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Technological revolution, labor markets and income distribution in the knowledge economy

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Abstract. *The concept of knowledge-based economy is a new model of economic development.*
In this article I am analyzing the defining elements of the knowledge economy in Europe and Romania, in terms of the technological revolution, the labor market and income distribution.
In order to perform this analysis, I will use the following economic indicators: the scientific research spending, the number of patents and the Gini index. To effectively compare the economic indicators that define the knowledge economy in the EU and in our country, I will test a series of econometric equations that describe the correlations between the Gini indexes and the determinant factors of the technological progress. Due to the complexity of interactions there will be used autoregressive tools. The comparison of the different forms of econometric estimation will take into consideration the results of similar studies in the literature, respectively the specific conditions in Romania. There will be analyzed the implications of new technologies on labor market and the income dynamics in the Romanian economy. On the other hand, there will be taken into account the impact of the current global economic crisis on the economic indicators analyzed.
The conclusions of the analysis will be reported to the requirements of the EU's strategic programs, in particular the "Europe 2020".

Keywords: technological revolution, knowledge based economy, economic crisis.

JEL Classification: 8E, 18D, 20B, 20I.

1. Introduction

The foundation of the knowledge economy concept was created by Peter Drucker.

In 1966, he described the difference between the manual worker and the knowledge worker: a manual worker uses his hands to produce "things", and a knowledge worker uses his intelligence to produce ideas, knowledge and information.

The "knowledge of economy" is a concept that can define a "knowledge economy", this focusing on the production and management of knowledge, or "knowledge based economy", which refers to the use of tools to produce economic benefits (Drucker, 1969).

The phrase was popularized by Peter Drucker in his book The Age of Discontinuity (Drucker, 1969). A key principle used is that education and knowledge are considered productive assets of a business, as they are the primary elements valuable in making a product or service.

The difference between the two perspectives comes from how the knowledge is perceived: product (knowledge economy) or instrument (knowledge based economy). This difference does appear only in theory. Both approaches are interdisciplinary, involving economists, programmers, IT engineers, mathematicians, chemists, psychologists and sociologists.

The knowledge economy is a component of the knowledge society. Thus it is ensured that the change rules and practices are applied successfully in the industrial economy. The safety of life and cultural diversity indirectly influences the economic environment. They provide optimal conditions for the development of education and thus of science. Therefore, education and science are areas whose development has a direct impact on the economy based on knowledge.

The entrepreneur is the mediator, who will turn invention into innovation. Innovation depends on the emergence of new social needs - economic. To become innovation, invention must be accompanied by research on how to use, so costs are minimal. It is therefore necessary to have some contractors who provide value an invention to meet a social need. (Roşca et al., 2006)

Also, another aspect that you should understand very well, is the human cost that it involves innovative transformations. Justify this idea from Joseph Schumpeter's statement quoted in Harry: "Innovation is really a process of creative destruction" (Harry, 2006, p. 18).

Technological revolution supports the development of the knowledge society, which, however, can mean the destruction of social relationships. In this context, the question arises: "Is there no risk of destabilization an entire generation for the name changes?"

2. Literature review

A widely accepted fact is that today we live in an era of economic globalization, technological revolution and new technology-based communication.

Based on these processes, the Lisbon Treaty indicate the need to modernize deep and competitive European economy and establishing, among others, the ambitious goal of building by 2010 a knowledge-based society.

The EU industrial policy objective is to increase the competitiveness of European industry so that it can maintain its role as drivers of sustainable growth and employment in Europe.

As described in the introduction the knowledge based economy is a relatively new concept in economics. The technological revolution and the income distribution also have a major impact on the development of this type of economy.

The revolution is defined in the Explanatory Dictionary of the Romanian Language as a "step in developing the profound social changes that occur in all areas of life. "Technology as defined in DEX is "the ensemble of processes, methods, operations etc. used to obtain a product". If we combine the two definitions in order to find out what is the technological revolution we would come to the conclusion that it is a "process that determines contemporary radical changes in the productive forces, the accelerated development of science and technology, by improving technological processes".

The technology has an important role in the information transfer and the age we live in is accelerating this process. This transfer is important because information, material-immaterial realities through combination, hierarchy and organization are the "basic human intrusion into the world without and within." (Stoica, 1997)

Information is not knowledge, but knowledge can be built only on a foundation based on information.

The concept of information society has been regarded as an invention of computer scientists and computer manufacturers in order to sell their products. The initiative our Government had by making a bid for all kinds of computer products shows that the information society is "an essential structure, the only way to bring the values of humanity and global requirements in each social group and each individual and the path to efficient solutions for solving problems or production resources." (Stoica, 1997)

The information society helps to solve problems of social conscience, such as those from professional or coagulated human relations in chat sessions or discussion groups on various topics such as love or friendship.

Working in frontier areas of information technology means working to streamline the transfer of information, and in this case the man redesigned information systems. Information is knowledge; knowledge is power and the ability to plan for the future. The future has a size based on the information and the best way to get into it is when you combine what we know and what we hope or want to achieve.

As the progress in science and technology revealed the limits of scientific rationalism as a method of validation of knowledge and proved that "information revolution" does not show a clear causal link, supported by logic between technological change and social change, the new company started to be called "knowledge society", based on

reconsidering the type of knowledge that underpins the economic and social development. (Roşca and Cotigaru, 2006)

Joseph Stiglitz has developed the concept of "knowledge economy". (Stiglitz, 1999) He believes that in the process of reducing the "knowledge gap", the investment in the most advanced technologies matters, but what is more important is the cultural and institutional change, including changing the way to think of individuals, the effort to develop their skills and confidence in using their own powers. "It's hard to describe this change: an acceptance of change, the recognition that the poverty in which they lived centuries was neither inevitable nor necessary and recognition of the centrality of knowledge and education in general and in particular science and technology". (Stiglitz, 1999)

In the past students' participation in class was equivalent to a full-time job. Students were helped by family or scholarships and loans, the students who had jobs were few. Today, most students work to pay their education and living expenses. Precisely for this reason the students' time for study is low so maybe they will require a longer period of time till they graduate.

In order to ease this problem with the studies we have technology. Today many universities facilitate the learning process through the use of computer and an Internet connection.

In some European universities the courses are conducted online via video chat, in Romania some teachers use computer presentations that they send to their students afterwards so that even those who cannot attend the classes have the materials needed for study.

3. Analysis

In my analysis in order to see the impact of technology on income distribution on the labor market in the knowledge based economy I used: the scientific research expenditure, the number of patents and the Gini index. These economic indicators were correlated using a panel data model because:

"The panel has a two-dimensional structure –it includes data with a dimension in time and an individual dimension. Each observation (y_{it}) corresponds to some specific units (individual) i, i = 1, ..., N, in a given time t, t = 1, ..., Ti, where N is the number of units recorded and T_i is the number of records in time realized for the i unit.

Eg. The unemployment Alba, Arad, ... 2014-January, February, ... " (Baltagi, 2005)

In my case I found y_{it} record on unit i at time t and k explanatory variables $x_{1;it}$, $x_{2,it}$, ..., $x_{k;it,}$ where i represents the country in my analysis I chose to do the analysis, t the period from 2003 to 2012, k the 28 countries under consideration.

I chose this model because in this analysis I could clearly highlight the advantages of using data for Panel:

- It allows the analyze of individual dynamics and the effects of ordering through time of the events (separation of individual effects and /or in time).
- It allows the control of heterogeneity that is induced by the invariant variables over time, or in the transverse structures, whether these variables are observable or not (dormant).
- The models make it possible, for example, to do a better examination of the dynamics of adjustment and allow the study of more complex behaviors.
- Econometric the number of comments, meaning the degrees of freedom increase, which leads to an increase of the power tests, of the consistency and efficiency of estimators and reducing the collinearity between variables. Is also reduced or eliminated the distortion induced by the aggregation activities, the companies or individuals. (Baltagi, 2005)

Of all the types of analysis models the best one that fits this situation represents the individual random effects model because:

- the records are randomly selected from a population of size; Most often, the information is available only for the samples and not for the entire population;
- the sample size (N) is high;
- the number of records in time (T) is relatively small.

In terms of the income inequality analysis we used two explanatory variables: the scientific research spending and the number of patents. To measure the income inequality we used the Gini index.

Most of the existing studies in the literature have concluded that the costs of scientific research have led to an uneven distribution of income in the host countries. These expenses can promote the income inequality by lowering wages of unskilled workers compared to those qualified.

The level of development (GDP per capita) is used in the model because the income inequality depends on the country's economic structure, which is related to the level of development.

The level of education holds especially for the supply side of the labor market. Clearly, the higher the wage inequality is the bigger the qualification bonus is, thus increasing the pressure on education to produce more skilled workers. We expect a higher tuition rate to increase the supply of skilled workers. This in turn should reduce wage inequality by increasing the supply of highly qualified labor force.

The basic form of the estimated model is:

$$GINI_{it} = b_0 + b_1 * RD_{it} + b_3 * GDP + b_2 * PAT_{it} + \alpha_i + \varepsilon_{it}$$

where RD is spending on scientific research and PAT number of patents, GINI is a variable used in the testing of income inequality.

The analysis covers the period 2003-2012 and uses data for the 28 Member States of the European Union. The main data sources were Eurostat database and the World Bank.

The number of patents reflects the work of a country in terms of innovation. Patents also indicate a country's ability to exploit information and translate it into potential economic gains. In this context, the indicators based on patent statistics are widely used to assess the inventive performance of countries.

About the European Union

In the empirical analysis we tested the correlation between the Gini index of GDP, with the number of patents and R & D expenses. As for the econometric equation with all the 3 influencing factors (GDP, patents, R & D) has not proved to be consistent, I correlated separately the intensity of the correlation on each factor.

The influence of GDP on income inequality

The var analysis on the panel of all the countries from the U.E. reveals the following econometric equation:

GINI_EU28 = 39.21569882 + 1.031320975*GINI_EU28(-1) - 1.324771447*GINI_EU28(-2) - 0.01773378415*GDP_EU28(-1) - 0.07068614028*GDP_EU28(-2)

We can observe an oscillatory dynamics of the Gini index on the 2 lags, respectively a strong inertial tendency (the attached coefficients for the lag 1 and 2 are more attached than the influence of the GDP). Instead the GDP has a significant influence in regard to the statistical tests, both the coefficients attached to the two lags having negative values. This means that the EU countries are situated on the right side of the Kuznetz curve. In other words the EU as a whole represents a developed economic and social area in which the growth of the macroeconomics results is accompanied by lowering the inequality of income distribution.

The explicit form of the autoregressive vector shows us that the inverse correlation between Gini and GDP is strong but fluctuating and with a low-trust degree.

The influence of the number of patents on income inequality

This econometric equation still reveals the oscillating and inertial tendency of the Gini index dynamics.

GINI_EU28 =60.45054391 + 1.634621694*GINI_EU28(-1) - 2.438822905*GINI_EU28(-2) - 6.564619968e-005*PAT_EU28(-1) - 3.990077599e-005*PAT_EU28(-2)

In terms of the intensity correlation of the number of patents with the Gini index we can observe that the influence is very low (6.56×10^{-5} or 3.9×10^{-5}, the coefficients of the 2 lags) and with a degree of very low confidence. What is interesting is the meaning of the correlation, this indicating a negative relationship on both lags which would mean a very small contribution to the increase of this indicator to the increase in the income inequality.

Influence of the R & D expenditure on the economic development

It can be seen that the costs of research and development have the greatest impact on income inequality (the attached coefficients 1.25 on the lag 1 and 4.55 on the lag 2 compared with the previous equations, significantly exceeding the coefficients attached to the lags of the Gini index).

GINI_EU28 = 58.31604935 - 0.6750831353*GINI_EU28(-1) - 0.6141033486*GINI_EU28(-2) + 1.250421013*RD_EU28(-1) + 4.549608398*RD_EU28(-2)

Moreover the signs of the coefficients of the 2 lags show that the upward dynamics of the two charges contribute to a significant increase in income inequality (especially on the lag 2).

This trend is explained by the fact that the investment in research and development is accompanied by structural changes in the labor market for highly skilled professions, where wage levels are high.

This phenomenon clearly proves the strong transition of the EU countries to the stage of an economy of knowledge.

About Romania

In which regards Romania we can see that our country is part of the overall trends in the EU. However there are certain peculiarities in the manifestation of the dynamic determinants of the income inequality examined above.

The GDP influence on income inequality in Romania is given by the following econometric equation:

GINI_RO =18.64680575 + 0.6478218051*GINI_RO(-1) - 0.2003762412*GINI_RO(-2) + 0.1005925099*GDP_RO(-1) - 0.03403098932*GDP_RO(-2)

This equation shows a lower inertia trend of the Gini index with respect to the one revealed for the whole EU (the attach coefficients are 0.647 for the first lag and 0.200 for the second lag), but the oscillating trend remains. Moreover the Student test shows a high failure rate for the two coefficients of the two lags for the Gini index. This indicates a transient state regarding the stability on income distribution in Romania. This transient state is observed in terms of the GDP influence, positive on the first lag (0.100) and negative on the second lag (-0.03). Under these conditions the tendency of the EU developed countries of diminishing the income inequality based on the measure of the GDP growth in Romania is still unclear.

The influence of the number of patents on income inequality in Romania is described by the following econometric equation:

GINI_RO = 20.10726118 + 1.007314383*GINI_RO(-1) - 0.5943399469*GINI_RO(-2) - 0.2387560581*PAT_RO(-1) + 0.2502758673*PAT_RO(-2)

This time the inertial tendency of the Gini index is clearer and more pronounced (the first coefficient is 0.007 and the second coefficient is -0.59, with much higher probabilities of

guarantee). As for the influence of the number of patent the trend at European level persists with a slight tint on further increasing the likelihood coefficients and guarantee of results.

The influence of R & D expenditures on the Gini index in Romania is described by the following equation:

GINI_RO = 28.27236148 + 0.3859320818*GINI_RO(-1) - 0.5245432193*GINI_RO(-2) + 21.39889129*RD_RO(-1) + 0.3017684252*RD_RO(-2)

This time it returns to the weak inertia trend of the Gini index (coefficient 0.385 on the first lag and -0.524 on lag 2) but this confirms the positive influence trend of R & D expense reported for the whole EU. Moreover the associated coefficient with the first lag is unusually high (21.39) this indicating significant modern technology transfers to Romania accompanied by unprecedented structural changes in the labor market in our country.

4. The Europe 2020 Strategy

Regarding the Europe 2020 Strategy this should focus on three priorities:

- Smart growth - developing an economy based on knowledge and innovation.
- Sustainable growth - promoting a more efficient economy in terms of resource use, greener and more competitive.
- Inclusive growth - promoting an economy with a high rate of employment, able to ensure economic, social and territorial cohesion.

These three priorities are mutually reinforcing and provide an overview of Europe's social market economy for the twenty-first century.

A single stronger market, deeper and more comprehensive is vital for growth and job creation. However, the current trends show signs of lower integration and disenchantment regarding the single market. The crisis has added temptations of economic nationalism. The vigilance of the Commission and the sense of responsibility they showed; all Member States have prevented a drift towards disintegration. However, it requires a new momentum - a genuine political commitment - to relaunch the single market by the rapid adoption of the initiatives mentioned above. Such political commitment will require a combination of measures to fill the gaps in the single market.

Every day businesses and citizens are faced with the persistent reality of the bottlenecks which affects the cross-border activities despite the legal existence of the single market. They realize that the networks are not sufficiently interconnected and that the enforcement of single market remains uneven. Often, for the same transaction, businesses and citizens still need to deal with 27 different legal systems. While our companies still face the daily reality of fragmentation and diverging rules, their competitors from China, the US or Japan can fully beneficiate from the strength they were given by their large home markets.

The single market was conceived before the arrival of Internet, before information and communication technologies became one of the main drivers of growth and before services became such a dominant part in the European economy. The emergence of new services (e.g. in areas such as content and media, health, smart energy measuring) shows huge potential, but Europe will only exploit this potential if it overcomes the fragmentation that currently blocks the flow of content online and access of consumers and businesses.

To gear the single market towards the objectives of the Europe 2020 Strategy it is necessary to have functioning and properly connected markets, where competition and consumer access can stimulate growth and innovation. On the basis of the Directive regarding services there must be created a single market that must ensure in the same time the quality of service provided to consumers. The full implementation of the Directive regarding the services could increase by 45% the volume of trade in trade services and foreign direct investment by 25%, resulting in an increase in GDP of between 0.5% and 1.5%.

5. Conclusions

This article analyses the relationship between the income inequality and the investment in R & D and the number of patents for the period 2003-2012 relative to the strategy "Europe 2020".

The results obtained at the level of the 28 European Union countries and in our country clearly show a pattern similar to the developed countries and those developing in terms of the investment in research and development has a direct influence over the GDP. I found a nonlinear effect: short-term income inequality is increasing with the increasing investment in R & D, but this effect diminishes over time with continued growth of these investments.

The increases in GDP per capita are associated with reductions in income inequality in all analyzed countries. This is an important result because one of the main targets of European policies is to increase the standard of living, thus increasing GDP/capita. Another major objective is to reduce income inequality. This study shows that these two objectives are not divergent; on the contrary, the policies concentrated on the increase of the individual welfare will result in a more equitable income distribution.

Another important conclusion is that research has a strong impact on income inequality. Although income inequality is a complex problem that requires multiple solutions, the policies relating to investment in this segment are among the most powerful levers available to countries in order to reduce inequality in the future. It is also clear that people with higher levels of education have a competitive advantage in the labor market in both good economic times and in bad. Therefore, policies that focus on achieving a higher level of education aimed at ensuring better jobs and, over time, could reduce income inequality.

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