variable LogSales and variable Sequel, coefficient evaluation supports hypothesis on positive influence of internal brand on sales. When we add other variables situation remains the same until we add variables Critics and LogGSAmount. As seen from the last regression they and variable Platform have the largest influence on sales. Internal brand of the game becomes insignificant.

It leads us to the following conclusion: if we control the variable Critics (in fact, quality of the product) presence of the brand does not stimulate sales. In fact if customer has to choose between two games of comparable quality and one of them is a sequel presence of a trademark would not influence the decision on purchase.

We should explain why regression analysis does not use such a variable as gamers' evaluation. The thing is that gamers can evaluate the game only after buying it. But when making decision on a purchase they consider the factors given in our analysis. Introduction of gamers' evaluation as a variable is unreasonable because of multi-collinearity: evaluation of gamers and critics are strongly correlated which would shift regression coefficients. Analysis uses variable LogGSAmount, as in that case statistics of R-squared at 0,7888 is higher than in the case of using variable LogIGNAmount (0,7828).

As for external brand of the game Table 5 shows that it does not have any influence on sales in any of the models.

Table 5: Regressive data analysis for videogames

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sequel	0.545*** (0.111)	0.545*** (0.112)	0.504*** (0.115)	0.494*** (0.114)	0.527*** (0.117)	0.285** (0.112)	0.261** (0.110)	0.0220 (0.0906)	0.0771 (0.0705)
ExBrand		0.000548 (0.117)	-0.00596 (0.117)	-0.146 (0.130)	0.0667 (0.150)	-0.0760 (0.143)	0.0512 (0.143)	0.0993 (0.117)	0.0317 (0.0908)
Multiplayer			0.212* (0.125)	0.200 (0.125)	0.240* (0.144)	0.261* (0.135)	0.378*** (0.134)	0.158 (0.110)	0.0926 (0.0857)
Platform				0.112** (0.0461)	0.106** (0.0484)	0.153*** (0.0471)	0.219*** (0.0483)	0.218*** (0.0393)	0.216*** (0.0306)
Genre dummies					YES	YES	YES	YES	YES
Publisher dummies						YES	YES	YES	YES
ESRB dummies							YES	YES	YES
Critics								0.0502*** (0.00334)	0.0174*** (0.00323)
LogGSAmount									0.552*** (0.0324)
Constant	-1.499*** (0.0865)	-1.499*** (0.0918)	-1.626*** (0.119)	-1.838*** (0.147)	-2.219*** (0.226)	-1.326*** (0.436)	-1.308*** (0.430)	-4.883*** (0.423)	-6.894*** (0.350)
Observations	675	675	675	675	675	675	675	675	675
R-squared	0.043	0.043	0.048	0.059	0.146	0.444	0.470	0.650	0.789

Standard errors are indicated in parentheses

*** p<0.01, ** p<0.05, * p<0.1

8. CONCLUSION

This paper presents findings of empirical studies in assessment of competitive factors affecting information product sales in the Internet. The author considered two types of the information product: software and videogames.

Firstly, the authors aimed at demonstrating the difference between free and paid software from the point of view of factors influencing their popularity. Research results show that consumers are influenced by different sets of factors depending on price category of software products.

In case of paid software, consumers are mainly influenced by expert evaluations of certain product. This can be explained by the fact that consumers are afraid of incurring material and emotional damage when choosing the product that does not meet all requirements. Therefore consumers tend to listen to experts who have certain knowledge in the given sphere and experience of working with necessary software. Users' evaluation and popularity of competing programs are also important factors.

It is worth mentioning that the price of paid software doesn't have considerable influence on customers' choice.

As for free software, users are influenced by popularity of competing software which can be explained by several reasons. First, there is almost no risk of incurring financial loss. Consumers tend to consider their own opinion and specific needs. Still expert evaluation factor remains important.

While researching videogames market we have received the following results: when looking at multi-factor model neither internal nor external brands have any influence on sales. If we take expert evaluation and users' comments out of equation internal brand becomes one of the most important factors influencing sales.

We have found out that with every year manufacturers tend to issue more and more sequels. It happens not because each sequel can boost sales but because sequels decrease risks incurred by producers. Internal brand of the game acts as security for the issuing company. It also decreases production costs as sequels have similar technology.

Results of this research can be useful for companies related to design and distribution of software and videogames in terms of forming better marketing campaigns for new information products.

This research is not ideal and as any other has several limitations. Firstly, presented linear regression models are not irrefragable. As regression test shows it is necessary to add missing internal and external factors influencing consumers' preferences. Secondly, research is subjective as work with data required using personal experience and intuition as different sources give different data on some software. Yet this research can be elaborated further and used in future research projects.

REFERENCES

- Ahmed, F. (2007), "Managing the business of software product line: An empirical investigation of key business factors", *Information and Software Technology*, Vol. 49, pp. 194-208.
- Amblee, N. and Bui, T. (2007), "Freeware Downloads: An Empirical Investigation Into the Impact of Expert and User Reviews On Demand for Digital Goods", in *AMCIS 2007 Proceedings*, Paper 21, available at: <http://aisel.aisnet.org/amcis2007/21> (accessed 16 May 2014).
- Astous, A. (1999), "Consumer Evaluation of movies on the Basis of critics' judgments", *Psychology & Marketing*, Vol. 16 N 8, pp. 677-694.
- Basurou, S., Chatterjee, S., Ravid, S. A. (2003), "How critical are critical reviews: The box office effects of film critics, star power, and budgets", *Journal of Marketing*, Vol. 67, pp. 103-117.
- Boatwright, P., Basurou, S., Kamakura, W. (2007), "Reviewing the reviewers: The impact of individual film critics on box office performance", *Quant Market Econ*, Vol. 5, pp. 401-425.
- Brynjolfsson, E. and Kemerer, C.F. (1995), "Network Externalities in Microcomputer Software: An Econometric Analysis of the Spreadsheet Market", *Management Science*, Vol. 42 N. 12, pp. 1627-1647.
- Popov, E.V. (2013), "Transactions & Institutions", *Montenegrin Journal of Economics*, Vol. 8 No2, pp. 115-123.

- Desai, K. K. and Basurou, S. (2005), "Interactive influence of genre familiarity, star power, and critic's reviews in the cultural goods industry: the case of motion pictures", *Psychology and Marketing*, Vol. 22(3), pp. 203-233.
- Duan, W., Gu, B., Whinston, A. B. (2008), "The dynamics of online Word-of-Mouth and product sales – An Empirical investigation of the movie industry", *J. Retailing*, Vol. 84, pp. 233-242.
- Eliashberg, J. and Shugan, S. M. (1997), "Film Critics: Influencers or Predictors?", *Journal of Marketing*, Vol. 61, pp. 68-78.
- "Gartner Says Worldwide Video Game Market to Total \$93 Billion in 2013", available at: <http://www.gartner.com/newsroom/id/2614915> (accessed 15 April 2014)
- Hoch, S.J. and Ha, Y.-W. (1986), "Consumer Learning: Advertising and the Ambiguity of Product Experience", *The Journal of Consumer Research*, Vol. 13, pp. 221-223.
- Katz, M. L. (1985), "Network externalities, competition, and compatibility", *The American Economic Review*, Vol. 75 N 3, pp. 424-440.
- Katz, M. L. and Shapiro, C. (1994), "Systems competition and network externalities", *Journal of Economic Perspectives*, Vol. 8, pp. 93-115.
- Koch, S. (2005), "Free/open Source Software Development", available at: [http://inethub.olvi.net.ua/ftp/Library/DVD-011/Koch_S._Free\[s\]Open_Sourse_Software_Development_\(2005\)\(en\)\(309s\).pdf#page=76](http://inethub.olvi.net.ua/ftp/Library/DVD-011/Koch_S._Free[s]Open_Sourse_Software_Development_(2005)(en)(309s).pdf#page=76) (accessed 29 May 2014).
- Kowatsch, T. (2009), "The use of free and paid digital product reviews on mobile devices in in-store purchase situations", in *Proceedings of 4th Mediterranean Conference on Information Systems MCIS in Athens, Greece*, pp. 12-18.
- Lee, D. and Mendelson H. (2008), "Divide and conquer: Competing with free technology under network effects", *Production and Operations Management*, Vol. 17 N 1, pp. 12-28.
- Liu, Y. (2006), "Word of Mouth for Movies: Its Dynamics and Impact on Box Office Revenue", *Journal of Marketing*, Vol. 70, pp. 74-89.
- Maruyama, M. and Ohkita, K. (2011), "Platform Strategy of video game software in Japan, 1984-1994: Theory and Evidence", *Managerial and Decision Economics*, Vol. 32 Issue 2, pp. 105-118.
- Okina, K. (2001), *Monetary Policy in a World of Knowledge-Based Growth, Quality Change and Uncertain Measurement*, Palgrave, New York, NY.
- "PwC Global 100 Software Leaders: The growing importance of apps and service", available at: http://www.pwc.com/en_GX/gx/technology/publications/global-software-100-leaders/assets/pwc-global-100-software-leaders-2014.pdf (accessed 28 April 2014).
- Sacranie, J. (2010), "Consumer Perceptions & Video Game Sales: A Meeting of the Minds", *The Park Place Economist*, Vol. 18, pp. 48-53.
- Stahl, F. and Maass, W. (2006), "Adoption and Diffusion of Digital Information Goods: An Empirical Analysis of the German Paid Content Market", *Electronic Markets*, Vol. 16 No 3, pp. 233-244.
- Zhu F. and Zhang X. (2010). "Impact of online consumer reviews on sales: The moderating role of product and consumer characteristics", *Journal of Marketing*, Vol. 74, pp. 133-148.

NEOLIBERAL RHETORIC AS A METAPHOR FOR QUASI-INSTITUTIONAL MONISM

VESELIN DRASKOVIC¹ and MILICA DELIBASIC²

ABSTRACT

After more than a decade of writing and critical analysis of neoliberalism, which resulted from a negative attitude towards the serious consequences that has produced in practice, We decided to try to explain its metaphorical essence. It is necessary, at least from a short historical distance, to examine individual opinions, conclusions and critics. We think that term neoliberalism has been incomplete, because it contains a significant metaphorical level. Therefore it can not be easily defined, especially not by using unilateral interpretation, according to which it represents imposed market entry in the specific context of public policy.

The aim of this manuscript is to point out:

- neoliberal causes of the permanent and crisis transition, which caused major problems and deformities, and created a new dogma with uncertain lifetime,*
- inadequate civilizational environment (in Huntington's definition), etatistic tradition (in Berdyaev's definition) and the creation of a quasi-institutional conditions that have enabled the introduction of new elitist (to a certain extent and sense of totalitarian) system under the mask of neoliberalism,*
- the fact that forcing of quasi-neoliberalism is a privilege of unreasonable and/or highly interest oriented „reformists“, because delaying changes means delaying development,*
- the difference between rhetoric and practice, ie. between the story of liberal democracy (which promotes the rights of individuals, human and social freedoms and human rights, as opposed to collectivism, totalitarianism and authoritarian policies) and quasi-neoliberal economic policies (global and transitional), that were dominant worldwide and paradoxically violates all liberal principles,*
- the use of state as a screen for expressing expansive nomenclature interests and non-market appropriation of its significant resources.*

In this manuscript We have marked neoliberalism as We perceive it: as a metaphor (or, metaphore) for multiple scam of the population. This text is an attempt to, with arguments of alternative choices and institutional pluralism, relativizes neoliberal apsolutism, and with argument of historical analogy to express the faith in terminating all empires and absurdity of human endeavor to conquer the world.

We start from the hypothesis that the quasi-neoliberalism in particular events (monism, privileges, dictation, etc.) resembles the elitist dirigisme.

KEY WORDS: *Neoliberalism, Quasi-neoliberalism, Transition, Quasi-neoliberal Economic Policies, Non-market Appropriation.*

JEL classification: P21; P37;

Received: February 25, 2014 / Accepted: September 12, 2014

¹ Professor, Head of doctoral studies at the study program Management in Maritime, University of Montenegro, Maritime Faculty of Kotor, Montenegro, e-mail: veso-mimo@t-com.me

² Postgraduate Student, International University of Travnik, Bosnia and Herzegovina, E-mail: 23.mildel@gmail.com

1. INTRODUCTION

The development paradigm with particular criteria and values has existed in all historical periods of the society. Development has always had a contradictory character, because order and chaos have never existed in a pure form, but in different combination, with domination of one form or the other. They were mutually interdependent and dependent in their intertwining. The dominance level of order or chaos in society was determined by the extent of the crisis in general and in specific areas, and consequently by the rate of development. One of the most important and the strongest driving forces of modern civilization is a connectivity, causality and dependence of the market economy (which basically contains private enterprise), of the technological progress and of the institutionally developed and of the flexible government regulation.

We live in a time that according to the perception of many authors, neoliberalism (as an ideology, doctrine, philosophy, theory and metaphor) in global and local boundaries *manifests* itself as an immoral, inhumane, brutal, chaotic, crisis and hegemonic system (order) of power, governance, violence, exploitation and greed. This is the time when everything is relativized, thanks to neoliberalism, paradoxically and ironically, due to interests and rhetorical absolutism of freedom and market. An alibi-neoliberals are placed in the position of neoliberal metaphor! It seems like amorphous, monotonous, orchestrated anti-state, anti-national and anti-development bluff, rooted in a patronizing state levers! L. Althusser (1970) has made a distinction between the state's repressive apparatus and the ideological state apparatus. The repressive apparatus is palpable and is applied in public bodies (police, judiciary, army, government administration). Ideological state apparatus is invisible and keeps the society together. It points out their interdependence. Ideology is a social process, which operates through certain segments of the society (church, family, education, politics, unions, media).

Nothing new, though! Economic science has often led a double life (in theory and in practice) during its development. Here is a follow-up statement by M. Kovacevic (2012): *„In these turbulent times, the issue of economic reforms and policies was relinquished to a group of economists of very modest knowledge and they were assigned to departments, or areas they had never been studying in their professional careers!“*

A new time requires new ways of thinking and behaving. It should be reduced to the adaptation towards civilizational achievements for active involvement in the contemporary processes and flows. This essay is an attempt to provide its own view of the neoliberal metaphor as a serious social challenge, and the response to that challenge. The task of economists is not only to provide answers to theoretical questions, but to objectively, ideologically, neutrally and critically analyze the economic theory and its application in economic reality, as well as explanation of the methods and factors that have contributed for the nations of post-socialist countries to quickly break up with everything (or almost everything) what they were worshipping for decades, and to expiate (many nostalgically) because of it today.

We intention was not to advocate a return to the old system. We guess it is quite clear that socialism was not effective, therefore its crisis had initiated the process of transition, *„changes in the value system had coincided with the economic necessity“* (I. Naisbitt).

Before the current global crisis D. Rodrik et al. (2004) concluded that the time of neoliberalism and the Washington Consensus (hereinafter: W.C.) is finished, and offered alternatives (what should be done after neoliberalism). Later, he formulated this idea in his article (2006) as follows: *„Proponents and critics agree that the measures inspired by W.C. did not give desired results. Therefore, current debate is not about whether W.C. is dead or alive, but what will replace it.“* The alleged "creator" of neoliberalism, J. Williamson, after the outbreak of the global economic crisis, said that it was a mistake. But as much as it was a mistake (yes, it is a mistake and a sin), it still lives. Not only in memories, not only in the abstract and inconsistent writings (interest-motivated) proponents and (futile) critics, but also in the everyday events of social and economic reality: inequality, poverty, exploitation, etc.. It lived before its new nomination, it lives and will live, but probably in some other forms and names. How and why?

The answer suggest words from the speech of N. Chomsky at the Rome Science Festival 2014, where he presented his new book „Masters of Mankind 1969-2013“. He said that technocratic and financial oligarchy rules the world, that European democracy is dying, because the policy only serves for bankers and bureaucrats to make profit and become richer. In addition, he said the following: *„Our societies are moving towards plutocracy, which is the main objective of neoliberalism. Numbers from the British Association of Oxfam are frightening - 85 richest people in the world have the same wealth as 3.5 billion of poor. This is the biggest attack on the world's population for the last 40 years ... it is just as important as the wealth that flows into the pockets of 1 % of those who are at the top, those who decide on world politics.“*

These words provoke memories of numerous works on neoliberalism (*pro et contra*). But perhaps the most striking statement was of Russian writer and historian N. Karamzin. When he arrived in Paris at the beginning of the 19th century, Russian immigrants greeted him at the train station and asked what was new in their country. He briefly replied: „Robbery!“ He was referring to unscrupulous plunder of those people who were high in the hierarchy. History is repeating in some things. Today, there is a strong awareness (and certificates) of the thefts, corruption and many other system abuses, which make social pathology of the society(s).

The latest Chomsky's oration, as well as Karamzin's statement, could have been an inspiration for writing this manuscript. But it is not. My motive is an old idea, to be jointly published and compared to a number of other and my own views, which has been partially published in various scientific papers and journals in recent decades. And to try to devise an objective story about subjective discussions on neoliberalism and its controversies, paradoxes, myths, reviews, approvals and contradictions, that were dominated, as it seems - by the antinomy and multivoice. So that this story would not be just a critique of a paradoxical, contradictory, crisis and longterm process (which does not flinch) with poor results, but a reminder and a landmark in the struggle for loudly proclaimed freedom, democracy, institutionalization and a some better, more just, more humane and more developed society.

The reason for writing this manuscript is not just analysis, explanation and critique of neoliberalism and its forms, but also the cause of its evolution towards vulgarized quasi-neoliberal model. The aim is to point to the existence and functioning of the vicious circle of crisis (global and transitional), created by the following relation: theoretical neoliberalism³ as an institutional monism - its vulgarization, dogmatization and subjectivity in practice - through manifestation of freedom of operation and connectivity of supranational and national elites - tycoonisation and the criminalization of the economy and society - reproduction of the crisis. Mentioned relation has been maintained by paradoxical contradictory between rhetoric of universalism (pluralism) and its practical reductionism (quasi - monism).

In our previous works We have repeatedly marked the holders of neoliberalism, quoting their grotesque thoughts and analyzing the detrimental effects in applying this model in transitional countries. Therefore, this article is not written to point out the culprits or their recognition (I realized that was useless long time ago), but only the phenomenological and ontological critique of quasi-institutional monism and advocating the institutional pluralism, which I believe is civilizational and development imperative.

We did not want to cite some orchestrated views of „neoliberals“, who are known, more or less. I thought it would be enough to name their arbitrary and dubious unsubstantiated opinions a common term: neoliberal rhetorics, dogma, apologetics, demagoguery, clocklotrism and, of course, a metaphor.

³ Liberalism has evolved from large scientific and intellectual doctrine to narrow ideological apologetics of the specific policies, which was (and still is) implemented in the interests of certain social groups. Losing touch with its scientific basis, ideology always called upon to it, declaring its continuity. Modern neoliberals are doing the same thing: referring to the tradition of the great thinkers of the past, ignoring the fact that they have gained fame in the struggle against feudal tyranny and absolutism, fighting for human rights, the constitution and civil freedom. In neoliberalism little remains of classical liberalism, even less could be said about the quasi-neoliberals and their dominant interest motives.

It is irrelevant for this article who, when, how, why and what has some „neoliberal“ once said or wrote. It is important that neoliberalism has continuously served as a metaphor! Another reason for avoiding so many neoliberal ideas, is that no neoliberal have never responded to my criticism and the questions that I have openly and publicly addressed to them, on several occasions. Naturally, some of those questions will be analyzed in this text again. However, I must mention two typical, too recognizable and often repeated regional neoliberal „pearls,“ which are distinguished by their non-scientific, tendentious, demagogic, declarative and defensive apologetics. They were published at various places and in various occasions, by authors from various countries in the region. I do not know if they were agreed, copied or just suspiciously and accidentally similar?

They emphasize that there is (in those countries i.e. just locally) alleged „ideological struggle between liberalism and protectionism, liberals and dirigisme“! Imagine that metaphysical simplification! As if there is any struggle and as if in that „struggle of opinions“ wins or decides one or the other? As if there is no battle of ideas among wellknown authors and developed countries? Existing in quasi-monistic, quasi-institutional, anti-developing and high interest circle of frauds, metaphors and „meta-phors“, so-called neoliberals seem not to notice the possibility of existing institutional pluralism featured in developed countries and economies?! Their view is purely monistic (out of habit, need and interest), through black-and-white prism. Therefore they see only liberals and dirigists! That is why at conferences they were always bothered by the term „mixed economy“, which was just a symbol of institutional pluralism. Blinded by privileged and exclusive individualism, they (intentionally) fail to recognize the logical and civil need for mass of effective owners, for rational and motivated individuals, nor enormous inequality and expansion of the crisis, caused by quasi-neoliberalism.

2. NEOLIBERAL EXPERIMENT

Globalization and transition have lost their universality and integrity, and therefore the confidence of the masses in positive outcome. That's why We wrote that globalization (some call it „filthy globalization“) should be globalized, and the transition should be reformed.

In most countries of transition reforms have been palliative and unsuccessful. Predictions and promises to improve the living conditions, freedom⁷ and economic development have not been realized. Delayed socio-economic processes and long-term reproduction of crises are accompanied by growing criminalization of society, negative selection of staff, ignoring knowledge and education, more debts, unemployment, dogmatism, destructiveness, instability, chaos, and many other negative phenomena and trends. Many authors believe that their quasi-institutionalization is common denominator, but neoliberalism is theological and ideological⁸ basis and fundamental cause. There is a difference between theoretical stronghold of neoliberalism and real practices and economic policies, where the theoretical model has been vulgarized by application of double standards, initiated by interest motives of the „reformers.“

Most of the counties in transition, particularly the Balkan countries, are characterized with deep post-socialist problems, deformations, and disproportions, which have been deepened and complicated even more by global economic crisis. These consequences are results of erroneous economic policies and nonexistence of consistent developmental strategy and they also represent the focus of threatening crisis. Certain decision makers of economic policies, in the midst of unprecedented state interventions, are glorifying neo-liberalism (thanks to which and on which waves they most probably came to power). They are forgetting that significant donations from abroad, direct foreign investments and loans are not the result of neo-liberal economic successes but of a concrete politics of the West towards the region (V. Draskovic, B. Yernkryan, and M. Draskovic 2014, p. 114). As for economic development of the Balkan region, it is based on permanent discrepancy between rhetoric on pluralistic institutional changes and monistic implementation of neo-liberal recipes of macroeconomic politics. The latter one has been extremely motivated by interests of insatiable appetites of state nomenclatures, which represented the main obstacle for institutional changes, apart from noticeable socio-pathologic milieu. All of this

resulted in long-term destabilization of economic systems through disinvestments and spilling over of positive effects in spending instead of production.

This is an opportunity to outline the key *diferencia specifica*. Whether it is about application of theoretical models of neoliberalism, or about its practical vulgarization (quasi-neoliberalism), the institutional monism is in question, with its anti-development character and directly opposed to institutional pluralism. Controlled, complementary and interactive functioning of all economic institutions is time imperative and has no alternative. The belief in the neoliberal formula grew into the myth and turned into a cult, which paved and expanded highways of globalization and transitional mission. These abovementioned formulas have caused enormous social and economic problems, inequality, discontent and crisis. A numerous alarming warnings and criticisms of neoliberalism, made by some known to economists, sociologists, and other authors, didn't help.

The latest global financial and economic crisis, which „followed up“ the existing transitional crisis and other crisis, has sobered up the world and gave a convincing answer to the question of its main cause. It became clear that neoliberal experiment and improvisations caused devastating and unfathomable consequences. Using various instruments of financial „gymnastics“, boundless neoliberal deregulation dynamics have exceeded actual limits of economic reality, as well as the moral and institutional requirements (constraints) of rational human behavior. The newly created panic situation have broken the mystical belief in magic and self-regulating power of the market. Transparent and interest-oriented neoliberal formulas of economic policy have been dismantled, but not destroyed, because their roots are deep and wiry in all spheres of social and economic reality. And their motives are infused into history. Through the prism of logic and gnoseology it only seems paradoxical. But through the lens of phenomenology and ontology, there is nothing strange, because the order of the above formulas is maintained by the same methodology by which it was created: paradoxes, promises, opportunistic behavior, interests of big capital and power ambitions.

The neoliberal formulas were (and sometimes remained) just myth, actually put in the function of creating and maintaining a dogmatic, elitist, destructive and greedy concept of establishing and maintaining power, which tends to become omnipotence and total domination (country, unprincipled coalition, party in power and privileged individuals). It is a new „business“ formula of so-called „clockotristic“⁴ character, used for maintenance and expansion of the hegemony of elite and their large capital, created by non-market actions. On a global and local level, it is based on exploitative motives and interests (towards underdeveloped countries and masses). It is well known that the development can not be based on the leaps. But it also can not be based on ignorance, immorality, lack of trust, lack of cooperation, social pathology, anti-civilizational and anti-human standards, anti-natural and anti-development antinomies, divestitures, false rhetorics, bluff, deceit, inequality, exploitation, unilateralism, monism, domination and demotivation.

Neoliberal ideological and economic formulas have been accepted as absolute truth, developmental monistic imperative preferred form of economic (market) relations and universal measure of social relations. Nothing was left outside the commercial efficiency and market competition: no education, no culture, no health or social care. Every interference by a public institution or social forces in the market has been declared unnecessary and harmful. It was numerously misused.

In their propaganda and practice, neoliberals have ignored the class relations, social differentiation and individuality in a mass scale. They have reduced the institution of state regulation to minimum services to the population (defense, justice and legislative system) and support of the market-based system, especially in the period of crisis and market fiasco (failure). Monistic quasi-market reforms in post-socialist transition period have failed to substitute the huge institutional vacuum, moreover, they have led to their expansion and transformation into a quasi-institutionalization.

⁴ Metaphore for selling goods for a bill, throwing dust in the eyes, bying pig in a poke, etc.

We have never criticized the known and indisputable advantages of realistic, desirable and useful liberalization, which involves the expansion of an integrated market and healthy competition, increase the efficient private sector as a mass phenomenon and socially sound entrepreneurship. I have always advocated the reallocation of resources in the most rational alternative use, the need to adopt the latest knowledge, skills and technology, to increase productivity and efficiency, economic stabilization that ensures economic growth and employment, the development of a pluralistic institutional order and the rule of legal state. We have written that original neoliberal economic doctrine, as a positive economic theory *per se*, was not a bad thing (on the contrary). It assumes specific conditions and limitations, based on certain assumptions, considerations and recommendations, which are useful in certain micro-and macro-economic conditions, and the selective application of the like. But, We have pointed out that: theoretical postulates are one thing, quite different, inadequate institutional and another conditions, where neoliberal recommendations are implemented, and third is their deviant and vulgarized application (marked with prefix quasi) in many underdevelopment, post-socialist economies.

There are regulated, efficient, flexible and strong (indeed: commercial, institutional, resource and organizational) developed countries, and there are resource and institutional collapsed so-called „rapacious“ post-socialist countries, which are mostly out of control. It has never been quite clear if the further „minimization“ was even possible?

In position of expressed post-socialist social and economic non-system (organizational, institutional and normative vacuum) it was not possible to create effective economic institutions. Government structures have opted for recombinant institutions, which enabled the establishment of various forms of quasi-institutional relations. Forcing institutional monism (of market) caused unforeseeable consequences. Various market constraints have contributed to the flourishing of uncontrolled forms of markets, which have nothing in common with the institution of effective regulation of market. The consequences were logical - elements of crisis have multiplied (low standard of living, social stratification, weak motivation system, unemployment, decline in production and all economic indicators, expansion of social pathology, criminalization of the economy and society, systemic corruption, gray economy, inefficient rule of law and al.). All this have deformed and reduced the economic reality and general institutional structure.

M. Draskovic and N. Grgurevic (2013, p. 72) state: *“Ignoring the essence of neo-institutional economic theories and institutionalization as a practical process and specific socio-economic development ‘technology’, using its potential weaknesses of a systemic nature (possibilities for manipulation), quasi-reformers have imposed the individual ‘efficiency’ on the social efficiency. Using various non-market methods and procedures, they have transferred a significant part of the social (state) property into private property... Even if there were good intentions (and there were not, only profitable), the realization of any rules of conduct can be multivariate, depending on institutional and cultural environmental factors, but primarily on interests of the dominant political party (or coalition) in power. Strategy of ‘growing institution’ (Stiglitz) and ‘transplanting the institutions’ (Polterovich) does not fit in here. The causes are always the same - social, political and interest, but also methodology of reproducing institutional dysfunctionality (paternalism, nepotism, passivity, tradition of violating the legal norms, possibilities for unpunished manipulations, abuse and compensation, log rolling, lobbying, annuity-oriented behavior, etc.).”*

In time, structure, quality, quantity and function, institutional changes were behind other transitional changes, instead of being their support, stimulus and guarantor. In addition, there was a large gap between the formally established economic institutions and economic behavior in practice, which was far from the standard norms. Practice has shown that the forming an efficient economy of dominant market type was unsufficient for bringing down the old control and managing mechanisms of the socialist system, for privatization of state assets and implementation of standard measures of macro-economic liberalization and stabilization. Many market institutions have not been formed, not even some of their essential segments. Also, the market infrastructure and culture have not been significantly enhanced. Unfortunately, integrated market is still an abstract noun, which is why it resembles the neoliberal mythology. Many market substitutes, mutant and pseudomarket structures have been rooted. Now, they only mimic a market

infrastructure: flea markets, black, gray and quasi-markets (in a function of survival of the majority of the population), and monopolies (in a function of enrichment of minorities - Draskovic 2010). Competition is reduced to these primitive market structures. Overall analyzes of market relations in most post-socialist countries show that monopolies have fully exploited all the opportunities that they were amply indicated (enabled by privilege).

After unsuccessful socialist experiment, economic and quasi-institutional experimentation was applied again. Maybe it's time to discuss the impact (that) individualism had on collectivism. Individuals had a concept of collectivist basis and ideas, which indoctrinated masses have unconditionally supported, at rallies, party meetings, revolutions and in practice. Post-socialist „neo-reformators“ were also just individuals, sheltered behind the party and/or academic titles. They have conceived so-called individualistic basis, which should have been applicable to all. But they were applicable and appropriate, as it seems, only and/or mostly to them - creators of quasi-individualism (vulgar neoliberalism), representatives of the nomenclature of authorities and their lobbyists. The application of (often rigid) own „development experiments“ with neoliberal macro-economic formulas of developed countries in terms of inadequate post-socialist microeconomic environment and particularly underdeveloped institutional environment, has led to disastrous consequences.

In this context, M. Delibasic (2014, p. 23) writes: *„Transitional institutional environment, predominantly focused on the promotion of market institutions and privatization, have lost not only pluralistic institutional capacity, but also some of its vital elements (legality, good judicial practice, control and changeability of government, the rule of law, etc..). That led to deterioration in the efficiency of the implicit social contract, an increase in opportunistic behavior and the formation of a quasi-market structures, which have consequently prevented the efficient functioning of markets. The non-market appropriation has been widely enabled, and transition reforms discredited. The social and organizational capital have received new control and new owners, with the help of a dominant alternative institutions and numerous conflicts of interest.“*

3. NEOLIBERAL PARALLEL AND NEOLIBERAL TOTALITARIANISM

Despite their parallel existence in time, globalization and the transition are overlapped in methodology, interests, crisis and ideology. Neoliberalism is their common denominator. A neoliberal parallel means that both processes were essentially manifested through the reproduction of large problems and crises (which in time and territory had different intensity, shape, origin and duration), but also through their shift from developed to underdeveloped countries, from rich to poor, through various forms of relationships and dependencies. Almost everything connected with globalization and transition is basing, beginning and ending with the story of forcing the market as economic institution (regulator and coordinator), competition as its primary lever and economic freedom as its basic assumption. However in practice, the market, competition and economic freedom are not forced as a new (neoliberal) landmark of „development“, but on the contrary - the formation of supranational authorities (global) and national (transition) elite.

Reform and practice of many post-socialist and other countries has severely reduced proclaimed principle of uncontrolled markets. Post-socialist transition has convincingly shown that the „reformers“ were balancing (in accordance with their own interests if necessary), between use of neoliberalism as a metaphor of the hegemonic order (by the rich minority) and disguised protectionism (towards the poor and the defenseless mass). In practice, the propagated competition and economic freedom have been substantially suppressed at every step of the growing international and national monopolies and non-market won competitions. Only the facade changed and apparently humanized the manifestations of the „reformed“ forms.

Post-socialist practice shows great similarities and/or the oneness of the neoliberal ideology application as a mask of the rich people (in the style of many authors: imperial) tendencies. Therein lies the specific parallelism of globalization and transition, the global and transitional quasi-neoliberalism. According to many negative events, it seems that socialist utopia, institutional monism and dogmas were just replaced with new utopia, new quasi-institutional monism and new dogmas. Dictation and violence of the state were replaced with dictation and violence of the

„new entrepreneurs“ (nouveau riche). The dominant and retrograde request of time – *getting rich at any cost* – remained the same. This is the essence of globalization parallelism and transition. Paroles, promises, domination of politics, the crisis reproduction, reformed apologetics and palliativeness, monistic thinking and monopolistic behavior, have been taken from ancient times in order to achieve this.

The doctrine of neoliberalism has undoubtedly been the ideological foundation of globalization and post-socialist transition, in approximately the same period of time. It is based on paradoxical and contradictory (civilization and rational logic, theory and practice) the principles of minimal (very limited) country and maximum (unlimited and uncontrolled / own-controlled) economic freedom and private property rights. It is clear what kind of relation can be between privileged minority and organized monopoly („effective entrepreneurs“) and most of the poor, the exploited and unorganized individuals, in terms of the so-called „mini“ or „micro country“, whose sole function is to guarantee „fair“ relations at the unlimited free market. But, that was not accomplished!

The experiment of dirigisme, as a form of institutional monism and totalitarianism in the present countries of transition, began in socialism. Firstly in Russia (1917), and after the Second World War in other Eastern European countries, including Yugoslavia. Its characteristics are:

- open repression of government system, domination of bureaucratic statism and control (command economy), with planned naturalization of goods-and-money relations, undeveloped and unorganized market,
- economic inefficiency caused by destimulative system, paternalism, lack of interest of employees, fictitious employment and so on,
- ideological and political subjectivism and dogmatism, which caused dissatisfaction of the people and a number of socio-pathological phenomenon,
- ideological blurring the essence of economic realities, dominated by the monopoly structure,
- virtual collectivism with organized economic and political coercion and equality at a low level of meeting needs,
- vicious circle of the system fundamental elements (state ownership - monopoly of the state sector - a complete planning determination - the path towards communism), and
- a number of negative consequences, such as price disparities, merchandise trade deficit, trade imbalances, speculative market, hidden inflation, low living standards, extensive economic growth, economic stagnation and crisis, reproduction of totalitarianism in all areas of life and work, systemic corruption, clear bureaucracy and so on.

These characteristics indicate that there is enough similarity with transitional („borrowed“) neoliberal dirigisme. Ideal neoliberal globalization and transition in its monistic aspirations have something in common with totalitarianism.

Shift of the socialist dirigisme paradigm was supposed to overcome the monopolistic position of the state in economic regulation, and its dominant share in the structure of ownership, referred to as the cause of the hindering economic and motivational mechanisms of post-socialist economic systems. Did neoliberalism find fertile ground in the former socialist countries or was it imposed from the outside, with the blessing of new „reformers“? Maybe that is irrelevant. More important is, unfortunately, imposed change of one dogma formation (socialist values) to another (primitive values of individualism and outdated liberal capitalism), rather than the transferring civilizational values. Civil, political and party monopolies were used to establish a specific quasi-institutional order, creating new monopolies, combined from nomenclature authority and privileged individuals. Socialist relations of state functions - privileges were extended and turned into a much more dangerous combination: *state functions - privileges - enrichment*. It has produced changes with multiple negative prediction and monopolies, which in almost all areas of society produce devastating consequences, disturbed relations between private and public interests, entrepreneurial and destined behavior.

Totalitarian projects, although based on different grounds, are designed to massively subdue almost all individuals over promises about alleged messianic character of some abstract, iconic

ideas. All these ideas were the basis of particular ideological matrix, which essentially (deterministic) subdues the masses to the elite and deprives them from real choices and propagated ideas („empires“ race, class, freedom, etc..). The ideas of totalitarianism were different (unity, preference, freedom), but in all of them was only one ideal, as their common denominator - *the dominance of the privileged*. And there was always a mask called *massiveness* for hiding cults. Realization was a combination various methods of dictation, terror and coercion.

Every totalitarianism has its mechanisms and structures, which represent paths of power. It is characterized by strong vertical and pyramidal government, led by the leader (dictator), which relies on the party hierarchy. None mega-ideology of totalitarianism *per se* does not contain anything vicious. On the contrary, it is very attractive to the masses. But its essence is in methods of governance. For example, in Russian socialism (communism) it was bolshevism. It is no coincidence that the V. I. Lenin had evaluated his sympathizers not only and not so much by their communist beliefs, but by degree of their bolshevism, and their willingness to abandon morality for achieving „*absolutely correct*“ goal. And „*the goal justifies the means*.“ Maybe that is why some authors call neoliberalism – „*neo-bolshevism*?“

Totalitarianism as a tendency for complete control and exclusion of many from accessing the resources and freedom, is the negation of human liberty, ie, kingdom of unfreedom. It is paradoxical that neoliberalism ostensibly imposes freedom, and doubts democracy, conditionally seen as majority rule. Any idea of massiveness is a potential threat to the alleged individual rights and freedoms! That's why neoliberals prefer the rule of the elite, executive and judicial authority.

Nihilistic fruits of totalitarianism are rhetorical and aggressive tautology, striving for practical obedience of the masses and establishing „eternal“ world order. These „fruits“ grow fast and mature – resulting in various problems. Transition was rhetorically based on ideas, slogans and promises of liberal doctrine. Its real flow, however, shows violence against society and the economy, and uncontrolled, haphazard processes, similar to primitive accumulation of capital (but with different consequences for the actors and methods of „organization“), followed by some devastating economic and social consequences. Forced attempts to shift a formational dogma (socialist values) with another („*outdated liberal capitalism*“ - a term by M. Friedman) in most cases did not lead to the replacement of old values with new civilizational values that exist in developed countries. There was a specific *metamorphosis* and *adaptation* of socialist values and their *recombination* with a range of different new values (positive and negative, civilizational and anti-civilizational).

The neoliberal totalitarianism is possible to replace with:

- finding and accepting the optimal proportions and flexible relations between private (mass, not the privileged!) and state structures, individual and common interests, entrepreneurial and predicted behavior,
- real transition towards democracy, institutional pluralism, market competition and entrepreneurial motivation, and
- creating conditions for the free exchange of property rights.

Real and radical institutional changes are general framework, the common denominator and the precondition of all other changes. Boundless economic „freedom“ for individuals, created by non-market enrichment, are possible only in terms of institutional vacuum and institutional monism. Restrictive and protective power over society can carry out only the state and its regulation. In theory, institutional monism (neoliberalism) denies institutional pluralism. In practice, quasi-institutional monism (quasi-neoliberalism) denies not only institutional pluralism, but also institutional monism. It is based on alternative and quasi-institutions. This is a paradox, which contains neoliberalism and has anti-institutional orientation.

The neoliberal mythology is not randomly selected. On the contrary! Neoliberal alibi-reformers believed (with reason) that market and democratic formula will have messianic affect

to the population, bringing them more faith, freedom, private initiative, entrepreneurship, private property, motivation, efficiency and so on. It is forgotten (or probably intentionally disregarded) that every mythology is generally irrational, while economy is assumed to have rational behavior. Therefore, important question is: Who benefits from unchecked and neoliberal „freeing the economy“ and who limited the economic freedoms? The answer is known. New privileged elite were formed. For economic quasi-liberals they were taboo and something that „market“ had (naturally) determined. For this problem of fundamental impunity, theorizing quasi-neoliberals mainly revolves in abstract, futile, and a vicious circle: *individualism - freedom - market - competition - private property - entrepreneurship - natural state of things*.

When economic decisions are influenced by the powerful administrative-party groups, then individual „players“ and their connections become meta-institutions, dominant over all other institutions. This has deformed the entire economic reality and institutional structure.

Modern realization of the „mini-state“ idea, in practice has led to a new form of totalitarianism and economic reductionism. In the most post-socialist countries in transition, it was a chance for minorities to enrich on monopolistic principles of non-market privilege and monistic institutional reasoning of the quasi-market, which was regulated on the principles of market restrictions. This was a major and intractable paradox of transitional development and cause for reproducing the post-socialist crisis.

Total distrust in state regulation is not logical nor productive (at least in crisis), nor is it appropriate to the growing IT, manufacturing, financial and civilization integration in the 21st century. The way out, volens-nolens, must be sought in a controlled, interactive and complementary functioning of various economic institutions (institutional pluralism). If we ignore (eliminate) institutional pluralism (in any possible combination) and/or put the individual (closely grouped) in control, if we reduce institution (rhetorically and practically) to monism (dirigisme or neoliberalism) or essentially to quasi-monism, then occurs the possibility of abuse, ignorance, oppression and converting to their opposite - a quasi-institutions. Then occurs a blockage of institutional change, the destruction of institutional synergy and institutional competition.

The possibility of institutional control is always directly proportional to development degree of institutional environment and level of the government control (policy). Counter-productive institutional monism is inevitably and quickly transforming to a variety of pathological forms, making a quasi-institutional matrix. It is largely determined by the parties in power, which participate in creating and strengthening distributive coalitions, monopolizing all aspects of life, cartelling the market and in turn influencing the public policy. This enables illegal and non-market appropriation of the state property. Rent-oriented behavior expands. Nominally (formally) exist democratic and other institutions, serving only as a cover for greedy realization of distributive coalition. The new „elite“ have no interest in strengthening institutional power of the state. This creates a vicious quasi-neoliberal circle of anti-institutionalization. It begins with an institutional vacuum and spreads across institutional reduction to institutional fiasco. By expansion of this vicious circle expands the aftermath: economic, sociopathological, social and other.

How was this vicious circle of anti-institutional maintained in a long term? Elimination of institutional competition leads to elimination of the market competition and deformation of economic institutions in the market regulation. This further leads to suffocation of economic freedom, entrepreneurship and natural market functions and principles. Affirmation of non-market behavior, with the blessing of neoliberal economic politics, stimulate rapacious appetites of the privileged nomenclatures, which take control over the institutional ownership. In terms of unprotected and unspecified property rights, manipulative redistribution is enabled in larger scale.

4. NEOLIBERAL INDIVIDUALISM OF THE PRIVILEGED (INDIVIDUALISM-INSTITUTIONALISM RELATION)

Paradoxically, a few things have been forgotten. *First*, if freedom has no social constraints, greed becomes driving impulse of privileged individuals for enrichment. *Second*, individualism is not mentioned, because it is a *metaphor for massiveness*. An abstract individuality is imposed, which

has proven to be a *metaphor for privileged individuality*. *Third*, such perverted and reduced individualism by some „reformers“ who have shown to be „skilled and capable entrepreneurs“ (so-called „*efficient owners*“) is imposed as a social and civilized norm. *Fourth*, individualism (of the privileged) has become a foundation of the formal institutional monism as theoretical and ideological basis for economic neoliberalism (economic clockotism, in terms of „*smoke and mirrors*“, without prejudice). It was and still is directly opposite to institutional pluralism, and therefore, to the real institutional change.

These paradoxes have created a wide and strong mechanism of sociopathology hindering the transition. It still represents insuperable obstacle to the strengthening and development of formal social, political and economic institutions in post-socialist countries.

Neoliberalism as a philosophy of methodological individualism and metaphor of „reformers“ has proven to be very suitable for building specific and dogmatic theoretical platform, which served as a motto for fast and non-market acquisition of wealth, power, and economic freedom of the privileged, whom alibi-economists often equated with economic „effective owners“. Since the process of enrichment was not innovative, or productive, or inheritance, or of market character, it was a reflection of the extremely rapacious accumulation. Therefore, it is clear that minorities got what population and/or state lost.

Synergistic effect and efficiency of economic institutions is possible only in conditions of economic freedom and effective individual owners as a mass phenomenon.

In modern economic theory and economic reality, quasi-neoliberals have maximally relativized the contrast and paradox (manifestational, apparent, and imposed) between individual and institutional. New front line between them is generated only by those economic neoliberals who easily carry the prefix alibi and quasi, and whose mission is dominantly interest oriented (more or less). Paradox of this combination (value pair of individual and institutional) is just an illusion and delusion of quasi-neoliberals, because in reality their non-exclusivity is actual generator of that combination. Undoubtedly, individual and collective are inseparable components of the most institutional arrangements and overall institutional order in modern developed economies.

We support *institutionalized individuality*, which should be massive, and not a single phenomenon of privileged and/or socio-pathological origin. I am against all forms of vulgarized individuality. Institutionalized individuality involves the application of the value and law criteria.

One could discuss the economic role of the state, minimum limits of rule of law, degree of institutionalization and the like. But justification of the interest oriented individualism (as a source of enrichment, various forms of monopoly, stratification and other negative phenomena) does not make any sense nor developmental effect. Institutionalized state is developing and protecting private interests. It specifies and protects property rights, economic freedom, contracts and market competition. On the other hand, privileged individualized state (personalized, clearly) develops and protects the interests of privileged individuals. It enables deprivation of property rights, disabling the formation of an efficient ownership structure. It does not guarantee the performance of the contract and economic freedom, hindering the formation of a relatively stable preference system, reducing economic choice, creating monopolies and so on. Institutionalized state does not know the epithets „minimum“ and „maximum“, while the conditionally "individualized" state is minimum by nature. It is a state that formally exists in all of its functions, but it is called „private“, because it is governed by an individual or small number of interest related individuals. In the first one, institutional (including legal) restrictions are consistently applied to all. In the second one, restrictions are applied selectively (with a few exceptions), which is contrary to the nature of institutions. In the first one there is institutional limitation for all. In the second one there is quasi-institutional limitlessness for the few (privileged). In the first one there is a fixing (specification) the rights and obligations of individuals. In the second one there is feigning, even the inevitable collectivity (referendum, voting, democracy).

Opinions of local analysts can be subjective. Thereafter, we are quoting the latest report of the USAID („Vijesti“, 29.07.2009. p. 9.), which emphasizes numerous deformations of economic policy makers in Montenegro: poor control and monitoring of the work of the executive power, weak institutions of the government, limited political competition and broad intertwining of po-

litical and economic elite⁵, limited publicity of the work of the government, poor implementation of the law, limited access to information, widespread use of personal connections, nepotism and favoritism, corruption as an activity for great gain with little risk, huge conflicts of interests, rigidity in politics and governing. When you add to these, anisotropy of information, negative selection of cadre, advantage given to political affiliation, as opposed to competency and many characteristics of hermetic society (it is still a long way to civil society), it is then clear that the economic policy could not have been much better.

5. NEOLIBERAL IMPERIALISM AND VIOLENCE

From the beginning, the quasi-neoliberal formulas have resembled the elitist, destructive and greedy concept of power, tending to turn into omnipotence, i.e. a total domination (of the few states, parties in power distribution coalitions and privileged individuals). This is a new dogmatic, anti-civilization, anti-formation and anti-development formula for maintaining and expanding of specific form of hegemonic order of monopolists and men in power („*restricted access to resources*“ – according to: North, Walis, and Weingast 2009). It can be considered not only economic, political and ideological, but also a moral nature of quasi-neoliberalism, in different dimensions: through the prism of sustainable development, inequality, double standards (accumulation of wealth and extravagance of the few, impoverishment and survival of others), a widening gap between rich and poor, criminalization of society and economy, provoking crisis, etc.

It is often forgotten that social and state control of opportunistic behavior is one of the fundamental institutions. When it fails (or delays), the quasi-neoliberal economic motivation is enabled, and that is equal to „*interest greed*.“ That initiates and maintains the flywheel of vicious elitist urge for rapid acquisition and accumulation of wealth, dominance and total power. Since ideology of totalitarianism and domination is the common denominator of all forms of imperialism, we can make a conditional conclusion that the formation of a quasi-neoliberalism has led to a new form of neoliberal imperialism, which inherited colonial (geographically) and the neo-colonial (industrial). Its core consists of pyramid financial and technological-organizational domination, control, addiction and related exploitation. Imperialist motives (interests) and exploitation are two sides of the same process. It is easy to distinguish legally defined economic freedom from freedom of action, with background of immoral, criminal, monopolistic, sociopathological and other quasi-institutionalized behavior.

All barren and irrational rhetorics and favoritism were followed by mythologizing, ideologization, dogmatisation, politisation, vulgarization, monopolization, exploitation and quasi-institutionalization. These are methodological leverages of neoliberal reforms, which essentially contain the social, political and economic clockotrim. In practice, it was severely manifested by applying double standards to the rich minority and the poor majority, illusionist vacillation between myth and reality, between individualism and institutionalism, for redistributing national wealth and achieving massive illegitimate uses.

Using various undemocratic methods, neoliberal deregulation was imposed as non-alternative variant, where private greed, in the best possible manner, motivated insatiable „entrepreneurial“ ambitions and „reform innovations“ of nomenclatures and their lobbyists. Categories and institutions of social capital, such as morality, justice, trust, control, origin of the property, rule of law, democracy, public safety, etc., are ignored.

Neoliberalism did not limit violence in society. On the contrary, it helped its expansion. According to North, Walis, and Weingast (2009) violence include various forms of social pathology: the non-market appropriation of rents, buying votes, corruption, exploiting privileges, coalitions of interests, ignoring the masses, etc.). The above authors have come to the conclusion that it is possible to achieve to political manipulation of the economy in order to build a privileged interest groups and anti-institutional incentives by political and economic competition. This occur-

⁵ Compare with: Acemoglu D. et al. Institutions and the Fundamental Causes, of Long-Run Growth / Handbook of Economic Growth, Ph. Aghion, S. Durland (eds), North-Holand, 2004.

red in the conditions of neoliberal implementation in countries with a policy of „limited access“, where some organizations and groups of elites were pulling the rent due to their privileges and some tacitly „special rights“. Those „rights“ are created in an institutional vacuum environments, characterized by personal relations and „strings“. Hence, the order is unstable and volatile, the politics is connected and dominates the economy, a minority (elite) manages the masses, informal and alternative institutions (which are extremely personified) dominate, and organizational structures are very unstable.

The above authors point out that restriction of access (inequality) is provided by a deficit of the rule of law, insufficient guarantees of rights and freedoms and the lack of competition in the political and economic system. Place in a hierarchy is determined by the position of individuals in relation to the law and the nature of its application. Civil society and democracy are underdeveloped, there is no strong opposition, so there is a partial provision of services by the state. Bureaucracy is poorly controlled and unprofessional. „Elites“ agree on the privileges, which include the right of ownership and access to certain types of activities. Creation and appropriation of rent is the „glue“ that holds the coalition together. This system of organizing society drastically reduces the efficiency of society, economy and politics. It produces deeply intertwined network of corruption, which is most evident in the relation patron - client. Its viability is based on the elimination of strong internal institutional structure.

Realization of the neoliberal project, as a selective and partial quasi-institutional monism, is a reduction of overall economic behavior, from economic activity through competition to motivation and employment. Non-market and violent separation of the population from the property is its de facto separation from economic freedom and the consequent suppression of individualism institutional monism, which favors the creation of monopolies. It fits in theoretical vulgarization of the neoliberal economic model, which is a deliberately premeditated institutional improvisation and imitation, that have caused all these troubles for most post-socialist countries and their economic subjects.

Is it possible that a quasi-neoliberals do not notice the imposed substitution of quasi-market structures, competition to all sorts of ubiquitous monopolies, efficient private sector of the rare nouveau riche, enterprises of rent-oriented and gray-economic behavior, effective social, political and economic institutions of group-individualistic improvisation, ideals of vice, institutional control by party-individual control, objective regulators (rules of the game) subjects („good players“ and their connections), etc.?

Lessons must be drawn from neoliberal failures. Liberalization is not the same as violence against it. Freedom presupposes the absence of restraint, but direct and indirect coercion in neoliberal conditions have been continued in a raw and sophisticated forms.

6. CONCLUSION

We came to the conclusion that neoliberalism is merely a *metaphor* that conceptually generates a conglomerated complex and contradictory context, which has its own doctrinal, terminological, institutional, developmental, cognitive, strategic, interest, redistributive, ownership, civilizational, geopolitical and ideological meaning and numerous practical quasi-manifestations. This manuscript is named „Neoliberal metaphor.“ Why? Because

- the term „metaphor“ covers a very wide range of phenomenology of neoliberalism, and consists of many paradoxes, contradictions, scams and myths,
- neoliberalism exists between two levels: rhetorical propaganda for creating an illusion, and practical restraint and control of change and freedom,
- everything is conspiratory and programmed for the purpose of greedy and non-market enrichment and strengthening power, without limits, and
- neoliberalism looks like meta-phor(a) of its creators.

It had been written a lot regarding neoliberalism (for and against it) with various aspects and even that it's dead! No, It is very much alive and continues to live in accordance with the logic of its metaphorical existence (especially in the minds of alibi-neoliberals). After all, it is just a metaphor, just a new name for an old phenomenon, since it identifies the specific regime of modern (neoliberal) capital accumulation and appropriation in terms of institutionally weak state. It is also a monistic metaphor for a „system with limited access to resources“ (North, Walis, and Weingast 2009). Everything else is academic discussion, outwitting, apologetics, dishonest, manipulative, hypocrisy, clockotristic and interest talk about freedom and market.

Sophistic stopgap and sophisticated quasi-neoliberal rhetoric and practice have generated original methods of organized use of privilege: rapacious privatization, intercommune economy, economic clockotristism and protectionism against his own people (my terms). Their mission continues in conditions of extremely reduced market and „entrepreneurship“ based on further robbing of the state and reproducing the non-market acquired wealth.

Institutional innovations imply civilization norms, placing economic behavior in realistic, moral, human and institutionalized frameworks, creation of competitive economic policy, which will honestly (and not rhetorically) favor healthy market competition and will take into consideration a given objective developmental frameworks and numerous market limitations. All of it without mythology, ideology, dogmatism and interest related misuses. Freedom of choice and free market - yes, but at own risk and money, within the limits of moral criteria, state responsibility, rational behavior, institutional standards, protected and well specified property rights!

Coalition of economic „reformers“, the nomenclature of government and their lobbyists accepted the offered neoliberal „development model“ because these alleged „new elites“ has identified with this new individualistic ideology and a new value system, which allowed unlimited expression of their personal interests, and thereby quick enriching and creating the power (social, political, party, economic). Their ideals are (temporarily) achieved.

All of this is achieved by applying neoliberal „methodology“ of double standards, sophist stopgap and futile rhetoric. All neoliberals (politicians, economists and others in the government and close to it) say they are democratic, freedom-loving, tolerant, development-oriented, pluralistic in everything, not just in one – they absolutize alleged „neoliberalism“ but they do not see its alternative (thus negating choice as the essence of democracy and economy). Propaganda of „absolute truth“ is always a prelude to apologetics. Everything has an alternative, it is only a matter of time and the conditions for its realization. But, irony of destiny is often paradoxical, as it is in many ways paradoxical neoliberal mission. If not for any other reason, then because of planetary collapse and appropriation of state property by nomenclature „reformers“ and their lobbyists. Only institutional innovations can neutralize party-lobby's structures and can activate missing control mechanisms, rule of law, economic freedoms and efficient instruments of economic policy.

Doctrine of W.C. is based on assumption that the distribution of social and collective action will be enhanced by reforms, and market reform should create benefits to the whole society and that it represents a long-term public good. It is obvious that the *mass* is replaced by privileged individualism. The question remains: How much is the authority, power, monopoly and property been secured by internal „winners“ and how much by external factors? That's the paradoxical situation, explained by L. Thurow (1997, p. 127), which has become a social and economic reality of global and national neoliberal order. Classic replacement of the thesis: instead of national policies governing the economy, they are dictated by external economic forces. Their various assistance were not granted without numerous the *quid pro quo*.

The tragedy of neoliberalism is its actual separation from its scientific and philosophical heritage, which has become a reactionary tool of the elite (class of non-market enriched individuals, who have appropriated the results of many generations) and the ideology of limitless power of big capital and business, which has destroyed the middle class of society, allowing freedom of exploitation.

All analyzes and conclusions stated in this article indicate the validity of the proposed hypotheses.

REFERENCES

- Althusser, L. (1970), "Lenin and Philosophy" and Other Essays, Ideology and Ideological State Apparatuses (<http://www.marxists.org/reference/archive/althusser/1970/ideology.htm>, downloaded 12.02.2014)
- Delibasic, M. (2014), "The Post-Socialist Transition Through the Prism of O. Williamson's Insight", *Montenegrin Journal of Economics*, Vol. 10, No. 1, 13-24.
- Delibasic, M. i Grgurevic N. (2013), "Framework for Researching the Modelling Possibilities of Institutional Behavior", *Montenegrin Journal of Economics*, Vol. 9, No. 4, 65-76.
- Draskovic, V. (2010), "The Real Institutionalization as a Condition of the Efficient Economic Politics and Economic Development", *Montenegrin Journal of Economics*, Vol. 7, No. 1, 5-20.
- Draskovic, V. and Draskovic, M. (2012), "Institutional Nihilism of the Post-Socialist Transition", *Montenegrin Journal of Economics*, Vol. 8, No 2, 191-206.
- Draskovic, V., Yerznkyan, B. and Draskovic, M. (2014), "Some Characteristics of the Institutional-Change-and-Innovation-Based Economic Development in the Countries in Transition", *Theory and Practice of Institutional Reforms in Russia*, Collection of scientific works ed. by B.H. Yerznkyan. Issue 28, CEMI Russian Academy of Sciences, Moscow, 114-122.
- Kovacevic, M. (2012), "Neoliberalizam u Srbiji – uspod i pad", *Balkan magazin*, 2. maj, <http://www.balkanmagazin.net/novosti-i-politika/cid128-37509>, downloaded 12.02.2014
- North, D.C., Walis, J.J. and Weingast, B. R. (2009), *Violence and Social Orders – A Conceptual Framework for Interpreting Recorded Human History*, The Syndicate of the Pres of the Cambridge University.
- Rodrik, D. et al. (2004), "Institution Rule: The Primacy of Institutions over Geography and Integration in Economic Development", *Journal of Economic Growth*, Vol. 9. No. 2, 131–165.
- Rodrik, D. (2006), "Goodbye Washington Consensus, Hello Washington Confusion? A review of the World Bank's Economic Growth in the 1990s: Learning from a Decade of Reform", *Journal of Economic Literature* 44(4), 973-987.
- Thurrow, L.C. (1997), *Buducnost kapitalizma: kako danasnje gospodarske snage oblikuju sutrasnji svijet*, Mate, Zagreb.

PROGRESSIVE INCOME TAXES AND MACROECONOMIC INSTABILITY

MOHANAD ISMAEL ¹

ABSTRACT

This paper aims to study the stability properties of a two-period over-lapping generations model with a progressive labor-income taxation rule. In this case, wage income tax rates are increasing with agent's income. Each representative agent lives two periods: youth and adulthood. In the first period, agents choose labor supply and allocate their after-tax income between consumptions and savings (capital accumulations). In the second period, agents are retired and consume entirely their savings returns. It is shown that progressive labor-income taxation policy acts as a destabilizing factor in the sense that a higher progressivity makes the emergence of indeterminacy and endogenous fluctuations more likely. These fluctuations appear if the elasticity of capital-labor substitution is sufficiently low. Moreover, we show that saving rate widens the range of parameters giving rise to endogenous fluctuations. The analytical findings are completed by a numerical example.

KEY WORDS: *Progressive income taxes; Indeterminacy; Overlapping generations; Endogenous labor supply.*

JEL classification: C62; E20; E32; H20;

Received: April 26, 2014 / Accepted: October 17, 2014

1. INTRODUCTION

Taxation is an unavoidable tool in contemporary economies used to finance public expenditures which in turn aim to achieve primary economic and social objectives. In particular, individual income taxes have been the largest source for U.S. government since the middle 20th century with an average of 8% of American GDP and about 45% of Federal Tax Revenue in 2008². Most OECD countries apply income taxes with progressive features where tax rate increases as the taxable base amount gets higher. For instance, the average income tax rate in 2008 ranged from roughly 2.6% of income for the bottom half of tax returns to about 23.27% for the top 1%³. Therefore, I think that considering a progressive taxation policy is a suitable strategy to keep a reasonable gap between rich and poor agents.

Individual income taxes consist of both labor-income tax and capital-income tax. However, in this paper, we restrict our attention to a labor-income tax only with a progressive policy. This is consistent with U.S. tax code where labor-tax rate is more progressive than capital-tax rate⁴.

Our objective is to study the stability effect of labor-income tax progressivity, in other words, does tax progressivity prevent/promote the emergence of endogenous fluctuations due to self-fulfilling expectations?⁵

¹ Assistant professor at economic department, Birzeit University, e-mail: maburjaile@birzeit.edu

² Congressional Budget Office, a preliminary analysis of the president's budget and an update of CBO's budget and economic outlook, March 2009.

³ For more details, see "Summary of Latest Federal Individual Income Tax Data" 2010, Fiscal Facts No. 249, Tax Foundation.

⁴ See Hall and Rabushka (1995).

⁵ Initially, income taxes have been considered as a stabilizing instrument by Musgrave and Miller (1948).

We propose an overlapping generation model (thereafter, OLG) with two-period consumption à la Diamond (1965) where in the first period, young agents allocate their after-tax wage income between consumption and saving. In the second period, old agents, who are retired, consume their entire income that comes from the returns of first-period saving. Government purchases which are financed through agent's labor income tax do not contribute to either production or agent's utility.

Since the seminal work of Diamond (1965) and Reichlin (1986), numerous studies have been extended to include fiscal policy. More precisely, Dromel and Pintus (2006) (thereafter D-P (2006)) focus on a non-linear progressive capital-income taxation rule in an OLG model à la Reichlin (1986) where they show that endogenous fluctuations are ruled out and saddle-point stability is ensured whenever tax progressivity is sufficiently high. Seegmuller (2003) proposes a constant tax policy together with public services in a similar OLG framework. However, Chen and Zhang (2009a, 2009b) and Gokan (2009a) consider an endogenous linear tax policy jointly with a two-period consumption OLG model. Particularly, Chen and Zhang (2009a) concentrate on labor-income taxation while Chen and Zhang (2009b) study the effect of capital-income tax rule on the appearance of endogenous cycles. They deduce that labor-income tax policy (resp. capital-income tax policy) operates as a destabilizing factor (resp. a stabilizing factor). These contradictory results are intuitively explained as labor income taxation makes consumption-saving ratio smaller for young agents which makes cycles more likely to emerge.

Comparing to above literature, considering a progressive labor-income tax in an OLG model is an extension of the work of Chen and Zhang (2009a). At the same time, this work allows to study the robustness of existing results obtained by D-P (2006) where they deduce that progressive fiscal policy has a stabilization power if taxed income finances all or at least most of consumptions generated by agents. Hence, first-period consumption might be a crucial element for the stability effect of fiscal rules in an OLG economy.⁶

This paper shows that high labor-income tax progressivity performs as a destabilizing factor in the sense that it promotes endogenous cycles. These cycles arise due to the presence of interaction of two conflicting effects on savings that operate through wages and real interest rate. The intuition goes as follows: assume that current capital increases from its stationary level. This implies an increase in wages and so more capital accumulations. At the same time, agents expect that an increase in future capital reduces future interest rate. Such an expectation induces them to supply less labor which in turn has a negative effect on capital accumulation. Cyclical paths emerge whenever the interest rate effect dominates the wage effect. This requires a sufficiently low elasticity of input substitution together with a high propensity to save out of after-tax wage income, a high tax progressivity and a high elasticity of marginal utility of consumption.

Therefore, while taxation policy acts as a destabilizing factor in our model, it has a stabilizing power in D-P (2006). Such a difference is due to that, in this paper, taxes are imposed on labor income and agents consume in both periods. On the contrary, D-P (2006) assume that taxes are imposed on capital income and agents consume only when they are old. These assumptions are crucial to give rise to different results from a stability point of view. In this study, indeterminacy requires high saving rate which means that a low fraction of consumptions is financed by labor income while in D-P (2006) consumptions are totally financed by capital income. This confirms their principle conclusion: if agent's consumptions are mostly financed by wage income (resp. capital income), then the endogenous fluctuations are ruled out if progressive taxes are applied to labor income (resp. capital income). Likewise, progressive labor-income tax is not helpful to stabilize both labor and consumptions since second-period consumption depends strictly on the interest rate.

⁶ See Cazzavillan and Pintus (2004) for the importance of the first-period consumption in OLG model.

The stability effects of taxation policies have been studied also in a one-sector infinite horizon representative agent model.⁷ The pioneering paper of Schmitt-Grohé and Uribe (1997) considers a balanced-budget rule with a constant returns-to-scale technology where a constant government spending is financed by fixed income taxes. This countercyclical tax policy can generate indeterminate steady state and a continuum of sunspots equilibria. However, Guo and Harrison (2004) extend Schmitt-Grohé-Uribe model by allowing endogenous government expenditures financed by proportional tax rates on capital and labor incomes. They show that indeterminacy does no longer appear and the economy exhibits saddle-path stability. Moreover, Guo and Lansing (1998) find that introduction a progressive income tax in a model with increasing returns as in Benhabib and Farmer (1994) can prevent agents' self-fulfilling expectations and provides a unique equilibrium. More recently, Dromel and Pintus (2007) consider a linear income-tax policy into the model of Benhabib and Farmer (1994) where it is assumed that this tax is constant and applied to income only when the latter is higher than a threshold value. They demonstrate that taxes can prevent the occurrence of endogenous fluctuations. The stabilizing role of the progressive tax can be interpreted as follows: when agents are optimistic and expect a higher wage tomorrow and simultaneously they realize to face an increasing tax rate. This reduces their expected after-tax returns and prevents the occurrence of self-fulfilling expectation.

The outline of this paper is the following: Section 2 presents the model. Section 3 characterizes the intertemporal equilibrium. Section 4 demonstrates the existence of a steady state. The local dynamics is introduced in section 5 followed by a numerical example in section 6 and finally section 7 concludes.

2. THE MODEL

We consider a competitive, non monetary, two-period overlapping generations model with identical agents. In each period t , N_t individuals are born and live only two periods "young and old". There exists a unique good which can be either consumed or saved. In the first period, agents allocate consumption and saving according to their after-tax income and in the next period they do not supply labor and consume the entire first-period saving returns. In addition, agents are imposed to pay a labor income tax which is supposed to be progressive.

Given the real wage w_t and the gross real interest rate R_{t+1} , an agent born at time $t \geq 0$ chooses labor l_t , saving s_t and both period consumptions (c_t, d_{t+1}) to maximize the following additive separable preferences:

$$\max_{c_t, d_{t+1}, l_t} [u(c_t / B) + \beta u(d_{t+1}) - v(l_t)] \quad (1)$$

Subject to

$$c_t + s_t = \varphi(w_t l_t) \quad (2)$$

$$d_{t+1} = R_{t+1} s_t \quad (3)$$

$$c_t \geq 0, d_{t+1} \geq 0$$

For all $t \geq 0$.

with $\varphi(w_t l_t) = w_t l_t - \tau(w_t l_t)$ is the after-tax income and $(w_t l_t)$ is the amount of tax payment, $\beta \in (0, 1)$ is the discount factor and B is a scaling parameter. Indeed, we assume a full depreciation rate of capital $\delta = 1$.

⁷ The role of taxation progressivity is also treated in a heterogeneous agents' framework. For instance, in a segmented agents model à la Woodford (1986), see among others, Dromel and Pintus (2008) and Lloyd-Braga, Modesto and Seegmuller (2008), however, heterogeneity à la Becker (1980) is considered by Sarte (1997), Sorger (2002) and Bosi and Seegmuller (2010).

Assumption 1. $u(x)$ is continuous, increasing $u'(x) > 0$ and concave $u''(x) < 0$ for $x_t = c_t / B$; d_{t+1} , while $v(l)$ is continuous for $0 < l_t < \zeta$ and increasing $v'(l) > 0$ and convex $v''(l) > 0$. Additionally, $\lim_{x \rightarrow 0^+} u'(x) = +\infty$, $\lim_{x \rightarrow +\infty} u'(x) = 0$, $\lim_{l \rightarrow 0^+} v'(l) = 0$ and $\lim_{l \rightarrow \zeta} v'(l) = 1$.⁸

For future reference, we present the following necessary elasticities: the elasticity of marginal utility of current and future consumption $\varepsilon_{11} = u''(x)x / u'(x) < 0$ for $x_t = c_t / B$; d_{t+1} , the elasticity of marginal disutility of labor $\varepsilon_v = v''(l_t)l_t / v'(l_t) > 0$ and $\gamma = s / \varphi(w_t l_t) \in (0, 1)$ is the propensity to save (saving over after-tax labor income).

Assumption 2. The function $\varphi(w_t l_t) \in C^2$ is positive with $\varphi(0) = 0$. Further, it satisfies $0 < \varphi'(w_t l_t) \leq 1$, $\varphi''(w_t l_t) < 0$ for all $w_t l_t > 0$. Moreover, the income tax is a progressive tax, that is $\varphi(w_t l_t) / w_t l_t$ is non-increasing for $w_t l_t > 0$ or equivalently $\varphi'(w_t l_t) w_t l_t / \varphi(w_t l_t) \leq 1$.

Income tax progressivity can be obtained whenever the marginal income tax rate is higher than the average tax rate. More explicitly, the marginal tax rate is $\tau'(w_t l_t) = 1 - \varphi'(w_t l_t)$ and the average tax rate is $\tau(w_t l_t) / w_t l_t = 1 - \varphi(w_t l_t) / w_t l_t$. Thus, progressive taxation requires marginal rate greater than average rate, i.e., $\varphi'(w_t l_t) \leq \varphi(w_t l_t) / w_t l_t$. The corresponding elasticities of after-tax income are:

$$(\eta_1, \eta_2) \equiv \left(\frac{\varphi'(w_t l_t) \cdot w_t l_t}{\varphi(w_t l_t)}, \frac{\varphi''(w_t l_t) \cdot w_t l_t}{\varphi'(w_t l_t)} \right) \quad (4)$$

where $\eta_1 \in (0, 1]$ and $\eta_2 \leq 0$. Moreover, η_2 measures the degree of marginal progressivity on labor income taxation.⁹

The Lagrangian function for household problem is:

$$\text{Lag} = [u(c_t / B) + \beta u(d_{t+1}) - v(l_t)] + \lambda_t [\varphi(w_t l_t) - c_t - s_t] + \mu_t [R_{t+1} s_t - d_{t+1}] \quad (5)$$

The first-order conditions with respect to c_t, d_{t+1} and s_t imply:

$$Bv'(l) = u'(c_t / B) w_t \varphi'(w_t l_t) \quad (6)$$

$$v'(l) = \beta u'(d_{t+1}) R_{t+1} w_t \varphi'(w_t l_t) \quad (7)$$

2.1 Firms

On the production side, firms which are identical utilize capital K_t and labor L_t to produce final goods and to maximize the profit:

$$\Pi_t = AF(K_t, L_t) - r_t K_t - w_t L_t$$

with $F(K_t, L_t)$ is the production function which has the following features.

Assumption 3. $F(K, L)$ is a continuous function defined on $[0, 1]$, homogeneous of degree one, strictly increasing in both arguments ($F_K(K, L) > 0, F_L(K, L) > 0$) and strictly concave

⁸ For details, see among others Dromel and Pintus (2006) and Bosi and Seegmuller (2010).

⁹ In this paper, tax progressivity is defined in marginal terms as implemented by Musgrave and Thin (1948).

($F_{KK}(K, L) < 0, F_{LL}(K, L) < 0$ and $F_{KK}F_{LL} - (F_{KL})^2 > 0$).¹⁰ Additionally, $F(0,0) = 0$ and the boundary conditions $\lim_{k \rightarrow 0^+} f'(k) = +\infty$, $\lim_{k \rightarrow +\infty} f'(k) = 0$ are satisfied, where $f(k) \equiv F(K, 1)$ is the production per labor and $k \equiv K / L$ is the capital-labor ratio.

If we set $\rho(k) \equiv f'(k)$ and $\omega(k) \equiv f(k) - kf'(k)$ we then obtain:

$$R(k) = A\rho(k) \text{ and } w(k) = A\omega(k) \quad (8)$$

As a result, the elasticity of interest rate $k\rho'(k)/\rho(k) = -(1-s)/\sigma < 0$ and the elasticity of real wage $k\omega'(k)/\omega(k) = s/\sigma > 0$, with $s \in (0,1)$ is the capital share in total income and $\sigma \in (0, +\infty)$ is the elasticity of capital-labor substitution.

2.2 Government

As in Schmitt-Grohé and Uribe (1997), Guo and Lansing (1998) and Bosi and Seegmuller (2010) labor income taxes are used to finance government expenditure G_t . Hence, the instantaneous government budget constraint is:

$$G_t = N_t \tau (w_t L_t) \quad (9)$$

Notice that public spending does not contribute to either production or household utility.

3. INTERTEMPORAL EQUILIBRIUM

The number of households at each generation grows at a constant rate $n > -1$ such that $1+n = N_{t+1}/N_t$ where N_t is the number of population born at time t . At equilibrium, all markets clears:

- Capital market clears according to capital-accumulation equation: $N_t s_t = K_{t+1}$.
- Labor market clears: $L_t = N_t l_t$.
- Government spending G_t is determined by the balanced budget rule (9).
- By Walras' law, output market also clears: $N_t (c_t + s_t) + N_{t-1} d_t + G_t = AF(K_t, L_t)$.

From market clearing conditions, one can easily demonstrate that:

$$s_t = k_{t+1} (1+n) l_{t+1} \quad (10)$$

Substituting (10) and the first-order conditions of the firms (8) together with conditions (2)-(3) in the first-order conditions (6) and (7) yields the following two dimensional dynamic system of k and l .

$$Bv'(l_t) = u' \left[\frac{\varphi(A\omega(k_t)l_t) - k_{t+1}(1+n)l_{t+1}}{B} \right] A\omega(k_t)\varphi'(A\omega(k_t)l_t) \quad (11)$$

$$v'(l_t) = \beta u' [A\rho(k_{t+1})k_{t+1}(1+n)l_{t+1}] A\rho(k_{t+1})A\omega(k_t)\varphi'(A\omega(k_t)l_t) \quad (12)$$

¹⁰ Notice that $F_L(K, L) = \partial F(K, L) / \partial L$ and $F_K(K, L) = \partial F(K, L) / \partial K$. This notation holds across the paper.

e. The Steady State

The steady state of the dynamic system (11)-(12) is a solution (k, l) of the system:

$$Bv'(l) = u' \left[\frac{\varphi(A\omega(k)l) - k(1+n)l}{B} \right] A\omega(k)\varphi'(A\omega(k)l) \quad (13)$$

$$v'(l) = \beta u' [A\rho(k)k(1+n)l] A\rho(k)A\omega(k)\varphi'(A\omega(k)l) \quad (14)$$

Obviously, there might exist one or multiple steady state for the system (13)-(14). However, to simplify the analysis, we follow Cazzavillan, Lloyd-Braga and Pintus (1998) by showing the existence of a normalized steady state such that $(k, l) = (1, 1)$ by selecting suitably the scaling parameters $A, B > 0$.¹¹

Assumption 4. $1 + \varepsilon_{11} > 0$.

This assumption has been made by, among others, Cazzavillan and Pintus (2004), Bosi and Seegmuller (2008) in order to ensure that consumptions in both periods and leisure are substitutable goods and saving function is increasing in the gross rate of return R .

Proposition 1. Let Assumptions 1 to 4 be satisfied, there exists a steady state of dynamic system (11)-(12) such that $k = 1$ and $l = 1$ for one of these cases:

1. If the following sufficient boundary conditions are satisfied:

$$\lim_{A \rightarrow \underline{A}} \beta u' [A\rho(1)(1+n)] A\rho(1)A\omega(1)\varphi'(A\omega(1)) < v'(1) \quad (15)$$

$$\lim_{A \rightarrow +\infty} \beta u' [A\rho(1)(1+n)] A\rho(1)A\omega(1)\varphi'(A\omega(1)) > v'(1) \quad (16)$$

then, $\exists A^* > \underline{A} \equiv \varphi^{-1}(1+n)/\omega(1)$ such that (14) is verified at $(k, l) = (1, 1)$. However, if at $(k, l) = (1, 1)$, we have $1 + \varepsilon_{11} + \eta_2 + 1 > 0$ for all A , then A is unique (because of the continuity of functions involved in (14), i.e., the functions $\{v, u, F, \varphi\} \in C^2$).

2. If the following sufficient boundary conditions are satisfied:

$$\lim_{A \rightarrow \underline{A}} \beta u' [A\rho(1)(1+n)] A\rho(1)A\omega(1)\varphi'(A\omega(1)) > v'(1) \quad (17)$$

$$\lim_{A \rightarrow +\infty} \beta u' [A\rho(1)(1+n)] A\rho(1)A\omega(1)\varphi'(A\omega(1)) < v'(1) \quad (18)$$

then, $\exists A^* > \underline{A} \equiv \varphi^{-1}(1+n)/\omega(1)$ such that (14) is verified at $(k, l) = (1, 1)$. However, if at $(k, l) = (1, 1)$, we have $1 + \varepsilon_{11} + \eta_2 + 1 < 0$ for all A , then A is unique (because of the continuity of functions involved in (14), i.e., the functions $\{v, u, F, \varphi\} \in C^2$).

Moreover, given the value of A , there exists $B > 0$ which is a unique solution of (13) at $(k, l) = (1, 1)$.

Proof. See Appendix (A).

¹¹ For simplicity, we concentrate on local dynamics around the normalized steady state without illustrating the possible existence of other steady state.

Corollary 1. Suppose that the after-tax income function $\varphi(\omega l)$ is locally isoelastic, then the boundary conditions (15)-(16) are sufficient for the existence of a unique $A > \underline{A}$.

Simply, if $\varphi(\omega l)$ has an isoelastic formulation around the steady state, then one can show that $\eta_2 = \eta_1 - 1$. As a result and according to Assumption 4 we have $1 + \varepsilon_{11} + \eta_2 + 1 > 0$.

f. Local Dynamics

In this section, we study the role of income taxation on the occurrence of endogenous fluctuations due to self-fulfilling prophecies. It is assumed that the after-tax income function $\varphi(\omega l)$ is locally isoelastic which provides that $\eta_1 = 1 + \eta_2$. Linearizing the dynamic equation (11)-(12) around the normalized steady state $k = l = 1$ yields the following Jacobian matrix J :

$$J = \begin{bmatrix} \varepsilon_{11}\gamma/(1-\gamma) & \varepsilon_{11}\gamma/(1-\gamma) \\ \varepsilon_{11} - (1-s)(1+\varepsilon_{11})/\sigma & \varepsilon_{11} \end{bmatrix}^{-1} \begin{bmatrix} Z_2 & Z_1 \\ -s(1+\eta_2)/\sigma & \varepsilon_v - \eta_2 \end{bmatrix} \quad (19)$$

with $Z_1 \equiv \varepsilon_{11}(1+\eta_2)/(1-\gamma) + \eta_2 - \varepsilon_v$ and $Z_2 \equiv s(1+\eta_2)(\varepsilon_{11}/(1-\gamma) + 1)/\sigma$.

The characteristic polynomial of (19) is $P(\lambda) = \lambda^2 - T\lambda + D$, where the trace $T = \lambda_1 + \lambda_2$ and the determinant $D = \lambda_1\lambda_2$ are respectively given by:

$$T = \frac{X_1 + X_2X_3}{\varepsilon_{11}\gamma(1-s)(1+\varepsilon_{11})} > 0 \quad (20)$$

$$D = \frac{s(1+\eta_2)(1+\varepsilon_v)}{\gamma(1-s)(1+\varepsilon_{11})} > 0 \quad (21)$$

with $X_1 \equiv \gamma\sigma\varepsilon_{11}(\varepsilon_v - \eta_2) + s\varepsilon_{11}(1+\eta_2)(1+\varepsilon_{11})$, $X_2 \equiv (1-s)(1+\varepsilon_{11}) - \sigma\varepsilon_{11}$ and $X_3 \equiv (\eta_2 - \varepsilon_v)(1-\gamma) + \varepsilon_{11}(1+\eta_2)$.

In this model, l_t is an independently non-predetermined variable, this means that the steady state is locally indeterminate if and only if both eigenvalues are located within a unit circle, i.e., $\lambda_1, \lambda_2 \in (-1, +1)$. Using the fact that the trace T and the determinant D are respectively the sum and the product of the eigenvalues, then local indeterminacy requires that $D < 1$ and $T < 1 + D$.

Therefore, we study analytically the conditions where the above inequalities are satisfied using the following parameters $\sigma, \varepsilon_{11}, \gamma, \eta_2$ and ε_v . As previously defined that is the elasticity of capital-labor substitution, ε_{11} is the elasticity of marginal utility of consumption, γ is the propensity to save (saving over after-tax labor income), η_2 is the degree of marginal progressivity labor-income taxes, ε_v is the elasticity of labor supply.

We present the critical values for $\eta_2, \varepsilon_{11}, \gamma, \sigma$ and ε_v in Appendix (B). Our main results are summarized in the following proposition:

Proposition 2: Given that $\gamma > \max\{\gamma^*, \gamma^D\}$ and $\sigma < \sigma^*$ together with Assumptions 1-4, local indeterminacy emerges at the following conditions:

1. $-1 < \varepsilon_{11} < \varepsilon_{11}^D$ for all ε_v and $\eta_2 < \eta_2^D$.
2. $\varepsilon_{11}^D < \varepsilon_{11} < 0$ with either $\varepsilon_v < \varepsilon_v^D$, for all η_2 or $\varepsilon_v > \varepsilon_v^D$ and $\eta_2 < \eta_2^D$.

Proof. See Appendix C.

Mainly, Proposition (2) states that endogenous fluctuations require a sufficiently low elasticity of capital-labor substitution and high saving rates. Moreover, the presence of high progressive taxations (η_2 is sufficiently low) enforces the appearance of indeterminacy.

4. DISCUSSIONS

In order to complete the characterization of economic stability, we provide the economic interpretations for local indeterminacy and show how the presence of progressive tax influences the appearance of endogenous cycles.

Before going through the economic intuition, we need to do the following computations: using (8) and the elasticity of interest rate $k\rho'(k)/\rho(k) = -(1-s)/\sigma$, we get:

$$\frac{\partial R_{t+1}}{R_{t+1}} = -\frac{(1-s)}{\sigma} \frac{\partial K_{t+1}}{K_{t+1}}, \quad \frac{\partial R_{t+1}}{R_{t+1}} = \frac{(1-s)}{\sigma} \frac{\partial L_{t+1}}{L_{t+1}} \quad (22)$$

$$\frac{\partial l_t}{l_t} = \frac{1+\eta_2}{\varepsilon_v - \eta_2} \frac{\partial w_t}{w_t}, \quad \frac{\partial l_t}{l_t} = \frac{1+\varepsilon_{11}}{\varepsilon_v - \eta_2} \frac{\partial R_{t+1}}{R_{t+1}} \quad (23)$$

The model of Cazzavillan and Pintus (2004) is recovered by setting zero labor income taxes, i.e., $\eta_2 = 0$. The objective of this section is to show how a high tax progressivity promotes indeterminacy. Endogenous fluctuations arise due to the presence of interaction of two conflicting effects on savings that operate through wages and real interest rate.

Let us start by the Benchmark model where $\eta_2 = 0$. Assume at time t an instantaneous increase in current capital stock K_t from its steady state. This generates two opposite effects through wages and interest rate: an increase in K_t implies a rise in the wage income, and according to (23), agents supply more labor. Given the budget constraint of young agents (2), a rise in wage income implies a rise in K_{t+1} .

The second effect is the anticipation effect that plays in the opposite direction in the sense that a higher K_{t+1} is followed by a decline in the interest rate R_{t+1} . Given

that $\frac{\partial l_t}{l_t} / \frac{\partial R_{t+1}}{R_{t+1}} = (1+\varepsilon_{11})/\varepsilon_v$, then a decrease in R_{t+1} is followed by a decline in the labor supply

and according to the budget constraint, a low accumulation of capital K_{t+1} occurs. A cyclical path emerges whenever anticipation effect dominates current effect. This setting requires a sufficiently low elasticity of capital-labor substitution as shown in (22) and a low elasticity of marginal disutility of labor ε_v as shown in (23). Indeed, equality (23) shows that the interest rate has a strong influence on current labor supply for sufficiently high elasticity of intertemporal substitution in consumption.

In the presence of a progressive tax,¹² equation (23) shows that a higher progressivity ($\eta_2 \rightarrow -1$) implies a lower elastic labor supply to both expected interest rate and real wage. In particular, when η_2 is close enough to -1 , wages do not have any influence on labor supply (see (23)). As a result, this makes the anticipation effect more dominant than the current effect and so deterministic cycles are more likely to appear. Therefore, progressive taxes act as a destabilizing factor. This result is reasonable because introducing progressive taxes on labor income can stabilize wage income only. However, this is not enough to stabilize future consumptions since the latter depends on the capital real returns.

Above results are almost similar to those obtained by Chen and Zhang (2009a) with linear tax policy. Conversely, D-P (2006) consider a model where agents can consume only in the second period and save in the first period. They demonstrate that progressive taxation of capital income performs as a stabilizer factor. Intuitively, our results are in line with Dromel and Pintus in the sense that tax progressivity does not perform as a stabilizer if consumptions are partially financed by a non-taxed capital income.

Finally, in order to study the effect of the saving rate on steady state stability, consider the bifurcation value of $\sigma = \sigma^*$ given by (30) in the Appendix and differentiate it with respect to γ , we obtain

$$\frac{\partial \sigma^*}{\partial \gamma} = \frac{(1-s)(1+\varepsilon_{11})}{\varepsilon_{11}} \frac{\varepsilon_{11} + \eta_2 - \varepsilon_v}{\varepsilon_v - \eta_2 - \varepsilon_{11}(\eta_2 + 1)} > 0 \quad (24)$$

Therefore, a higher saving rate makes the emergence of local indeterminacy more likely. This result is analogous to Cazzavillan and Pintus (2004) after setting $\eta_2 = 0$. Therefore, in their model, the necessary condition for local indeterminacy becomes $\sigma < \sigma_{C,P}^*$ with

$$\sigma_{C,P}^* \equiv -\frac{s + (1 + \varepsilon_{11})(1-s)\gamma - 1}{\varepsilon_{11}}$$

The positivity of $\sigma_{C,P}^*$ requires a sufficiently high saving rate, that is, $\gamma > \gamma_{C,P}$ with $\gamma_{C,P} \equiv (1 + \varepsilon_{11} - s)/(1 + \varepsilon_{11})(1-s)$. Additionally, one can easily find that $\sigma_{C,P}^* < s$ and $\partial \sigma_{C,P}^* / \partial \gamma > 0$. Thus, endogenous fluctuations necessitate a low elasticity of input substitution (complementary inputs) and a high propensity to save.

5. A NUMERICAL ILLUSTRATION

In this example, we present numerically the analytical results obtained in Proposition (2). To do that, consider the following explicit formulas for the production function, the preference and the after-tax income function respectively:

$$y = Af(k) = A[s k^{-\zeta} + (1-s)]^{-1/\zeta} \quad (25)$$

$$u(x) = \frac{x^{1-\varepsilon}}{1-\varepsilon} \text{ and } v(l) = \frac{l^{1+\chi}}{1+\chi} \text{ with } x = \frac{c}{B}, d \quad (26)$$

$$\varphi(w_t l_t) = (w_t l_t)^{1+\eta_2} \quad (27)$$

with $A > 0$ is the a scaling parameter, $s \in (0,1)$, $\eta_2 \in (-1,0)$, $\varepsilon \in (0,1)$, $\chi > 0$ and $\zeta > -1$ with $\zeta \neq 0$, $n = 0.5175$ and $\beta = 0.3$. Further, one can easy show that the elasticity of capital-labor substitution is $1/(1+\zeta)$, the elasticity of marginal utility of consumption is $\varepsilon_{11} = -\varepsilon < 0$

¹² Notice that the presence of a progressive tax implies that η_2 declines from 0 to -1 .

which is the inverse of the elasticity of intertemporal substitution in consumption $-1/\varepsilon$, the elasticity of marginal labor supply is simply $\varepsilon_v = \chi$ and the first-order elasticity of after-tax income is $1 + \eta_2 \in (0,1)$.

Given the normalized steady state $(k; l) = (1,1)$ then, capital share in total income does not depend on the elasticity of capital-labor substitution, thus $s \in (0,1)$. Let us set $s = 1/3$, then according to Proposition (2) one can show that the critical value $\varepsilon_{11}^D = -1/2$. Consistent with case (1) of Proposition (2), choose $\varepsilon = 0.55$ and $\chi = 1$ we obtain $\eta_2^D = -0.55$. Therefore, consider $\eta_2 = -0.8$, we can easily compute the lower bound of the propensity to save values $\gamma^D = 0.44444$ and $\gamma^* = 0.73215$. Since $\gamma > \max\{\gamma^*, \gamma^D\}$, then choose $\gamma = 0.74$, we get that indeterminacy appears if and only if both eigenvalues of Jacobian matrix (19) belong to a unit cycle, i.e., $\lambda_1, \lambda_2 \in (-1,1)$. Therefore, setting $\sigma = 0.005$, we show that endogenous cycles emerge for above critical values with $\lambda_1 = 0.99419 \in (0,1)$ and $\lambda_2 = 0.60411 \in (0,1)$. Finally, given the above values, we compute the scaling parameter value $A = 12.134 > \underline{A} = 12.071$ which is necessary for normalizing the steady state.

Concerning the case (2) of Proposition (2), choose $\varepsilon = -0.4$ we obtain that $\varepsilon_v^D = 0.2$. Choose again $\varepsilon_v = 0.1$ and $\eta_2 = -0.5$, we can compute that $\gamma^D = 0.45833$ and $\gamma^* = 0.71667$. Thus, set $\gamma = 0.72$ we deduce the upper bound of the elasticity of capital-labor substitution $\sigma^* = 4.1667 \times 10^{-3}$, as a result, for $\sigma = 0.004$, endogenous cycles appear with eigenvalues: $\lambda_1 = 0.99872$ and $\lambda_2 = 0.63739$ and the scaling parameter $A = 6.2145 > 3.4542 = \underline{A}$.

The second conditions of case (2) are $\varepsilon_v > \varepsilon_v^D$ together with $\eta_2 < \eta_2^D$. Let us set $\varepsilon_v = 0.8$, then we get $\eta_2^D = -0.33333$. Therefore, choose $\eta_2 = -0.7$, then the saving rate values are $\gamma^D = 0.45$ and $\gamma^* = 0.78947$. If we consider $\gamma = 0.8$, then $\sigma^* = 1.2346 \times 10^{-2}$, so that, indeterminacy is obtained for $\sigma = 0.01$ with the eigenvalues: $\lambda_1 = 0.97181$ and $\lambda_2 = 0.57882$ with $A = 9.9204 > 6.0236 = \underline{A}$.

According to above numerical example, it is shown that local indeterminacy is obtained for non-plausible values of saving rate γ .¹³ Moreover, one can observe that endogenous cycles require a sufficiently low elasticity of capital-labor substitution close to the Leontief case. However, for realistic values of consumption-wage ratio, around 65%, indeterminacy is no longer appears and the equilibria is locally unique and converges to the steady state.

6. CONCLUSION

We have studied the effect of a progressive labor-income tax policy on steady state properties in an OLG model where agents can consume in both periods (young and old). It is supposed separable preferences with respect to current-period consumption, future-period consumption and labor supply. Agents have to pay taxes related to their wage income. Further, the production function exhibits a constant return-to-scale property. It is shown that progressive taxes act as a destabilizing factor where it makes endogenous fluctuation more likely. Similar to previous literature, indeterminacy occurs for sufficiently low elasticity of factor substitution close to Leontief and non-realistic high values of young's saving rate.

¹³ The annual ratio of personal consumption expenditures over GDP has an average of 0.65 over the period (1959 – 2008) for US economy (see Economic Report of the President, 2008).

APPENDIX

A) Proof of Proposition 1.

Consider (13) and (14) at the normalized steady state $(1,1)$, we get:

$$v'(1) = \frac{1}{B} u' \left[\frac{\varphi(A\omega(1)) - (1+n)}{B} \right] A\omega(1) \varphi'(A\omega(1)) \quad (28)$$

$$v'(1) = \beta u' [A\rho(1)(1+n)] A\rho(1) A\omega(1) \varphi'(A\omega(1)) \quad (29)$$

Let us start with equality (29): LHS is a positive constant but the RHS is either increasing or decreasing in A . If we denote the RHS as $Q(A)$, then one can show that $\partial Q / \partial A = 1 + \varepsilon_{11} + \eta_2 + 1$ which depends on A . Whenever $\partial Q(A) / \partial A > 0$ (resp. < 0), then the RHS of (29) is strictly increasing (resp. decreasing) in A . Moreover, the positivity of first period consumption requires $A > \underline{A} \equiv \varphi^{-1}(1+n) / \omega(1)$.

Let us firstly focus on the case where $\partial Q(A) / \partial A > 0$. In this case, the existence of a value A^* that solves (29) requires the following boundary conditions: $\lim_{A \rightarrow \underline{A}} RHS < v'(1)$ and $\lim_{A \rightarrow +\infty} RHS > v'(1)$. Notice that if $\partial Q(A) / \partial A > 0$ for all A , then A^* is unique.

However, when $\partial Q(A) / \partial A < 0$, the existence of A^* which solves (29) necessitates initially $\lim_{A \rightarrow \underline{A}} RHS > v'(1)$ and further $\lim_{A \rightarrow +\infty} RHS < v'(1)$. If $\partial Q(A) / \partial A < 0$ for all A , then A^* is unique.

Given $A = A^*$, then from (28), the LHS is a positive constant and the RHS is decreasing in B according to Assumption 4. In addition, $\lim_{B \rightarrow 0^+} RHS = +\infty$ and $\lim_{B \rightarrow +\infty} RHS = 0^+$, therefore, there exists a unique $B^* > 0$ that solves (28).

Consequently, we have shown that there are unique $A^* > \underline{A}$ and $B^* > 0$ such that $(k, l) = (1, 1)$ is a steady state of the system (11)-(12). ■

B) The critical values.

Here, we present the critical values of the model:

$$\sigma^* \equiv \frac{\varepsilon_{11}(1+\eta_2)[s(1+\varepsilon_v) - (1+\varepsilon_{11})] + (1-s)(1+\varepsilon_{11})[(\varepsilon_v - \eta_2)(1-\gamma) + \varepsilon_{11}\gamma]}{\varepsilon_{11}[\varepsilon_v - \eta_2 - \varepsilon_{11}(1+\eta_2)]} \quad (30)$$

$$\gamma^* \equiv \frac{\varepsilon_{11}(1+\eta_2)(1+\varepsilon_{11} - s(1+\varepsilon_v)) - (1-s)(1+\varepsilon_{11})[\varepsilon_v - \eta_2]}{(\varepsilon_{11} + \eta_2 - \varepsilon_v)(1-s)(1+\varepsilon_{11})} \quad (31)$$

$$\gamma^D \equiv \frac{s(1+\eta_2)(1+\varepsilon_v)}{(1-s)(1+\varepsilon_{11})} \quad (32)$$

$$\eta_2^* \equiv -\frac{\varepsilon_{11}s(1+\varepsilon_v) + (1+\varepsilon_{11})(1-s)\varepsilon_v - \varepsilon_{11}}{\varepsilon_{11}s(1+\varepsilon_v) - (1+\varepsilon_{11})(1-s + \varepsilon_{11})} \quad (33)$$

$$\eta_2^D \equiv \frac{(1-s)(1+\varepsilon_{11})-s(1+\varepsilon_v)}{s(1+\varepsilon_v)} \quad (34)$$

$$\varepsilon_v^D \equiv \frac{(1-s)(1+\varepsilon_{11})-s}{s} \quad (35)$$

$$\varepsilon_{11}^D \equiv \frac{2s-1}{1-s} \quad (36)$$

$$\varepsilon_{11}^{**} \equiv s-1 \quad (37)$$

C) Proof of Proposition 2.

In this proposition, we show that the existence of endogenous fluctuations requires $D < 1$ and $T < 1 + D$. Let us begin with $D < 1$.

$D < 1$ if and only if $\gamma > \gamma^D$ with $\gamma^D > 0$. However, $\gamma^D < 1$ is met if and only if $\eta_2 < \eta_2^D$ with $\eta_2^D > -1$. Since η_2 is the second-order elasticity, then it should always be negative, so $\eta_2^D < 0$ if and only if $\varepsilon_v > \varepsilon_v^D$. One has to be sure that ε_v^D is positive, a direct inspection implies that for $\varepsilon_v^D > 0$ if and only if $\varepsilon_{11} > \varepsilon_{11}^D$.

As a result $D < 1$ for (1) $\varepsilon_{11} > \varepsilon_{11}^D$, $\gamma > \gamma^D$ and either $\varepsilon_v > \varepsilon_v^D$ and $\eta_2 < \eta_2^D$ or $\varepsilon_v < \varepsilon_v^D$, for all $\eta_2 < 0$. In addition, (2) $D < 1$ for $\varepsilon_{11} > \varepsilon_{11}^D$, $\eta_2 < \eta_2^D$ and $\gamma > \gamma^D$ for all $\varepsilon_v > 0$.

Furthermore, $T < 1 + D$ if and only if $\sigma < \sigma^*$. The latter inequality requires $\sigma^* > 0$ which is met for $\gamma > \gamma^*$ with $\gamma^* < 1$. The positivity of requires that $\gamma^* > 0$ and this inequality is satisfied if and only if $\eta_2 < \eta_2^*$. It is immediate to verify that $\eta_2^* > 0$ for $\varepsilon_{11} > \varepsilon_{11}^{**}$ and $\eta_2^* < 0$ for $\varepsilon_{11} < \varepsilon_{11}^{**}$. On the one hand, when $\eta_2^* > 0$, then $\gamma^* > 0$ for all $\eta_2 < 0$.

As a result, $T < 1 + D$ for $\sigma < \sigma^*$ and $\gamma > \gamma^*$ with $\varepsilon_{11} > \varepsilon_{11}^{**}$ for all $\eta_2 \in (-1, 0)$ and all values of $\varepsilon_v > 0$. On the other hand, whenever $\varepsilon_{11} < \varepsilon_{11}^{**}$ then $\eta_2^* \in (-1, 0)$ always. As a result, $T < 1 + D$ for $\sigma < \sigma^*$, $\varepsilon_{11} < \varepsilon_{11}^{**}$ and for all $\varepsilon_v > 0$ with either $\gamma > \gamma^*$ and $\eta_2 < \eta_2^*$ or $\gamma \in (0, 1)$ and $\eta_2 > \eta_2^*$.

If we do the intersection between the conditions of $D < 1$ and those of $T < 1 + D$ and considering that $\varepsilon_{11}^{**} < \varepsilon_{11}^D$ and $\eta_2^D < \eta_2^*$ for $\varepsilon_{11} < \varepsilon_{11}^{**}$, we get the local indeterminacy conditions summarized in Proposition (2).

REFERENCES

- Becker, R. A. (1980), "On the Long-run Steady State in a Simple Dynamic Model of Equilibrium with Heterogeneous Households", *Quarterly Journal of Economics* 95, 375-382.
- Benhabib, J., and Farmer, R. (1994), "Indeterminacy and Increasing Re-returns", *Journal of Economic Theory* 63, 19-41.
- Bosi, S. and Seegmuller, T. (2008), "Can Heterogeneous Preferences Stabilize Endogenous Fluctuations?" *Journal of Economic Dynamics and Control* 32, 624-647.
- Bosi, S. and Seegmuller, T. (2010), "On the Role of Progressive Taxation in a Ramsey Model with Heterogeneous Households", *Journal of Mathematical Economics* 45, pp. 977-996.
- Cazzavillan, G., and Pintus, P. (2004), "Robustness of Multiple Equilibria in OLG Economies", *Review of Economic Dynamics* 7, 456-475.
- Cazzavillan, G., Llyod-Braga, T. and Pintus, P. (1998), "Multiple Steady States and Endogenous Fluctuations with Increasing Returns to Scale in Production", *Journal of Economic Theory* 80, 60-107.
- Chen, Y., and Zhang, Y. (2009a), "Endogenous Income Taxes in OLG Economies", MPRA Paper No. 16412.
- Chen, Y., and Zhang, Y. (2009b), "Endogenous Income Taxes in OLG Economies: A Clarification", MPRA Paper No. 16824.

- Dromel, N., and Pintus, P. (2006), "Are progressive Fiscal Rules Stabilizing?" Document de Travail 05, GREQAM.
- Dromel, N., and Pintus, P. (2007), "Linearly Progressive Income Taxes and Stabilization", *Research in Economics* 61, 28-29.
- Dromel, N., and Pintus, P. (2008), "Are Progressive Income Taxes Stabilizing?" *Journal of Public Economic Theory* 10, 329-349.
- Gokan, Y. (2009a), "Dynamic Effects of Government Budgetary policies in Reichlin's Overlapping Generations Model with Externalities", Mimeo.
- Guo, J.-T. (1999), "Multiple Equilibria and Progressive Taxation of Labor Income", *Economic Letters* 65, 97-103.
- Guo, J.-T., and Harrison, S. G. (2004), "Balanced-Budget Rules and Macroeconomic (In) stability", *Journal of Economic Theory* 119, 357-363.
- Guo, J.-T., and Harrison, S. G. (2008), "Useful Government Spending and Macroeconomic (In)stability Under Balanced-Budget Rules", *Journal of Public Economic Theory* 10, 383-397.
- Guo, J.-T., and Lansing, K. (1998), "Indeterminacy and Stabilization Policy", *Journal of Economic Theory* 82, 481-490.
- Hall, R. and Rabushka, A. (1995), "The Flat Tax", 2nd Edition, Hoover Institute Press, California.
- Llyod-Braga, T., Modesto, L., and Seegmuller T. (2008), "Tax Rate Variability and Public Spending As Sources of Indeterminacy", *Journal of Public Economic Theory* 10, 399-421.
- Musgrave, R.A., and Thin, T. (1948), "Income Tax Progression, 1929-1948", *Journal of Political Economy* 56, 498-514.
- Reichlin, P., (1986), "Equilibrium Cycles in an Overlapping Generations Economy with Production", *Journal of Economic theory* 40, 89-102.
- Sarte, P.-D. (1997), "Progressive Taxation and Income Inequality in Dynamic Competitive Equilibrium", *Journal of Public Economics* 66, 145-171.
- Seegmuller, T. (2003), "Endogenous Fluctuations and Public Services in a Simple OLG Economy", *Economic Bulletin* 5, No.10, 1-7.
- Schmitt-Grohé, S., and Uribe, M. (1997), "Balanced-Budget Rules, Distortionary Taxes, and Aggregate Instability", *Journal of political Economy* 108, No. 05.
- Sorger, G. (2002), "On the Long-run Distribution of Capital in the Ramsey Model", *Journal of Economic Theory* 105, 226-243.
- Woodford, M. (1986), "Stationary Sunspot Equilibria in a Finance Constraint Economy", *Journal of Economic Theory* 40, 128-137.

THE LONG WAVES IN THE POST-INDUSTRIAL ECONOMY

VICTOR Ye. DEMENTIEV¹

ABSTRACT

Possibility of preservation of Kondratiev cycles in the conditions of post-industrial economy is considered. The reasons of emergence of doubts in such opportunity are explained. The role of complexity of innovations in preservation of recurrence of development of economy during a post-industrial era is shown. The special attention is paid to not monotony of accumulation of knowledge. The relationship between changes in the financing of basic research in the United States industry and the phases of the long wave of economic development is explained.

KEYWORDS: *Kondratiev cycles, post-industrial economy, network effects, long waves in economy, innovation.*

JEL classification: E32; L11; O31; O32;

Received: February 25, 2014 / Accepted: September 12, 2014

1. INTRODUCTION: THE FEATURES OF POST-INDUSTRIAL ECONOMY AS A SOURCE OF DOUBTS IN PRESERVATION OF LONG WAVES

The post-industrial economy is related to the accumulation of human capital. The pace of its renewal presents to be a key factor shaping the dynamics of production. If the human society faces the process of transition to lifelong learning, then the absence of significant pulsations in accumulating this factor looks as the expression of a new nature of economic development.

Such a concept as 'the innovative conveyor' sometimes is featured in the discussions of the modern innovative problematics. According to one of the treatments, it represents a 'technological' line, where the inputs are the knowledge and competencies and the output is the production (products and services - Derbeneva 2003). Another treatment of this conveyor implies the interminable process of realizing the innovative projects just one after another without any delays. The renewal of the technological economy basis presents not as massive investments in the fixed assets of large corporations but as the investment conveyor from which new productions having much less sizes come from.

The beginning of postindustrial economy sometimes is viewed as the time of replacement of easily reorganized network structures with relatively small participants for the large corporations. It is argued that under the information and network economy physical size of an enterprise loses its significance because of virtualising many stages of the production cycle, that the intellectual companies cannot have any tangible assets at all (or almost at all - Diatlov et al. 2008, pp. 117-118). Under the prevalence of such companies in the post-industrial economy the necessity of accumulating large amounts of resources for the renewal of technological basis of production remains a disputable point. Such necessity is one of the cyclicity factors in the concept of N.D. Kondratiev (2002). One should take notice of the fact that in the picture of cyclic waves in the economy of the United States presented by Klepach and Kuranov (Klepach and Kuranov 2003) the amplitude of regular cycles is decreasing gradually.

What factors are capable to lead to keeping of long waves in the post-industrial economy?

¹ Professor, CEMI RAS (Moscow, Russia), E-mail: dementev@cemi.rssi.ru

2. POSTINDUSTRIAL DEMAND AND MASS PRODUCTION

The postindustrial epoch is related reasonably to the multiplying of human needs and their individualization. Though the individualization of needs as well as the growth of uncertainty because of increasing the rate of technological development don't exclude the necessity of realizing the large projects, in particular, in the energy area. According to the assessment of Makarov and Kleiner, one should expect that in future the era of individualization and that of standardization will alternate with each other (Makarov, Kleiner, 2007, p. 50).

A personal computer became the symbol of the postindustrialization of some kind which has begun. Such computer has provided huge opportunities for repairing the individual nature of the very process of working destroyed by the industrial capitalism. The individual configuration of personal computers is made of the elements manufactured in the mass order. The development of modern information technologies provides increasingly more opportunities to combine conveyor manufacturing with executing the individual orders.

Significant niches for the large business remain in the post-industrial economy, despite the individualization of demand and supply. The competition induces its representatives to make forced investments into new General Purpose Technologies (GPTs), when somebody of the rivals behaves so. Being late in such sectors causes the loss of market positions. The competition pressure becomes the factor of a certain synchronization of investments into the radical innovations, which results in disturbing the uniformity of the innovation process and contributes to this process being performed in separate efforts.

3. THE INEQUALITY OF TECHNOLOGICAL DEVELOPMENT BECAUSE OF INNOVATIONS COMPLEXITY

The synergetic effects determined by the linkages between the technological innovations remain the factor of inequality of innovation process in the post-industrial economy. So far, J. Schumpeter and S. Kuznets took notice of this fact. The cyclic fluctuations in the level of those stocks of technological inventions and R&Ds which are addressed by entrepreneurs seeking new effective combinations of production factors, emerge as a cause of the wave nature of economic development (Kuznets, 1940, p. 263). According to the estimation of S. Kuznets, such explanation is trustworthy as 'there may be pauses when there is no large potential available to make changes to incentivize and motivate the leading force of the entrepreneurial genius' (Kuznets, 1940, p. 264). He notes that the pulsation of such kind can be adopted only for the most important innovations, such as the energy of steam, electricity and so on, that is the innovations connected with the Kondratiev cycles (Ibid.). Indeed, S. Kuznetz has specified the innovations that began to feature as the GPTs further.

The Helpman and Thachtenberg model enables to present the influence of synergetic effects on the development of such technologies. The model implies deriving two stages in forming the GPT. The components of a new technology are developed at the first stage. The transition to a new production technology happens when the amount of this components reaches some critical level. That is a synergetic effect. The critical level can be consistent with such amount of components, which can be a starting point of profitability of a new technology (Helpman, Trajtenberg, 1998).

4. THE INFLUENCE OF NETWORK EFFECTS ON THE PRODUCTION AND TECHNOLOGY RENEWAL

Many markets of information products and services are featured by the network effects. The specific feature of the markets with such effects is the existence of a threshold level of the amount of purchasers (of their critical mass). The offered product (or a service) becomes attractive for a wide mass of consumers and the demand is increasing fast after exceeding this threshold level.

For the markets with network effects one may talk about the critical mass of innovative investments. The ability of innovator to mobilize in a short period of time such amount of invest-

ments that will enable to act ahead in forming a critical mass of acquirers, and, as a consequence, to capture leading positions in the relative market is meant.

It's not surprising that the leading role in the world sector of information and communication technologies belongs to the large transnational business which accounts for about 90% of the world output of this sector. Whereas each of the leading 250 companies has the return exceeding 5 billion dollars a year, mergers and acquisitions are still going on. The amount of cross-border transactions of such kind in the ICT sector for the recent years remains at the level of 1500 per year with total cost accounting for 180 billion dollars (Brodsky, 2009).

The network effects enforce the motivation to fill the markets intensely. The open innovations of different kinds serve as one of the tools of this acceleration. When it is analyzed, the central attention is usually paid to the mutual development of new products and technologies, when a rather flexible policy for the intellectual property is conducted for sake of uniting such efforts. (Chesbrough, 2012). The treatment of open innovations as a readiness for sharing the developments to promote successfully the innovative ideas and products appears to be very relevant for the markets with network effects (West, Gallagher, 2006). It can be evidenced by the actions of the US company connected with manufacturing electromobiles Tesla in this respect². It removed the restrictions imposed on using its patents. The actions of such kind enhance the paces of innovation diffusion, which can lead to the waveability of economic development even under the uniform innovation flow (Polterovich, Khenkin, 1988).

5. THE PROBLEM OF COORDINATION OF INNOVATION PROCESSES AS A FACTOR OF THEIR NOT MONOTONY

As S. Kuznets (1940, p. 263) noticed, the large-scale innovations are connected with the change of existing economic relations and as long as their reorganisation is going on, it prevents the next large innovation from being implemented successfully. Despite the sceptical attitude of Kuznets to such explanation, it is close to a later treatment of the role of institutional circumstances in the process of renewal of the technological basis of production (Freeman and Perez 1988; Van Duijn 1983). It concerns the fact that this renewal is being braked until the institutional innovations open the scope for new technological trends, to concentrate the entrepreneurial activity along these trends.

Though the effective selection of institutional innovations implies the preceding experience accumulation and the selection of new prospective technologies, the removal of barriers for which is ensured is ensured by such innovations. Hence, a certain move along the technological trends of a new long wave is going on within the economic relations of the preceding long wave. The necessity of institutional preparation for the next moving along these trends can be viewed as one of the reasons of interim break during the rise period of the long wave.

At the same time, the issue, what obstacles the institutional innovations in the development of new technologies help to overcome, if the implementation of these innovations starts even without such innovations remains open. Addressing the problem of coordination of such innovations, which are not limited to the fragmentary improvement of the technological base of production but ensure its principal renewal, helps to find a solution for such problem.

Some researchers (Teece 1986; Stieglitz and Heine 2007; Rayna and Striukova 2009) point to the importance of additional assets to ensure the success of innovations. Such assets can involve the network of suppliers or business partners, manufacturing machinery, customers base and reputation. The thesis about the necessity of additional assets to ensure the successful competition at the innovation markets is very close to the idea about a special set of resources to realize the potential of such technologies inherent to the Shumpeterian models focused on the GPTs. The larger the range of such resources is, the more complex is the task of ensuring the coordinated formation of capacities for the production of these resources.

² Fashion for Tesla: the Russian businessmen leave their cars for electromobiles(<http://top.rbc.ru/retail/17/06/2014/930722.shtml>).

When the potential of a GPT gets to its exhaustion stage, the resistance of institutions ensuring the coordination of activity based on this technology is able to impede the timely renewal of the institutional system and the radical renewal of technological base of production together with it. In the opinion of Bresnahan and Trajtenberg, the institutions which are designed to solve the problems of coordination, happen to be more inertial than the leading technologies. It results in the fact that institutional changes and the technological development incentivized by them have a non-monotony nature.

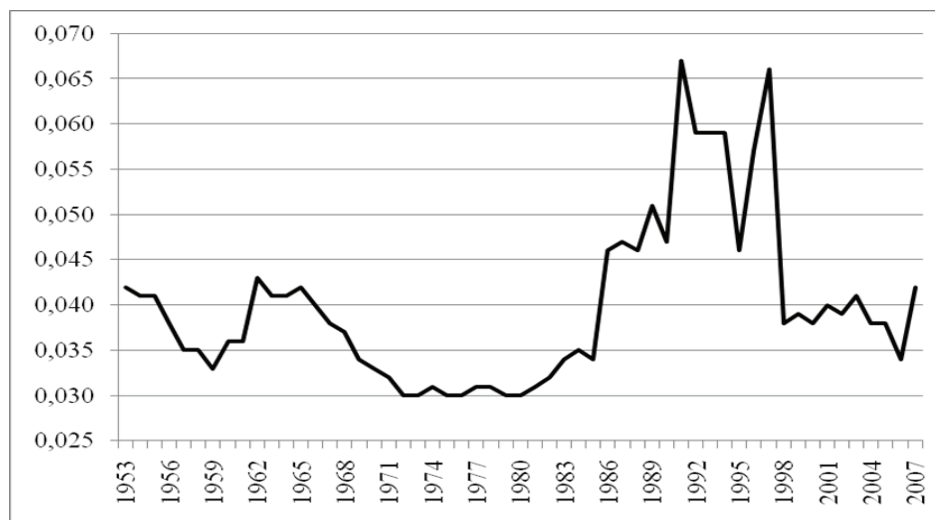
6. NON-MONOTONY NATURE OF KNOWLEDGE ACCUMULATION

One of explanations of the pauses in the innovative activity of entrepreneurs relates these pauses to the exhaustion of the stock of inventions which are able to serve as a basis for new directed technical changes. As S. Kuznets (1940, p. 264) notes, such situation can be determined, in particular, by the functioning of economic system. For example, the electricity had to wait until the economic opportunities of the steam are exhausted by the economic system and until the attention of inventors and engineers is not addressed towards the problems of using electricity. If it is so, then the proposition on the disruptions in the development of technological opportunities should be analyzed based on the historical evidence.

This recommendation of Kuznets began to be realized in 1970th, when the discussion of the long waves became active again. The attention was paid to find the thickenings in the historical sequence of the basic innovations, as well as to define the stages of the long wave during which such thickenings happen. The studies of G. Mensch played a key role in the revival of discussions on these points. G. Mensch linked the cyclic activation of basic innovations with the depression stages of the long waves. The analysis of Mensch was continued and underpinned by the studies of Kleinknecht (1981, 1987) based on a much wider data set. Though the groundlessness of criteria of selecting the innovations remains the weak feature of statistical innovation clasterization studies of such kind. As a result, both, a steam-engine and a pen, appear in the same row of basic innovations.

Under the current conditions the fundamental studies play a major role in forming new directed technical changes. In this connection deriving the regularities of development of such studies during the period of emerged formation of the knowledge economy can shed light on the likelihood of the innovative pauses emergence and wave phenomena appearance during the growth of such economy.

Fig. 1: The share of financing basic research in the expenditures on R&D in the US industry



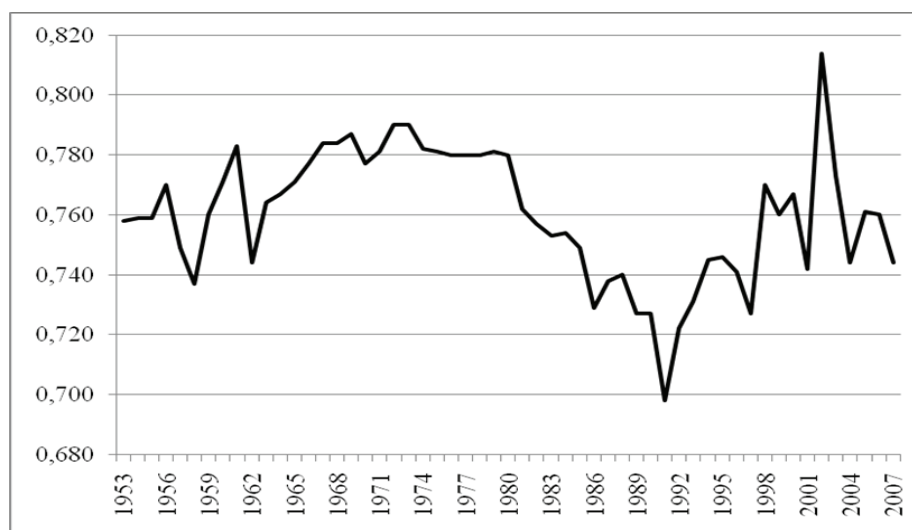
Source: Calculated using the data of the National Science Foundation

The changing attention to the fundamental studies can be evidenced by the dynamics of the share of expenditures connected with them in the US industry (Figure 1). It can be seen that the scientific activity shifted to the area of basic research in 1960th and 1980th. In terms of dating the long waves, these periods happen at the stages of maturity and depression of the fourth long wave. Simultaneously, the years since the mid-80th to the first middle of 1990th should be viewed as a transition period of some kind in the US economy from the aggression stage to the synergy stage of the fifth long wave (Dementiev 2012).

How can the presented evolution of financing fundamental studies be explained? The maturity stage of the long wave is featured by the gradual exhaustion of potential of improvements of technological basis of this wave. The decreasing return from the investments in such improvements follows the next decline of the long wave. The diminishing share of funds to support the improving research in 1970th and 1980th (Fig. 2) is admissible to be interpreted as a reaction to such situation connected with technologies of the fourth long wave.

The aim to enlarge the scientific base for a new large step in technological development leads to the increase of the share of financing basic research at the maturity stage of the long wave. The applied research designed to seek the abilities of commercialization of scientific inventions and using elements of new technologies to prolong the lifecycle of existing production processes become active, when improving the technologies that are at this stage doesn't provide any significant competitive advantages (Fig. 3). Though such way of improving them has its own limits which influence the share of financing the applied research in 1970th.

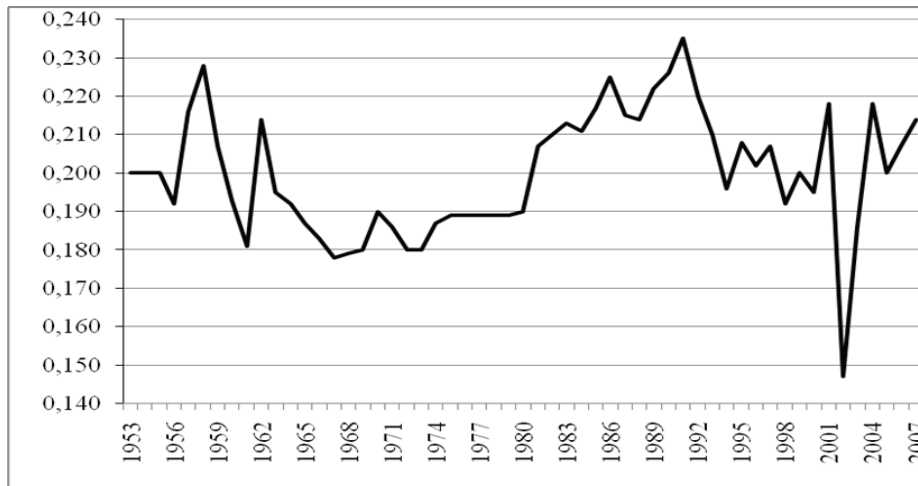
Fig. 2: The share of financing the improving research in the expenditures on R&D in the US industry



Source: Calculated using the data of the National Science Foundation

Approaching these limits means that the prospects of the further development are connected with forming new sectors. Though, what will be the image of a new technological base of production is found during the process of forming and testing different directed technical changes under the transition period. Such research is supported by fundamental and applied studies having quite a high share of financing (Figs 1 and 3). The accumulation of knowledge complex ensuring its effective commercialization comes to the front. In addition, the attention to specific directed technical changes has been growing not only in applied research but in the fundamental ones as well. When new prospective sectors have already emerged, the share connected with these research in the structure of financing R&Ds is decreasing and the share of improving research is growing (Fig. 2).

Fig. 3: The share of financing applied research in the expenditures on R&D in the US industry



Source: Calculated using the data of the National Science Foundation

The presented sequence of changes in distributing investments in R&Ds has its own economic sense. On the other side, it is these changes that influence the economic situation. The cyclic shifting of emphases in the studies being determined by the change of demands for the nature of their results presents to be an important component of the inner mechanism of forming long waves of economic development. The rhythm of big cycles, emergence of breaks as innovative pauses in them, the service terms of basic capital goods depend, in most part, on this component. There is no reason to suggest that the logics of knowledge accumulation won't keep further in the post-industrial economy.

7. CONCLUSION

The factors which can add long-wave fluctuations to the innovative development, will act under the post-industrial epoch as well. A special issue is connected with the amplitude of fluctuations of innovative activity of entrepreneurs and the impact of such fluctuations on the dynamics of economic development.

The analysis of regularities of technological development suggests that initially the role of a new GPT is reduced to the change of some constituents of technologies which already exist. The effect of such changes determined mainly by the synergy coming from the implementation of separate parts of the next technological paradigm into the existing one. The synergy of mutually additive inventions and innovations that belong to a new GPT comes to the front further either. Such synergy leads to the emergence of principally new technologies and products.

The modern economy provides numerous examples of the high absorbing capacity of the preceding sectors in relation to new technologies. As can be evidenced by the investments of different sectors in computers, peripheral equipment and software, the basic demand for these technologies was demonstrated by the mature industrial sectors (Dementiev 2013, p. 42).

The effective adaptation to new technologies enables several sectors to develop successfully during the period encompassing several long waves, forming so-called infra-trajectories (Hirooka, 2006). Several sectors of the preceding technological paradigms can become the supporting sectors of a new paradigm (Glaziev 2010, p. 89).

Such development of some sectors can't eliminate the cyclicity connected with new GPTs. However the more diversified the economy is, the stronger is the damping impact of infra-trajectories on its innovative development. Moving along this trajectory doesn't allow the sector to get rid of creative destruction, as it implies the partial substitution of its technologies. At the

same time the partial nature of the renewal adds some smoothness to the production development.

The public economic policy remains as one of the factors determining the amplitude of long waves of innovative development. The state support is crucial to decrease the likelihood of the innovative pauses emergence, which are connected with the deficit of the new GPT knowledge ready for effective commercialization. Active financing the structures specializing in knowledge commercialization by the state doesn't ensure the success of economic policy. Such financing can enhance the inequality of economic development, when the lack of knowledge stock is aggravated by the weakness of demand for innovations by the sectors that already exist.

REFERENCES

- Bresnahan, T. F. and Trajtenberg, M. (1995), "General Purpose Technologies 'Engines of Growth'?", *Journal of Econometrics*, Elsevier, Vol. 65, No. 1, 83-108.
- Brodsky, N. (2009), "World tendencies of development ICT and experience of Russia", *Connect*, No. 9, <http://www.connect.ru/article.asp?id=9447>
- Chesbroug, H.W. (2012), "With open innovation to success", IEDC - Bled School of Management, Bled.
- Dementiev, V.E. (2012), "Long Waves in the Economy: Investment Aspect", *Working paper # WP/2012/297*, Moscow, CEMI RAS.
- Dementyev, V.Ye. (2013), "Structural Factors of Technological Development", *Economics and Mathematical Methods*, Vol. 49, No. 4, 33-46.
- Derbenyova, O. Yu. (2013), "The concept of 'innovative conveyor' in The innovation-oriented development of Petrozavodsk State University", *Continuous education: XXI century. Release 4*. <http://dx.doi.org/10.15393/j5.art.2013.2169>
- Diatlov, S. A., Maryanenko, V.P. and Selishchev, T.A. (2008), *Information and network economy: structure, dynamics, regulation*, SPb., Asterion.
- Freeman, C. and Perez, C. (1988), "Structural Crises of Adjustment: Business Cycles and Investment Behaviour", in *Technical Change and Economic Theory*, Edited by Dosi G. et. al., Pinter Publishers, London and New York, 38-66.
- Glazhev, S.Yu. (2010), *Strategy of advancing development of Russia in the conditions of global crisis*; Ekonomika, Moscow.
- Helpman, E. and Trajtenberg, M. (1998), "A Time to Sow and a Time to Reap: Growth Based on General Purpose Technologies", in Helpman Elhanan (ed.), *General Purpose Technologies and Economic Growth*, MIT Press, Cambridge, MA, 55-83.
- Hirooka, M. (2006), *Innovation Dynamism and Economic Growth. A Nonlinear Perspective*, Cheltenham, UK – Northampton, MA: Edward Elgar.
- Kleinknecht, A. (1981), "Observations on the Schumpeterian Swarming of Innovations", *Futures*, Vol. 13, No. 4, 293-307.
- Kleinknecht, A. (1987), *Innovation patterns in crisis and prosperity: Schumpeter's long cycle reconsidered*, Macmillan, London.
- Klepach, A. and Kuranov, G. (2013), "Cyclical Waves in the Economic Development of the U.S. and Russia (Issues of Methodology and Analysis)", *Issues of Economics*, No. 11, 4-33.
- Kondratiev, N.D. (2002), *Big cycles of conjuncture and theory of anticipation*, Selected works, Editions Yakovets Yu.V., Abalkin L.M., Ekonomika, Moscow.
- Kuznets, S. (1940), "Schumpeter's Business Cycles", *The American Economic Review*, Vol. 30. No. 2, Part 1, 257-271.
- Makarov, V. L. and Kleiner G. B. (2007), *Microeconomics of knowledge*, Ekonomika, Moscow.
- Mensch, G. (1979), *Stalemate in Technology: Innovations Overcome the Depression*, Ballinger Publishing Company, New York.
- Polterovich, V., and Henkin, G. (1988), "An Evolutionary Model of the Interaction of the Processes of Creation and Adoption of Technologies", *Economics and Mathematical Methods*, Vol. 24, No. 6, 1071-1083.
- Rayna, T. and Striukova, L. (2009), "The curse of the first-mover: when incremental innovation leads to radical change", *Int. J. Collaborative Enterprise*, Vol. 1, No. 1, 4-21.
- Stieglitz, N. and Heine K. (2007), "Innovations and the role of complementarities in a strategic theory of the firm", *Strategic Management Journal*, Vol. 28. No. 1, 1-15.
- Teece, D.J. (1986), "Profiting from technological innovation: implications for integration, collaboration, licensing and public policy", *Research Policy*, Vol. 15, No. 6, 285-305.

- Van Duijn, I. I. (1983), *Fluctuations in innovations over time*, C. Freedman (ed.). Long Waves in the World Economy, Butterworth, London.
- West, J. and Gallagher S. (2006), "Challenges of open innovation: The paradox of firm investment in open-source software", *R&D Management*, Vol. 36, No. 3, 319-331.

CRITERIA FOR MANAGING MATERIAL RESOURCES STOCK AT INDUSTRIAL ENTERPRISES

GONTAREVA IRYNA¹, KROKHMAL SVETLANA² AND DOROKHOV OLEKSANDR³

ABSTRACT

The purpose of this article is to establish criteria for management of the stock, distributed during the production process.

The article states that at the industrial enterprises with a long production cycle, the material resource is distributed over the various stages of the technological process and ceases to be a resource, only getting the form of products shipped. The authors substantiate the necessity of finding an optimal profile of stock distribution in the course of the multi-phase production process at industrial enterprises.

The synthesis of Green coefficient calculation formula with Wagner-Whitin algorithm was proposed to achieve the optimal profile of levels of different types of stocks.

The article presents the profiles of stock distribution for different types of production with a large multiproduct engineering enterprise "Electrotyazhmash" (Kharkiv, Ukraine) being taken as an example.

Future research will be aimed at improving the accuracy of the calculations and verification of their effectiveness in practice of the other industrial enterprises.

KEYWORDS: *stocks, material resources, management criteria, production process, profile of stocks distribution, Wagner-Whitin algorithm.*

JEL Classification: L60, M11

Received: 12.05.2014 / Accepted: 29.11.2014

1. INTRODUCTION

The share of material and energy inputs expenditure in the cost of industrial products increases and can reach up to 75%, so the search for the ways of reducing such expenditure has constantly been conducted for a long time.

In recent years, the urgency of this problem for the enterprises of Ukraine has increased due to the growth in their volume in the current assets structure Fig. 1.

A way to solve the problem is to increase turnover by reducing stocks of material resources in warehouses. In this case the margin condition for inventory reduction is the possibility of disruptions in the production process.

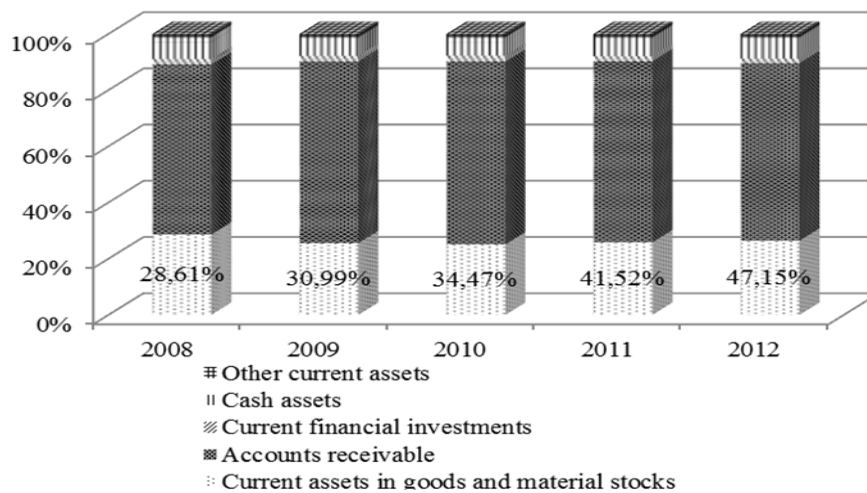
Many researchers have conducted search for an optimal or rational solution of the problem, though we will only cite those whose work has had the greatest influence on this paper. They are a Nobel laureate in Economics, K. J. Arrow (2000), V. S. Ponomarenko, A. I. Pushkar and O. M. Trydid (2002). The results obtained are undoubtedly important both theoretically and practically.

¹ Simon Kuznets Kharkiv National University of Economics, Department of Economy of Enterprise and Management, e-mail: lider.06@mail.ru

² SE Plant "Electrotyazhmash", e-mail: obvorozhitelnaja@ukr.net

³ Simon Kuznets Kharkiv National University of Economics, Department of Informations Systems, e-mail: aleks.dorokhov@meta.ua

Fig.1. Current Assets Structure in the Industry of Ukraine in 2008-2012.



Source: Ukrstat database, authors' calculation

And yet, some approaches require additional consideration. In particular, it concerns the transition from considering the concentrated material supply management systems to enterprise systems with distributed parameters.

The purpose of this article is to establish criteria for the management of distributed inventory, dispersed in the midstream of the production process.

2. ANALYSIS OF THE LAST RESEARCHES AND PUBLICATIONS

The global criterion of the quality of material procurement is ensuring a stable and smooth process of production. Stability and reliability of the supply system is evaluated by the accomplishment of the tasks facing the company, i.e. the full completion of all planned activities in accordance with the requirements to the deadlines, quality of results and processes for their achievement. Refusal implies disruption in the operation of the production system leading to the failure to accomplish scheduled tasks qualitatively and on time (Gontareva 2012, p. 64).

There are three main groups of stock management methods (Repina 2012, pp. 166-173):

- a) direct optimization methods – different models of economically sound stock size and a "just in time" approach based on them;
- b) methods based on the queuing theory. They present stock like a stream of elements that are in the queue for being serviced (used);
- c) simulation, the most famous model of system dynamics of J. W. Forrester.

Each of these groups has its own advantages and disadvantages, as well as preconditions and limits of applicability. The common thing among them is the fact that groups represent the stock of material resources concentrated in one place: a raw materials warehouse, in-process storage, and finished goods warehouse. Actually, a material resource in different processing power is distributed throughout the manufacturing process and, according to the global criterion of the supply function quality, only ceases to be a resource, getting the shape of a shipped product.

This approach is similar to the model of multiphase queuing system with storage after each stage. However, firstly, these models are not ready for practical use. Only single-phase queuing models are widely described and used (Volkova and Kozlov 2004, p. 508; Kozlovskiy, Markina and Makarov 2006, pp. 93-94). This is due to the great complexity of analytical calculation of efficiency indicators, which requires solution of higher order differential equations (Patrushev and Rembeza 1988, pp. 217-238).

Secondly, it is assumed that the number of phases of the multiphase model is larger than the number of storage space points (Patrushev and Rembeza 1988, p. 137). At the same time, the number of storage space points at an enterprise may exceed the number of phases. Anyway, they are available before the first phase, a raw materials warehouse, and after the final one, a warehouse of finished products. This is because the external resources inflow is not considered in the queuing models, the orders availability is sufficient. In production systems customer needs for products are a necessary but not sufficient condition to start the process. It is the availability of material, technical and human resources which is, in fact, a sufficient condition.

Thirdly, performance indicators of a multiphase queuing system do not take into account the possibility of forming a system-wide stock made up of separate interphase ones, which is the main feature of a distributed system.

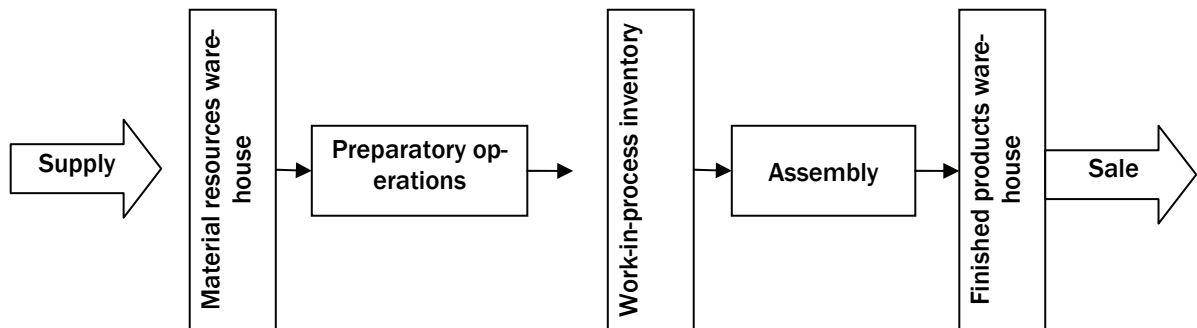
The description of the system with distributed parameters involves changing the values of one or more parameters of the spatial and/or temporal coordinates. The difference in the profiles of distribution of variables in the coordinates can significantly change the indicators of the system performance. In economics, the range problems of distributed systems include, in particular, the problem of finding the optimal relative position of objects for production and sales purposes. In the MRP (Material Requirements Planning) methodology, this approach is applied in product positioning and production technology. The concept of product positioning determines the degree of processing of the objects of labor, of which the enterprise forms the main stocks: raw materials, assembly units and finished products.

The choice of the positioning strategy is based on the desired reaction rate on the order for the supply of products. If you intend to immediately supply rather standardized products, the majority of stocks of the enterprise will contain finished products; if you intend to supply a limited range of assembly units, it is necessary to collect a large number of standard size products, with basic supplies being stored in the form of production reserve; in the single-unit and experimental production the stocks are formed as raw materials (Gavrilov 2002, pp. 46- 49).

Production system response speed increases if stocks are stored in the form of finished products, which results in a decrease of

- efficiency since the cost of storage includes production costs; and
- flexibility of supply under the variations in consumer demand for various standard size products. In other words, it is necessary to build an optimal profile of stocks distribution in the course of the multi-phase production process (Fig. 2).

Fig. 2. Structure of the multiphase production process



Source: authors' own research

The best-known solution to this problem was proposed by J. Green (1997). He introduced the coefficient (K):

$$K = \frac{PT}{DT}, \quad (1)$$

where

PT – the time required for production, the time from placing an order for raw materials until delivery of products to customers (total time of manufacture);

DT – the time of processing the order acceptable by customers (delivery time).

Here we consider three options:

a) the delivery time is longer than the total manufacturing time, while the main stocks should be in the form of raw materials;

b) the delivery time is longer than the time of the final assembly, but shorter than the total manufacturing time, while the main stocks should be in the form of work- in-process inventory; and

c) if the delivery time is shorter than the time of the final assembly, then the main stocks must be formed as finished products. Here it is necessary to make two stipulations: the client's allowable waiting time is a difficult to be defined random variable with a large spread of values; and the coefficient does not give an optimal distribution of stocks throughout the manufacturing cycle stages.

3. THE RESEARCH BASIC MATERIAL

3.1. THEORETICAL RESULTS

To achieve an optimal level profile of different types of stocks it is suggested to modify the coefficient by combining the k coefficient calculation formula with a Wagner-Whitin algorithm.

The Wagner-Whitin algorithm is used to plan the optimum size of lot-sizing run in production and able to meet the a priori known demand in successive time periods. This algorithm is based on the principles of dynamic programming. It uses a system of two equations as the rules allowing the optimal solution (Sadjadi, Aryanezhad and Sadeghi 2009, p. 120.):

$$C_i^{(j)} = S_i + C(P_i + P_{i+1} + \dots + P_j) + h(J_{i+1} + 2J_{i+2} + \dots + (j-1)J_j) \quad (2)$$

$$c_i = \min[C_i^{(j)} + C_{j+1}], \quad (3)$$

where

S_i – the cost of resetting or order is accepted as permanent for the period i , UAH;

C – unit price, UAH;

P_i – production in period i , units;

h – inventory unit holding cost, UAH;

$C_i^{(j)}$ – total period cost, UAH;

c_i – minimum cost for the two consecutive periods, UAH.

J_i – stocks by the end of period i , units

$$J_i = J_{i-1} + P_i - d_i, \quad (4)$$

where d_i – demand in period i , units.

Despite its complexity, the Wagner-Whitin algorithm is used widely enough in planning lots run in production or determining the optimal materials order size. This is explained by the fact that it captures almost all the limitations of the various modifications of the Wilson immediate optimization formulas (Gonzalez and Tullous 2004).

To solve the posed in the article problem of determining the optimal profile of stocks during the production process the article proposes to present equation (2) in the following way:

$$C_i^{(j)} = S_i P_i + C(P_i + \dots + P_j) + (h_i P_i + \dots + h_j P_j), \quad (5)$$

where in this case:

P_i – stocks in phase i of the production cycle, units

h_i – inventory holding cost in phase i of the production cycle, UAH /units.

In turn:

$$S_i = S(k_{i+1} + \dots + k_j) \quad (6)$$

$$h_i = Hk_i \quad (7)$$

$$k_i = \frac{Pt_i}{PT}, \quad (8)$$

where

S_i – total order and resetting cost for the whole production cycle, UAH /units;

k_i – coefficient of relative duration of phase i of the production cycle;

H – total inventory holding cost for the whole production cycle, UAH /units;

Pt_i – length of the production phase i from the start of the production cycle to the end of phase i .

The equation (6) shows that the farther from the final phase are basic stocks the higher are costs of supply (distribution) of the product to the customer. Conversely, the equation (7) shows that the closer to the final phase are basic supplies the greater is the cost of storage.

3.2. EMPIRICAL RESULTS

A large engineering multiproduct enterprise can manifest different profiles of stock distribution. Kharkiv "Electrotyazhmash", (Ukraine) produces a wide range of electrical equipment for various industries. The structure of the types of the enterprise products is shown in Table 1.

The largest share in the total commodity output of the enterprise in 2010-2013 is occupied by the traction electric motors, turbogenerator, hydrogenerator and generator production. Each of them has different cycles of production.

Turbogenerator and hydrogenerator production have the longest cycle of production - more than one year, traction electric motors and generator production is characterized by 1.5-3 month long production cycle.

Control facilities production is usually associated with the cycles of turbogenerator production or manufacture of large electrical machines. Control facilities production has a production cycle of about 3-4 months.

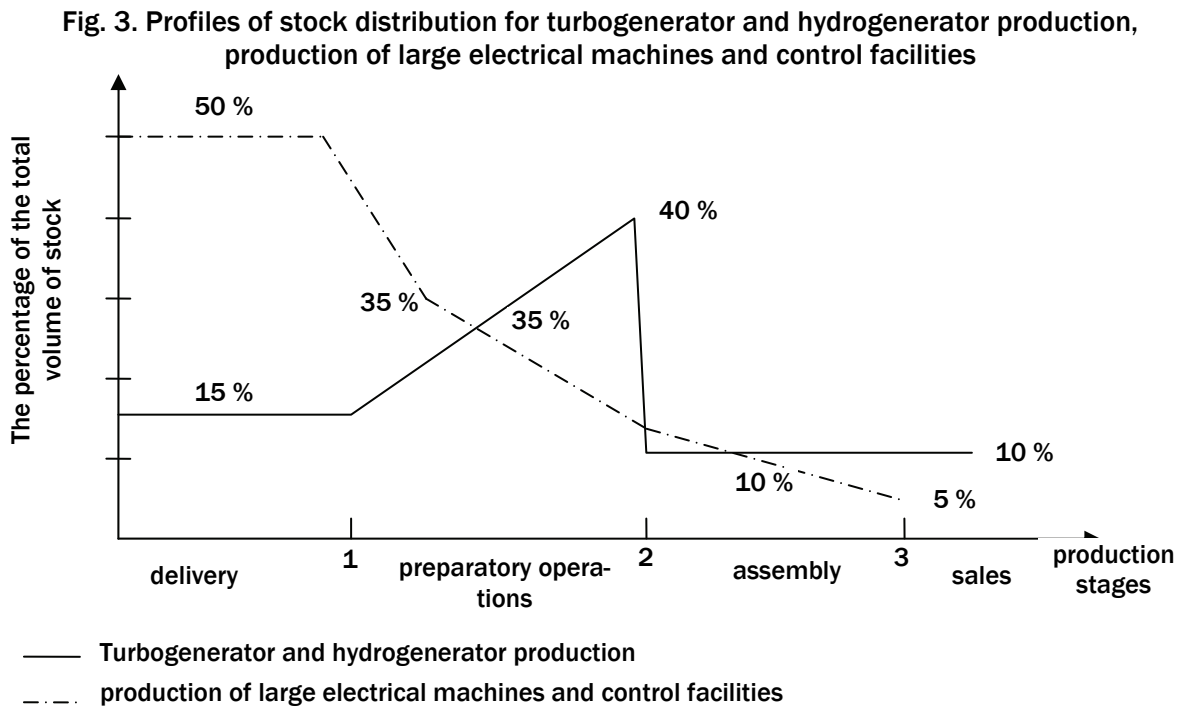
Since the products are characterized by different production cycles, as well as various forms of production organization, the production of each type must have an appropriate approach to reproduction of material resources.

The preliminary analysis shows that determination of the optimal profile of stock distribution using the Wagner-Whitin algorithm is only necessary for the motor and generator production. In turbogenerator and hydrogenerator production, having a long production cycle, single unit output, and no assembly operation (it is carried out either by the client or on the test bench of a related enterprise), the profile of stock distribution is determined experimentally (Fig. 3, solid line).

Table 1: The structure of the types of Electrotiyazhmash products

No.	Types of production	2010		2011		2012		2013	
		Thousand UAH	Share, %	Thousand UAH	Share, %	Thousand UAH	Share, %	Thousand UAH	Share, %
1	Turbogenerators and Hydrogenerators	299627,7	34,7	201876,1	18,6	419943,0	28,9	370088,9	29,4
2	Traction electric motors	417385,4	48,3	679728,1	62,8	765359,6	52,7	670284,7	53,3
3	Generators	74183,0	8,6	108165,4	10,0	127806,5	8,8	115333,9	9,2
4	Control facilities	39249,1	4,5	60717,0	5,6	76109,7	5,2	71983,8	5,7
5	Large electrical machines	0	0	5548,8	0,5	28513,3	2,0	2501,6	0,2
6	Other Products	13036,4	1,5	27109,0	2,5	27288,1	1,9	16111,0	1,3
7	Maintenance service	222,2	0	0	0	6181,8	0,4	10940,4	0,9
Total:		864721,3	100,0	1083144,4	100,0	1451202,0	100,0	1257244,3	100,0

Source: . "Electrotiyazhmash" database, authors' own research and calculations



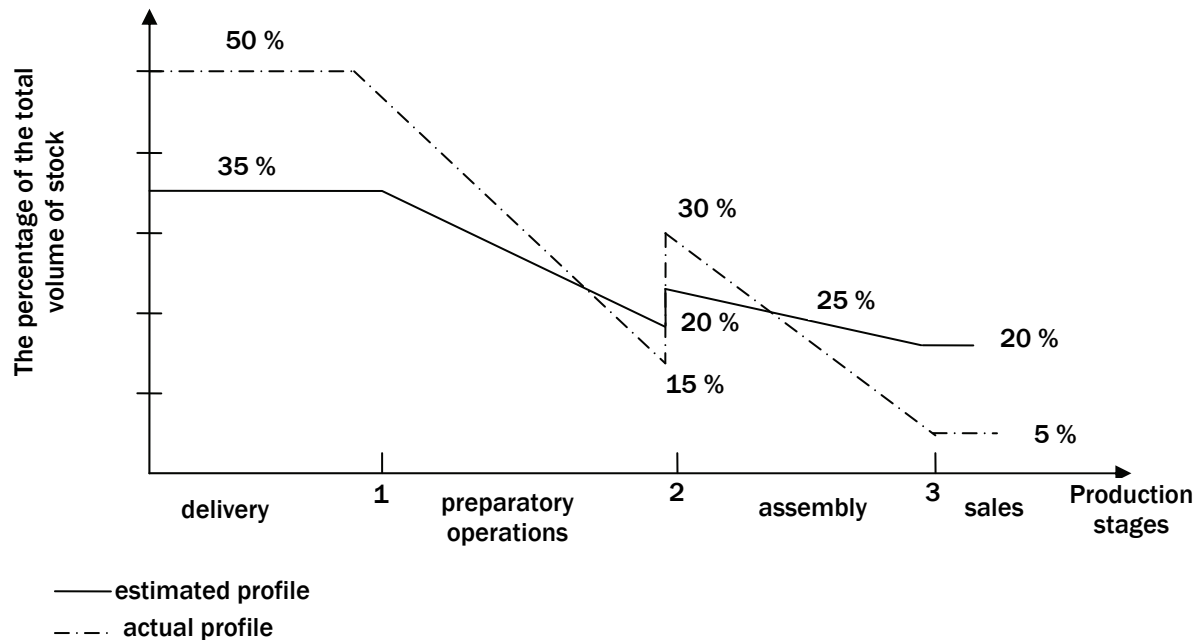
Legend: 1 – material resources storage; 2 - WIP inventory 3 - finished products storage

Source: authors' own research

In the production of large electrical machines with its single item nonscheduled output and related control facilities production the profile is shifted to the material resources storage (Fig. 3, dashed line).

For traction electric motor and generator production the calculations were made using the Wagner-Whitin algorithm and criterion (5) developed in this article. Fig. 4 shows the calculated (solid line) and actual profiles of stock distribution during the manufacturing process.

Fig. 4. Estimated and actual profiles of stock distribution for motor and generator production



Legend: 1 – material resources storage; 2 - WIP inventory 3 - finished products storage

Source: authors' own research

To simplify the calculations the electric motor type EDP-810 was accepted as a single base standard size product by the price and duration of the production cycle, and storage and delivery costs according to the main component of this product. In future it is planned to check the stability of the profile both for different sizes, and average data.

4. CONCLUSION

Thus, the criteria for determining the optimum profile of stock distribution for industrial enterprises during manufacturing process have been modernized. Results showed that the calculated profile differs from that obtained empirically.

Future research will be aimed at improving the accuracy of the calculations and verification of their effectiveness in practice.

REFERENCES

- Errou K. Dzh. (2000), „K teorii tsenovogo prispособleniya“, *Vehi ekonomicheskoy myisli: Teoriya firmyi*, pod red. V.M. Galperina. – SPb., Ekonomicheskaya shkola, 432–447 - in russian: Эрроу К. Дж. (2000), „К теории ценового приспособления“, *Вехи экономической мысли: Теория фирмы*, под ред. В.М. Гальперина. – СПб., Экономическая школа, 432–447)
- Ponomarenko V. S. (2002), *Stratehichne upravlinnya rozvytkom pidpryyemstva: navch. posibnyk*, V. S. Ponomarenko, O. I. Pushkar, O. M. Trydid, Vyd. KhNEU, Kharkiv. - in ukrainian: Пономаренко В. С. (2002), *Стратегічне управління розвитком підприємства: навч. посібник* / В. С. Пономаренко, О. І. Пушкар, О. М. Тридід. – Харків : Вид. ХНЕУ.)

Gontareva I. V. (2012), „Otsinyuvannya stiykosti tsykliv i protsesiv v ramkakh efektyvnoho rozvytku pidpryyemstv“, *Problemy ekonomiky*, No. 3, 63-66 - in ukrainian: Гонтарева І. В. (2012), „Оцінювання стійкості циклів і процесів в рамках ефективного розвитку підприємств“, *Проблеми економіки*, No. 3, 63-66.)

Ryepina I. M. (2012), *Aktyvy pidpryyemstva: taksonomiya ta diahnostyka*, KNEU, Kyiv - (in ukrainian: Рєпіна І. М. (2012), *Активи підприємства: таксономія та діагностика*, КНЕУ, Київ.)

Sistemnyiy analiz i prinyatie resheniy: slovar-spravochnik (2004), Pod red. V. N. Volkovoy, V. N. Kozlova. – M. : Vyssh. shk., Moskva - in russian: Системный анализ и принятие решений: словарь-справочник (2004) / Под ред. В. Н. Волковой, В. Н. Козлова, Высш. shk., М.)

Kozlovskiy V. A., Markina T. V., and Makarov V. M. (2006), *Proizvodstvenniy i operatsionniy menedzhment*, SPb., Spetsliteratura, Moskva - in russian: Козловский В. А., Маркина Т. В., Макаров В. М. (2006), *Производственный и операционный менеджмент*, СПб, Спецлитература, М.)

Nadezhnost i effektivnost v tehnike: Spravochnik v 10 t.: T. 5: Proektniy analiz nadezhnosti (1988) / Pod red. V. I. Patrusheva, A. I. Rembezyi, Mashinostroenie, Moskva - in russian: Надежность и эффективность в технике: Справочник в 10 т.: Т. 5: Проектный анализ надежности (1988) / Под ред. В.И. Патрушева, А. И. Рембезы, Машиностроение, М.)

Gavrilov, D. A. (2002), *Upravlenie proizvodstvom na baze standart MRP II*, SPb., Piter - in russian: Гаврилов Д. А. (2002), *Управление производством на базе стандарта MRP II*, СПб., Питер.)

Green, J. H. (1997), "Production and Inventory Control Handbook" [Electronic resource] / James H. Green editor and shief; 3rd ed., Access mode: <http://www.amazon.com/Production-Inventory-Control-Handbook-Greene/dp/0070244286>

Sadjadi S.I., Aryanezhad, Mir.B. Gh., and Sadeghi H. A. (2009), "An Improved WAGNER-WHITIN Algorithm / S. J. Sadjadi", *International Journal of Industrial Engineering & Production Research*, Vol. 20, No. 3, 117-123.

Gonzalez, J.J., and Tullous, R. (2004), "Optimal Lot Size Decisions Using the Wagner-Whitin Model with Backorders: A Spreadsheet Version" [Electronic resource], Second World Conference on POM and 15th annual POM Conference, Cancun, Mexico, Access mode: http://www.pomsmeetings.org/ConfProceedings/002/POMS_CD/Browse%20This%20CD/PAPERS/002-0234.pdf

PHRONETIC RESEARCH - METHODOLOGY THAT MATTERS TO CORPORATE GOVERNANCE RESEARCH

MIRJANA KULJAK¹

ABSTRACT

Corporate governance is an area of social life where values, power and conflicts have been acknowledged as inherent, legitimate and perplexing in a distinctive manner in different social contexts. Yet, mainstream social science approach takes epistemic, context independent stance based on predictive and rule based theory that often neglects what human beings consider as right and proper to do. On the other hand, phronetic concept and methodology acknowledge context, values and power in social and organizational research and raise the importance of case studies in addressing issues of viable corporate governance. The aim of this paper is to explore possibilities for the implementation and development of phronetic methodology in the area of corporate governance research. Our assumption is that possibilities that phronetic methodology offers have only been partially exploited in research on corporate governance. In order to explore the issue, we analyze literature contributions in the area of corporate governance from phronetic methodological perspectives that have been developed by Jennifer Rowley, Paul Gibbs and Bent Flyvbjerg in social and organizational research. The analysis shows that phronetic methodology has not been fully exploited in corporate governance research. Consequently, the value-rationality standpoint it employs could contribute in searching for answers that are practical, prudent and capable of changing the reality of corporate governance.

KEYWORDS: corporate governance, phronetic methodology, power, values

JEL Classification: B41; B59; G34; M14

Received: May 25, 2014 / Accepted: November 20, 2014

1. INTRODUCTION

Although the issue of convergence vs. divergence of corporate governance systems continues to attract the attention of researchers, a growing body of literature on hybrid systems that combine characteristics of outsider and insider corporate governance model has emerged over the last decade. In addition, more recent studies emphasize the difference between formal and informal components of a corporate governance system, taking into account the influence of culture and tradition within particular national contexts. In order to encompass all these various characteristics of national corporate governance systems and contexts, the case study method has been proliferating in research, bringing along the question of generalizability of research results and validity of theory to the forefront of today's organization research. At this point, we introduce the notion that social science, in general, and specifically in research on corporate governance, should not and cannot follow epistemic approach as practiced by natural sciences in their attempt to produce explanatory and predictive theories. Rather, knowledge should offer contextually relevant answers that are practical, prudent and capable of changing the reality of corporate governance since the immanent traits of corporate governance include values, interests, power and influence that interfere in a way that is specific in different cultural contexts. That is the rationale

¹ Assistant Professor, University of Montenegro, Faculty of Economics, Podgorica, Montenegro, e-mail: mira@ac.me

behind our attempt to examine possibilities to employ and develop a phronetic methodology for the purposes of corporate governance research.

The term 'phronetic social science' was articulated by Bent Flyvbjerg (2001), who referred to Aristotle's theory and philosophy of phronesis as a practical virtue for analyzing and changing social phenomena. Flyvbjerg employed the methodology in studies of megaprojects, city management and organization of democracy and its public and private institutions (Flyvbjerg, Landman, and Schram 2012). He addressed (2006, p. 382) the cases of phronetic research that was conducted in the organization of the firm, accounting, organization of science and technology, organization of government organization of consumption, insurance and risk, space and architecture, policing, poverty and welfare, sexual politics and psychology, then in research on ethics, responsibility, organization of labor and municipalities. Jennifer Rowley and Paul Gibbs (2008) looked for useful phronetic models and concepts in the literature on the learning organization and organizational learning. As they found out that there is the paucity of reference to wisdom in that literature, they developed the theme of practical wisdom and the essence of the practically wise organization.

Building on the contributions in phronetic organizational research, and particularly on conceptual and methodological work of Flyvbjerg, and conceptual work of Rowley and Gibbson the one hand, and the emerging literature in phronetic corporate governance research on the other, in this paper we examine how concept and methodology of phronetic organization research could be further developed for the purposes of corporate governance research.

2. METHODOLOGY

Firstly, we introduce some notions on 'phronetic social science'. Secondly, basic remarks from the literature on theoretical and philosophical background of phronetic research in corporate governance are presented. And, thirdly, we review recent literature in the phronetic corporate governance field from the methodological point of view. The list of literature that has been analyzed encompasses some of the newest contributions that explicitly addressed phronetic approach in corporate governance research. That is by no means a comprehensive list of literature that could be relevant for phronetic corporate governance research. Comparison of literature has been performed along the lines of the methodological guideline developed by Flyvbjerg and conceptual work of Jennifer Rowley and Paul Gibbs, leaving the space for adding new lines of comparison i.e. the development of phronetic corporate governance research in particular, and phronetic methodology in general.

3. "PHRONETIC SOCIAL SCIENCE"

From the point of view of history and philosophy of methodology, explicit emergence of phronetic methodology is more significant than one could conclude from its recent practical employment. It started back in ancient and medieval history when cornerstone of nowadays the dominant stream of scientism had been adopted and developed. Now, it challenges the scientific society itself to reconsider its values and power to change the reality of scientific life – which point to choose on the scale between social engineering and social participation.

Flyvbjerg (2001), a leading international expert in the field of programme management and planning, articulated the term 'phronetic social science'. He borrowed the term 'phronesis' from Aristotle and used it in a sense of ethical-practical wisdom or prudence. Although there have always been researchers in social science who, more or less deliberately, employed some aspects of phronetic approach, Flyvbjerg was the first who developed a phronetic methodology and explicitly employed it in his research of social phenomena. He made a clear delineation between social and natural science in terms of fruitfulness of methodology that each science employs. Thus, while epistemological methodology is advantageous in producing cumulative and predictive knowledge in natural science, phronetic methodology is advantageous in analyzing and changing social phenomena that rely on values and power of social actors. Consequently, for each science there is a specific type of rationality – in natural science an instrumental rationality yields better

results while in social science value rationality is more fruitful. Moreover, he emphasizes that it cannot be expected from social science to follow epistemic methodology of natural science in producing cumulative and predictive type of knowledge, in order to prove its validity. On the contrary, social science should analyze social phenomena taking into consideration values and power in order to change reality.

Flyvbjerg's ideas on power, rationality, optimism, misrepresentation, delusion, deception, mass media, as well as ideas he drew from Habermas and Foucault have been widely incorporated into project planning and management in order to foster social participation while changing reality. From the organizational point of view, he also developed methodological guidelines for phronetic organization research that represent a starting point for further phronetic organization research. In each case, building on Aristotle's ethical tradition, Flyvbjerg formulated specific four value-rational questions that participants in research are expected to answer from an individual perspective:

- a) where are we going,
- b) is this development desirable,
- c) what, if anything, should we do about it, and
- d) who gains and who loses, and by which mechanisms of power?

According to the methodology, the answers are by no means expected to be complete but rather used as an input for further discussion in analyzing social phenomena.

4. PHILOSOPHICAL AND THEORETICAL BACKGROUND OF PHRONETIC RESEARCH IN CORPORATE GOVERNANCE

Philosophy and the theory of corporate governance already accommodate themselves to the reality that values and power are issues that matter in a globalized world, with big corporations, media, financial institutions, political players and international organizations having significant power to shape the society in line with their values. They acknowledge that corporate governance is a playground where interests of owners, capital, work, environment, politics, local community and other corporate stakeholders are continuously interfering at the organizational level. These aspects are encompassed mainly by philosophy and theory that lay behind political theories of corporate governance. On the other hand, if perceived from an individual perspective, as different persons follow different values, have different interests and exert different degree of power, it cannot be expected that there are universally best answers or answers that would be equally acceptable for all in all situations, in terms of gains and losses that emerge from changes in corporate governance reality. Hence, the philosophy and theory of corporate governance should take into account differing values and power of different corporate stakeholders and individuals, since they could prefer different paths of corporate governance development and undertake different steps to change a corporate reality.

While issues of values and power in the area of corporate governance were researched to a considerable extent, it is only recently that phronetic approach itself has been employed in this area of research. David Perkins and John E. Timmerman (2005) critically examined, from a Christian perspective, the virtue/situationism debate on the role that virtuous personal character plays in business and corporate governance. They put emphasis on the identification and cultivation of character as the primary basis for ensuring ethical behavior, thus serving as the basis for making a better reality. Alejo José G. Sison (2008) thoroughly presented Aristotelian philosophical foundations of today's corporate governance. He places the discussion of corporate governance in the economic, legal and cultural context with an emphasis on subjective ethical human practice and presented a series of case histories.

In his conceptual paper Grassl (2010) showed how Aquinas' views on the structure of the moral act can be reconstructed and applied to the process of decision making in management in a way that harmonizes instrumental rationality and personal morality. The paper opens up a field of empirical research by introducing the interplay of deliberative and prescriptive stages in deci-

sion-making and should be revisited for the purposes of further development of phronetic methodology in decision-making in management, and in corporate governance, as well. Ignacio Ferrero and Alejo José G. Sison (2012) carried out a survey on virtue in the area of business and management in which they charted the evolution of ethics articles from 1980-2011 and established clusters of authors and themes, supplying it with a solid philosophical and anthropological foundation. Jowere Mukusha (2012) engaged in a philosophical ethical analysis on the impact of good corporate governance as the key to sustainable development in case of Zimbabwe that could be employed elsewhere.

Wendelin Küpers and David Pauleen (2013) have addressed the importance of multidimensional approach while practicing the phronetic approach. They analyzed works of other researchers from the following perspectives: historical continuum and spiritual and religious traditions, limits of practical wisdom and the status of embodied prâxis, sowing seeds for phronetic approach in hostile ground, acceptance and legitimization of wisdom, and emerging wisdom research agenda, especially in the fields of organization and leadership.

From the theoretical perspective, in the corporate governance literature there are several major theoretical frameworks: agency, stewardship, resource dependence, stakeholder and managerial-hegemony. They emerged from various disciplines such as finance, economics, accounting, law, management and organizational behavior.

Yet, so far there has been no theory of corporate governance emerging from any discipline rooted in phronetic approach. A useful starting point for the inclusion of values, power and control into the corporate governance analysis is the literature overview presented by Shann Turnbull (1997), which deals with models of analyzing corporate governance from the perspectives of culture, power and cybernetics. While he argued that the literature acknowledges the importance of value consensus in keeping together participants in transactions on the basis of mutual trust and confidence, he found that power, on the contrary, was a neglected issue that has been only partly included in political models of corporate governance. As to the cybernetic models of analyzing corporate governance, he reminds that these models are dependent upon information and control architecture of social institutions, and control is dependent on power. An interesting trait of the cybernetic approach is the inclusion of complex dynamic environment into complex control systems.

Corporate governance theories have been approached from the phronetic stance in the work of Jeanetha Brink (2006). She categorized the theories such as agency theory, managerial hegemony, stewardship theory, external pressures, stakeholder theory, theories of convergence, critique of shareholder value, post-Enron theories, but also presented the following theories based on the changed society of the minimal state: new public management, good governance, socio-cybernetic system, self-organizing networks. In the area of theory of the firm, values and power are included as part of informal social structures and personal relationships within the social capital theory of the firm (Chisholm and Nielsen 2009). Furthermore, a view of the firm as a common good built on the Aristotelian-Thomistic tradition (Sison and Fontrodona, 2012) has recently emerged as very promising for the corporate governance research.

In order to enable further discussion on what could be named as phronetic corporate governance theory, we briefly review some recent concepts emerging from the area of management, organization and leadership. Thus, Rendtorff (2010) discussed recent approaches in the theory and philosophy of management in a complex society in the case of Denmark. In addition to the general theory of organization, which is built on systems theory and polycontextual understandings, he emphasized two additional dimensions – conceptualization of a concept of leadership based on virtues of integrity, dignity, and judgment, as opposed to management, and understanding how the strength and power of discipline are embedded in the management technologies of corporate religion and existentialism. This is a good example of how considerations of elements of theories and philosophical concepts can help contextualize the importance of the emergence of values-driven management and corporate governance in a complex national context.

Po-Keung Ip (2011) articulated a concept of Kingly Governance based on Confucian core moral elements of benevolence, rightness, ritual following, wisdom and trustworthiness, and as-

sessed the concept against the practice in today's China. In addition, Nicolai Foss and Peter Klein (2013) have recently made important and promising reconsideration of Hayek's work. Although their notions are meant to be used by organization researchers working on the micro foundations of routines and capabilities, Hayek's work is important for phronetic organization research as well. Not only did Hayek criticize the rationalist model of designed action, but he also raised the issue of how to enable the best use of tacit knowledge (phronesis being an aspect of tacit knowledge) in a more subjectivist i.e. constructivist and sense making way. Simultaneously, virtue ethics has been increasingly applied in theoretical and empirical business researches, at different levels of analysis and from various perspectives - at the individual level concerning management behavior and decision models, at the organizational level in creating organizational climate, communities and at the society level in measuring the impact of business on the environment in which it operates (Fontrodona, Sison and Bruin, 2013).

5. METHODOLOGICAL ISSUES IN PHRONETIC CORPORATE GOVERNANCE RESEARCH - RECENT LITERATURE CONTRIBUTIONS

Flyvbjerg's (2006, b) a guideline for phronetic organization research is a good starting point to examine how issues of values and power could be approached in phronetic corporate governance research as well. His suggestions concern the following: focusing on values, placing power at the core of analysis, getting close to reality, putting emphasis on little things, looking at practice before discourse, studying cases and contexts, asking 'how' and 'why' questions, moving beyond agency and structure, and dialoguing with a polyphony of voices. On the other hand, we acknowledge the contribution of Jennifer Rowley and Paul Gibbs (2008) concerning the concept of wise organization. They developed the concept as an extension of the concept of learning organization, which encompasses a plethora of diversifying values and interests of corporate stakeholders. According to the authors, organization is capable of learning through the process of practical wisdom associated with the seven pillars of wisdom: understanding dynamic complexity; developing personal wisdom competency; deliberating towards ethical models; refreshing shared sustainable vision; group wisdom dynamics; deliberated praxis; and embodied learning. Both concepts we use as, to date, the most comprehensive and as a reference point for the assessment of newer contributions in phronetic corporate governance research.

Different authors have emphasized different aspects of phronetic methodology in corporate governance research and we now turn to a chronological overview of their contribution. Nayak, Maclean, Harvey and Chia (2007) explored the lives and careers of Indian business elites from a practice perspective. They found that corporate governance has been shaped by mediating symbolic forms embedding complex web of connections between national values, individual dispositions and institutional practices. It is the symbolic forms, as a synthesis of values, which seems to be promising in further development of phronetic methodology.

Cairns, Sliwa and Wright (2010) developed an example of a critical scenario method that could be used by managers in international business. The method is based on Flyvbjerg's social science interpretation of the concept of *phronēsis* and explicitly puts in use the four questions that he defined as relevant to be answered in social science research. The method has been developed for educational purpose to foster mainstream and alternative discourses, but is suggested to be used in practice for solving complex problems in a globalised economy, beyond that of profit maximization. Also, as it takes into account different perspectives, it is particularly suitable for corporate governance practice.

Colombo (2011) explored virtue as a necessary supplement to legal rules and regulation of corporate enterprise. He analyzed corporation and corporate law from the perspective of virtue ethics and suggested that corporations and company law should enable more space for corporate officers to act free in exercising the virtue behavior. As the prevailing legal approach to corporation is contractarian, which adopts nexus-of-contracts view of corporation that puts emphasis on economics, rules and regulations, he broadened the approach by articulating a vision of corporation as a nexus-of-virtue, which focuses on virtue-ethics. In future research it would be interest-

ing to examine if this approach has any common methodological points with studies conducted in informal institutions of corporate governance.

Arjoon (2012) in his essay on Aristotelian-Thomistic approach to corporate governance and ethical decision-making analyzed eight peer-reviewed journal articles that addressed ethical deficits which cause moral failings. He promotes the idea that virtue ethics, human dignity and natural law ethical principles of subsidiarity, solidarity and the common good should be integrated into business practice as a corrective to some aspects of market behavior.

Garah, Beekun, Habisch, Lenssen and Adai (2012) provided an exploratory overview of papers focusing on practical wisdom for management in different contexts from Islamic traditions, both from academic and practitioner-oriented perspectives. They demonstrated that the Islamic tradition offers valuable practical wisdom insights into multiple areas, including leadership, human resource management, action learning, knowledge transfer, and business ethics. As the authors noted, some basic questions need to be explored further, such as the relationship between the origins of religious wisdom traditions in a relatively simple socio-economic context and their adaptability to today's globalized economy.

Ruwhiu and Cone (2013) used a narrative approach in their study of culturally bounded pragmatic leadership in the world of Maori philosophy, ethics and knowledge (wisdom). They contributed to a deeper understanding of culturally specific behaviors that are reflective of good practice and rely on indigenous logics. The approach employed in this study is advantageous particularly in those cases where leadership practices are under significant influence of culturally specific behavior.

Verhezen (2013) explicated how wise decision-making might be incorporated in a model of corporate governance and analyzed how to embed the notions of accountability and responsibility in corporate governance. He focused on the issue of legitimacy of the corporate board stemming from law, customs and norms, that designates the power (formal and informal authority) and the obligation (formal accountability and informal responsibility) to board members, enabling them to create a wise leadership. As Verhezen argues, wise leadership constitutes the basis for transactional economic value. Therefore, it is a challenge for future research to examine how concepts of bounded rationality and wise decision-making could be embedded within one theoretical corporate governance concept.

While almost all these literature contributions in phronetic corporate governance research addressed some specific issues and aspects of phronetic methodology, the work of Cairns, Sliwa and Wright (2010) deals more explicitly with the phronetic methodology itself. However, when tentatively assessed against the lines of phronetic methodology developed by Flyvbjerg and pillars of wise organization developed by Rowley and Gibbs, their relative contribution could be perceived in a more organized way, as represented in Table 1. The elements of comparison that have been extracted from each contribution concern those that the authors more or less explicitly emphasized in their work. It doesn't mean that other elements are not present in their research, but they are rather implicitly included.

In terms of coverage of suggested elements, the closest to the approaches of Flyvbjerg, and Rowley and Gibbs are contributions of Nayak, Maclean, Harvey and Chia (2007), Cairns, Sliwa and Wright (2010), and Ruwhiu and Cone (2013), all covering almost all the elements. Next to them are approaches of Garah, Beekun, Habisch, Lenssen and Adai (2012), and Verhezen (2013), with differing and half coverage of suggested elements. And, lastly, contributions that partially overlap with Flyvbjerg, and Rowley and Gibbs approaches, covering the similar elements, concern Colombo (2011) and Arjoon (2012).

Table 1: *Corporate governance phronetic research literature (contributions)*

Flyvbjerg's lines of employing phronetic methodology	<i>Nayak, Maclean, Harvey and Chia (2007)</i>	<i>Cairns, Sliwa and Wright (2010)</i>	<i>Colombo (2011)</i>	<i>Arjoon (2012)</i>	<i>Garah, Beekun, Habisch, Lenssen and Adauli (2012)</i>	<i>Ruwhiu and Cone (2013)</i>	<i>Verhezen (2013)</i>
Focusing on values	✓	✓	✓	✓	✓	✓	✓
Placing power at the core of analysis		✓					✓
Getting close to reality	✓					✓	
Putting emphasis on little things							
Looking at practice before a discourse	✓	✓	✓	✓	✓	✓	
Studying cases and contexts	✓				✓	✓	
Asking 'How' and 'Why' questions	✓	✓		✓	✓	✓	✓
Moving beyond agency/structure dualism	✓		✓			✓	
Dialoguing with a polyphony of voices							
Rowley and Gibbs's pillars of wise organization							
Understanding dynamic complexity	✓	✓					
Developing personal wisdom competency	✓	✓				✓	✓
Deliberating towards ethical models	✓	✓	✓	✓		✓	✓
Refreshing shared sustainable vision	✓					✓	✓
Group wisdom dynamics	✓	✓				✓	
Deliberated praxis	✓	✓	✓	✓		✓	✓
Embodied learning		✓					
Type of research/ Method used	Exploratory	Methodological	Exploratory	Critical analysis	Exploratory	Narrative	Critical analysis
Corporate governance issues/areas of further extension/employment of the research	Symbolic forms	Critical scenario method for complex problem solutions	Nexus-of-virtue	Promotion of virtue ethics in practice	Contextualization in a simple national and global context	Significant culturally specific practice	Conceptualization of new concepts

On the other hand, when assessing which element proposed by Flyvbjerg, and Rowley and Gibbs has been covered most by recent research, the following elements emerged: focusing on values, looking at practice before discourse, asking "how" and "why" questions, deliberating organizational behavior towards ethical models and practice. It seems that values and practice are still the main concern of recent research, as suggested by Flyvbjerg, Landman, and Schram (2012), and Jennifer Rowley and Paul Gibbs (2008).

It seems that value informed perspectives and the notion of practical wisdom need further theoretical and methodological development, and phronetic methodology itself is yet to be developed, either through further employment of Flyvbjerg's methodology, extensions of existing works of other researchers or emergence of new approaches. As indicated in Table 1, further extensions/employment of existing research of various types (exploratory, narrative, critical analy-

sis) could be expected in the following areas/issues: symbolic forms, critical scenario method for complex problem solutions, nexus-of-virtue, promotion of virtue ethics in practice, contextualization in a simple national and global context, significant culturally specific practice, and conceptualization of new concepts. Relatively less employed lines of phronetic methodology are those that are listed as follows: placing power at the core of analysis, getting close to reality, putting emphasis on little things, studying case and contexts, moving beyond agency/structure dualism, dialoguing with polyphony of voices. From organizational point of view following traits of organization are still to be examined: understanding dynamic complexity, developing personal wisdom competency, refreshing shared sustainable vision, group wisdom dynamics, and embodied learning.

6. CONCLUSION

In this paper we explore the prospects of employing and developing phronetic methodology in the area of corporate governance research. Phronetic methodology in social science has been developed by Bent Flyvbjerg on the basis of Aristotle's philosophical concept of phronesis in a sense of behavior that relies on value judgment, practical wisdom or prudence, in a dynamic and complex context. Since corporate governance is a playground where interests of owners, capital, work, environment, politics, local community and other corporate stakeholders and individuals continuously intersect at the organizational level and across society, on the one hand, and since different persons follow different values, have different interests and exert a different degree of power, prefer different paths of corporate governance changes in terms of gains and losses they expect on the other, phronetic methodology appears to be a missing approach or, better to say, a proper match when it comes to research in the area of corporate governance.

The most recent theoretical and conceptual contributions open a range of possibilities for development of phronetic corporate governance theories and varieties of phronetic methodologies, one could say – as many as there are different corporate governance practices. The most developed methodological approaches till nowadays have been brought by Flyvbjerg, Landman, and Schram (2012), and Jennifer Rowley and Paul Gibbs (2008). Their suggestions have been used to review contributions of recent emerging literature on corporate governance that explicitly addresses elements of phronetic methodology i.e. values and power. It appeared that phronetic methodology is in its early stage of development in the area of corporate governance, and a diversity of approaches are yet expected to emerge in order to come to answers that could be used as an input for further discussion in analyzing corporate governance.

Further extensions/employment of existing studies of various types could be expected in the following areas/issues: symbolic forms, critical scenario method for complex problem solutions, nexus-of-virtue, promotion of virtue ethics in practice, contextualization in a simple national and global context, significant culturally specific practice and conceptualization of new concepts. In addition, there is room for future research to employ those lines of phronetic methodology that have been less emphasized in the existing research, such as placing power at the core of analysis, getting close to reality, putting emphasis on little things, studying case and contexts, moving beyond agency/structure dualism, dialoguing with a polyphony of voices. From the organizational point of view, challenging issues are the following traits of wise organization: understanding dynamic complexity, developing personal wisdom competency, refreshing shared sustainable vision, group wisdom dynamics, and embodied learning.

REFERENCES

- Arjoon, S. (2012), *Ethics of the good: an Aristotelian-Thomistic approach to corporate governance and ethical decision-making*, unpublished doctoral dissertation, Teesside University, Middlesbrough.
- Bhatnagar, A. (2012), "Business Ethics and Management by Gandhian Values", *International Indexed & Referred Research Journal*, Vol. IV, No. 38, 19-20.
- Brink, J. (2006), *Corporate governance in public-private partnerships: a public sector management perspective*, Doctoral dissertation, Stellenbosch University, Stellenbosch.

- Cairns, G., Sliwa, M. and Wright G. (2010), "Problematizing international business futures through a critical scenario method", *Futures*, Vol. 42, No. 9, 971-979.
- Cairns, G. and Wright, G. (2012), "Augmented critical scenario method: Analysing stakeholders' achievement of their objectives within future scenarios", *ANZAM 2012*, 1-12.
- Chisholm, A. M. and Nielsen, K. (2009), "Social Capital and the Resource-Based View of the Firm", *Int. Studies of Mgt. & Org.*, Vol. 39, No. 2, 7-32.
- Colebatch, H. (2009), *Making sense of governance. Paper presented at World Congress of IPSA, Santiago, Chile*, available at: http://paperroom.ipsa.org/app/webroot/papers/paper_3514.pdf, (accessed 06 August 2013).
- Colombo, R. J. (2011), *Towards a nexus of virtue. Legal Studies Research Paper No. 11-17, Hofstra University*, available at: <http://ssrn.com/abstract=1908889> or <http://dx.doi.org/10.2139/ssrn.1908889>, (accessed 08 August 2013).
- Dunfee, T. W. and Fort, T. L. (2003), "Corporate hypergoals, sustainable peace, and the adapted firm", *Vand. J. Transnat'l L.*, No. 36, 563-617.
- Ferrero, I. and Sison, A. J. G. (2012), "A Survey on Virtue in Business and Management 1980-2011", *School of Economics and Business Administration working paper 07/12*, University of Navarra, Pamplona, available at: http://www.unav.edu/documents/29056/1939939/WP_UNAV_07_12.pdf, (accessed 17 November 2013).
- Flyvbjerg, B. (2001), *Making Social Science Matter: Why Social Inquiry Fails and How it can Succeed Again*, Cambridge University Press: Cambridge, UK.
- Flyvbjerg, B. (2006), "Five Misunderstandings About Case-Study Research", *Qualitative Inquiry*, Vol. 12, No. 2, 219-245.
- Flyvbjerg, B. (2006a), "Making Organization Research Matter: Power, Values, and Phronesis", In *The Sage Handbook of Organization Studies*, Stewart RC, Hardy C, Lawrence TB, Nord WR (eds). Sage: Thousand Oaks, CA, 370-387.
- Flyvbjerg, B., Landman, T. and Schramm, S. (eds) (2012), *Real Social Science: Applied Phronesis*. Cambridge University Press, Cambridge, UK.
- Fonrodona J., Sison, A. J. G. and de Bruin, B. (2013), "Editorial Introduction: Putting Virtues Into Practice. A Challenge for Business and Organizations", *Journal of Business Ethics*, No. 113, 563-565.
- Foss, N. J. and Klein, P. G. (2013), "Hayek and Organizational Studies". Department of Strategic Management and Globalization, *Working paper No. 3*, Copenhagen Business School, Frederiksberg, available at: <http://openarchive.cbs.dk/handle/10398/8655>, (accessed 25 December 2013).
- Garah, El. W., Beekun, R. I., Habisch, A., Lenssen, G. and Adau, C. L. (2012), "Practical wisdom for management from the Islamic tradition", *Journal of Management Development*, Vol. 31, No. 10, 991-1000.
- Goede, M. (2011), "The wise society: beyond the knowledge economy", *Foresight - The Journal of future studies, strategic thinking and policy*, Vol. 13, No. 1, 36-45.
- Grant, P. and McGhee, P. (2012), "Phronesis and spirituality in the workplace", *Spirituality, Leadership and Management*, Vol. 6, No. 1, 24-34.
- Grassl, W. (2010), "Aquinas on management and its development", *Journal of Management Development*, Vol. 29, No. 7/8, 706-715.
- Ip, P. K. (2011), "Kingly Governance as Wise Management", paper presented at the International Conference on Wise Management in Organizational Complexity, Shanghai, China, available at: <http://www.ceibs.edu/ecclar/images/2012/03/27/184D75661F6BE0E2167EE2DF8B76946D.pdf>, (accessed 10 December 2013).
- Küpers, W. and Pauleen, D. (eds) (2013), *A Handbook of Practical Wisdom Leadership, Organization and Integral Business Practice*, Ashgate Publishing Limited: Surrey, UK.
- Macaulay, M. and Arjoon, S. (2012), "Harmonizing the individual and the organization: an Aristotelian-Thomistic model of corporate governance", *International Journal of Organization Theory & Behavior*, Vol. 15, No. 4, 548.
- Mukusha, J. (2012), "Business nakedness in the absence of good corporate governance", *Journal of Sustainable Development in Africa*, Vol. 14, No. 2, 15-24.
- Nayak, A., Maclean, M., Harvey, C. and Chia, R. (2007), "Entrepreneurship, corporate governance, and Indian business elites", *International Journal of Indian Culture and Business Management*, Vol. 1, No. 1, 9-27.
- Perkins, D. and Timmerman, J. E. (2005), "A critical examination of the debate over virtue ethics and situationism", Paper presented at the 21st Annual Conference of the Christian Business Faculty Association, Seattle Pacific University, Seattle, WA.

- Rendtorff, J. D. (2010), "Philosophy of management: Concepts of management from the perspectives of systems theory, phenomenological hermeneutics, corporate religion, and existentialism", In *Elements of a Philosophy of Management and Organization*, Koslowski, P. (ed). Springer: Berlin, Heidelberg, 19-44.
- Rowley, J. and Gibbs, P. (2008), "From learning organization to practically wise organization", *Learning Organization, The*, Vol. 15, No. 5, 356-372.
- Ruwhiu, D. and Cone, M. (2013), "Pragmatic leadership: A return to wisdom", *Journal of Management & Organization*, No. 19, 25-43.
- Sison, A. J. G. (2008), *Corporate Governance and Ethics: An Aristotelian Perspective*, Edward Elgar Ltd: Cheltenham, UK/Northampton, MA.
- Sison, A. J. G. and Fontrodona, J. (2012), "The Common Good of the Firm in the Aristotelian-Thomistic Tradition", *Business Ethics Quarterly*, Vol. 22, No. 2, 211-246.
- Turnbull, S. (1997), "Corporate Governance: Its scope, concerns & theories", *Corporate Governance: An International Review*, Vol. 5, No. 4, 180-205.
- Verhezen, P. (2013), "Managerial Wisdom in Corporate Governance", In *Wise Management in Organisational Complexity*, Mike J. Thompson MJ, Bevan D (eds), Palgrave Macmillan: London, U.K., 198-216.

IDENTIFICATION AND ANALYSIS OF SPECIFIC PROBLEMS IN THE RATIONALIZATION OF MACRO-LEVEL LOGISTICS NETWORKS USING TRAVELLING SALESMAN PROBLEM

SLAVOMIR VUKMIROVIC¹, DRAGO PUPAVAC², AND MIMO DRASKOVIC³

ABSTRACT

The fundamental objective and purpose of this work is the identification and analysis of specific problems in the optimization of macro-level logistics networks. Using mathematical models based on Exhaustive Search Algorithm, and graphical models in resolving the travelling salesman problem, two specific problems in the optimization of macro-level logistics network have been identified and analyzed: a) Problem with multiple optimal solutions, and b) Problem with redundant relation. The hypothesis on possibilities of use of the TSP model, using exhaustive search algorithm in the rationalization of distribution in macro-level logistics networks has been proven.

KEY WORDS: *macro-level logistics networks, rationalization, travelling salesman problem, exhaustive search algorithm*

JEL classification: L92.

Received: July 05, 2014 / Accepted: December 02, 2014

1. INTRODUCTION

Macro-level logistics networking aims at ensuring an adequate supply to numerous logistics centres, their sub-systems and all logistics subjects in a particular area at regional and national level. Such networks are built to enable hundreds of millions of different products to be supplied to millions of consumers. Satisfying various desires and needs of such a large number of consumers with different financial possibilities in the process of assuring optimal flow development in logistics network represent a true challenge for logistics managers. Choosing the relevant information technology and computer software to enable us to create optimal node connections (cities, distribution centres, ports, and terminals), and arrange the optimal transportation routes, is the key factor of macro-level logistics network modelling for an effective distribution of goods. In investigating the problem above, the following scientific hypothesis has been proposed: Object-oriented programming allows us to architect and visualize exhaustive search algorithm to solve the Travelling Salesman Problem, and identify multiple optimal solutions and problems with redundant relations aimed at optimising the distribution channels in macro-level logistics networking.

2. TRAVELLING SALESMAN PROBLEM DETERMINANTS

Travelling Salesman Problem (TSP) can be formulated in the following way: TSP, is to find the best possible route based on given criteria, where minimum distance between cities or minimum travelling cost are the most commonly used optimization criteria. TSP, is to visit all the cities and return to the starting point under the condition of visiting each city only once. The travelling salesman problem (TSP) is one of the most studied problems in management science. Optimal approaches to solving travelling salesman problems are based on mathematical programming.

¹ Professor, Economic Faculty of Rijeka, Croatia, E-mail: svukmirovic@gmail.com

² Professor, Polytechnic of Rijeka, Croatia, E-mail: drago.pupavac@veleri.hr

³ Assistant professor, University of Montenegro, Maritime Faculty of Kotor, Montenegro, e-mail: rookie@t-com.me

But in reality, most TSP problems are not solved optimally. When the problem is so large that an optimal solution is impossible to obtain, or when approximate solutions are good enough, heuristics are applied. Two commonly used heuristics for the travelling salesman problem are the nearest neighbour procedure and the Clark and Wright savings heuristic [1].

Table 1 realistically captures the travelling salesman problem complexity.

Table 1: Number of alternative routes with n cities

Number of cities	Number of solutions	Time (sec)	Time (h)
3	1	0,000000001	2,77778E-13
4	3	0,000000003	8,33333E-13
5	12	0,000000012	3,33333E-12
6	60	0,00000006	1,66667E-11
7	360	0,00000036	1E-10
8	2520	0,00000252	7E-10
9	20160	0,00002016	5,6E-09
10	181440	0,00018144	5,04E-08
11	1.814.400	0,0018144	0,000000504
12	79.833.600	0,0798336	0,000022176
13	239.500.800	0,2395008	0,000066528
14	3.113.510.400	3,1135104	0,000864864
15	43.589.145.600	43,5891456	0,012108096
16	6,54E+11	653,837184	0,18162144
17	1,046E+13	10461,39494	2,90594304
18	1,778E+14	177843,714	49,40103168
19	3,201E+15	3201186,853	889,2185702
20	6,082E+16	60822550,2	16895,15283

Source: Author's prepared

Table 1 reveals the exponential (factorial) growth of number of possible solutions and computation time in relation to the number of nodes in a logistics network. Computation time is calculated on the assumption that a single instruction takes 1 nanosecond to execute.

In terms of combinatorial optimization, the Travelling Salesman Problem (TSP) can be formulated in the following way: Given a list of n cities C and distance d_{ij} from city i to city j ; TSP, is to find the best possible way of visiting all the cities by visiting each city only once finding minimum total travel distance. In analogy to the above definition, the following formulations are valid: 1) Travel distance or distance between cities is symmetric: (1) $d_{ij} = d_{ji}$; 2) Final list of cities is defined as incoming variable by the formula $C = (c_1 \dots c_n)$, while distance matrix containing distance between city c_i and city c_j for each pair i, j is defined by $d(c_i, c_j)$. In view of the fact that distance matrix is symmetric, the following equation is valid: $c_{ij} = c_{ji}$; 3) Permutations or in other words all permuted relations that can be achieved for a given number of cities are computed as resulting variables. Permutations $p(1), \dots, p(n)$ in the list $1, \dots, n$ are calculated and compared to give the minimum sum.

It follows from the above, that the following equation can represent the travelling salesman problem [10]:

$$\sum_{1 \leq i \leq n-1} d(c_{\pi(i)}, c_{\pi(i+1)}) + d(c_{\pi(n)}, c_{\pi(1)}) \quad (1)$$

Above equation is the sum of length of routes that begin in city $c_{p(i)}$, $i=1$ visiting each city in defined pattern $(c_{p(i)}, c_{p(i+1)})$ and returning to the starting point $c_{p(1)}$. This algorithm gives travel distance for all possible routes and finds the shortest route. In addition, the number of possible routes is the factorial of n cities, or number of permutations of n elements.

3. REAL DISTRIBUTION PROBLEMS IN MACRO-LEVEL LOGISTICS NETWORKING

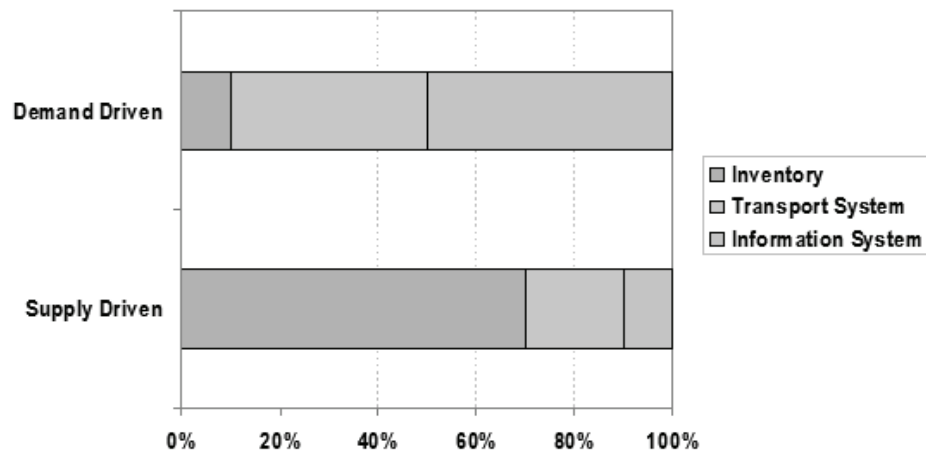
Logistics Network can be defined as a system of interrelated logistics centres, communications, corridors, ports, terminals, lines or services (...), logistics chains, logistics and distribution chains, transportation chains, transportation networks (...) built to enable fast, safe and rational production process of logistics products [2]. The growing flows of freight have been a fundamental component of contemporary changes in economic systems at the global, regional and local scale. These changes are not merely quantitative (more freight) but structural and operational. The fundamental question does not necessarily reside in the nature, origins and destinations of freight movements, but how this freight is moving. Accordingly, it is important to identify different types of logistics networks such as conventional logistics networks, multimodal logistics networks, micro-level logistics networks, macro-level logistics networks and global logistics networks, and carry out their optimization.

Unlike micro-level logistics networks, which are functioning within a relatively small geographical area, **macro-level logistics networks** are created and designed for a particular market at national scale, or macro-level logistics system i.e. **macro-level logistics network in the Republic of Croatia**. It is indicative for such logistics networks that they are primarily composed of multiple small-sized, mid-sized and large **logistics centers**, which network, horizontally and vertically, multiple producers, manufacturers, suppliers, warehouses, trade centers, industrial centers, agents (...), clients, consumers (...).

When discussing **optimization of macro-level logistics networks**, it must be borne in mind that optimization of transportation chains, logistics chains, logistics and distribution chains and transportation networks essentially means optimization of logistics network. More important issues that have to be borne in mind when revolving possibilities of logistics network optimization are the following: 1) Selecting optimal routing, or communications (roads), railways, ship lanes, air corridors, river shipping routes, pipelines (...), and all sorts of infrastructure objects, plants and systems; 2) Selecting the most acceptable mechanization and transportation means; 3) Selecting the most acceptable combination of advanced transportation technologies; 4) Selecting the most convenient goods manipulation, transportation and distribution time; 5) Selecting the most suitable combination of methods of goods stock optimization; 6) Selecting the most acceptable transportation chains, logistics chains and logistics and distribution chains; 7) Selecting the most appropriate information technology and information systems to effectively support all logistics activities in logistics networking; 8) Selecting the most suitable models for goods flow management, information flow management, financial flow management, and ownership management; 9) Selecting the most appropriate human resources combination.

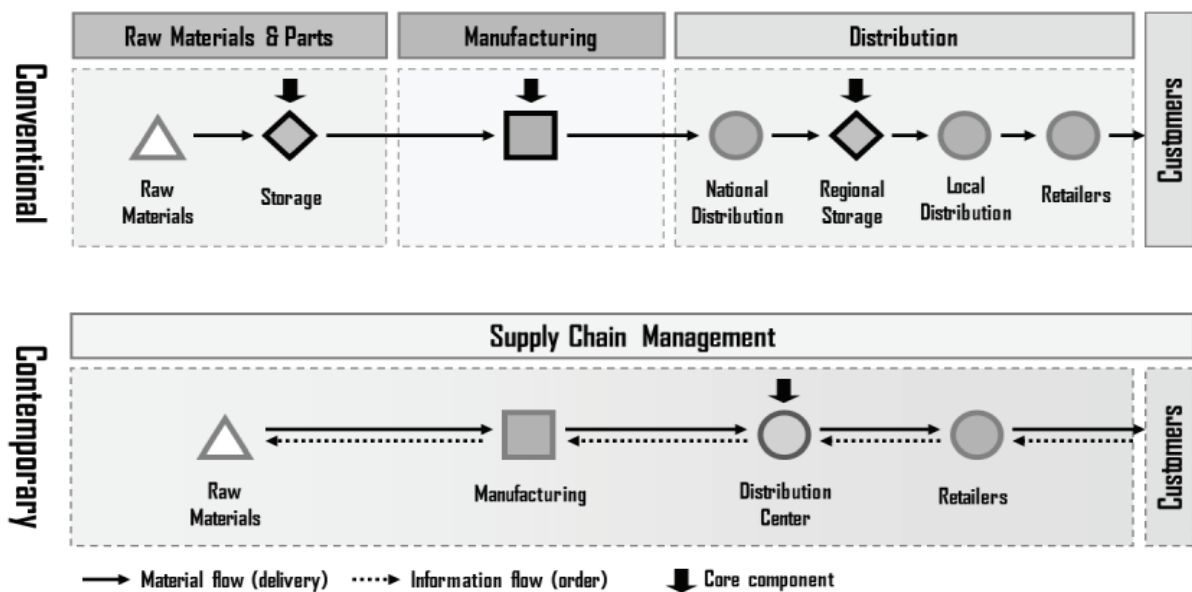
Logistics network is a fundamental prerequisite for efficiency of distribution system. The expansion of classical infrastructure such as highway, terminal and airports are essential for the development of modern distribution system. Distribution systems are embedded in a changing macro and micro economic framework, which can be roughly characterized by the terms of flexibilization and globalization [3]. Distribution systems have become increasingly driven by demand instead of by supply (cf. figure 1).

Figure 1: Changes in the Relative Importance of Logistical Functions in Distribution Systems [4]



This implies many organizational changes in logistics network, especially in flows, nodes and locations and network setting (cf. figure 2).

Figure 2: Conventional and contemporary arrangement of goods flow [5]



Flows. Recent freight flows tend to be of lower volumes, of higher frequency, often taking place over longer distances. In the supply chain now we have unlimited flow of information without time lag. Reverse flows are also important part of supply chain. Concentration of storage or warehousing in one facility, instead of several and this facility is increasingly being designed as crossdocking. According to recent research, fully 33% of firms are choosing consolidated and/or closed warehouses and distribution centres aiming at optimization of logistics network [6].

Nodes and locations. Concentration of logistics function in certain facilities at strategic locations is prevalent. Many improvements in freight flows are achieved at terminals. Facilities are

much larger than before. Freight flows are directed through large ports and major airports, also highway intersections with access to a regional market.

Networks. The setting of networks leads to a shift towards larger distribution centres, often serving significant trans-national catchments. Some goods still requiring a three-tier distribution system, with regional, national and international distribution centres.

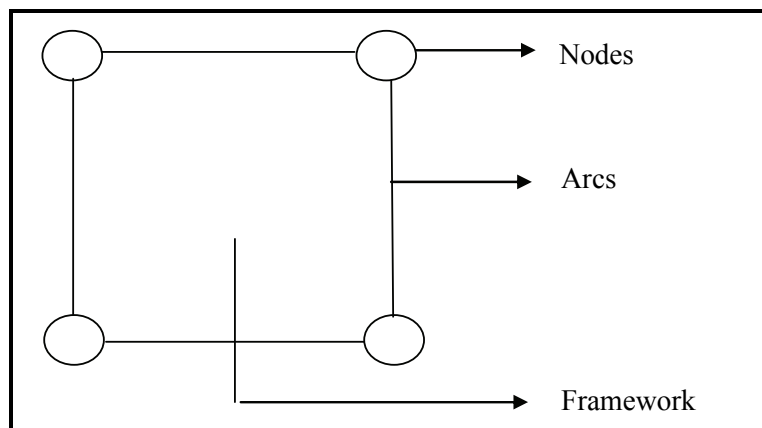
Problems and characteristics that have been identified in distribution systems in macro-level logistics networks ask for an advanced approach to the optimization of flows in logistics network, which may offer multiple optimal solutions. Sub-optimal solutions are likely to contribute to the logistics network optimization if within acceptable tolerances. Furthermore, empirical research confirms redundancy of flows in logistics network. In view of SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats), the problem with multiple optimal solutions may be considered an opportunity for selecting or building optimal flows in logistics network. On the other hand, the problem with redundant relations represents a threat or weakness in modelling and choosing optimal flows in logistics network. This whole process of identifying problems, gathering data, creating work environment to evaluate existing logistics network and design optimal logistics network profile is a demanding task that can be executed successfully only using a scientific approach.

4. RATIONAL SOLUTION MODELLING IN MACRO-LEVEL LOGISTICS NETWORK

4.1 Definition and Elements of Logistics Network Models

In this work, we discuss modelling of rational solutions in macro-level logistics networks, and need to define logistics network elements. By using a subtle qualitative and quantitative approach to analyze the logistics network definition, we are able to establish that each logistics network is made up of nodes, directed arcs, connecting pairs of nodes and network framework (See Chart 3).

Figure 3: Logistics Network Model Elements [7]



Each element of logistics network has its own significant characteristics:

- **Logistics framework** are smaller or larger geographical areas having various forms, bordered by communications, corridors, channels, lines or services (...). Multiple areas or 'eyes' can refer to smaller or larger logistics gravitational zones around smaller or larger logistics and distributions centres or logistics centres within logistics networks where logistics and transportation chains are operating (...).
- **Logistics nodes** are commonly smaller or larger logistics centres, where warehouses, terminals, free zones, trade centres, industrial zones (...) are located, and are interrelated by logistics and distribution chains or logistics and transportation chains (...). Logistics network nodes can also refer to logistics and distribution centres or industrial centers that are operating in

particular logistics gravitational zones through logistics and distribution chains, or logistics and transportation chains (...).

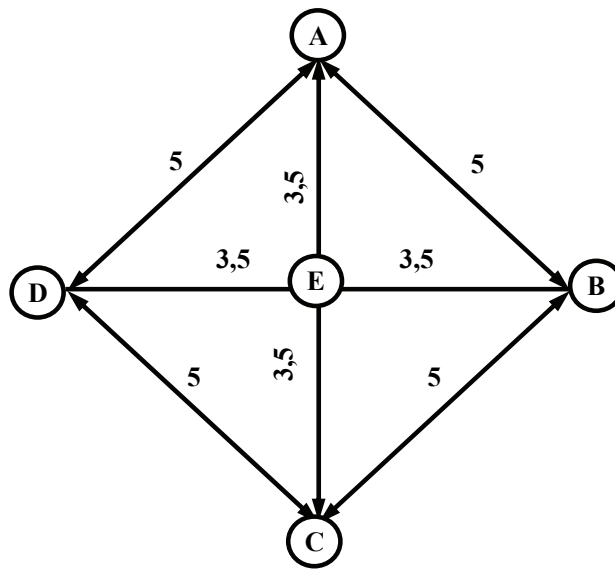
- **Logistic arcs** or routes are a single link between two nodes that are part of a larger network that can refer to tangible routes such as roads and rails, or less tangible routes such as air and sea corridors.

Linear programming models with a mathematical structure corresponding to networks are called network models [8].

4.2 Square Pyramid Model in Generating Multiple Optimal Solutions in Macro-level Logistics Network

Macro-level logistics network model that uses a base of a square pyramid allow us to demonstrate and analyze possibilities of generating a large number of optimal solutions that have equal or similar values. The base of a square pyramid [9] is a square having equal sides and equal angles. The base of a square pyramid is also made of diagonals that intersect at right-angles. The intersection of diagonals is the central node of the base that is equally distant from all other nodes. Square Pyramid Model is described in the Figure 4. The nodes and arcs have been marked up according to the Figure 3.

Figure 4: Macro-level Logistics Network



Source: Author's prepared

Table 2 describes an example of use of the square pyramid model in resolving and analyzing the travelling salesman problem.

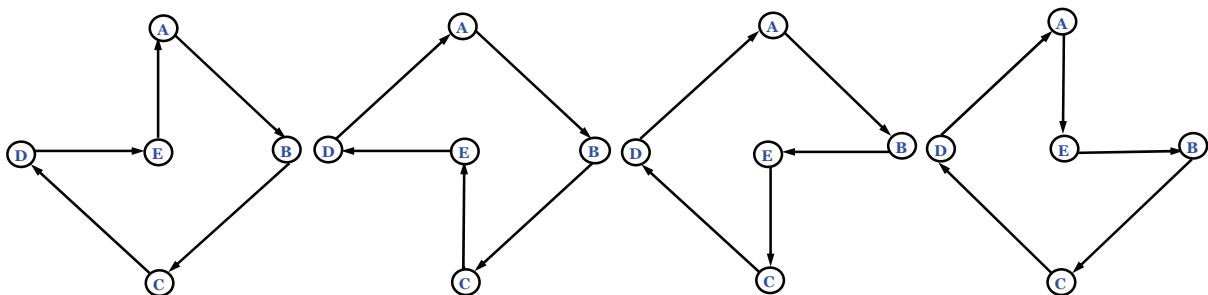
Figure 4 is an example of use of the square pyramid model in resolving and analyzing the travelling salesman problem. Table 2 shows input data and the solution obtained in VBA for Excel. The cell range K1:O5 contains transportation route lengths (arcs) that correspond to the dimensions indicated in the pyramid diagram in the Figure 4. The cell range J1:J24 offers all possible solutions, which have been categorized from the lowest to the highest. The Table 2 shows that there are 8 optimal solutions which result in equal minimum values of the total transportation route (22). Considering the matrix from the cell range K1:O5 is symmetric, it follows that the model has generated 4 optimal solutions. Figure 5 is a graphical display of optimal solutions for the square pyramid model.

Table 2: Finding solution by use of Visual Basic for Excel

	A	B	C	D	E	F	J	K	L	M	N	O	P	Q
1	1	2	3	4	5	1	22	1,0	5,0	7,0	5,0	3,5	1	A
2	1	2	3	5	4	1	22	5,0	1,0	5,0	7,0	3,5	2	B
3	1	2	5	3	2	1	22	7,0	5,0	1,0	5,0	3,5	3	C
4	1	5	2	3	4	1	22	5,0	7,0	5,0	1,0	3,5	4	D
5	1	5	4	3	2	1	22	3,5	3,5	3,5	3,5	1,0	5	E
6	1	4	5	3	2	1	22	1	2	3	4	5		
7	1	4	3	5	2	1	22	A	B	C	D	E		
8	1	4	3	2	5	1	22							
9	1	2	5	4	3	1	24							
10	1	2	4	3	5	1	24							
23	1	3	5	2	4	1	26							
24	1	3	2	4	5	1	26							

Source: Author's calculations

Figure 5: Optimal Solution Graphical Display



Source: Author's prepared

4.3 Macro-level Logistics Model in Redundancy Problem Analysis

Redundant relation may occur in case of a difference between mathematical and physical TSP model. In such a case, in a mathematical model, each city (node) is visited only once exactly, while in a physical model, a city can be visited twice meaning that the car goes two times the same route, or is repeating the route.

The mathematical model is described in the Table 3, while the physical model can be displayed graphically as shown in the Figure 6. It can be concluded from the optimal relation A-B-E-C-D-A generated by use of mathematical model, that each node has been computed one time exactly. In other words, each city is visited exactly once. On the other hand, the graphical model reveals that the node C has been repeated two times. Here follows the interpretation of difference between the mathematical and graphical (real) model.

Table 3: Redundancy Problem Mathematical Model

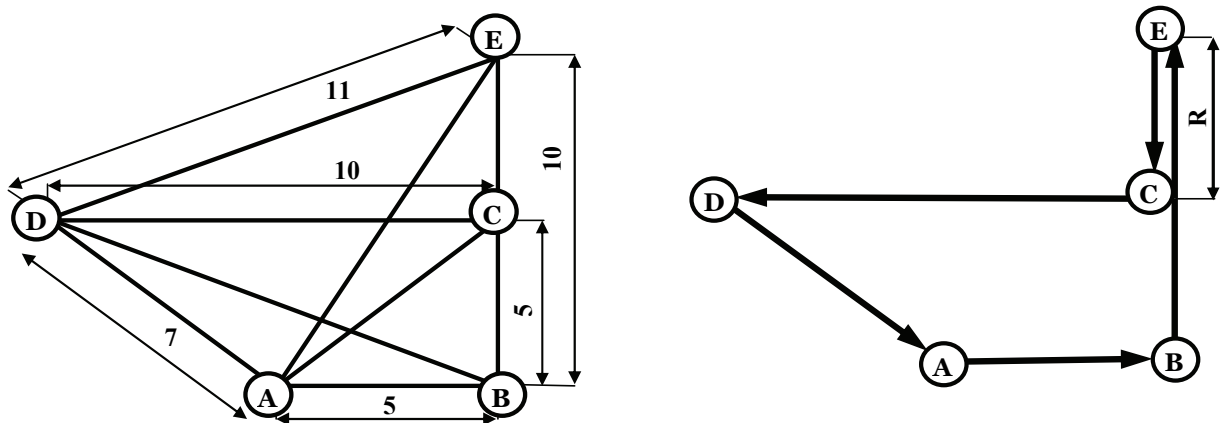
	A	B	C	D	E	F	J	K	L	M	N	O	P	Q
1	1	2	5	3	4	1	32	1,0	5,0	7,0	7,0	11,0	1	A
2	1	4	3	5	2	1	32	5,0	1,0	5,0	11,0	10,0	2	B
3	1	2	3	5	4	1	33	7,0	5,0	1,0	5,0	5,0	3	C
4	1	4	5	3	2	1	33	7,0	11,0	5,0	1,0	11,0	4	D
5	1	2	3	4	5	1	37	11,0	10,0	5,0	11,0	1,0	5	E
6	1	2	4	3	5	1	37	1	2	3	4	5		
7	1	5	4	3	2	1	37	A	B	C	D	E		
8	1	5	3	4	2	1	37							
23	1	5	4	2	3	1	45		Optimal relation					
24	1	3	2	4	5	1	45		A - B - E - C - D - A					

Source: Author's calculations

In the graphical model, redundant relation can be explained in the following way: Given the relations AB and BC that belong to the same straight line, where $BC \subseteq AB$, are the graph elements (arcs), we can conclude that the relation BC is redundant. In this example, the graphical model of redundant relation is shown in the Figure 6. The chart reveals the optimal relation A-B-E-C-D-A. The chart also reveals that the straight lines BE and EC, where $EC \subseteq BE$, belong to the group of arcs (straight lines) that make the optimal solution meaning that EC is the redundant relation.

It can be seen from the Figure 6 that redundant relation means running in place in the context of return and double movement along the same relation. In mathematical terms, an optimal relation line, as in this example as well, passes exactly once through each node. The real optimal relation passes two times through the node C, where the mathematical model recognizes the relations BE and EC, but not the relation BC that is part of the relation BE.

Figure 6: Redundancy Problem Graphical Model



Source: Author's prepared

5. TSP BASED DISTRIBUTION RATIONALIZATION IN MACRO-LEVEL LOGISTICS NETWORK

In this work, we explore the travelling salesman problem based distribution rationalization in macro-level logistics networks at regional scale. In our example, the macro-level logistics network binds up together the following cities of Croatia: Rijeka (RI) and Zagreb (ZG), Italy: Trieste (TR) and Udine (UD), Slovenia: Ljubljana (LJ), Celje (CE) and Maribor (MB), and Austria: Klagenfurt (KL)

and Graz (GR). The cities have been interrelated via major and regional roads intended exclusively for motor vehicles. Table 4 contains distance between the cities.

Table 4: Distance between selected European cities

			1	2	3	4	5	6	7	8	9
RB	City	Abb	RI	LJ	ZG	GR	MB	CE	UD	KL	TR
1	Rijeka	RI	1	141	166	331	266	220	147	220	75
2	Ljubljana	LJ	142	1	143	195	130	79	159	85	101
3	Zagreb	ZG	160	139	1	183	118	152	291	224	232
4	Graz	GR	329	195	189	1	70	123	300	139	296
5	Maribor	MB	260	127	121	70	1	55	272	186	228
6	Celje	CE	220	77	154	121	56	1	237	161	179
7	Udine	UD	147	159	295	296	289	238	1	160	75
8	Klagenfurt	KL	220	88	227	136	185	162	161	1	178
9	Trieste	TR	75	94	230	289	224	173	74	173	1

Source: Author's calculations

Distance data has been calculated with Google Maps, digital mapping that can be found in a variety of computer applications, offering many services such as browsing satellite images, planning travel routes, locating places etc. Google Maps technology allows us to obtain an automatic graphical display of a chosen relation on digital map.

Google Maps is a web mapping service application and technology provided by Google that offers maps of the whole world. Google Maps satellite images are not updated in real time; we see images stored on the server. Google Maps also offers street view, address browsing, a route planner for travelling by foot, car, bike or public transport.

Table 5: Finding Solution by use of Visual Basic for Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	1	3	4	5	6	2	8	7	9	947	1	141	166	331	266	220	147	220	75	1	RI
2	1	9	7	8	2	6	4	5	3	948	142	1	143	195	130	79	159	85	101	2	LJ
3	1	9	7	8	4	5	6	2	3	950	160	139	1	183	118	152	291	224	232	3	ZG
4	1	3	5	4	6	2	8	7	9	950	329	195	189	1	70	123	300	139	296	4	GR
5	1	9	7	8	2	6	5	4	3	951	260	127	121	70	1	55	272	186	228	5	MB
6	1	3	2	6	5	4	8	7	9	960	220	77	154	121	56	1	237	161	179	6	CE
7	1	9	7	2	8	4	5	6	3	968	147	159	295	296	289	238	1	160	75	7	UD
8	1	7	9	2	8	4	5	6	3	976	220	88	227	136	185	162	161	1	178	8	KL
9	1	3	6	5	4	8	2	7	9	980	75	94	230	289	224	173	74	173	1	9	TR
10	1	9	7	2	8	4	6	5	3	989	1	2	3	4	5	6	7	8	9		
11	1	3	6	5	4	8	2	9	7	993	RI	LJ	ZG	GR	MB	CE	UD	KL	TR		
12	1	3	5	6	4	8	2	7	9	996											
40319	1	6	8	3	7	5	9	4	2	2042											
40320	1	6	7	5	9	4	2	3	8	2045											

Source: Author's calculations

In the rationalization of regional macro-level logistics network, Exhaustive Search Algorithm built in Visual Basic has been used. Object-oriented programming in VBA for Excel has been used to build and visualize exhaustive search algorithm in order to compute one or multiple optimal transportation routes. Table 5 contains TSP problem results in the given example. The results have been calculated by program Visual Basic in Excel spreadsheet environment, created by the authors of this work. It can be seen from the Table 5, that 40,320 possible transportation routes (relations) have been computed with the minimum route length having 947 km.

Table 6 reveals optimal transportation routes having values within an acceptable tolerance of 1% as compared to the best optimal value, or minimum route length as computed. Based on the data obtained from the Table 6, it can be seen that five optimal relations have been computed within an acceptable tolerance of 1% using object-oriented programming in VBA for Excel by use of a method based on exhaustive search algorithm.

To place route relations in order, in the Table 6, we used ordinal numbers RB, beginning with the lowest distance. RBS means routes that refer to the same communication flow and have opposite directions. It can be seen from the Table 4 and results given in the Table 5 that those routes are nearly, but not completely symmetric. For instance, the distance from Rijeka to Zagreb is 166 km, while the distance between Zagreb and Rijeka is 160 km. Besides distance and deviation, the table contains estimated driving time for each route.

Table 6: Optimal relations within acceptable tolerance limits

RB	RBS	Transport relation										Length	Tol.	Time
1	1A	1	3	4	5	6	2	8	7	9	1	947	0,0%	11,15
		RI	ZG	GR	MB	CE	LJ	KL	UD	TR	RI			
2	2A	1	9	7	8	2	6	4	5	3	1	948	0,1%	11,11
		RI	TR	UD	KL	LJ	CE	GR	MB	ZG	RI			
3	3A	1	9	7	8	4	5	6	2	3	1	950	0,3%	10,52
		RI	TR	UD	KL	GR	MB	CE	LJ	ZG	RI			
4	2B	1	3	5	4	6	2	8	7	9	1	950	0,3%	11,18
		RI	ZG	MB	GR	CE	LJ	KL	UD	TR	RI			
5	1B	1	9	7	8	2	6	5	4	3	1	951	0,4%	11,14
		RI	ZG	UD	KL	LJ	CE	MB	GR	ZG	RI			
6	3B	1	3	2	6	5	4	8	7	9	1	960	1,4%	10,57
		RI	ZG	LJ	CE	MB	GR	KL	UD	TR	RI			

Source: Author's calculations

The value of optimal relation has been tested by summation of transport directions in optimal relation (Table 7) and has been compared with solution which has been calculated by usage of programming language for mathematical modeling Xpress (Figure 7).

Table 7: Testing of optimal solution

1	3	4	5	6	2	8	7	9	1	Ukupno
RI	ZG	GR	MB	CE	LJ	KL	UD	TR	RI	
166 + 183 + 70 + 55 + 77 + 85 + 161 + 75 + 75 =										947

Source: Author's calculations.

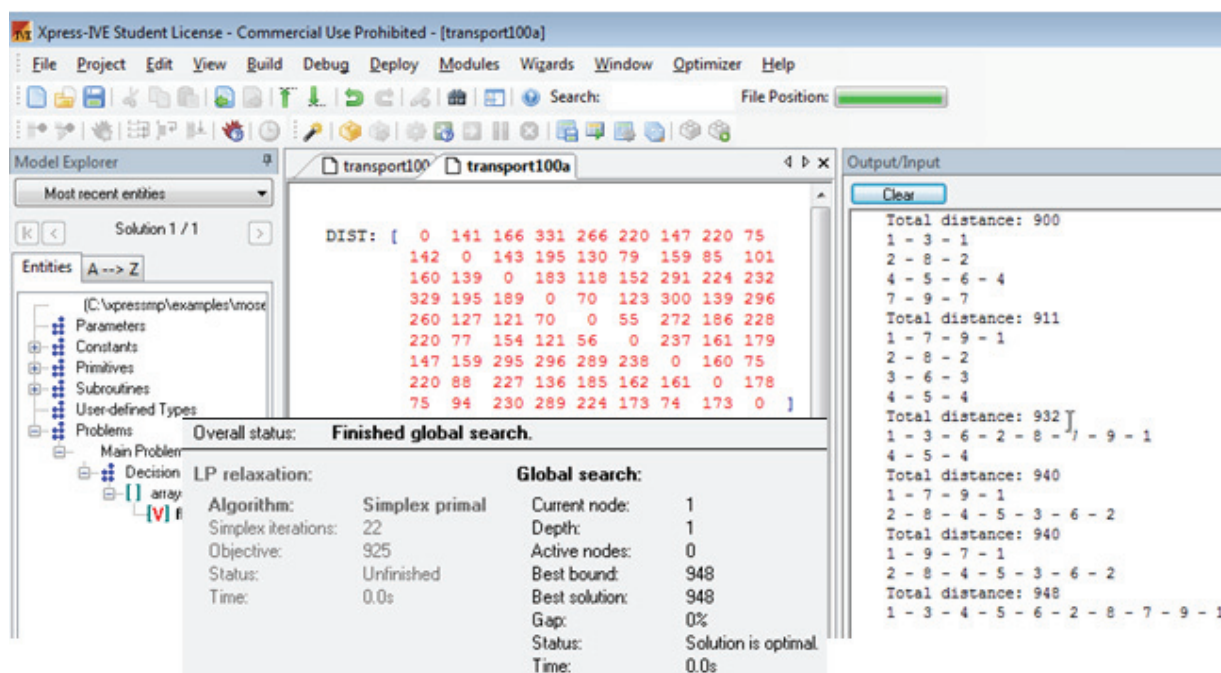
The Figure 7 shows that calculated optimal solution calculated in program Xpress (948) has deviation of 0,1% in comparison with optimal solution calculated in Visual Basic (947).

In our regional macro-level logistics network example, the optimization criterion (factor) is the minimum travel distance. Considering multiple optimal solutions within particular acceptable tolerance we are able to make comparative analysis and create synergy of all relevant factors that determine the best (optimal) solution, or group of optimal solutions.

After analyzing results, the most acceptable arises to be the first relation (RB – 1). If analyzing estimated driving time as well, the most acceptable would be the third relation (RB – 3) with minimum distance deviation as compared to the first one, while the estimated driving time of the third route (10,52) is considerably shorter than the first one. These results have largely confirmed multiple optimal solutions within given acceptable tolerances.

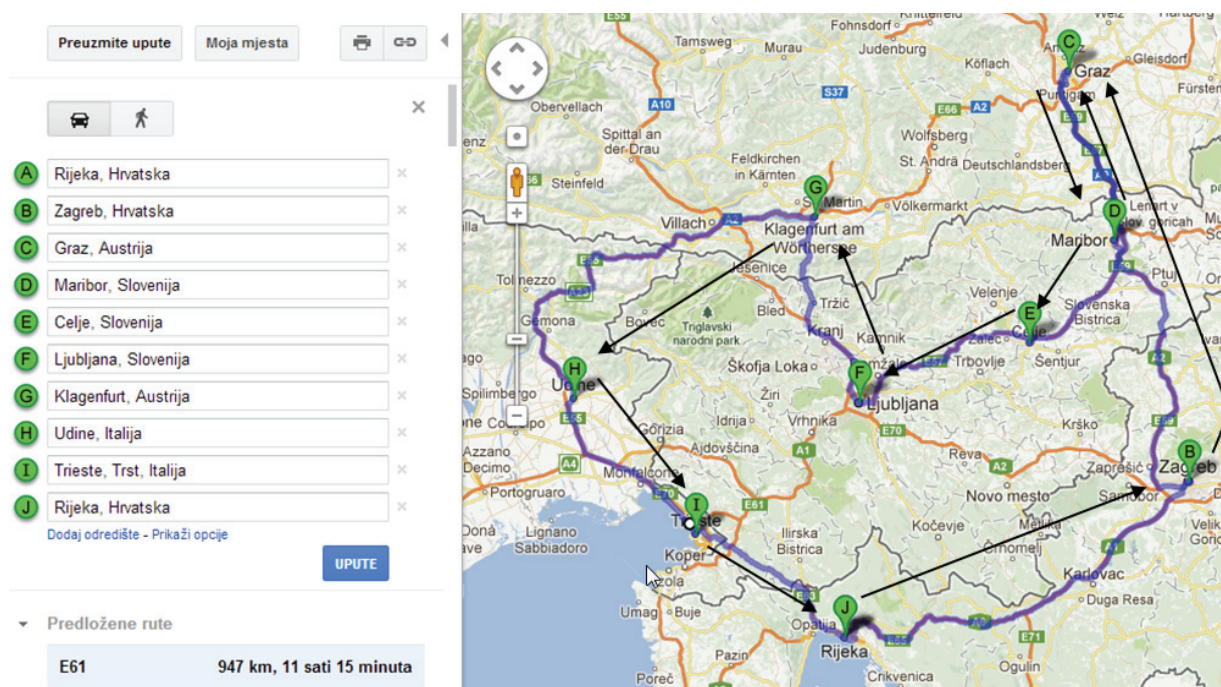
Optimal relations are displayed on the maps 1, 2 and 3.

Figure 7. Optimal solution calculated by usage of programming language Xpress



Source:

Map 1: Optimal transportation route RB-1



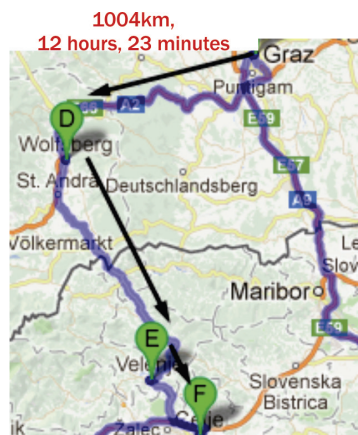
Source: Author's prepared according to Google map

Map 1 is the graphical display of the optimal transportation route RB-1 having the least length. The map and route direction are shown in the right part of the image, while distance values and estimated driving time are indicated in the left part of the image.

The map reveals the redundant relation Maribor–Graz–Maribor, which means that Maribor is visited twice. The relations Zagreb–Maribor and Maribor–Graz, where Graz–Maribor is the subgroup of the relation Zagreb–Maribor, belong to the group of communication flows (arcs) that compose the optimal solution. This means that there is a redundant relation Graz – Maribor, which is marked on the map by arrows of opposite directions.

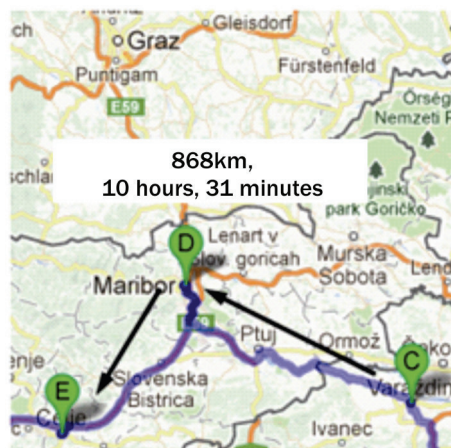
Redundancy problem can be solved in several ways: 1) Accepting redundant relation. In case of increased traffic on the route Graz–Maribor with optimal use of transportation capacities, this redundant relation may be considered an opportunity. 2) Changing route and adding new city. In this example, instead of the route Graz – Maribor – Celje, another route can be proposed: Graz – Wolfsberg – Velenje – Celje, where two more cities would be added (Map 1a). The proposed route will probably not be accepted as in that case the total distance would be 1004 km, which is a deviation of 5,6% with respect to the minimum distance. 3) Replacing city. In the example, Graz can be replaced with Varaždin (Map 1b). In such a case, the total distance is 868 km, or 8% shorter than the minimum distance as computed before introducing the modification; this proposal, therefore, is likely to be taken into account.

Map 1a: Resolving problem with redundant relation I



Source: Author's prepared according to Google map

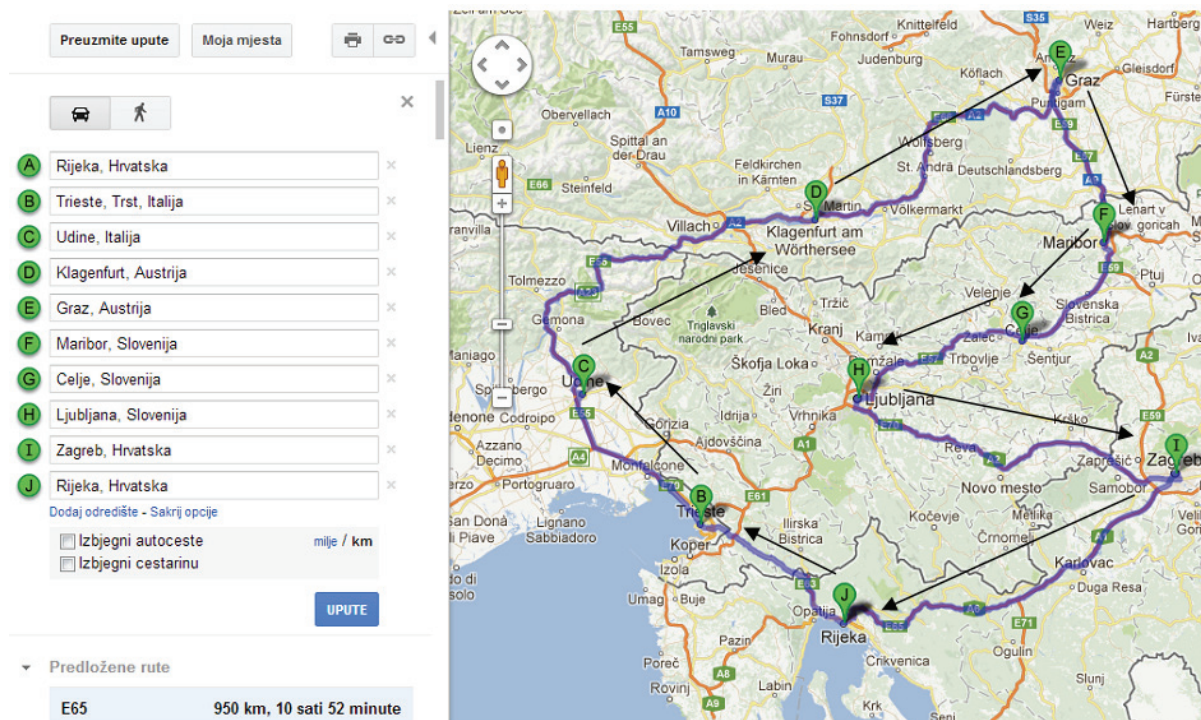
Map 1b: Resolving problem with redundant relation 2



Source: Author's prepared according to Google map

Map 2 graphically displays the optimal transportation route (RB-3 in Table 6) that integrates the best results in terms of minimum distance and shortest driving time.

Map 2: Optimal transportation route RB-3



Source: Author's prepared according to Google map

6. CONCLUSION

In the rationalization of regional macro-level logistics networks, exhaustive search algorithm built in Visual Basic was used. Object-oriented programming in VBA for Excel was considered in modeling and visualization of exhaustive search algorithms to compute one or multiple optimal transportation routes. Scientific contribution of this work reflects in the fact that most modern software solutions enable computation and insight into one optimal solution. In this work, we have proven that using visual and object-oriented methods of programming and modelling in building exhaustive search algorithm, we are able to simulate models with multiple optimal solutions for smaller samples, up to 10 transportation centres with clear interpretation of results not only for equal optimal values but also nearly equal values, and defining acceptable tolerances.

Identification and scientifically founded analysis of problems with multiple optimal relations and problems with redundant relations allow us to make a significant influence to the synergy of parameters of successfulness and effectiveness of transportation from the starting point to the destination: minimum distance, minimum time, minimum cost, and maximum exploitation of transportation capacities. Integrated modelling and programming, based on object-oriented technology and visualization in VBA for Excel can serve as a tool for understanding and solving problems in macro-level logistics networks, and may become a mean for creating and interpreting ideas. In the very process of building models and developing programs we are able to conceive essential problem particulars that have not been previously clearly identified, enabling us not only to resolve the problem, but redefine it and upgrade the program accordingly.

Methodological frame of use of Visual Basic as a development tool in the visual modelling of exhaustive search algorithm in VBA for Excel can serve as an incentive in creating new highly sophisticated algorithms, which will enable us to compute multiple optimal solutions with possibility of integrating a bigger number of samples (cities, transportation centres).

REFERENCES

- [1] Heizer, J. and Render, B. (2004), *Operations Management*, seventh edition, Pearson Prentice Hall, New Jersey.
- [2] Zelenika, R. and Pupavac, D. (2008), *Menadzment logistickih sustava*, Ekonomski fakultet Sveucilista u Rijeci, Rijeka.
- [3] Rodrigue, J.P. et al. (2006), *The Geography of Transport Systems*, Routledge, London and New York.
- [4] Federal Highway Administration, Office of Freight Management, available at: <http://ops.fhwa.dot.gov/freight/>, (accessed 01-04-2013).
- [5] Hesse, M. and J-P Rodrigue (2004) "The Transport Geography of Logistics and Freight Distribution", *Journal of Transport Geography*, Vol. 12, No. 3, pp. 171-184.
- [6] Napolitano, M. (2011), "2011 Warehouse/DC Operations Survey, Logistics Management", available at: http://www.logisticsmgmt.com/article/2011_warehouse_dc_operations_survey/(accessed: 05.10.2012.)
- [7] Zelenika, R. (2005), *Logistički sustavi*, Ekonomski fakultet u Rijeci, Rijeka, 2005.
- [8] Shapiro, J. (2001), *Modeling the Supply Chain*, Duxbury Thomson Learning, USA.
- [9] Vukmirovic, S., Kovacevic, I., and Grubic, A. (2007), "Visualisation of model decision designing by usage of graphical aids and Visual Basic for applications within spreadsheets interface", *MIPRO 2007*, Proceedings of the 30th International Convention, Computers in Education, Opatija.
- [10] CM30073 Advanced Algorithms and Complexity, http://people.bath.ac.uk/masnnv/Teaching/AAlg12_1.pdf

A REGRESSION MODEL OF INFLATION IN MONTENEGRO

VESNA KARADZIC¹

ABSTRACT

A regression model of inflation in Montenegro is specified and estimated employing the technique of OLS on a monthly time series data for the three year period 2010-2013. The stationary and co-integration tests were adopted to examine the data in order to establish whether there exist a long-run relation among the variables. Several diagnostic tests were used to check for the specification of the model and problems of heteroscedasticity, autocorrelation and multicollinearity in the estimated regression model. The regression model is used to test theory on empirical data in case of Montenegro. As expected, the estimated model is another empirical evidence of the Philips curve i.e. theoretical trade-off between unemployment and inflation in a short run. Moreover, the results of the regression analysis proved theory that there is a direct relation between inflation and import-to-export ratio, while the relation inflation - GDP rate is an indirect one.

KEY WORDS: Inflation, Regression model, Stationary, Co-integration

JEL classification: C13, C22, C51

Received: August 21, 2014 / Accepted: November 12, 2014

1. INTRODUCTION

In the last decades, inflation has been one of the main problems of the world economy. The generalized increase of the prices lead to significant distortions in the economic, monetary, political and social environment. Inflation is a potential obstacle and a permanent threat to every economy. It is one of the main factors of economic crisis, it discourages investments and it determines the capital migration. Due to its multiple influences and mainly negative impact on economic development inflation is one of the most researched economic phenomenon. (Draskovic, 2007)

During 1990s Montenegro had experienced major economic, political and social instability and very volatile price dynamics with high level of inflation. The Montenegrin economy is a specific one in a sense that the monetary policy is of limited power because Montenegro has no its own currency, but instead uses euro even though it is not a member of eurozone. By introducing the Deutch Mark as a national currency in 1999, and in Euro in 2004, Montenegrin government has denied the main instrument of monetary policy. However, in the last decade Montenegro has achieved better price stability with periodic oscillation due to structural reforms (introduction of DEM, Euro, implementation of VAT, etc)(Lipovina-Bozovic, 2013).

In Montenegro, inflation is important not only for economic but also for political reasons. Montenegro has started the process of EU integration and as a candidate state for EU membership it has the task to keep inflation at certain specified level. Therefore the Central Bank of Montenegro has to control inflation and mitigate its negative impact on Montenegrin economy.

This paper contributes with the empirical research of the relations between inflation and the most important macroeconomic variables in Montenegro. The regression model is used to test theory on empirical data for Montenegro, i.e. to test whether the inverse relations between inflation on one side and unemployment and GDP on the other side hold for Montenegro during the current economic crises, as well as whether there is a direct relation between import-to-export ratio and inflation.

¹ University of Montenegro, Faculty of Economics, vesnaka@ac.me

2. METHODOLOGY AND DATA

Consumer price index is the most often used measure of inflation. Statistical Office of Montenegro has recently started to produce CPI with the base in 2003. Its creation marked important introduction and implementation of international standard in the statistics of price dynamics in Montenegro. Inflation being endogenous variable of the regression model in this paper is measured by CPI.

To develop a regression model of inflation it is necessary to identify and underline the main influence factors, i.e. exogenous variables. Those factors are very diverse and have origin within national economy as well as from external sources. Montenegro is a small and open economy using euro as its own currency. Since agricultural and processing industries make up less than 20% of GDP of Montenegro, it is an import dependent economy. From the large number of known inflation influence factors, having in mind restrictions regarding the availability of data, after preliminary statistical analysis, several (level) variables including number of unemployed (UNEMP), gross domestic product rate (LOG(GDP)), minimal consumer basket (CONS_BASK) and import-to-export (IMP_EXP) ratio are chosen to constitute the set of exogeneous variables in the regression model of inflation in case of Montenegro. The statistical test of significance and omitted variable specification test indicated wages as insignificant variable and consequently it was dropped from the model.

The data are obtained from MONSTAT (Statistical Office of Montenegro) and from Central bank of Montenegro. The data are of the time-series form, i.e. the monthly data from January 2010 to December 2013.

The method of analysis in this paper is the Ordinary Least Square (OLS) technique applied to a multiple regression model. The OLS is a statistical technique used to estimate structural parameters of the model in such a way as to minimize the sum of the deviations of the actual observation from their model estimated values. It is one of the most commonly used methods in estimating relationships in econometric models and it produces best, linear, unbiased estimates (BLUE) (Koutsoyiannis, 1997).

According to standard econometric procedure it is necessary to firstly check the data for possible non-stationarity. This need arises from the fact that if a time series data is non-stationary, the regression performed on variables with unit root would be "spurious" (Granger and Newbold, 1974) or "dubious" (Phillips, 1987). A series is stationary if its mean and variance are constant over time and the value of covariance between the two time periods depend only on the distance or lag between the two periods and not the actual time at which the covariance is computed (Gujarati, 2004). To test stationary several tests can be used. In this paper the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests are implemented.

Secondly, it should be tested whether the identified non-stationary series are co-integrated. The variables are said to be co-integrated if they satisfy the condition that there exist at least $(k-1)$ co-integrating equations i.e. stationary linear combinations of individually non-stationary variables. (Maddala and Kim, 1998).

After the model is estimated several diagnostic tests has to be done so that all needed corrections, or even different estimators can be employed if necessary. These diagnostic tests are used to check for the specification of the model, as well as for the possible problems of heteroscedasticity, autocorrelation and multicollinearity in the estimated regression model. For that purpose we employed Ramsey RESET and JB tests to check for specification, White Heteroscedasticity test, Breusch-Godfrey Serial Correlation LM test and correlation matrix.

3. EMPIRICAL RESULTS

Stationary test

Most economic time series are far from stationary when expressed in their original measure units. Non-stationary can have important consequences for regression models and inference. That is why Unit-root tests should be performed on all used time series before the model specification. The Augmented Dickey Fuller (ADF) or Phillips Perron (PP) unit root test for stationary were performed with the following results.

Table 1: Unit root tests

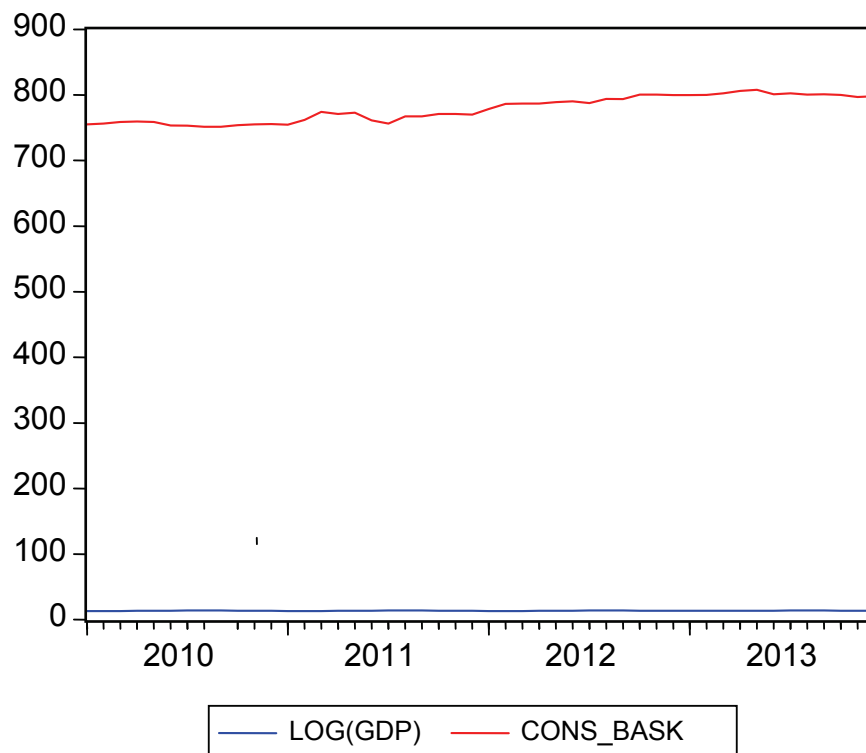
Variable	ADF test statistic	p-values	PP test statistic	p-values	Order
CPI	-1.133729	0.06947			I(0)
UNEMP			-3.895493	0.0042	I(0)
LOG(GDP)	-1.313193	0.6135			I(1)
D(LOG(GDP))	-13.54689	0.0000			I(0)
CONS_BASK	-0.907978	0.7771			I(1)
D(CONS_BASK)	-6.522120	0.0000			I(0)
IMP_EXP			-5.254857	0.0001	I(0)

Test results show that series inflation, unemployment and import-to-export ratio are stationary in absolute form, while series GDP rate and minimal consumer basket are stationary on first difference. That is why we opted to calculate changes in GDP rate and consumer basket and use the change instead of level variables, i.e., $D(\text{LOG}(\text{GDP}))$ and $D(\text{CONS_BASK})$, respectively.

Co-integration test

Two series, GDP and minimum consumer basket, are found to be non-stationary and it is necessary to test whether they are co-integrated. The Johansen test is used to test the hypothesis about the rank of the co-integrating relationships that exist among the variables. Figure 1 indicates that GDP rate and minimum consumer basket follow the similar paths while having direct relationship.

Figure 1: Non-stationary variables



The null hypothesis of the Johansen test states that there is no co-integrating equations. It is rejected if Trace statistic and Max-Eigenvalue are higher than corresponding critical value at 0.05 significance level.

Table 2: *Johansen co-integration test*
Series: LOG(GDP), CONS_BASK

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Max-Eigen Statistic	0.05 Critical Value
None *	0.332668	19.00028	15.49471	18.20106	14.26460
At most 1	0.017604	0.799226	3.841466	0.799226	3.841466

* denotes rejection of the hypothesis at the 0.05 level

The Johansen test indicates that there exist one co-integrating equation at 5% significance level meaning that there exist a stationary linear combination of non-stationary series GDP rate and minimal consumer basket. This result satisfies the requirement that there must be at least (k-1) number of co-integrating equations for the variables to be integrated. Consequently, carrying out a regression on these variables may not produce a spurious regression.

Estimation of the model

Based on the analysis we specified the model represented by the following equation

$$CPI_t = \alpha + \beta_1 UNEMP_t + \beta_2 D(CONS_BASK)_t + \beta_3 D(LOG(GDP))_t + \beta_4 IMP_EXP_t + \varepsilon_t$$

The OLS estimates of the regression model of inflation in Montenegro are presented in the table 3.

Tabela 3: *OLS Estimates of the regression model*

Dependent Variable: INFLATION (CPI)

Sample (adjusted): 2010M02 2013M12

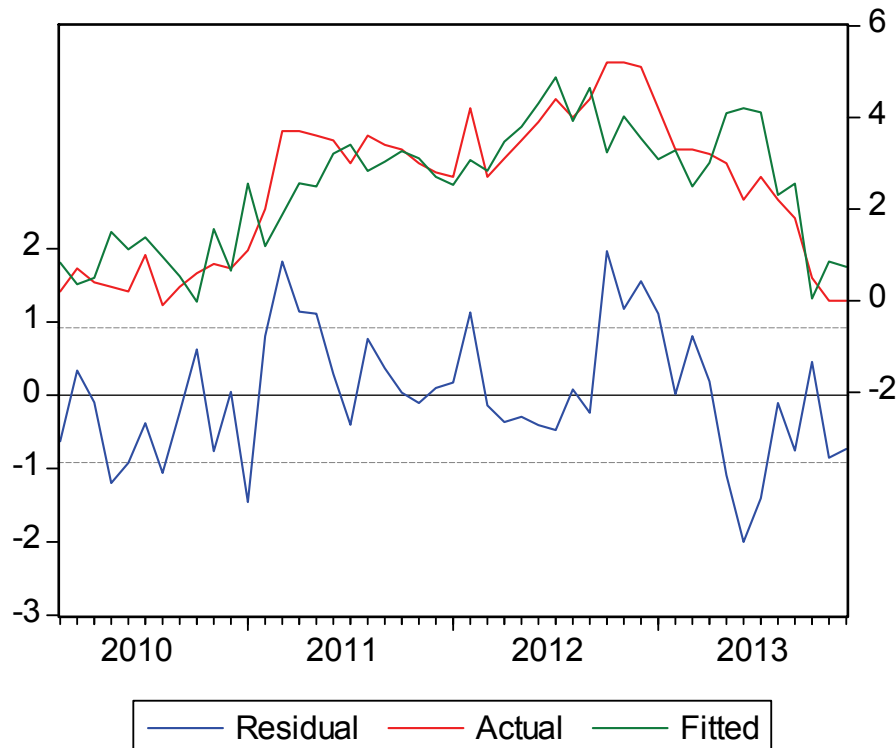
Included observations: 47 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	p-values
C	37.06151	14.23898	2.602820	0.0127
UNEMP	-0.000 853	0.000107	-7.976519	0.0000
D(CONS_BASK)	0.043082	0.007187	5.994599	0.0000
D(LOG(GDP))	-3.215435	0.881846	-3.646256	0.0007
IMP-to-EXP	10.40189	2.754461	3.776379	0.0005
R-squared	0.694509	Mean dependent var	2.480851	
Adjusted R-squared	0.665414	S.D. dependent var	1.590821	
S.E. of regression	0.920185	Akaike info criterion	2.771804	
Sum squared resid	35.56309	Schwarz criterion	2.968628	
Log likelihood	-60.13739	F-statistic	23.87086	
Durbin-Watson stat	2.071316	Prob(F-statistic)	0.000000	

From the estimated model, it is obvious that all coefficients came out with the right and expected signs; all exogenous variables are statistically significant at less than 1% significance level. More over, the estimated F-statistic proves whole model to be a significant one, i.e. joint influence of the explanatory variables on the variation of inflation (70%) is highly significant.

From the Actual-Fitted- Residuals graph it can be seen whether the model is successful in estimating the actual inflation.

Figure 2: Actual-Fitted- Residuals of the model



The figure suggests that in the most of the studied months the correlation real life – model is high.

Diagnostic tests

The **specification** of the regression is tested by Ramsey RESET test and Jarque Bera test.

Ramsey RESET (REgression Specification Error Test) is a general test for the model specification error regarding omitted relevant variable, incorrect functional form and correlation between explanatory variable and error. In any of this cases misspecification causes biased and nonconsistent OLS estimates.

Table 4: Ramsey RESET test

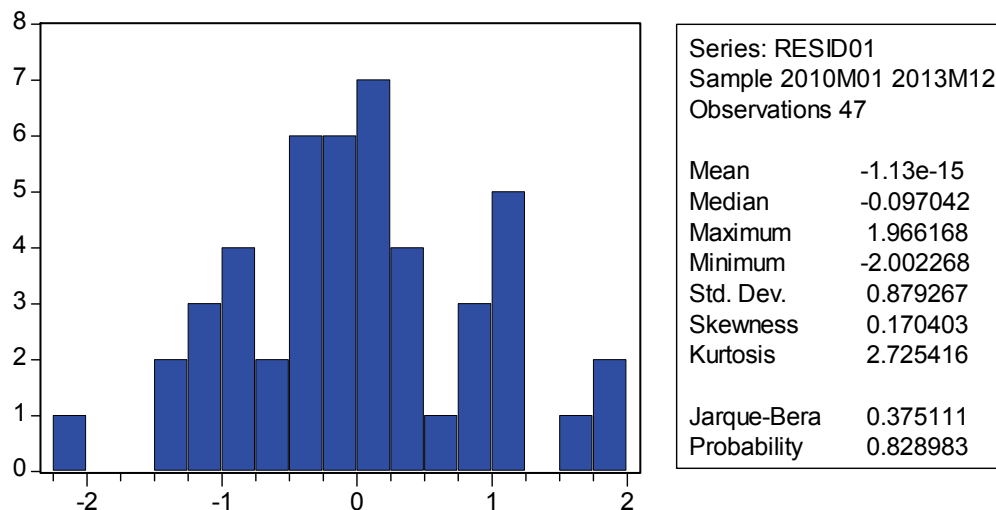
F-statistic	3.783319	Probability	0.031272	
Log likelihood ratio	8.142853	Probability	0.017053	
Test Equation:				
Dependent Variable: INFLATION (CPI)				
Sample: 2010M02 2013M12				
Included observations: 47				
Variable	Coefficient	Std. Error	t-Statistic	Prob.

C	-5.219326	34.37772	-0.151823	0.8801
UNEMP	0.000230	0.000834	0.276153	0.7839
D(CONS_BASK)	-0.014151	0.044039	-0.321329	0.7496
D(LOG(GDP))	0.704493	3.043618	0.231466	0.8181
IMP-to-EXP	-4.557235	10.13808	-0.449517	0.6555
FITTED^2	0.828453	0.458743	1.805921	0.0785
R-squared	0.743105	Mean dependent var	2.480851	
Adjusted R-squared	0.704570	S.D. dependent var	1.590821	
S.E. of regression	0.864666	Akaike info criterion	2.683658	
Sum squared resid	29.90591	Schwarz criterion	2.959212	
Log likelihood	-56.06596	F-statistic	19.28423	
Durbin-Watson stat	2.069670	Prob(F-statistic)	0.000000	

The null hypothesis of the RESET test that model is misspecified can be rejected at 5% significant level. According to RESET test the model specification is a correct one.

Jarque-Bera test (JB) test is used to check the specification of the model by testing normality assumption of the model residuals. This test first computes skewness and kurtosis measures of OLS residuals. For a normally distributed variable, $s=0$ and $k=3$. The JB test of normality is a test of a joint hypothesis that s and k are 0 and 3, respectively, in which case the JB statistic value is expected to be 0 (Gujaraty, 2004).

Figure 3: Jarque Bera test



In figure 3 the residuals from the estimated regression model seem to be symmetrically distributed. Application of JB test under the null hypothesis that the residuals are normally distributed shows that JB statistic is 0.375 and its probability is 83%. Hence, the hypothesis that the residuals are normally distributed can not be rejected both at 5% and 1% significant level. JB test indicates that the model specification is a correct one.

White Heteroscedasticity test is employed under the null hypothesis that errors in regression model have constant variance regardless of the X_i value, i.e. stochastic errors are homoscedastic.

Table 5: *White Heteroscedasticity test*

F-statistic	1.148044	Probability	0.355056
Obs*R-squared	9.148469	Probability	0.329927

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Sample: 2010M02 2013M12

Included observations: 47

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	676.6744	1171.447	0.577640	0.5669
UNEMP	0.002382	0.003490	0.682620	0.4990
UNEMP ^2	-4.02E-08	5.53E-08	-0.727837	0.4712
D(CONSUM_BASK)	-1.863047	1.139831	-1.634494	0.1104
D(CONSUM_BASK) ^2	0.001207	0.000732	1.647636	0.1077
D(LOG(GDP))	2.273095	145.0021	0.015676	0.9876
D(LOG(GDP))^2	-0.122719	5.317273	-0.023079	0.9817
IMP_EXP	-9.219247	15.12609	-0.609493	0.5458
IMP_EXP ^2	26.13625	27.86993	0.937794	0.3543
R-squared	0.194648	Mean dependent var	0.756662	
Adjusted R-squared	0.025101	S.D. dependent var	1.004659	
S.E. of regression	0.991970	Akaike info criterion	2.992169	
Sum squared resid	37.39215	Schwarz criterion	3.346453	
Log likelihood	-61.31597	F-statistic	1.148044	
Durbin-Watson stat	1.793241	Prob(F-statistic)	0.355056	

According to the results of the White Heteroscedasticity test the null hypothesis can not be rejected. Hence, it can be concluded that there is no problem of heteroscedasticity in the model.

Breusch-Godfrey Serial Correlation LM test is applied to check whether there is a problem of errors autocorrelation in the regression model.

Table 6: *Breusch-Godfrey Serial Correlation LM Test*

F-statistic	1.529103	Probability	0.168181
Obs*R-squared	17.83718	Probability	0.120724

Results of the test indicate that there is no serial autocorrelation in the model. This result was expected since estimated value of DW statistic is close to 2.

Finally, the correlation matrix of all explanatory variables is computed in order to check for the multicollinearity among the explanatory variables.

Table 7: Correlation coefficients matrix in the regression model

	D(CONSUM_BASK)	D(LOG(GDP))	UNEMP	IMP_EXP
D(CONSUM_BASK)	1.000000	0.010602	0.058631	0.247404
D(LOG(GDP))	0.010602	1.000000	-0.494622	-0.094548
UNEMP	0.058631	-0.494622	1.000000	0.267255
IMP_EXP	0.247404	-0.094548	0.267255	1.000000

All the correlation coefficients are lower than 0.50 leading to conclusion that multi-colinearity is not a problem in the estimated regression model.

The employed diagnostic tests revealed that the problems of misspecification, heteroscedasticity, autocorrelation and multicollinearity are not detected in the model. Therefore, the specification of the regression model need not be changed nor transformed; estimated regression coefficients are BLUE.

4. CONCLUSION

The goal of this paper was to estimate the regression model of inflation in Montenegro. The estimated model is an empirical evidence of the Philips curve i.e. theoretical trade-off between unemployment and inflation in a short run. The estimated values of regression coefficients are in accordance with theory. An increase in unemployment results in a decrease in inflation, while a rise in minimum consumer basket results in inflation rise. On the other side, rise of the GDP rate has negative effect on inflation causing it to fall, while the increase in import-to-export ratio results in inflation increase.

REFERENCES

- Drašković, V. (2008), *Politika ciljne inflacije: svjetska iskustva i crnogorske specifičnosti*, http://staro.rifin.com/root/tekstovi/casopis_pdf/ek_ec_581.pdf
- Enders, W. (2004), *Applied econometric time series*, John Wiley and Sons, 2nd edition
- Fabris, N., Kalezić, Z., Đuranović, M. „Obračun bazične stope inflacije“, http://www.cb-mn.org/slike_i_fajlovi/fajlovi/fajlovi_publikacije_radne_studije/obracun_bazicne_stope_inflacije.pdf
- Granger, C.W.J. and Newbold, P. (1974), „Spurious Regression in Econometrics“, *International Journal of Social Science*, Vol.5, No.1.
- Green, W.H. (2011), *Econometric Analysis*, Prentice-Hall, 7th edition.
- Gujarati, D. (2004), *Basic Econometrics*, 4th Ed., The McGraw-Hill, New York.
- Hamilton, J.D. (1994), *Time series analysis*, Princeton University Press, Princeton.
- Jovićić, M. (2002), *Ekonometrijski metodi*, CID, Ekonomski fakultet, Beograd.
- Kovačić, Z. J. (1995), *Analiza vremenskih serija*, Ekonimski fakultet, Beograd.
- Koutsoyiannis, A. (1997), *Theory of Econometrics: Introductory to Exposition of Econometric Methods*, 2nd edition., Macmillan Publishers Ltd, London
- Lipovina-Božović, M. (2013), „A Comparison of the VAR Model and the PC Factor Model in Forecasting Inflation in Montenegro“, *Economic Annals*, Vol. LVIII, No. 198.
- Madala, S.G. and Kim, I.M. (1998), *Unit Root, Cointegration, and Structural Change*, Cambridge University Press, New York.
- Mankiew, G. (2004), *Principi ekonomije*, CID, Ekonomski fakultet, Beograd.
- Mladenović, Z., Nojković, A. (2012) *Primenjena analiza vremenskih serija*, CID, Ekonomski fakultet, Beograd, prvo izdanje.
- Phillips, P.C.B. (1987), „Time Series Regression With Unit Root“, *Econometrica*, Vol. 55, No. 2.
- Jeffrey M. and Wooldrige, J.M. (2006) *Introductory econometric – A Modern Approach*, Thomson South-Western.
- <http://www.cb-mn.org>
- <http://www.monstat.org>

Author Guidelines

Submit to the journal

Submissions should be sent via email to: Professor Veselin Draskovic
veso-mimo@t-com.me

Review process

Each paper is reviewed by the editor and, if it is judged suitable for this publication, it is then sent to two referees for double blind peer review. The authors' names are anonymous to the reviewers. Based on their recommendations, the editor then decides whether the paper should be accepted as is, revised or rejected.

The Editorial Board retains the right to methodologically adjust the article to the journal propositions and standards of the English language, as well as not to consider articles which do not meet the requirements of these guidelines.

Copyright

Articles submitted to the journal should not have been published before in their current or substantially similar form, or be under consideration for publication with another journal. Use this in conjunction with the points below about references, before submission i.e. always attribute clearly using either indented text or quote marks as well as making use of the preferred Harvard style of formatting. Authors submitting articles for publication warrant that the work is not an infringement of any existing copyright and will indemnify the publisher against any breach of such warranty.

The author is responsible for ensuring the authenticity of data, facts, quotations and other information. The Editorial Boards may publish articles for discussion, without necessarily sharing the author's views.

Manuscript requirements

Please prepare your manuscript before submission, using the following guidelines:

Format

All files should be submitted as a Word document, A4 format, Garamond, font size 11 pt.

Article Length

Articles should be between 3000 and 10000 words in length. For long articles, compliance of editor-in-chief is required. Pictures, graphics and other attachments should be marked and sent as separate files, or in text, and must not exceed the journal format with margins.

Article Language

It is strongly recommended to send articles in the English language. However, upon the compliance of the Editorial Board, it is possible to publish articles in some of the other world languages. Authors from Montenegro and surrounding countries should submit articles both in English and mother tongue due to the bilingual nature of the website.

Article Title Page - An **Article Title Page** should be submitted alongside each individual article. This should include:

- **Article Title** - A title of not more six eight words should be provided.
- **Author Details** - Details should be supplied on the **Article Title Page** including: Full name of each author, Affiliation of each author, E-mail address of the corresponding author
- **Structured Abstract** - Authors must supply a structured abstract: Purpose, Methodology, Approach, and Findings. Maximum is 250 words in total.
- **Keywords** - Immediately after the abstract, provide a maximum of 6 keywords.
- **Article Classification** - The articles are classified in the following categories: original scientific paper, preliminary communication, review, professional paper, and book review.
- **Classification codes** - Please provide up to 6 standard JEL codes. The available codes may be accessed at JEL:  http://www.aeaweb.org/journal/jel_class_system.html

□ **Article structure** - The structure of article should comprise: the title, abstract, key words, introduction, subtitles, conclusion and bibliography. Articles can also be structured in the following way: introduction, starting hypotheses, solutions, discussion, conclusion and bibliography. Divide your article into clearly defined and numbered sections (1, 2,3, ...). Subsections should be numbered 1.1 (then 1.1.1, 1.1.2 ...), 1.2, etc. (the abstract is not included in section numbering).

□ **Footnotes** - Footnotes should be used as least as possible, and only for the necessary explanations, with the continuous use of Arabic numbers.

References

Literature is not to be numerated. It is to be arranged in alphabetic order of authors and chronologically for the articles of the same author. Literature is to be quoted according to the examples for books, magazines and other sources.

References to other publications must be in *Harvard style* and carefully checked for completeness, accuracy and consistency. You should cite publications in the text: (Ilic, 2009) using the first named author's name or (Ilic and Tot, 2009) citing both names of two, or (Tot et al., 2009), when there are three or more authors. At the end of the paper a reference list in alphabetical order should be supplied:

- *For books* Surname, Initials (year), *Title of Book*, Publisher, Place of publication.
e.g. Bagdikian, B. H. (1983), *The Media Monopoly*, Beacon Press, Boston.
- *For book chapters* Surname, Initials (year), "Chapter title", Editor's Surname, Initials, *Title of Book*, Publisher, Place of publication, pages.
e.g. Picard, R. G. (2005), "Money, Media, and the Public Interest", in Overholster, G., Jamieson, K. H. (Ed.), *The Press*, Oxford University Press, Oxford, pp. 337-350.
- *For journals* Surname, Initials (year), "Title of article", *Journal Name*, volume, number, pages.
e.g. Thacher, D. and Rein, M. (2004), „Managing Value Conflict in Public Policy”, *Governance* Vol. 17 No 4, pp. 457-486.
- *For published conference proceedings* Surname, Initials (year of publication), "Title of paper", in Surname, Initials (Ed.), *Title of published proceeding which may include place and date(s) held*, Publisher, Place of publication, Page numbers.
e.g. Draskovic, V., Grego, Z., Draskovic, M. (2011), "Media Concentration, Neoliberal Paradoxes and Increase in Virtuality", in *Media Concentration proceedings of the international conference in Podgorica, Montenegro 2011*, Elit, Podgorica pp. 33-45.
- *For working papers* Surname, Initials (year), "Title of article", working paper [number if available], Institution or organization, Place of organization, date.
e.g. Drašković, V. (2007), "Specificities and problems of Montenegrin transition", working paper, Leeds University Business School, TIGER, Warsaw, September.
- *For newspaper articles (authored)* Surname, Initials (year), "Article title", *Newspaper*, date, pages.
e.g. Miller, M. C. (1997), "The Crushing Power of Big Publishing", *The Nation*, 17 March, p. 10.
- *For newspaper articles (non-authored)* *Newspaper* (year), "Article title", date, pages.
e.g. *Vijesti* (2011), „The New Media“ 2 December, p. 5.
- *For electronic sources* If available online, the full URL should be supplied at the end of the reference, as well as a date that the resource was accessed.
e.g. Compaine, B. M. (2005), „The Media Monopoly Myth: How New Competition is Expanding our Sources of Information and Entertainment”, available at: http://www.NewMillenniumResearch.org/archive/final_Compaine_Paper_050205.pdf (accessed 10 december 2011).