A NEW ECONOPHYSICS MODEL TO STUDY HUMAN RESOURCES IN EUROPEAN UNION

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Abstract. *In this paper a new econophysics model of Human Resources evolution is proposed and discussed. For this purpose an analogy between the mechanical model especially the dynamic model and the Human Resources in European Union as regression function of second degree consideration is used. The model is tested on the values for the period 1990-2010.*

Keywords: *econophysics, mechanical dynamic model, regression functions, human resources.*

1. Introduction

Econophysics applies various models and concepts imported from condensed matter and statistical physics to analyze economic and financial phenomena. This new field of research has generated a lot of methodological debate (Schinckus, 2010a). It is often presented as a positivist discipline that provides a more empirical basis to economics .Despite the novelty of this new approach, more and more papers about econophysics have been published in journals devoted to Physics and Statistical Mechanics. Several meeting series dedicated to this topic are regularly organized and moreover, new Ph.D. programs in Econophysics recently appeared in some universities. Nowadays, Econophysics appears to be a new step in the history and the evolution of Physics Sciences and then the question about the disciplinary characteristics of Econophysics must then be asked (Schinckus, 2010a; Gallegati et.al, 2006; McCauley, 2006).

For the 1970s, a new theoretical movement has been initiated by some physicists who began publishing articles devoted to the study of social phenomena, such as the formation of social groups (Weidlich, 1971) or social mimicry (Callen&Shapiro, 1970). The next decade confirmed this new theoretical trend (labelled sociophysics), as the number of physicists publishing papers devoted to the explanation of social phenomena and the

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number of themes analysed continued to increase. During the 1990s, physicists turned their attention to economics, and particularly financial economics, giving rise to econophysics. Although the movement's official birth for example announcement came in a 1996 article by Stanley and his team (Stanley et. al., 1996), econophysics was at that time still a young field. Econophysics can be defined as "a quantitative approach using ideas, models, conceptual and computational methods of statistical physics". Today, econophysics is an institutionalized field, with different journals proposing a prolific literature about the way of characterizing the evolution of financial prices. There is an "extreme diversity" of models recently developed by econophysicists and many theoretical frameworks still emerge. (Bucsa et. al., 2011; Stanley et. al., 1996)

Econophysics presents itself as a new way of thinking about the economic and financial systems through the "lenses" of physics (Schinckus, 2010b). As much as neoclassical economics imported models from classical physics as formulated by Lagrange (Mirowski, 1989) and financial economics built on the model of Brownian motion also imported from physics, econophysics tries to model economic phenomena using analogies taken from modern condensed matter physics and its associated mathematical tools and concepts. Using the standard tools of statistical mechanics including microscopic models like Ising model and scaling laws, econophysicists aim at explaining how complex economic systems behave. Broadly speaking, econophysics is founded on general statistical properties that reappear across many and diverse phenomena. This statistical regularity can be characterized by scaling laws that are considered as the heart of econophysics (Bouchard, 2002; Staley et.al., 2000). These scaling laws can take a variety of forms. The objective of the next section is to offer a generic formula characterizing the main distributions usually used by econophysicists (Bucsa et. al., 2011).

The theories of Human Resources Management have the origin in United States of America (Brewster, 2004; Brewster, 1994). The management of Human Resources in particular has been heavily influenced by thinking in USA. The impact of the globalization was influenced on the way that people are managed, particularly in Europe Union (Brewster, 2004; Brewster, 1994). In human resources management (HRM), in particular is the US model of HRM one that will inevitably be followed in Europe? Our understanding of management in general and human resources management in particular has been heavily influenced by thinking in the United States of America. This is perhaps not surprising from a country that has been for decades the largest economy in the world.

HRM like many other aspects of management was originally conceptualized and developed in the United States of America. The study of personal management was partly a file clerk's job, partly a housekeeping job, partly a social worker's job and partly a fire-fighting to head of union trouble (Drucker, 1989). The American's theories about HRM would work anywhere in the world. Relationships between the structural characteristics of work organizations and variables or organization context will be stable across societies (Hickson et.all, 1974). Their main findings from cases in the USA, Canada and then UK were that companies are subject to the same relationships in terms of size, dependence on parent group and technology irrespective of country. Hickson et.al offered a culture free context of organization structure (Hickson et.al, 1974). Kidger appreciated that grew in isolation from the world economy are having their approaches supersede by universally applicable techniques (Kidger, 1991). Other models of Human Resources Management (HRM) are continually being developed. And the rhetoric at least of HRM has been spread to many other countries both in the theoretical discourse and within employing organizations. From the early days, there have been calls for comparative HRM, studying similarities and differences in management systems and the way people are managed in different countries (Brewster, 2004; Brewster, 1994; Redding, 1994). Whether the US derived visions of Human Resource Management (HRM) apply everywhere in the world is an important question for both theory and practice since following US prescription in either area may be detrimental if theories are not transferable, for example, the need for a contingent approach encompass cultural, sectorial and regional differences. Similarly, other theorists have also argued for the need to cover both national differences and organizational contingencies, although they have used different terminologies: macro economy, micro economy (Gronghaug, 1992) exogenous, endogenous (Brewster, 2004; Brewster, 1994), external and internal variable (Morley, 2004). How the theory applies particularly to the European setting remains a conceptual and empirical challenge. One problem is that the complications noted above make research difficult and there is a scarcity of empirical data (Brewster, 2004; Brewster, 1994). Despite these theories and the complexities of understanding different national contexts geographical differences are apparent, and the effort to understand them is important. There are a number of critical differences between the North American context and the European (Brewster, 1994). Such a comparison involves substantial generalization. We must remain aware of the substantial differences of the substantial differences within

North America, even within individual states in the USA and the differences between European countries (Nicolov, 2011).

Present paper will present a new econophysics model for modelling the human resources of the European RDI sector, especially for EU15 respectively EU25. The new econophysics model will be a dynamic one.

2. The Dynamic Model

In figure 1 we can see the point *M*, represented in a Cartesian coordinate system OXYZ by the position vector: $\overrightarrow{r_M}$. Each coordinate axis corresponds to a line unit vector called: $\vec{i}, \vec{j}, \vec{k}$ are the unit vectors of the coordinate axes and axes and property meaning: $|\vec{i}| = |\vec{j}| = |\vec{k}| = 1$ (Nicolov, 2009).

Position vector of point *M*1 has analytical expression:

$$\vec{r}_1 = r_x.\vec{i} + r_y.\vec{j} + r_z.\vec{k}.$$

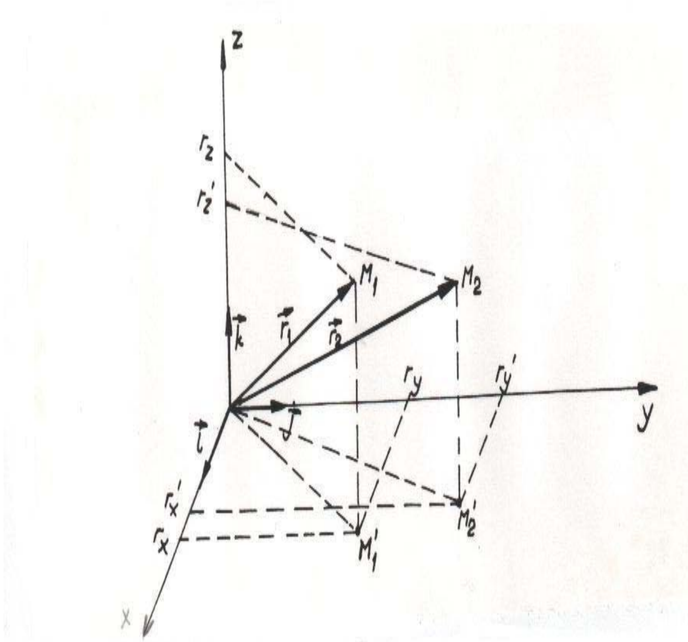

Figure 1. Cartesian coordinate system. (Nicolov, 2009).

Since the coordinates *rx*, *ry* and *rz* can depend on time, we can write the following parametric equations: $r_x = r_x(t)$, $r_y = r_y(t)$, $r_z = r_z(t)$. Elimination of parametric equations leads to the trajectory equation: $z = z(x, y)$.

If a material point moves from point M_1 to point M_2 by using *a* path *c*, its position vector of time-varying r_1 to r_2, the analytical expression:

$$\vec{r}_2 = r'_x.\vec{i} + r'_y.\vec{j} + r'_z.\vec{k}.$$

Velocity of the material point in the Cartesian coordinate system by definition is expressed as:

$$\vec{v} = \frac{d\vec{r}}{dt} = \dot{\vec{r}} = \dot{r}_x \cdot \vec{i} + \dot{r}_y \cdot \vec{j} + \dot{r}_z \cdot \vec{k}.$$

So we can write the following relations:

$$v_x = \dot{r}_x = \frac{dx}{dt};\ v_y = \dot{r}_y = = \frac{dy}{dt};\ v_z = \dot{r}_z = \frac{dz}{dt}.$$

According to the definition, the acceleration of the material point is given by: $\vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{r}}{dt}.$

Force acting on the material point is a Newtonian type force. Knowing the material point mass (m) and applying Principle 2 of Newtonian mechanics, we have the relations:

$$\vec{F} = m \cdot \vec{a} \text{ or } \vec{F} = m \cdot a_x \cdot \vec{i} + m \cdot a_y \cdot \vec{j} + m \cdot a_z \cdot \vec{k}.$$

Knowing his position vector of a material point, i.e. trajectory equation and parametric equations, one can determine the speed, acceleration and type of force acting on it. Knowing the type of force acting on the material point trajectory equation can be determined that he is travelling based on the forces acting: $\vec{F} = m \cdot \vec{a}; \vec{a} = \frac{\vec{F}}{m}.$

If acceleration is shaped as $\vec{a} = \frac{d\vec{v}}{dt}$, separate variables: and then we make the integration by using initial conditions and then we obtain: Speed Law: $\vec{v} = \vec{v_0} + \int_{t_0}^{t} \vec{a} \cdot dt.$

Given the definition of velocity: $\vec{v} = \frac{d\vec{r}}{dt}$ and, separate variables are $d\vec{v} = \vec{a} \cdot dt,$ we make the integration by using initial conditions and obtained the law of motion: $\vec{r} = \vec{r_0} + \int_{t_0}^{t} \vec{v} \cdot dt.$

If we write on the 3 axes are called parametric equations:

on Ox: $x = x_0 + \int_{t_0}^{t} v_x \cdot dt$; on Oy: $y = y_0 + \int_{t_0}^{t} v_y \cdot dt$; on Oz: $z = z_0 + \int_{t_0}^{t} v_z \cdot dt$.

By eliminating the parametric equations of the trajectory equation we obtain:

$$z = z(x, y) \Rightarrow \vec{r} = x \cdot \vec{i} + y \cdot \vec{j} + z \cdot \vec{k}.$$

3. Results

In the present paper is studied the determinants indicators for European competitiveness by linking RDI indicators from the next databases: EIS2004, EIS2005, IUS2010, IUS2011.

The IUS2010 contain a list of 25 indicators that captures national performance CDI. 19 indicators were carried over from the previous EIS 009 and 12 indicators were not modified, two indicators were combined and 5 indicators were partially modified by using broader or narrower definitions or different names. Considering the merging of 2 indicators, 18 indicators from IUS2010 are equivalent to those of EIS2009 and in addition were introduced seven new indicators. IUS uses the most recent statistics from EUROSTAT and other internationally recognized sources as available at the time of analysis.

IUS2011 distinguishes between three main types of innovation indicators on 8 dimensions, for a total of about 25 different indicators. Input key factors in the analysis of external innovation performance of firms covering the three dimensions of innovation are: human resources, open, excellent and attractive research systems, finance and support. Business activities relate to the company's innovation efforts, grouped into three dimensions of innovation are as follows: investment firms and spirit connections entrepreneurial and intellectual assets. Output factors related to effects on innovation activities of firms in innovation have 2 sizes: Innovators and economic effects. These are indicators for presenting the performance of RDI. Some indicators of innovation at EU level, such as public spending on RDI, can be more easily influenced by policy interventions than others, such as private innovation SMEs.

It is deal in the next part with Science and engineering graduates aged 20-29 per 1,000 inhabitants, for EU15 respectively EU25.

Science and engineering graduates aged 20-29 (per 1,000 inhabitants) (‰) (Source EIS2004, EIS2005) is defined as all post-secondary education graduates belongs to ISCED 5A with and above in life sciences (ISC42), physics (ISC44), mathematics and statistics (ISC46) engineering calculation (ISC48) and engineering trades (ISC52), production and processing (ISC54), architecture and building (ISC58) (Canberra Manual, 1995). Population reference was for age groups between 20 and 29 years inclusive. This indicator is a measure of the supply of graduates in science and engineering education. Due to problems of comparability of educational qualifications in various parts of the EU countries, this indicator uses broad categories of education. This means that it covers everything from graduate degree. A broad coverage can also be an advantage, because even a year graduates of programs are valuable for incremental innovation in manufacturing and services.

In 2004 EIS the data are recorded from the period 1993-2004.We have the only valid data for these indicators for the period 1997-2002, for represented category EU15 and EU25. So, for the case of EU15 recorded values was 10.3 ‰ in 1997, a figure which increased to 12.47 ‰ in 2002. These values can vary for EU25 between 9.28 ‰ and 11.49 ‰.

In table 1 and figure 2, we can see the Human Resources modelling.

Table 1.
Human Resources modelling

Science and engineering graduates aged 20-29 (per 1,000 inhabitants) (‰) (EU15)	$Y_{EU15(SE)} = 0.10x^2+0.310x+7.449$
Science and engineering graduates aged 20-29 (per 1,000 inhabitants) (‰) (EU25)	$Y_{EU25(SE)} = 0.10x^2+0.311x+8.468$

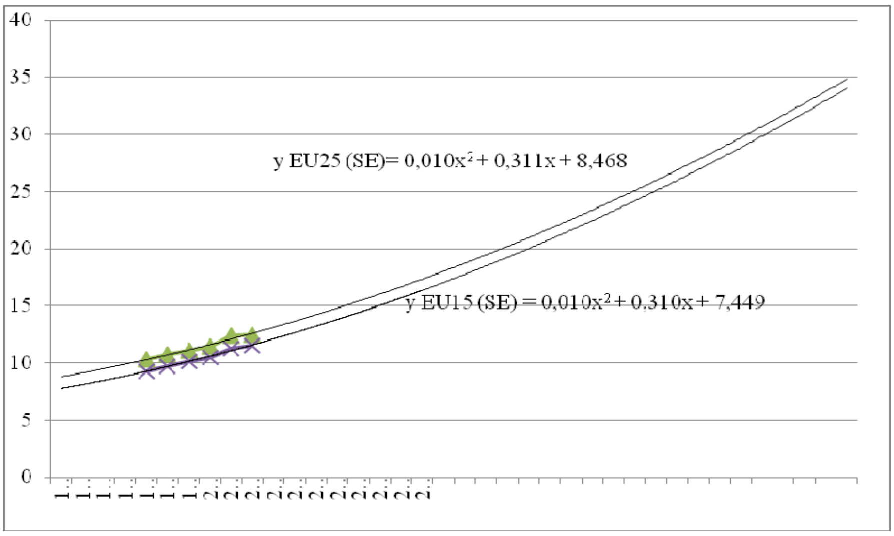

Figure 2. Modelling Human Resources for European Union for the period 1990-2010 and for the next 20 years.

We can see from here that the curves which represent HR modelling are as follows:

- For the case of EU15 of science and engineering graduates aged 20-29 per 1,000 inhabitants represented in ‰ is:

$$Y_{EU15(SE)} = 0.10x^2+0.310x+7.449.$$

- For the case of EU25 of science and engineering graduates aged 20-29 per 1,000 inhabitants represented in ‰ is:

$$Y_{EU25(SE)} = 0.10x^2+0.311x+8.468.$$

4. Conclusions

From the present study of the indicators in the modelling used for the last 20 years and the next 20 years we can see that the majority observe an accelerated trend which respect the econophysics dynamic model presented above, the individual trajectories for each indicator.

In the study of human resources can draw the following conclusions: equations generated to characterize the evolution and future trends for each studied case are all second degree equations similar to parametric equations of econophysics model already presented. It is noted that the equations that characterize the development of human resources are generated by a set of differential equations of the form $y = AX^4 + BX^3 + CX^2 + Dx + E$, which by differentiating twice even give equations obtained. These equations characterize a dynamic phenomenon in accelerated system.

Most of the previous studies were performed on samples of firms in each country while this study is estimated on a sample consisting of EU15, EU25. Our sample size is different from the samples used by other authors. The difference can also be attributed to the choice of explanatory variables. In addition, input data on innovation and firm size, previous studies have simulated the output of RDI studies on depending on the demand side and technological factors, sources of information for innovation, cooperation models and firm specific characteristics, such as age, existence RDI facilities from the impact of change on performance management (Hashi & Stojcic, 2012). Hashi and Stojcic results presented in their paper in 2012, confirms the shape model introduced in this study (Hashi & Stojcic, 2012).

REFERENCES

[1] Bouchaud J.-P. (2002), An Introduction to statistical finance, Physica A 313 (1), 238-251.

[2] Brewster C. (1994), European HRM: reflection of, or challenge to the American Concept? In P. S. Kirkbride Ed., *Human Resource management in Europe*, London, Routledge.

[3] Brewster C. (2004), European perspectives on human resource management, *Human Resource Management Review,* 14, 365-382.

[4] Bucsa G., Jovanovic F., Schinckus C. (2011), A unified model for price return distributions used in econophysics, Physica A 390 3435-3443.

[5] Callen E., Shapiro D. (1974), A theory of social imitation, Physics Today 12(2) (1974) 23-28.

[6] Canberra Manual (1995), The measurement of scientific and technological activities manual on the measurement of human resources devoted to Science & Technology organization for economic co-operation and development, OECD and ECSC-EC-EAEC, Brussels-Luxembourg.

[7] Drucker P. (1989*),* The new realities: In government and politics, in economics and business, in society and world view. New York: Harper & Row.

[8] Fagerberg J. Srholec M (2008), *National Innovation Systems, Capabilities And Economic Development*, Research Policy 37 (2008) 1417-1435

[9] Fagerberg J. (1996), *Competitiveness, Scale and R&D*, No 1996545, Working Papers Archives from Centre for Technology, Innovation and Culture, University of Oslo, http://EconPapers.repec.org/RePEc:tik:wparch:1996545,

[10] Gallegati M., S. Keen, T. Lux, Ormerod P. (2006), *Worrying trends in econophysics*, Phys. A 370, 1-6.

[11] Hashi, I., Stojcic, N. (2012), The impact of innovation activities on firm performance using a multi-stage model: Evidence from the Community Innovation Survey 4. Res. Policy (2012), http://dx.doi.org/10.1016/j.respol.2012.09.011.

[12] Hickson D., Hinnings C. R. McMillan & J. P. Schwitter (1974), The culture – free context of organization structure: A tri national comparison, *Sociology,* 8, 59-80.

[13] http://www.proinno-europe.eu/metrics

[14] Kidger P. J. (1991), The emergence of international human resource management, *International Journal of Human Resource Management*, 2(2) 149-163.

[15] Lam A. (2006), *Organizational Innovation*, pag.115-147, in The Oxford Handbook of Innovation edited by Jan Fagerberg, D. Mowery, Richard Nelson, O.U.P, New York.

[16] Lam A., Lundvall B. (2008), *The Learning Organisation and National Systems of Competence Building and Innovation*, Online at http://mpra.ub.uni-muenchen.de /12320/ MPRA Paper No. 12320.

[17] McCauley J. (2004), *Dynamics of Markets: Econophysics and Finance*, Cambrigde University Press, Cambrigde.

[18] McCauley J. (2006), Response to `worrying trends in econophysics', Physica A 371, 601.

[19] Mirowski P. (1989), More Heat Than Light: Economics as Social Physics, Physics as Nature's Economics, Cambridge University Press, Cambridge, New York.

[20] Morley M. J. (2004), Contemporary debates in European Human Resource Management: Context and content, *Human Resource Management Review*, 14 353-364.
[21] Morten Berg Jensen, Bjorn Johnson, Edward Lorenz, Bengt Ake Lundvall (2007), *Forms of knowledge and modes of innovation*, Research Policy 36, pp. 680-693.
[22] Mowery D, Sampat B (2006), *Universities in National Innovation System*, pp. 209-239, in The Oxford Handbook of Innovation edited by Jan Fagerberg, D. Mowery, Richard Nelson, Oxford University Press, New York.
[23] Narula R, Zanfei A. (2006), *Globalization of Innovation: The Role of Multinational Enterprises*, pp. 318-347, in The Oxford Handbook of Innovation edited by Jan Fagerberg, D. Mowery, Richard Nelson, Oxford University Press, New York.
[24] Naubahar S. (2006), *Emergence and development of the National Innovation Systems concept*, Research Policy, 35, 745-766.
[25] Nicolov M. F. (2009), *Physics for Engineers (in Romanian)*, *Aurel Vlaicu* University Publishing House, Arad.
[26] Nill Jan, Kemp René (2009), Evolutionary approaches for sustainable innovation policies: From niche to paradigm?, Research Policy, **38,** 668-680.
[27] Redding S. G. (1994), Comparative management theory: Jungle, zoo or fossil bed?, *Organization St.*, 15, 323-359.
[28] Rickles D. (2008), *Econophysics and the complexity of the financial markets*, in: J. Collier, C. Hooker (Eds.), Handbook of the Philosophy of Science, in: Philosophy and Complex Systems, vol. **10,** North Holland, Elsevier Editions, New York.
[29] Schinckus C. (2010a), Is econophysics a new discipline? The neopositivist argument, Phys. **A** 389, 3814-3821.
[30] Schinckus C. (2010b), *Econophysics and economics: sister disciplines?* Am. J. Physics 78 **(1),** 325-327.
[31] Stanley Eugene, Nunes Amaral, et al. (2000), *Econophysics: what can Physicists contribute to Economics?* International Journal of Theoretical and Applied Finance 3 (3), 335-346.
[32] Stanley H., Afanasyev V., et al. (1996), Anomalous fluctuations in the dynamics of complex systems: from DNA and physiology to econophysics, Physica A, 224 **(1),** 302-321.
[33] Weidlich W. (1971), *The statistical description of polarization phenomena in society*, British Journal of Mathematical and Statistical Psychology, 24 **(1),** 251-266.